OG-Anatomy is a simplified compilation of core gross anatomy designed for undergraduate medical students. It is also useful for dental, nursing, pharmacy, biomedical science, and postgraduate students specializing in surgical fields.The content follows a regional approach and each region is organized into objectives, anatomical facts, clinical notes and review questions

Click on body region to view content

Lower Limb | Upper Limb & Back | Head & Neck | Neuro anatomy | Thorax | Abdomen | Pelvis & Perineum

Region Explorer: Lower Limb

- **Gluteal region**
- **Organization of the thigh**
- **Hip joint**
- **Popliteal fossa**
- **Knee joint and related structures**
- **Leg and dorsum of the foot**
- **Ankle joint**
- **Foot**

Region Explorer: Upper Limb and back

- **The back and scapula region**
- **The pectoral region and axilla**
- **Shoulder joint and arm**
- **Cubital region, elbow joint and forearm**
- **The hand and wrist joint**

Region Explorer: Head and Neck

The Skull and Scalp

The Orbit, Eyeball and Face

Cervical Fascia and posterior triangles of the neck

The anterior triangle and root of neck

The temporal, parotid, infratemporal and submandibular regions

The oral cavity and pharynx

The nasal cavity and paranasal sinuses

The Larynx and the ear

Region Explorer: Neuroanatomy

Region Explorer: Thorax

- The Chest wall, pleura and lungs
- The superior mediastinum
- The middle mediastinum, heart and pericardium
- The posterior mediastinum, posterior thoracic wall and verterbrocostal articulations

Region Explorer: Abdomen

- Anterior abdominal wall
- The peritoneum
- Organs of the supracolic compartment
- The Intestines
- Retroperitoneal organs
- Blood supply and lymphatic drainage of GIT
- Posterior abdominal wall and thoracic diaphragm

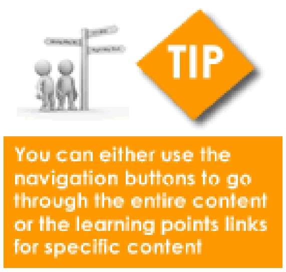
Region Explorer: Perineum

- Organization of the perineum
- Male and female external genitalia
- Summary of Pelvic viscera
- Blood supply, innervation and lymphatic drainage of pelvic viscera

Gluteal region

Learning points

1. Parts and subparts of the pelvic bone and proximal femur
2. Extents, landmarks and cutaneous innervation of the gluteal region.
3. Attachments, innervation and actions of the 3 large gluteal muscles
4. Attachments, innervation and actions of the 6 short gluteal muscles
5. Nerves of the gluteal region
6. Formation and contents of greater and lesser sciatic foramina.
7. Root value, course, relations and distribution of sciatic nerve
8. Formation and location of the cruciate and trochanteric anastomoses.
9. Applied anatomy of the gluteal region



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Organization of the thigh

Learning points | Core anatomy | Applied anatomy | Review questions

Learning points

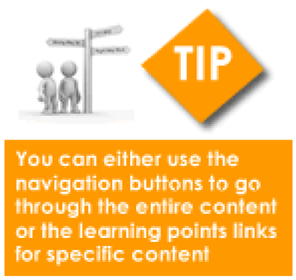
1. Extents of the thigh
2. The Femur
3. Subcutaneous nerves, veins and lymphatics
4. Fascia lata
5. Compartments and muscles of the thigh
6. Femoral triangle, sheath and canal.
7. Adductor canal.
8. Femoral artery and vein
9. Femoral nerve
10. Obturator nerve

You can either use the navigation buttons to go through the entire content or the learning points links for specific content

The Hip Joint

Learning points

1. **Articulating surfaces**
2. **Capsule and synovium**
3. **Stability factors**
4. **Relations**
5. **Blood supply**
6. **Innervation**
7. **Movements**
8. **Applied anatomy**



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Popliteal fossa

Learning points | Core anatomy | Applied anatomy | Review questions

Objectives

1. Location and boundaries
2. Contents
3. Popliteal artery
4. Nerves
5. Applied anatomy

TIP

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Objectives

---

1. **Articulating surfaces**
2. **Capsule**
3. **Synovium**
4. **Stability factors**
5. **Menisci**
6. **Blood supply**
7. **Innervation**
8. **Movements**
9. **Applied anatomy**

You can either use the navigation buttons to go through the entire content or the learning points links for specific content

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Learning points

1. **Extents of the leg**
2. **Osteology: Tibia and fibula**
3. **Cutaneous nerves and vessels**
4. **Compartments and muscles in the leg**
5. **Common peroneal nerve**
6. **Tibial nerve**
7. **Arteries of the leg**
8. **Dorsum of foot**
9. **Applied anatomy**

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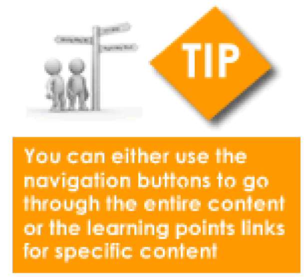
Learning points | Core anatomy | Applied anatomy | Review questions

Learning points

1. Classification and articular surfaces
2. Capsule and synovium
3. Stability factors
4. Relations
5. Blood supply and innervation
6. Movements
7. Applied anatomy

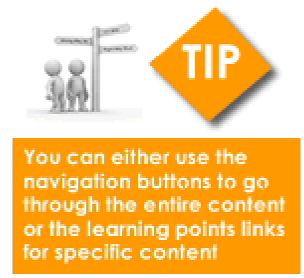


Learning points

You can either use the navigation buttons to go through the entire content or the learning points links for specific content

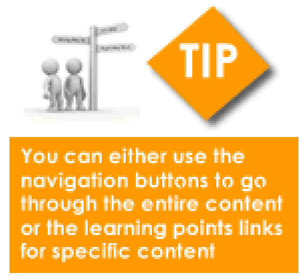
1. **Functions**
2. **Skin and fascia**
3. **Muscles**
4. **Neurovascular structures**
5. **Formation and maintenance of arches**
6. **Joints of the foot**
7. **Applied anatomy**

Learning points



1. **Scapula**
2. **Muscles of the Scapula region and back**
3. **Movements of the Scapula**
4. **Scapula anastomosis**
5. **Vertebrae**
6. **Intervertebral discs**
7. **Curvatures of spine**
8. **Occipital bone**
9. **Applied anatomy**

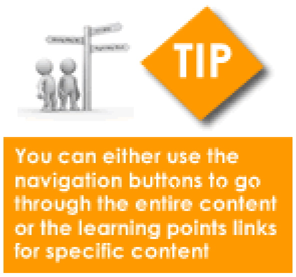
Learning points



The pectoral region

The axilla

Learning points



Functional adaptation of the upper limb

Shoulder joint complex

1. Glenohumeral
2. Acromioclavicular
3. Sternoclavicular
4. Coracoclavicular
5. Scapulothoracic

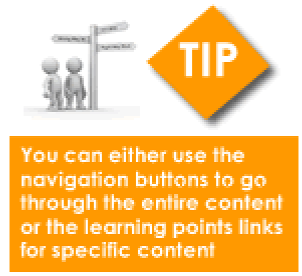
Arm

1. Compartments
2. Muscles
3. Nerves
4. Blood vessels
5. Quadrangular space
6. Triangular space

Learning points

1. **Functional adaptations of the hand**
2. **Osteology of the hand**
3. **Skin, fascia and palmar aponeurosis**
4. **Compartments and muscles of the hand**
5. **Fibrous and synovial flexor sheaths**
6. **Cutaneous innervation of the hand**
7. **Arterial supply of the hand**
8. **Carpal tunnel**
9. **Distal Radioulnar joint**
10. **Wrist joint and joints of the hand**

11. **Applied Anatomy**



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THE SKULL AND SCALP

Learning Points

- Scalp

  (+) Extents
  (+) Layers
  (+) Blood supply
  (+) Innervation
  (+) Lymphatic drainage

- Parts of the various skull bones.
- Foramina on the skull.
- Applied Anatomy
- Review questions

You can either use the navigation buttons to go through the entire content or the learning points links for specific content

Learning Points

1. **Orbital margins**
2. **Coats of the eyeball**
3. **Opthalmic nerve**
4. **Opthalmic vessels**
5. **Oculomotor nerve**
6. **Ciliary ganglion**
7. **Trochlear nerve**
8. **Abducent nerve**
9. **Muscles of the eyeball**
10. **Optic nerve**
11. **Blood supply to the eye**
12. **Bones of the face**
13. **Blood supply, lymphatic drainage and innervation of the face**

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Learning Points

1.Fascial planes of the Neck

a) Investing layer
b) Pretracheal layer
c) Prevertebral

2. Boundaries of posterior triangle of the neck
3.Contents of Posterior triangle of neck:

- Vessels
- Nerves
- Muscles

You can either use the navigation buttons to go through the entire content or the learning points links for specific content

Learning points | Core anatomy | Applied anatomy | Review questions

Learning Points

1) Subdivisions and their contents of the Anterior triangles of the neck

- Muscular triangle
- Carotid triangle
- Submandibular/ Digastric triangle
- Submental triangle

2) Thyroid gland.

3) Parathyroid glands

4) Midline of the neck

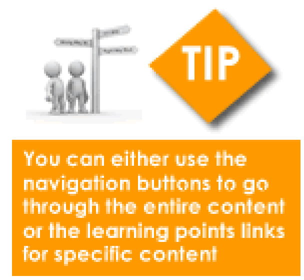
- Cervical esophagus
- Cervical trachea

5) Structures at the root of the neck

- Subclavian artery and vein
- Vagus nerve
- Phrenic nerve
- Thoracic duct
- Sympathetic trunk

6) Applied anatomy

7) Review questions



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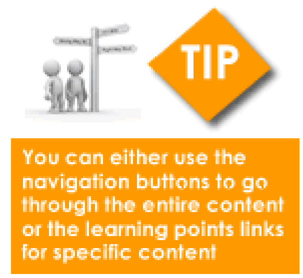

Learning points | Core anatomy | Applied anatomy | Review questions

Learning points

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The Nasal Cavity and Paranasal Sinuses

Learning points | Core anatomy | Applied anatomy | Review questions

Objectives:

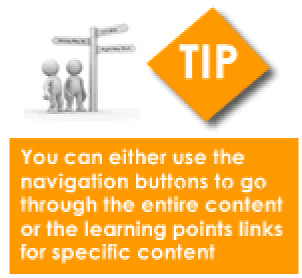
1. External nose
2. Nasal cavity
3. Blood supply of nasal cavity
4. Paranasal Sinuses:

   Frontal air sinus

   Ethmoidal air cells

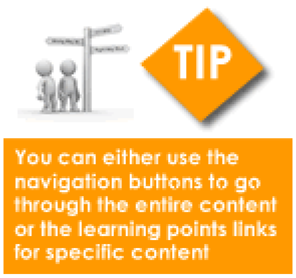
   Sphenoidal air sinus

   Maxillary air sinus



The Larynx and the Ear

Learing points



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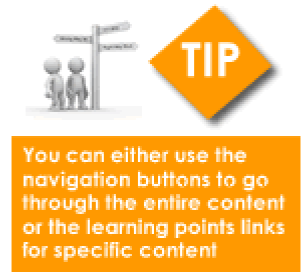
INTRODUCTION TO NEUROANATOMY

Learning points | Core anatomy | Applied anatomy | Review questions

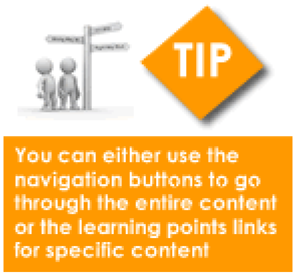
Learning Points

- The need for a nervous system
- Divisions and subdivisions of the nervous system
- Functional organization of the nervous system
- Factors/structures that protect/support the central nervous system.



The Spinal Cord

Learning Points



Cranial cavity and meninges

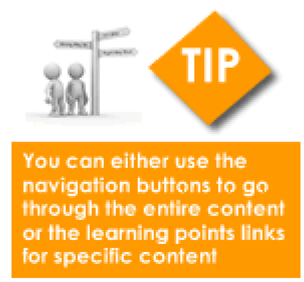
Learning points

1. **Boundaries and contents of cranial fossae**
   .
   Anterior

   Middle

   Posterior

2. Dural venous sinus
3. Organization of cavernous sinus
4. Blod supply of the dura
5. Innervation of the dura
6. Emissary veins
7. Weak points of the skull
8. Cranial meningeal extensions
9. Subarachnoid cisterns



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Learning points | Core anatomy | Applied anatomy | Review questions

Surface topography and functional localization of the cerebral cortex

Learning Points

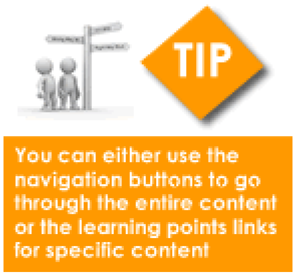
1. Main lobes of the cerebrum

2. Gyri, sulci and functions of the following lobes:

   - Frontal
   - Parietal
   - Temporal
   - Occipital

3. Applied anatomy

4. Review questions



Blood supply to the brain

Learning Points

Brain stem and the base of brain

Learning points

Medial aspect of the brain

Learning points

- Introduction
- Corpus callosum and commissures
- Cingulate gyrus and paracentral lobule
- Fornix
- Septum pellucidum
- Pineal gland
- 3rd Ventricle
- 4th Ventricles

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Learning points | Core anatomy | Applied anatomy | Review questions

Brain stem

Learning points

- Overview of brainstem
- Mid brain
- Pons
- Medulla

Diencephalon

Learning points

Learning Points

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Organisation of the ventricular system

Learning Points

- General organization of ventricular system
- Cerebrospinal fluid functions, formation, circulation and reabsorption.
- Position and relations of lateral ventricle
- Position and relations of third ventricle
- Position and relations of fourth ventricle

Cerebellum

Learning Points

- Position of cerebellum
- Subdivisions of cerebellum
- Cerebellar arteries
- Cerebellar nuclei
- Cerebellar peduncles
- Cerebellar connections
- Cerebellar functions
- Cerebellar dysfunction

organisation of the basal gangalia

Learning Points

- Components of basal ganglia
- Connections of basal ganglia
- Functions of basal ganglia
- Disorders of basal ganglia

General sensory systems

Learning Points

Objectives

Outline

- Visual pathways
- Auditory pathways
- Vestibular pathways
- Gustatory pathways
- Olfactory pathways

Somatic Motor Systems

Learning Points

1. Upper and lower motor neuron systems
2. 'Pyramidal' pathways
3. Corticoreticulospinal system
4. 'Extra pyramidal' pathways
5. Lower motor neuron as integrator
6. Reflexes

The Autonomic nervous system

Learning Points

Limbic System

Learning Points

Cranial nerves

Learning points

Nerves of the orbit

- Oculomotor nerve
- Trochlea nerve
- Abducens nerve

Nerves of the Face

- Trigeminal nerve
- Facial nerve

Nerves to Oropharyngeal and Neck Structures

- Glossopharyngeal nerve
- Vagus nerve
- Spinal accessory nerve
- Hypoglossal nerve

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Chest Wall, Pleura and Lungs

Learning points | Core anatomy | Applied anatomy | Review questions

Learning Points

1. **Osteology**

   Thoracic vertebrae
   ribs
   Sternum

2. Thoracic apertures
3. The pleura
4. Lungs
5. Respiratory movements
6. Applied anatomy

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Learning points

1. **Extents**
2. **Contents**
   - (+) **Thymus**
   - (+) **Thoracic duct**
   - (+) **Thoracic trachea**
   - (+) **Phrenic nerves**
   - (+) **Aorta arch**
   - (+) **Brachiocephalic trunk**
   - (+) **Left common carotid artery**
   - (+) **Left subclavian artery**
   - (+) **Superior vena cava**
   - (+) **Brachiocephalic vein**

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The Middle Mediastinum, Heart and Pericardium and the Superior Mediastinum

Learning points

Posterior Mediastinum and posterior chest wall

Learning points

Anterior Abdominal Wall and the Peritoneum

Learning points

---

1. **Organization of anterior abdominal wall**

   Divisions Fascia and muscles

   Rectus sheath

   Blood supply,Lymphatic drainage and Innervation

2. **Organization of Inguinal canal**

   Boundaries

   Contents

3. **Spermatic cord**
4. **Applied anatomy**
5. **Review questions**

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The peritoneum

Learning points | Core anatomy | Applied anatomy | Review questions

Learning points

1. General organization of peritoneum
2. Lesser omentum
3. Greater Omentum
4. Mesentry

Organs of the supracolic compartment

Learning points

The position, relations, blood supply, lymphatics innervation and applied anatomy of:

1. Liver
2. Gallbladder
3. Stomach
4. Spleen

The intestines

Learning points

Retroperitoneal organs

Learning points

The position, relations, blood supply, lymphatics and applied anatomy of:

1. Pancreas
2. Kidneys
3. Ureters
4. Supra renal glands
5. Duodenum

Blood supply and lymphatic drainage of Gastro intestinal system

Learning points

Posterior abdominal wall and diaphragm

Learning points

Learning points | Core anatomy | Applied anatomy | Review questions

Learning points

1. **Boundaries of the perineum**
2. **Parts and functions of the pelvic diaphragm**

   Levator ani: parts and functions

   External anal Sphincter

   Coccygeus
3. **Boundaries and contents of perineal fascia and pouches**

   Superficial pouch

   Deep pouch
4. **Central tendon of diaphragm**
5. **Boundaries and contents of ischio-anal fossa**

Learning points

1. **Male external genitalia**

   Scrotum

   Testis & epididymis

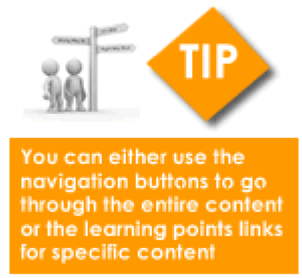
   Penis

2. **Female external genitalia**

Learning points

Location, relations, blood supply, innervation, lymphatics and applied anatomy of:

1. Rectum
2. Anal canal
3. Uterus
4. Uterine tubes
5. Ovaries
6. Male urethra
7. Urinary bladder
8. Prostate gland



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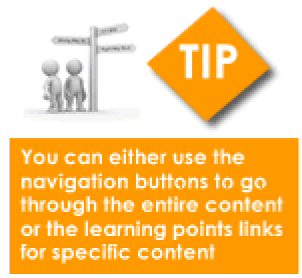
Learning points | Core anatomy | Applied anatomy | Review questions

Learning points



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taskBar

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Topic by topic list on Gross Anatomy Lectures

2 Teaching Schedule

Department Of Human Anatomy week by week teaching schedule

3 Copyright Info

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4 Development Team

members involved in development of project anatomy


Topographic Anatomy
The Lower Limb


Topographic Anatomy
The Upper Limb


Topographic Anatomy
Head and Neck


Topographic Anatomy
Thorax

Topographic Anatomy

Abdomen

Topographic Anatomy

Pelvis and Perineum

Gluteal region and back of the thigh

Bones of the Gluteal region:

The gluteal region comprises dorsal surfaces of three bones

- **Hip bone**
- **Sacrum**
- **Proximal femur**

How Would You Determine The Side Of The Hipbone ?

Hover on hot point to show name

- Acetabulum faces antero-laterally
- Obturator foramen is antero-inferior
- Pubis faces Anteriorly
- Ischial tuberosity is postero-inferior
- Iliac crest faces supero-lateral

In the anatomical position, the anterior superior iliac spine is in the same plane as the pubic symphysis.

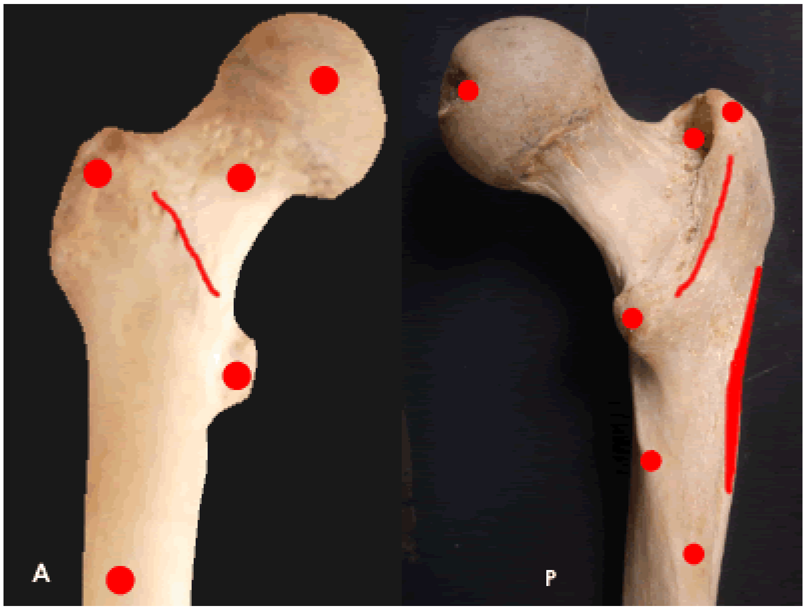
The Femur

How Would You Determine The Side Of The Hipbone ?

Hover over hotpoint to show name

Siding the femur:

- The head of the femur faces supero-medial.
- The greater trochanter faces laterally.
- The anterior surface is convex while the posterior is concave.
- Femoral condyles are inferior.

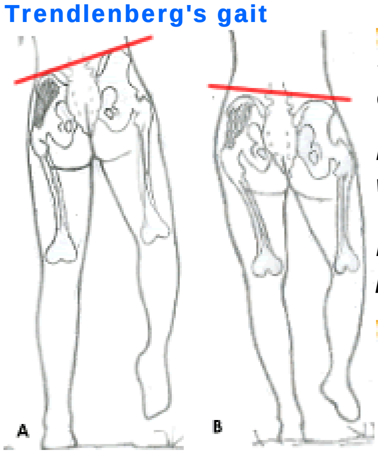


[Review the clinical anatomy of the osteology]

Gluteal region and back of the thigh

Applied Anatomy

Trendlenberg's gait



When any of the features of lateral balance control fails, the supporting is upset. The pelvis tends to fall on the unsupported side when the individual stands on the affected limb. This is called Trendelenberg sign. The person walks with a characteristic lurching or waddling gait.

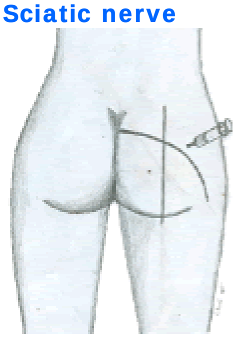
In A : Negative trendlenberg's test . The hip abductors are acting normally tilting the pelvis upwards when the opposite leg is raised from the ground

In B : Positive Trendelenberg's test . The hip abductors are unable to control the dropping of the pelvis when the opposite leg is raised

Causes of such a condition include:

- Paralysis of the gluteus minimus and medius
- Dislocation of the hip joint
- Fractures of the neck of the femur
- Collapse of the head of the femur e.g. from avascular necrosis, slipped epiphysis, tuberculosis of head of femur
- Severe arthritis of the hip joint

Sciatic nerve



Can be compressed at lower border of gluteus maximus by sitting on a bench with a sharp edge.

May be injured by misplaced deep intravascular injections. To prevent this, the injection is usually given in the superolateral quadrant.

May be injured in posterior dislocation of the hip joint.

Sciatic Hernia

Pelvic structures may protrude through the greater sciatic foramen. This is called sciatic hernia. It compresses the contents of the foramina and may present with pain, numbness and weakness in the lower limb if sciatic nerve is compressed.

Trochanteric bursitis

The extensive bursa between the great trochanter and the gluteal aponeurosis may be a site of infection. Patient complains of pain and swelling in the trachanteric region. Sometimes there may be a pus discharge.

Snapping hip

In this condition, a snap is heard and felt on certain hip movements. The snap is attributed to slipping of a tendinous aponeurosis- probably that of the gluteus maximus – over the greater trochanter. It is harmless and treatment is not required.

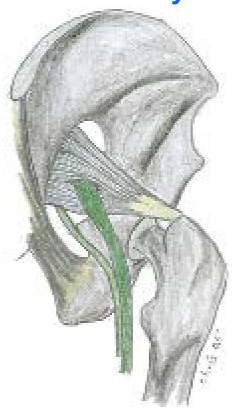
Slipped disc

Pain of a prolapsed or strained lumbar intervertebral disc if often referred to the gluteal region or lateral aspect of the thigh.

Weaver's bottom

Inflammation of the bursa over the ischial tuberosity

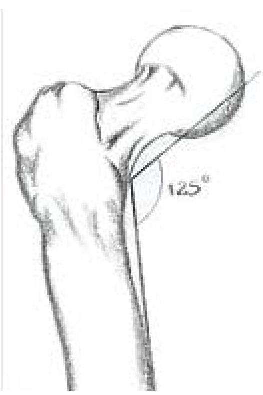
Piriformis syndrome



When the sciatic nerve divides in the pelvis, the common peroneal nerve may exit either:

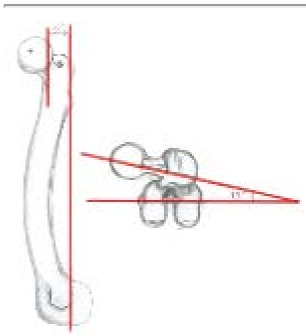
- below Piriformis
- pierce piriformis
- pass above piriformis

When it pierces piriformis, it may be compressed by contractions of this muscle. This causes piriformis syndrome.



Angle of inclination:

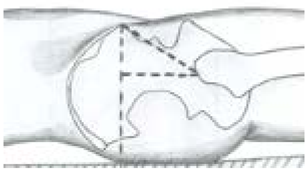
The neck is about 5cm long and makes an angle of 125 ° with the shaft in males and in females (about 110°). This is called the angle of inclination. It is widest at birth and diminishes with age till adolescence.



Angle of anteversion

The neck is also tilted slightly forward at an angle of 10-15° . This is the *angle of anteversion*.

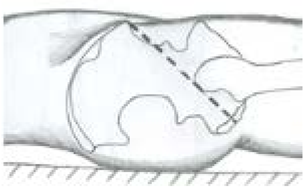
The proximal border of the greater trochanter is level with the centre of the femoral head.



Bryant's triangle:

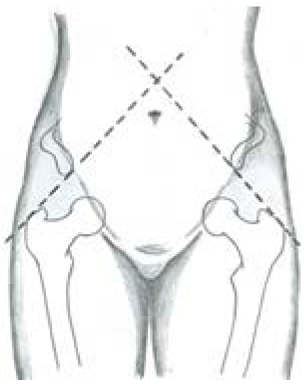
With the patient lying supine:

- Drop a perpendicular from the anterior superior iliac spine to the horizontal
- Project a second line upwards from the tip of the greater trochanter to meet the first line at 90°
- Join the anterior superior iliac spine to the tip of the greater trochanter.



Nelaton's line:

This is a line between the anterior superior iliac spine and the ischial tuberosity, with the patient in the supine position. The tip of the greater trochanter lies on or below this line. If it lies above the line, the femur has been displaced upwards.



Shoemaker's line:

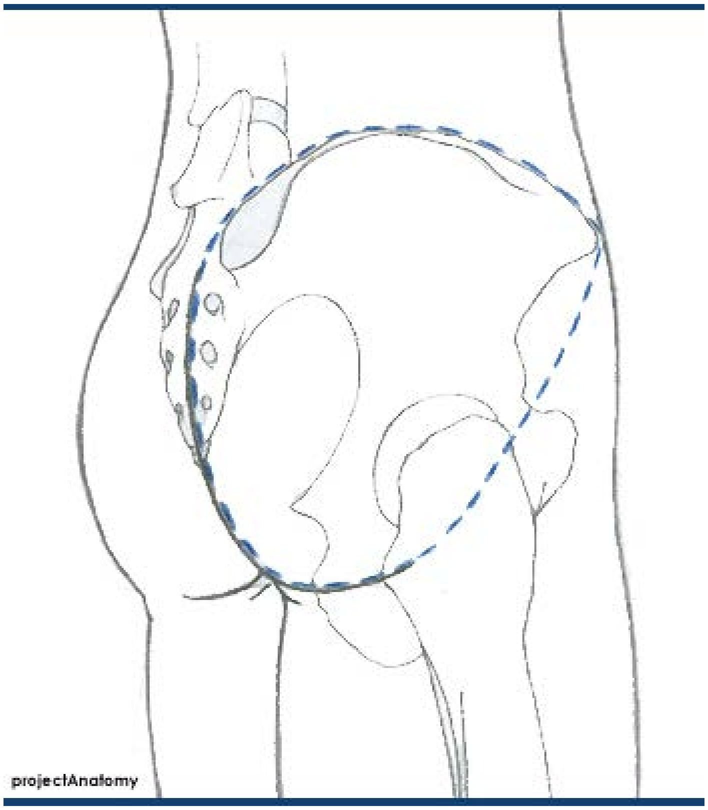
A line projected on each side of the body from the greater trochanter beyond the anterior superior iliac spine. The two lines normally meet in the midline at or above the umbilicus. If one femur is displaced upwards, the lines meet away from the midline. If both are displaced upwards the lines meet below the umbilicus.

Review Questions

1. Describe the attachments,innervation and functions of gluteus medius and minimus, indicating their role in bipedal striding and disorders thereof
2. State the root value, course and distribution of the main nerves in the gluteal region. Add brief notes on possible sites and effects of their injuries
3. Briefly describe the anastomoses in the gluteal region indicating their significance

Gluteal region and back of the thigh

Extents



Superiorly: Iliac crest

Medially: Natal cleft

Inferiorly: Gluteal fold

***Laterally**:* Curved line joining anterior superior iliac spine, greater trochanter and lateral end of gluteal fold.

Anteriorly: A curved line between anterior superior iliac spine and greater trochanter.

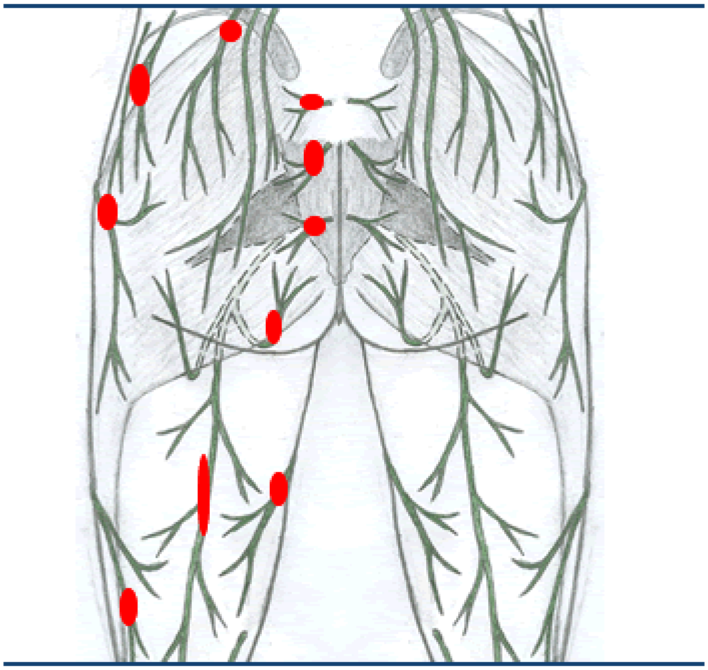
Palpable Landmarks

- Iliac crest
- Anterior superior iliac spine
- Greater trochanter
- Dorsal sacrum and coccyx
- Posterior superior iliac spine. This is at the level of: 2nd sacral spine.
- The middle of sacroiliac joint marked by a skin dimple.

Cutaneous Nerves

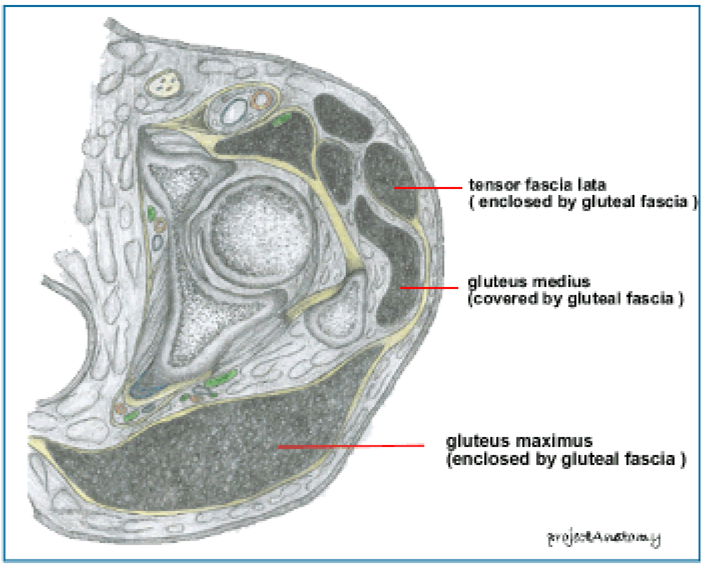
Hover over hotspot to show name

- Subcostal
- Iliohypogastric



- Posterior branch of lateral cutaneous nerve of the thigh.
- Posterior cutaneous nerve of the thigh.
- Dorsal rami of L1-3; S1-3.

Gluteal Fascia

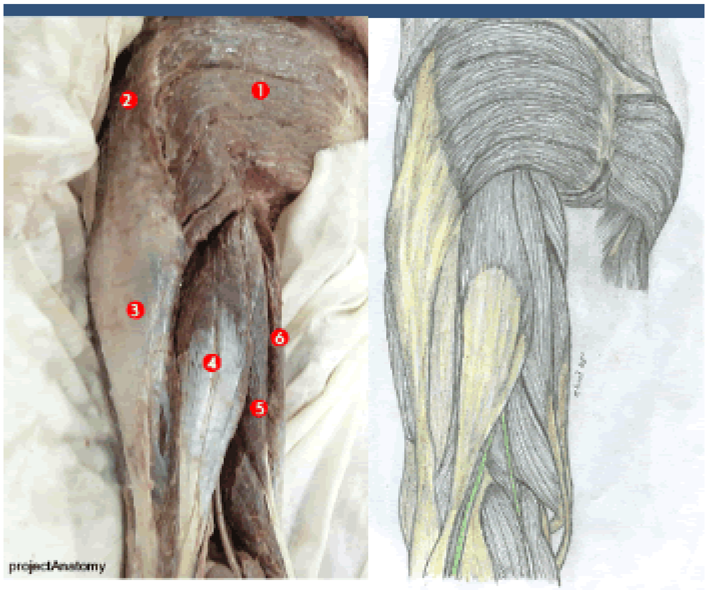


- Encloses gluteus maximus and tensor fascia lata.
- Covers gluteus medius.
- Bound to skin below gluteus maximus to produce the gluteal fold.
- Continuous with fascia lata.

task ***Draw crossection at great trochanter and show extents of gluteal fascia.***

Gluteal region and back of the thigh

Gluteal Muscles:



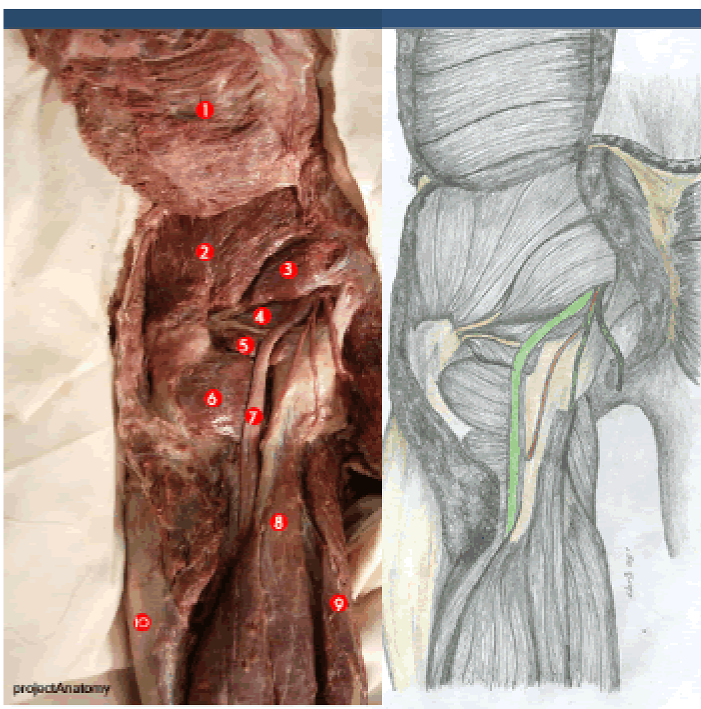
Hover mouse to show muscle names

Three large gluteal muscles:

- Gluteus maximus (1) *inserted onto the Iliotibial tract (3)*
- Gluteus medius
- Gluteus minimus

task **Note the muscles 1, 2 ,3 ,4 ,5 and 6 on the picture.**

task **Note attachements of these muscles and be able to identify them on the hip bone and femur.**



Hover mouse to show muscle names

Six small lateral rotators:

- Piriformis
- superior gamellus
- inferior gamellus
- Obturator externus
- Obturator internus
- Quardratus femoris

What is the role of gluteus medius an minimus in bipedal striding?

Lateral balance control

The gluteus medius and minimus of the supporting limb abduct the pelvis tilting and holding it so that the pelvis on the swinging side is prevented from sagging to the unsupported side.

This supportive mechanism of the two muscles is generally referred to as **lateral balance control.**

Its integrity depends on three main features:

- The **two muscles** must be functioning normally.
- The **hip joint** must be intact.
- The **length** and and **neck shaft angle** of the **femur** must be normal

What happens when any one of the features of lateral balance control is compromised? Answer

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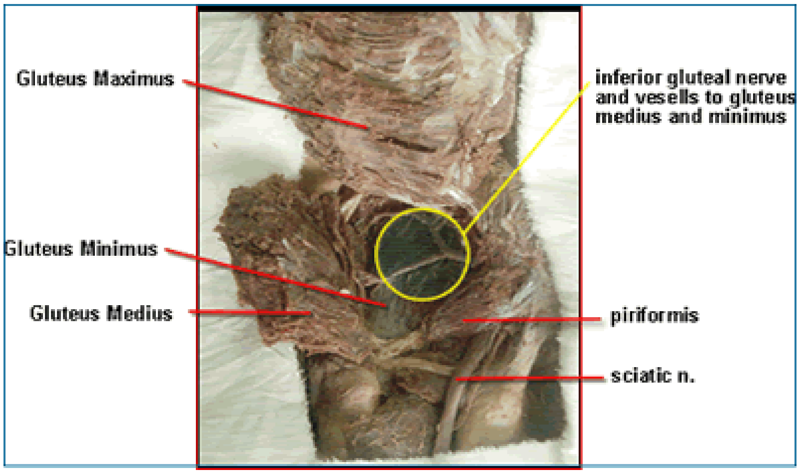
Gluteal region and back of the thigh

Nerves Of The Gluteal Region

Inferior gluteal nerve:



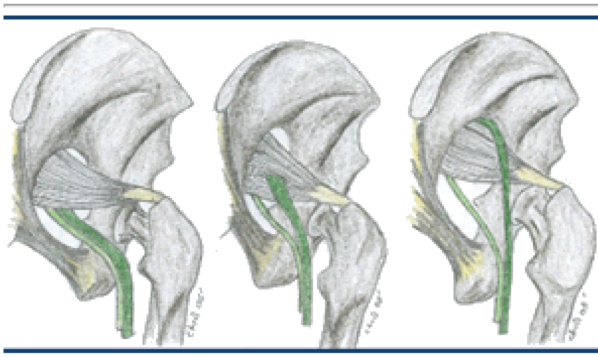
Root Value L1 - L2

Distribution:

- Gluteus Medius
- Gluteus Minimus
- Tensor fascia lata

task **How would bipedal striding be impaired in case of injury to the superior gluteal nerve? Hint: Trendlenberg's gait**

Sciatic Nerve In The Gluteal Region:



Origin:

- Root value L4,5, S1,2,3
- Two nerves: Tibial and Common peroneal.

The sciatic nerve normally comes out infrapiriformic with the tibial and common peroneal components together.

It separates in the popliteal region or may divide high up the common peroneal component passing through the piriformis or over the piriformis.

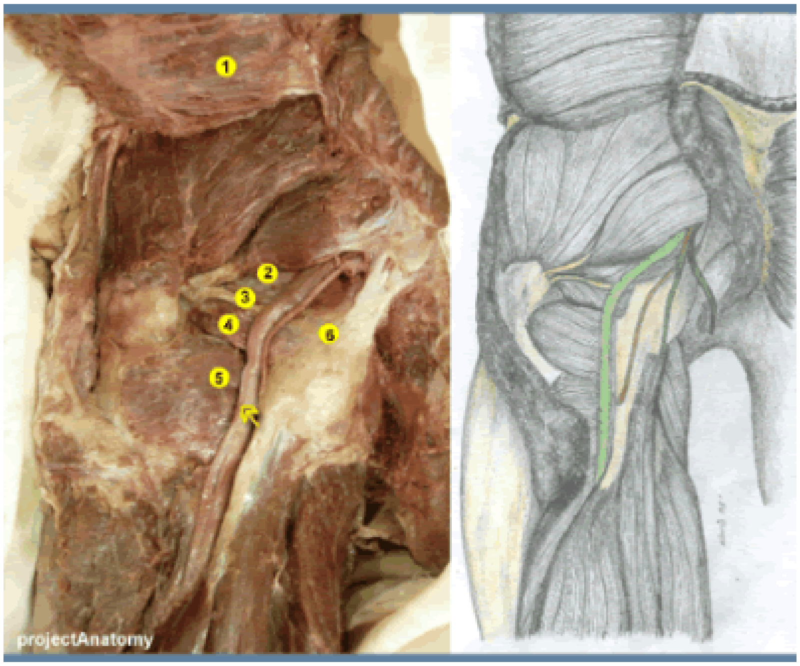
task ***What is the root value of the tibial component of the sciatic nerve?***

task ***Look up piriformis syndrome and state its manifestation.***

Course and relations:

Identify the points labelled 1 to 6 which form relations to the sciatic nerve (pointed)

- Deep anterior to gluteus maximus
- Lies on (posterior to the following from above downwards):
  - Ischium
  - Obturator internus and gamelli
  - Quardratus femoris



Distribution:

- Supplies NO muscles in the gluteal region.
- Supplies hip joint through articular branches.

Landmarks:

Midway between ischial tuberosity and greater trochanter

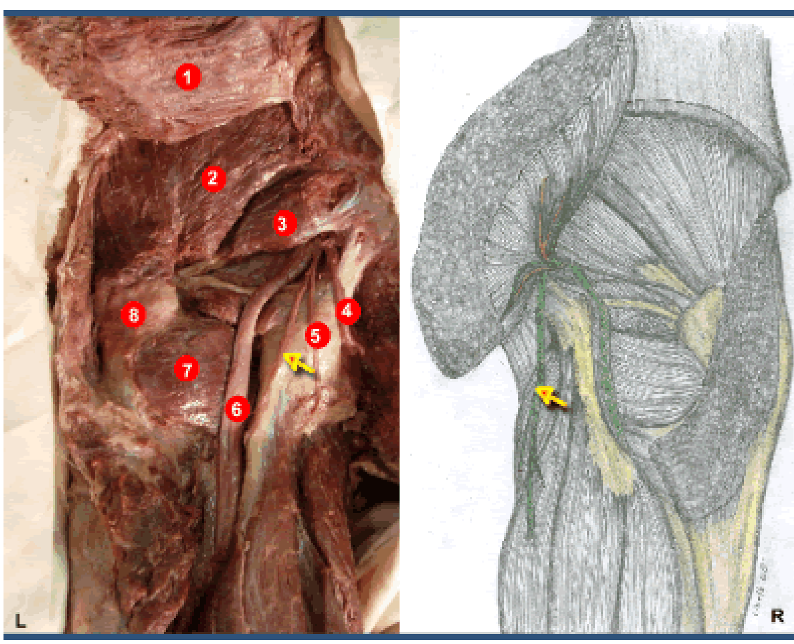
Blood supply:

The sciatic nerve derives its blood supply from:

- Inferior gluteal artery via the companion artery of sciatic nerve
- Longitudinal anastomosis at the back of the thigh

Posterior Cutaneous Nerve Of the thigh:

task ***Name the branches of the posterior cutaneous nerve in the gluteal region***



Origin: S 1-3

Infrapiriformic under cover of gluteus maximus.

Runs with inferior gluteal artery posterior or medial to sciatic nerve.

Distribution:

All cutaneous to:

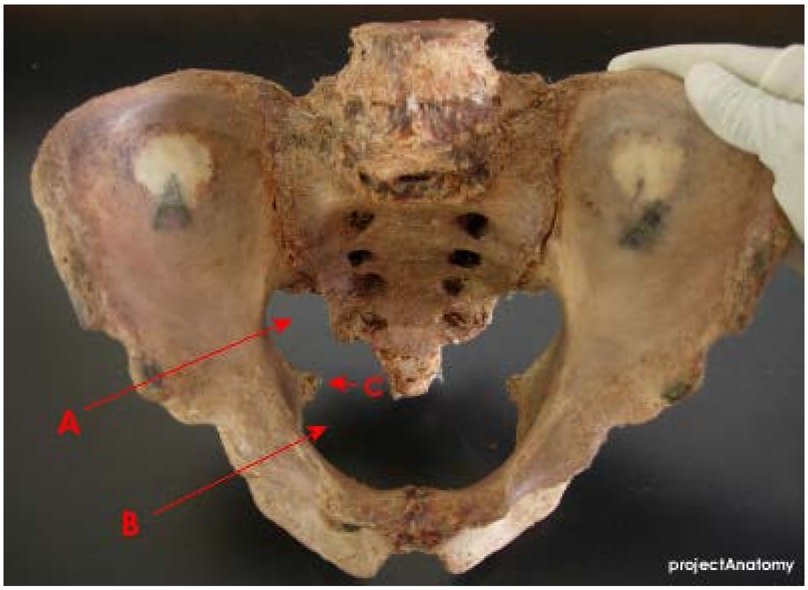
- Gluteal region
- Perineum including scrotum or labia majora
- Back of the thigh

task ***Note the posterior cutaneous nerve of the thigh (Pointed)***

task ***Identify the structures labelled 1 to 8 in relation to this nerve.***

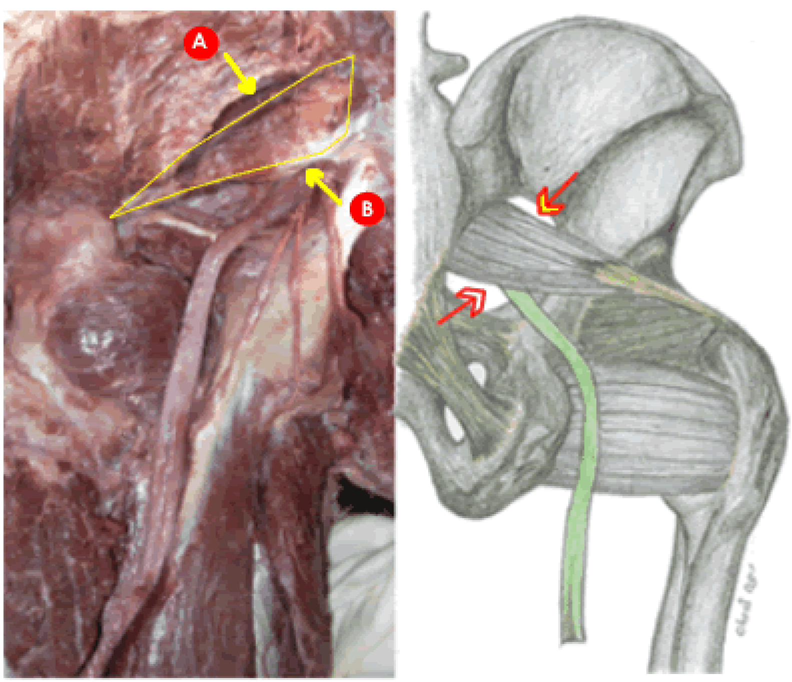
Gluteal region and back of the thigh

Sciatic Foramina



Greater and lesser sciatic notches are converted into foramina by sacrotuberous and sacrospinous ligaments.

task ***Identify the greater and lesser sciatic foramina and ischial spine on the pelvis shown. Name two muscles that attach onto the ischial spine.***



The greater sciatic foramen is divided into two compartments by the Piriformis muscle namely the *Infrapiriformic* and *Suprapiriformic* compartments below and above the muscle respectively.

What structures transerve the foramina indicated below ?

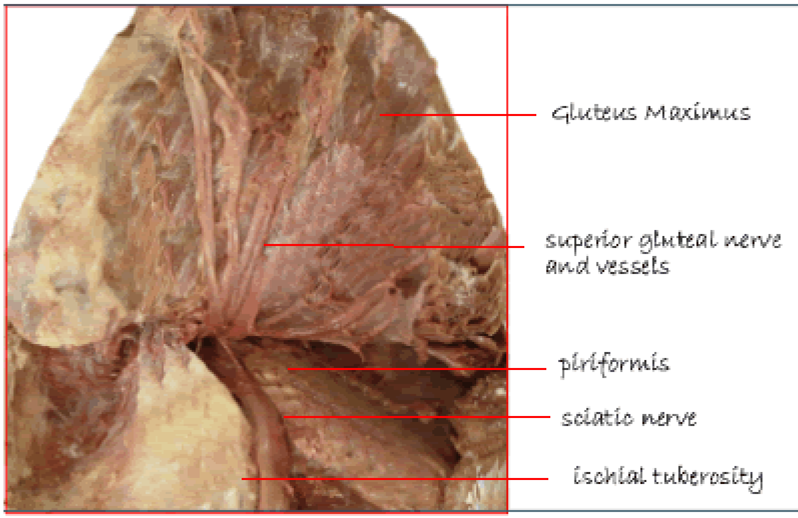
Infrapiriformic	Suprapiriformic	Lesser sciatic foramen

<< -Check answer ->>

Note that the pudendal nerve and internal pudendal vessels exit the pelvis through greater sciatic foramen and enter the perineum through the lesser sciatic foramen.

Gluteal region and back of the thigh

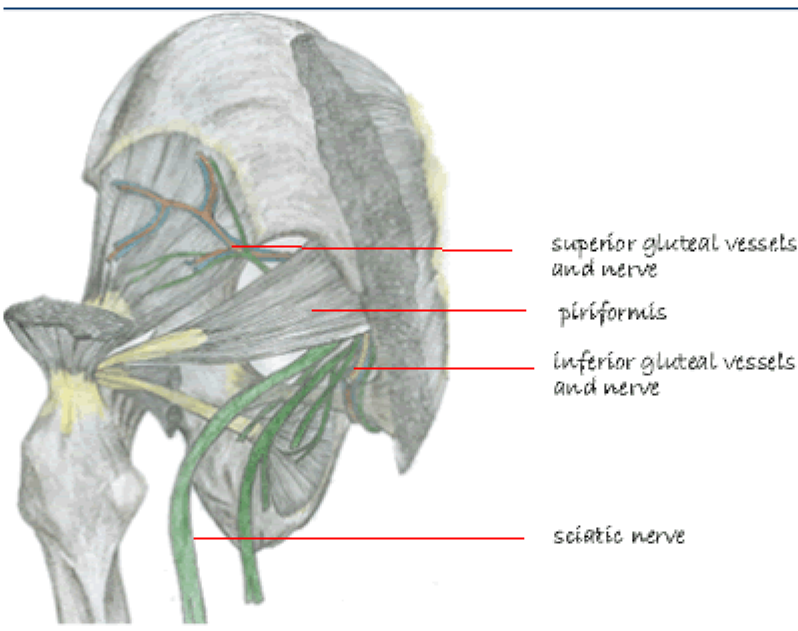
Arteries Of Gluteal Region



Origin:

The gluteal arteries arise from the internal iliac artery. They are the superior and the inferior gluteal arteries.

task ***Name the other branches of the internal iliac artery (6 Mks)***



Course:

The superior and inferior gluteal arteries exit through the suprapiriformic and infrapiriformic compartments of greater sciatic foramina respectively.

Superior Gluteal:

Distribution:

The superior Gluteal artery gives branches to all the three large Gluteal muscles.

Anastomosis of Superior Gluteal artery:

At the anterior superior iliac spine, it anastomoses with:

- Deep circumflex iliac artery

- Ascending branch of lateral circumflex artery

Both of these arise from the femoral artery (from ext. iliac artery)

Trochanteric anastomosis:

In the trochanteric fossa, the supeior gluteal artery anastomoses with branches of:

- Inferior gluteal artery
- Ascending branches of the medial and lateral circumflex femoral arteries

---

Inferior Gluteal:

It supplies the following structures:

- Gluteus maximus
- Hip joint
- Soft tissues behind the coccyx
- Sciatic nerve

Cruciate Anastomosis at lesser trochanter:

- Inferior gluteal artery
- Transverse branch of lateral circumflex femoral artery
- Transverse branch of medial circumflex artery
- Ascending branch of 1st perforating artery from profunda femoris

Note that through these three anastomoses, the internal iliac and external iliac arteries communicate.

In this way, there is provision for collateral circulation should any of the arteries be occluded or ligated.

Organization of the thigh

Learning points

1. Parts of the femoral bone
2. Extents of anteromedial thigh
3. Subcutaneous nerves and vessels
4. Inguinal lymph nodes
5. Fascia lata
6. Compartments and muscles of the thigh
7. Femoral triangle, sheath and canal.
8. Adductor canal.
9. Deep arteries in the thigh
10. Deep Nerves in the thigh
11. Applied anatomy

You can either use the navigation buttons to go through the entire content or the learning points links for specific content

organization of thigh

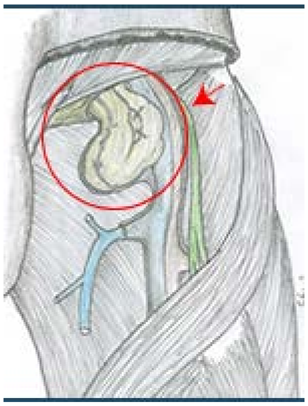
Osteology:

- The bone found in the thigh region is the femur.

Hover on the points to show more info

Applied Anatomy:

Femoral Hernia:



The femoral canal is a weak area through which abdominal contents may protrude into the thigh.

Note:

1. A femoral hernia is relatively small since it contained in the limited femoral canal.
2. It can be palpated below the inguinal ligament.
3. It is frequently strangulated.
4. In cases where an abnormal obturator artery exists, it is necessary to be cautious in dealing with the lacunar ligament to avoid division of the vessel, which may result in serious hemorrhage.
5. It passes through the femoral canal and emerges through the saphenous opening. The latter is 4cm lateral to the pubic tubercle.
6. The hernia ,as it emerges through the saphenous opening, is covered by the fascia transversalis and cribriform fascia.
7. If the hernia continues to emerge in the subcutaneous tissue, it normally takes a recurrent course anterior to the inguinal ligament along the line of the inferior epigastric vessels.

Swellings in the femoral triangle:

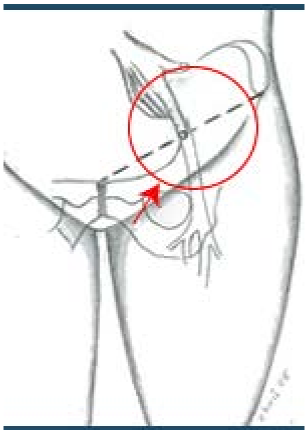
Can be caused by:

- Femoral hernia
- Inflamed/ enlarged lymph nodes
- Abcess
- Lipoma
- Aneurisms of the vessels
- Neuromas
- Muscle tumors
- Psoas abcess, usually arising from TB spine
- Saphena varix, e.t.c • X. Ectopic breast and testis

Surgical management of these conditions including femoral hernia repair requires sound knowledge of the topographic deposition of the contents.

Femoral Artery:

The artery can be pressed against the iliopubic eminence below the inguinal ligament



at the mid-inguinal (femoral point), to reduce bleeding from a distal cut.

Anterior dislocation of the hip joint may compress or kink the artery due to its close proximity. It is separated merely by the iliopsoas tendon.

Femoral artery catheterization is now a common procedure

The pulsating artery is commonly used to locate the femoral vein just medial to it

---

Lateral cutaneous nerve of the thigh

This nerve is sometimes compressed as it passes through the inguinal ligament, causing pain and altered sensation in the lateral side of the thigh (meralgea paraesthetica).

Surgical treatment of this condition requires division of the inguinal ligament and freeing the nerve of any fascial compression.

Varicose Veins:

Varicose veins are dilated, elongated and tortuous veins. Some common causes include:

- Valvular incompetence
- Pelvic tumors
- Long hours of standing
- Pregnancy

Lymphatic Drainage:

Inguinal nodes can be mapped on a lymphangiogram

Done by injecting the territory of drainage with a radio opaque dye and taking a radiograph.

Compartment Syndrome:

Compression of nerves, blood vessels and muscles in the compartments

Fluid accumulation in a tight osteofascial compartment, causes vascular insufficiency in the distal regions.

Causes: Burns, bleeding, inflammation

Presentation; (5Ps): pain, palor, paraesthesia, paralysis, pulselessness

Fractures causing unnoticed blood loss:

If the femur is fractured even in abscence of major vessel tear , bleeding occurs from the marrow, bone and muscular vessels

Because of the tight fascia, considerable amounts of blood may be lost before any evidence of swelling is noticed.

Muscle herniae:

If the fascia lata is cut and not repaired well, contracting muscles may herniated through the defect. This may impair contraction.

Safe and danger sides of the thigh:

The medial side of the thigh is the danger side because of major nerves and vessels

. The lateral side of the thigh is the safe side

Muscle tears and bone avulsion:

Forceful contraction of the muscles may cause tears e.g. hamstring tears in footballers.

Strong tendons, may forcefully chip off (avulse) bone.

Obturator nerve injury

Sites and causes of injury

- In the abdomen or pelvis by compression from tumors
- Obturator externus
- Obturator canal by obturator hernia

Effects of injury

- Loss of hip adduction
- Loss of sensation medial thigh
- Impaired hip and knee joint sensation

organization of thigh

Review Questions:

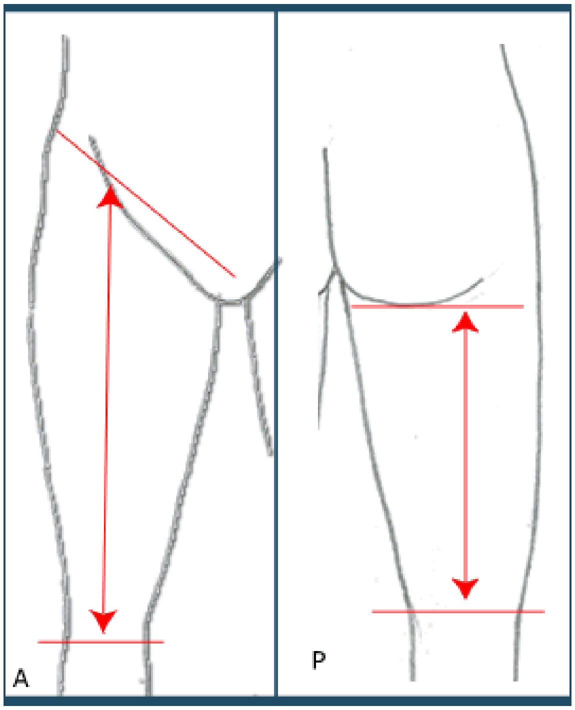
1. Describe the boundaries including floor and roof and contents of the femoral triangle. Add notes on femoral hernia.

2. Give an account of the origins, course , landmarks , branches and distribution of the femoral artery. Add notes on various anastomosis involving it and state their importance.

3. Write briefly about the origins, course and distribution of femoral nerve

4. Outline the boundaries and contents of the adductor canal.
5. Define clearly the regions drained by the inguinal lymph nodes.

Extents:



- Between the gluteal region and the knee
- Posteriorly from the gluteal fold to the plane of the knee join
- Anteriorly from the inguinal ligament to the knee joint (patella)
- Medially from the perineo-femoral function / fold to the knee
- Laterally from a curved line joining anterior superior iliac spine through greater trochanter to gluteal fold to the knee

Organization of the thigh

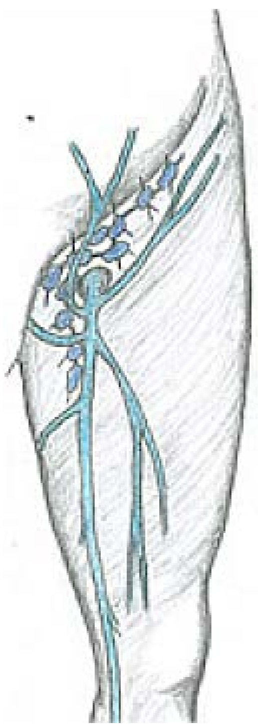
Inguinal Lymph Nodes

Divided into a deep and a superficial group

Superficial nodes

These are arranged in form of a letter T:

- The vertical group along the great saphenous vein.
- The horizontal group parallel to the inguinal ligaments.



Area Of Drainage

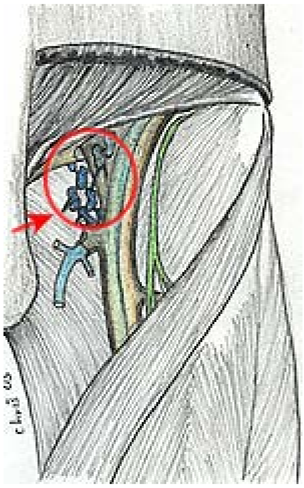
- Superficial tissues of the lower limb except the lateral foot, heel and back of the leg which drain into popliteal lymph nodes.
- Gluteal region.
- Trunk below the umbilicus.
- The perineum including the distal third of the anal canal, vagina and urethra
- External genitalia except the testis and the glans penis/ clitoris
- Fundus and the body of the uterus

Note: Inflammation (enlargement) of these nodes may signifiy infection or malignancy.

Deep nodes

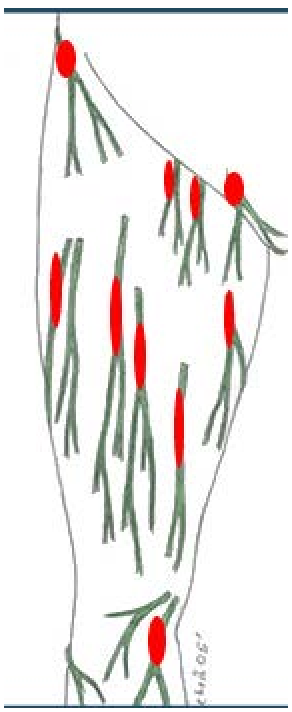
These are arranged along the femoral vein and drain these areas:

- Deep structures of the lower limb
- Glans penis or clitoris
- They are connected by lymph vessels to the superficial nodes and also to the external iliac nodes.



Subcutaneous Nerves and Vessels

Nerves:

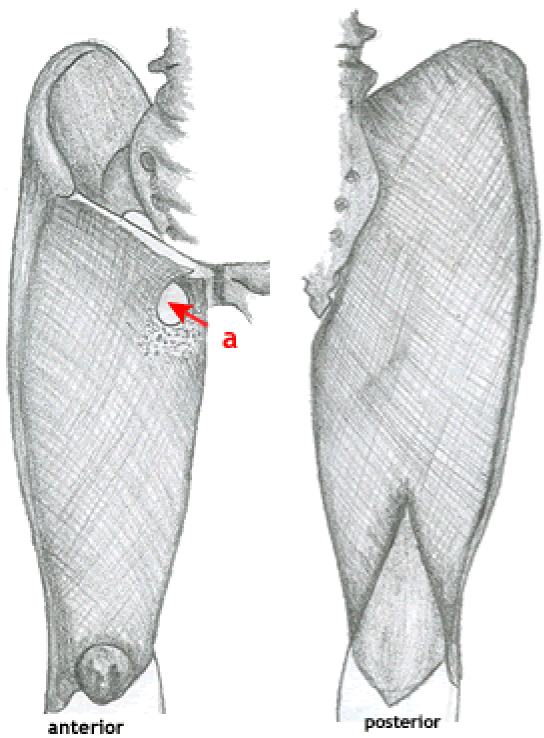


- Anterior cutaneous nerves of the thigh (lateral, intermediate, medial)
- Posterior cutaneous nerve of thigh
- Femoral branch of genitofemoral nerve
- Cutaneous branches of obturator nerve
- Ilioinguinal nerve
- Subcostal nerve

Fascia Lata

This is the deep fascia of the thigh

Attachement:



Onto the bony prominences and ligaments.

Proximal:

- Inguinal ligament
- Anterior superior iliac spine
- Sacrum
- Sacrotuberous ligament
- Body of pubis
- Pectineal line
- Ischial tuberosity
- Ischiopubic ramus

Distal:

- Tibial condyles
- Head of fibula

Note the saphenous opening [a] through which the saphenous vein drains into the femoral vein

Muscles enclosed:

- Tensor fascia lata
- Gluteus maximus

Modifications:

- Iliotibial tract
- Intermuscular septa (medial and lateral both attached to the linea aspera)
- Falciform margin of saphenous opening

task

Which muscles insert onto the iliotibial tract?

Name the muscles and neurovascular structures found in each compartment.

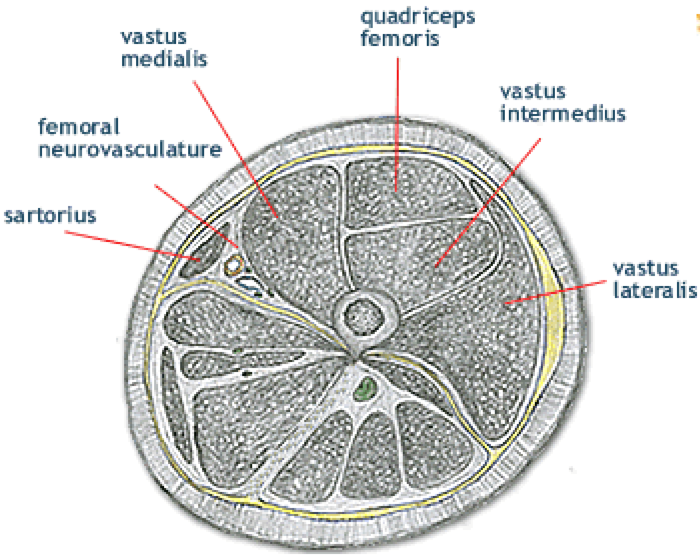
Functions:

- Muscle attachéments
- Enclose and contain thigh muscles
- Compartmentalize the thigh

task ***What is 'Compartment syndrome?'***

Compartments Of the Thigh

ANTERIOR COMPARTMENT:



Between medial and lateral intermuscular septa.

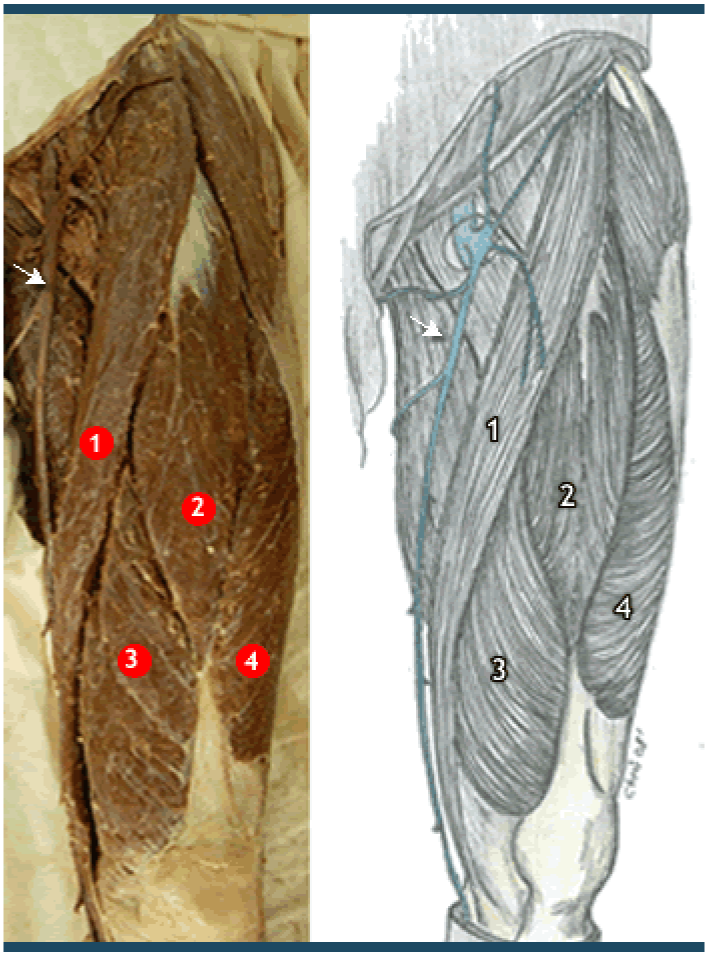
Contents:

- Quadriceps femoris
- Hip flexors (iliacus, psoas major, pectineus and sartorius)

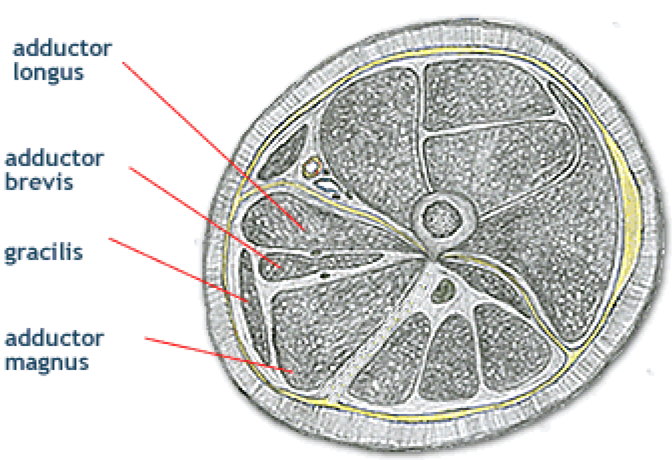
task ***Review attachments and actions of these muscles.***

- Femoral vessels
- Femoral nerve

Hover over the red areas to see the muscle names



MEDIAL COMPARTMENT:



Separated from the anterior compartment by medial inter muscular septum.

There is no septum separating it from posterior compartment

Contents

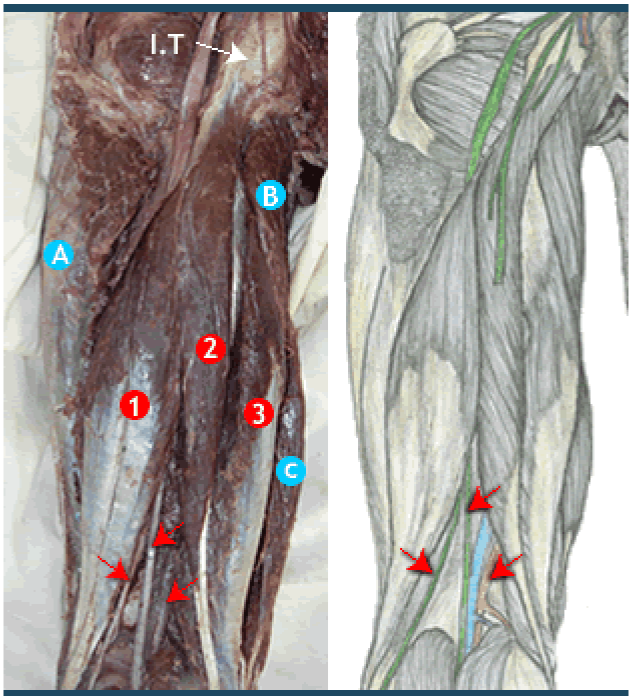
- Adductor muscles including gracilis
- Obturator nerve
- Profunda femoris artery
- Obturator artery

posterior Compartment

Separated from the anterior compartment by lateral intermuscular septum.

Hover to show names

Contents:



- Hamstring muscles (name them and review their attachements and actions)
- Sciatic nerve and its branches
- No artery. Receives blood from Profunda femoris through its perforating branches which form a longitudinal anastomosis.

Note:

Short head of bicep femoris is not a true hamstring because:

- It arises from linea aspera and not ischial tuberosity.
- It is innervated by common peroneal and not tibial nerve.
- It flexes the knee but does not extend the hip joint.

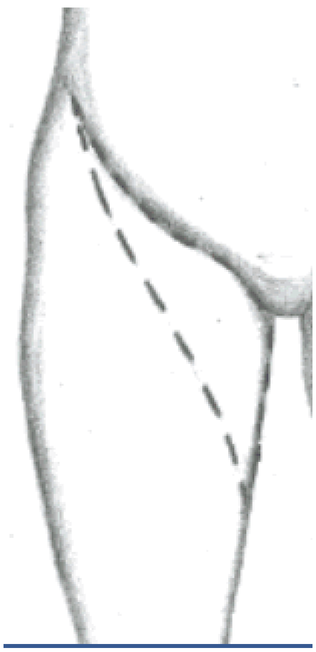
Adductor Magnus is functionally divided into two:
1. The ischial (harmstring) component:

- Arises from the ischial tuberosity
- Innervated by tibial nerve
- Extends the hipjoint

2. The pubic (adductor) component:

- Arises from the pubis
- Innervated by obturator nerve
- Adducts the hip joint

FEMORAL TRIANGLE:
Location and boundaries



Location:
Anteromedial in the upper thigh

Bounded by:

Superiorly, the inguinal ligament extending from the anterior superior iliac spine to the pubic tubercle.

Laterally, medial border of sartorius.

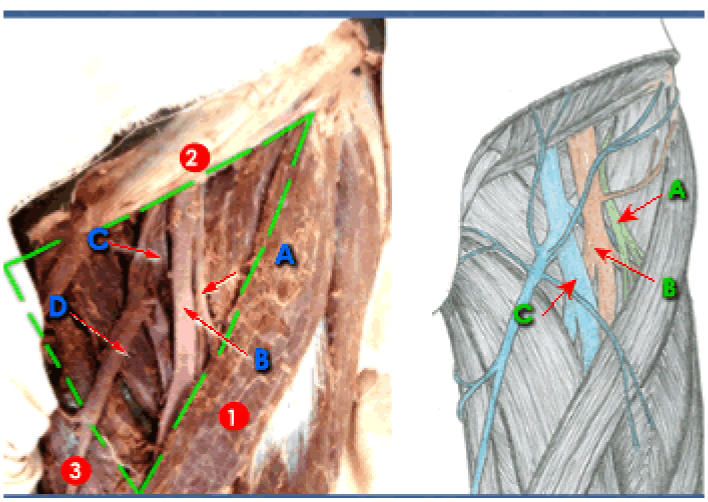
Medially, medial border of adductor longus.

Roof (anterior): fascia lata pierced in the region of saphenous opening to form cribriform fascia.

Floor (posterior): adductor longus, pectineus, iliopsoas.

Apex continues into the adductor canal.

CONTENTS OF THE FEMORAL TRIANGLE

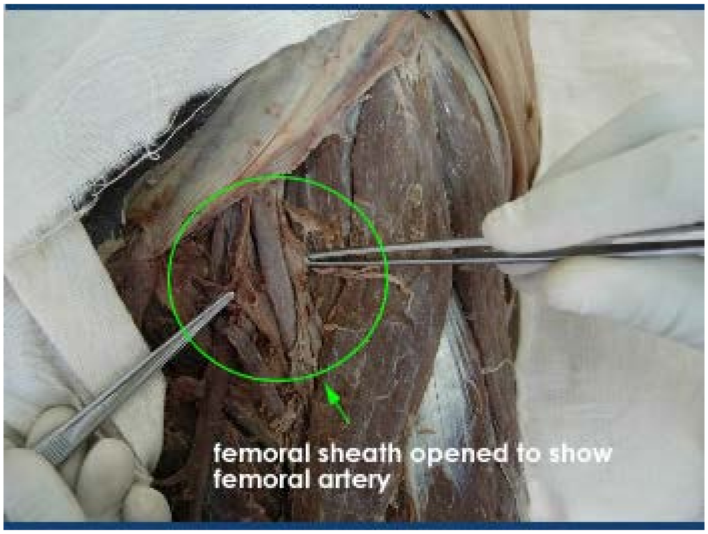


Hover over the hotspots to show names

- Femoral vein **(C)** and its proximal tributaries.
- Femoral artery **(B)** and its proximal branches.
- Femoral nerve **(A)** and its branches.
- Inguinal lymph nodes.

FEMORAL SHEATH

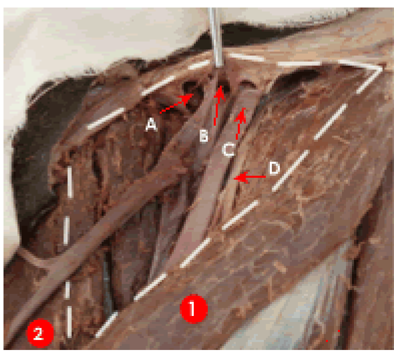
Formed by fascia transversalis anteriorly and fascia iliaca posteriorly.

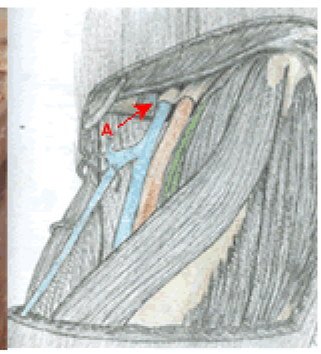


Divided into three compartments by two antero-posterior septa.

- *Medial* compartment is called the **femoral canal.**
- *Middle* (intermediate) compartment contains the femoral vein.
- *Lateral* compartment contains the femoral artery and femoral branch of genitofemoral nerve.

THE FEMORAL CANAL





Is the medial compartment of the femoral sheath (A)

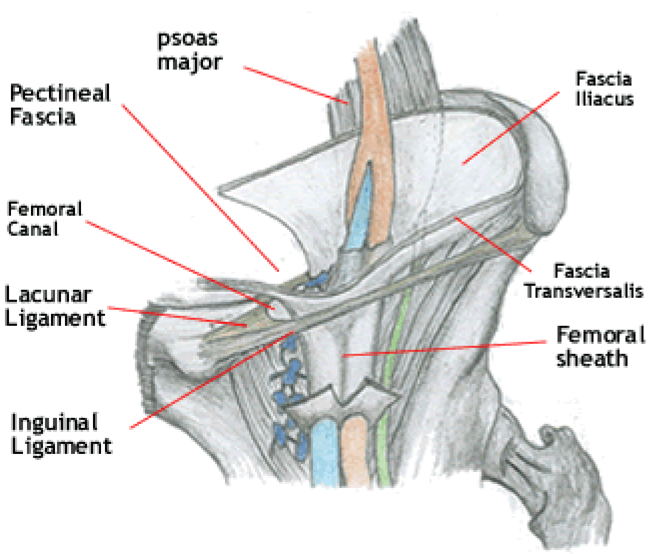
Allows expansion of the vein e.g. during exercise.

It contains:

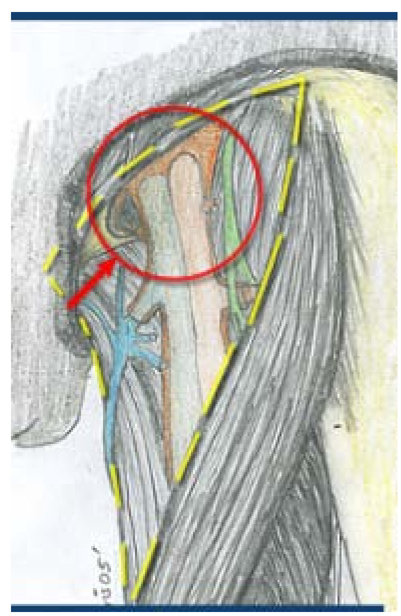
- fat,
- loose connective tissue,
- lymph vessels connecting deep inguinal to external iliac nodes
- nodes of Cloquet.

task ***Identify the muscles labelled 1 and 2 which form boundaries of the femoral triangle and the contents labelled A to D .***

Boundaries of femoral canal

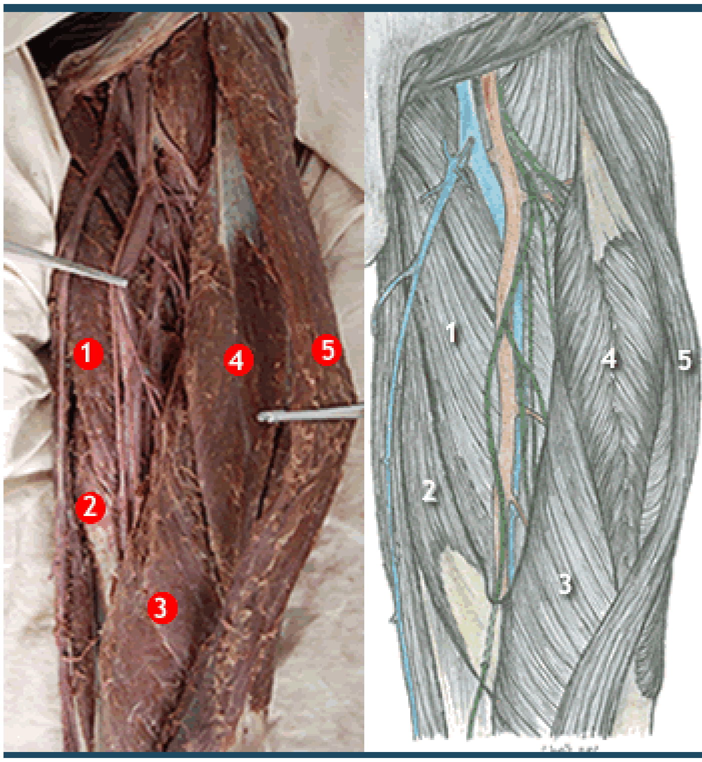


- **Anterior*:*** Inguinal ligament
- **Posterior**: Pectineus and its fascia
- **Medially*:*** Lacunar ligament
- **Laterally*:***Femoral vein



THE ADDUCTOR CANAL:

Boundaries:



Roof (anterior):
Fascia and overlying sartorius

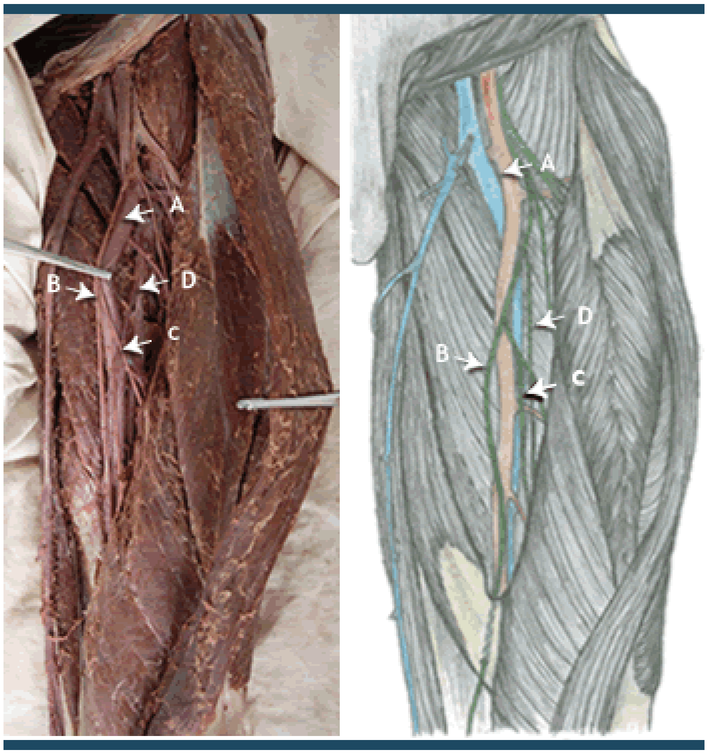
Anterolateral:
Vastus medialis

Posteromedial:
Adductor longus above and adductor magnus below

task ***Name the muscles labelled 1- 5***

Contents of adductor canal:

- Femoral artery and vein **(A)**
- Saphenous nerve **(B)**
- Nerve to vastus medialis **(C)**
- Posterior branch of obturator nerve



Subsartorial nerve plexus:

Found on the roof and is formed by:

- Medial cutaneous nerve of the thigh
- Saphenous nerve
- Anterior division of obturator nerve

task ***What does the subsartorial plexus supply?***

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organization of thigh

Learning points | Core anatomy | Applied anatomy | Review questions

Femoral Vein

Extent

From the **adductor hiatus** as a continuation of the popliteal vein, to the **inguinal ligament** where it continues as external iliac vein.

Course

- Initially posterolateral to the femoral artery then behind and eventually medial to the femoral artery.
- Runs on adductor magnus, longus, then pectineus.
- Covered by sartorius, medial to vastus medialis.

Tributaries

- Profunda femoris vein.
- Lateral and medial circumflex veins.
- Great saphenous vein.
- Deep external pudendal vein Deep circumflex iliac vein.
- Occasionally the subcutaneous vein which usually drain into great saphenous vein

task ***What is the direction of blood flow to the femoral vein?***

task ***How does sitting for long predispose one to pulmonary embolism (Check deep venous thrombosis).***

Femoral Artery:

Continuation of the external iliac artery below inguinal ligament

Extents.

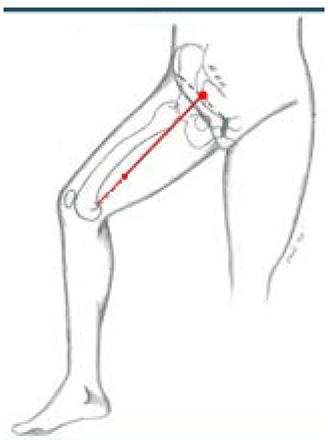
From inguinal ligament to adductor hiatus

Course

- Runs between iliopsoas tendon and pectineus on adductor longus then magnus before exiting adductor canal to become popliteal.

- Covered by femoral sheath, fascia lata, superficial inguinal nodes, superficial fascia and skin.
- Femoral branch of genitofemoral nerve runs more lateral than anterior to it.
- Crossed by the medial cutaneous nerve of the thigh.
- Between femoral vein and femoral nerve.
- Separated from the hip joint capsule by tendon of psoas major.
- In adductor canal it is covered by skin, fascia, sartorius and fibrous sheath of the canal. Femoral vein is first medial then posterior and finally lateral to it.

Surface landmarks of the femoral artery



• Femoral point between anterior superior iliac spine and pubic symphysis.
• Corresponds to upper two thirds of a line joining femoral point to adductor tubercle when thigh is semi flexed, abducted and laterally rotated.

Branches:

Superficial:

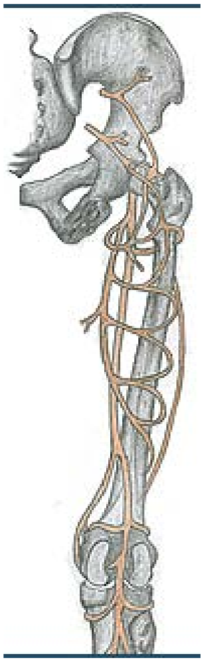
- Superficial epigastric
- Superficial circumflex iliac
- Superficial external pudendal

Deep:

- Profunda femoris
- Deep external pudendal
- Muscular branches
- Frequently lateral and medial circumflex femoral arteries
- Descending genicular

What is the most advantageous point to compress the femoral artery to reduce bleeding from a distal cut?
(Hint femoral point)

Anastomoses:



- Trochanteric anastomosis
- Cruciate anastomosis
- Longitudinal anastomosis : Formed by perforating branches of profunda femoris
- Anterior superior iliac spine anastomosis
- Genicular anastomosis

Thus, through its branches, the external and internal iliac arteries communicate.

Name the arteries that join at each of the anastomoses above.

Femoral Nerve

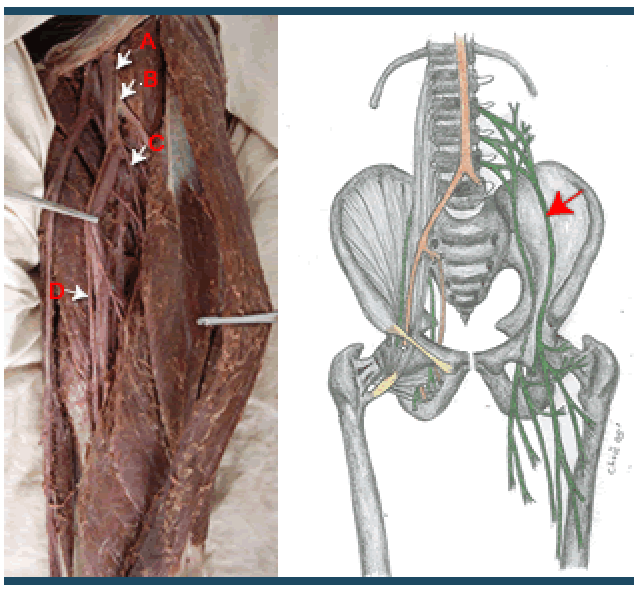
Origins:

Begins from the posterior divisions of ventral rami of L2 , L3, L4 lumbar plexus.

Course

- Exits abdomen deep to inguinal ligament.
- Lateral to femoral artery, outside femoral sheath.
- Found in groove between psoas major and iliacus.

Branches and distribution :



Divides into superficial and deep branches separated by lateral circumflex artery.

Superficial branches

- Intermediate cutaneous nerve of the thigh
- Medial cutaneous nerve of the thigh
- Muscular branches to the sartorius and pectineus

Deep Branches

- Muscular branches to rectus femoris, vastus medialis, intermedius and lateralis
- Saphenous nerve

Note: *The saphenous nerve is the only continuation of the femoral nerve beyond the adductor canal.*

task ***What is meralgia paraesthetica?***

Obturator Nerve

Origins:

Anterior divisions of ventral rami of L2.3.,4

Course

- Exits pelvis through obturator canal joined from below and behind by obturator vessels.
- Divides into anterior and posterior branches:
- Anterior one emerges above obturator internus
- Posterior one pierces obturator externus
- Adductor brevis separates the two branches.

Branches and distribution :

Branch	Distribution
Anterior	**Gracilis** **Adductor longus** **Adductor brevis** **Pectineus** **Hip Joint** **Femoral artery** **Medial aspect of lower thigh and upper leg**
Posterior	**Adductor magnus** **Obturator externus** **Knee joint**

The Hip Joint

Applied anatomy

Dislocations

Dislocation of the hip joint may cause injury to the surrounding structures e.g. the **sciatic nerve** if posterior or **femoral nerve** and **vessels** if anterior .

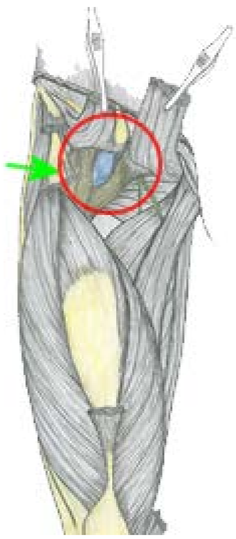
Surgical Approach

The hip joint is frequently approached anterolaterally by opening a wedge between sartorius and tensor fascia lata. In this position only rectus femoris covers the hip joint capsule.

Joint Replacement

In severe damage of the hip joint e.g. by arthritis hip replacement may be done using a steel prosthesis. It may be partial when only one component is replaced or total when both components are replaced

Psoas Bursa



Communication of the psoas bursa with the joint cavity may provide a route for spread of infection.

Femoral neck Fracture

Avascular Necrosis

In intracapuslar fractures of the neck of the femur, the retinaculae and contained vessels may be torn. This leads to necrosis of the proximal fragment. proximal segment.

Pain / Discomfort

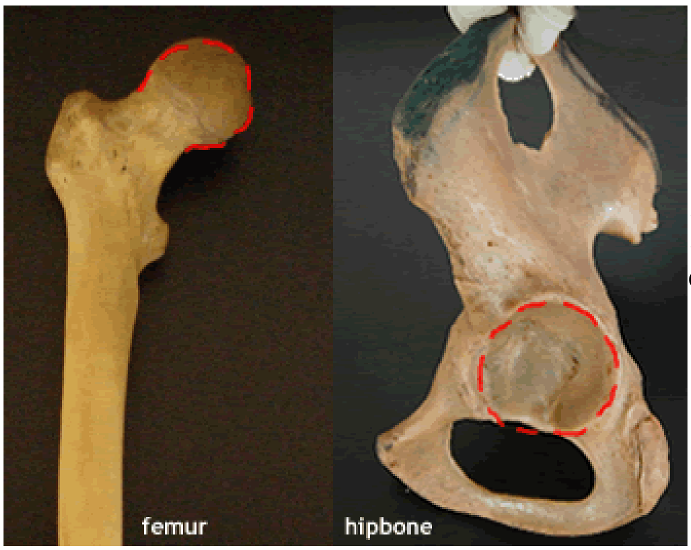
Pain or discomfort in the hip region may be due to disorders from a distance e.g.

- Disorders of the spine and sacroiliac joints
- Disorders of the lower abdomen or pelvis
- Occulusive vascular disease
- Referred pain from e.g. the knee joint due to common innervation

Review Questions

1. Describe the organization and applied anatomy of the hip joint
2. State the presentation, possible complications and treatment options for fracture neck femur.
3. Describe the various modalities of evaluating integrity of the hip joint.

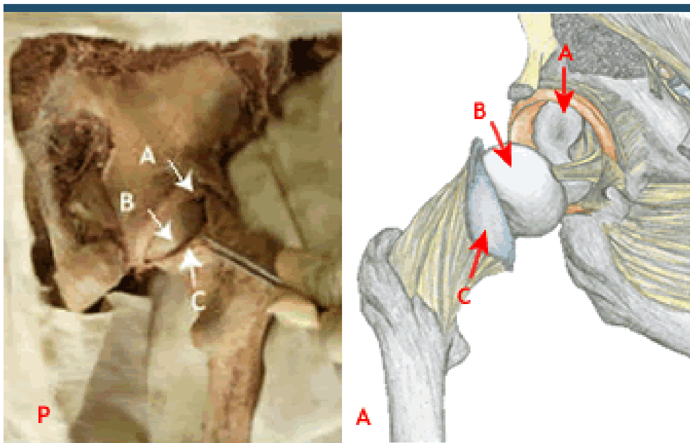
Classification and articular surfaces



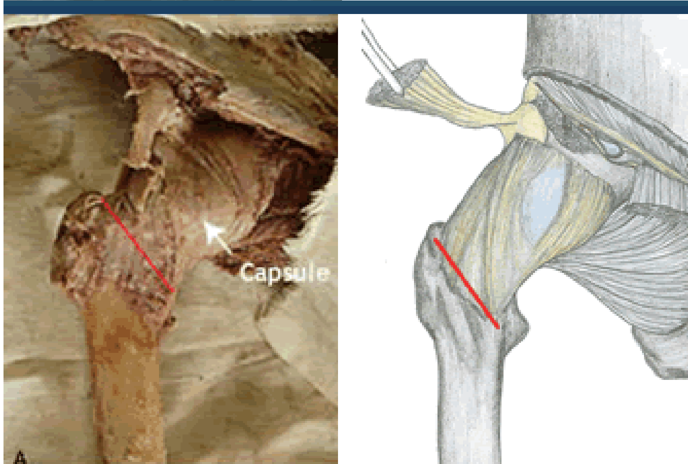
- Multiaxial / synovial of the ball and socket variety
- Formed between the spherical head of the femur and acetabulum of the hipbone

Capsule Features

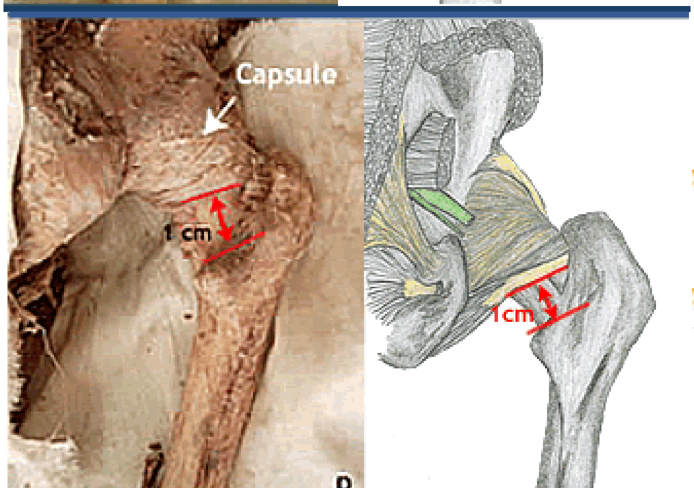
hover over hotspot to show name



Thick and Strong



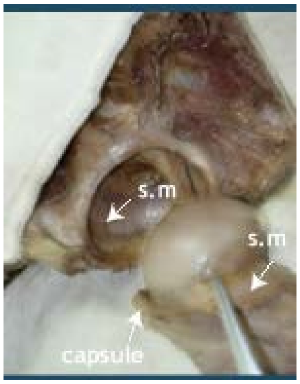
Proximally attached to the acetabular labrum and edges of the acetabular notch



Distally attached to the intertrochanteric line anteriorly
1 cm above the intertrochanteric crest posteriorly

Reflections onto the neck called retinaculae which carry blood vessels to the head of the femur

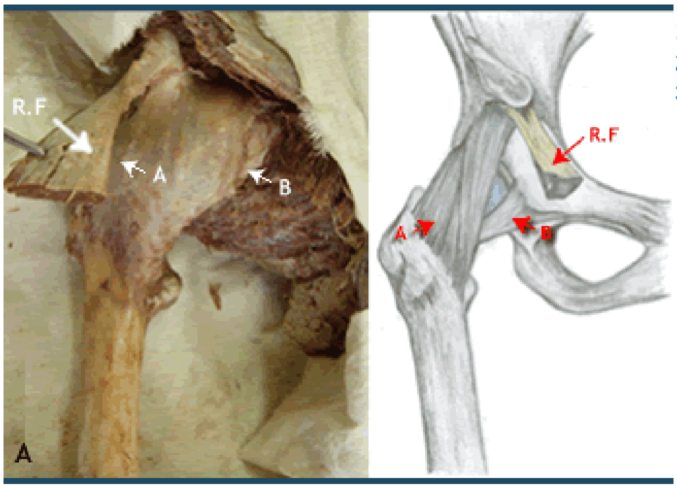
3.3 Synovial membrane



Lines inner surface of the capsule

Continues onto the neck as far as articular cartilage

Stability Factors



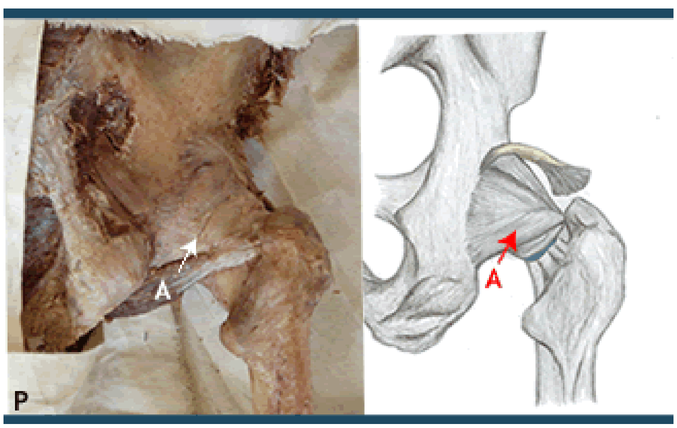
1. Deep acetabulum enhanced by the labrum acetabulare
2. Thick strong capsule
3. Ligaments:

- Iliofemoral ligament
- Ischiofemoral ligament
- Pubofemoral ligament

RF: Rectus femoris
A: Iliofemoral ligament
B: Pubofemoral ligament

4. Muscles sorrounding the joint e.g.

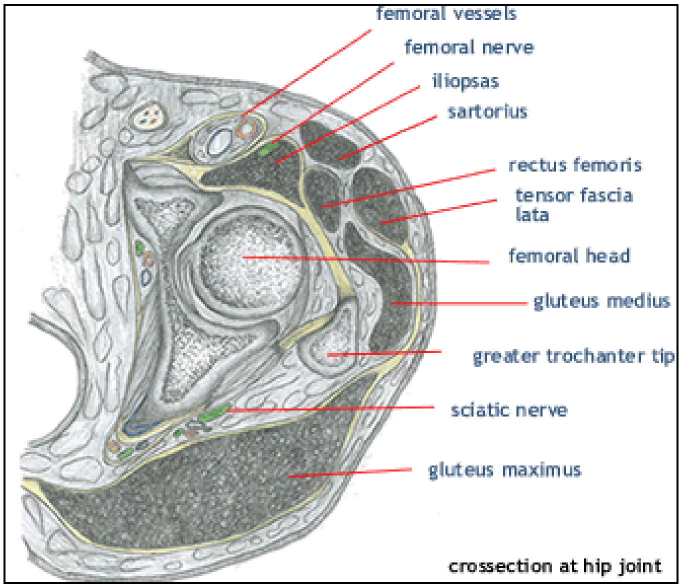
- Obturator externus and internus ,
- Quadratus femoris ,
- Iliacus ,
- Pectineus etc.



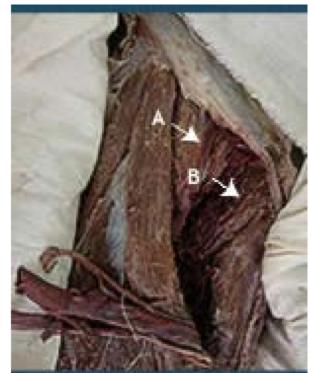
The Hip Joint

Learning points | Core anatomy | Applied anatomy | Review questions

Relations



Anterior
Iliopsoas **(A)** and pectineus **(B)** separating the hip joint from the femoral vessels and nerve



Superior
Gluteus minimus and reflected head of the rectus femoris **(RF)**

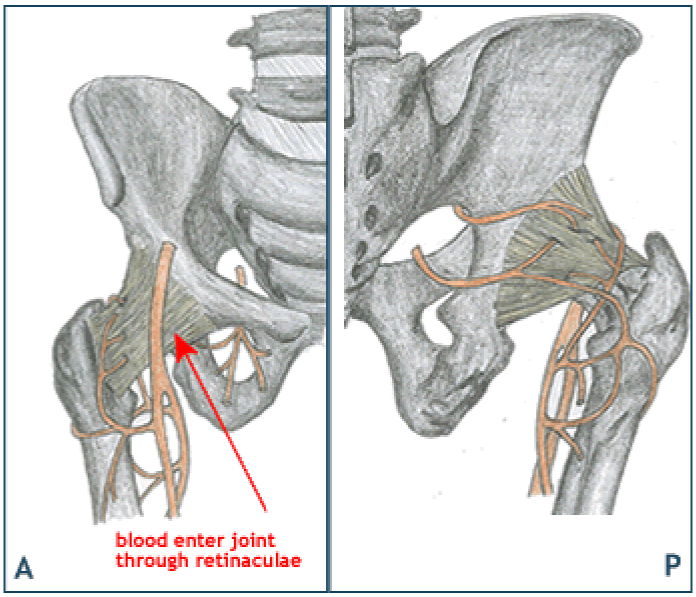
Posterior
Piriformis, obturator internus , gamelli and quadratus femoris separating the joint from sciatic nerve and gluteus maximus

Medially
Acetabular roof separating the joint from pelvic viscera

Inferior
Obturator externus

Laterally
Gluteus medius and tensor fascia lata

3.6 Blood Supply



Blood enters the head from three directions:

1. **Lateral**:

   (+) trochanteric
   (+) cruciate anastomosis.

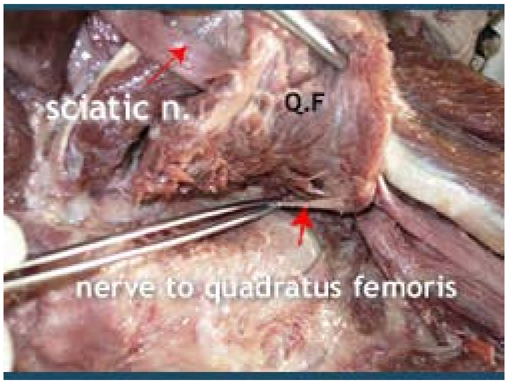
   They reach their destinations through the retinacula

2. **Medially** from the obturator artery through the ligament of the head of the femur

3. From the **nutrient arteries** running through the medullary cavity

This anastomosis persists even in old age but in 20 % it is never found

Innervation of the hip joint



Innervation of the capsule of the hip joint is derived from the following nerves:

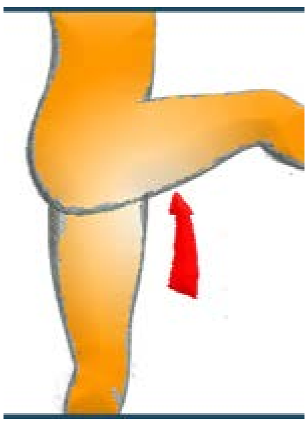
- **Femoral nerve** via the nerve to rectus femoris
- **Tibial component** of the sciatic nerve via the nerve to quadratus femoris (*diagram QF = quadratus femoris*)
- **Anterior division of obturator nerve**
- **Superior gluteal nerve**

The Hip Joint

Learning points | Core anatomy | Applied anatomy | Review questions

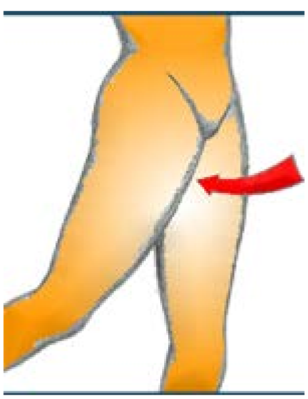
3.8 Movements

Flexion



Iliopsoas, rectus femoris, pectineus, sartorius

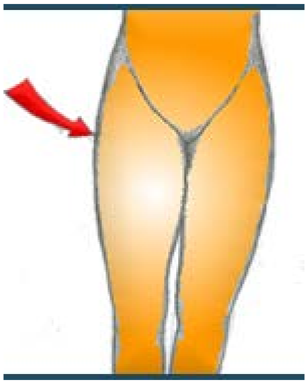
Extension



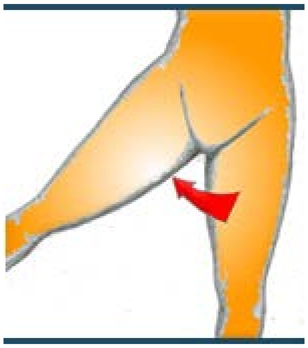
Gluteus maximus, hamstrings, gravity

Adduction

Adductor magnus, longus, brevis and gracilis

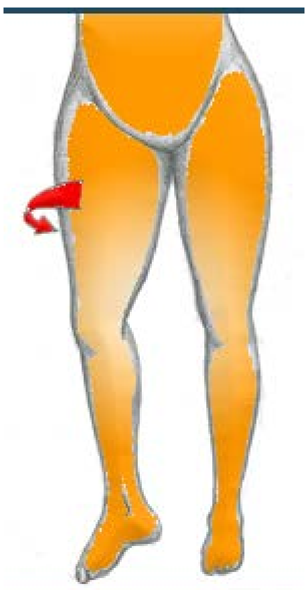


Abduction



Gluteus medius and minimus

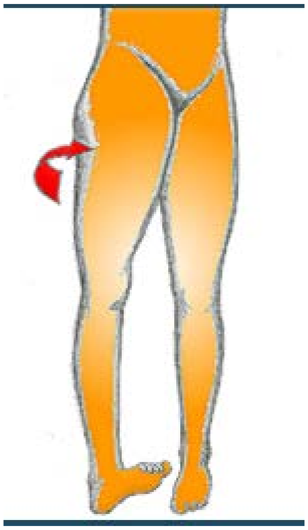
Lateral Rotation



Short lateral rotators: piriformis, quadratus femoris, gamelli, obturator externus & internus, gluteus maximus

Medial Rotation

Iliopsoas, gluteus medius and minimus



Notes:

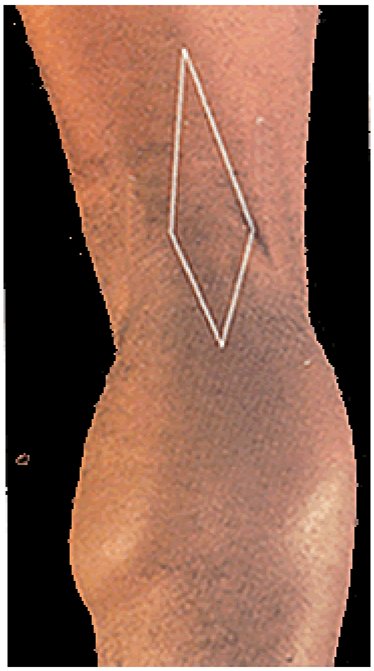
1. Flexion is limited, when the knee is flexed, by the thigh coming into contact with anterior abdominal wall: when the knee is extended by tension in the hamstrings.

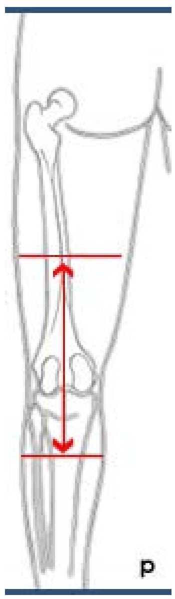
2. Rotation occurs around an axis joining centre of the head of the femur to the intercondylar notch of the femur.

3. The use of the rotators of the hip is appreciated in every step of walking when the pelvis is medially rotated on the weight bearing limb and the swung limb is laterally rotated in order to keep on the line of advance
4. Abduction of the trunk on the lower is seen when one limb is lifted off the ground in standing position and the whole weight is carried by the opposite limb

Poplipteal Fossa:

Location:

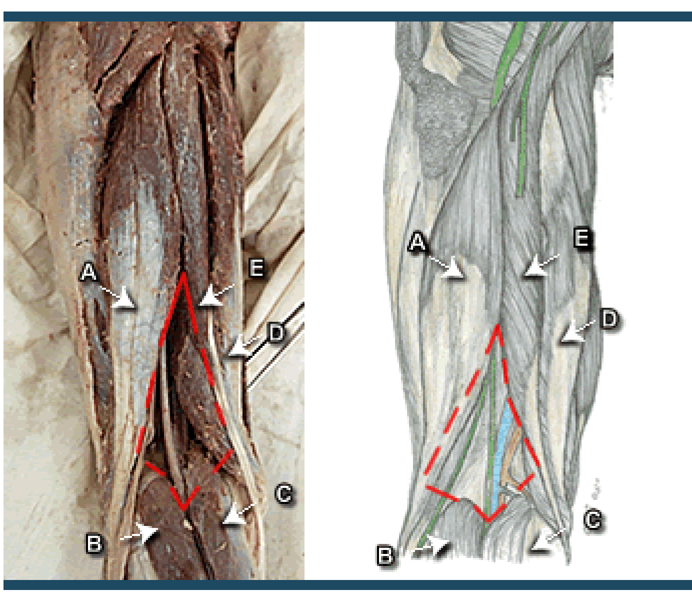




- At the back of the thigh.
- Forms a hollow when the knee is flexed and bulges slightly when the knee is fully extended.
- Posterior to lower third of the femur, the knee joint and upper part of the tibia.

Hover over hotspot to show muscle layer

Boundaries:



Laterally
Biceps femoris above, plantaris and lateral head of gastrocnemius below.

Medially
Semimembranosus and semitendinosus above, medial head of gastrocnemius below.

Floor (Anteriorly)
Popliteal surface of femur, the oblique popliteal ligament, the back of the tibia and the fascia covering the popliteus.

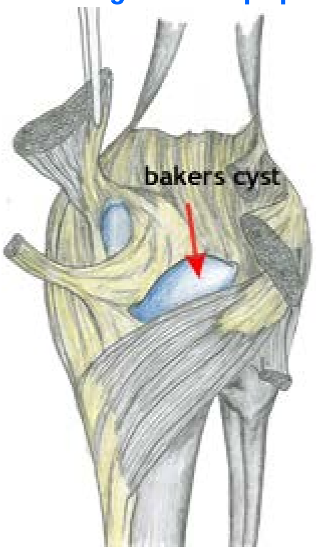
Roof (Posteriorly)
The poplipteal fascia.

Bony boundaries

The medial and lateral supracondylar lines above, and soleal line below.

Clinical Anatomy

Swellings in the popliteal fossa

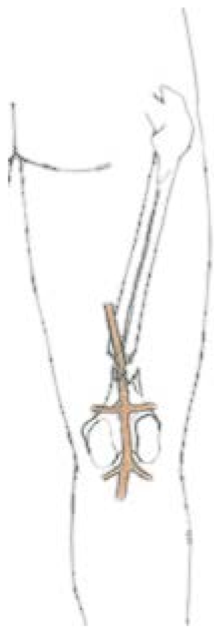


This maybe caused by:

- Inflamed (enlarged) lymph nodes which signify infection or malignancy in the area of drainage of the nodes.
- Aneurysms of popliteal artery or vein.
- Lymphomas
- Abscess
- Neuromas
- Popliteus muscle tumor
- Baker's cyst – protrusion of synovium through the knee joint capsule.
- Septic arthritis of the knee joint

For surgical management of these conditions, the topographic anatomy of the contents must be minded.

The popliteal artery



Injury may follow supracondylar femoral fracture or posterior dislocation of the knee

Popliteal artery entrapment syndrome

- Caused by compression of popliteal artery between gastrocnemi
- Presents with features of leg and foot ischaemia usually intermittent.

Popliteal artery aneurysms

- Can rupture or thromboembolise and cause limb loss

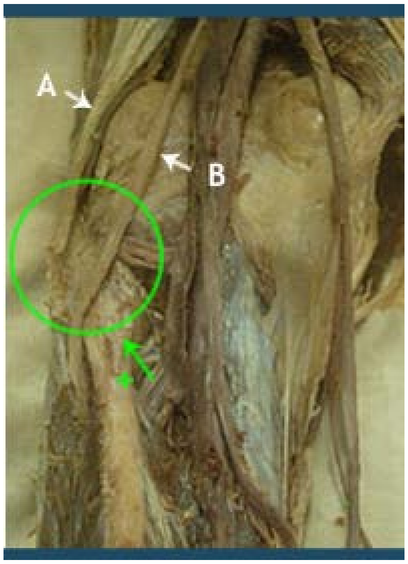
Popliteal vein fat embolism

- May follow supracondylar fracture femur

Common peroneal nerve

- Nerve can be inadvertenty sectioned during biceps femoris tenotomy as in when easing contractures
- Nerve may be compressed against lateral femoral condyle

popliteal region

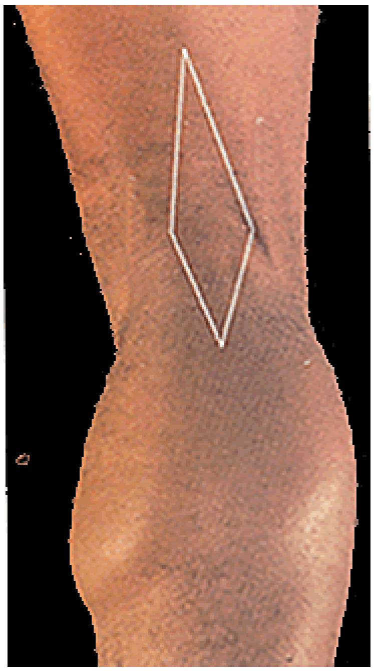


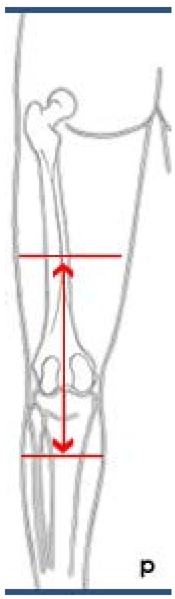
Review Questions:

1. Describe the boundaries including roof (posterior wall) and floor (anterior wall) of the popliteal fossa.
2. State the main contents of the popliteal fossa.
3. State the extents, surface landmarks and branches of the popltiteal artery.
4. Define the region(s) drained by popliteal lymph nodes.
5. What conditions would present as soft masses in the popliteal fossa?

Poplipteal Fossa:

Location:

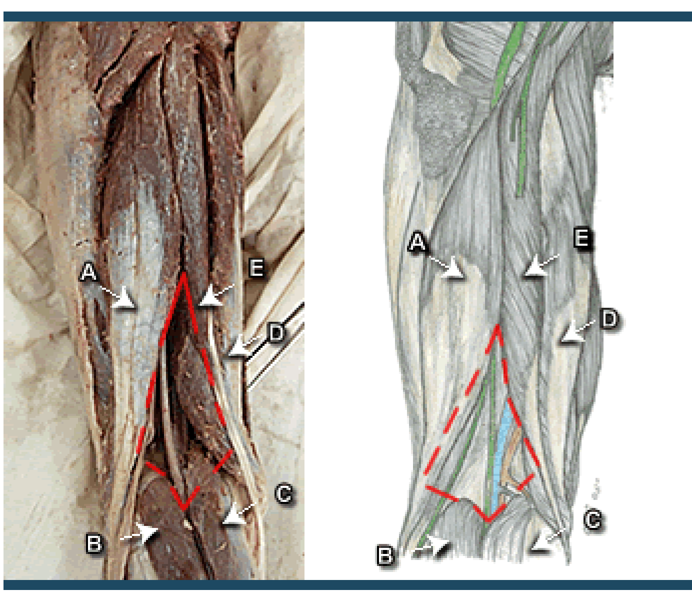




- At the back of the thigh.
- Forms a hollow when the knee is flexed and bulges slightly when the knee is fully extended.
- Posterior to lower third of the femur, the knee joint and upper part of the tibia.

Hover over hotspot to show muscle layer

Boundaries:



Laterally
Biceps femoris above, plantaris and lateral head of gastrocnemius below.

Medially
Semimembranosus and semitendinosus above, medial head of gastrocnemius below.

Floor (Anteriorly)
Popliteal surface of femur, the oblique popliteal ligament, the back of the tibia and the fascia covering the popliteus.

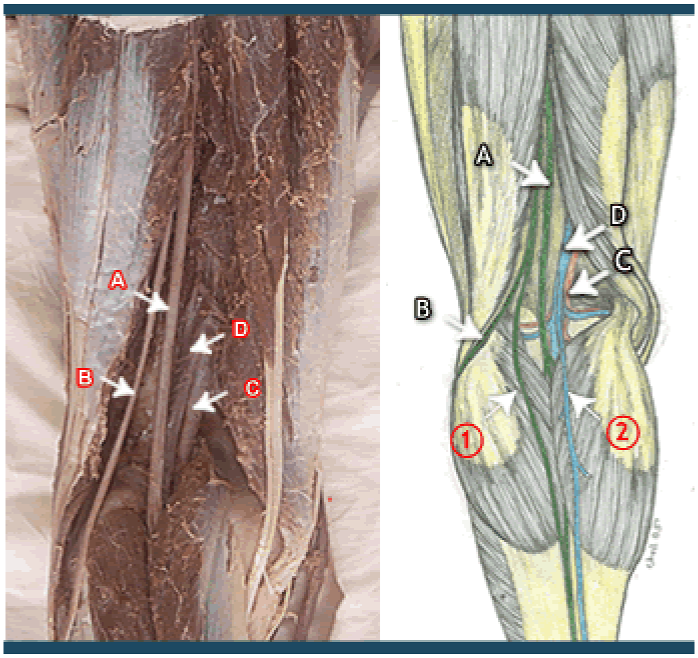
Roof (Posteriorly)
The poplipteal fascia.

Bony boundaries

The medial and lateral supracondylar lines above, and soleal line below.

Popliteal fossa

Contents:



- Popliteal artery and its branches
- Popliteal vein and its tributaries
- Tibial and common peroneal nerves.
- Termination of the small saphenous vein.
- Lower part of the posterior cutaneous nerve of the thigh.
- Popliteal lymph nodes, connective tissue and fat.

Hover over hotspot to show name

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Popliteal Artery

Extents

The popliteal artery is the continuation of the femoral artery

From the Adductor hiatus to the soleal arch / lower border of the popliteus muscle

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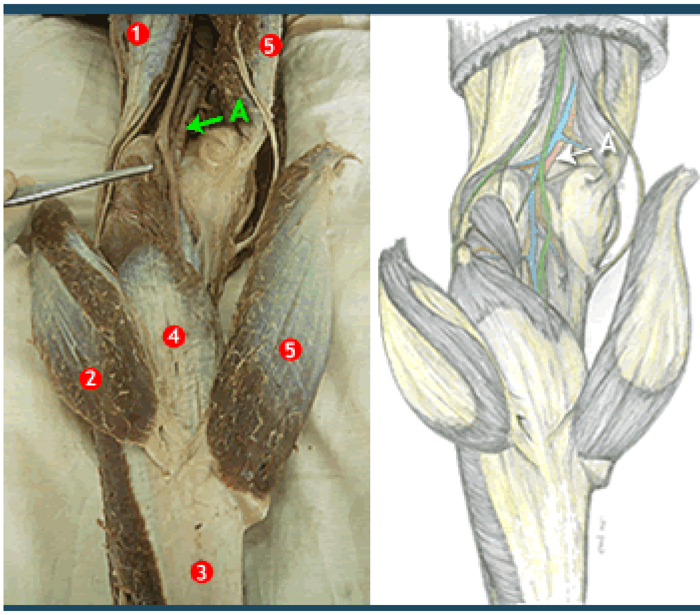
Relations:



Hover over hotspot to show muscle layer

Anteriorly:
Femur (fat intervening), capsule of knee joint and popliteus (covered by the popliteus fascia)

Posteriorly:
Gastrocnemius and plantaris . crossed from lateral to medial side by the tibial nerve and popliteal vein , the vein being between the artery and the nerve

Laterally:
Above are biceps femoris, tibial nerve, popliteal vein and the lateral condyle of the femur and below are plantaris and lateral head of gastrocnemius.

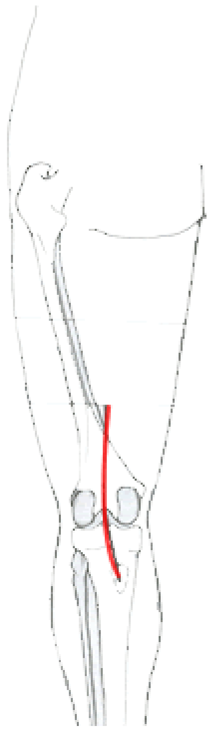
Medially:
Above are semimembranosus and the medial condyle of the femur and below are the tibial nerve, popliteal vein and medial head of gastrocnemius.

Variations:

- Early bifurcation (above the level of popliteus)
- Division into anterior tibial and peroneal arteries with rudimentary posterior tibial
- Trifurcation:Anterior and posterior tibial and peroneal arteries.

Surface Anatomy :

Represented by a line from the junction of the middle and lower thirds of the thigh down and laterally to the midline between femoral condyles. It continues obliquely inferomedially



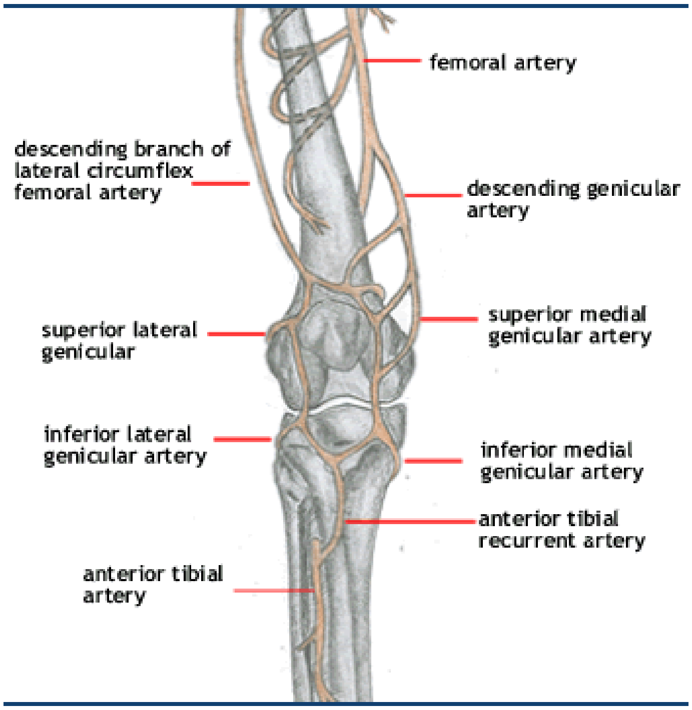
until the level of the tibial tubersosity.

Branches:

These include:

- Muscular branches.
- Artcicular (genicular) branches to knee joint.
- Anterior tibial artery.
- Posterior tibial artery.

Genicular Anastomosis:



Note the following:

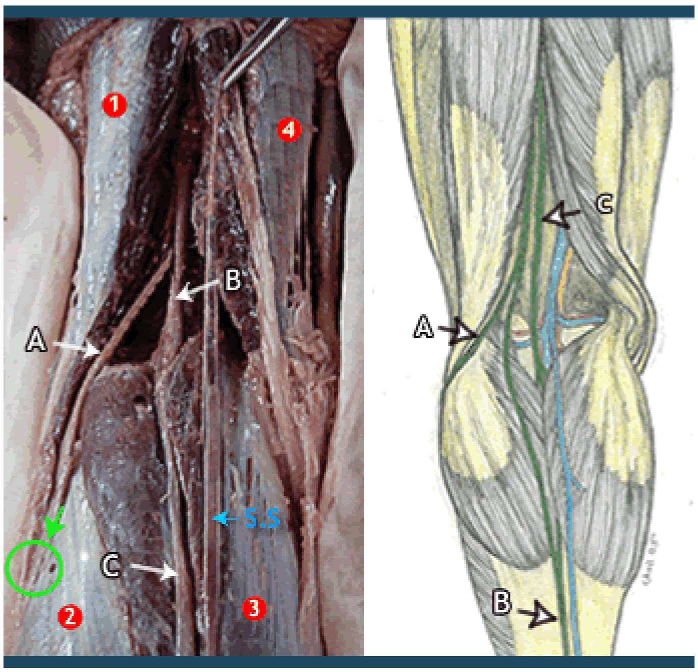
1. Two named genicular branches of popliteal artery on each side – a superior and an inferior.
2. Three supplementary arteries:

- Descending genicular branch of the femoral artery superomedially.
- Descending branch of the lateral femoral circumflex artery, superolaterally.
- Anterior recurrent branch of anterior tibial artery, inferolaterally.

3. The inferior lateral genicular artery runs along the lateral meniscus; an unnamed artery runs similarly along the medial meniscus.

Nerves of the popliteal fossa:

Hover over hotspot to show name



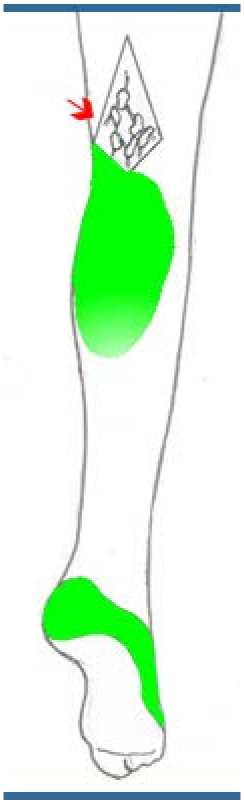
Note the following points about these nerves.

1. The formation of the sural nerves by branches of the tibial (medial sural) and common peroneal (lateral sural) nerves.
2. All motor branches in this region spring from the tibial nerve, one branch coming from the medial side, the others from its lateral side, hence, its safer to approach the nerve on its medial side.
3. The common peroneal nerve follows the medial border of the biceps femoris.

Popliteal Lymph Nodes:

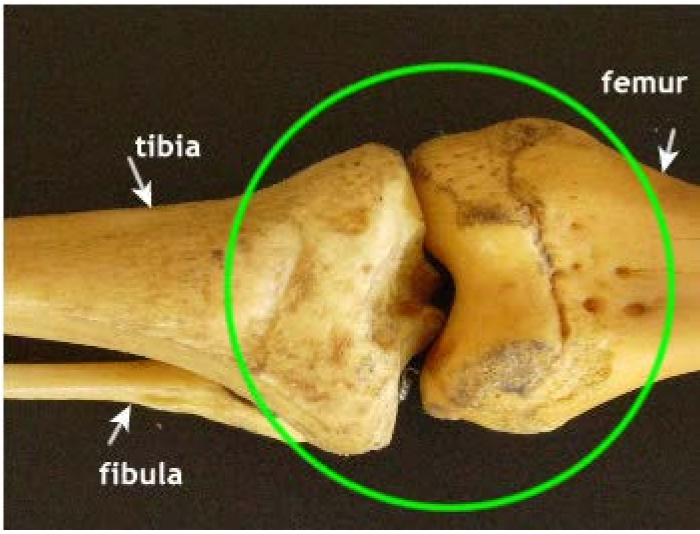
Lymph nodes embedded in the fat drain the

- Lateral part of the foot
- The heel
- Back of the leg



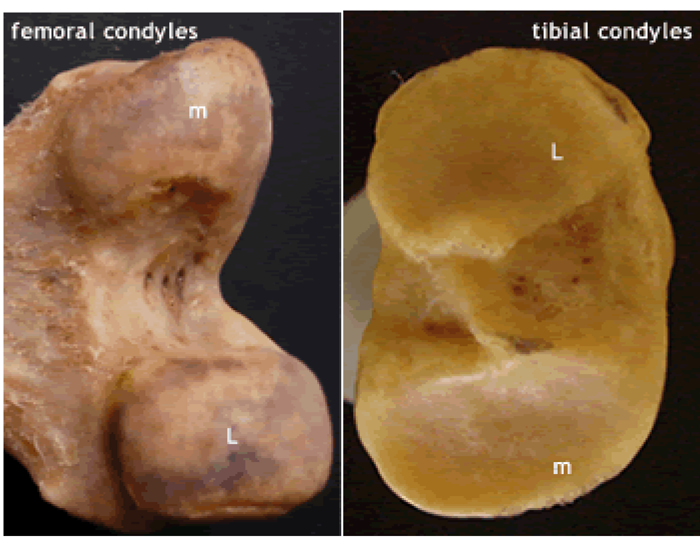
THE KNEE JOINT:

Classification:



Compound synovial of the condylar and sellar variety between condyles of femur and tibia and posterior surface of patella.

Articular surfaces:



The articular surfaces of the joint are far from being congruent and the joint would be very unstable were it not for the support provided by the ligaments, tendons and muscles around it. The femoral condyles are convex from side to side and from before backwards. The lateral condyle flattens from before backwards more rapidly than the medial one. The tibial condyles are flat and are separated form each other by the intercondylar area.

Applied Anatomy

Meniscal tears

The medial meniscus is more commonly torn because it is less mobiile.

- Peripheral tears bleed- red tears
- Central tears don't bleed- white tears

Cruciate Ligament injuries

- Anterior cruciate more commonly affected as its more fixed

Collateral ligament sprains or ruptures

- Occur because of forced twisting: Abduction or adduction

Arthritis of the knee joint

- Osteoarthritis, septic arthritis, synovitis,

Bursitis

- Clergyman's knee - infrapatella bursa
- Housemaids knee - pre patella bursa

Unhappy triad

This simultaneous tear of three structures attached to each other:

- Medial meniscus
- Anterior cruciate ligament
- Tibial collateral ligament

It is a common injury among footballers, and occurs during forceful abduction and lateral rotation of the leg. These movements cause excessive tension on the medial aspect of the knee.

Surgical Approach

- The knee joint is widely exposed from the front on either side of the patella by incisions through the vasti and alongside the patella and its ligaments

- Exposure of the back of the knee joint capsule through the popliteal fossa involves opening up the interval between the tibial nerve and Semimembranosus
- The nerves and vessels are displaced laterally
- The medial head of gastrocnemius is detached.

Knee aspiration

Usually carried out from the side at the upper margin of the patella, the needle entering the suprapatella bursa.

Injection into the knee

Joint is entered at the lower border of the patella on either side of the patella ligament. Care must be taken not to damage menisci or joint surfaces.

Arthroscopy

This is the examination of the knee cavity using scope. The approach is usually on the lateral side of the patella ligament.

The knee joint is clinically five joints in one. Because lesions in other joints can cause symptoms in the knee joint, and also because of its complexity, the joint can clinically be looked as made up of:

- Medial tibio-femoral joint
- Lateral tibio-femoral joint
- Patellofemoral joint
- Proximal tibio-femoral joint
- Hip joint

Home | Gross Anatomy | Topic Index | Chapter 9

Learning points | Core anatomy | Applied anatomy | Review questions

Review Questions

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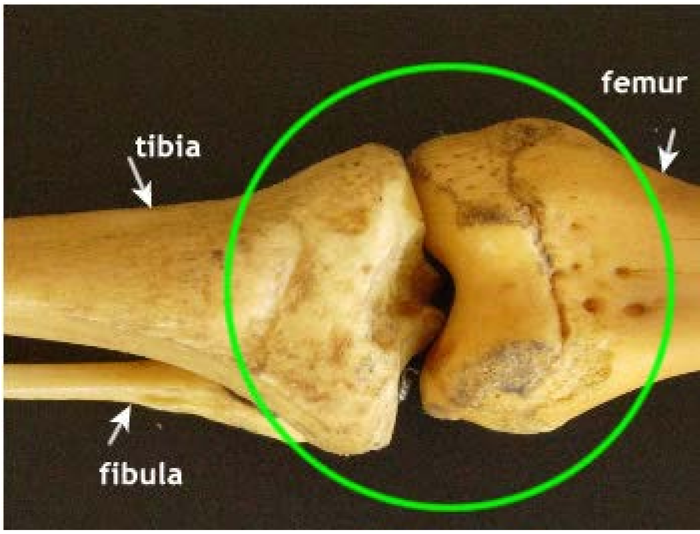
1. Give an account of the classification, relations, stability factors, blood supply, innervation and movements of the knee joint.
2. Write short notes on the attachements and functions of:

- *Menisci*
- *Cruciate ligaments*
- *Patella*

3. Give an account of the locations and communications of the bursae around the knee joint.

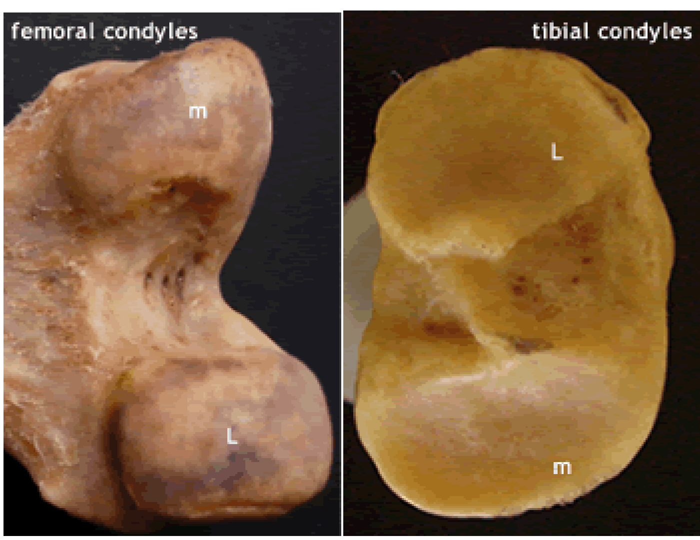
THE KNEE JOINT:

Classification:

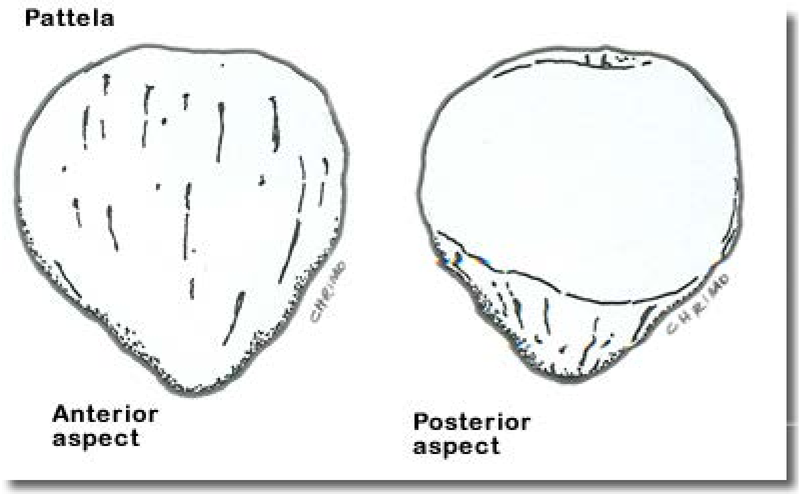


Compound synovial of the condylar and sellar variety between condylies of femur and tibia and posterior surface of patella.

Articular surfaces:

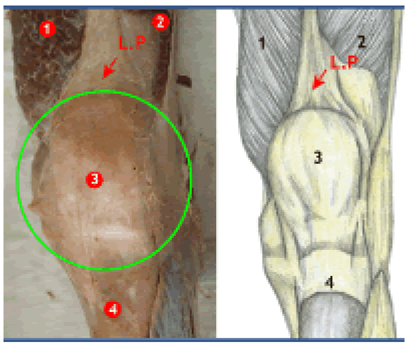


- Superior surface of tibial condyles
- Femoral condyles
- Posterior surface of the patella


Pattela
Anterior
aspect
Posterior
aspect

Fibrous capsule

- Attached to margins of articular surfaces
- Can be divided into posterior, medial, lateral and anterior portions.



Anteriorly Replaced by quadriceps tendon-patella-ligamentum patella complex

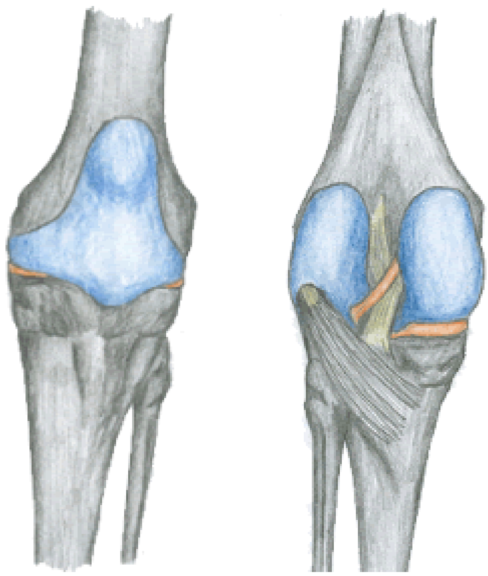
Anterolaterally reinforced by lateral patella retinaculae

Anteromedially reinforced by medial patella retinaculae

Posteriorly reinforced by oblique and arcuate popliteal ligaments

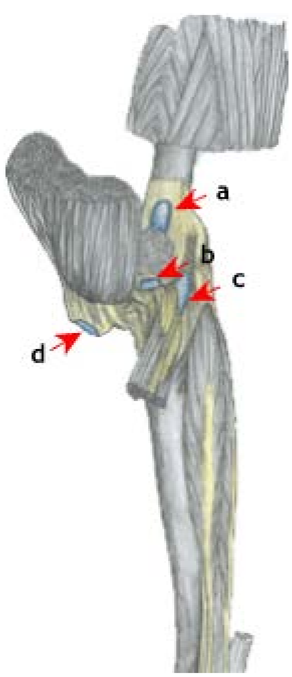
Synovium and Bursae

Synovium of the knee joint:



- Lines inside of capsule
- Extends upwards as suprapatella bursae
- Extends on the sides deep to the aponeurosis of the vasti
- Covers the lateral and anterior aspects of cruciate ligaments
- Passes between the two cruciate ligaments to form the inter cruciate bursae
- Forms alar folds on either side of the patella
- Extends downwards as infrapatella fold (ligamentum mucosae)

Bursae around the knee joint:



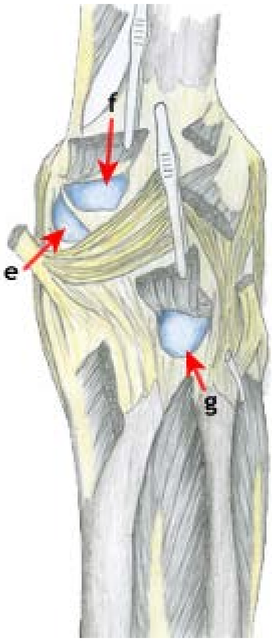
Four large bursae namely:

- Suprapatellar
- Subcutaneous prepatellar
- Subcutaneous infrapatellar
- Deep infrapatellar

9 smaller un named bursae located between

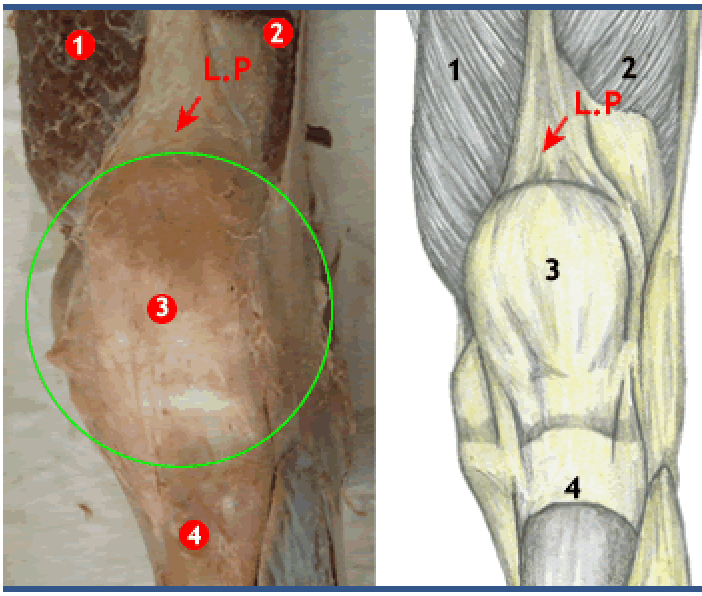
1. Tendons and capsule
2. Tendons and bones
3. Two tendons
4. Tendons and ligaments

Task: Name the bursae around the knee joint labelled a-f


f
e
g

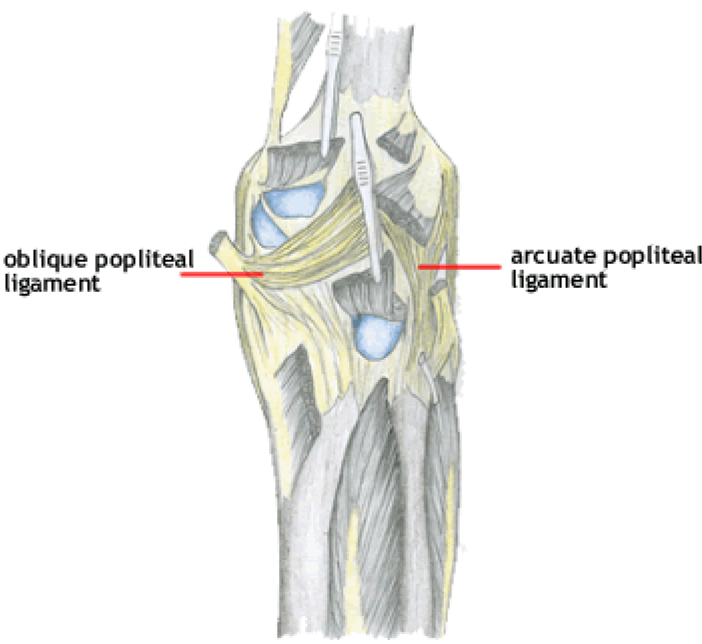
Ligaments

Ligamentum patellae:



Anteriorly: Ligamentum patella.

Oblique popliteal ligament:



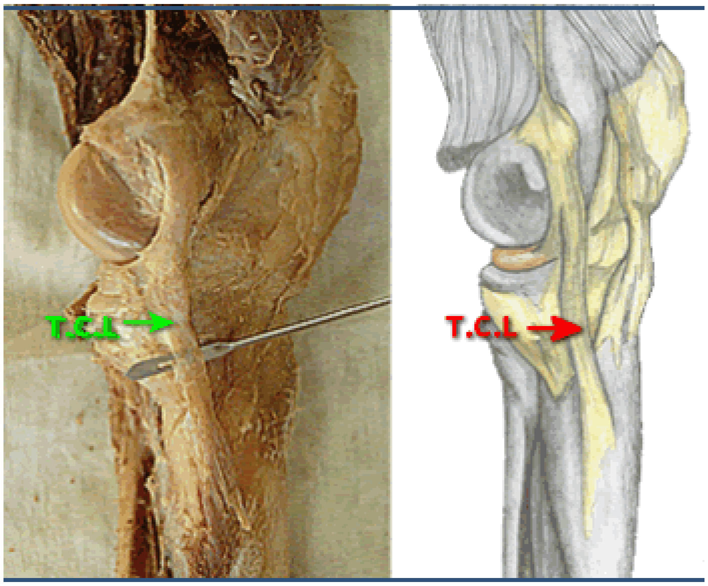
- This is an expansion from the tendon of the semimembranosus.

Arcuate popliteal ligament:

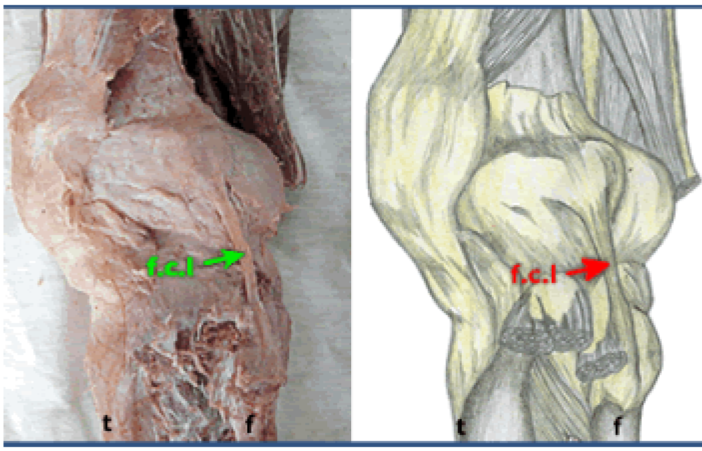
- Condensation of the fibrous origins of popliteus muscle

Tibial collateral ligament:

- Is a capsular thickening.



Fibular collateral ligament:

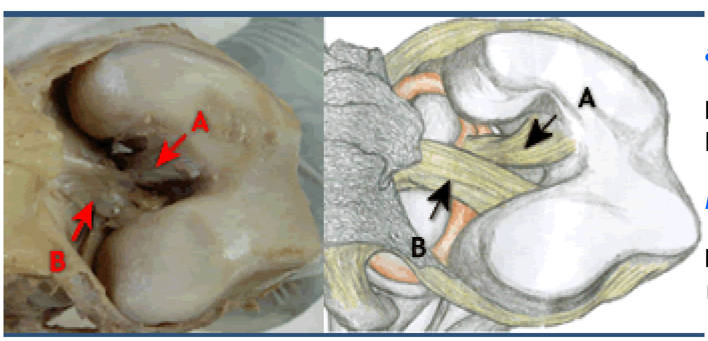


Extracapsular ligament

(Note the fibular collateral ligament [f.c.l] inserting onto the fibula [f])

Cruciate ligaments

Called cruciate because they cross each other in the saggital plane.

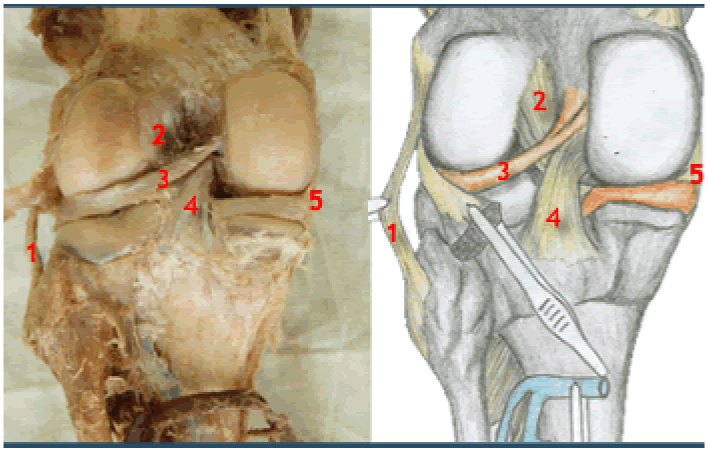


a) Anterior cruciate ligament.

From anterior tibial intercondylar crest to medial surface of the lateral femoral condyle.

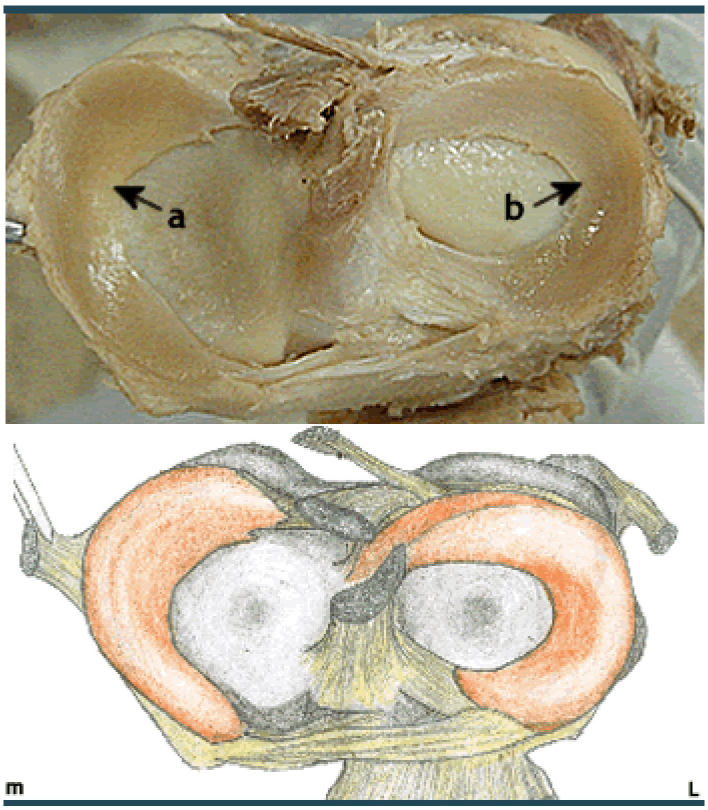
b) Posterior cruciate ligament.

From posterior tibial intercondylar crest to lateral surface of medial femoral condyle.


2
3
4
5
1
2
3
5
4
1

Menisci:

Semilunar fibro cartilaginous discs



Medial:

Nearly semicircular and larger. More fixed by attachment to tibial collateral ligament and anterior cruciate.

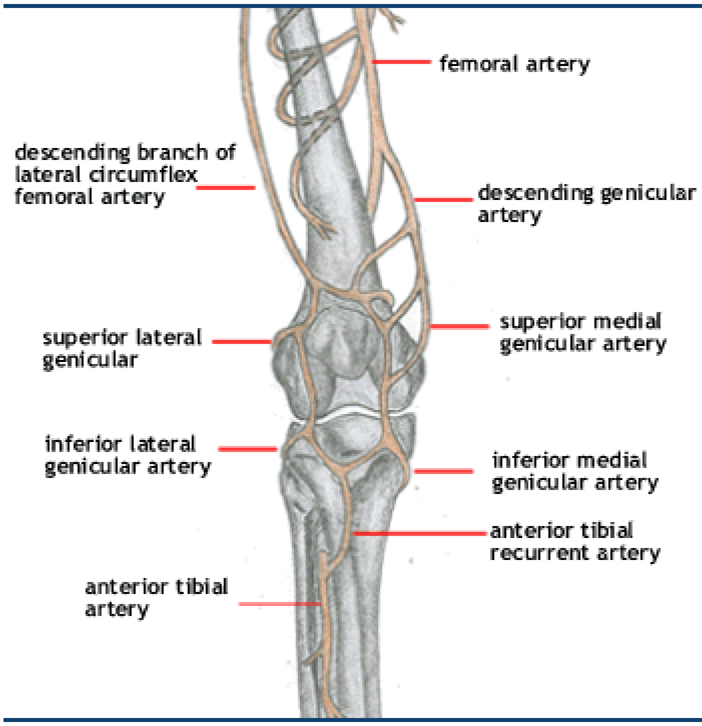
Lateral:

Nearly circular in shape. more mobile

Functions of the menisci:

1. *Increase the congruence of articular surfaces*
2. *Shock absorbance.*
3. *Protect the articular cartilage on the femoral and tibial condyles.*
4. *Distributes synovial fluid*
5. *Increase proprioceptive sensibility*

Blood supply:



Genicular anastomosis formed by the following arteries

From popliteal artery

- Superior medial genicular
- Inferior medial genicular
- Superior lateral genicular
- Inferior lateral genicular
- Middle genicular

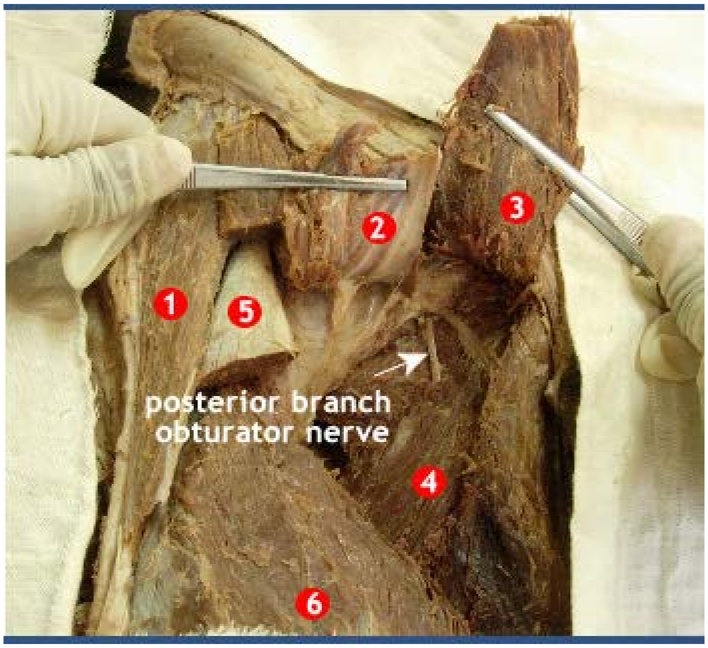
From other sources

- Anterior recurrent branch of the anterior tibial artery.
- Descending genicular from the lateral circumflex femoral
- Descending genicular from the femoral artery

Venous drainage occurs through the corresponding veins that empty into the popliteal and femoral veins respectively.

Innervation:

Hover over hotspot to show name



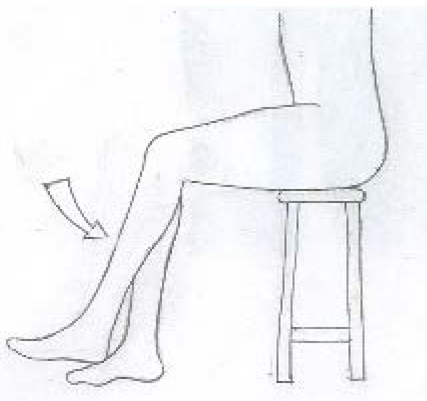
- Posterior branch of the obturator nerve.
- Saphenous branch of the femoral nerve.
- Genicular branches of the tibial nerve.
- Genicular branches of the common peroneal nerve.

Movements:

- Flexion.
- Extension.
- Medial rotation of the flexed knee.
- Lateral rotation of the flexed knee.

Muscles producing the movements:

Flexion:

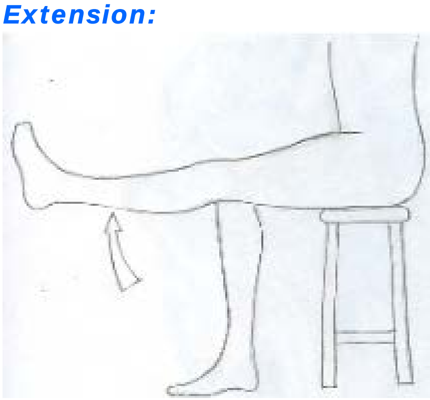


- Harmstrings

Others assisting:

- sartorius,
- Gracilis
- Popliteus and also by the
- Gastrocnemius
- Plantaris when the foot is on the ground.

Extension:



- Quadriceps femoris
- Tensor fascia latae

Medial rotation of the flexed leg:

- Popliteus,
- Semitendinosus,
- Semimembranosus
- Sartorius and
- Gracilis.

Lateral rotation of the flexed knee:

- Biceps femoris

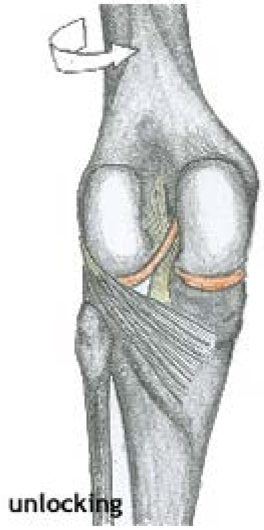
"Locking" and "Unlocking" mechanisms of the knee

Locking:

- Additional 30° of knee extension caused by medial rotation of femur on the tibia.
- Caused by longer articulating surface of the medial femoral condyle

Unlocking:

- Initial 30° of knee flexion
- Caused by lateral rotation of femoral condyle on the tibia.
- Done by popliteus muscle

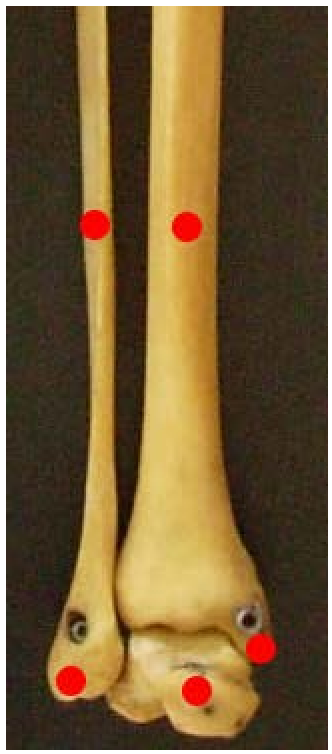

unlocking

Bones of the leg

Bones of the leg include the

1. the tibia
2. the fibula

s.



Note :

1.The tibia is subcutaneous and has one large nutrient artery in the proximal 1/3 therefore its blood supply is precarious.

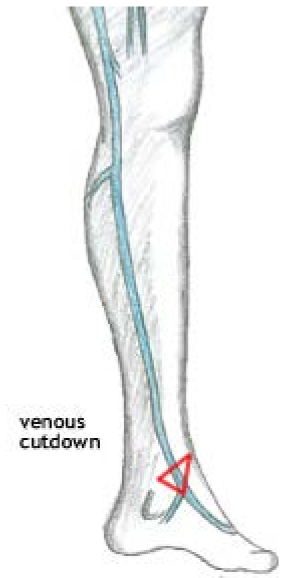
2. The narrowest part of the tibia is between middle and distal thirds. This is the commonest site of fracture.|

3. Fractures of the distal tibia unite poorly and often fail to unify because of poor blood supply.

4. Fibular commonly fractures in the distal third. It is not a weight bearing bone and so parts of it can be used in bone graft

Applied Anatomy

1.) Venous cutdown



The long saphenous vein can be exposed a thumb breadth above and anterior to the medial malleolus.

It can therefore be used to rapidly infuse fluid in dehydrated individuals especially children.

This procedure is called *venous cutdown* .

Great saphenous vein grafts

The GSV is used for coronary bypass. During its harvesting or in cutdown, the saphenous nerve may be injured causing pain and paraesthesia after surgery.

2.) Varicose veins

These are dilated elongated tortuous veins. This condition can be caused by;

- Perforator valvular incompetence causing backflow from deep veins
- Compression of external or common iliac veins such as in pregnancy or pelvic tumors.
- Prolonged standing

Possible complications of this condition include;

- Thrombosis and subsequent embolism due to venous stasis
- Varicose ulcers; due to poor circulation and impaired tissue perfusion

Usually managed by;

- Muscular exercise

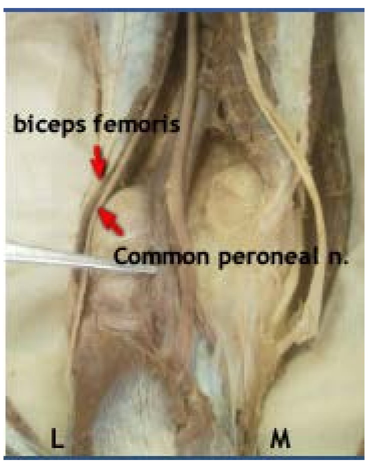
- Use of elastic stockings
- Ligation of faulty perforators.

---

3. Common peroneal nerve

Most commonly injured nerve in the lower limb as it winds round fibula neck by :-

- Direct trauma
- Pressure by plaster casts or over hard bends
- Fracture/ dislocation of fibula
- Superficial wounds



Other sites of injury:

- Gluteal region e.g. piriformis syndrome
- Popliteal fossa: supracondylar fractures
- Biceps femoris tenotomy
- Over the lateral femoral condyle
- Over fibula head

Injury results in

- Unopposed plantar flexion causing ***foot drop.*** This causes a **high *steppage gait*** to ensure that toes don't scrape the ground
- loss of eversion
- weakened inversion
- Sensory loss over the lower lateral leg and dorsum of the foot.

Surgical approach to the nerve is by following it medial to tendon of biceps femoris

---

4. Tibial Nerve

Main effect is paralysis of calf muscles, and sensory loss on the lower calf and sole.

Tested for standing on tiptoe

Surgical approach in middle of popliteal fossa. Split gastrocnemius and soleus vertically in midline

---

6. Popliteal Artery

Intermittent claudication

- Pain in the leg muscles on walking or running which stops at rest
- Caused by atherosclerosis or compression of popliteal artery

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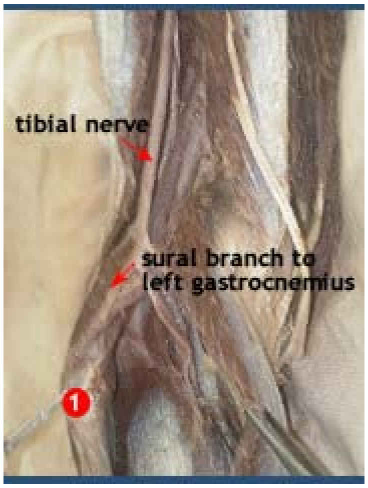
7. Muscular Necrosis



Each head of gastrocnemius receives one artery only, as opposed to soleus with several branches. Occlusion of the artery to gastrocnemius can cause necrosis of the muscle with soleus being spared.

---

8. Deep Venous Thrombosis

The gastrocnemius has sinusoids and therefore blood flow is sluggish. In prolonged immobility there maybe thrombosis (deep venous thrombosis). This can lead to embolism.

Compartment Syndrome

See section under thigh

The anterior compartment is the tighest therefore the most commonly affected.

Precarious blood supply to the Tibia

This is because

- The tibia has a large subcutaneous surface
- Only one large nutrient artery in the proximal third
- No muscle attachment in the distal third

Therefore tibial fractures in the distal third heal slowly and may fail to unite

---

Dorsum of foot

Testing of extensor tendons

Tendon	Innervation	Test

Tibialis anterior	Deep peroneal (L4)	Dorsiflex foot against resistance
Extensor hallucis longus	Deep peroneal (L6)	Dorsiflex hallux against resistance
Extensor digitorum longus	Deep peroneal (L5, S1)	Dorsiflex lateral four toes against resistance

Dermatomes

In injury to peroneal nerve, loss of sensation over dorsum with sparing of 1st inter-digital cleft localizes injury to the superficial branch.

Venous access

Subcutaneous layer is scanty on the dorsum of the foot. This allows easy visualization and access of veins.

Dorsalis Pedis

Palpation of dorsalis pedis pulse is important in evaluating peripheral vascular disease of the lower limb.

Review Questions

1. Give an account of the origin , course and communication of the long saphenous vein. Add brief notes on the causes , effects and treatment of varicose veins.

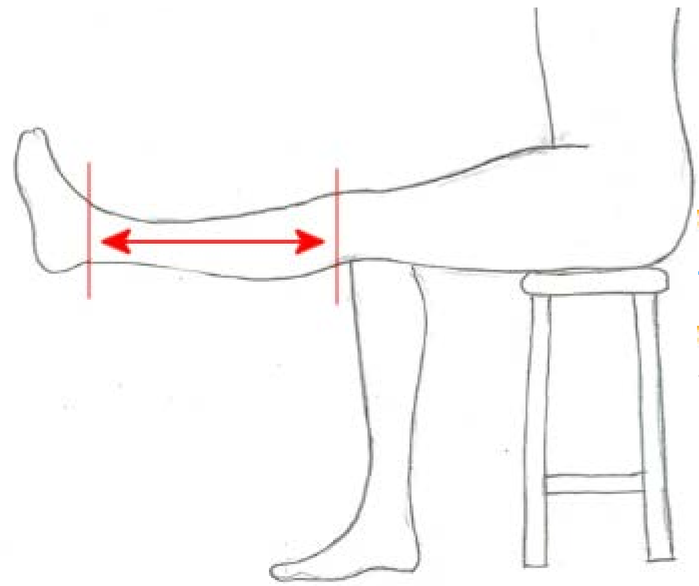
2. Give an account of the origins , course , relations and distribution of the common peroneal nerve . Add notes on the causes and effects of injury to this nerve

3. Describe using clear diagrams the formation and contents of the various leg compartments . Add brief notes on the causes and effects of compartment syndrome in the leg.

4. Explain briefly the pattern of blood supply to the tibia and comment on the clinical importance of this pattern .
5. Discuss the origins , branches , distribution and surface landmarks of the anterior and posterior tibial arteries. Add notes on the anastomoses between this and with other arteries.

ORGANISATION OF THE LEG

EXTENTS



Between the knee and the ankle joint

The skin of the leg

Thin, in some areas directly adherent to the periosteum of the anterior tibia, distal fibula

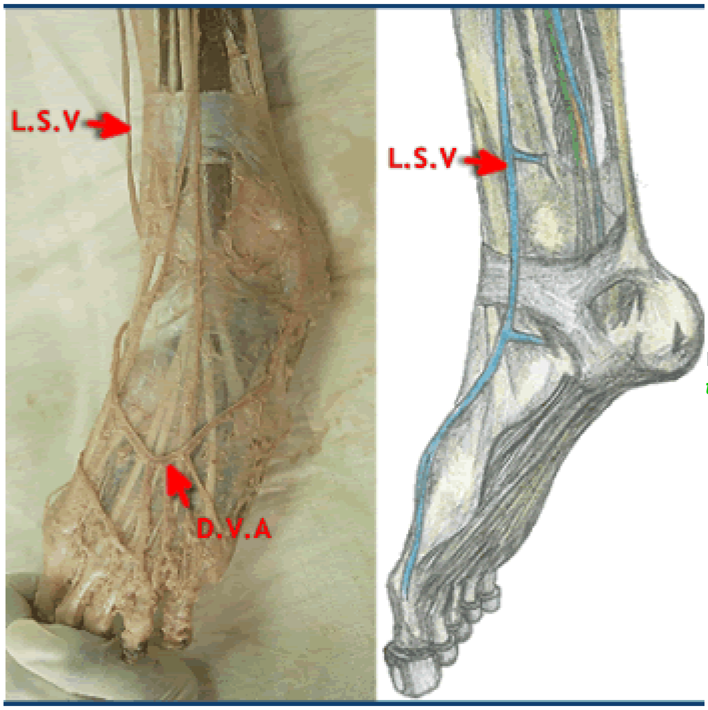
structures in the superficial fascia

The saphenous, short and accessory saphenous vein and their tributaries.

a) the long saphenous vein

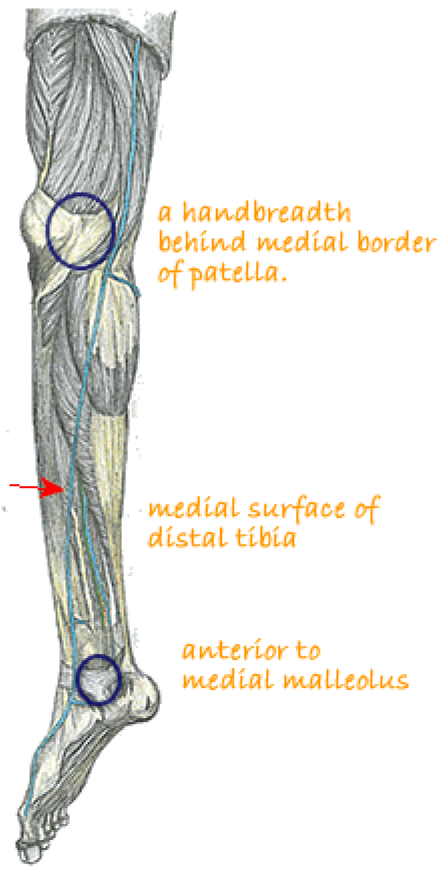
Origins

medial continuation of the dorsal venous arc, joined by the



medial marginal vein of the foot. ***(Dorsal Venous arc [D.V.A] forming the long saphenous vein [L.S.V] on the medial side of the foot)***

Course



- Runs with sapheous nerve
- Runs a thumb breath anterior and medial to the medial malleolus
- Medial surface of the distal tibia
- Behind the medial border of the proximal tibia
- Handbreadth behind medial border of patella
- Medial convexity of the thigh
- Passes through saphenous opening 3-4cm below and lateral to the pubic tubercle

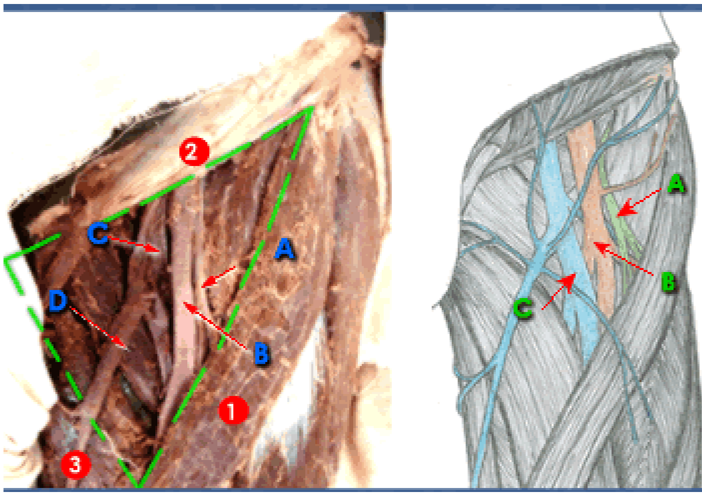
Communications

- With the small saphenous vein
- With the thoraco-abdominal veins via the superficial epigastric vein

- With the deep veins via the perforators. The perforating veins have valves that ensure blood flow only from superficial to deep.

task ***what conditions predispose to [varicose veins]***

Termination;



- Femoral vein ***(note the long saphenous vein[D] terminating into the femoral vein [C])***

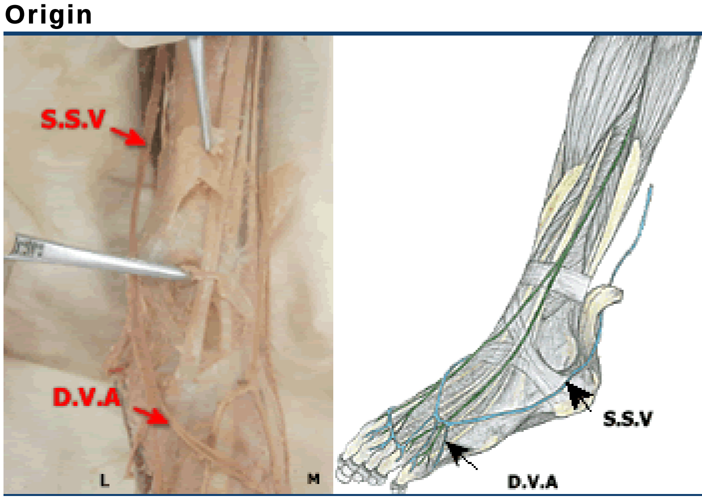
task ***what is meant by [venous cutdown]***

task ***name the contents of the femoral triangle shown on the diagram***

[for a continuation of the long saphenous vein in the thigh click here]

b) Small saphenous vein

Origin



lateral continuation of the dorsal venous arch ***(note the small saphenous vein [s.s.v] originating from the dorsal venous arch [D.V.A] on the lateral side of the foot)***

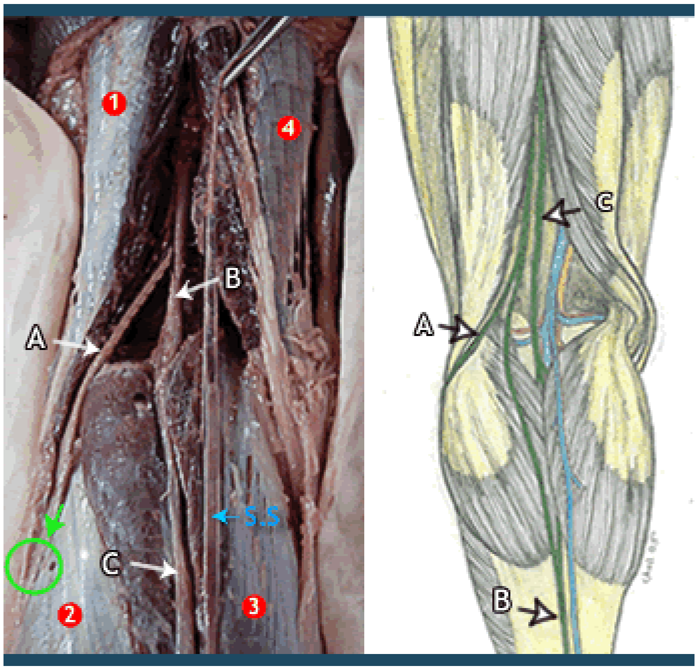
Course

- Lies with sural nerve behind lateral malleolus.
- Passes in the midline of the calf
- Pierces the deep fascia midleg

Tributaries

- Several unnamed tributaries at the back of the leg

Termination



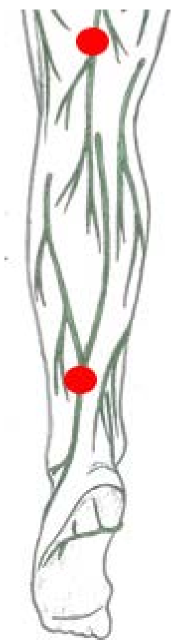
Popliteal vein ***(small saphenous vein [S.S] runnig together with the sural nerve [C] and terminating in the popliteal fossa to popliteal vein)***

Communication

with long saphenous vein

With deep veins

Cutaneous nerves



- Posterior cutaneous nerve of the leg
- Lateral cutaneous nerve of the calf
- Sural nerve
- Saphenous nerve
- Lateral cutaneous nerve of the leg(musculocutaneous nerve)

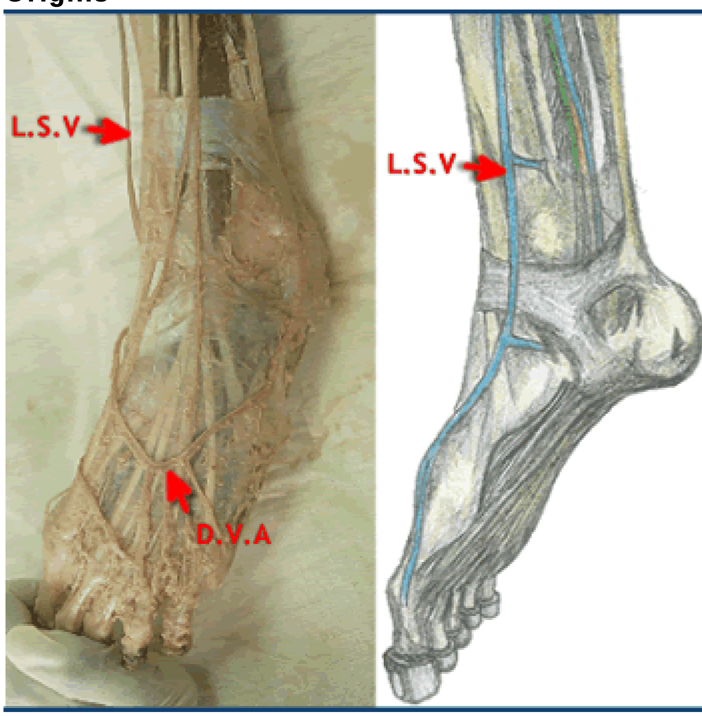
Structures in the superficial fascia

The saphenous venous system

- Great saphenous vein
- Small saphenous vein
- Accessory saphenous vein

The long saphenous vein

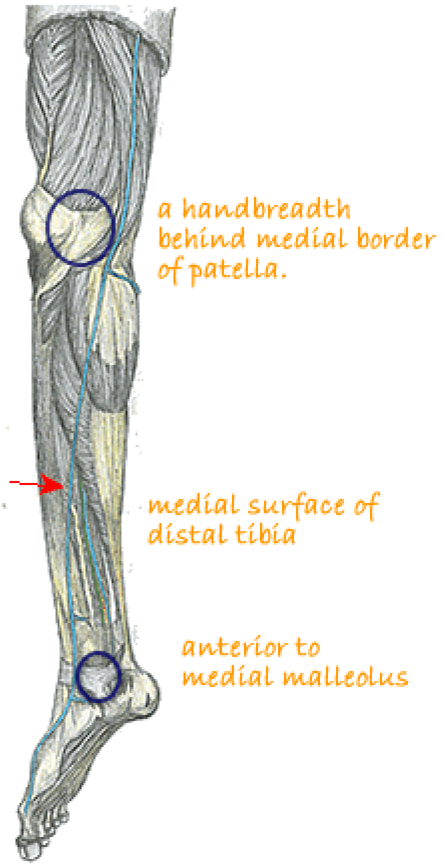
Origins



medial continuation of the dorsal venous arc, joined by the medial marginal vein of the foot. ***(Dorsal Venous arc [D.V.A] forming the long saphenous vein [L.S.V] on the medial side of the foot)***

Course

- Runs a thumb breath anterior and medial to the medial malleolus
- Medial surface of the distal tibia
- Behind the medial border of the proximal tibia
- Handbreadth behind medial border of patella
- Runs with sapheous nerve
- Medial convexity of the thigh
- Passes through saphenous opening 3-4cm below and



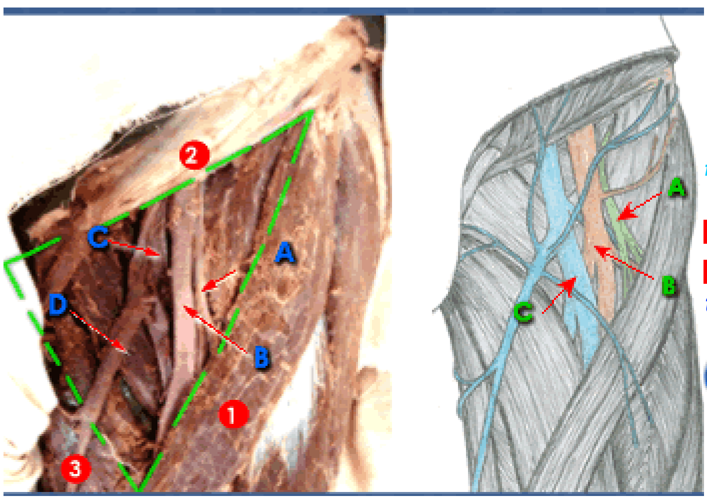
lateral to the pubic tubercle

Communications

- With the small saphenous vein
- With the thoraco-abdominal veins via the superficial epigastric vein
- With the deep veins via the perforators. The perforating veins have valves that ensure blood flow only from superficial to deep.

task ***what conditions predispose to varicose veins***

Termination



- Femoral vein *(note the long saphenous vein[D] terminating into the femoral vein [C])* s

task ***what is meant by venous cutdown***

task ***name the contents of the femoral triangle shown on the diagram***

for a continuation of the long saphenous vein in the thigh click here

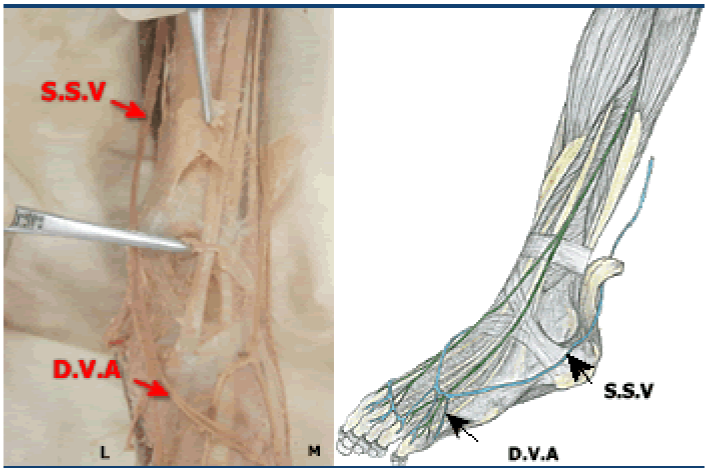
b) Small saphenous vein

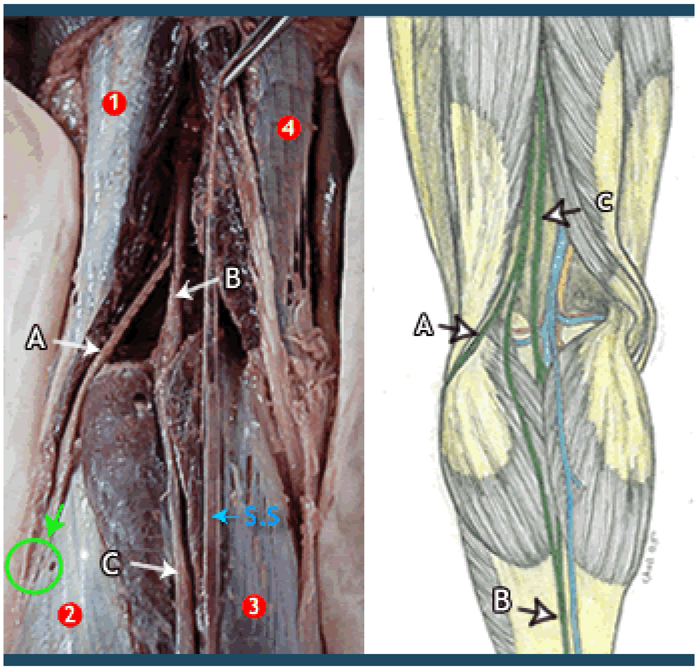
Origin

lateral continuation of the dorsal venous arch *(note the small saphenous vein [s.s.v] originating from the dorsal venous arch [D.V.A] on the lateral side of the foot)*

Course

- Lies with sural nerve behind lateral malleolus.
- Passes in the midline of the calf
- Pierces the deep fascia midleg





Tributaries

Several unnamed tributaries at the back of the leg

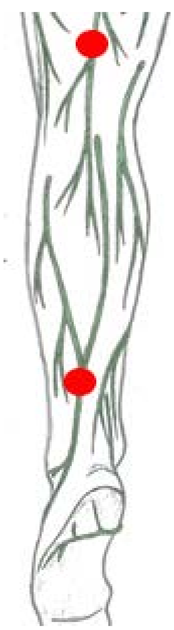
Termination

Popliteal vein ***(small saphenous vein [S.S] runnig together with the sural nerve [C] and terminating in the popliteal fossa to popliteal vein)*** with long

Communication

- saphenous vein
- With deep veins

Cutaneous nerves



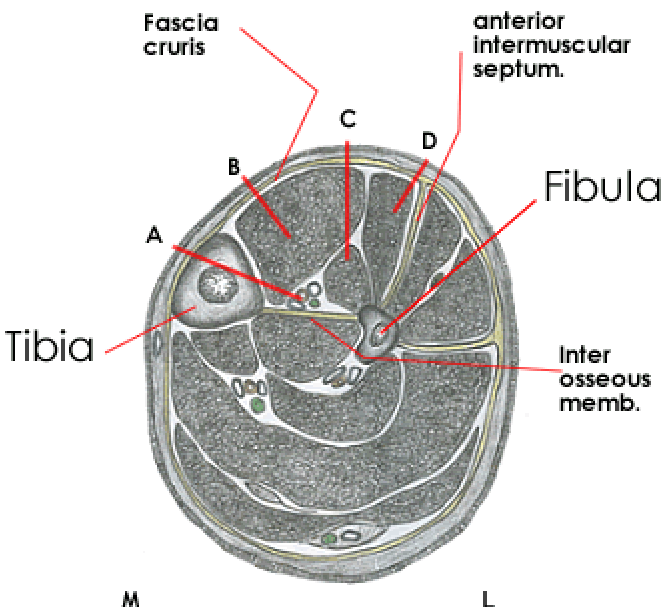
- Posterior cutaneous nerve of the thigh
- Lateral cutaneous nerve of the calf
- Sural nerve
- Saphenous nerve
- Lateral cutaneous nerve of the leg(musculocutaneous nerve)

task ***Name the other nerves***

MUSCLE COMPARTMENTS IN THE LEG

1. Anterior / extensor compartment

Boundaries



Laterally: extensor surface of the fibula and anterior intermuscular septum.

Medially: extensor surface of the tibia

Anteriorly: fascia cruris

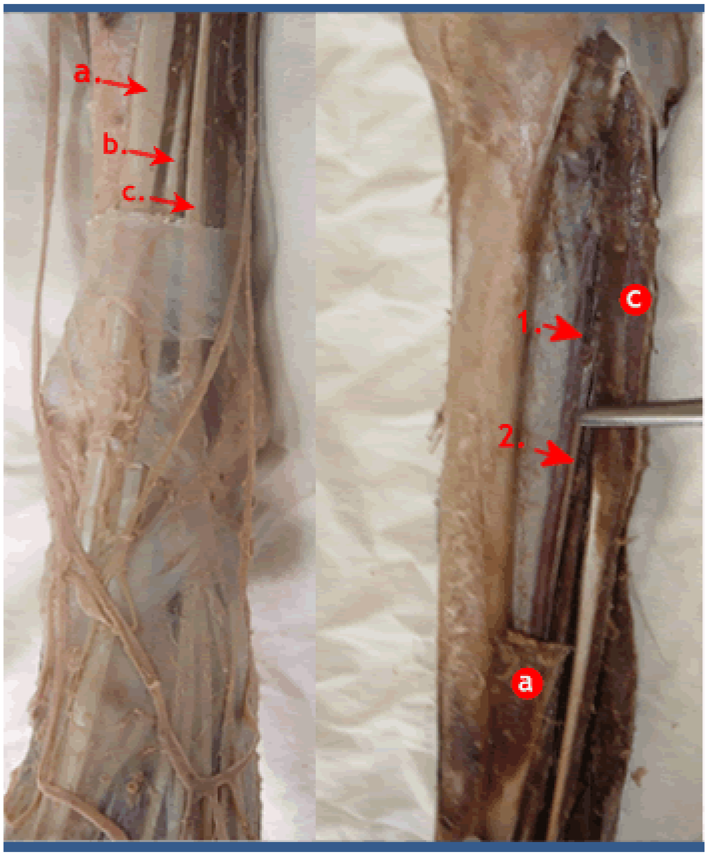
Posteriorly: interosseous membrane

Task: Name the structures labelled A-D

Contents

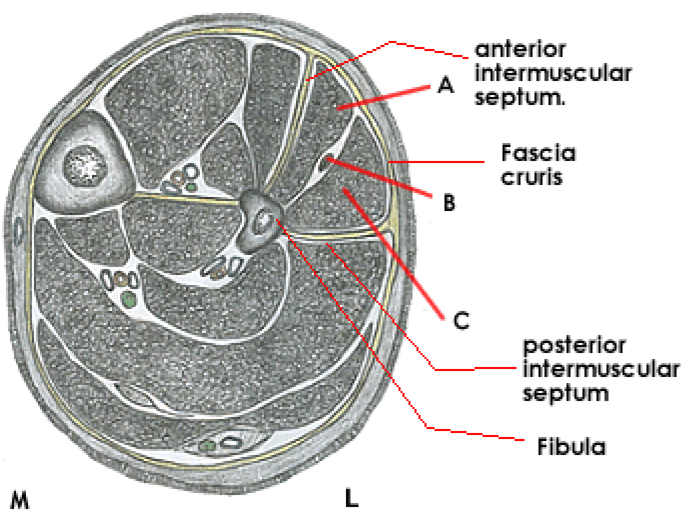
- Ankle extensor/ dorsiflexor muscles (review their attachments)
- Deep peroneal nerve
- Anterior tibial arteries

note : This the tightest of the compartments, therefore more vulnerable to compartment syndrome



2. Lateral compartment

Boundaries



Anteriorly: anterior intermuscular septum

Posteriorly: posterior intermuscular septum

Medially: peroneal surface of the fibula

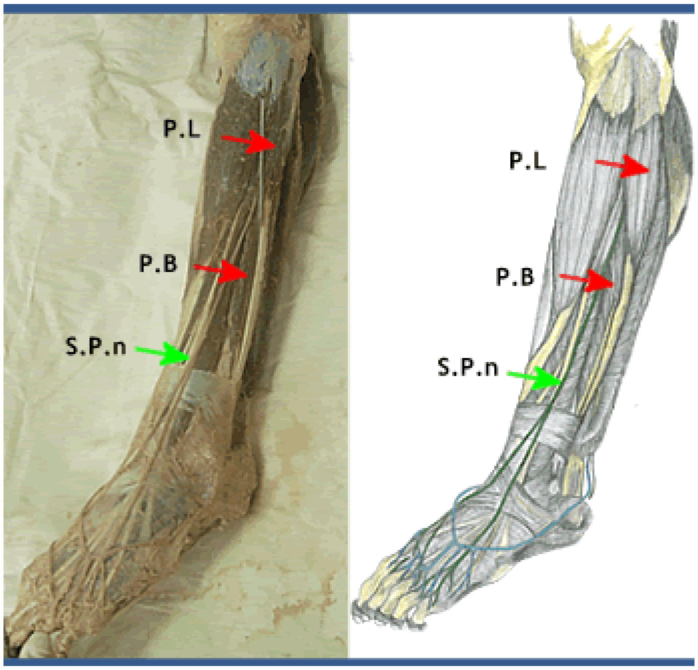
Laterally: fascia cruris

Contents

- Peroneus longus and brevis(review their attachment)
- Superficial peroneal nerve

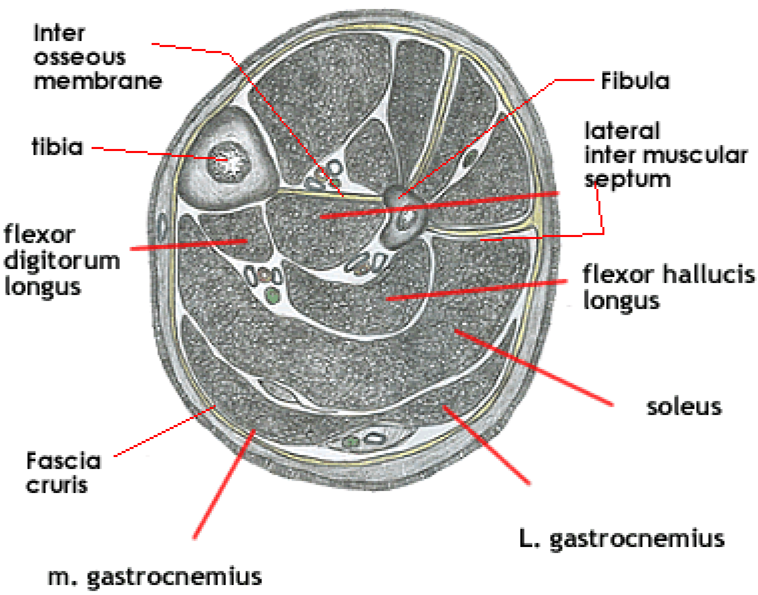
(note the peroneus longus [P.L] , peroneus brevis [P.B] and Superficial Peroneal nerve [S.P.n])

*No artery. Blood supply by branches of peroneal artery in the posterior compartment.



3. The posterior compartment

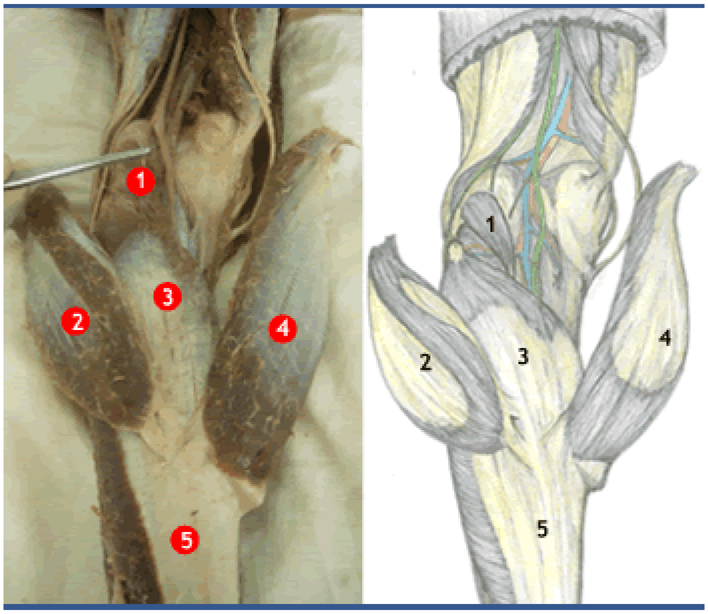
Boundaries

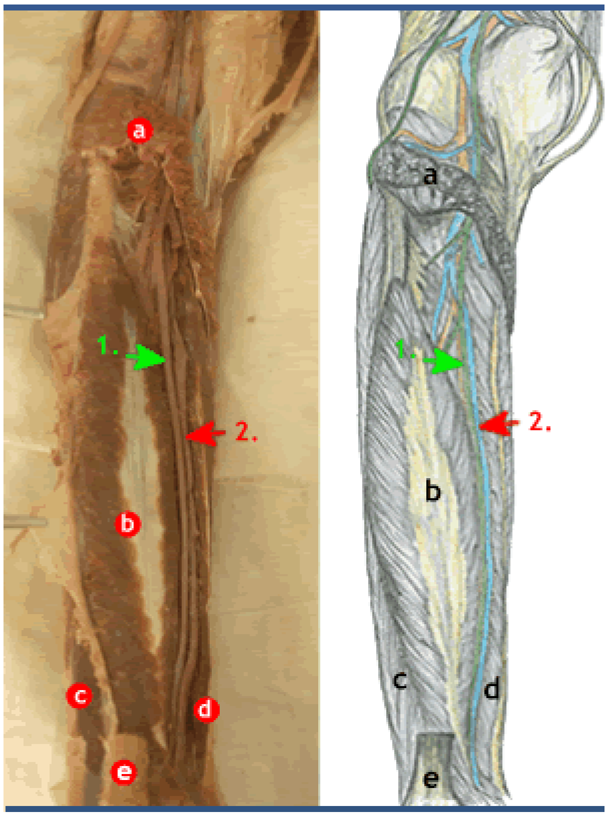


- **Anteriorly:** tibia, fibula and the interosseous membrane
- **Anteromedially:** fascia cruris
- **Postero-laterally:** lateral intermuscular septum

Contents

Superficial triceps surae – soleus and two heads of gastrocnemius' plus plantaris when present (review their attachments)



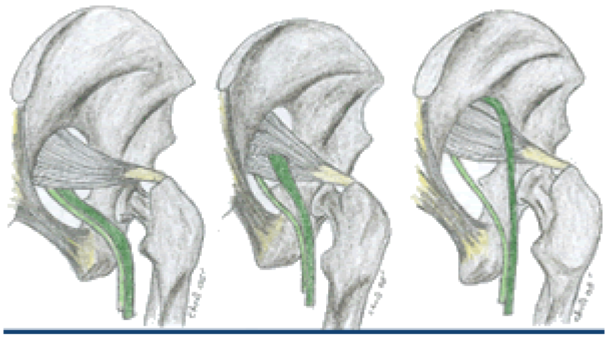


Deep;

- Flexor muscles (review their attachments)
- Posterior tibial artery
- Tibial nerve

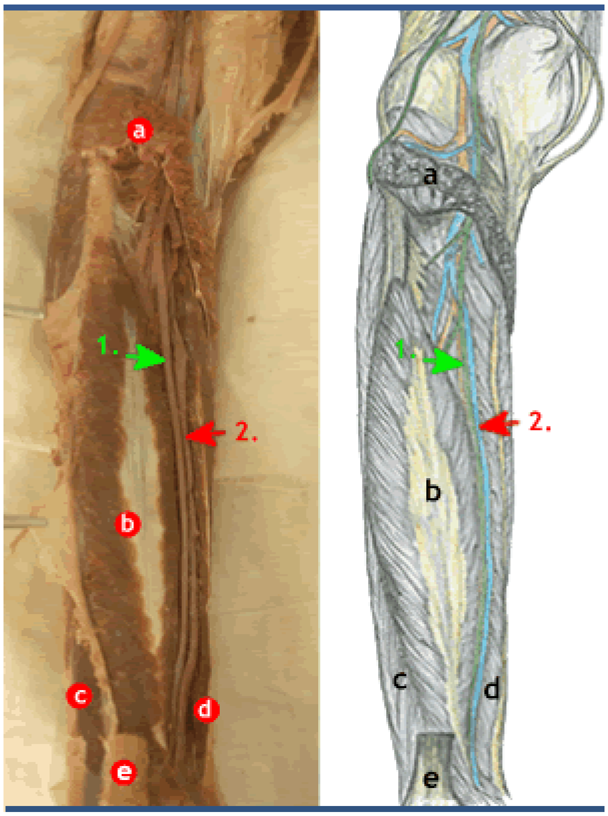
Tibial nerve

Origins



The continuation of sciatic nerve (L4-S3)

Course:



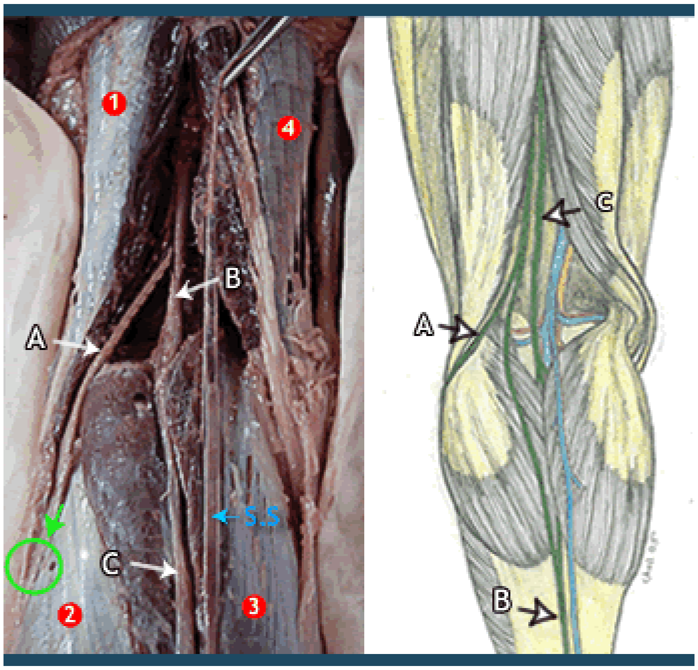
- Runs over popliteus
- Passes through soleal arc
- Runs between superficial and deep layers of muscles
- Passes behind flexor retinaculum

(note the tibial nerve [1.] lateral to the posterior tibial arch [2.] passing through the soleal arch)

Distribution:

it supplies:

- Hamstrings



Knee joint

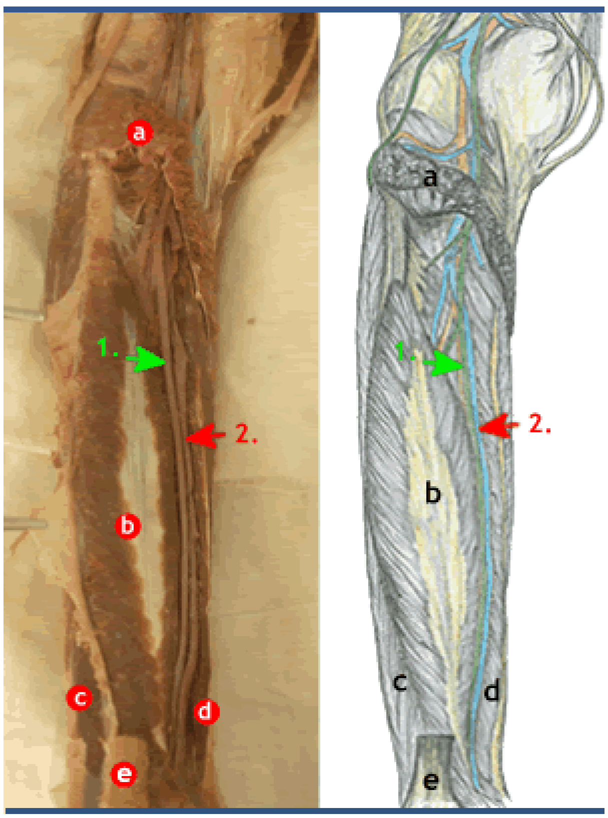
- Back of the leg
- Calf and flexor muscles of the leg
- Muscles and skin, plantar foot

task ***how would you test for the integrity of the tibial nerve ?***

Learning points | Core anatomy | Applied anatomy | Review questions

ARTERIES OF THE LEG:

Posterior Tibial artery:



Origin:

Continuation of popliteal artery

Course

- Through soleal arc
- Between deep and superficial layers
- Behind medial malleolus
- Deep to flexor retinaculum- tarsal tunnel

Branches

- Peroneal
- Muscular-leg muscles
- Nutrient artery to the tibia
- Articular to proximal tibiofibular and ankle joint
- Medial and lateral plantar

Landmark

Midway between medial malleolus and tendon achilles

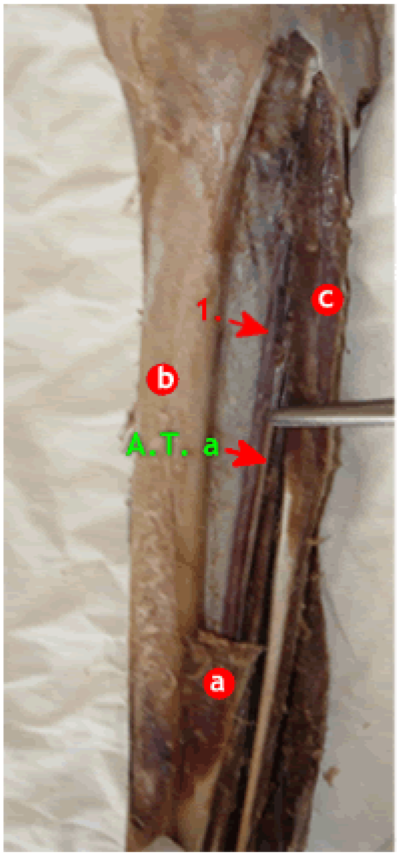
Anterior tibial artery

Origin

- Popliteal

Course

- Proximal opening in interosseous membrane
- Anterior to interosseous membrane
- With deep peroneal nerve
- Between tibialis anterior and extensor hallucis longus proximally



Distally between extensor hallucis longus and extensor digitorum longus

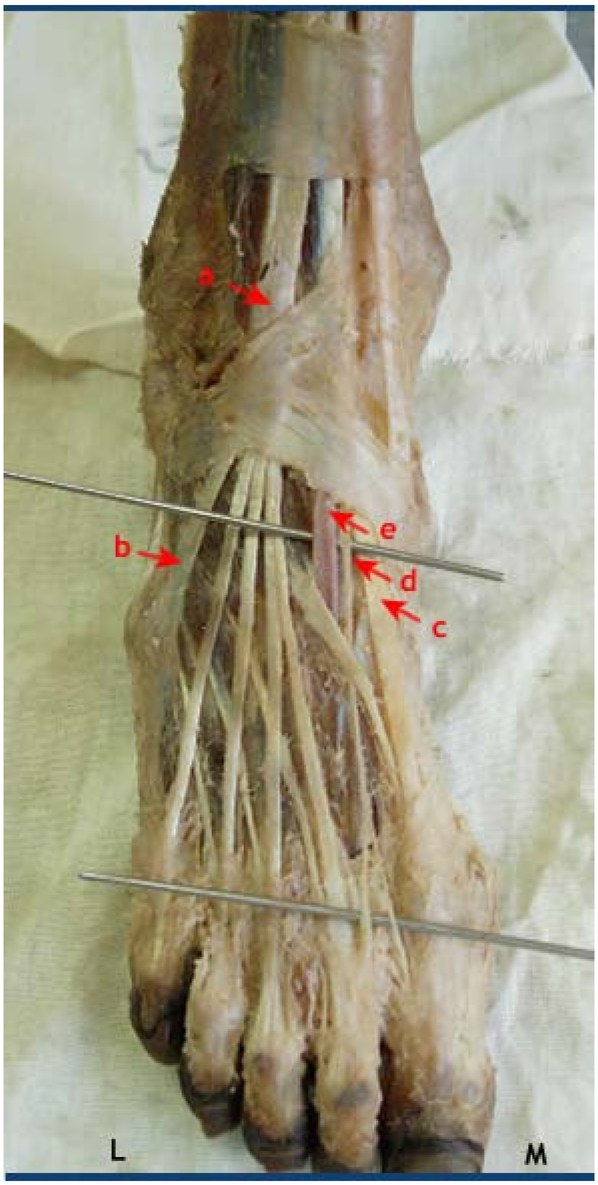
Branches

- Muscular to anterior compartment
- Malleolar
- Calcaneal branches
- Continues as dorsalis pedis

Landmarks

- Between tendons extensor digitorum longus and extensor hallucis

Dorsum of the foot



Contents

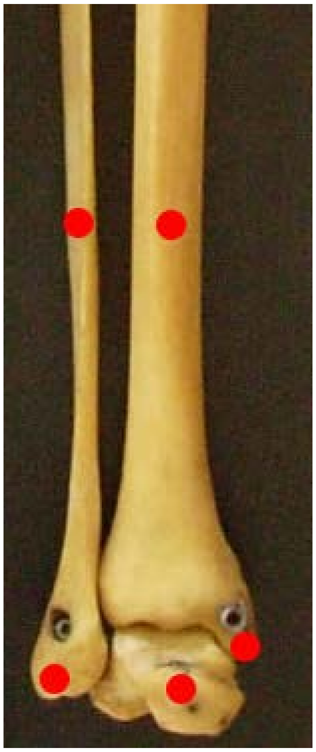
- Tendons of extensor muscles
- Extensor digitorum brevis
- Cutaneous nerves
- Dorsal venous arch
- Dorsalis pedis artery
- Extensor retinaculum
- Dorsal surfaces of tarsals, metatarsals and phalanges

CHAPTER 11: The Ankle Joint

Osteology

The ankle joint is formed by the lateral mallleolus (fibula), medial malleolus (tibia) and the trochlea surface of the talus

Hover over the hotpoints to show the names.



Applied anatomy

Ankle sprains

False" sprains refer to overstretching of the ligaments and/or capsule.

True sprains refer to tear of some fibres of the ligaments.

Acute sprains of the "lateral ankle":

- Caused by excessive inversion of the foot in plantarflexion.
- Anterior talofibular and calcaneofibular ligament are partially torn.

Acute sprains of the "medial ankle":

- Less common than the lateral
- Caused by excessive eversion
- Frequently the ligament avulses off the tip of the medial malleolus.

Fracture dislocation of the Ankle joint:

Because of the tight fit in the tenon-mortise configuration, dislocation without malleolar fracture is rare.

Commonly caused by forced external rotation and over-eversion of the foot.

The talus is externally rotated forcefully against the lateral malleolus.

Consequently:

- The torsion effect on the lateral malleolus causes it to fracture spirally.
- The talus moves laterally, medial ligament becomes taut
- If the talus is forced to move further, its rotatory movement results in its violent contact with the posterior inferior margin of the tibia, which shears off.

Immobilization of the ankle joint:

When the joint has to be immobilized e.g. a plaster cast, it is done in slight plantarflexion / neutral since:

- In dorsiflexion , there is tension on the ligaments, and the anterior structures would shorten while the posterior would be overstretched.
- In plantarflexion, the posterior structures would shorten, and the anterior ones overstretched.

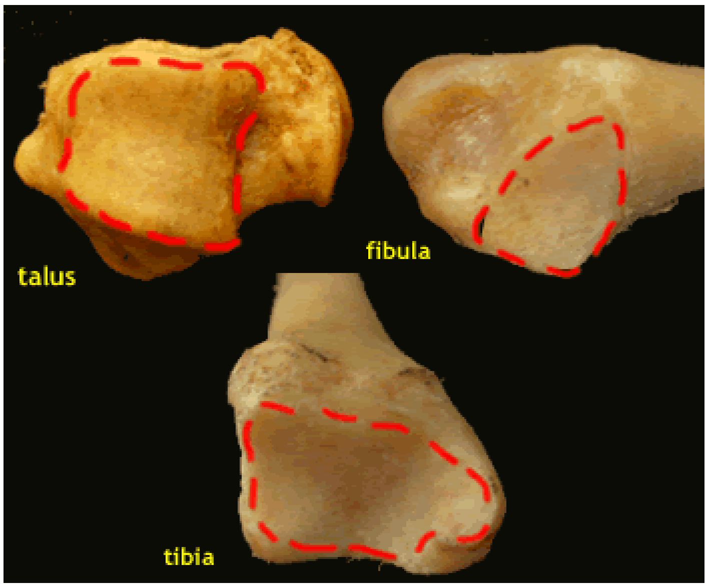
Review Questions:

- Give an account of the classification, stability factors, relations, blood supply and innervation of the ankle joint.Add brief notes of injuries at this joint and their mechanisms.

Classification and Articular surfaces:

Synovial joint of the tenon-mortise variety. Functionally hinge.

Articular surfaces:



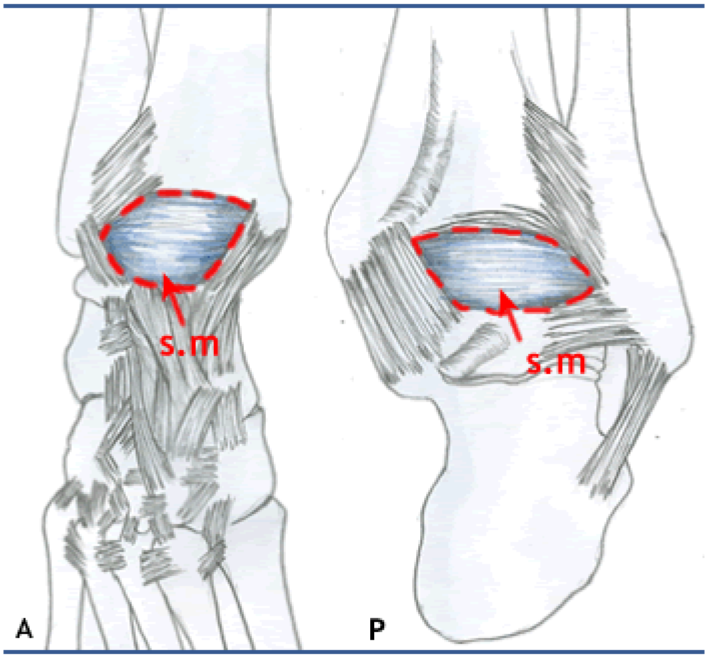
- Inferior surface of the tibia
- Medial surface of lateral malleolus
- Lateral surface of the medial malleolus
- Trochlear and malleolar surfaces of talus

Capsule Features:

- Thin anteriorly and posteriorly
- **Capsular attachments-**
  - Articular margins of bones
  - On anterior surface of part of talus
  - Posterior tibiofibular ligament

Synovial membrane:

- Lines the internal surface of fibrous capsule
- Separated from anterior and posterior parts of capsule by fat pads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Capsule Features:

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  - Articular margins of bones
  - On anterior surface of part of talus
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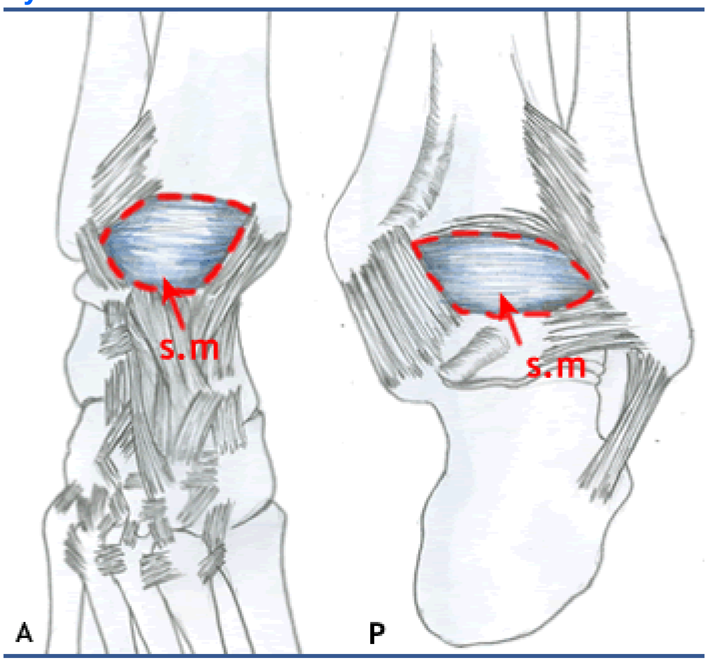
Synovial membrane:



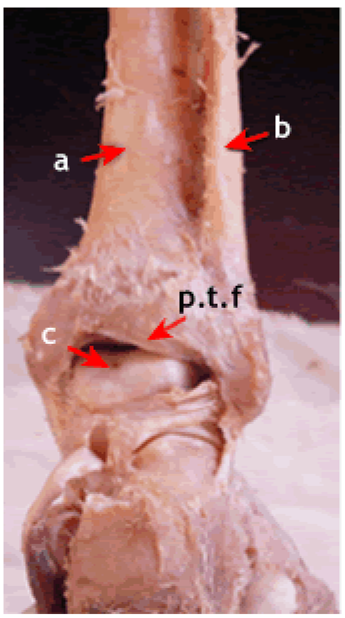
- Lines the internal surface of fibrous capsule
- Separated from anterior and posterior parts of capsule by fat pads

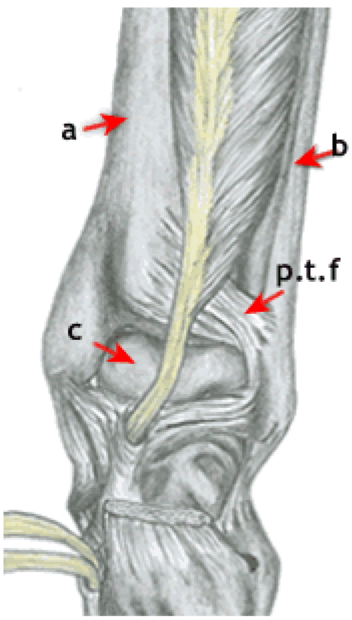
CHAPTER 11: The Ankle Joint

Stability Factors

- Tight fit of talus between the malleoli
- Strong ligaments
- Tendons bound in place by retinaculae

a) Configuration of articular bones





The two malleoli form a deep (socket-mortise) for the talus (tenon).This mortise is deepened posteriorly by the inferior part of the *tibiofibular ligament (transverse tibiofibular ligament [p.t.f])*

Note the following bones:

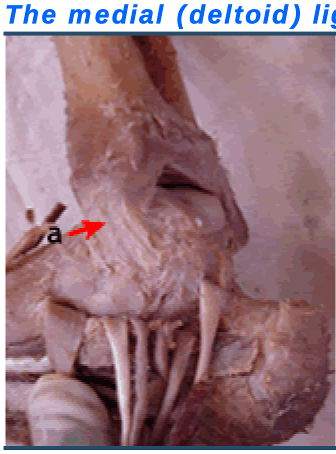
a) the tibia

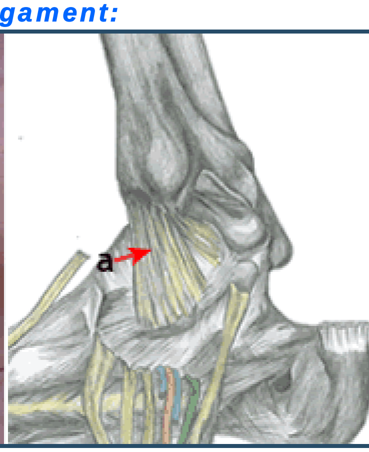
b) the fibula

c) the talus

b) Collateral ligaments

The medial (deltoid) ligament:

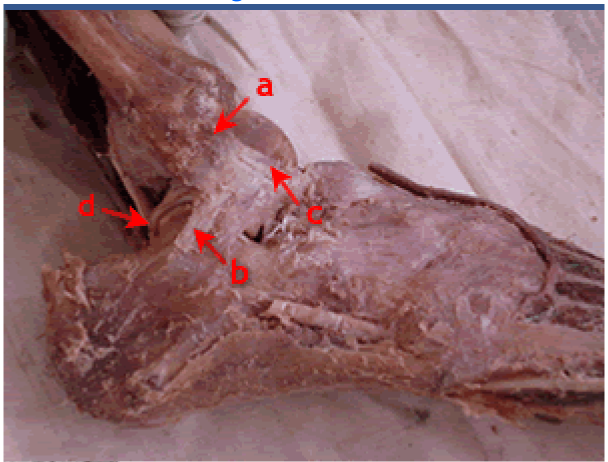


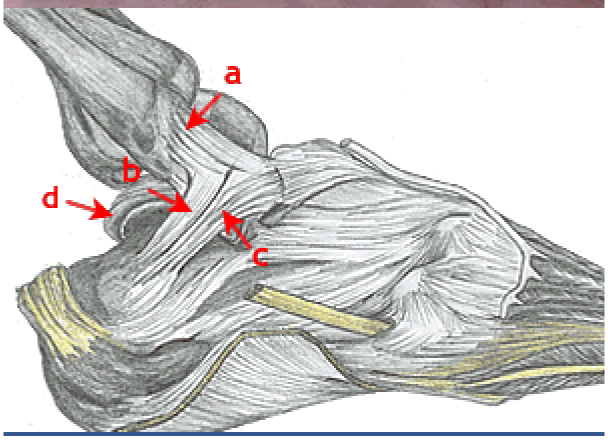


Extends from medial malleolus to:

- Neck of talus (deep part)
- Tubercle of talus
- Sustentacular tali of calcaneous
- Spring ligament
- Tuberosity of the navicular

Lateral collateral ligament





Extending from lateral malleolus.

It consists of three parts:

- Anterior talofibular ligament: Attached to the neck of the talus
- Calcaneofibular ligament: Attached to the lateral surface of calcaneous.
- Posterior talofibular ligament: Attached to the lateral tubercle of the talus.

Note:
Tendons crossing the joint are held in place by the retinaculae.

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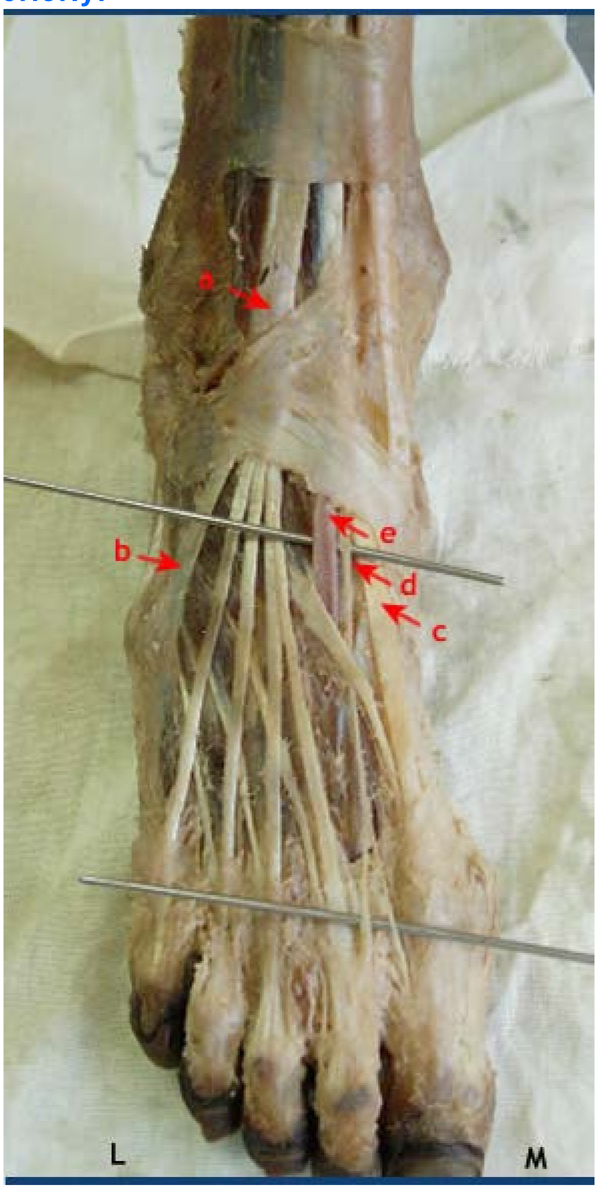
CHAPTER 11: The Ankle Joint

Relations of the joint:

Anteriorly:

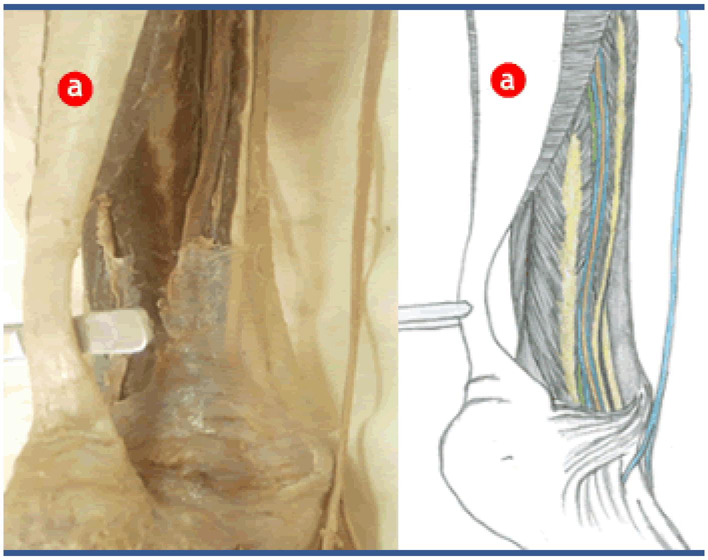


From medial to lateral :

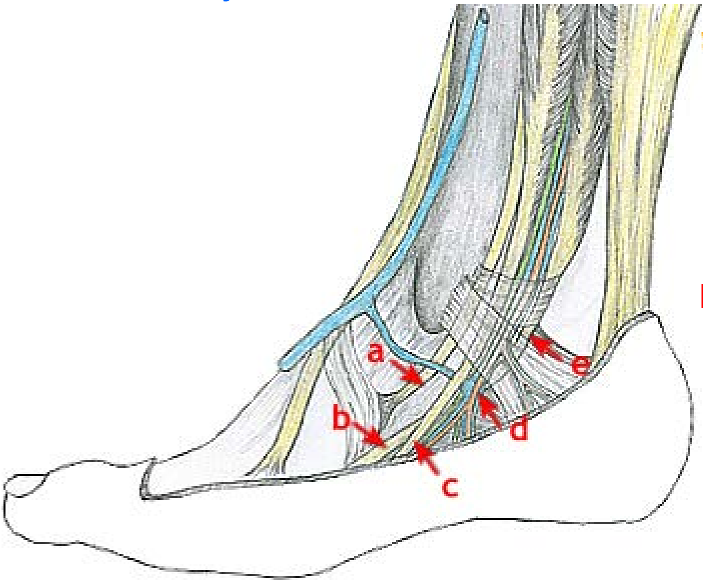
- Tendons of tibialis anterior
- Tendons of extensor hallucis longus
- Anterior tibial vessels
- Deep peroneal nerve
- Tendons of extensor digitorum longus
- Tendons of peroneus tertius.

Posteriorly:

The tendo calcaneus, separated from the joint capsule by a pad of fat.



Posteromedially:



From before backwards,

- The tendons of tibialis posterior
- Flexor digitorum longus,
- Posterior vessels,
- Tibial nerve,
- Tendon of flexor hallucis longus.

task **Try and identify these relations on the illustrations alongside.**

Posterolaterally:

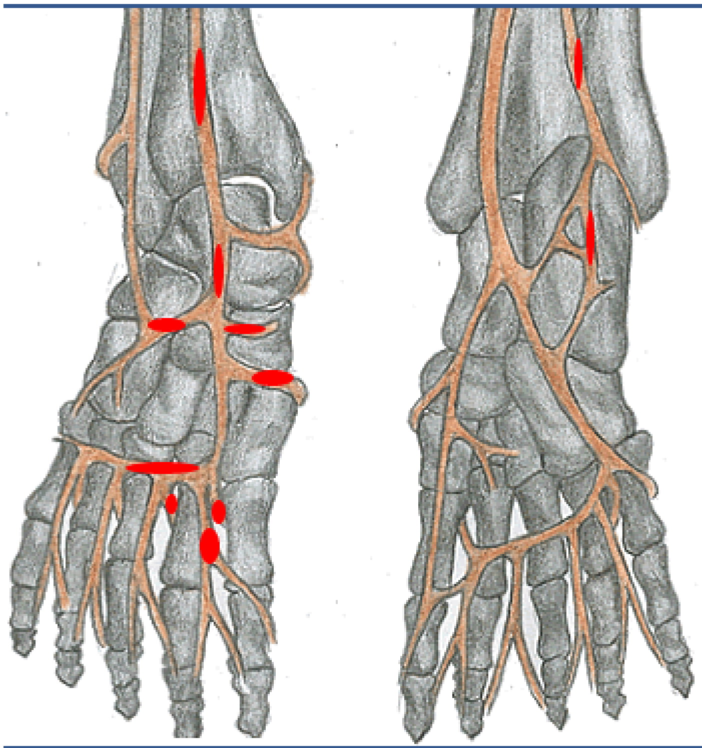
The tendons of peroneus longus and brevis.


a
b

Blood supply and Innervation:

Blood Supply:

Hover over points to show information



Talocrural anastomosis formed by:

- Malleolar branches of:
  - Anterior tibial
  - Posterior tibial
  - Peroneal arteries
- Recurrent branches (minor) of:
  - Dorsalis pedis
  - Calcaneal branches of lateral and medial plantar vessels

task ***What is the pattern of / and blood supply to the talus? What is the importance of this as relates to the ankle joint?***

Innervation:

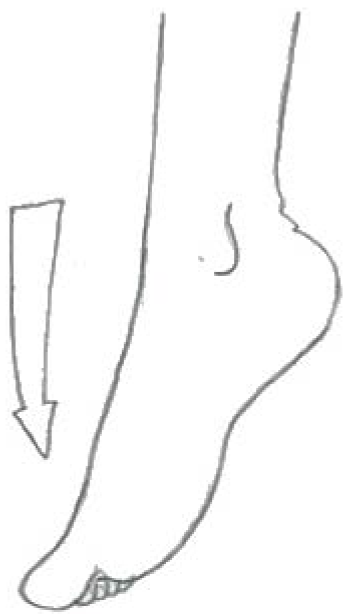
The nerves are derived from the deep peroneal (anterior tibial) and tibial nerves

.

Movements about the joint:

Axis of these movements passes through tip of lateral maleolus and just below the tip of the medial malleolus.

Plantar flexion:



- Gastrocnemius,
- Soleus,
- Flexor digitorum longus
- Flexor hallucis longus,
- Tibialis posterior

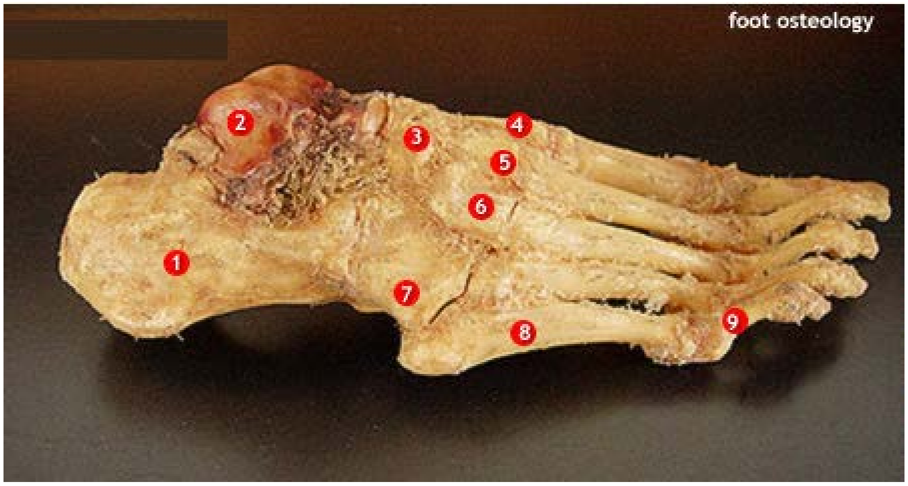
Dorsiflexion:

- Tibialis anterior,
- Extensor hallucis longus
- Extensor digitorum longus
- Peroneus tertius.

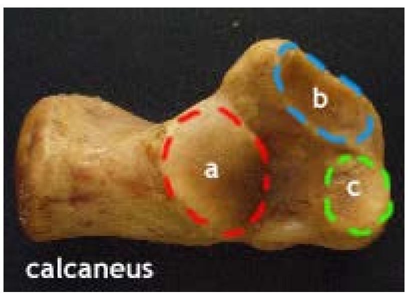
Note:

- The articular surface of the talus is wider anteriorly. So during dorsiflexion, the malleoli hold the talus very tightly – maximum stability.
- In full plantarflexion, the ligaments of the distal tibiofibular joint are less tout and small amounts of rotation, abduction and adduction are possible.

Bones of the foot:



Calcaneus:



Articular surfaces of the calcaneus:

a) Talus
b) Navicular
c) Cuboid

Talus:

Identifiable features:

- The head (Its crest slopes medially)
- The neck
- Trochlear surface (for articulation with the distal tibia)
- Surface for articulation with the fibular malleola

Note: Blood supply of the talus is from the distal aspect to the proximal. Thus in fractures of the neck, blood supply to the body may be cut off resulting in *vascular necrosis*.

Advantages of multiple bones (joints) in the foot:

- Confers pliability and adaptability to uneven surfaces.
- Permits long flexors and short muscles to exert their action on the bones of the forefoot and toes, thus assisting the propulsive action of gastrocnemius and soleus.

The Foot

Applied Anatomy:

Congenital disorders:

Include flat foot, clubfoot, for which see embryology textbooks.

Fracture of talus:

Although the talus has no muscles attached onto it, it has a rich blood supply from branches of:

- Dorsalis pedis
- Posterior tibial artery
- Peroneal arteries

These arteries run from anterior to posterior. In fractures of the talar neck, these vessels are disrupted and avascular necrosis of the body of the talus may occur.

Match fractures:

Also called stress or fatigue fractures usually affect the 2nd or 3rd metatarsal shafts. Follows walking long distances or marching as among soldiers.
Note :The fracture is thin, may be overlooked but may heal with excessive bone formation.

Hammer toe:

Flexion deformity of an interphalangeal joint.

May be due to weak lumbricals, or other imbalance of the delicate arrangement of flexor and extensor tendons.

The affected joint is sharply angled into flexion.

Secondary contracture of the planter aspect of the joint capsule fixes the deformity, and a callosity usually, forms over the dorsum of the flexed joint, from pressure.

Pain in the foot (metatarsalgia):

May be caused by:

- Anterior flat foot
- March fracture
- Neuroma (abnormal fibrous thickening) of a digital nerve.

Planter fascitis:

Pain beneath the heel on standing or walking. Caused by inflammation of soft tissues at the site of attachment of the planter aponeurosis onto the calcaneal tuberosity.

Calcaneal spur

A bony projection from the calcaneal tubercle.

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The Foot

Learning points | Core anatomy | Applied anatomy | Review questions

Review Questions:

- Give an account of the formation, maintenance and functions of the arches of the foot.
- Describe the distribution of the medial and lateral plantar nerves and arteries.
- Outline the organization of the intrinsic muscles of the foot.

CHAPTER 12: The Foot

Functions of the foot:

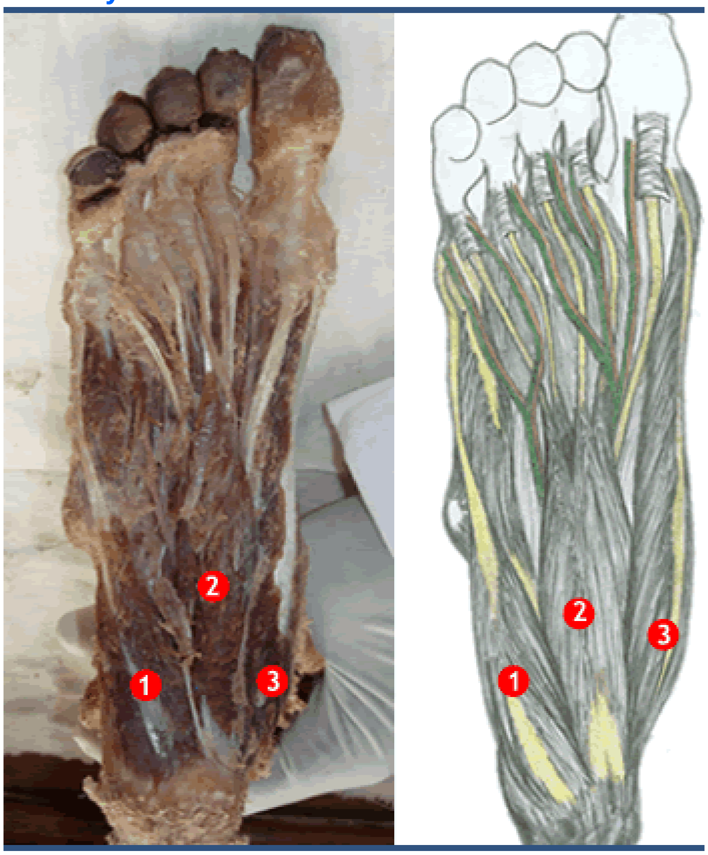
- Weight support
- Serve as a lever to propel the body during locomotion (walking or running)

task ***How is the human foot adapted for walking?***

Muscles of the foot:

The muscles of the foot are arranged in four layers:

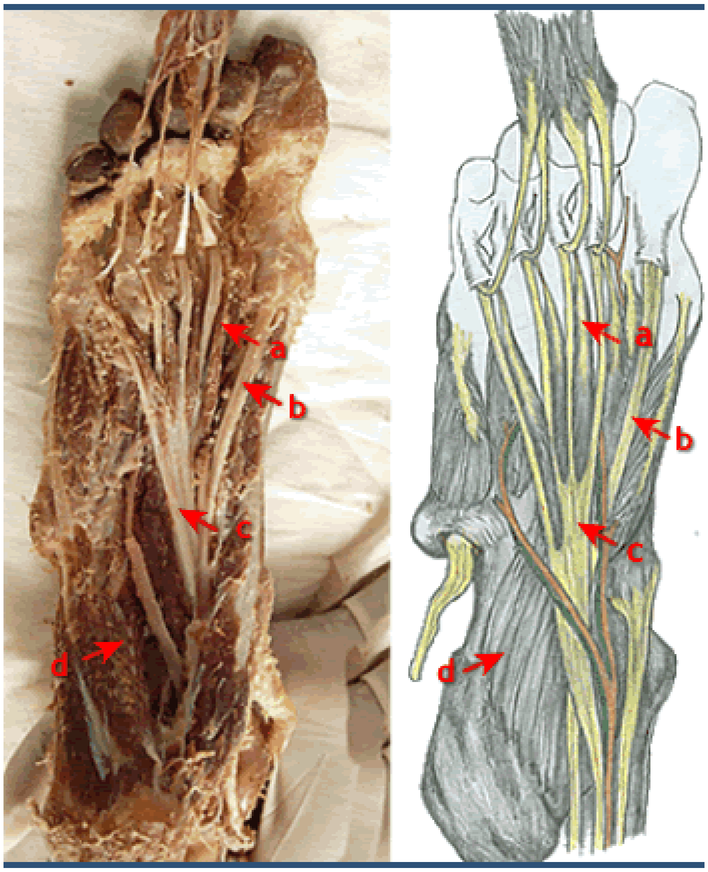
First layer:



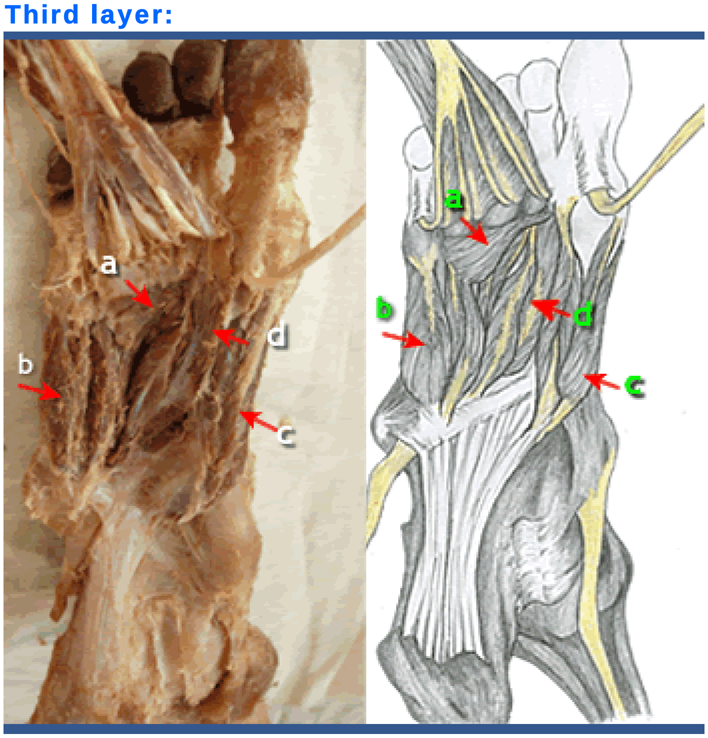
- Abddductor digiti minimi **(A)**
- Flexor digitorum brevis **(B)**
- Abductor hallucis **(C)**

Second Layer:

- Lumbricals **(a)**
- Tendon of flexor hallucis **(b)**
- Tendon of flexor digitorum brevis **(c)**
- Flexor accesorius **(d)**



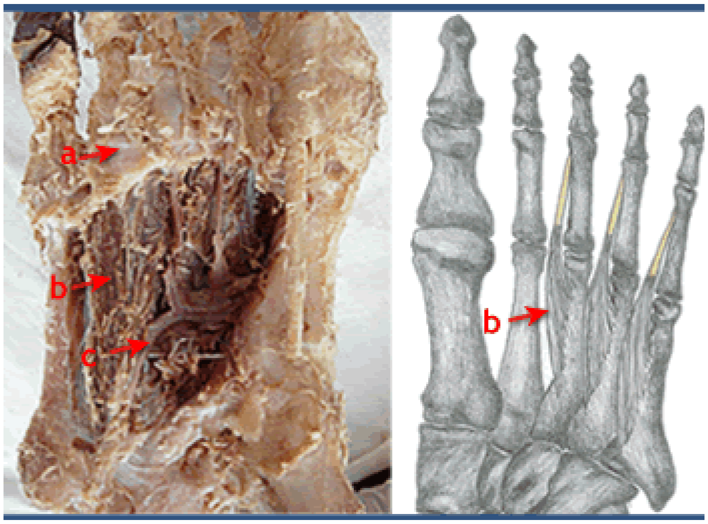
Third layer:



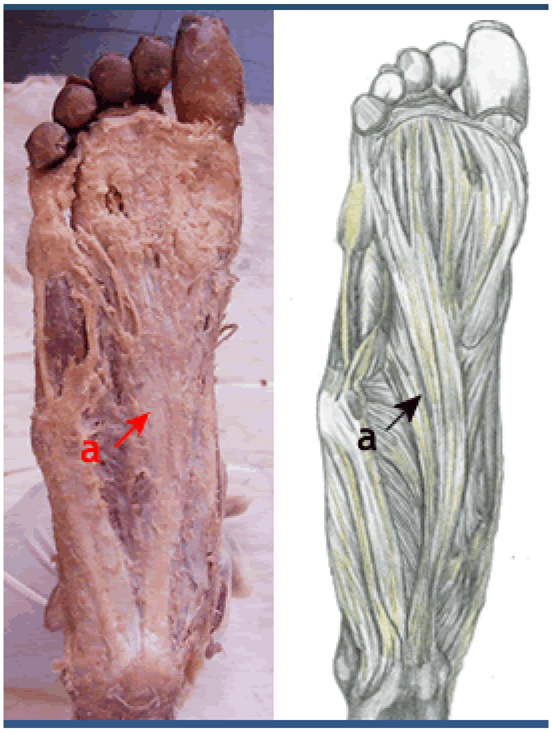
- Adductor hallucis (**a**)- transverse head, (**b)**- oblique head)
- Flexor digiti minimi **(b)**
- Flexor hallucis brevis **(c)**

Fourth layer:

- Tendon of peroneus longus
- Tendon of tibialis posterior
- Planter and dorsal interossei **(b)**


a
b
c
b

Skin and Fascia of the foot:



The planter aspect of the foot is covered by *glabrous skin*, with a *prominent stratum corneum*.

The subcutaneous tissue (superficial fascia) is fibrous.

Elastic fibrous septa divide the subcutaneous tissue into fat filled compartments.

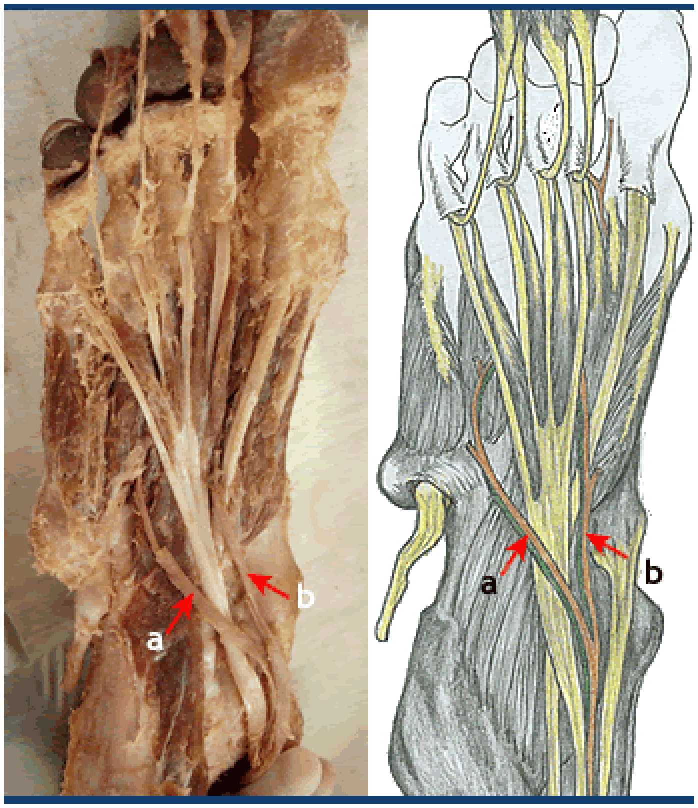
The septa anchor the skin to the underlying plantar aponeurosis, and limit the mobility.

. **The planter aponeurosis**

- Collagenous deep fascia
- Arises posteriorly from the Calcaneous, and fans dividing into five bands for each toe.

Neurovascular structures of the foot.

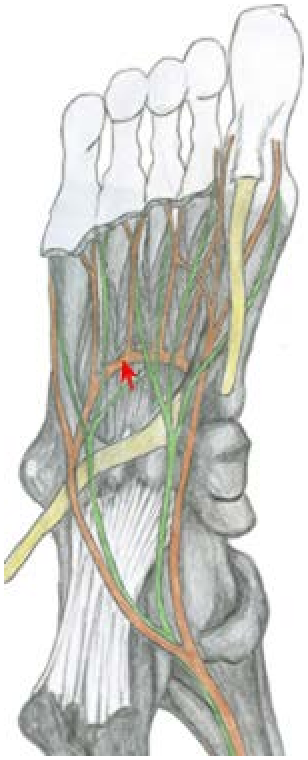
The planter vessels:



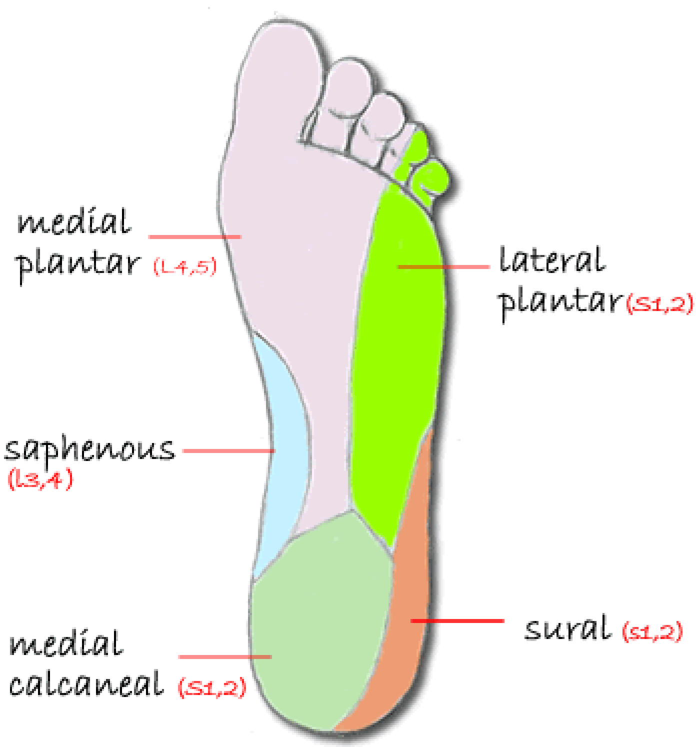
- The medial and lateral planter arteries are derived from the posterior tibial artery deep to the flexor retinaculum.
- The arteries are accompanied by vena committantes.
- Lie between the first and second muscle layers.
- They anastomose to form arterial plantar arch

Note:

- The veins that accompany the perforating arteries take blood from the sole and interosseus muscles to the dorsal venous arch.
- The veins among the planter muscles act as a “sole pump”, which aids the “soleal pump” of the posterior compartment of the calf.



The planter nerves:



Medial and lateral planter nerves branches of tibial nerve:

The **medial planter nerve** supplies:

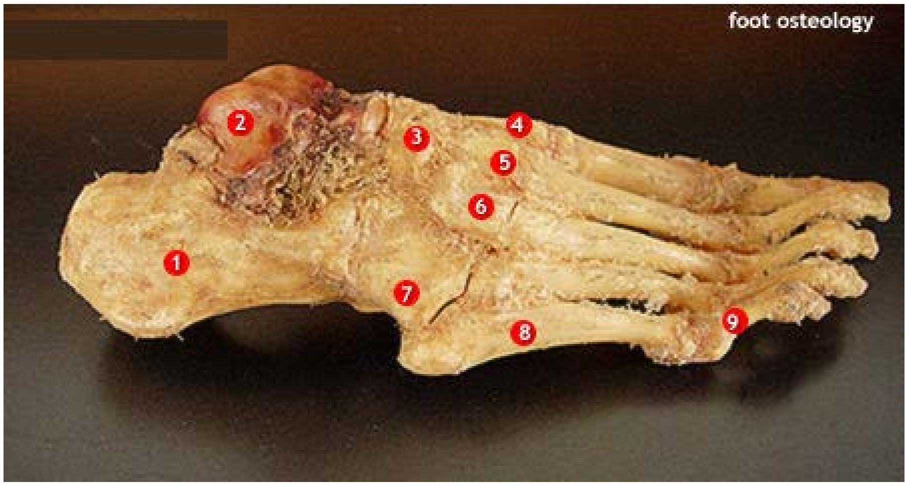
- Abductor hallucis,
- Flexor digitorum brevis,
- Flexor hallucis brevis
- First lumbrical.
- Sensory innervation to the medial three and a half toes

Lateral cutaneous branch communicates with the lateral planter digital branch.

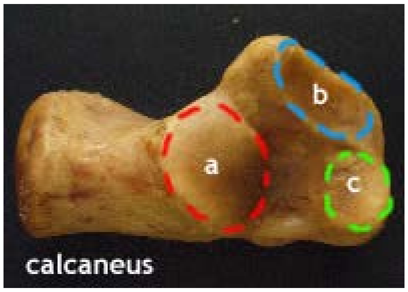
The **Lateral planter nerve** supplies:

- Flexor accessoriuss
- Abductor digiti minimi,
- Flexor digiti minimi,
- Interossei,
- Adductor hallucis,
- Medial 3 lumbricals
- Skin over the lateral 1 1/2 digits.

Bones of the foot:



Calcaneus:



Articular surfaces of the calcaneus:

a) Talus
b) Navicular
c) Cuboid

Talus:

Identifiable features:

- The head (Its crest slopes medially)
- The neck
- Trochlear surface (for articulation with the distal tibia)
- Surface for articulation with the fibular malleola

Note: Blood supply of the talus is from the distal aspect to the proximal. Thus in fractures of the neck, blood supply to the body may be cut off resulting in *avascular necrosis*.

Advantages of multiple bones (joints) in the foot:

- Confers pliability and adaptability to uneven surfaces.
- Permits long flexors and short muscles to exert their action on the bones of the forefoot and toes, thus assisting the propulsive action of gastrocnemius and soleus.

Arches of the foot.

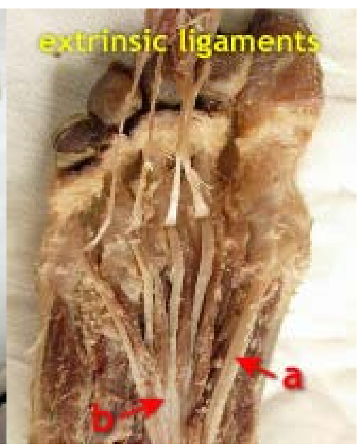
Functions of the arches:

1. To facilitate weight transmission
2. To confer resilience
3. To protect the soft tissues

Formation of the arches

Configuration of the articular surfaces.

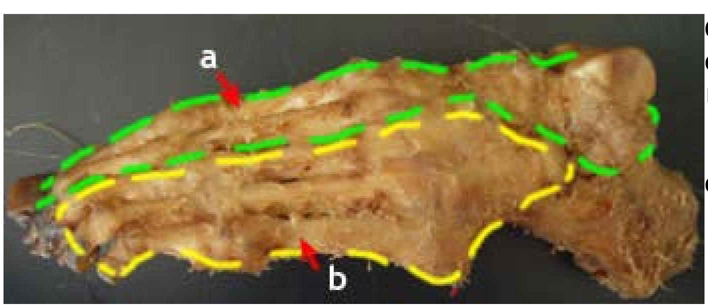
Maintenance of the arches:



- The intrinsic ligaments of the foot.
- Extrinsic ligaments e.g. deltoid
- Intrinsic muscles.
- Tendons of extrinsic muscles.

Arch	Bones	Major support structures

Medial longitudinal arch (a)

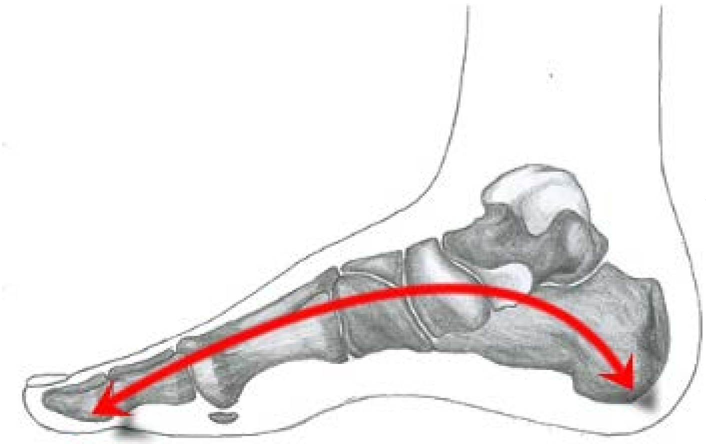


Calcaneous, talus, navicular, cuneiforms and 1st and 3rd metatarsals.

* **Talus** is keystone in the center

- Plantar ligaments especially calcaneonavicular ligaments.
- Tendons of anterior and posterior tibialis.
- Deltoid ligament
- Intrinsic foot muscles related to medial 3 metatarsals.
- Plantar aponeurosis.

Lateral longitudinal arch (b)

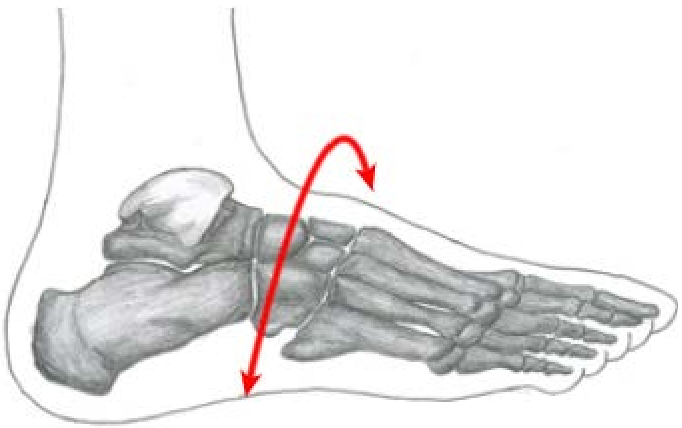


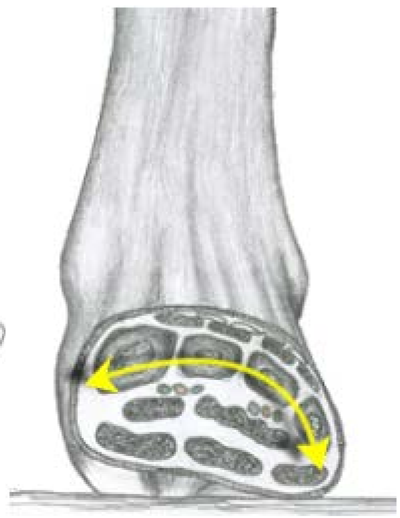
- Distal end of Calcaneous
- Proximal end of the cuboid: lateral 2 muscles

* **Cuboid** is the key stone

- Long and short planter ligament.
- Intrinsic muscles in the lateral side of the foot.
- Plantar aponeurosis
- Peroneus longus and brevis.

Transverse arch:



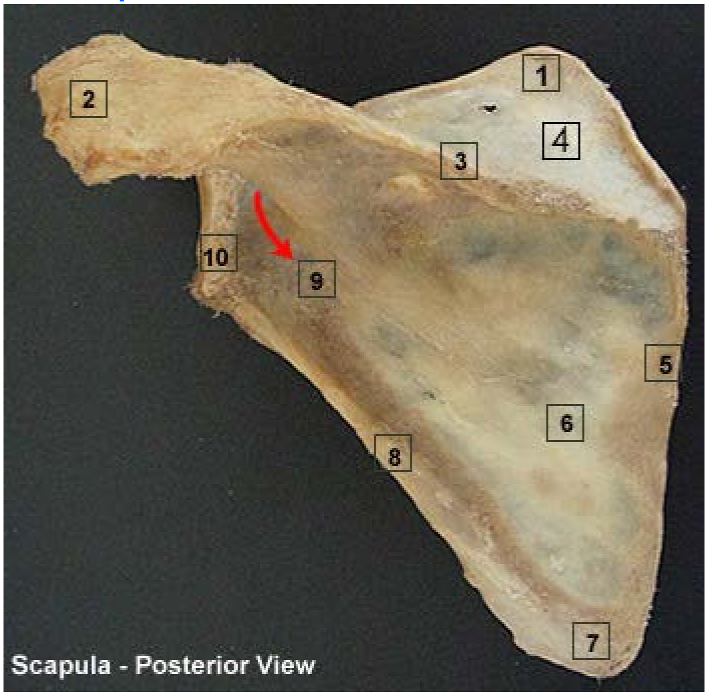


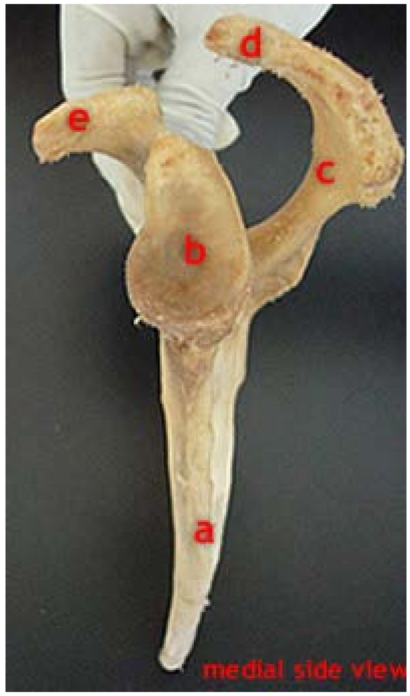
- Cuneiforms
- Bases of metatarsals

- Deep transverse intrinsic ligaments
- Plantar ligaments
- Intrinsic muscles especially dorsal interossei and transverse head of adductor hallucis
- Peroneus longus and brevis

CHAPTER 13: Back and Scapula Region

The Scapula: Main Parts: Hover over the labelled numbers to show names





task **Identify the stractures labelled 1-7.**

Applied Anatomy:

Pulsating scapula

In cases of **coarctation of the aorta** distal to the origin of subclavian artery, blood will be **diverted** to the s**ubclavian artery** then get back to the descending aorta through the intercostal arteries in the **scapula anastomosis**.

In such a case, the anastomosis opens up markedly. The scapula may even pulsate with the heartbeat. Dilatation of the intercostal arteries may erode and even cause **notching of the ribs**, evident on chest x-rays.

Fractures of the scapula:

Usually result from severe trauma such as occurs in run-over accident victims or in occupants of automobiles involved in crashes.
Injuries are usually associated with **rib fractures** but the fractured scapula usually requires very little treatment because the sandwitching muscles adequately splint the fragments

Dropped shoulder and Winged scapula

- The position of the scapula on the posterior chest wall is maintained by the muscles there attached. If the muscles are paralysed, there is an imbalance.
- In paralysis of the **trapezius**, the **scapula drops (dropped shoulder)**, while in paralysis of **serratus anterior**, the scapula sticks out of the chest wall especially when reaching out or pushing. This is called **"winged" scapula**.

Low back Pain

Pain in the lumbar region

A common cause of disability

Common causes

1. Prolapsed Intervertebral disc
2. Osteoarthritis
3. Ligamentous strains
4. Muscle spasms

Prolapsed IVD

Occurs more commonly in the lumbar region due to weight

Commonest direction is posterolateral because

- The annulus fibrosus is thinner posteriorly
- Central part is strengthened by the posterior longitudinal ligament

This herniation compresses the spinal nerves leading to pain in the area of distribution of the nerve e.g. **sciatica**: Pain in the region of distribution of sciatic nerve

Severe prolapsed disc can narrow the vertebral canal (**spinal stenosis**) thus compressing the spinal cord

Ligamentous Strains

Overstretching of the vertebral ligaments can cause back pain

The posterior ones are usually more commonly involved

Muscle Spasms

Spasms of intrinsic muscles of the back e.g. multifidus, rotatores and transverso spinalis as well as the long erector spinae will cause back pain.

Abnormal Curvatures

Lordosis: Exaggerated lumbar curve

Scoliosis: Lateral curvature of spine associated with hemi-vertebrae, poor posture, over-weight

Kyphosis: Exaggerated thoracic curvature frequently seen in TB spine

Traumatic Back Disorders

Fracture- dislocation of vertebrae are more liekely to occur in the mobile segments e.g. lumbar and cervical

Congenital disorders

- Hemi-vertebrae
- Spina bifida

Back Stiffness

Can be caused by

- Muscle spasms
- Ligamentous destruction
- Fascial tightening
- Neurological disorders

Degenerative Back Disorders

Include

- Osteoarthritis
- Ligamentous ossification

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Back and Scapula Region

1. Describe the respective sites of muscle attachment on the scapula
2. Describe movements of the scapula and indicate their axes and significance
3. Describe the extents, attachments, functions and clinical significance of vertebral ligaments
4. Describe the parts, attachments , functions and clinical significance of intervertebral discs
5. Describe the organization, attachments, functions and clinical significance of erector spinae muscles
6. a) List the distinguishing features of vertebrae from various regions

   b) Name the curvatures of the back and state their basis and significance

J. Ogengó

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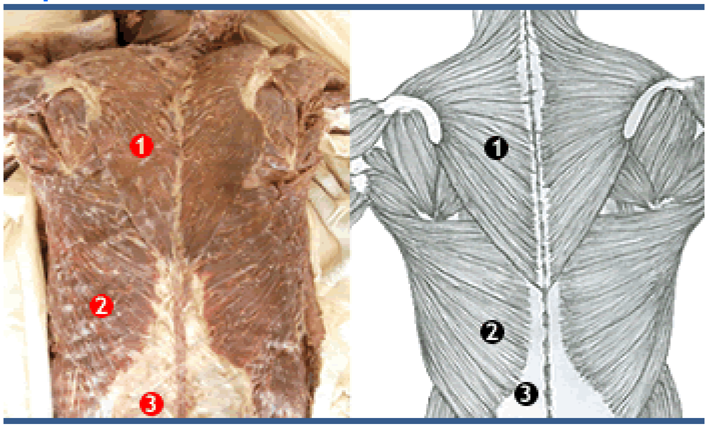
CHAPTER 13: Back and Scapula Region

Learning points | Core anatomy | Applied anatomy | Review questions

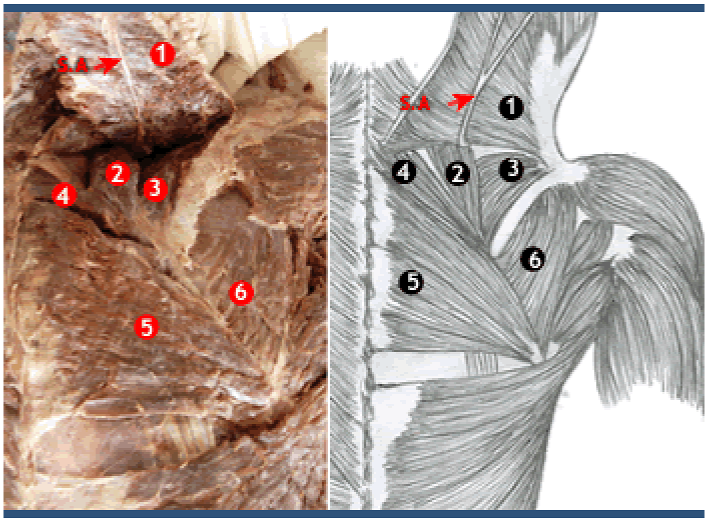
Muscles of scapula region and back:

Superficial:



Hover over hotspot to show infomation

Rhomboids:



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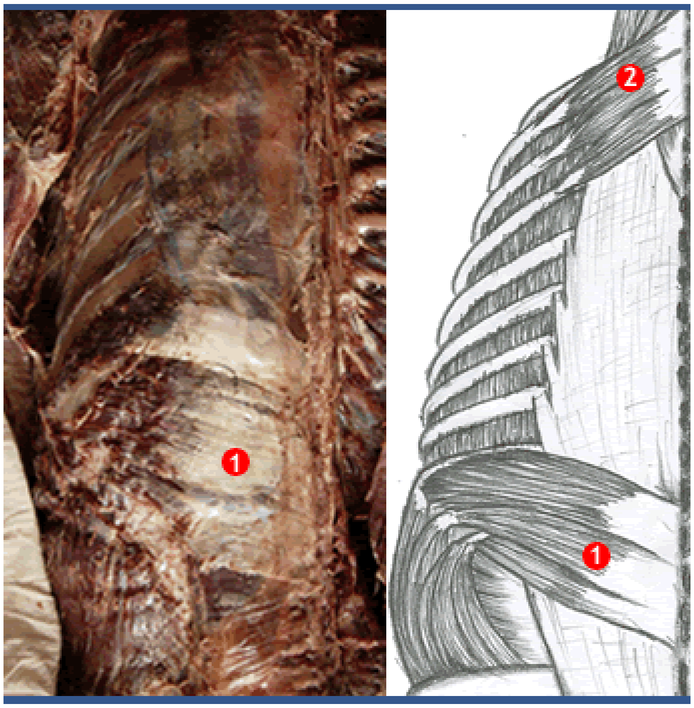
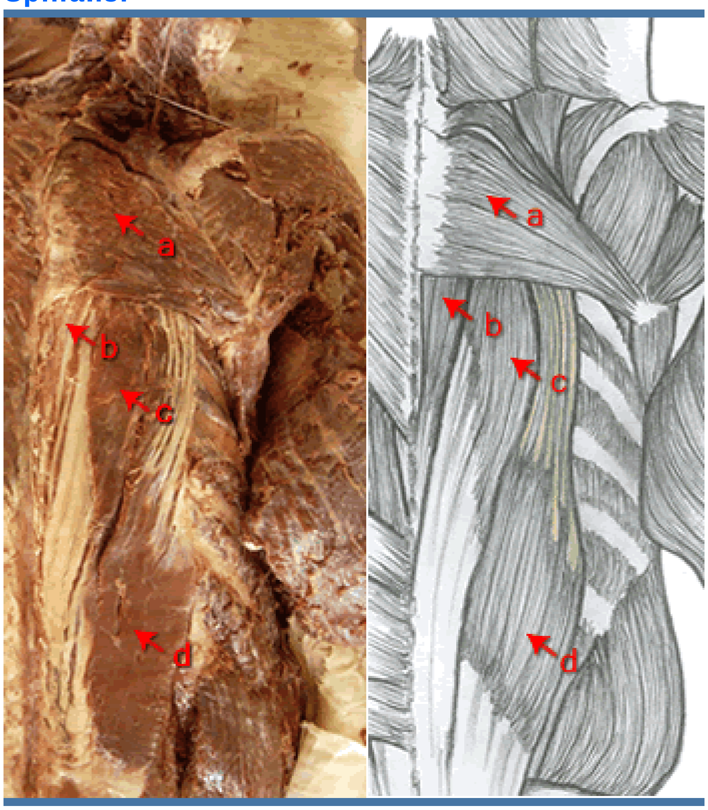
Serratus Muscles:

Hover over hotspot to show name

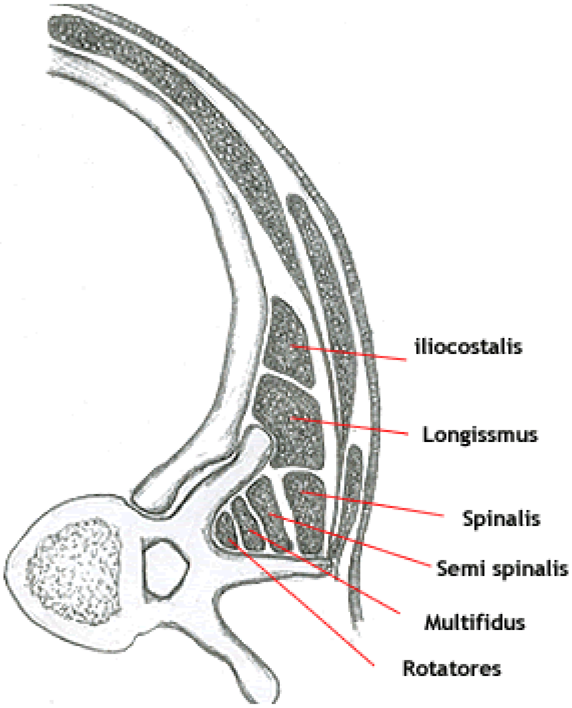


Spinalis:



Hover over hotspot to show name

Transversospinalis


iliocostalis
Longissmus
Spinalis
Semi spinalis
Multifidus
Rotatores

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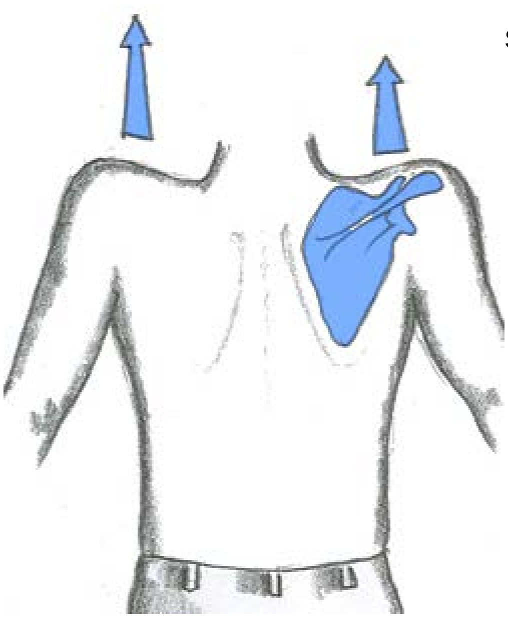
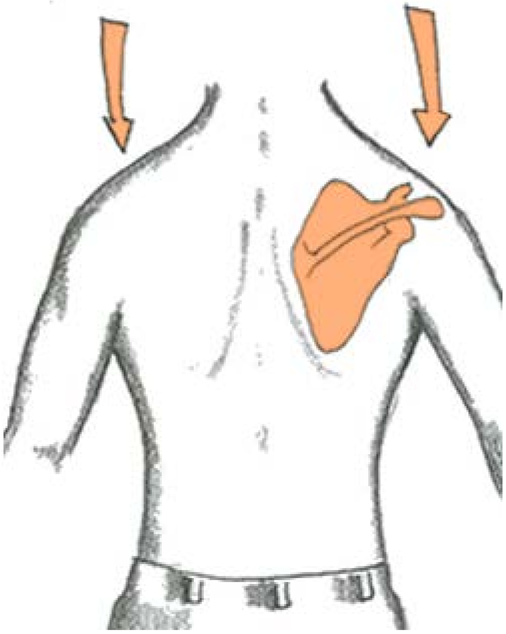
CHAPTER 13: Back and Scapula Region

Learning points | Core anatomy | Applied anatomy | Review questions

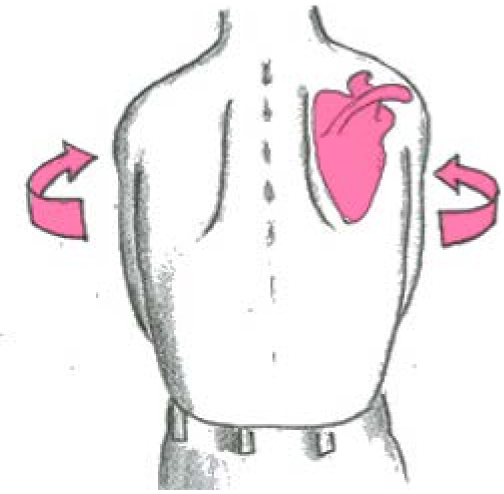
Movements of the scapula:

The scapula is able to slide freely over the chest wall because of the loose connective tissue between serratus anterior and that wall.All the movements occur around the sternoclavicular joint with minor adjustments at the acromioclavicular joint.

Movement	Occasion (Situation)	Muscles
Elevation:		
	Shrugging shoulders	• Upper fibres of trapezius • Levator scapulae
Depression:		
	Dropping shoulders (“at ease”).	• Lower fibres of pectoralis major • Latissimus dorsi • Pectoralis minor



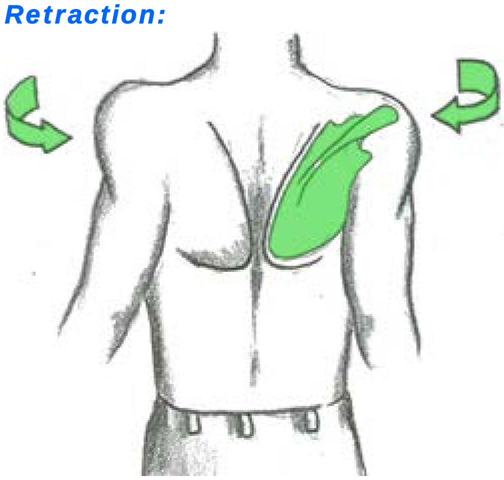
Protraction:



- Reaching forwards
- Punching
- Pushing

- Serratus anterior
- Pectoralis minor

Retraction:



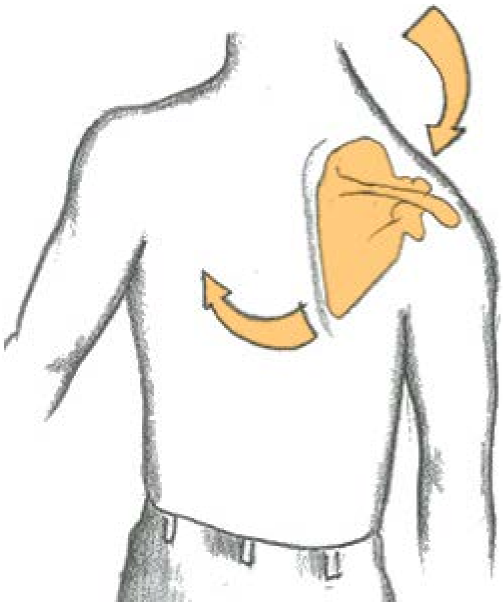
Drawing back the shoulders (“atten...tion”)

- Middle fibres of trapezius
- Rhomboid major
- Rhomboid minor

Medial rotation:

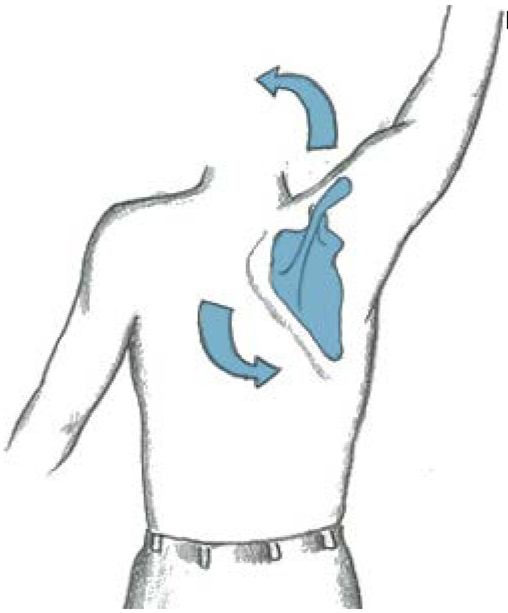
Assist to draw the shoulders back.

- Levator scapulae
- Rhomboid major and minor.



- Weight of the upper limb.

Lateral rotation:



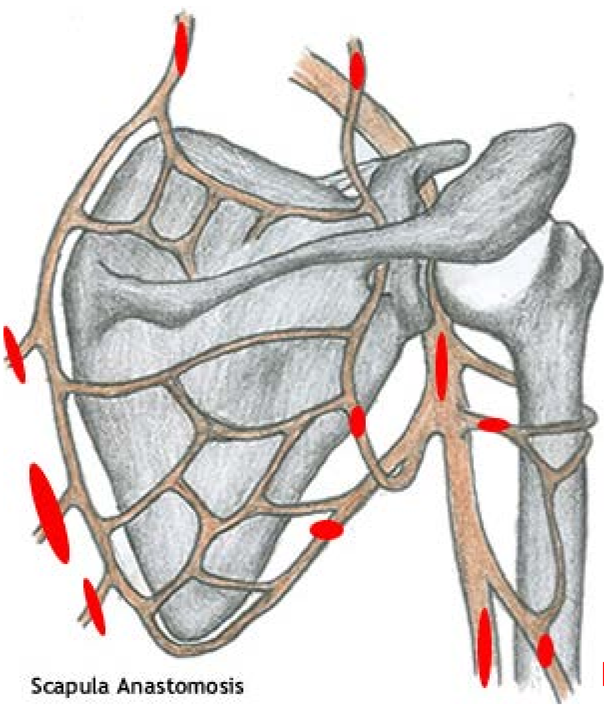
During shoulder abduction.

- Upper fibres of trapezius.
- Lower fibres of trapezius.
- Lower part of serratus anterior.

CHAPTER 13: Back and Scapula Region

Scapula Anastomosis:

Contributing arteries:



Scapula Anastomosis

Click on the hot spots to show arteries contributing to the scapula anastomosis

- Suprascapular (from subclavian a.)
- Transverse cervical (from thyrocervical trunk.)
- Circumflex scapular (from subscapular of 3 rd part of axillary)
- Thoracodorsal (from subscapular of 3 rd part of axillary)
- Posterior intercostal

Functions

- Ensure adequate arterial supply to the middle scapula.
- Form a subsidiary route through which blood can pass from the proximal part of the subclavian artery to the third part of the axillary artery when either subclavian or axillary artery is blocked between these two points

task ***What is the most appropriate site to do a ligature of an injured axillary or subclavian artery?***

CHAPTER 13: Back and Scapula Region

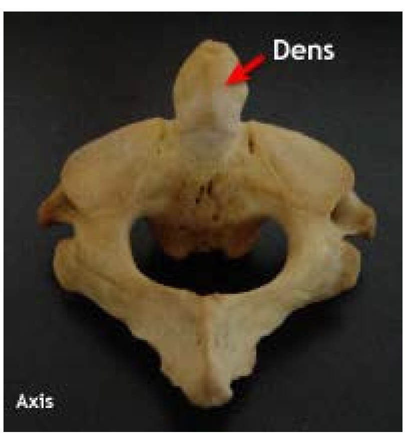
Vertebrae:

Note the following about the vertabrae from different regions.

- Is ring shaped
- Has no body nor spinous process
- Has lateral masses instead
- Superior articular facets are kidney shaped
- Has anterior and posterior arches bearing a tubercle in the center
- Posterior arch has a groove on the superior surface. This groove has vertebral arteries and C1.
- Has an articular surface for the dens on the interior surface of the anterior arch

task **How does the atlas differ from other cervical vertebrae?**

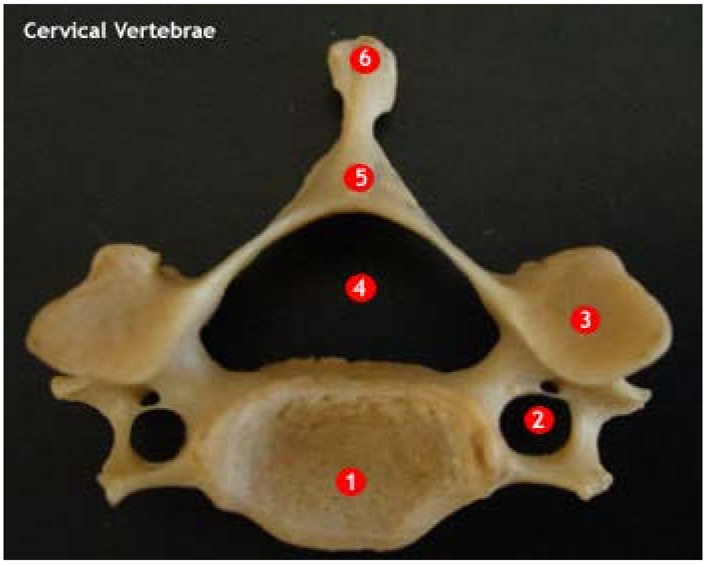
task **What type of joint is the atlanto-occipital joint?**



- Has a tooth like dens/ odontoid process projecting from its body
- The dens has articular facet for the atlas
- Short thick bifid spine
- The vertebral foramen is wide

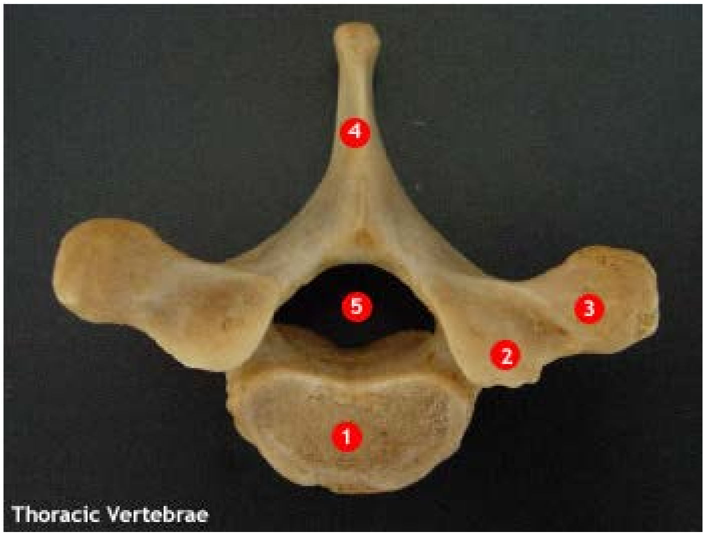
Cervical Vertebrae:

- Seven in number.
- The vertebral foramina are large and triangular.



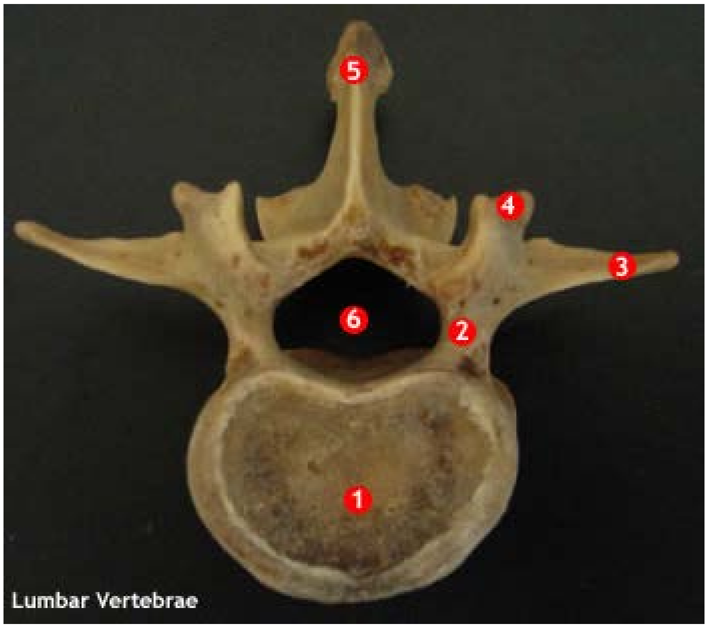
- The spinous processes are short and bifid except that of the atlas, that is reduced to a tubercle, and that of C7 which is long and non-bifid. The axis has a massive spinous process.
- The transverse processes are short and perforated.

Thoracic Vertebrae:



- Twelve in number.
- Long spinous procces sloping downwards.
- Prescence of costal facets.
- Heart- shaped body.
- Circular vertebral foramina that become progressively triangular on either end.

Lumbar Vertebrae



- Five in number.
- Kidney-shaped body.
- Long, slender horizontal transverse processes.
- Small triangular vertebral foramina.
- Large, oblong horizontal spinous processes (short and sturdy).

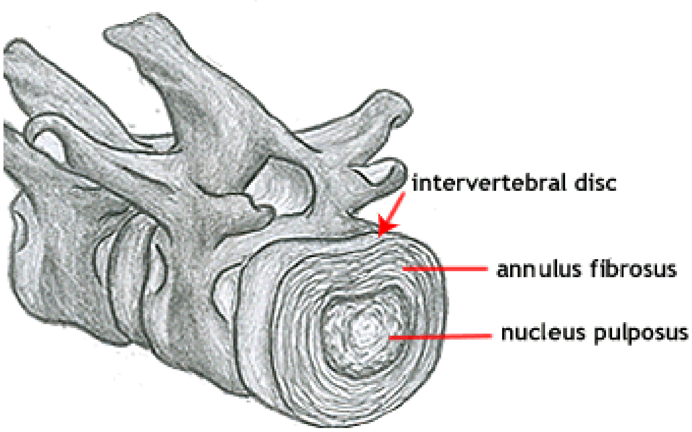
Sacrum

- Five in number
- Fused
- Demarcated by four transverse lines
- Progressively smaller distally
- Equidistant sacral foramina on each side

Coccyx

- Four in number
- Fused into a small triangular bone

Intervertebral Disc:
Structure:



- The *annulus fribrosus*, whose fibres are arranged in a parallel manner and criss-cross with those of the next layer. Note that it is of mesenchymal origin.
- The *nucleus pulposus*, at the center of the disc. It is a fibrogelatinous pulp that is a remnant of the notochord.
- Hyaline cartilage covering the bone surfaces

Function:

The major functions of the Intervertebral disc include:

1. Acting as a shock absorber.
2. Transmition of weight.
3. Holding adjacent vertabrae together.

Note:
As a result of aging, the nucleus pulposus becomes increasingly fiibrocartilagenous and contains less water, while in people relieved of gravity (astronauts) there is an increase in height of several centimeters.

task ***In what direc***

tion does the IVD herniate in injury and what is the effect of this?

Vertebral Ligaments

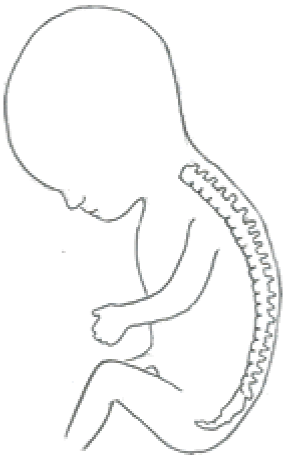
Ligament	**Extents**
Anterior Longitudinal	Over anterior surfaces of vertebral bodies From cervical to sacral
Posterior Longitudinal	Over posterior surfaces of vertebral bodies From cervical to sacral

Inter Laminar	Between adjacent laminae
Inter Spinous	Between adjacent spines
Supra spinous	Runs over tips of spines

Function

- To hold vertebrae together

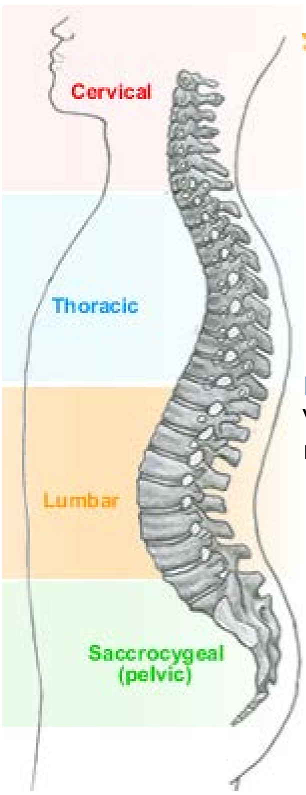
Vertebral Column Curvatures:



primary curves:Thoracic and sacral curves: present at birth

Secondary curves: Cervical and lumbar: Develop at 3 and 9 months respectively

Adult Curvatures:

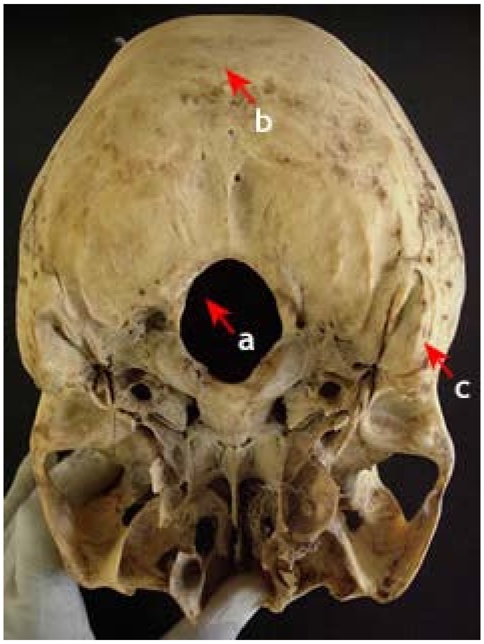


Include

- **Cervical curvature**; convex anteriorly (c1 – T2)
- **Thoracic curve**, concave anteriorly (T2 – T12)
- **Lumbar curve**, convex anteriorly (T12 and lumbosacral joint)
- **Saccrococcygeal (pelvic) curve**, concave anteriorly (lumbosacral joint to tip of the coccyx)

Note:
Vertebral column characterized by gentle sinuous bends, which give the column some resilience, but the intervertebral discs are the major shock absorbing devices.

The occipital bone:



Note the external occipital protuberence (inion), superior nuchal line, inferior nuchal line and mastoid process (on the temporal bone).

task ***What are the origins , insertions and actions of the trapezius muscle?***

The Sternum

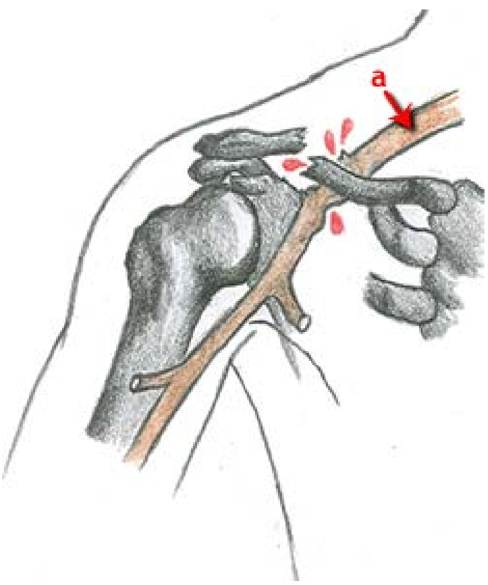
The sternum is made up of three parts i.e

1. The manubrium
2. The body
3. The xiphoid process

What is the importance of the sternum in clinical practice?

Applied Anatomy

1.0 Fracture of the clavicle



The clavicle is most commonly fractured bone in the body.

It is more commonly fractured than dislocated because:

1. Runs a sigmoid course
2. Held in place by strong ligaments
3. Presents areas of relative weakness

The fractures usually occur as a result of a fall on the shoulder or outstretched hand.

The commonest site of fractures is between the distal and middle thirds.

The lateral fragment is depressed the weight of the arm and the deltoid, and is also pulled medially and forward by pectoralis major.

The medial end is tilted upwards by the sternomastoid muscle.

The brachial plexus and axillary vessels are in danger of injury.

The close relationship of the supraclavicular nerves to the clavicle may result in their involvement in callus formation after fracture of the bone.

This may be the cause of persistent pain over the side of the neck.

The clavicle's subcutaneous position impairs its blood supply, thus delaying union following fracture.

2.0 Compression of the subclavian vessels and brachial plexus

The interval between the clavicle and the first rib in some patients may become narrowed, causing compression of neurovascular structures there.

- Most of the symptoms are caused by pressure on the lower trunk of the plexus producing pain down the medial side of the forearm and hand, and wasting of the small muscles of the hand.
- Pressure on the vessels may compromise the circulation of the upper limb.

3.0 Dislocation of the acromioclavicular joint

Falls on the shoulder may dislocate the acromioclavicular joint, forcing the acromion under the clavicle and tearing the coracoclavicular ligament.

4.0 Breast Cancer

Cancer of the breast can spread via lymphatics, or venous channels. During haematogenous spread, the communication with the vertebral venous plexus provides a route for spread to the central nervous system.

Because of the axillary tail , and early involvement of the axillary lymph nodes in breast cancer, always examine the axilla whenever you do breast examination

---

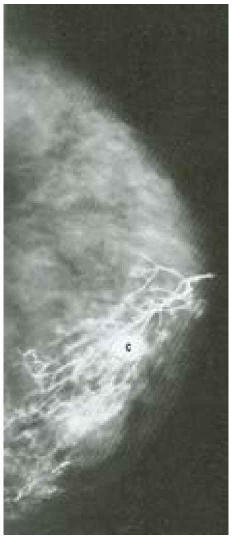
5.0 Accessory mammary tissue

Accessory breasts or nipples may occur above or below the normal breast in either sex.

- Commonly, these accessory or supernumerary "breasts" consist only of a nipple and an areola, but sometimes, true glandular tissue is present also.
- Supernumerary breasts are usually found along a line extending from the axilla through the normal breast to the groin, this being regarded as the milk line , or line along which mammals with multiple breasts usually develop them. Occasionally, supernumerary breasts are found beyond the usual extent of the milk line, for instance, on the neck or on the vulva or femoral triangle.

Mammography

This is radiographic examinaion of the breast. Extensively used for screening breasts for benign annd malignant tumors and cysts. It can detect very small lesions unnoticed by clinical examination. Because the process is usually repeated often, only very small doses are used.



Suspensory ligaments and skin dimpling

The breast tissue is divided into 15- 20 compartments that radiate from the nipple by fibrous septa that extend from the skin to the underlying fascia.
If the fibrous tissue gets involved in malignant disease, or inflammation or abcess,they may contract and pull on the skin, causing its dimpling to give an orange peel appearance(peau de orange)

Radical mastectomy

Operation done on patients with localized cancer of the breast with early spread to lymph nodes
It comprises of removal of the breast together with lymph vessels and nodes that drain the area. The excised mass consists of the following;

1. *A large area of the skin overlying the tumor and including the nipple*
2. *All the breast tissue*
3. *Pectoralis major and associated fascia*

4. *Pectoralis minor and associated fascia*
5. *All the fat, fascia and lymph nodes in the axilla*
6. *Fascia*

The following **must be spared**

1. *Axillary vessels*
2. *Brachial plexus*
3. *Nerves to serratus anterior and latismus dorsi*
4. *Postoperative edema of the upper limb is due to removal of lymph vessels/nodes draining the upper limb*

Modified radical mastectomy

Done to patients with clinically localized cancer
The primary tumor is removed together with axillary lymph nodes, fat and fascia
The pectoral muscles are left intact

Mastitis
This is acute infection of the breast common during lactation. Bacteria gain entrance into breast tissue through a crack in the nipple. Initially, the fibrous septa contain the infection in one lobe
Abcess drainage

Radially arranged ducts usually drain these.

Simple mastectomy

This is removal of the beast, done usually in localized cancer of the breast.
Usually combined with radiotherapy and/or hormonal therapy of axillary lymph nodes

---

Clavicle

Abnormal development of the clavicle may result in the absence of most of each clavicle. The shoulders will be very narrow and the individual may be able to bring the shoulders together in the midline.

The clavicle results from fusion of two ossification centers. Sometimes fusion fails, resulting in a defect that separates the outer third and the inner two thirds. Following upper limb trauma, this defect may be confused for a fracture

---

Injuries of brachial plexus

Can be caused by

- Violent separation of the head and shoulder as may occur in a fall from a motorcycle or during delivery
-
- Violent stretching of the arm above the head as in breech delivery, fall from a tree, skidding, e.t.c.
- Wounds in the neck or axilla
- Surgery in the lower neck or axilla
- Chronic irritation by heavy loads carried on the side of the neck
- Compression by a tumor, abnormal rib, or contracting muscle.
- Fractured clavicle, and in the case of nerves, any other bone.

The injuries may be classified into two:

Upper type, which involves the roots C5, 6, and results in unopposed medial rotation and in adduction of the upper limb. This position is sometimes referred to as "porter's, waiters' or policeman's hand". The paralysis "Erb's or Erb- duchenne paralysis) affects mainly the shoulder and arm.

- , which involve **C8,T1** and result in **claw hand**. This is also called **Lampe's** or **Klumpke-Dejerine paralysis**.

Summary of nerve injuries in the upper limb

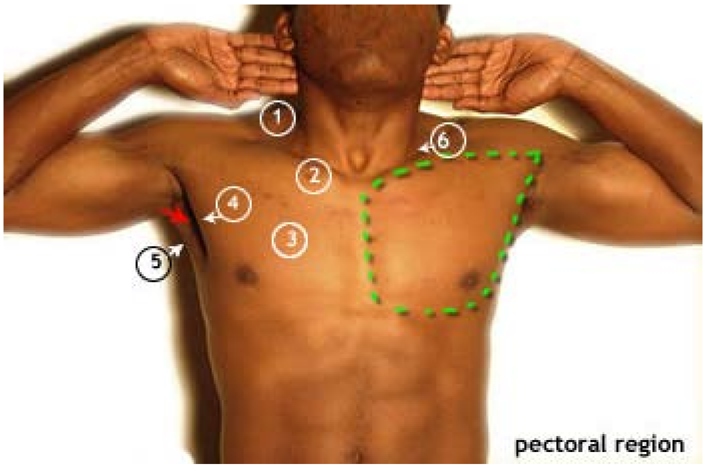
Nerve	Common site and causes	Effects
Radial	1. Fracture humeral shaft 2. Axilla by poorly fitting crutches (Crutch palsy) 3. Saturday night palsy – draping arm over chair while drunk 4. Supracondylar humeral fracture	1. Wrist drop 2. Sensory loss over 1st dorsal interosseous
Axillary	1. Shoulder dislocation 2. Fracture surgical neck humerus 3. Misplaced injections into deltoid	1. Weakened shoulder abduction 2. Anaesthesia over lower part of deltoid
Ulna	1. Behind medial humeral epicondyle by fracture or compression or traction in cubitus valgus 2. Supracondylar humeral fracture 3. Wrist	1. Claw hand 2. 'Guttering' between metacarpals due to wasting of interossei 3. Sensory loss on ulna side of hand
Median	1. Wrist- by cuts or compression in carpal tunnel 2. At elbow by compression in cubital fossa 3. Struther's ligament 4. Supracondylar humeral fracture/ brachial artery aneurysms	1. Wasting of flexor muscles 2. Wasting of thenar muscles 3. Hand with index finger straight 'Pointing finger position' 4. Sensory impairement over radial 3/5th of palmar surface of hands

Review Questions

1. Describe the features, relations, muscle attachments and applied anatomy of the **clavicle**
2. Describe the position, relations, blood supply, lymphatic drainage and applied anatomy of **mammary gland**
3. Describe the boundaries and contents of **axilla**
4. Write short notes on extents, branches and distribution of **axillary artery**
5. Describe the formation, branches, distribution and injuries of **brachial plexus**
6. Describe the organization and respective territory of drainage of **axillary lymph nodes**

CHAPTER 14: THE PECTORAL REGION AND THE AXILLA

The Pectoral Region: Introduction



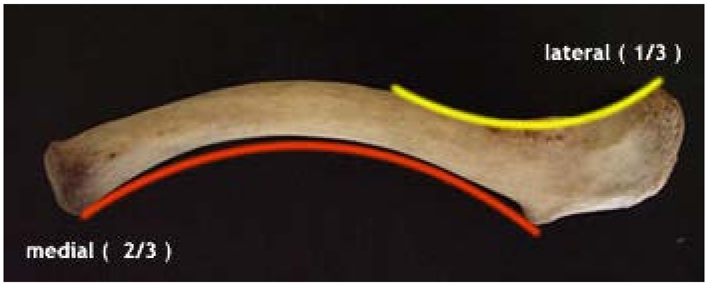
The region is of clinical importance because of the clavicle (the most commonly fractured bone) and the mammary

hover over the rounded areas to show names

CHAPTER 14: THE PECTORAL REGION AND THE AXILLA

The Clavicle

Gross features



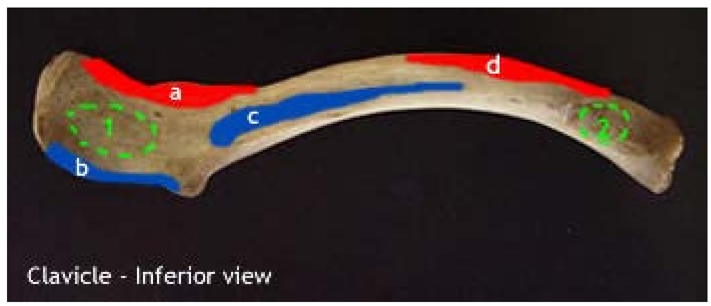
Sigmoid bone.

- Medial 2/3 convex anteriorly.
- Lateral 1/3 concave anteriorly.

Sternal articular surface more rounded.

Inferior surface rougher due to muscle and ligamentous attachments.

Muscular attachments



Some unique features of the clavicle

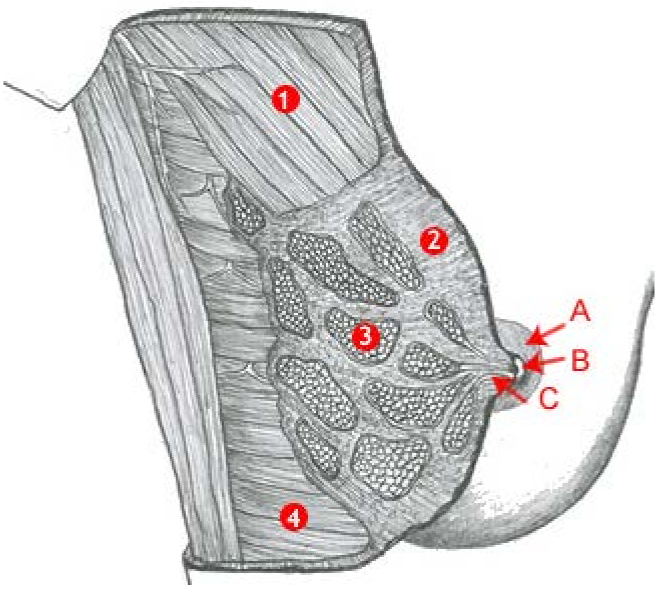
- Starts ossification during week 5, while the others commence during week 8. Ossification is completed around 25 years, while for the others, it is about 18-21 years.
- It runs a sigmoid horizontal course. Most long bones are vertical and straight. (*Compare with the femur or tibia*)
- It does not have a marrow cavity; its core is occupied by spongy bone.
- The *medial 2/3* ossifies *endochondrally* while the lateral 1/3 ossifies intramembranously.

Functions of the clavicle

- Hold the upper limb away from the trunk and increase the range of movement, especially abduction.
- Transmit weight from the upper limb to axial skeleton.
- Provide attachment for muscles.

The Mammary Gland:

Position



- Pectoral region
- Subcutaneous
- From lateral border of the sternum to mid-axillary line.
- Axillary tail extends further into axilla.
- From 2 nd to 6 th ribs.
- Nipple in 4 th intercostals space about midclavicular line.

Relations

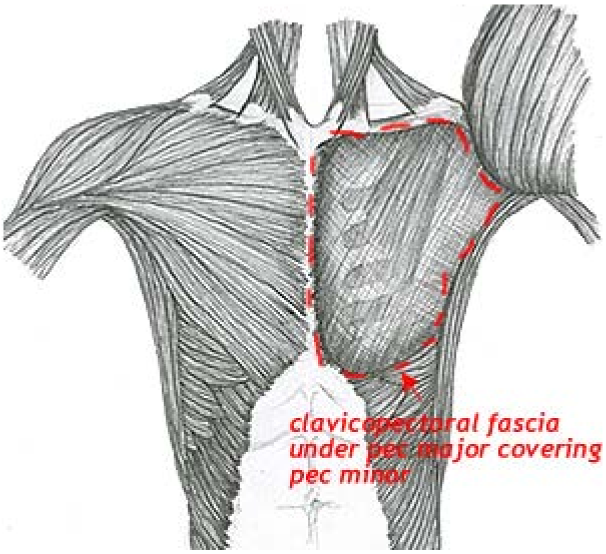
Overlies fascia covering 4 muscles

- Pectoralis major.
- Serratus anterior.
- External oblique abdominis aponeurosis.
- Rectus abdominis

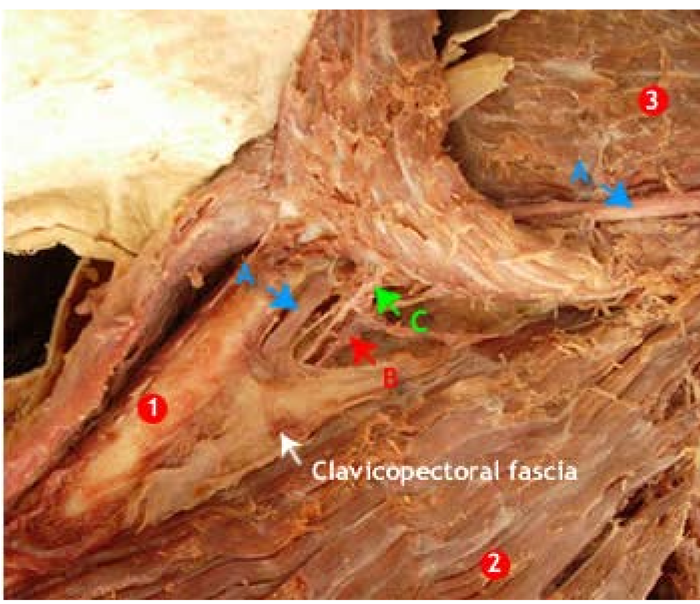
Separated from this fascia by *submammary space (***retro mammary space***)* with loose connective tissue. This is the basis for free mobility of the breast over chest wall.

CHAPTER 14: THE PECTORAL REGION AND THE AXILLA

Clavipectoral Fascia



Clavipectoral fascia arises from the clavicle, encloses subclavius, pectoralis minor and attaches to axillary fascia.



Hover over hotspot to show information

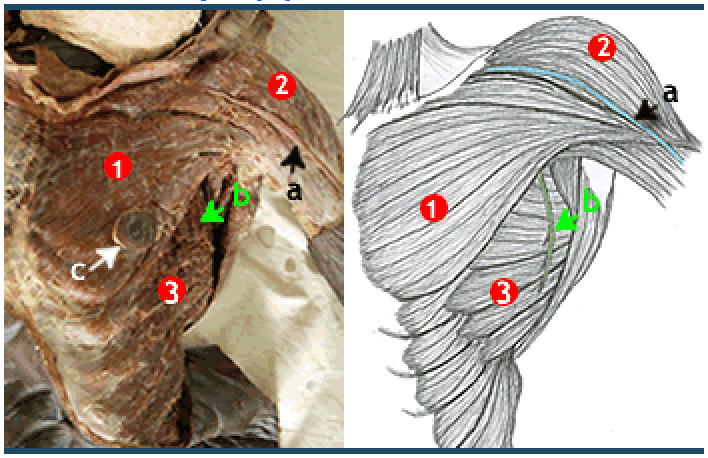
Pierced by

1. Cephalic vein
2. Thoracoacromial artery
3. Lymphatics
4. Lateral pectoral nerve

task ***Identify the structures labelled 1, 2,3.***

Muscles in the Pectoral Region

Pectoralis Major (1)



Origin

- Medial half of the clavicle
- Anterior surface of the sternum
- First six costal cartilages

Insertion

- External oblique.
- Lip of bicipital (intertubacular) groove of humerus

Actions

- Adduction of the extended limb
- Medial rotator of the arm
- Flexion of the upper limb (Clavicular portion)
- Depression of the arm and shoulder (sternocostal head)
- Elavation of the ribs (used in artificial respiration)

Innervation

- Medial pectoral nerve
- Lateral pectoral nerve

task ***Identify muscles 2 and 3***

Pectoralis minor (2)

Origin

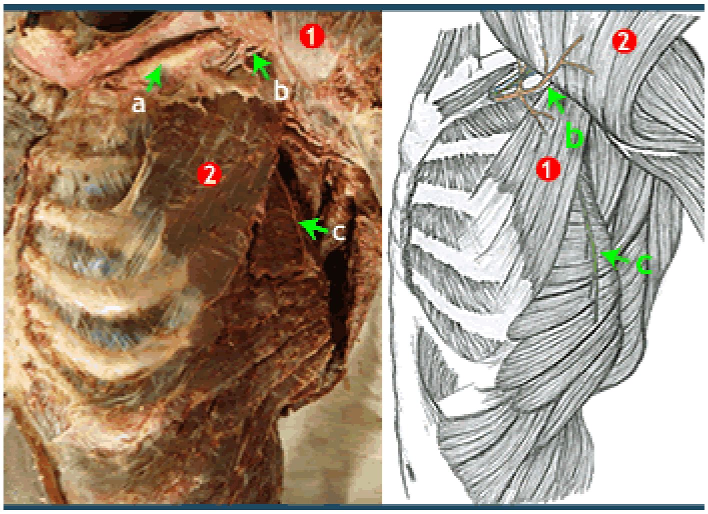
- 3 rd -5 th ribs
- fascia covering the intercostal muscles

Insertion

- Coracoid process of the scapula
- Rarely the tendon of insertion passes upwards to blend with the coracohumeral ligament

Innervation

- Medial pectoral nerve(from the medial cord of the brachial plexus)



Actions

- Depresses the point of the shoulder
- With the serratus anterior, it draws the scapula forwards round the thoracic wall

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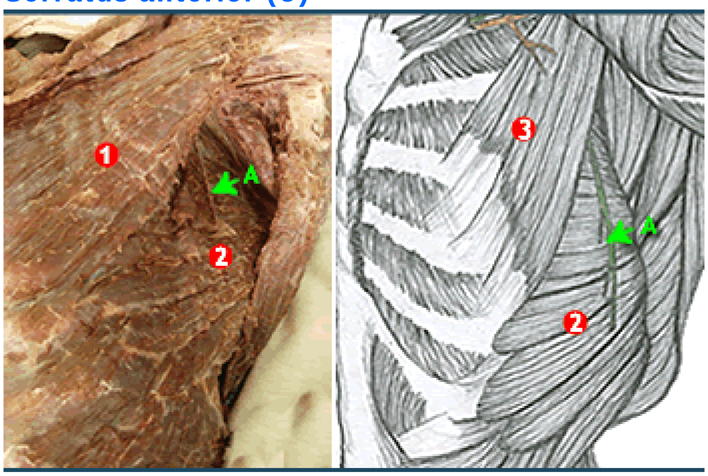
Serratus anterior (3)



Origin

Upper 8 sibs anterolaterally

Insertion

- First slip: inferior angle of scapula
- Next three: medial border of the scapula
- Last four: inferior angle of scapula

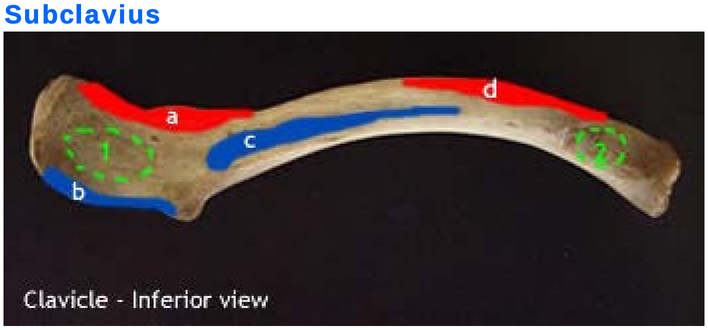
Innervation

- Long thoracic nerve (C5,C6 C7)

Actions

- Protraction of the scapula
- Lateral rotation of the scapula

Subclavius



Origin

- Junction of the first rib and its costal cartilage

Insertion

- Inferior aspect of clavicle (***Area marked [C]***)

Innervation

- Upper trunk of brachial plexus (C5, C6)

Actions

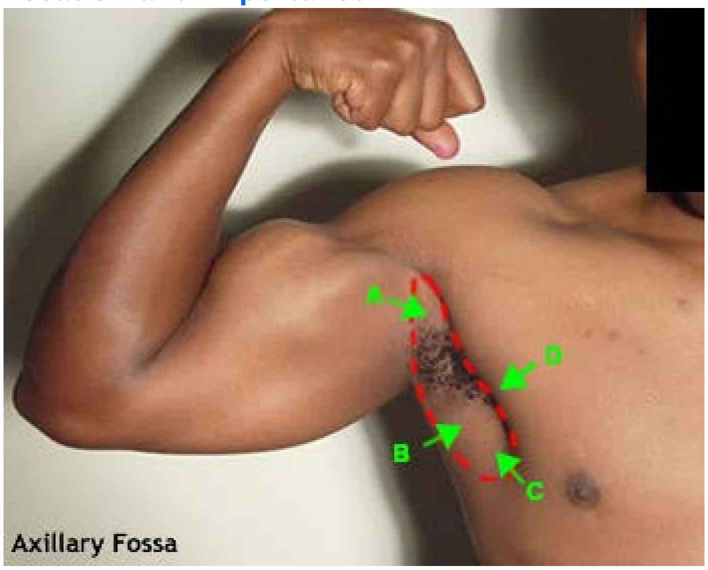
- Depresses lateral part of clavicle

Note: *The subclavius acts as a buffer between a fractured clavicle and subclavian artery*

CHAPTER 14: THE PECTORAL REGION AND THE AXILLA

The Axilla

Location and importance



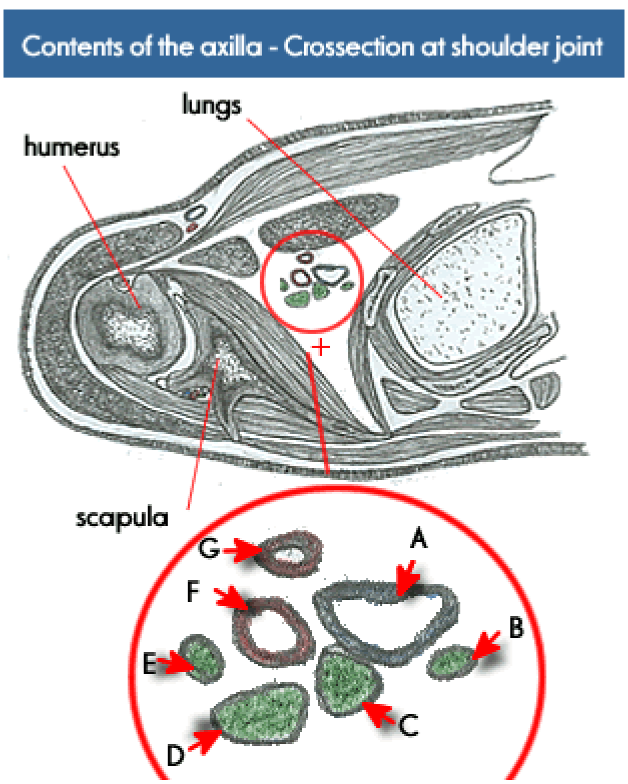
Pyramid-shaped space between the upper part of the arm, and the side of the upper chest.

Provides passage for nerves, blood and lymph vessels from the root of the neck to the upper limb.

Note the boundaries:

- Anterior axillary fold [D]
- Posterior axillary fold [B]
- Base formed by skin [C]
- Lateral border [A] formed by humerus.

Boundaries



Apex:

- Anterior: the lateral part of the clavicle.
- Posterior: upper part of the scapula.
- Medially: outer border of the first rib.

Walls:

- Anterior: pectoralis major, minor and subclavius
- Posterior: subscapularis, latissimus dorsi and teres major
- Medial: upper 5 ribs and intercostal muscles covered by serratus anterior.
- Lateral: biceps brachii and coracobrachialis.

Base:

- Anterior: lower border of pectoralis major.
- Posterior: tendons of latissimus dorsi and teres major muscle
- Medial: chest wall
- Floor: axillary fascia and skin stretching between the anterior and posterior walls.

Contents

The Axillary Artery

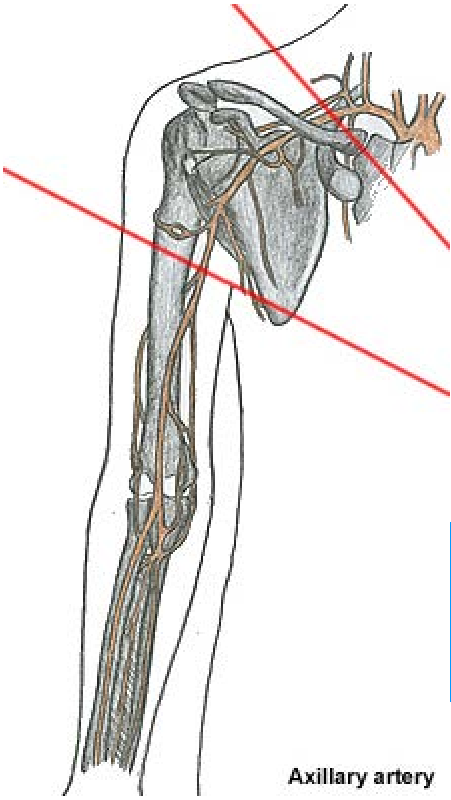
Extents:
Lateral border of **first rib** as a continuation of subclavian artery to the **lower border of teres major** where it continues as brachial artery

Parts:

Divided into three by pectoralis minor muscle.

- *Part 1* is proximal to the muscle.
- *Part 2 i*s posterior to the muscle.
- *Part 3* is distal to the muscle.

Part	Branch	Branches and distribution
First Part	• **Supreme thoracic**	Upper chest wall
Second part	• **Lateral thoracic**	Runs with long thoracic nerve to supply serratus anterior and lateral breast
	• **Thoracoacromial**	• Deltoid branch-deltoid muscle • Acromial branch-thoracoacromial joint • Clavicular branch-clavicle • Pectoral branch-pectoralis major and breast
Third Part	• **Subscapular**	• Circumflex scapular-scapular region • Thoracodorsal-scapular region and latissimus dorsi



Anterior humeral circumflex	Shoulder joint
Posterior humeral circumflex	Deltoid, humerus and shoulder joint.

Axillary Vein

- Extends from the **lower border of teres major** where it is formed by union of **basilic vein** and "**brachial vein**" to the lateral border of 1 st rib where it continues as subclavian vein
- Located medial to the axillary artery
- Receives tributaries corresponding to the branches of the axillary artery; and the **cephalic vein.**

CHAPTER 14: THE PECTORAL REGION AND THE AXILLA

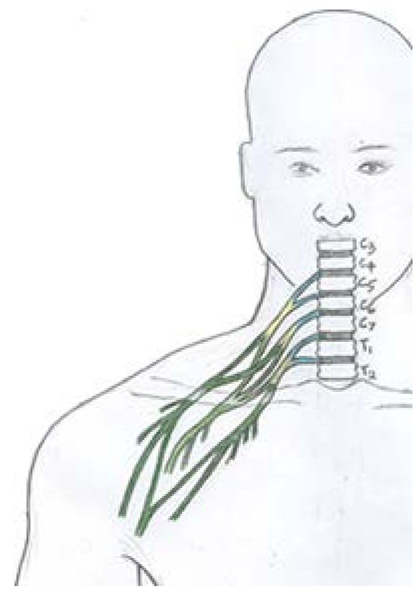
Contents

Brachial plexus

Origins

Vertical rami of C5-T1 Occasionally it is *prefixed* i.e. C4 contributes; or it is post fixed i.e. T2 contributes

Parts



Roots, trunks, divisions, cords and branches.

In relation to the clavicle, there are 3 parts namely

1. **Supraclavicular** (cervical) - Roots and trunks
2. **Clavicular** (retroclavicular) – Divisions
3. **Infraclavicular** (axillary) – Cords and branches

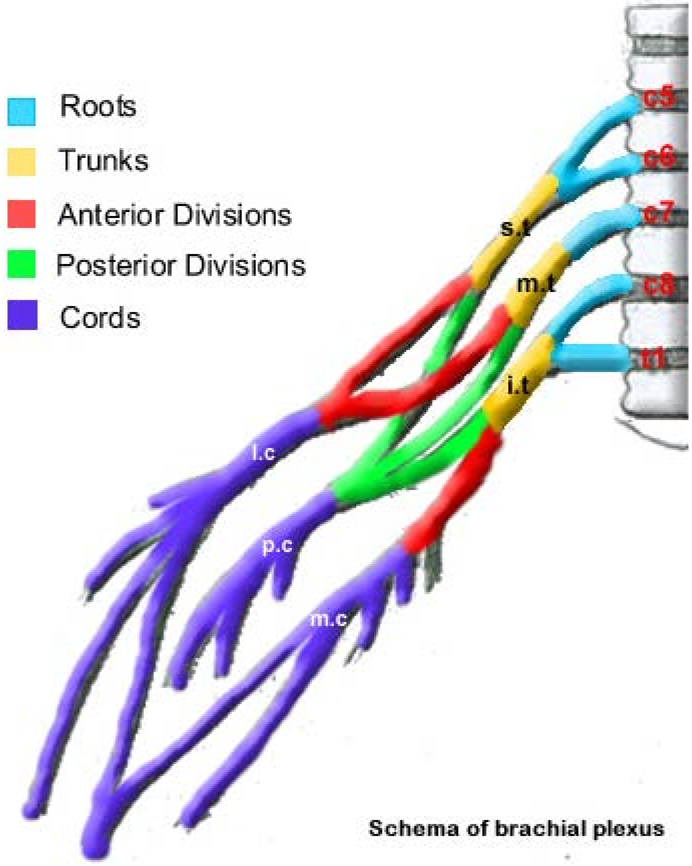
Formation

Formation of trunks

- Roots C5 and C6 unite to form the ***superior trunk [s.t]***
- Root C7 continues as the ***middle trunk [m.t]***
- Roots C8 and T1 unite to form the ***inferior trunk [i.t]***

Formation of divisions and cords

- Each trunk divides into an ***anterior*** and ***posterior*** division
- The ***anterior divisions*** of the upper and middle trunk from the ***lateral cord [l.c].***
- The ***anterior division*** of the lower trunk continues as the ***medial cord [m.c]***
- All the ***posterior divisions*** form the ***posterior***



Schema of brachial plexus

cord [p.c]

Osteology

The osteology in this topic includes the following

1. Humerus
2. Scapula
3. Clavicle

Humerus

Scapula

Review the anatomy of the scapula

Clavicle

Review the anatomy of the clavicle

Applied Anatomy

Dislocation of the shoulder joint

Axillary nerve
Hill sachs lesion

Neers classification

Fractures of proximal humerus -Neers classification

1. Lesser tubercle
2. Greater tubercle
3. Anatomical neck
4. Surgical neck

Biceps brachii

When the arm is raised from the side it assists the Supraspinatus and Infraspinatus in rotating the head of the humerus in the glenoid cavity.
It also holds the head of the bone firmly in contact with the glenoid cavity, and prevents its slipping over its lower edge, or being displaced by the action of the Latissimus dorsi and Pectoralis major, as in climbing and many other movements

The peculiar relations of the tendon of the long head of the Biceps branchii to the shoulder-joint appear to subserve various purposes

1. In the first place, by its connection with both the shoulder and elbow the muscle harmonizes the action of the two joints, and acts as an elastic ligament in all positions
2. It strengthens the upper part of the articular cavity, and prevents the head of the humerus from being pressed up against the acromion, when the Deltoid contracts; it thus fixes the head of the humerus as the center of motion in the glenoid cavity.
3. By its passage along the intertubercular groove it assists in steadying the head of the humerus in the various movements of the arm.

Review Questions

1. Describe the classification , capsular attachments , stability factors , relations , innervation , blood supply and movements of the glenohumeral joint

2. Outline the configuration and relations of the sternoclavicular and acromioclavicular joints

3. Give a brief account of the boundaries and contents of the

- Quadrangular space
- Upper and lower triangular spaces
- Cubital fossa

1. Give an account of the formation and contents of the compartments of the arm

2. Write briefly about the attachments innervation and functions of

- Rotator cuff
- Deltoid muscle

1. Give a brief account of the sites of muscle attachments and neurovascular relations of the humerus

Functional adaptation of the upper limb

The upper limb is modified for prehension and tactile sensibility. Part of the adaptation for prehension is increased movement at the joints, often at the expense of stability. The “working tool” i.e. the hand is positioned at the end of a long strut with a freely mobile base (the shoulder joint complex) and two foldable members (the arm and forearm).

This shoulder joint complex allows a wide range of movement on account of the following factors:

- *Shallow glenoid cavity* which accommodates only ½ the head of the humerus.
- *Laxity of the capsule* of the glenohumeral joint.
- Replacemnt of strong ligaments by a musculotendinous “cuff” (*Rotator cuff)* – often referred to as ligaments of variable tension
- A synovial highly movable *sternoclavicular joint*.
- Presence of a *long clavicle* that holds the upper limb away from the trunk.
- A *freely movable scapula* over the chest wall.

Components of the shoulder joint complex

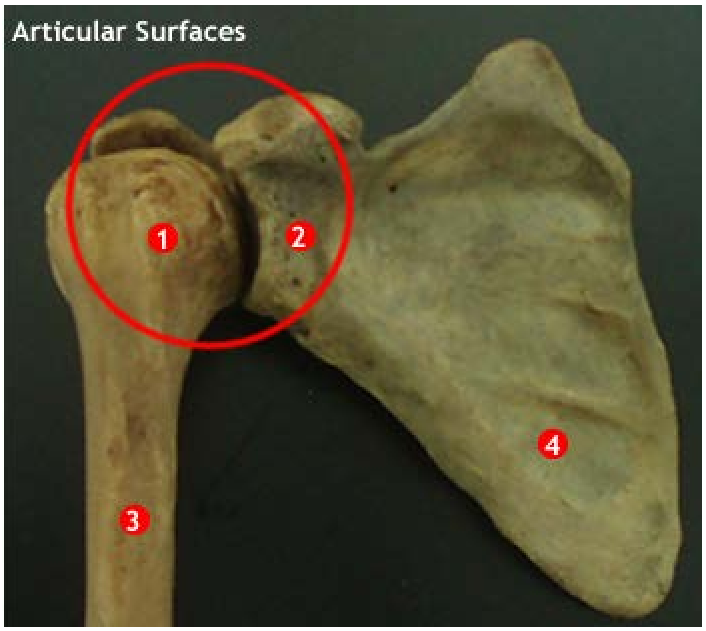
- Glenohumeral joint
- Sternoclavicular joint
- Acromioclavicular joint
- Scapulothoracic “joint”
- Coracoclavicular “joint

Glenohumeral Joint

Classification

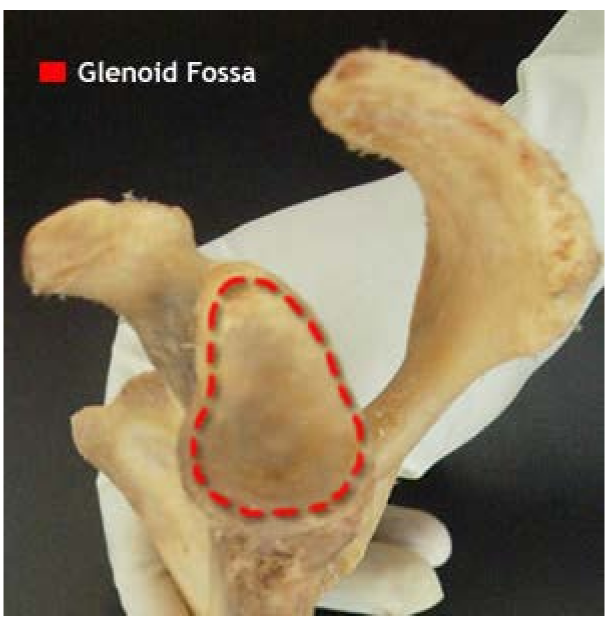
The shoulder joint is a ***synovial joint*** of the ***ball-and-socket*** (enarthroidal) type. ***Functionally multiaxial***

Articular surfaces



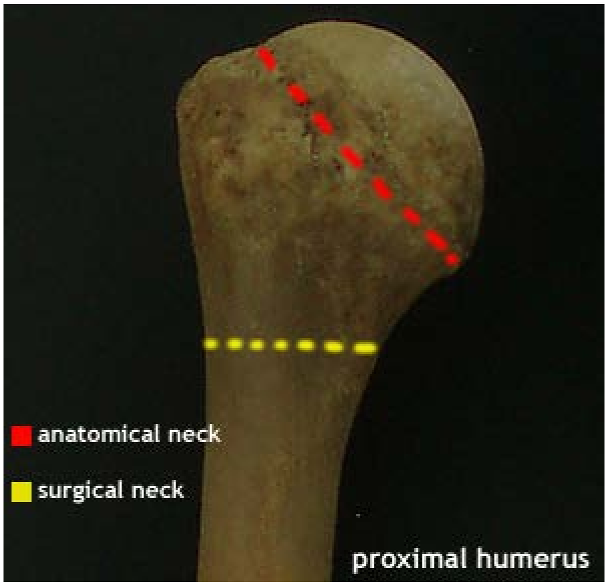
1. The *hemi spherical head of the humerus* ***(1)***
2. The *glenoid cavity of the scapula* ***(2)***. (The rim of the glenoid cavity is deepened by the glenoid labrum)

Glenoid Fossa



- Concave vertically and A/P
- Articular surface represents just over 1/3 that of humeral head
- The Gleniod labrum, triangular in cross-section like the hip, surround and deepens the glenoid fossa

Head Of Humerus



- Forms 2/5 of a sphere
- Regardless of position only 1/3 of head is in contact with gleniod at any one time.

Joint surface markings

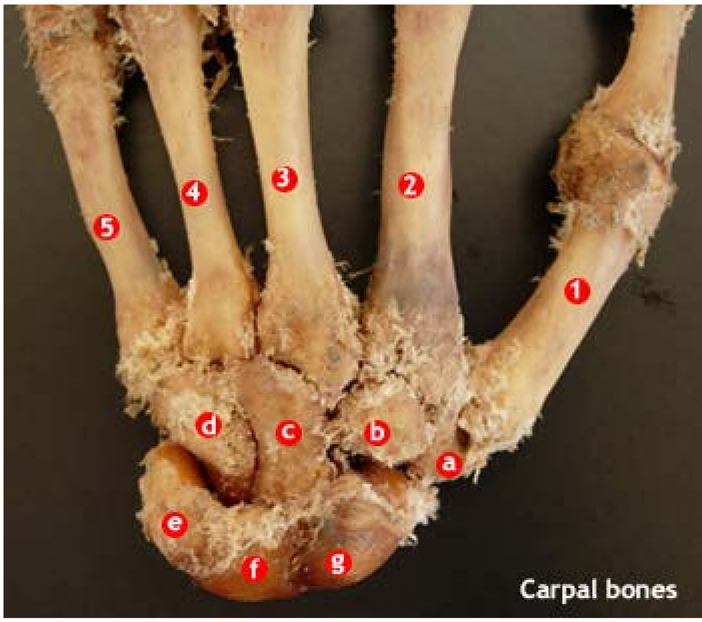
The midpoint of the joint is approximately 1cm lateral to the apex of the coracoid process
A vertical line slightly concave laterally through this point gives an indication of the joint line

Note : *The joint is unstable: it is built for mobility, not stability, and dislocation is more common at this joint than at any other in the body.*

CHAPTER 18 : The Joints of the wrist , hand and fingers

Organization of the Hand

Hand Osteology

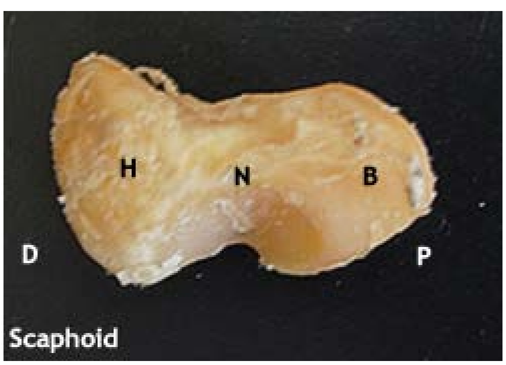


- **Eight carpal bones**

Scaphoid, Lunate, Trapezium, Triquetrium, Hamate, Capitate, Triquetral and Pisiform

- **Five metacarpals**
- **Fourteen phalanges**

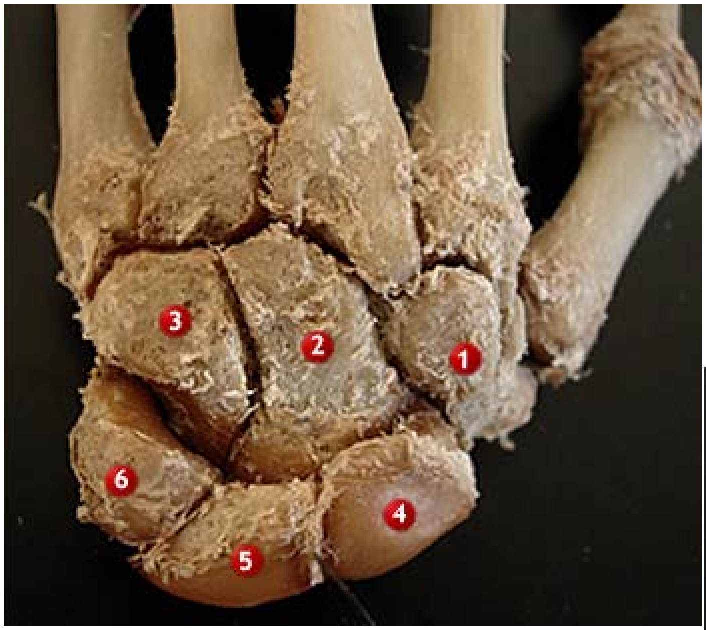
The Scaphoid bone



- Has a body, neck and head.
- The blood supply to the body is from the distal end
- Scaphoid fractures are common.

Other carpal bones

- Dislocations are common with the Lunate
- Triquetral makes contact with ulna at adduction
- The tendon of the *flexor carpi ulnaris, pisohamate* and *piso-metacarpal ligament* attach to the pisiform
- Trapezium characterized by grove for tendon of flexor carpi radialis. To it is attached the flexor retinaculum and radial collateral ligament
- Capitate is centrally placed and is the largest carpal



bone

- Hamate affords attachment to flexor retinaculum and has rough dorsal and palmar surfaces for ligament.
- Capitate is first to ossify. Pisiform is last (***What is the order for the others?)***

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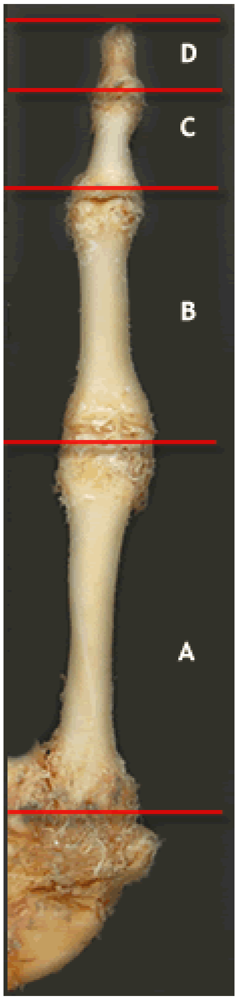
metacapals and phalanges :



Metacarpals are long bones with head, shaft and base.

The second metacarpal has the largest base and shaft

- The 14 phalanges bear heads, shafts and bases
- Note primary ossification centers for the shafts and secondary centers for base of 1 st and heads of other metacarpals

CHAPTER 18 : The Joints of the wrist , hand and fingers

Applied anatomy

CHAPTER 18 : The Joints of the wrist , hand and fingers

Review questions

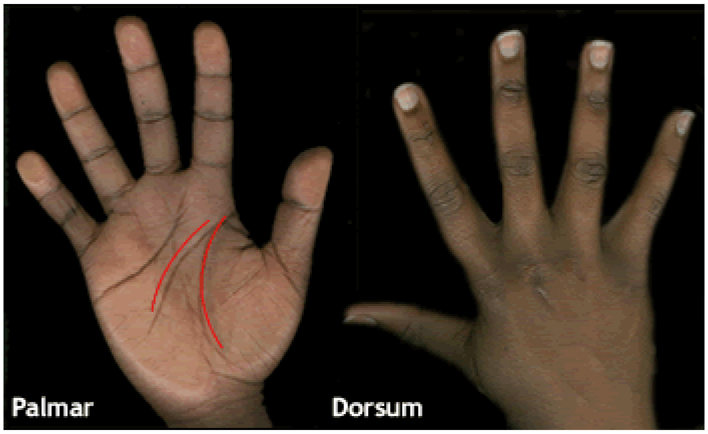
CHAPTER 18 : The Joints of the wrist , hand and fingers

Adaptative features of the hand

- Mobility of the thumb
- Opposability of pollex
- Elongated digits
- Palmar creases
- Palmar aponeurosis
- Small motor units
- Dense sensory innervation
- Cerebral representation of hand in cortex
- Presence of nails
- Freely movable hand
- Wide range of pronation and supination

CHAPTER 18 : The Joints of the wrist , hand and fingers

Skin and fascia

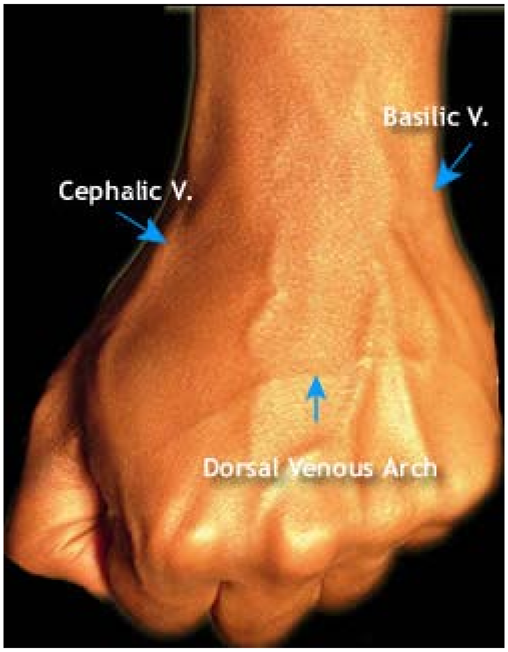


- Thick on the palmar side and loose dorsal side
- A fibrous subcutaneous tissue overlies the thick aponeurosis
- The Palm has **flexor lines** (creases) and **papillary ridges** to improve grip

Palmar aponeurosis

- The **palmar aponeurosis** is reinforced by fibers from palmaris longus tendon
- It is a continuation of the **flexor retinaculum.** Distally divided into longitudinal slips which diverge to the fingers
- Its modifications include:
    - *Thickened central part*
    - *Medial septum to 5 th metacarpal*
    - *Lateral septum to 1 st metacarpal*
    - *Thickened to form superficial transverse metacarpal ligaments at level of metatarsal heads*
    - *Inserts onto the fibrous flexor sheaths*
    - *Distal attachment to the dermis via creases*
    - *Digital nerves and vessels, lumbrical tendons pass between distal slips*
    - *Palmaris brevis attaches to it*
    - *Thinned over the thenar and hypothenar eminences*
    - *Contracted in Dupuytrens contracture resulting in flexed ring and little fingers*

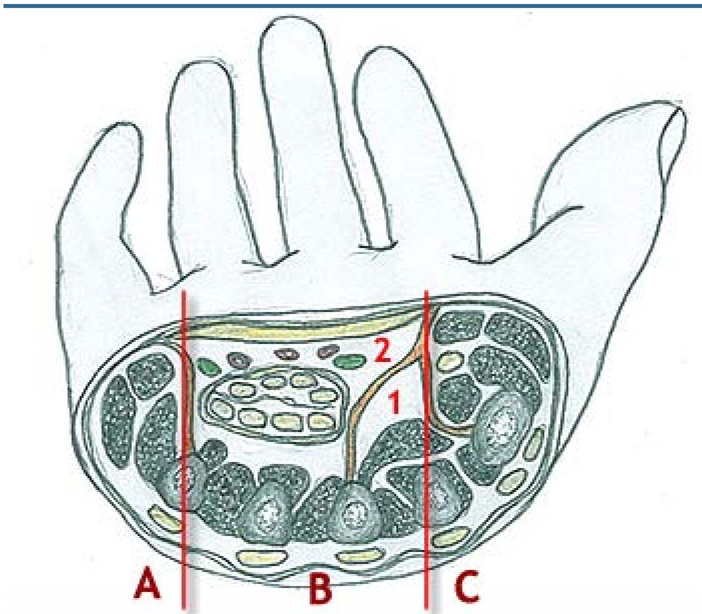
Also note the following:-



- The **dorsal venous network** lies beneath skin of the back of hand, superficial to extensor tendons
- The Network drains into **cephalic** (radial side) and **basilic** (ulnar side) veins
- Beyond the extensor retinaculum, extensor tendons spread out over the hand
- Tendons are connected by oblique fibers (**intertendinous connections)**

CHAPTER 18 : The Joints of the wrist , hand and fingers

Compartments and fascial spaces of the hand



These allow mobility but offer little resistance to infection.

They are bounded by connective tissue.
The spaces include

- Dorsal spaces
- Hypothenar space
- Midpalmar space
- Thenar space
- Web spaces
- Pulp spaces

The mid palmar space lies between the palmar aponeurosis anteriorly and palmar interossei and metacarpals posteriorly. It contains the *flexor tendons, lumbricals, superficial arterial arch, nerves and vessels*

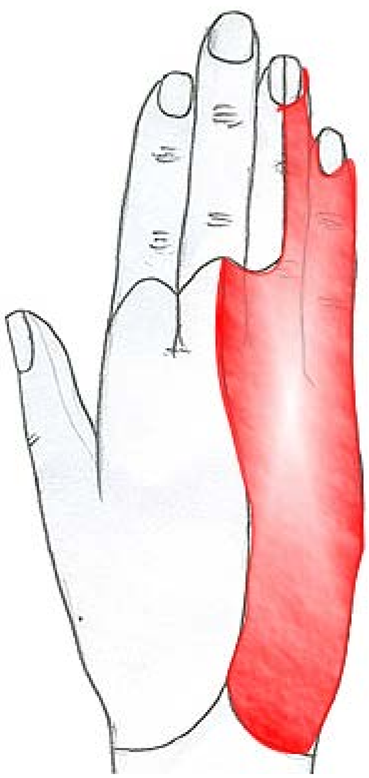
The thenar space contains flexor pollicis longus, flexor indicis, 1st lumbrical and digital nerves to pollex and index. What are the boundaries of the thenar space?

CHAPTER 18 : The Joints of the wrist , hand and fingers

Hand innervation

Main nerves; ulnar, radial, median, cutaneous nerves

Ulnar nerve



Passes anterior to flexor retinaculum and divides into *superficial* and *deep* branches
Superficial: supplies palmaris brevis and medial one and half fingers
Deep branch- this arches deep in the concavity of the deep palmar arch and gives motor braches to

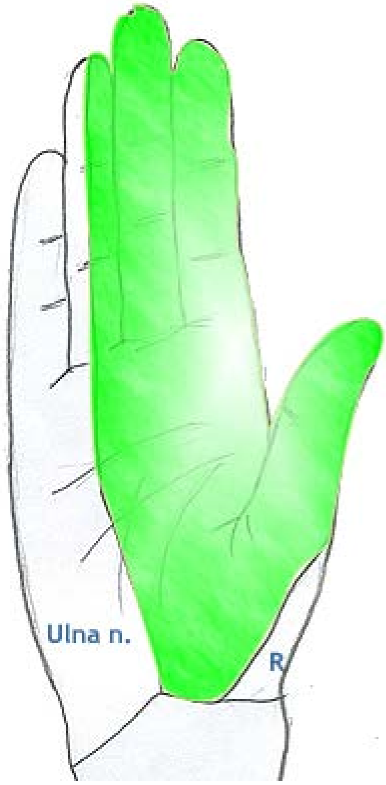
- hypothenar muscles
- medial two lumbricals
- 8 interrossei
- deep head of flexor pollicis brevis
- heads of adductor hallucis

Ulnar nerve injury presents with

- Claw hand
- Loss of sensation medial one and half fingers
- Loss of finger abduction
- Loss of finger adduction
- Atrophy of hypothenar eminence and inter-metatarsal spaces

Median nerve

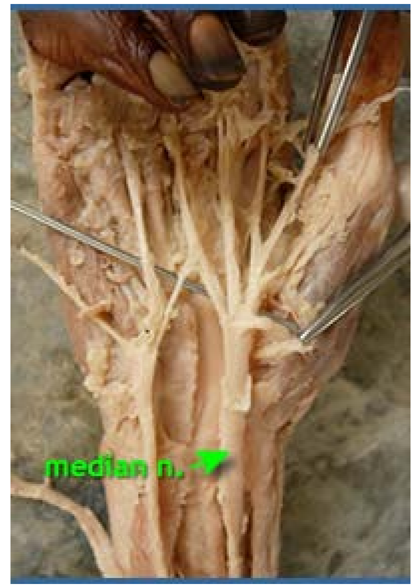
- Deep to *flexor retinaculum*
- Gives a *recurrent branch* to thenar muscles
- The nerve then gives a medial and a lateral branches
- The medial branch gives 2 common digital for 2nd and 3rd clefts and sides of ring middle and index fingers.
- The lateral supplies palmar skin, radial side of index and whole of the thumb



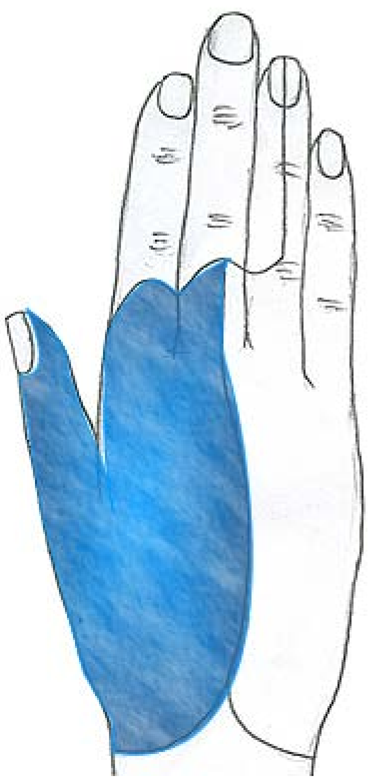
on the palmar surface and distal dorsal surface.
The branch to the index finger supplies the 1 st lumbrical

Medial nerve injury

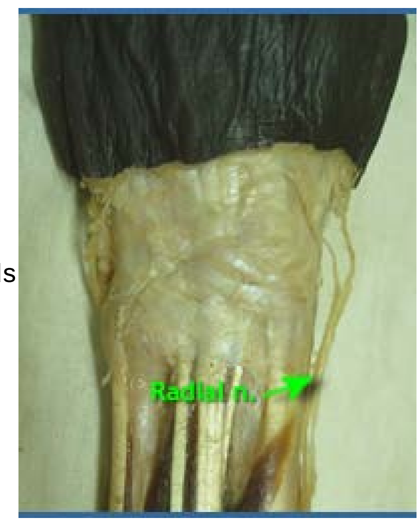
- The hand position is described “papal hand”
- There is loss of sensation on the palmar medial three and half fingers to include their nail beds
- Loss of opposability with atrophy of thenar muscles.



Radial nerve



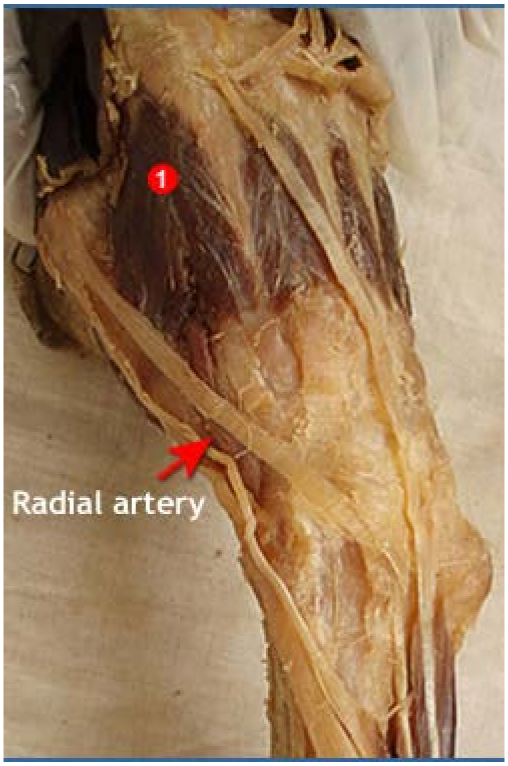
- It is a continuation of superficial terminal branch
- At dorsum of hand it divides into 4-5 dorsal digital branches
- Supplies lateral three and half fingers on the dorsal side except the nail beds



CHAPTER 18 : The Joints of the wrist , hand and fingers

Arterial blood supply

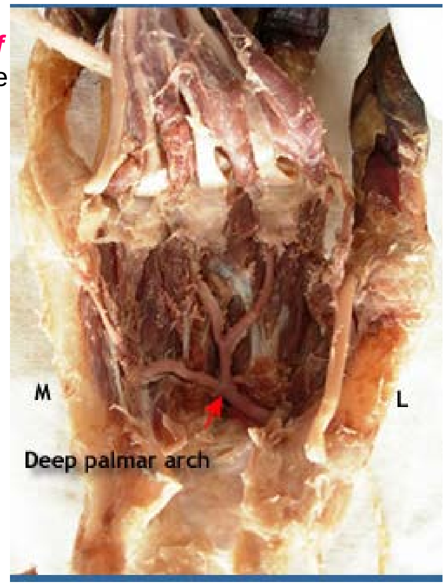
Radial artery



This vessels crosses the ***anatomical snuff box***, enters the hand and runs deep to the two heads of dorsal interosseous muscle

It Gives off:

- Radialis indicis
- Princeps pollicis
- Then continues to form the deep palmar arterial arch.
  The deep arch anastomoses with the deep branch of ulnar artery
- The arch gives off three metacarpal arteries which anastomose with common digital branches of the superficial arterial arch
- Other branches anastomose with dorsal metacarpal arteries



Ulnar artery

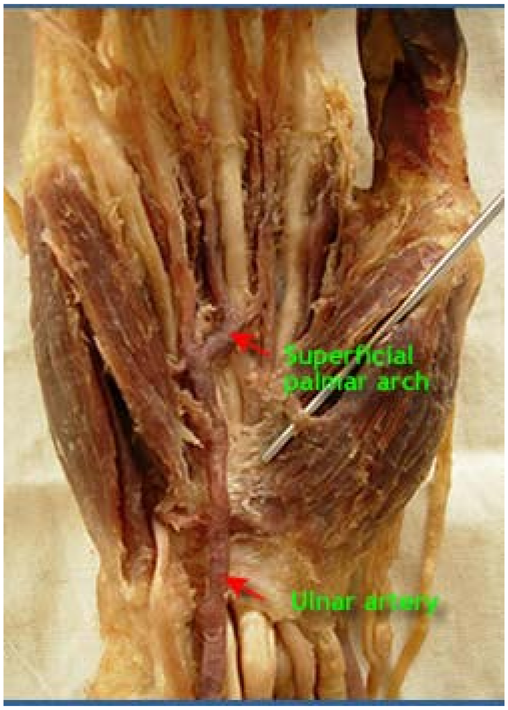
The ulnar artery continues beyond the flexor retinaculum as the superficial arterial arch

This is often an incomplete arch

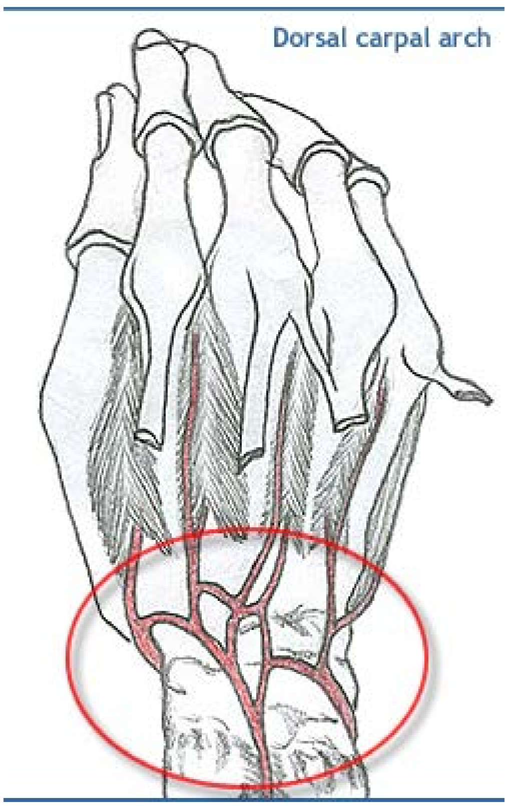
Braches

- Palmar digital artery to ulnar side of little finger
- Common digital arteries that supply adjacent fingers

Palmar digital vessels anastomose with dorsal digital arteries



Dorsal carpal arterial arch



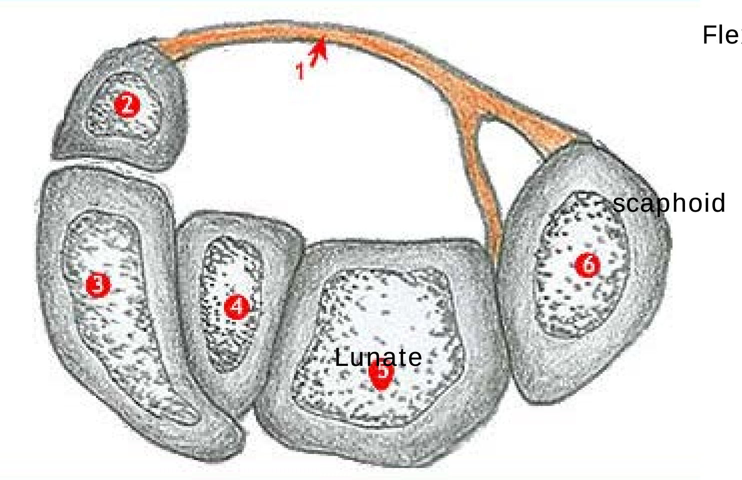
- Formed by branches of radial, ulnar and anterior interosseous arteries.
- Gives off dorsal metacarpal arteries which then split to supply adjacent fingers
- Anastomose with palmar metacarpal branches from the deep palmar arch

CHAPTER 18 : The Joints of the wrist , hand and fingers

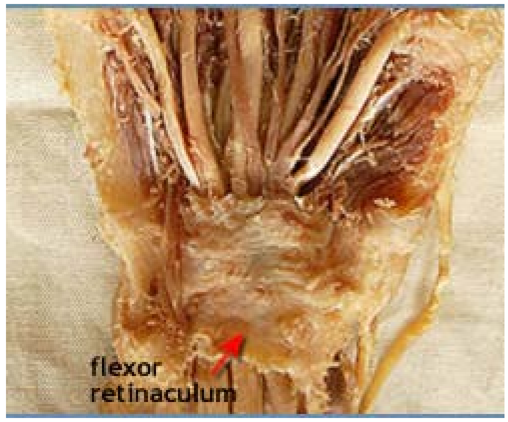
THE CARPAL TUNNEL

Boundaries:

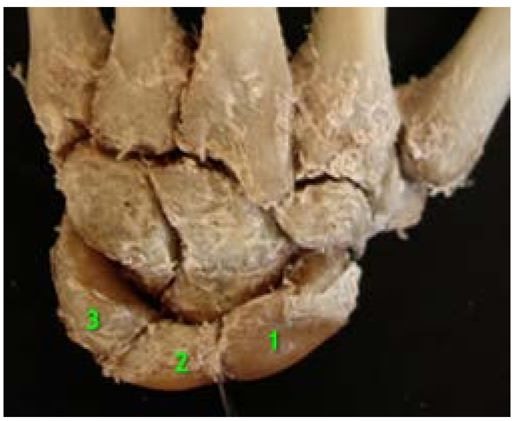
Anterior:



Flexor retinaculum



Posterior:



Carpal bones (lunate, triquetral, scaphoid, trapezoid)

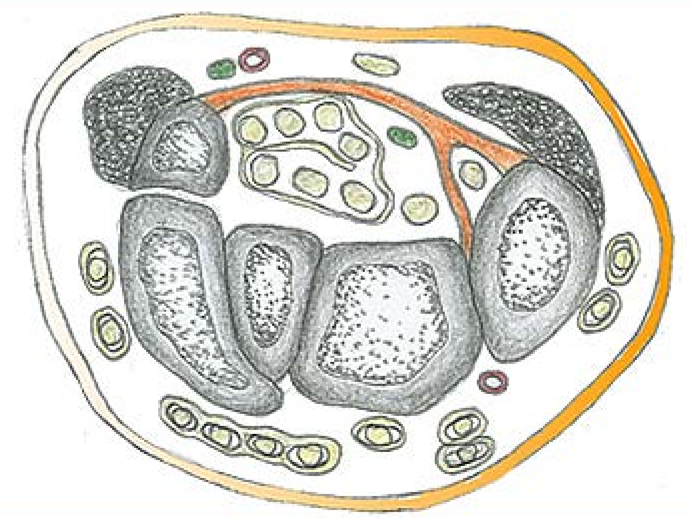
Medial:

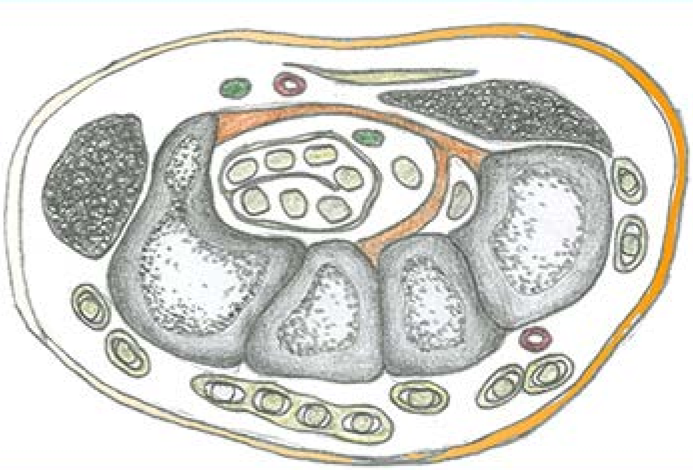
Hook of hamate, pisiform

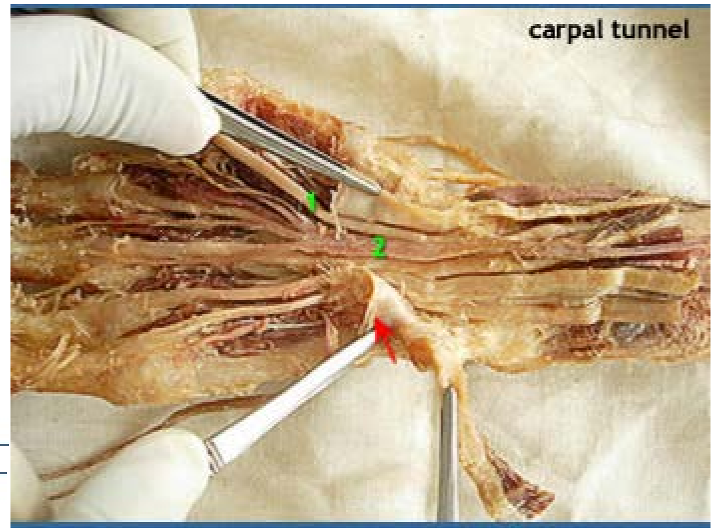
Lateral:

Tubercle of scaphoid, ridge of trapezium

Contents:







- The median nerve
- All long flexor tendons of fingers and thumb
- The synovial sheaths
- Connective tissue

Note:

- The four tendons of the superficial flexor are separate and lie in two rows, with the middle and ring finger tendons in front of the index and little finger tendons.
- The tendons of flexor digitorum profundus lie deeply in one plane.
- All the eight tendons (of superficialis and profundus) share a common flexor sheath.
- The tendons of flexor policis longus lies in its own synovial sheath.
- At the lateral end of the tunnel a deep lamina from the flexor retinaculum is attached to the medial lip of the groove on the trapezium.
- The tendon of flexor carpi radialis, enclosed in its own synovial sheath, runs in the groove in this subcompartment of the carpal tunnel.
- The median nerve passes deep the flexor retinaculum between the flexor digitorum superficialis tendon to the middle finger and the flexor carpi radialis.

Carpal tunnel syndrome:

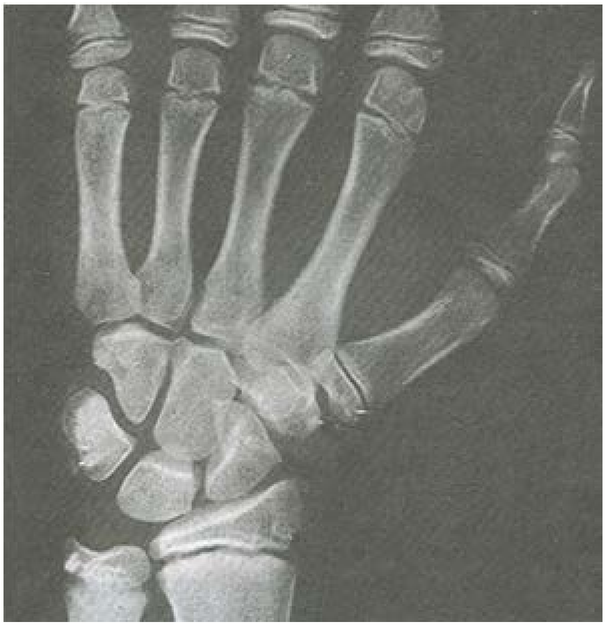
Compression of the median nerve in the carpal tunnel due to arthritic changes in the wrist joint, synovial sheath thickening or edema. **Symptoms:**

- Impaired sensation over three and half digits on the thumb side
- Wasting and weakening of thenar muscles

CHAPTER 18 : The Joints of the wrist , hand and fingers

Distal Radio-Ulnar joint

Classification



Uniaxial syno vial pivot point

Articular surfaces

- Convex head of the **Ulnar**
- The concave Ulnar notch of the radius
- Convex proximal surface of the **carpus** (formed by the scaphoid , lunate and the triquetrium and their interosseous ligaments

Note: The triangular, fibrocartilaginous articular disc is attached by its base to the lower margin of the Ulnar notch of the radius and by its apex to a fossa at the base of the Ulnar styloid. The proximal surface of the disc articulates with the ulnar head

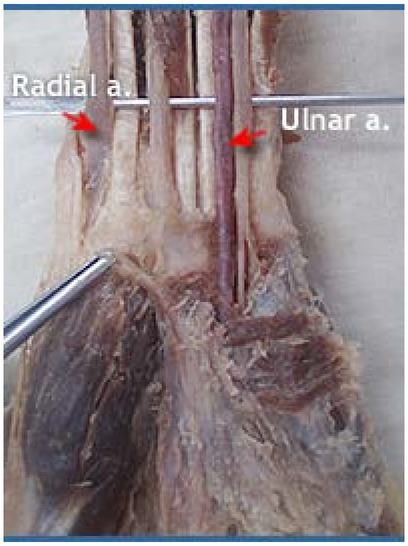
Capsule

- Attached to the margins of the articulating surfaces and is continuous with the capsule of radio-carpal joint

Synovial membrane

- Projects proximally, as the recessus sacciformis, posterior to the pronator quadratus and anterior to the interosseus membrane.

Blood supply

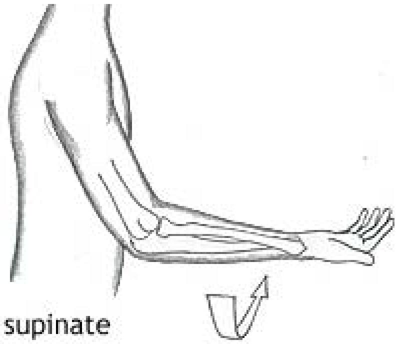


- Ulnar artery
- Radial artery
- Anterior interosseus

Innervation

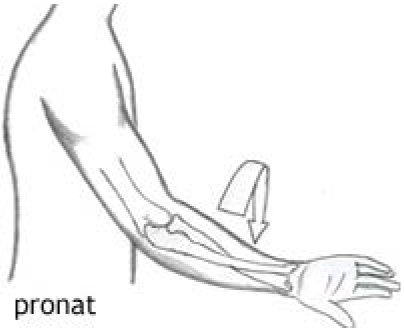
- Anterior interosseus nerve
- Posterior interosseus nerve

Movements



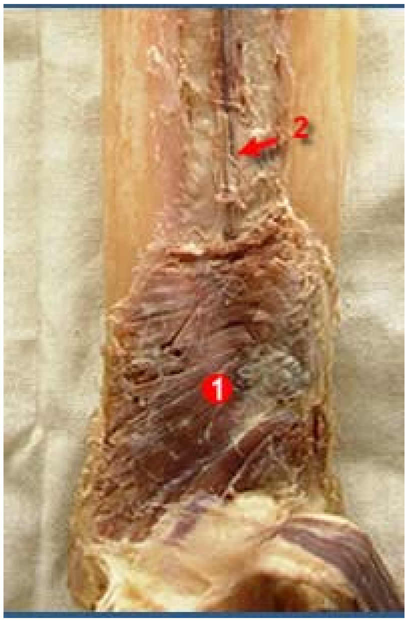
Pronation

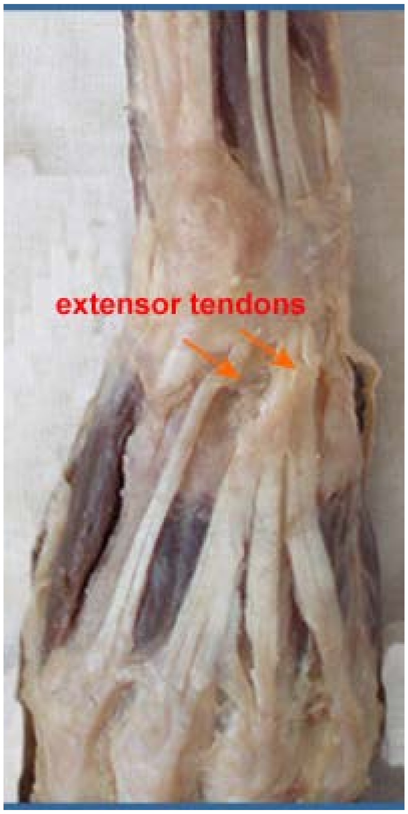
Supination



Relations

- **Anteriorly**
  - Pronator quadratus
  - Flexor tendons
- **Posteriorly**
  Extensor tendons
  Anterior interosseus artery





Clinical anatomy

- Cole's fracture

CHAPTER 18 : The Joints of the wrist , hand and fingers

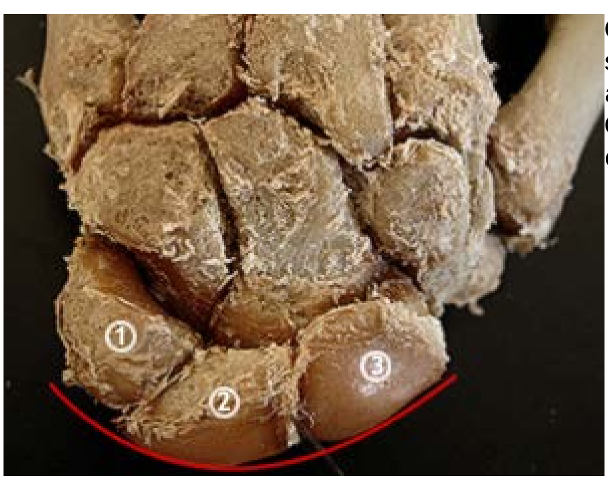
Hand Joints

Wrist joint (radiocarpal articulation)

Classification:

Synovial ellipsoid joint

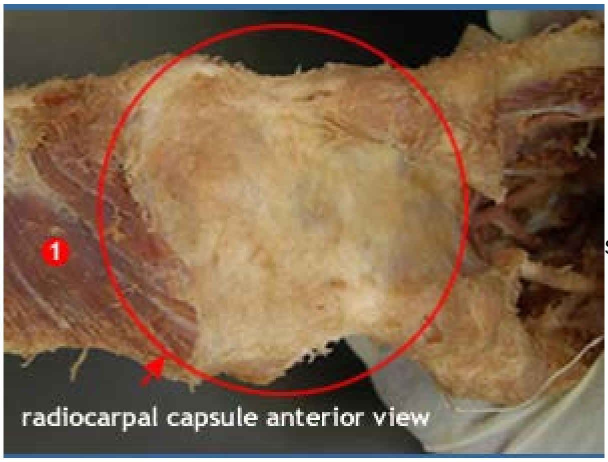
Articular surfaces:



Concave ellipsoid distal surface of radius and articular disc
Convex proximal surfaces of :

- Triquetral ***(1)***
- Lunate ***(2)***
- Scaphoid ***(3)*** bones

Capsule:



Surrounds the joint and is thickened to form palmar, dorsal and collateralligaments

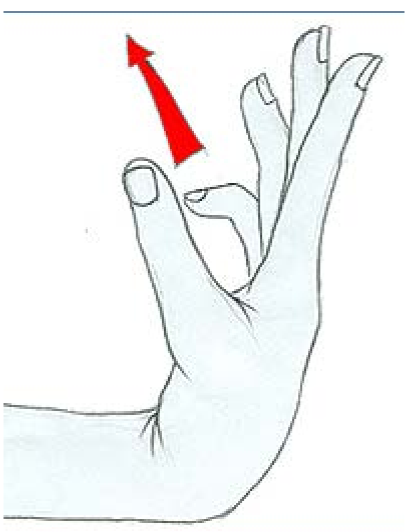
Innervation:

Posterior and anterior interosseous nerves

Blood Supply

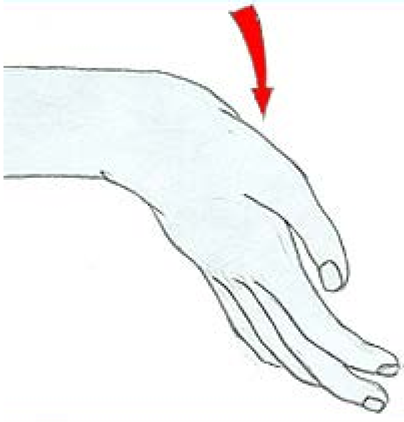
Carpal rete: Ventral and dorsal network

Movements:

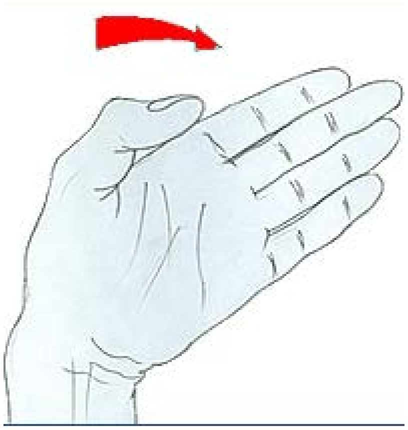


Flexion

Extension



radial abduction



ulnar adduction

Movements accompanied by those at midcarpal joint

Total range of flexion 80° , of extension 60°

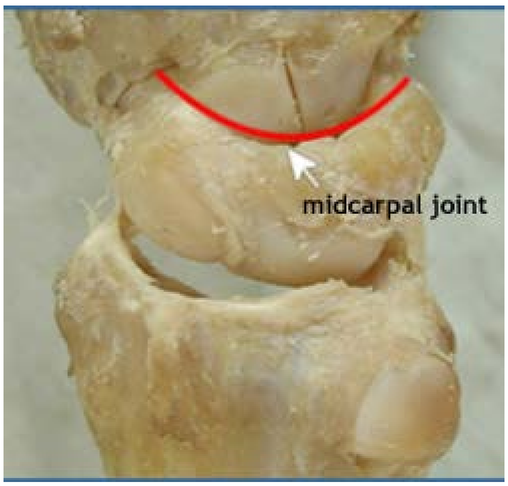
More flexion at midcarpal joint while more extension at wrist joint

Range of abduction 15° , range of adduction 45° . ***Why the difference?***

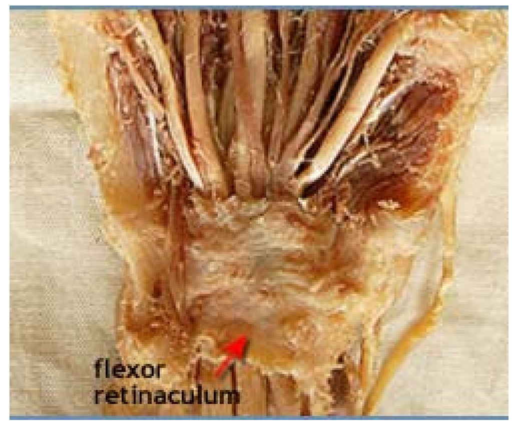
Movements produced by:

Movement	Muscle
Flexion	flexor carpi radialis, flexor carpi ulnaris, palmaris, flexors of Fingers and thumb
Extension	Radial extensors, ulnar extensor, extensors of fingers and thumb
Abduction	Flexor carpi radialis, two radial extensors, abductor pollicis longus
Adduction	flexor carpi ulnaris, extensor carpi ulnaris

Intercarpal joints



- Synovial
- Intercarpal ligaments connect the bones. Flexor retinaculum is an accessory intercarpal ligament
- Thin capsule
- Synovial cavity may communicate with radiocarpal joint
- **Midcarpal joint** is a compound sellar joint between the proximal and distal row of carpal bones
- Carpometacarpal joints often communicate with intercarpal joints



- The 1 st carpometacarpal joint of the thumb is a saddle joint between **trapezium** and **1 st metacarpal.** Opposition occurs here. It has a loose and lax capsule allowing ranges of movement

Metacarpophalangeal joints

- Synovial joints allowing flexion, extension, abduction and adduction
- **Palmar ligaments** limit extension
- **Transverse metacarpal ligaments** are additional stability
- **Collateral ligaments** flank the joints

Interphalangeal joints

- Uniaxial
- Capsule
- Extension is limited by palmar and collateral ligaments

1st Carpometacarpophalangeal Joint

Classification

- Synovial joint of sellar variety

Articular surfaces

- 1st metacarpal base and trapezium

Reasons for increased mobility

- Extensive articular surfaces and their shape
- Laxity of the capsule
- Obliquity of ligaments

Capsular attachments

From: Circumference of metacarpal base

To: Rim of distal trapezial articular facet

Capsule is thickest laterally and dorsally

Ligaments

Lateral ligament: From lateral surface of trapezium to radial side of metacarpal base

Palmar and dorsal ligaments: From palmar and dorsal surfaces of trapezium to ulnar side of metacarpal base

Relations

Palmar surface:

Thenar muscles

Dorsal surface:

Long and short extensors

Medial:

1st dorsal interosseous
Tendon of flexor pollicis longus

Lateral

- Tendons of abductor pollicis longus
- Extensor pollicis brevis

Movements

Movement	Muscles	Innervation
Flexion	Flexor pollicis brevis Opponens brevis Flexor pollicis longus	Median nerve
Extension	Abductor pollicis longus Extensor pollicis brevis and longus	Radial N.
Abduction	Abductor pollicis longus and brevis	Radial N.
Adduction	Adductor pollicis	Radial N.

Opposition	Opponens pollicis	Ulnar N.
Circumduction	All above muscles	All nerves

Innervation

- Radial n.
- Median n.
- Ulna n.

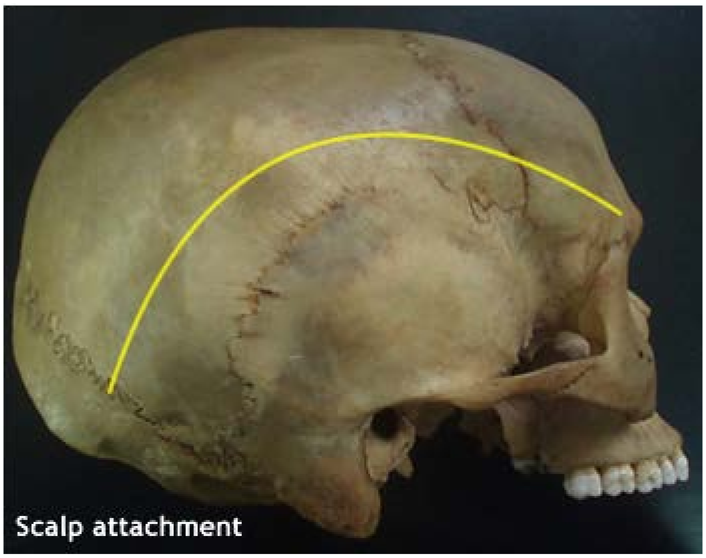
Blood supply

- Branches of radial artery

THE SCALP

The scalp is the composite soft tissue structure that covers the calvaria.

Extents

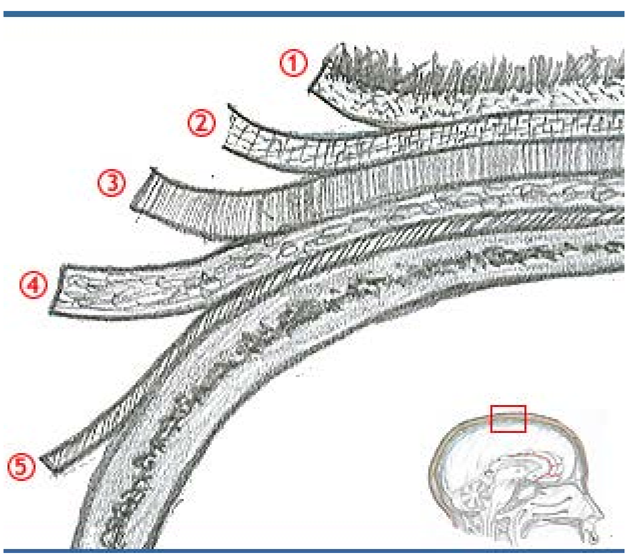


Superiorly: Superior nuchal line.

Laterally: Superior temporal line and continous with the fascia over temporalis muscle.

Anteriorly: Attached to the upper part of orbicularis oculi and the overlying skin of the eyebrow.

Layers

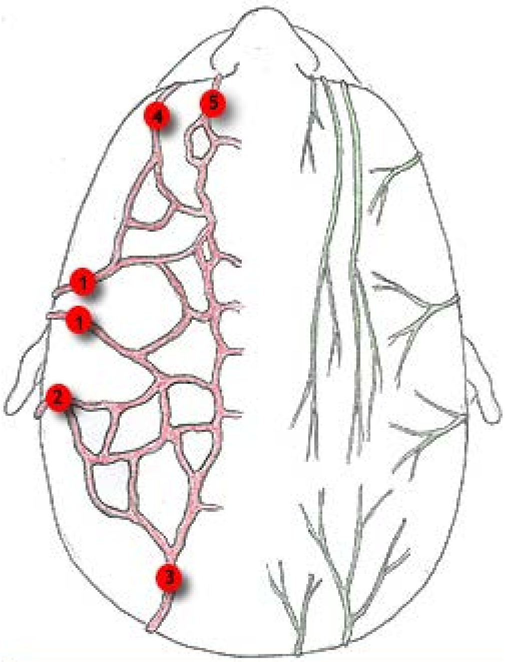


Skin: Thick, hairy and rich in sweat glands.
Connective tissue: Dense, irregular and highly vascular.
Aponeurosis: Unites frontalis and occipitalis muscles.
Loose areolar tissue:Potential space.
Pericranium:Attaches to suture lines.

Hover to show names

Blood supply

Arterial:



External carotid branches:

1. Superficial temporal artery.
2. Posterior auricular artery.
3. Occipital artery.

Internal carotid branches:

1. supraorbital artery
2. Supratrochlear artery, both from the opthalmic artery.

Note:

- *These branches anastomose freely with each other threfore scalp wounds bleed profusely but heal rapidly when cut.*
- *The arterial walls are attached to the dense connective tissue of the second layer of the scalp and tend to be held open and bleed profusely when cut.*

Venous:

The veins run back with the arteries.

- The supraorbital and supratrochlear veins drain into the facial vein
- The superficial temporal vein drains into the retromandibular vein.
- Occipital veins drain into the vertebral veins.
- The posterior auricular vein drains into the external jugular vein.

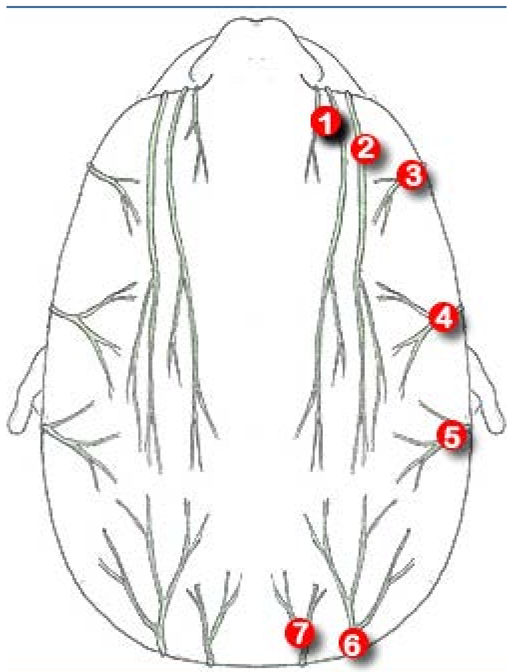
The veins connect with intracranial sinuses through emissary veins

Innervation

The scalp receives sensory innervation from:

- Supratrochlear Nn **(1)**
- Supraorbital Nn **(2)**
- Zygomaticotemporal Nn **(3)**
- Auriculotemporal Nn **(4)**
- Lesser occipital Nn (C2,C3) **(5)**
- Greater occipital Nn (C2) **(6)**
- Third occipital Nn (C3) **(7)**

Facial nerve supplies occipito-frontalis muscle



Lymph drainage

Lymphatic channels from the posterior half of the scalp drain to occipital and posterior auricular nodes

Lymphatic channels from anterior half drain to the parotid nodes.

The lymph eventually reaches the submandibular and deep cervical nodes .

Applied Anatomy of the Scalp

1. The scalp enjoys a rich blood supply in which there is an exentesive antero-posterior and right-left anastomosis.

Thus wounds of the scalp bleed profusely but heal very rapidly. The blood vessels are located in the connective tissue layer. The tunica adventitia of the vessels merges with the connective tissue. When lacerated, the elastic recoil of theconnective tissue holds the vessels open.

2. The veins of the scalp are connected to the intracranial venous sinuses by emissary veins. Therefore

- Raised intracranial pressure may be manifested in dilatation of scalp veins
- Infections or malignancies can spread between intracranial and extracranial sites

3. The **aponeurosis** connects the frontalis and occipitalis muscles. If it is cut coronally. contraction of the muscle usually **gapes the wound**.

4. The layer of loose connective tissue constitutes the **plane of avulsion**. The superficial three layers usually peel off as a unit with their blood vessels. Therefore such injuries still heal well. Fluid, for example, that accumulates in this layer spreads over the entire extent of the aponeurosis reaching the eyelid and presents as a **black eye**.

5. The **pericranium**, that is the periosteum of the skull bones is tightly adherent to the **sutures**. Accordingly, blood that accumulates and clots i.e **cephalohematoma** is confined to one bone for example the right parietal.

Applied anatomy of the Skull

1. The skull has weak points e.g.

- The **pterion**: Meeting point of frontal, parietal, temporal and greater wing of sphenoid. This point overlies the anterior branch of **middle meningeal** in the epi dural space. Therefore, fractures commonly tear the artery causing **epidural hematoma**.
- Squamous temporal
- Orbital roof
- Nasal bones

- Cribriform plate

These points are easily fractured causing injury to the underlying organs.

2. In **fractures** of **cribriform plate** and **petrous temporal bone**, **meninges** and mucous membranes may be torn

causing CSF to leak through the nose **(CSF rhinorrhoea)** or ear **(CSF otorrhoea)**

3. The foramina have **rigid boundaries**. So , in space occupying lesions, contents of the foramina are often

compressed e.g j**ugular foramen syndrome** in which cranial nerves and jugular veins are compressed causing

neurological and vascular symptoms.

4. Abscence of diploe in babies facilitates **moulding**.

5. **Fontanelles** and sutures in newborns permit brain growth, **delayed closure** suggests **retarded skeletal growth** or **raised intracranial pressure.**

THE SKULL AND SCALP

Review Questions:

1. Give an account of the parts of the bones that form the skull. Make reference to weak points on the skull.
2. Tabulate the foramina of the skull, in which bone they are found and what structures they transmit.
3. Describe the extent, layers, blood supply, innervation, lymphatic drainage and applied anatomy of the scalp.

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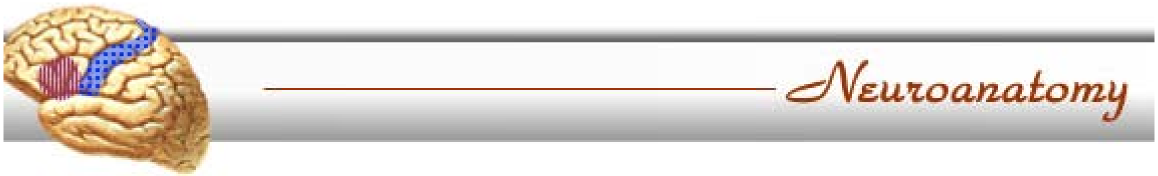

Glossary

Cranium	The cranium of the skull comprises all of the bones of the skull except for the mandible.
Skull	The skull refers to all of the bones that comprise the head.
Calvaria	The calvaria refers to the cranium without the facial bones attached.
Calotte	The calotte consists of the calvaria from which the base has been removed.
Splanchocranium	The splanchocranium refers to the facial bones of the skull.
Neurocranium	The neurocranium refers only to the braincase of the skull.
Endocranial	Refers to the interior of the braincase.
Suture	The saw-like edge of a cranial bone that serves as joint between bones of the skull.
Fissure	A narrow slit or gap.
Foramen	A hole in a bone usually for the transmission of blood vessels and/or nerves.
Fossa	A pit, depression, or concavity, on a bone, or formed from several bones.
Spinous	Descriptive of a sharp, slender process.
Tubercle	A small process or bump, an eminence.

Tuberosity	A large rounded process or eminence.
Pterion	H shaped suture between the frontal, parietal, squamous temporal and the greater wing of the sphenoid.
Suprameatal triangle	Located supero-posteriorly to the external auditory meatus, formed by a tangent off the opening of the EAM, the anterior edge of the mastoid process and the superior margin of the opening of the EAM. It overlies the mastoid antrum (air space) and tenderness here suggests infection of the air space(mastoiditis).

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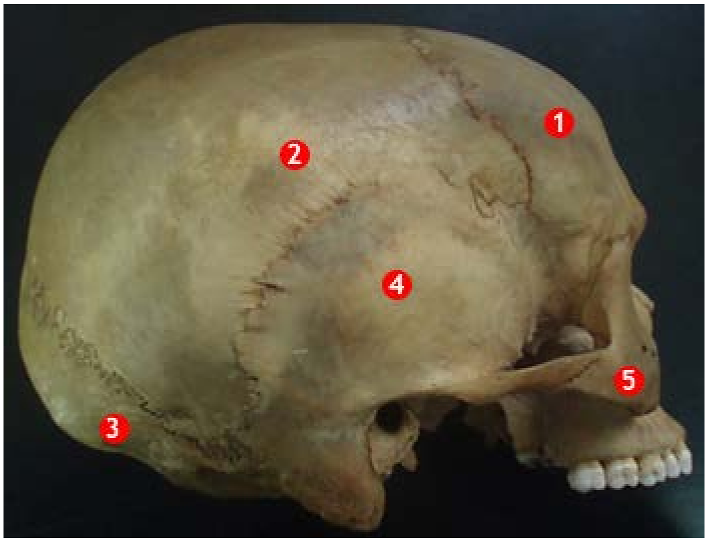
THE SKULL AND SCALP

Learning points | Core anatomy | Applied anatomy | Review questions

The Skull

Made of three components: Neurocranium, chondrocranium and viscerocranium.

The **Neurocranium** (Calvaria or skull top)



Norma lateralis

Four flat bones

Paired

- Parietal
- Temporal

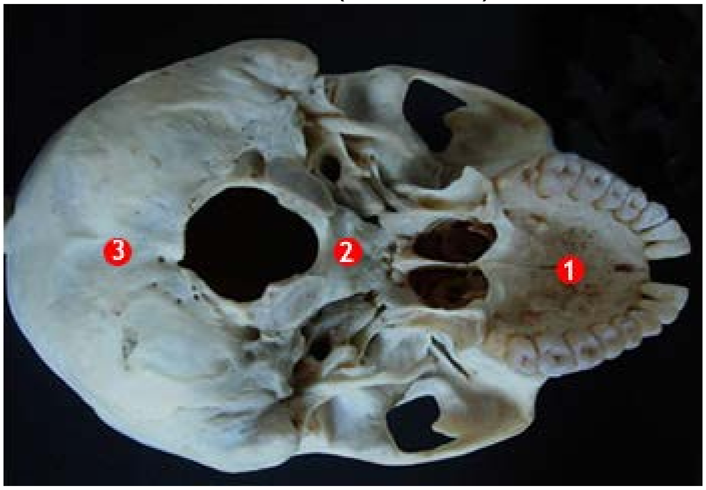
Unpaired

- Frontal
- Occipital

Sutures:

- **Coronal**: between frontal and parietal
- **Sagittal**: between the two parietals
- **Squamosal:** between parietal and temporal
- **Lambdoid**: between parietal and occipital

The **Chondrocranium** (Skull base)

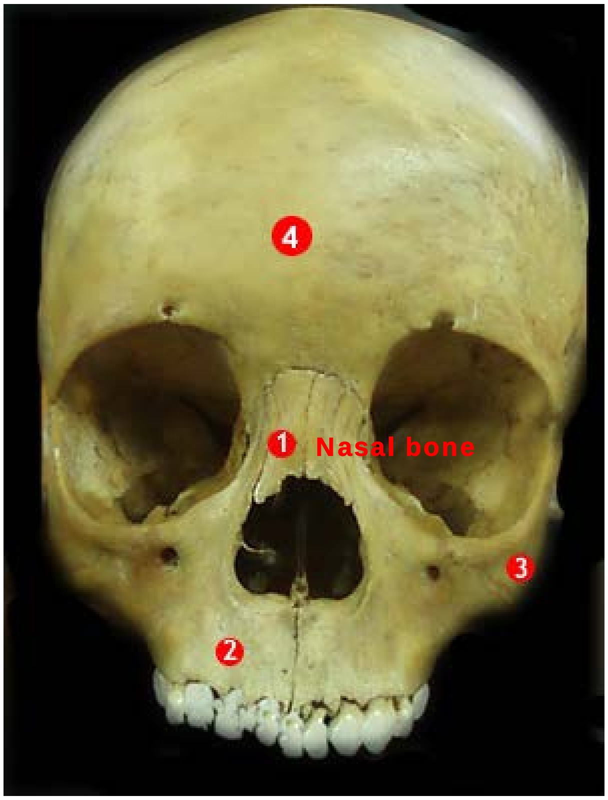


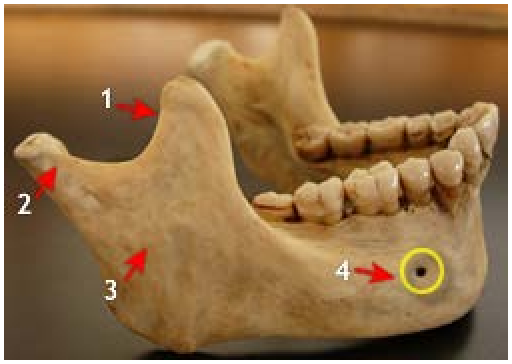
Made up of the following:

- Occipital bone.
- Sphenoid.
- Part of temporal bone (petrous)
- Palatine.

It contains various foramina for the transmission of nerves and vessels.

The **Viscerocranium** (Facial skeleton)





- Paired facial bones include:-
  - Nasal
  - Zygomatic
  - Lacrimal
  - Maxillae
- Unpaired facial bones include:-
  - Palatine
  - Maxillae
  - Mandible
  - Vomer

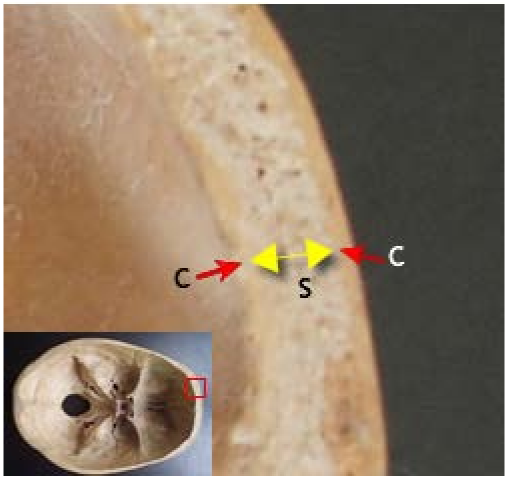
task ***Hover to identify the parts labelled.***

Structure of skull bones

Infants:

Inner and outer table.

task ***Outline the other differences between a newborn and an adult skull .***



Adults:

Consists of :

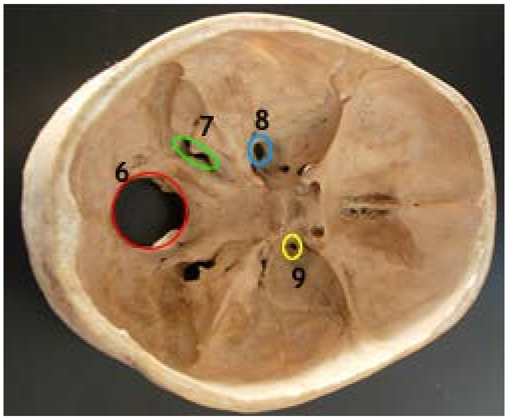
- an **outer table** of compact bone
- a **layer of spongy** bone (diploe)
- an **inner table** of compact bone

Note the two layers of Compact bone (C) and Spongy bone (S)

Cranial Foramina

FORAMEN	LOCATION	STRUCTURES TRANSMITTED
Supraorbital (1)	Superior orbital margin	Supraorbital artery, vein and nerve
Infraorbital (2)	Inferior orbital margin	Infraorbital artery, vein and nerve

FORAMEN	LOCATION	STRUCTURES TRANSMITTED
Zygomaticofacial (3)	Zygomatic bone	Zygomaticofacial artery, vein and nerve
Mental (5)	Mandibular body	Mental artery, vein and nerve



Magnum (6)	Between the squamous and basilar part of occipital bone.	spinal cord, meninges, spinal arteries, spinal accessory nerve, vertebral arteries, emissary veins, cervical meningeal nerve.
Jugular foramen (7)	Anterolateral to Hypoglossal canal, at the level of the styloid process	Glossopharyngeal nerve, internal jugular vein, vagus nerve, emissary veins and the spinal accessory nerve
Carotid canal (8)	Anterior to the jugular foramen	Internal carotid artery and nerve plexus and emissary vein
Lacerum (9)	Between the basilar part of occipital bone, the body of sphenoid and the petrouspart of temporal bone	Covered by cartilage in life. Related to the internal carotid artery superiorly

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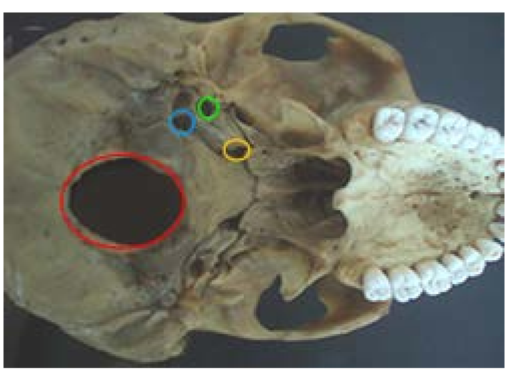
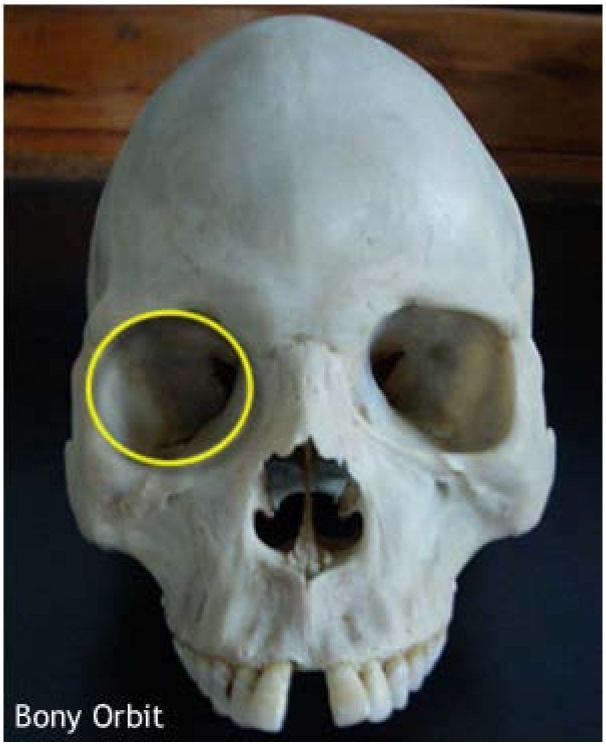


Hypoglossal canal	Anterolateral to occipital condyles	Hypoglossal nerve, emissary vein
Foramen spinosum	In sphenoid spine	Nervous spinosum, middle meningeal artery
Foramen ovale	Anteromedial to	Mandibular nerve, accessory meningeal

		foramen spinosum	artery, lesser petrosal nerve, emissary vein
	Stylomastoid		Stylomastoid artery, facial nerve, emissary vein
	Foramen rotundum		Maxillary nerve
	Superior orbital fissure	Between the lesser and greater wing of sphenoid	Ophthalmic, oculomotor, trochlear and abducens nerve ophthalmic veins
	Inferior orbital fissure	Orbital part of maxillae	Continuation of maxillary nerve
	Optic canal	Lesser wing of sphenoid	Optic nerve, meninges, ophthalmic artery
	**Lingual**	Mandibular body (internal surface)	Lingual nerves and vessels

THE ORBIT

The Orbit



It is shaped like a pear or a four-sided pyramid with the apex situated posteriorly and the base anteriorly.

Orbital Margins and walls

Orbital Margins:

Superior (s): Frontal bone.

Lateral margin (L) : Zygomatic bone.

Inferior margin (I): **Zygomatic** and **maxillary bones**.

Medial margin(m): maxilla, lacrimal and **frontal bones**

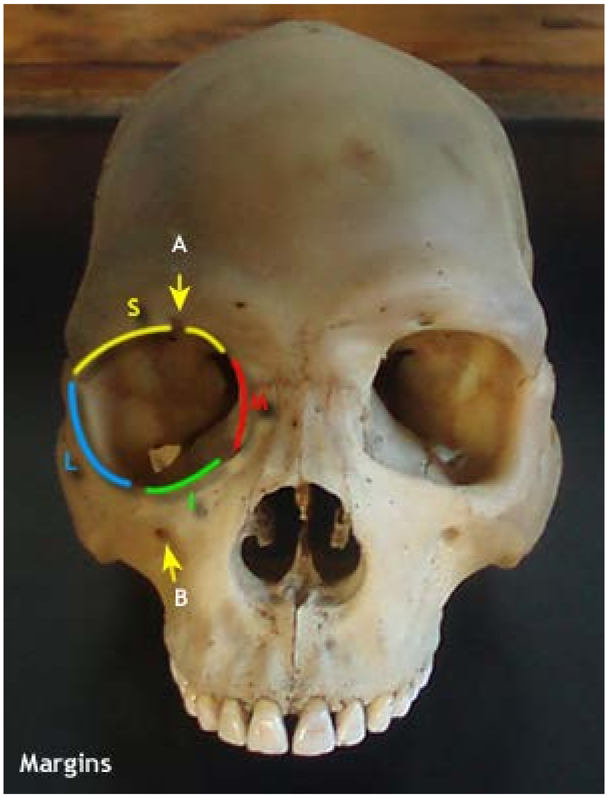
Orbital Walls

Roof: Frontal and sphenoid bones

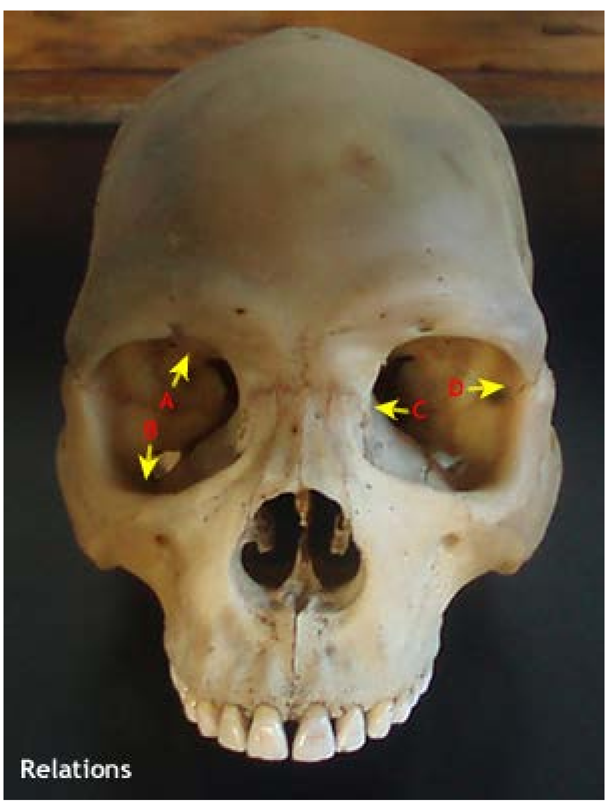
Lateral wall: Zygomatic and Sphenoid bones.

Floor: Maxilla, Zygomatic and palatine bones.

Medial wall: Ethmoid, lacrimal and frontal bones



Orbital Relations and Foramina



Relations

Superior: Anterior cranial fossa and frontal sinus **(A)**.

Inferior: Maxillary sinus **(B)**.

Medial: Ethmoid and sphenoid air sinuses **(C)**.

Lateral: Temporal fossa infront and middle cranial fossa behind **(D)**

Foramina

Supra orbital	supra orbital nerve & vessels
Supra trochlea	supra trochlea nerve & svessels
Infra orbital	infra orbital nerve & vessels
Superior orbital fissure	oculomotor , trochlea, opthalmic, abducens, nerves & opthalmic veins
Inferior orbital fissure	maxillary nerve
Optic canal	optic nerve, opthalmic artery, central artery of retina

Clinical Anatomy

The Orbit

1. **Exopthalmos:**

   protrusion of the eyeball. Some causes include retrobulbar tumors such as lipomas, rhabdomyosarcomas, optic nerve schwannomas, orbital cellulitis and haematomas

2. The thin orbital walls are easily fractured. This often causes the eyeball to sink causing **enopthalmos**

3. The topographic relationship of the orbit with other cavities allows infections to spread easily between them
4. Paralysis of the extraocular muscles may cause 'paralysis' of the eyeball or **opthalmoplegia** or deviation of the eyeball in one direction or another. This is called **strabismus** and often causes double vision- **diplopia**
5.
6. Impaired **corneal reflex** suggests damage to the sensory nerve (opthalmic) or motor (facial) or related brain stem centres

7. **Impaired pupillary responses** suggest damage to parasympathetic pathways, oculomotor and sympathetic system as in **Horner's syndrome**

The Face

The face has a rich blood supply characterized by **extensive anastomosis** . Therefore lacerations **bleed profusely** and heal rapidly. Muscle contraction may gape wounds and hold vessels open, worsening the bleeding.

Veins of the **upper face** including the upper lips, nose, eyelids and forehead communicate with the **cavernous venous sinus** through:

- Ophthalmic veins
- Deep facial veins

Those of the **forehead** also communicate with the **superior sagittal sinus** through an emissary vein in foramen cecum.

These communications are potential routes for spread of infection from the face to the intracranial structure. For this reason, this part of the face is considered the **danger area of the face.**

Injury to the **facial nerve** paralyses muscles of facial expression. Such paralysis is characterized by:

- Deviation of the face to the normal side when the patient opens the mouth as in yawning or smiling

- Accumulation of food in the vestibule of the mouth – between the cheeks and teeth.

- Inability to close the eye causing corneal exposure and drying, hence vulnerability to ulceration

- Obliteration of nasolabial groove

- Loss of the corneal reflex on the affected side

OG anatomy
J. Ogeng'o
palsoftweblink
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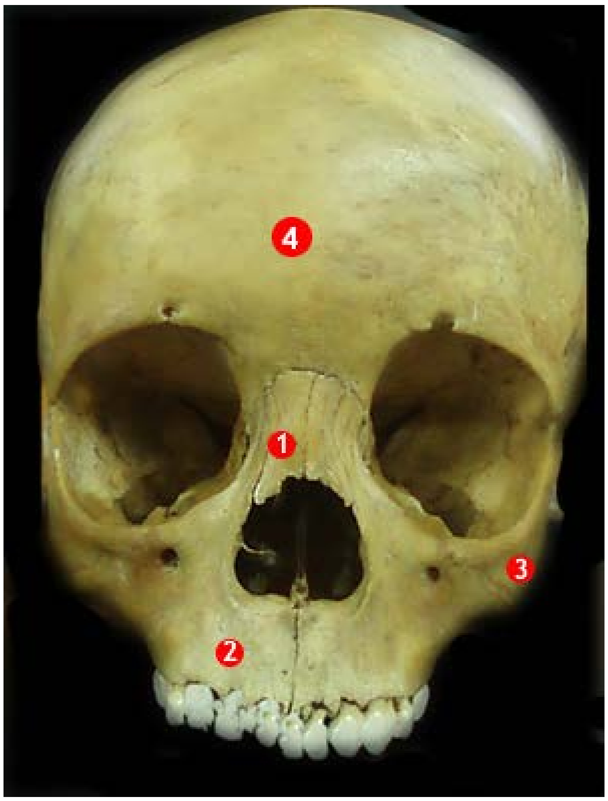
Learning points | Core anatomy | Applied anatomy | Review questions

Review Questions

1. Describe the boundaries and relations of the orbital cavity including the margins. Add notes on the clinical relevance of these relations
2. Describe the attachments, innervation and actions of the extraocular muscles
3. Outline the origins; and distribution of the oculomotor, trochlear and abducens nerve
4. Describe the coverings, movements and blood supply of eyeball
5. Describe the origins, course and distribution of the ophthalmic veins
6. Outline the possible causes of exophthalmos
7. Enumerate briefly on the sensory innervation, blood supply, lymphatic drainage and main characteristics of the muscles of the face.

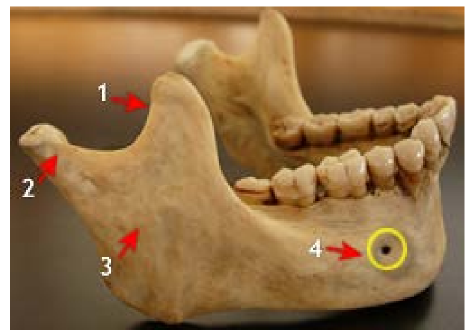
The Face

Skeleton



Paired facial bones include:-

- Nasal
- Zygomatic
- Lacrimal
- Maxillae



Unpaired facial bones include:-

- Palatine
- Maxillae
- Mandible
- Vomer
- Frontal bone

task ***Identify the parts of the mandible labelled above.***

Muscles

click on the hot spots to show names

Muscles of the face share four main characteristics :

- They are generally **subcutaneous**
- They are arranged around the **orifices** of the face, thus acting as **sphincters** and **dilators**
- They are innervated by **facial nerve**
- They are embryologically derived from the **2 nd branchial arch**

Blood Vessels

The face receives a rich blood supply from both internal and external carotid arteries through various arteries:

Artery	Source	Region
Facial Artery	External carotid	Mandibular, maxillary, zygomatic and nasal parts
Supratrochlear **Supraorbital**	Opthalmic- internal carotid	Forehead
Zygomatico-facial **Zygomatico- temporal** **Infraorbital**	Maxillary - External carotid	Side of face, upper jaw
Mental	Maxillary – External carotid	Lower jaw

The veins accompany the arteries and intimately join the external and internal jugular veins

Lymphatics

- From the lower lip and chin – **submental nodes**
- From the forehead and cheeks – **Submandibular nodes**
- Around the ear – **Pre –auricular nodes**

Innervation

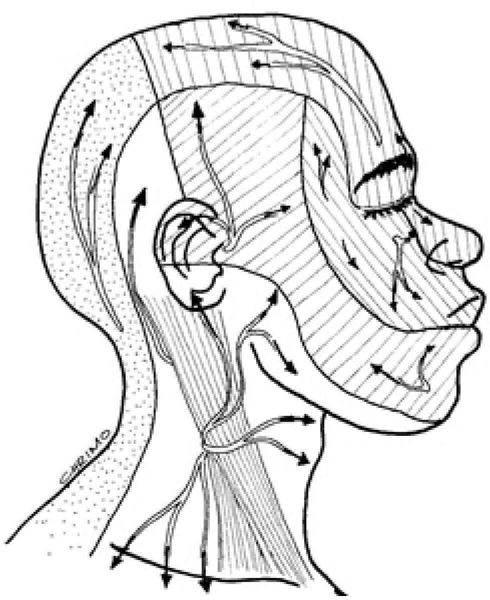
Sensory innervations is derived from the divisions of the trigeminal nerve

Forehead- **Ophthalmic**

Maxillary region – **Maxillary**

Mandibular region and anterior to the ear – **Mandibular**

Motor innervation is provided by branches of the facial nerve



The Eyeball

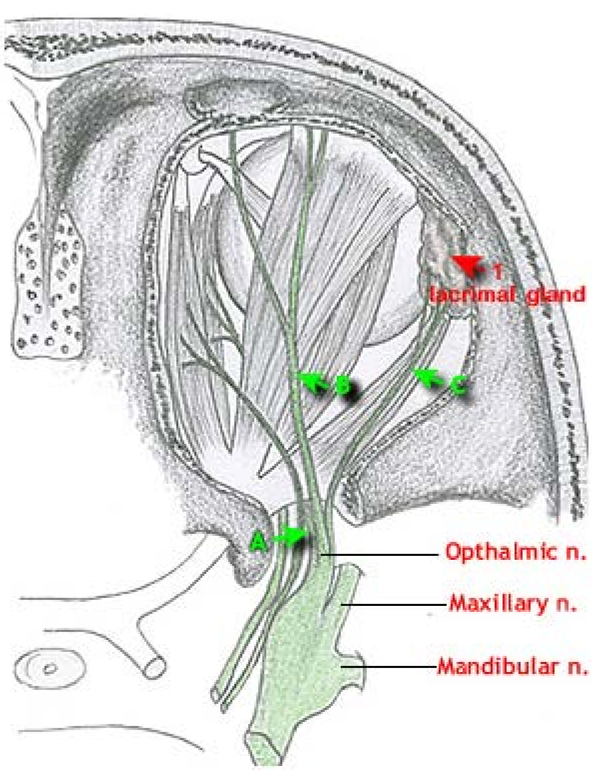
Three coats

- **Corneoscleral coat**: cornea and sclera
- **Uveal tract**: choroid, ciliary body and iris
- **Retina.**

Contents of Orbit

- Eyeball
- Opthalmic nerve
- Opthalmic artery and branches
- Opthalmic vein and its tributaries
- Ciliary Ganglion
- Extra-ocular muscles
- Optic nerve
- Retrobulbar Fat
- Lacrimal apparatus.

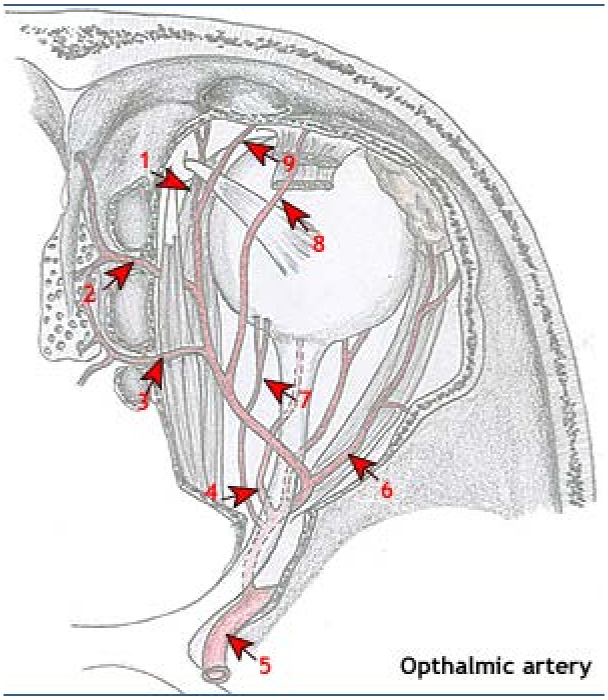
Opthalmic nerve & its branches:



First division of trigeminal nerve.

Branch	Distribution
Lacrimal nerve	• Lacrimal gland • Dura mater • Upper eyelid
Frontal nerve	• Forehead • Root of nose • Scalp • Frontal sinus
Nasocilliary nerve	• Eyeball • Conjuctiva • Nasal cavity • Ethmoidal sinus • Sphenoidal sinus

Ophthalmic Artery & branches



Arises from the internal carotid artery

Branch	Distribution
Central artery of retina	• Retina
Long and **short cilliary** arteries	• Uveal tract of eyeball
Lacrimal artery	• Lacrimal gland, Eyelids, Meninges
Muscular branches	• Extra ocular muscles
Supratrochlear & supra orbital	• Scalp, Frontal bone, Frontal sinus
Dorsal nasal arteries.	• Nose
Anterior & posterior ethmoidal	• Nasal cavity, Ethmoidal sinus, Sphenoidal sinus, cranial dura

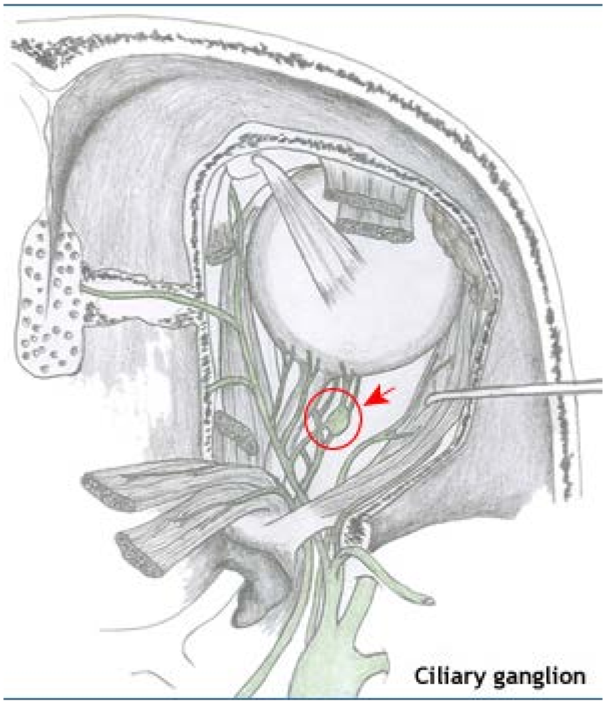
Opthalmic Veins

- Drain the orbital contents
- Important communications:
  - Facial vein,
  - Pterygoid plexus
  - Cavernous sinus.

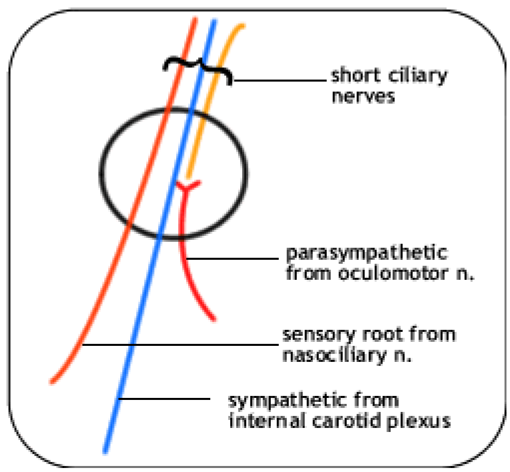
Motor Nerves of Orbit

Nerve	Muscles Supplied
A) Oculomotor nerve	• Superior rectus • Medial rectus • Inferior rectus • Inferior oblique
B) Trochlear Nerve:	• Lateral rectus.
C) Abducent Nerve:	• Superior oblique muscle

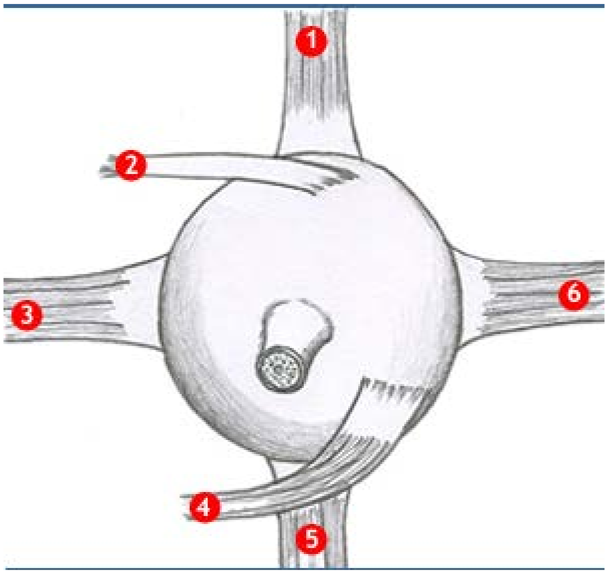
Ciliary Ganglion



- Is a parasympathetic ganglion
- Preganglionic fibres from **Edinger Westphal** nucleus through **Oculomotor nerve**
- Situated between the optic nerve and lateral rectus
- Postganglionic fibres supply the **ciliary muscles** and **sphincter pupillae**.
- Sympathetic nerves from internal carotid plexus pass through it.

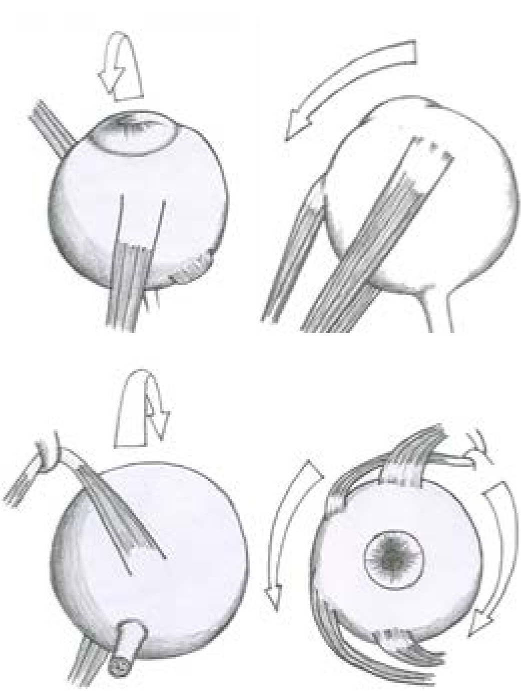


21.4.2 Muscles of the eyeball :



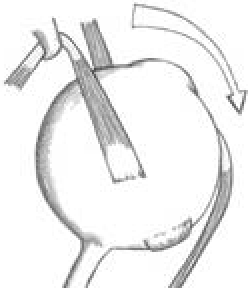
Muscle	Origin	Insertion
The recti • Superior rectus • Inferior rectus • Medial rectus • Lateral rectus	Common tendinous ring	Front portion of the sclera
Superior oblique	Sphenoid bone, passes through a cartilaginous pulley (the trochlear)	Back of the scleras
Inferior oblique	Maxilla	Back of the sclera.

Actions of the muscles of the eyeball



Movement may be considered to be around a vertical axis (abduction and adduction) , a lateromedial axis (elevation and depression) and an anteroposterior axis (extorsion and intorsion)

Muscle	Action
Lateral rectus	Abduction
Medial rectus	Adduction
Superior recti	Elevation
Inferior recti	Depression
Superior oblique	Turns cornea downwards and outwards
Inferior oblique	Turns cornea upwards and inwards



a) Optic nerve

- Second cranial nerve.
- Extends from the eye to the optic chiasma.
- May be considered to be an extension of the brain
- Has got three parts: **Orbital**, **canalicular** and **intra cranial**
- Contains **second order neurons**
- Sorrounded by meninges and tendons of extra ocular muscles
- Traversed by **central artery** and central vein of retina

Note the **optic nerve [1]** , **optic chiasma [2]** and **optic tract [3]**

21.4.4 Blood Supply to the eye

From the **ophthalmic artery** by: way of the

- Central artery of the retina,
- Short and long posterior ciliary arteries
- Anterior **ciliary arteries** (from muscular branches of ophthalmic artery)

The veins accompany the arteries and drain into the cavernous sinus by way of the ophthalmic vein

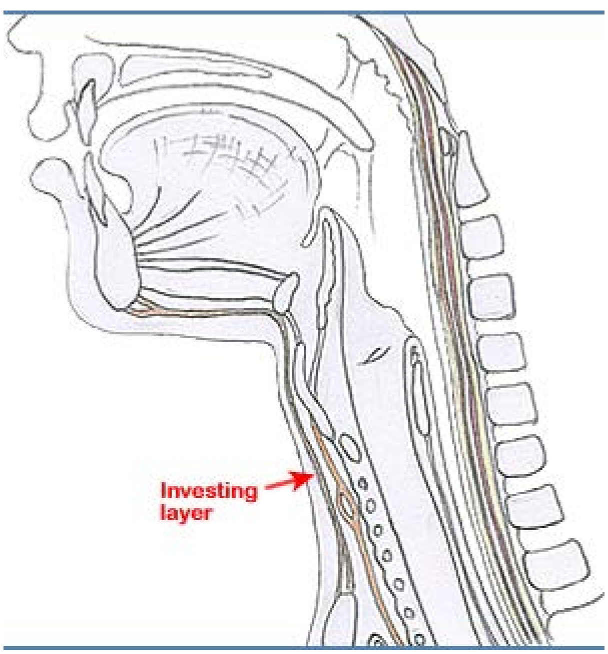
Fascia of the neck

Functions

1. Affords the slipperiness which enables structures to move and pass over one another , without difficulty, e.g. during swallowing.
2. Allows twisting of the neck without it creaking like a manilla rope.
3. It allows a looseness that provides the easiest pathways for vessels and nerves to reach their destinations.

Layers (components)

Investing layer



Attachments

Proximal

- External occipital protuberances
- Superior nuchal line
- Ligamentum nuchae
- Spines of cervical vertabra
- Mastoid process
- Lower border of the mandible
- Zygomatic arch
- Styloid process
- Hyoid bone

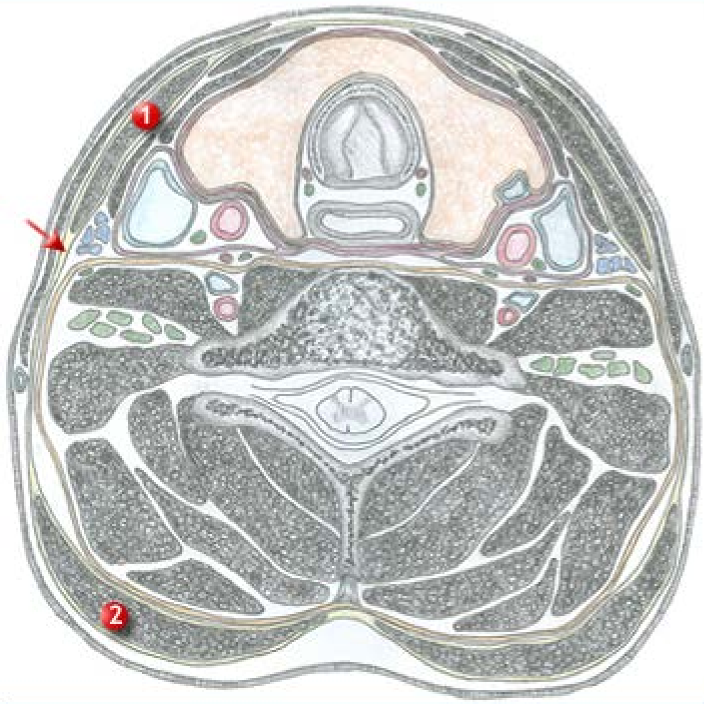
Distal

- Acromion
- Clavicle
- Manubrium sterni

structures enclosed / surrounded

Encloses

- Sternomastoid muscle **(1)**



- Trapezius **(2)**
- Omohyoid muscle
- Parotid
- Submandibular gland

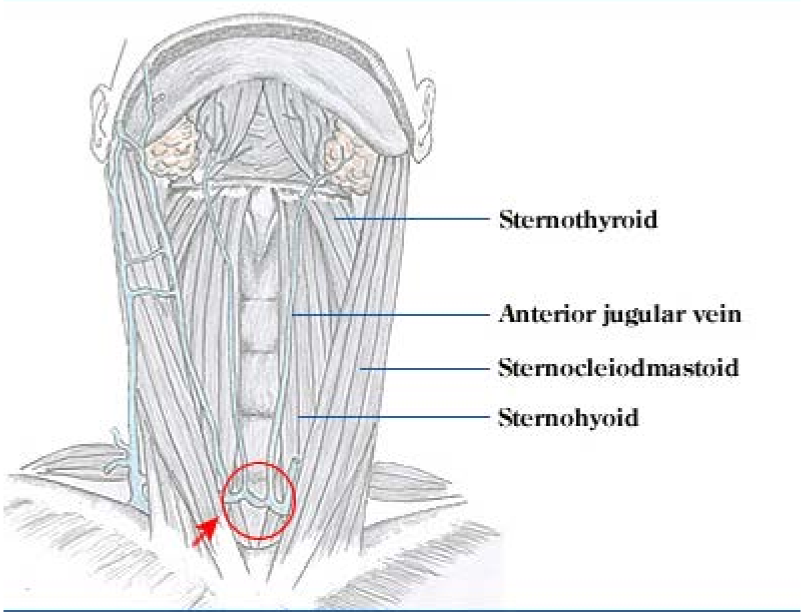
Roofs

- Posterior triangle of the neck
- Anterior triangle of the neck

Covers

- Infrahyoid muscles

Suprasternal space (of Burns)



- In the **Suprasternal notch,** the investing fascia splits into two layers:
  - One attaches to the anterior border of the manubrium
  - The other to the posterior border
- This leaves a small suprasternal space containing:
  - A little fat
  - A lymph node
  - Lower sections of the anterior jugular veins
  - Jugular venous arch
  - Sternal heads of sternomastoid

Structures piercing the investing fascia

- External jugular vein
- Cervical plexus
- Lymphatics

Applied Anatomy

Nerve point of the neck: is the region around the midpoint of the **posterior border of the sternocleidomastoid** muscle. Several nerves lie superficially here, deep to the platysma. This point is important because:-

- **Slash wounds** of the neck may severe these relatively superficial nerves , resulting in loss of cutaneous sensation in the neck, and posterior part of the scalp.
- **Anaesthetic agent** can be injected here.

Brachial plexus block . Local anaesthetic solution is injected around the brachial plexus, superior to the midpoint of the clavicle. Be careful to locate the subclavian artery by palpation so it is not damaged.

Subclavian artery, can be pressed in the suprascapular fossa, to control bleeding in the upper limb.

Block dessection, is sometimes done in this region for the removal of lymph nodes. The accessory and Phrenic nerves, together with the other structures should be saved.

Safe / danger sides. The accessory nerve may be used to divide the posterior triangle into a carefree area superiorly and a danger area inferiorly, which has major nerves and blood vessels

Investing Fascia: Forms a tight sheath for the glands especially the parotid, restricting swelling. Iinflammation of this glands causes pain due to high pressure.

Pretracheal Fascia:

- The thyroid is completely enclosed in pretracheal fascia. The attachments to the larynx and trachea result in movement of the thyroid gland with larynx during swallowing. When a neck swelling moves in this way, it is almost certain to be associated with the thyroid gland.
- The Spaces around the pretracheal fascia provides for spread of infection. Thus infections from the head and neck can spread infront of the trachea or behind the esaophagus and reach the superior mediastinum .

Prevertebral Fascia:

The **retropharyngeal space** between pharynx and pre-vertebral fascia is clinically important because it frequently becomes infected secondary to upper respiratory tract infections in childhood. The swelling appears on one side of the posterior pharyngeal wall and may obstruct the airway. In adults such infections are usually secondary to tuberculosis of the cervical vertebral column.

External Jugular Vein is relatively superficial therefore:

- It can be easily lacerated
- Can be used to draw blood, infuse drugs or catheterize the heart
- is visible when distended in heart failure

It pierces investing fascia therefore, when lacerated

- Can bleed profusely
- Predispose to air embolism

Review Questions

1) Describe the boundaries, sub divisions and their respective contents of the posterior triangle of the neck

2) Write short notes on:

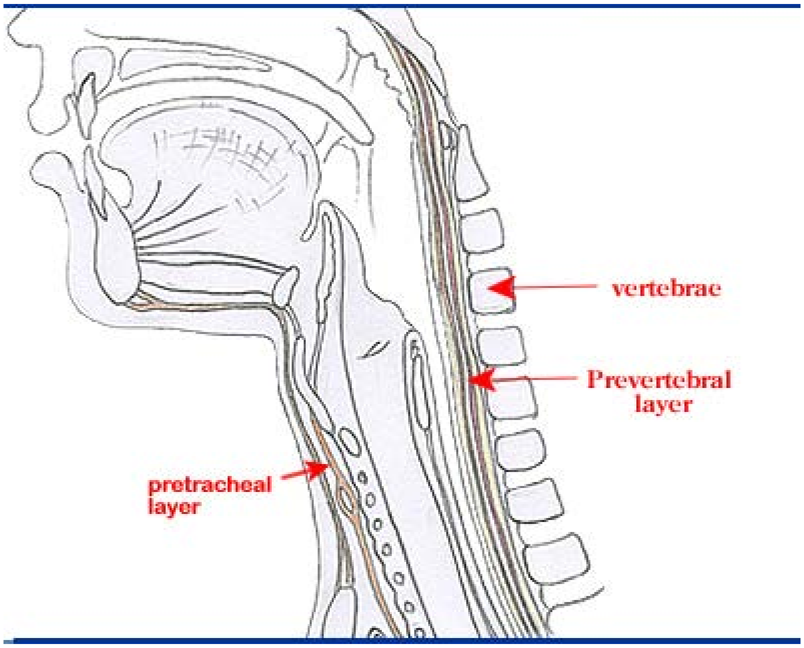
- External jugular vein
- Cervical plexus
- Pretracheal fascia

3) Describe the attachments, extents, enclosures and applied anatomy of the investing cervical fascia

b) Pretracheal layer

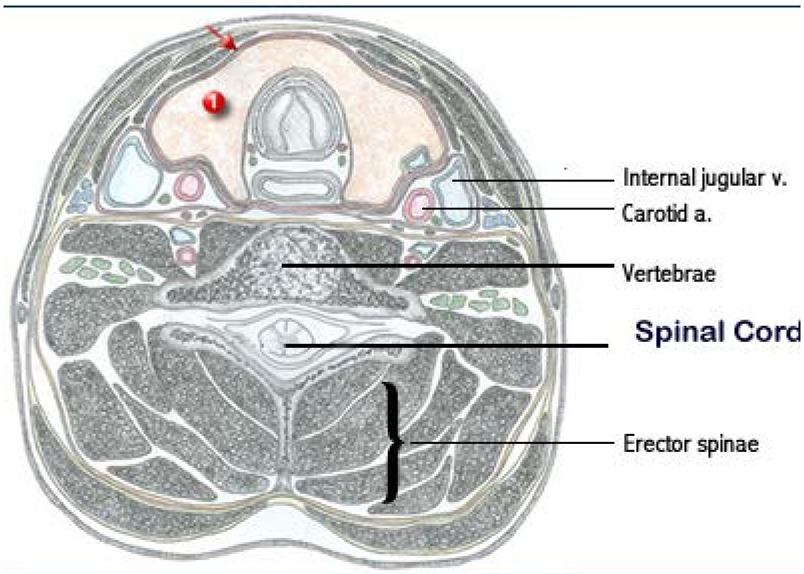
It is limited to the front part of the neck, but more extensive than the name suggests

Attachments



- From hyoid bone to the superior mediastium.
- Oblique lines of thyroid cartilage
- Cricoid cartlage
- The pericardium, and T. adventitia of the bases of great vessels.
- Becomes continous with bucopharyngeal fascia covering constrictor muscles behind.

Structures sorrounded / enclosed



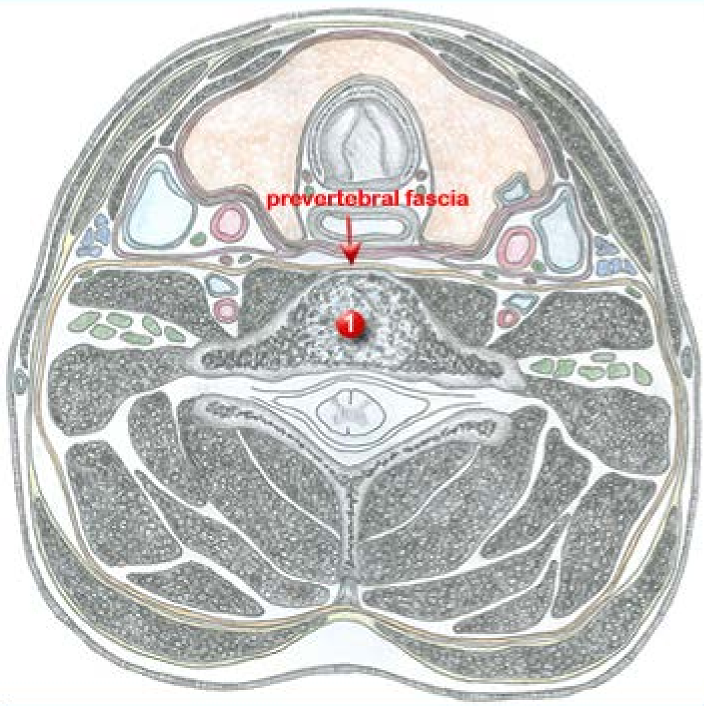
- Thyroid gland **(1)**
- Infrahyoid muscles
- Air and food passages

Modifications

- The fascia at the back of the thyroid lobe is thickened to form a lateral ligament or "ligament of Berry" which gains attachment to the cricoid cartilage.
- At the level of the thyroid isthmus a looser attachment of the pretracheal fascia occurs infront of trachea.

The prevertebral layer

Attachments

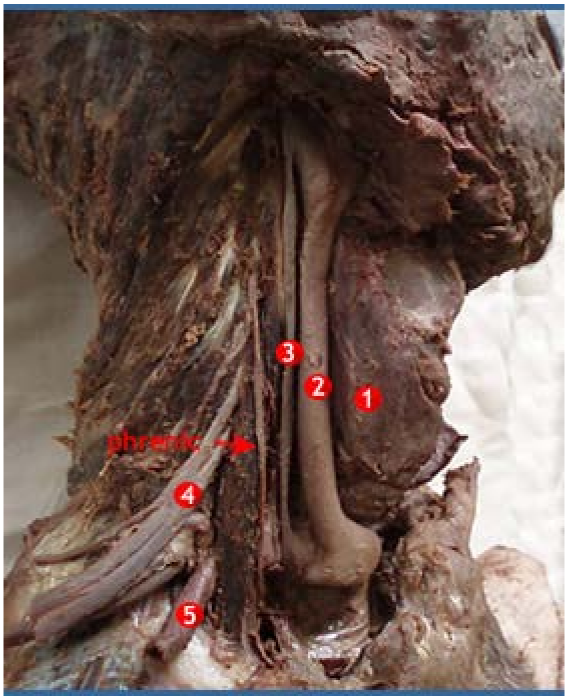


- Base of the skull
- Transverse process of cervical vertebrae
- Extends further down into the abdomen

Structures covered

- Prevertebral muscles
- Scalene muscles
- Phrenic nerve

Thus, it covers the floor of the posterior triangle of the neck

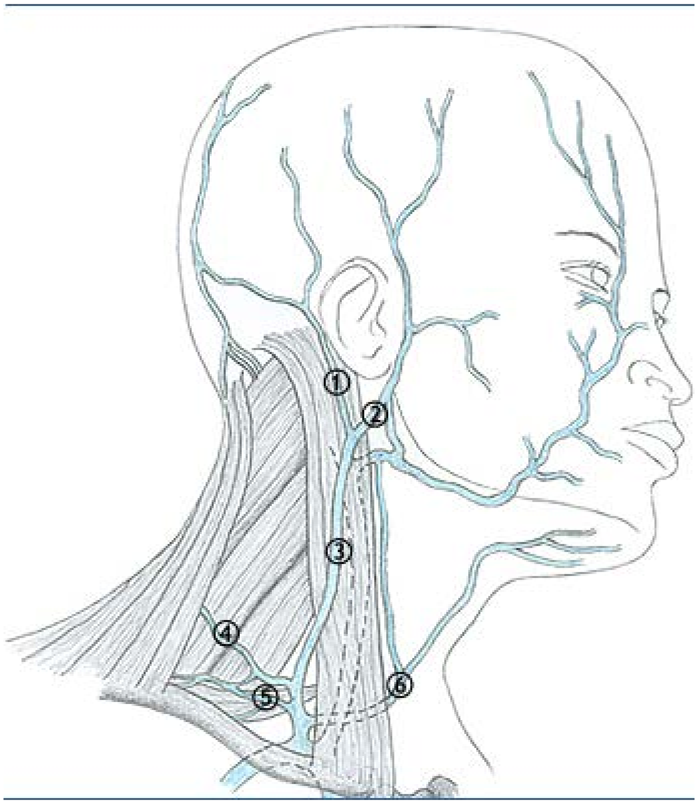


Modifications

- In front of the subclavian artery, it is prolonged laterally as the **cervico-axillary(axillary)** sheath which invests the brachial pexus and the vessels.
- The **carotid sheath** – said to be derived from fusion or pretracheal and prevertebral fascia. Surrounds the
    - Common and the internal carotid arteries.
    - Internal jugular vein
    - vagus nerve

contents

The external jugular vein



- This vein is formed near the angle of the mandible by the union of the posterior branch of retromandibular and posterior auricular veins .
- It crosses sternocleidomastoid muscle, runsover the roof of the triangle and joins the subclavian veins
- The vein drains most of the scalp and face on the same side.
- This vein dilates and becomes visible in fluid overload, in heart failure in SVC obstruction, prolonged raised intrathoracic pressure, e.t.c.
- The walls of the vein are attached to the deep fascia. If the vein is lacerated, the fascia pulls the vein open and blleding is severe. Also, air embolism could follow.

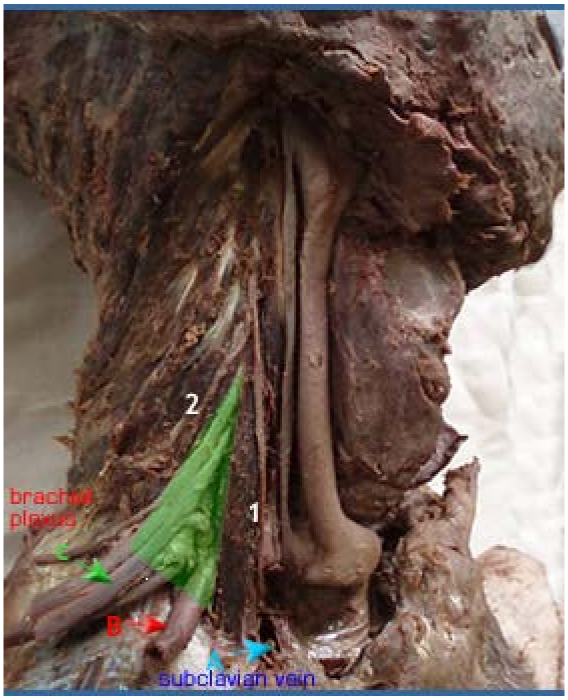
task **what are the tributaries of the external jugular vein?**

Arteries

- The subclavian artery (third part) **-B**
- **Transverse cervical artery** from the thyrocervical trunk to supply muscles in the scapular region.
- **Suprascapular artery** from the thyrocervical trunk.
- **Occipital artery**, from the external carotid artery.

Note the boundaries:

A: Anterior scalene muscle
B: Middle scalene muscle



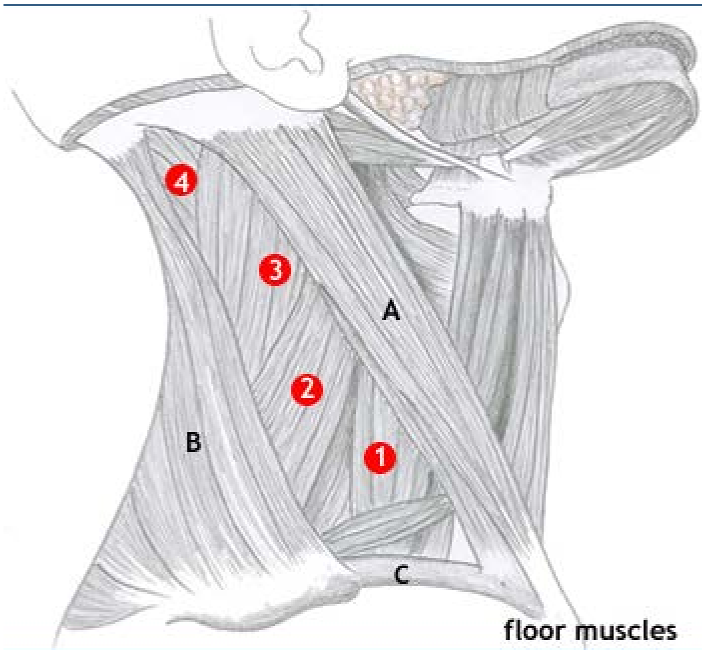
Nerves

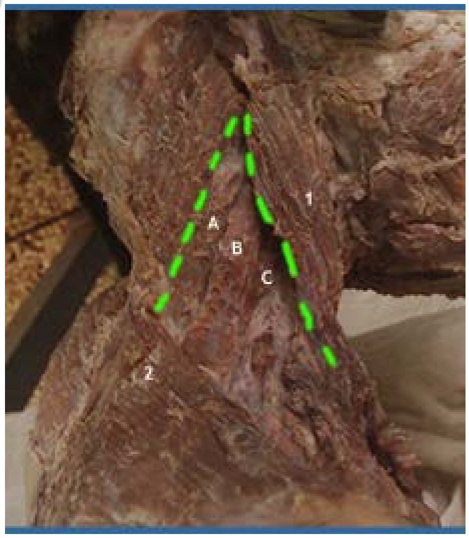
- **Spinal accessory nerve** to the sternocleidomastoid muscle and the trapezius muscle.
- Cervical plexus and its cutaneous branches from up downwards.
- **Lesser occipital nerve** (c2)
- **Great auricular nerve** (c2 c3)
- **Transverse cervical nerve (**c2 c3)
- **Suprascapular nerves** (c3c4)

Supraclavicular part of the brachial plexus

Muscles

- See those forming the floor
- Inferior belly of the omohyoid muscle
- fibrofatty connective tissue, the lymph nodes





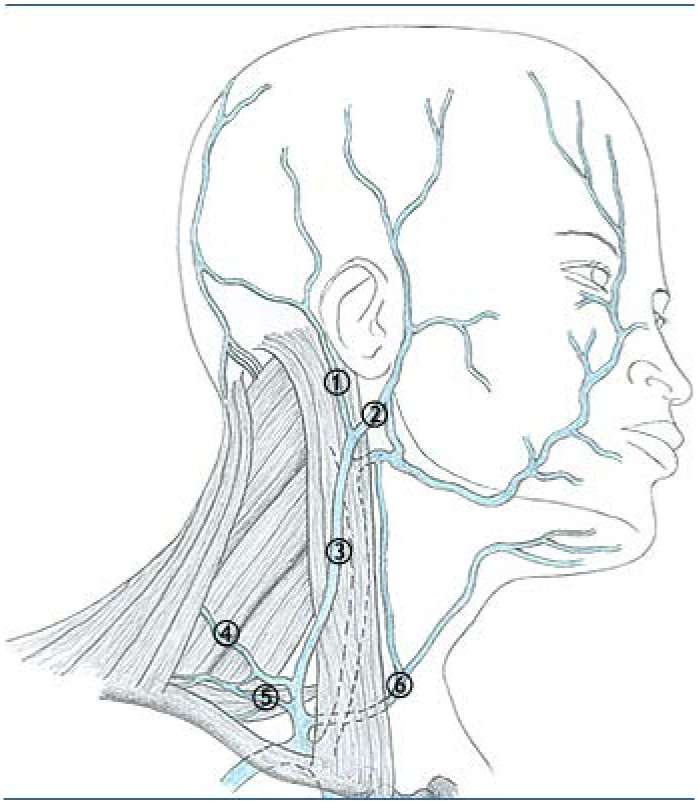
subdivisions

- The inferior belly of omohyoid mscle, divides the posterior triangle into two;
    - The larger occipital triangle
    - The smaller supraclavicular/ omoclavicular triangle.

task ***what are the respective contents of these triangles?***

contents

The external jugular vein



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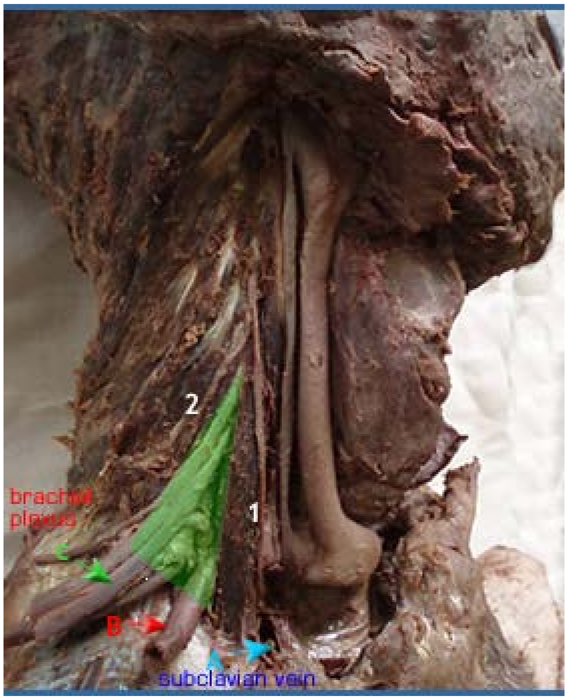

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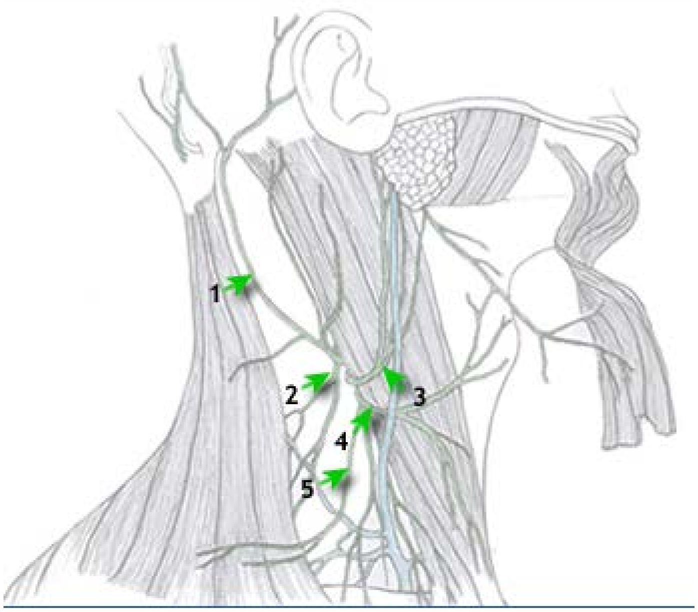

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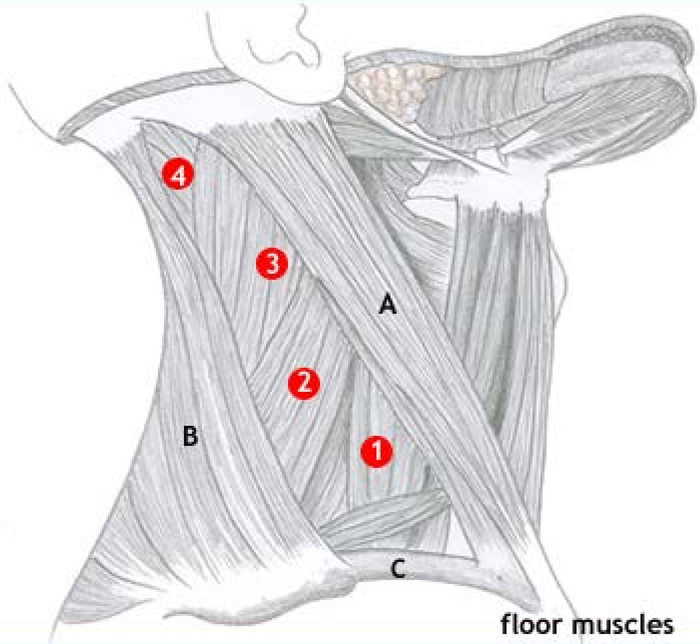

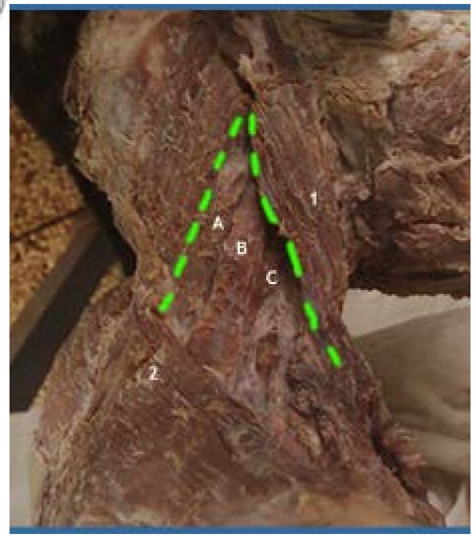

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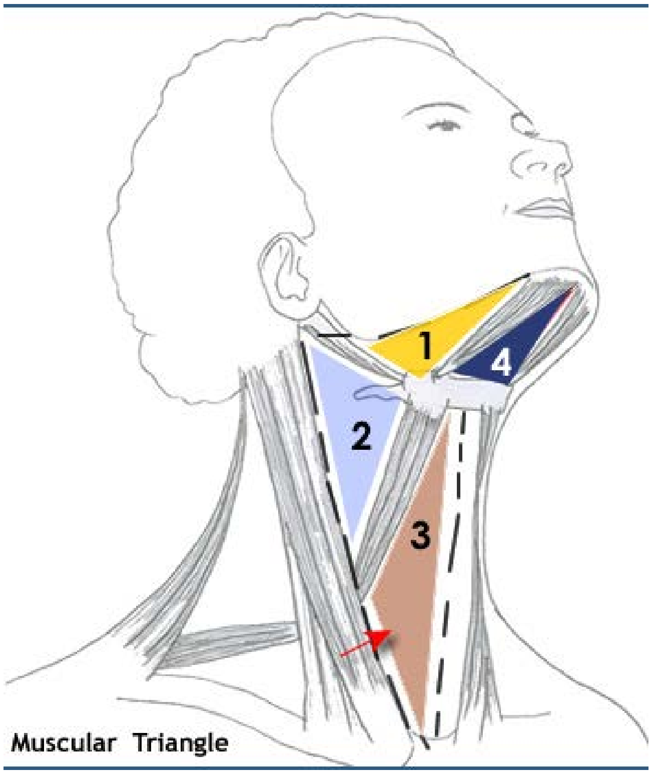
OG anatomy J. Ogeng'o palsoftweblink

Learning points | Core anatomy | Applied anatomy | Review questions

The anterior triangle and of the neck

Boundaries

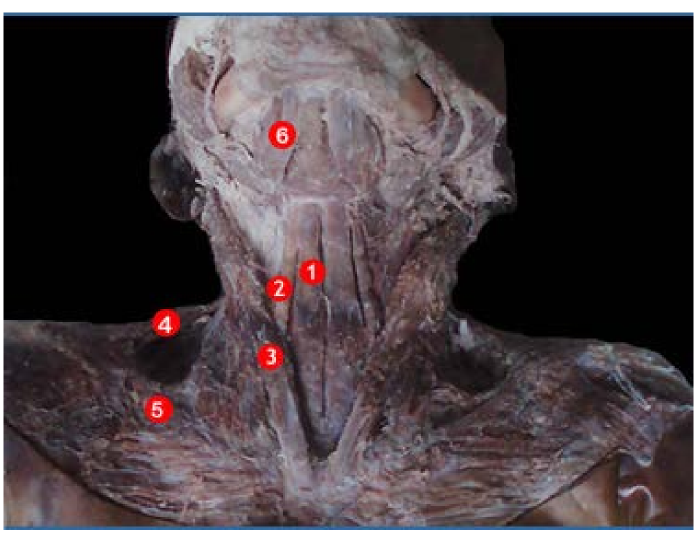


Anteriorly	Anteromedian line of the neck
Posteriorly	Anterior border of the sternocleidomastoid muscle
Superiorly	Inferior border of mandible
Apex	Jugular notch

Subdivisions

- Digastric triangle (1)
- Carotid triangle (2)
- Muscular triangle (3)
- Submental triangle (4)

Muscular Triangle



Boundaries

Medially	the midline
Inferolaterally	Anterior border of the sternocleidomastoid muscle
Superolaterally	superior belly of omohyoid

Contents

1) Infrahyoid muscles (strap muscles).

- Sternohyoid
- Sternothyroid
- Thyrohyoid
- Omohyoid* forming part of the boundary.

Note

- These muscles are innervated by ansa cervicalis (c1-c3) except thyrohyoid that is innervated by C1 via Hypoglossal nerve. They depress the hyoid bone and larynx during swallowing and speaking, anchoring it in position

2) **The anterior jugular veins**, run in both sides of the midline. They are joined by the jugular arch at the suprasternal notch.

task **Identify the structures labelled 4-6**

Applied Anatomy

Thoracic inlet syndrome

The thoracic inlet is a space with rigid boundaries and it is fairly congested. Any space-occupying lesion in this space is likely to compress the contents. These include:

- A cervical rib
- Enlarged lymph nodes
- Cancer of the lung
- Enlarged thymus
- Retrosternal goitre, etc.

(What are the effects of the compression?)

Scalenus anterior syndrome

The scalene triangle/ gapis bounded by:

Posteriorly: Scaleneus medius

Anteriorly: Scaleneus anterior

Base: First rib

Through this gap, pass the subclavian artery and the brachial plexus.

Compression of these structures causes the scalenus anterior syndrome.

Submental triangle

In infections or cancer from any of the areas of drainage of the submental nodes, especially the tip of tongue and lip, the first nodes to be involved are submental nodes. Subsequently, the submandibular and deep cervical get involved.

A discharging sinus on the point of the chin often results from an abscess of a mandibular incisor tooth. The pus from the infected tooth passes from the apex of the submental triangle located at the inferior end of the symphysis menti where it forms a sinus from which pus escapes.

Thyroid gland

Thyroglossal duct cysts (TDC): May develop from a persistent thyroglossal duct anywhere along the course of the duct. The cysts may be in the tongue in the midline of the neck or retrosternal. TDC move up with protrusion of the tongue

• **Thyroglossal duct sinuses:** Are openings into the skin from a patent part of the thyroglossal duct. They usually open in the neck and could be due to perforation of the cyst following infection.

• **Ectopic thryoid gland:** Could be in the tongue, larynx, retrosternal or hyoid region.

• **Goitre:**

This is an enlargement of the thyroid gland. It could be due to iodine deficiency, hormone or enzyme defect, infection or tumor. May be associated with *hyperfunction* or *hypofunction* .
(What are the features of each?)

Besides, goitre causes compression of the following:

- Trachea: affecting breathing.
- Oesophagus: affecting swallowing.
- Recurrent laryngeal nerve: affecting voice.

A ***retrosternal goitre*** is worse for there is no space for expansion.

• Thyroid gland in its capsule is enclosed by pretracheal fascia, which attaches inter alia to the hyoid bone. Thus, the thyroid gland *moves upwards with swallowing and speech*. This is a good test for masses in the neck. Thyroglossal cysts move when the tongue is protuded due to the attachment of the thyroglossal duct to the tongue.

• The **inferior thyroid artery** runs close to the recurrent laryngeal nerve **near the gland**. Thus, the artery should be ligated further laterally to avoid injury to the nerve.

The **superior thyroid artery** **is closer** to the external laryngeal nerves *superiorly than near the gland*. Thus, this artery can be ligated as close to the gland as possible without danger of injury to the nerve.

• In thyrodectomy, the recurrent laryngeal nerve must be preserved. The parathyroids must be identified and at least one spared.

• Since colossal sizes of goitre may damage the recurrent laryngeal nerve, it is good habit to do **laryngoscopy** before thyroidectomy, so that pre-operative damage can be distinguished from post-operative damage.

Horner's syndrome

Results from damage to the cervical sympathetic chain.

Therefore it presents with

- Ptosis
- Myosis
- Facial flushing on the affected site

Trachea

***Tracheitis*:** Inflammation of the trachea from viral or bacterial infection, allergies are frequent causes of cough and upper airway discormfort

***Tracheostomy*:** This is the creation of an opening into the trachea to **relieve upper airway obstruction**
Done between **first** and s**econd tracheal rings** or through **fourth rings**. A tracheostomy tube is then inserted into the trachea and secured. During this procedure, the following anatomical relations must be safeguarded:

- Isthmus of thyroid gland

- Inferior thyroid veins
- Occassional thyroidea ima
- Left brachio cephalic vein
- Jugular venous arch
- Pleura may be encountered particularly in infants and children
- Thymus in infants and children

In **infants** , the **trachea** is **small**, **mobile** and **soft**. Accordingly it is easy to cut through its posterior wall and d**amage the esophagus**

Deviation of trachea: Tracheal deviation from the midline occurs when it is pushed away as in case of massive pleural effusion, lung tumor or when it is pulled to one side. Om cases of lung fibrosis or occasional dextrocardia.

Esophagus

Esophageal cancer

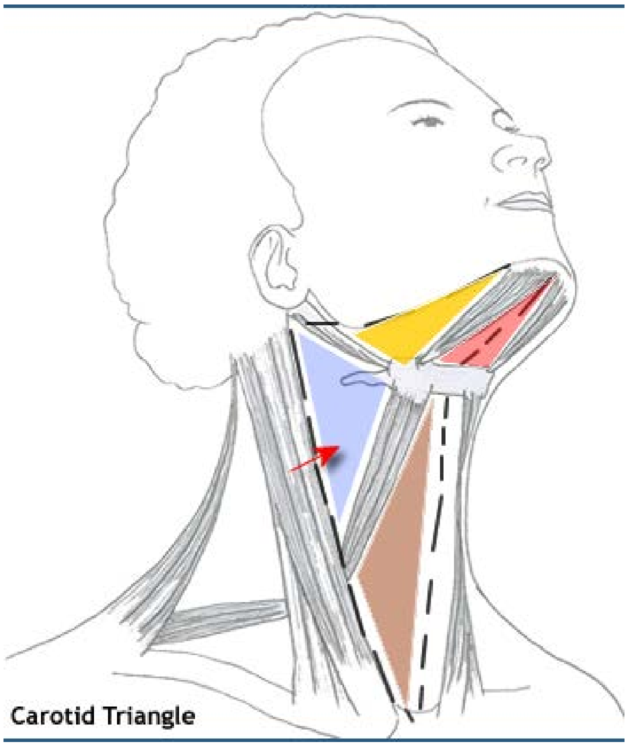
- Presents with difficulty in swallowing
- Commonly diagnosed by esophagoscopy
- Causes enlargement of inferior deep cervical nodes
- Compresses inferior laryngeal nerve producing hoarsenes
- Tracheo esophageal fistula
- Congenital defect with communication between trachea and esophagus

Learning points | Core anatomy | Applied anatomy | Review questions

Review Questions

1. Give an account of the boundaries , contents and applied anatomy of the various subdivisions of the anterior triangle of the neck
2. Describe the location , extents , relations , blood supply and lymphatic drainage of the thyroid gland. Add notes on the clinical importance of the topographic relations of the arteries and nerves of the thyroid
3. State the boundaries , contents and clinical relevance of the scalene triangle and the triangle of the vertebral artery
4. Give an account of the course ,origin,relations and distribution of the vagus nerve in the neck
5. Describe the origin , course and distributions of the vertebral artery . Add a note on the clinical importance.
6. Discuss the distribution of the first part of the subclavian artery .

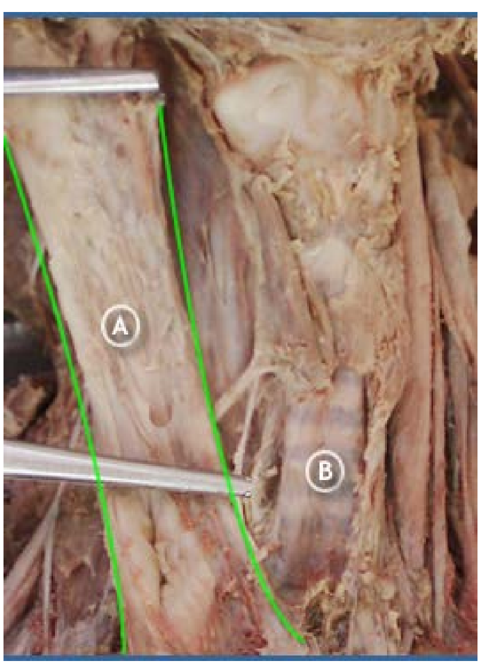
The Carotid Triangle



Boundaries:

Superomedially	Posterior belly of the digastric
Laterally:	Anterior border of the sternocleidomastoid muscle
***Inferomedially*:**	superior belly of omohyoid

Contents:

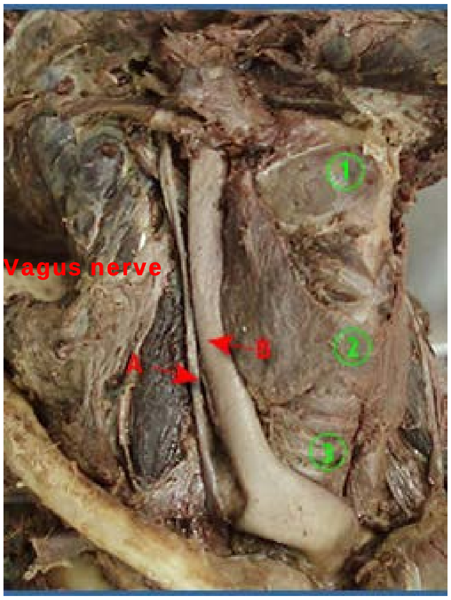


The carotid sheath:

Location: Longitudinal interval between cervical viscera (pharynx, esophagus, larynx, trachea and thyroid gland) medially, and prevertebral muscles posteriorly

Formation:

- Prevertebral fascia behind
- Pretracheal fascia medially



Contents of **carotid sheath**

- Common and Internal Carotid arteries medially.
- Internal jugular vein laterally.
- Vagus nerve posteriorly and between the above two.
- Ansa cervicalis embedded in the carotid sheath(anteriorly).
- Deep cervical lymph nodes.

Note:

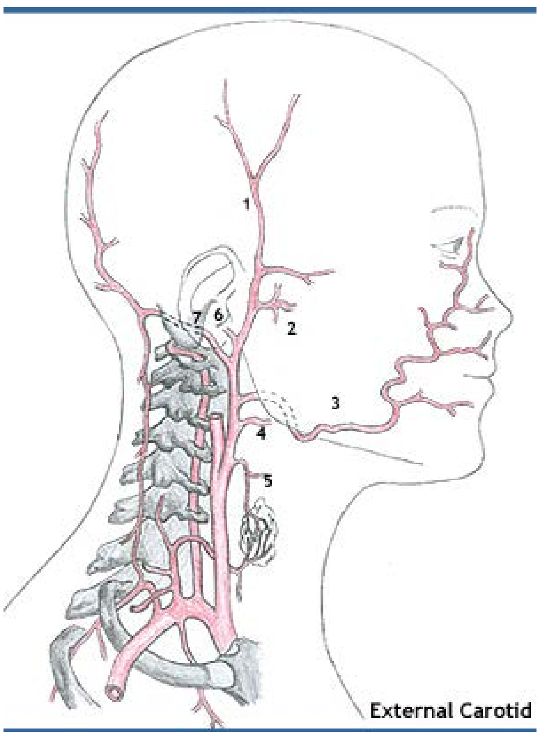
1) **Common carotid** artery divides at superior border of thyroid gland **(C3,4)**.

2) The **carotid sinus** (the baroreceptor) is a slight dilatation at the proximal part of the internal carotid artery. It is innervated by:

- Carotid sinus nerve, a branch of glossopharyngeal.
- A branch of vagus nerve.
- Sympathetic division of ANS.

3) The **carotid body**, is a small reddish brown, ovoid mass of tissue located at the carotid bifurcation. The same nerves that go to the carotid sinus innervate it.

Common carotid artery



Origin

Right:

Brachio cephalic trunk- behind right sternoclavicular joint

Left:

Aortic arch – behind manubrium sterni

Course

- Extends from sternoclavicular joint to upper border of thyroid gland c3/ c4
- Anterolateral neck in the carotid sheath lateral to trachea/ esophagus and larynx/ pharynx
- Palpable between sternocleidomastoid and angle of the mandible
- Divides in the carotid triangle into internal and external carotid arteries

Innervation

- Parasympathetic: Submandibular ganglion
- Sympathetic: superior cervical ganglion

Branches

From the ventral side:	From the dorsal side:	Terminates by dividing into:

• Superior thyroid artery. **[5]** • Lingual artery. **[4]** • Facial artery. **[3]** • Ascending pharyngeal (may form from medial side).	• Occipital artery. **[7]** • Posterior auricular. **[6]**	• Superficial temporal artery **[1]** • Maxillary artery. **[2]**

Internal jugular vein

Origin

- Union of sigmoid and inferior petrosal sinuses

Extent

- Base of skull to sternoclavicular joint

Landmark

- Between sternal and clavicular heads of sterno cleido mastoid muscles

Tributaries

- Pharyngeal veins
- Lingual
- Common facial
- Superior thyroid
- Middle thyroid

Termination:

Joins subclavian vein to form brachio-cephalic vein

Vagus Nerve

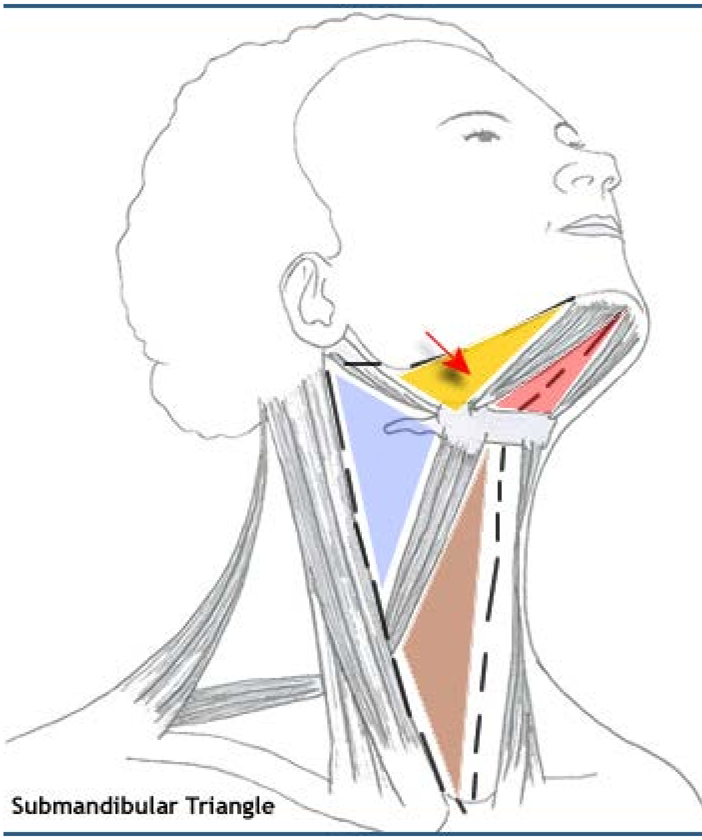
Course

- Emerges through jugular foramen
- Two ganglia- superior and inferior cervical ganglia
- Runs straight down in the carotid sheath
- Between and behind carotid artery and internal jugular veins
- At the root of the neck, it passes infront of the subclavian artery to enter mediastinum
- Branches and distribution

Branch	Distribution
Meningeal	• Dura of posterior cranial fossa
Auricular	• Postero inferior quadrant of external surface of tympanic membrane • Floor of external auditory meatus • Skin on the cranial auricular canal

Carotid body branch	• Carotid body • Carotid sinus
Pharyngeal branch	• Muscles of pharynx except stylopharyngeus • Muscles of soft palate except tensor palate
Superior laryngeal	•
External Laryngeal	• Cricothyroid muscle • Inferior pharyngeal constrictors
Internal Laryngeal	• Pharyngeal mucosa • Laryngeal mucosa above vocal folds
Recurrent Laryngeal	• Trachea and Esophagus • Cricopharyngeus • Laryngeal muscles except cricothyroid • Laryngeal mucosa below vocal folds •
Cardiac branches	• Heart

Submandibular Triangle (Digastric)



Boundaries:

Anterosuperiorly: Inferior border of the mandible.

Inferomedially: Anterior belly of digastric.

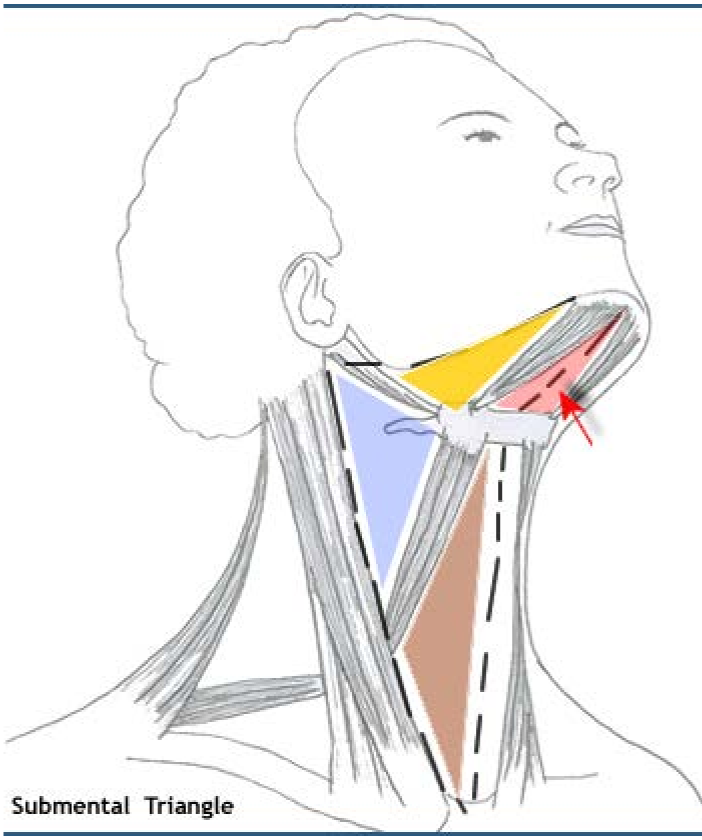
Inferolaterally: Posterior belly of digastric.

Contents:

- Submandibular gland
- Hypoglossal nerve.
- Mylohyoid nerve.
- Facial artery and vein.
- Submandibular lymph nodes

Submental Triangle

Boundaries:



Submental Triangle

Inferiorly: Body of hyoid bone.

Laterally: Right and left anterior bellies of digastric.

Floor: Two mylohyoid muscles.

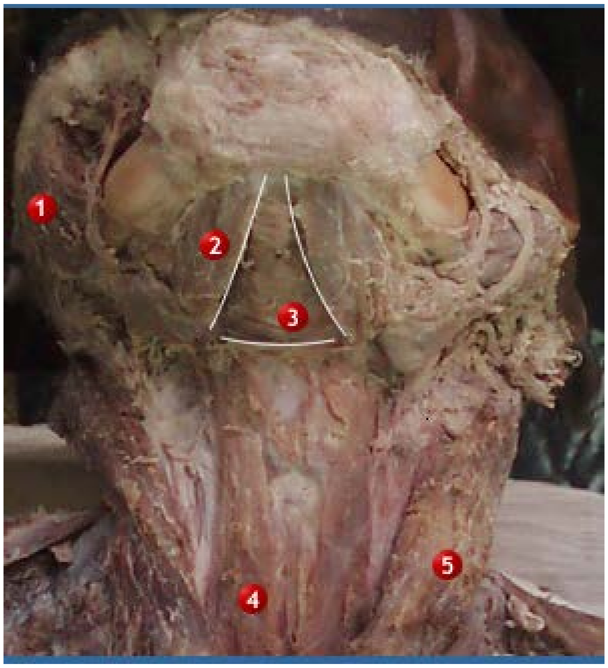
Apex: At inferior end of the symphysis menti.

Contents of submental triangle

Submental lymph nodes. These receive lymph from the following areas:

- Tip of the tongue.
- Floor of the mouth.
- Mandibular incisor teeth and associated gingivae
- Central part of the lower lip.
- Skin of the chin.

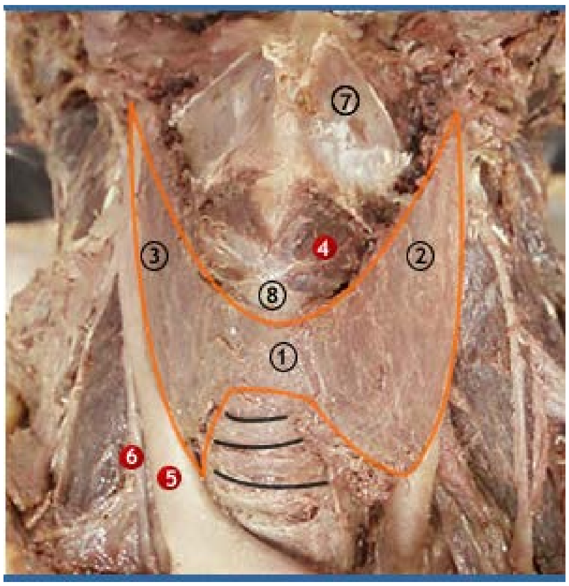
Lymph from here drains into submandibular and deep cervical lymph nodes.



Submental veins and arteries. The submental veins unite to form the anterior jugular vein.

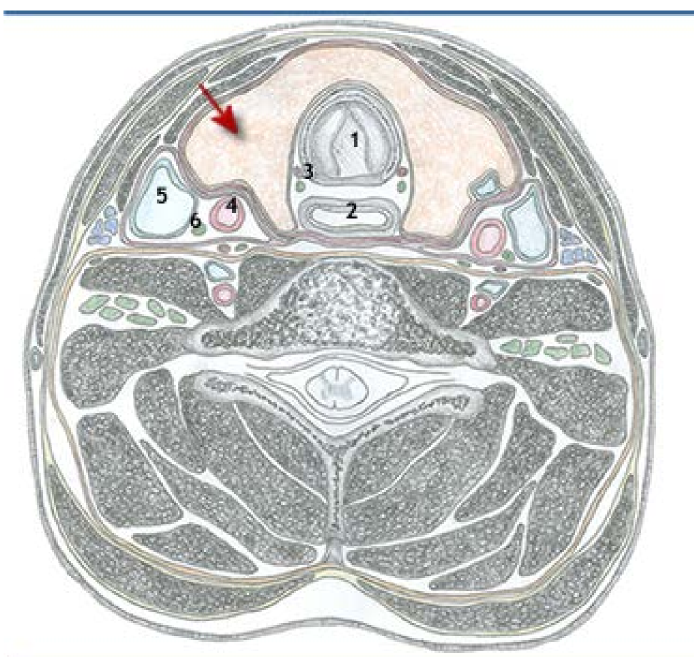
Thyroid Gland

Position:



- Antero- inferior part of the neck
- Isthmus is midline between second and fourth tracheal rings
- The lobes are antero-lateral between C4 and C6
- Lobes are between trachea and esophagus medially and carotid sheath laterally.
- Deep to platysma and strap muscles.

Relations:



Isthmus

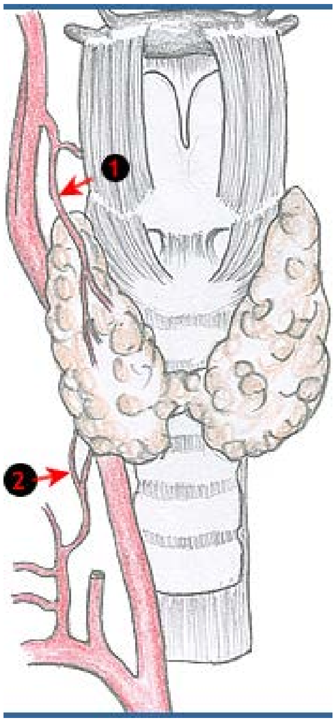
Anteriorly:	Strap muscles, anterior jugular veins
Posterior	Second to fourth tracheal rings
Laterally	Continous with lobes
Superiorly	Anastomosis of superior thyroid artery
Inferiorly	Anastomosis of inferior thyroid artery

Lobes

Antero laterally	Strap muscles, anterior jugular veins
Posterior	Parathyroid glands, prevertebral muscles.
Postero-laterally	Carotid sheath and its contents (common carotid artery **(4)**,internal jugular vein **(5)** ,vagus nerve **(6)**. The sympathetic chain is nearby.
	Larynx**(1)** pharynx and external laryngeal nerve

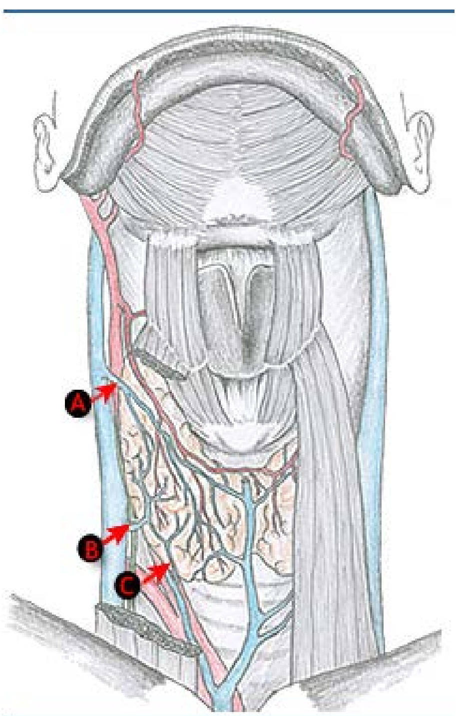
Medially — above, trachea,oesophagus **(2)** and recurrent laryngeal nerve below.

Blood supply:



- **Inferior thyroid artery** from the thyrocervical trunk
- **Superior thyroid artery** from the external carotid artery.
- Occasional (unpaired) ***thyroidea ima*** (middle thyroid) from brachiocephalic trunk .
- Several unnamed twigs from **pharyngeal** and **tracheal vessels.**

All these arteries anastomose with each other.



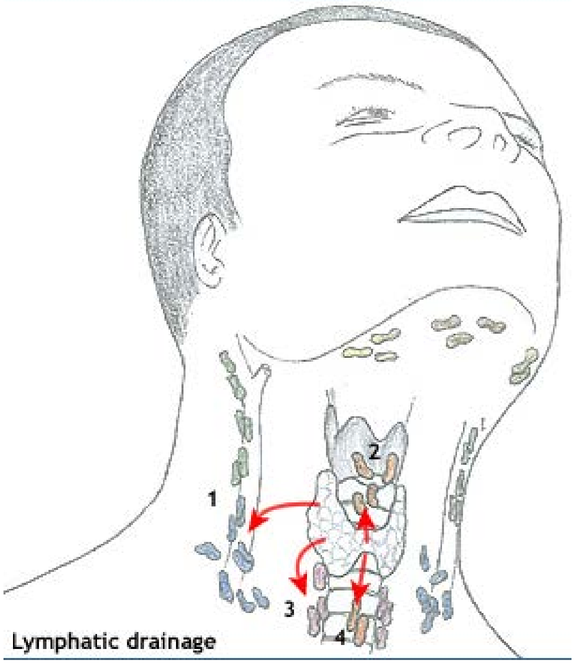
Venous

- **Superior thyroid vein (A)** – Internal jugular vein
- **Middle thyroid vein (B)** – Internal jugular vein
- **Inferior thyroid vein (C)** – Brachio cephalic vein.

The inferior thyroid veins cover the trachea inferior to the thymus. They constitute potential sources of haemorrhage in tracheostomy.

Lymphatic drainage:

- Inferior deep cervical lymph nodes **[1].**



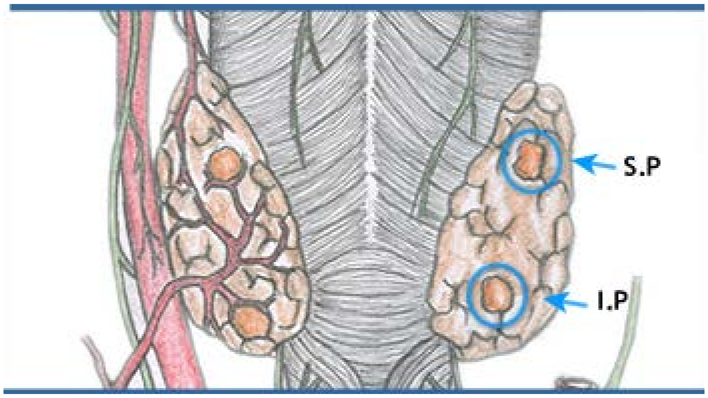
- Prelaryngeal lymph nodes **[2]**
- Paratracheal lymph nodes **[3]**.
- Pretracheal lymph nodes. **[4]**
- Parasternal lymph nodes.

Some may empty directly into the thoracic duct.

Innervation:

Autonomic innervation from the cervical sympathetic ganglia and vagus. This innervation is vasomotor and affects the gland indirectly through the action on blood vessels.

The parathyroid glands



- They are small, yellowish-brown endocrine glands
- Located posterior to the thyroid, in their own capsule, but sharing the same fascial investment.
- The superior are thought to originate in the 4 th pharyngeal pouch.
- The superior ones are consistent in position.
- The inferior are inconsistent and could be found in the anterior mediastinum.

Blood supply

- Usually by the inferior thyroid arteries but may be supplied by the superior thyroid arteries or from longitudinal anastomosis between superior and inferior thyroid arteries.
- The veins drain into the thyroid plexus of the veins on the anterior surface of the thyroid.

Lymphatics of the Parathyroid glands

- Inferior deep cervical lymph nodes.
- Paratracheal lymph nodes.

The lymph vessels from here end in the thoracic duct.

Innervation of the parathyroid glands

Autonomic from the cervical sympathetic chain (and vagus). These are vasomotor.

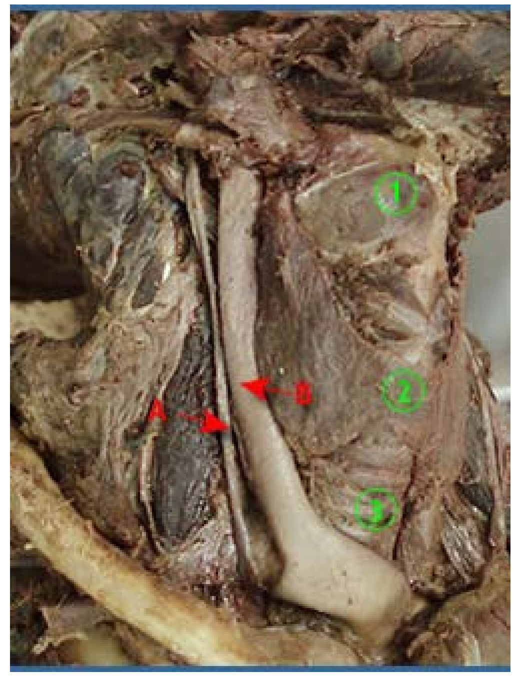
Functions of parathyroid glands

- The parathyroid glands are essential for regulation of blood calcium.

(What are the functions of calcium in the body?)

- They are in danger of being destroyed or removed during thyroidectomy. Surgeons usually leave bits of the thyroid posteriorly or identify and preserve at least one of them.

The Midline of the Neck



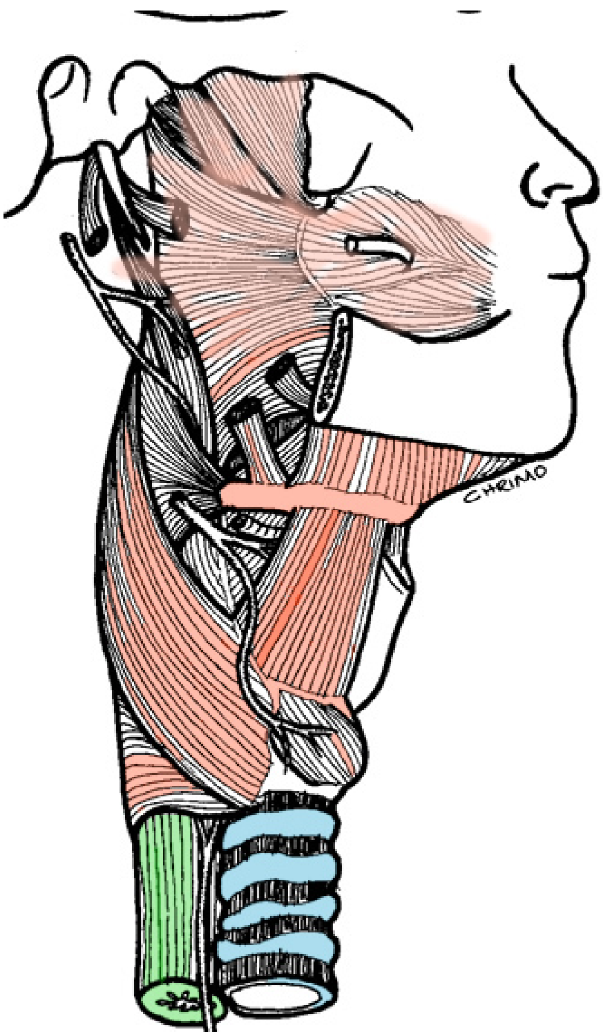
- Hyoid bone
- Thyrohyoid membrane
- Thyroid cartilage
- Cricothyroid membrane
- Cricoid cartilage
- Crico-tracheal ligament
- Thyroid gland isthmus
- Tracheal rings
- Jugular venous arch.

It is important to identify these important midline structures.

(When and where is tracheotomy and laryngectomy done? What structures may be injured?)

Cervical esophagus

Position



- Continuous with laryngopharynx at pharyngo esophageal junction
- Starts at lower border of cricoid cartilage (C6 vertebrae) and ends at thoracic inlet
- In the median plane
- Inclines slightly to the left

Relations

Anterior	Posterior	Right	Left
• Trachea • Recurrent laryngeal nerve in tracheoesophageal groove	• Longus coli • Body of C7	• Right lobe of thyroid • Right carotid sheath • Apex of right pleura	• Left lobe of thyroid • Left carotid sheath • Left subclavian artery • Apex of left pleura • Thoracic duct

Musculature

- Voluntary muscle
- Outer longitudinal and inner muscle
- Cricopharyngeal fibres of inferior constrictor act as a sphincter

Blood supply

- Segmental anastomosing esophageal branches
  of inferior thyroid artery
- Veins drain into inferior thyroid vein

Lymphatic drainage

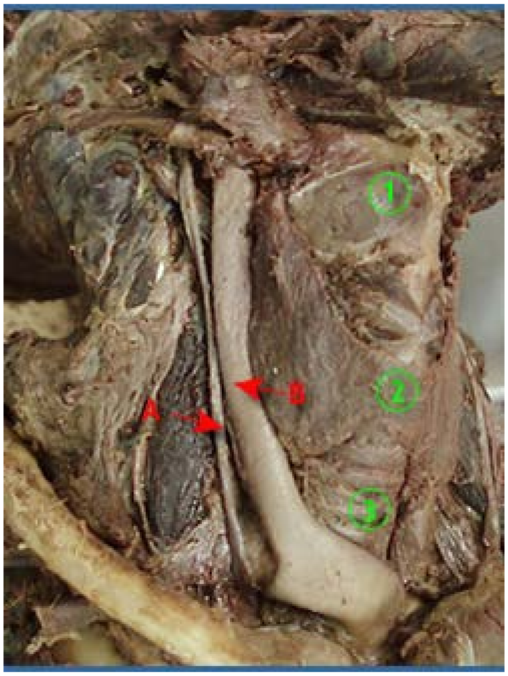
- Para tracheal nodes
- Inferior deep cervical lymph nodes

Innervation

- Somatic motor and sensory: Recurrent laryngeal nerve
- Vasomotor: Inferior cervical sympathetic ganglion through plexus on inferior thyroid artery

Cervical trachea

Position



- Found in the midline of the lower neck
- Continues from larynx into thoracic trachea
- Extends from lower edge of cricoid cartilage (C6) to thoracic inlet at T1
- Inclines backwards as it descends

Relations

Anterior

- Isthmus of thyroid gland occassionaly pyramidal lobe and thyroidea ima if present
- Inferior thyroid vein
- Jugular venous arch
- Sternohyoid and sternothyroid muscles
- In babies left brachiocephalic vein and pleurae

Posterior

- Esophagus
- Recurrent laryngeal nerve and inferior thyroid artery
- Lateral
- Lobes of thyroid gland
- Carotid sheath and its contents
- Brachiocephalic trunk on the right side

Blood supply

- Inferior thyroid artery
- Inferior thyroid vein

-
-

Lymphatic drainage

- Pre tracheal nodes
- Paratracheal nodes
- Inferior deep cervical nodes

Innervation

Sensory - Recurrent laryngeal nerve
Sympathetic- Inferior cervical ganglion

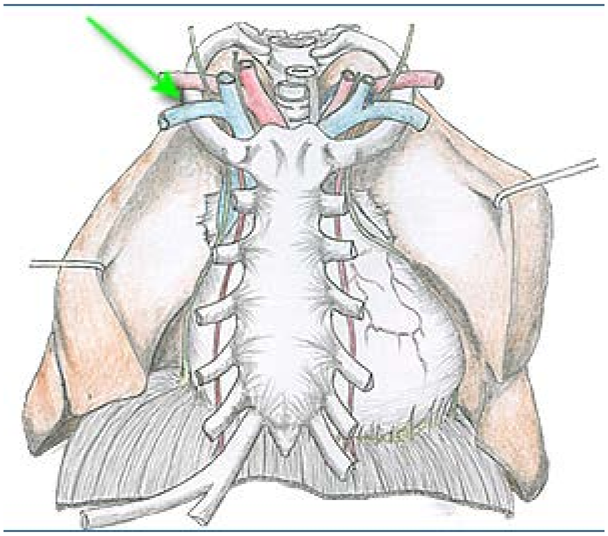
J. Ogeng'o

palsoftweblink

Learning points | Core anatomy | Applied anatomy | Review questions

The Root of the Neck

Hover to show names



Structures at the root of the neck

- Brachio cephalic trunk
- Subclavian artery and its branches
- Subclavian vein
- Termination of internal jugular vein
- Thoracic duct
- Apex of lung
- Phrenic nerve
- Vagus nerve

Contents:

1)The arteries:

- The brachiocephalic trunk.
- Right common carotid.
- Right subclavian.
- May also give thyroidea ima.

Left subclavian artery.

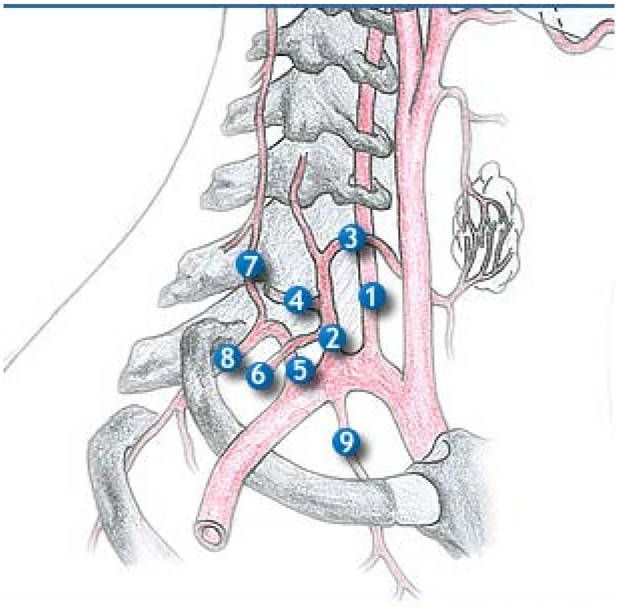
Deep cervical

Divided into 3 parts by scalenus anterior muscle.

Part 1:

Medial to the muscle and gives 3 branches:

- **Vertebral artery** : Enters foramen transversarium at C6
- **Thyrocervical trunk** : Inferior thyroid artery, transverse



cervical artery and suprascapular artery.

- **Internal thoracic artery**.

Part 2:

Posterior to the muscle and gives 1 branch, the **costocervical** trunk which gives **superior intercostal** and **deep cervical** arteries.

Part 3:

Lateral to the muscle, usually giving one branch (dorsal scapula). It may also occasionally give the suprascapular artery.

Fig 2.0: Variant branching of subclavian artery

Task: Identify the arteries labelled 1-6

Relevance of subclavian artery branches to respiration

Branch	Distribution relevant to respiration
Vertebral	• Respiratory center in the midbrain • Cervical cord segments that give phrenic nerve
Internal thoracic	• Intercostal muscles • Ribs and sternum • Thoracic diaphragm

	Phrenic nerve • Abdominal wall
Supreme Intercostal	• 1st two ribs
Inferior thyroid	• Trachea • Larynx • Cervical portion of spinal cord
Transverse Cervical	• Trapezium and Scapula muscles
Suprascapular artery	• Clavicle and scapula to which accessory muscles are attached

2)The veins:

- External jugular veins.
- **Anterior jugular veins**: These either drain into the external jugular or subclavian vein.

The two veins are joined by the jugular venous arch, but could unite to form a single trunk in the midline of the neck. These veins have no valves.

- The **subclavian vein**: A continuation of the axillary vein. This vein usually has only one named tributary, the external jugular vein. The veins that correspond to the arterial branches either drain into the external jugular or brachiocephalic vein.
- The **internal jugular vein,** in the carotid sheath. The internal jugular vein and subclavian veins unite to from the brachiocephalic vein.

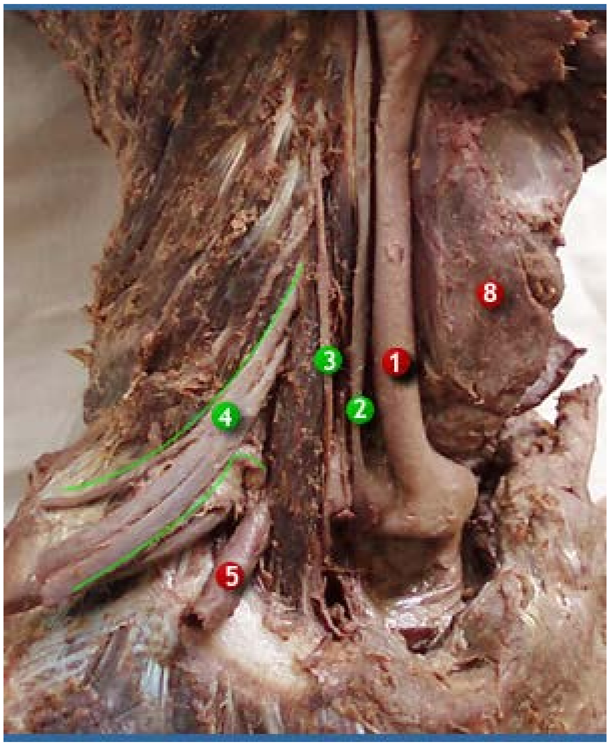
3)Nerves

The Vagus Nerve:

This is cranial nerve 10. Located between common carotid and the internal jugular vein. This nerve gives the following branches in the neck:

- **Meningeal nerve**: Recurrent to the dura.
- **Auricular nerve**: Anastomoses with similar branches from the glossopharyngeal and facial nerves and supplies the pinnae and external auditory meatus.
- **Pharyngeal nerves:** Join the pharyngeal plexus.
- **Superior laryngeal nerve:** Divides into internal laryngeal and external laryngeal.
- **Recurrent laryngeal nerve:**
- **Cardiac branches**: Cardiac plexus.

Full details on Vagus nerve



The Phrenic Nerve:(C3, 4, 5)

Root value :

- C3, C4, C5

Course

- Descends obliquely on the anterior surface of scalenus anterior muscle
- Crosses first part of sub clavian artery on the left
- Crosses posterior to sub clavian vein on both sides
- Lies anterior to the internal thoraci artery
- Goes through thoracic inlet

Distribution

- Parietal pericardium
- Parietal pleura
- Thoracic diaphragm
- Biliary apparatus

4)Sympathetic Trunk:

From T1 to T4. There are 3 ganglia, lies on pre-vertebral fascia behind carotid sheath

Inferior cervical ganglion: At the level of the superior border of the neck of the first rib. It is commonly fused with the first thoracic ganglion to form cervicothoracic ganglion (Stellate ganglion).

Middle cervical ganglion: On the anterior aspect of the *inferior thyroid artery* , at the level of cricoid cartilage pm the posterior aspect of inferior thyroid.

Superior cervical ganglion: Located at the level of the axis and atlas / (C1/ C2) / angle of mandible.

From these ganglia, postganglionic fibres reach their targets in four principal ways:

- Joining spinal nerves.
- Joining cranial nerves.
- Forming plexuses on blood vessels
- Directly.

Provides secretomotor innervation to blood vessels and glands of the head and neck

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Lymphatics

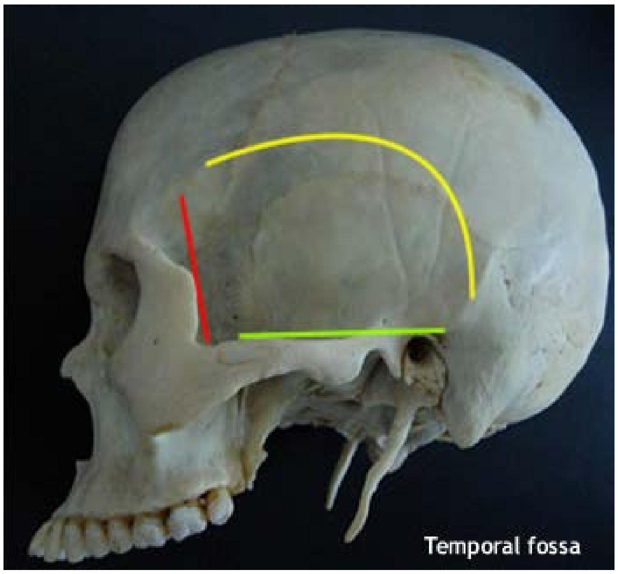
• There are lymph nodes within the carotid sheath, along the internal jugular vein. Another group runs along the transverse cervical artery. These, deep cervical lymph nodes are divided into superior and inferior, relative to the omohyoid muscle.

• The efferents drain into the jugular lymph trunk, which drains into the right lymphatic duct, or the thoracic duct. Both of these ducts enter the venous system, at the junction of the subclavian and the internal jugular veins.

Brachial Plexus

Apex of Lung and Pleura

24.1 The Temporal Region



Boundaries

Superior:	Superior temporal lines
Inferior:	Continous with infratemporal fossa
Lateral :	Temporalis fascia
Medial wall:	Squamous temporal, greater wing of sphenoid, parietal and frontal bones (around pterion)
Anterior	Zygomatic process of frontal bone, the zygomatic bone and maxilla.
Posterior:	Arch of squmaous temporal bone

Contents

- Temporalis muscle and associated nerves and vessels
- Superficial temporal artery and vein

contents

Temporalis muscle: muscle of mastication

Origin:

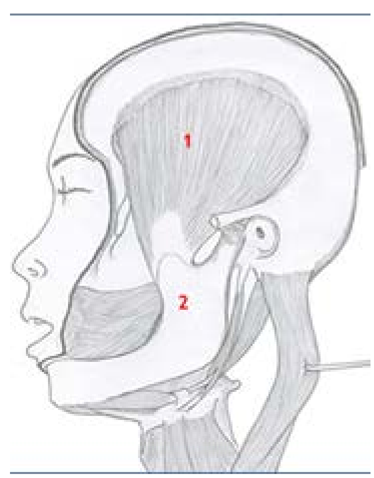
- Temporal fossa between the inferior temporal line and the infratemporal crest,
- Deep surface of the temporalis fascia.

Insertion: medial aspect of coronoid process of the mandible

Blood supply:

- Deep temporal branches of the maxillary artery
- Superficial temporal artery

Innervation: Temporal branches of mandibular nerve



Action:

- Elevates the mandible when the open mouth is closed,
- Retracts the protruded mandible.

Applied anatomy

Parotid

- The parotid gland is enclosed by thick tight investing cervical fascia. Therefore inflammation of the gland is very painful and compresses the structures contained especially the facial nerve and retromandibular vein
- During parotid surgery due care must be taken to avoid injury to the facial nerve as this will cause paralysis of muscles of facial expression
- Because of the close relationship of parotid gland and external auditory meatus, inflammation of the parotid gland may present with ear aches
- MUMPS (Parotiditis) presents with swelling and pain around the ear made worse on chewing or sucking on lemon
- The location of the opening of the parotid duct is important in sialography

Infra temporal fossa

- The lingual nerve passes submucosally along the lingual aspect of the alveolar area of the 3 rd molar tooth.

  The inferior alveolar nerve , as it passes through the mandibular canal, is close to the root of the 3 rd molar tooth.

  Accordingly, these two nerves are at risk of injury during extractions of the 3 rd molar or mandibular fractures .

- **Mandibular nerve block** is the procedure of applying local anaesthesia to the mandibular nerve. The injection

  needle is passed through the mandibular notch, into the infratemporal fossa where the local anaesthetic is injected.

  This procedure blocks all the sensory branches of the mandibular nerve.

- **Inferior alveolar nerve block** : In this procedure, the inferior alveolar nerve is anaesthetised by injecting the anaesthetic fluid around the mandibular foramen.

  All the mandibular teeth are anaesthetised to the midline. The skin and mucous membrane of the lower lip, the labial alveolar mucosa and the gingivae and the sskin of the chin are also anaesthetised.

Submandibular region

A common site of swellings which could be due to:

- Inflammation of lymph nodes due to infection of the:

1. Upper respiratory tract,
2. Oral cavity,
3. Pharynx
4. Scalp
5. Face

- Submandibular abscess
- Cystic hygroma
- Lymphoma
- Submandibular gland inflammation and tumors

During surgery in this region, care must be taken not to damage

- Hypoglossal nerve
- Marginal mandibular and cervical branches of facial
- Lingual nerve
- External Carotid artery and its branches
- Internal jugular vein and its tributaries

Temporomandibular Joint

Dislocation

- May follow yawning or taking a large bite, a blow to the chin when the mouth is open, fracture mandible
- Is uncommon posteriorly because of post glenoid tubercle
- Strong intrinsic lateral ligament
- Is associated with injury to articular branches of the auriculotemporal nerve

TMJ Surgery

Care must be taken to preserve the closely related facial and auriculotemporal nerves and their branches.

TMJ Arthritis

Follows degeneration but occassionaly infection
Causes abnormal function that may result in dental occlusion and joint clicking

Review Questions

1. Describe the location , relations , blood supply , lymphatic drainage and secretomotor pathway for the parotid , submandibular and sublingual glands
2. Give an account of the branches and distribution of the external carotid artery . Add notes on the sites of anastomosis between external and internal carotid arteries
3. Outline briefly the boundaries and contents of the infratemporal fossa. Do specific notes on a) attachments and actions of the temporalis and pterygoid muscles b) parts and distribution of the maxillary artery and their distribution c) branches and distribution of the Mandibular nerve
4. Describe the origin , course and distribution of the hypoglossal nerve
5. Outline the attachments and relations of the hyoglossus muscle
6. Write briefly about : a) styloid apparatus b) parts , foramina , relations and sites of muscle attachments on the mandible
7. Give a brief account of the classification , stability factors , relations , blood supply , innervation and movements (including relevant muscles) of the temporomandibular joint .

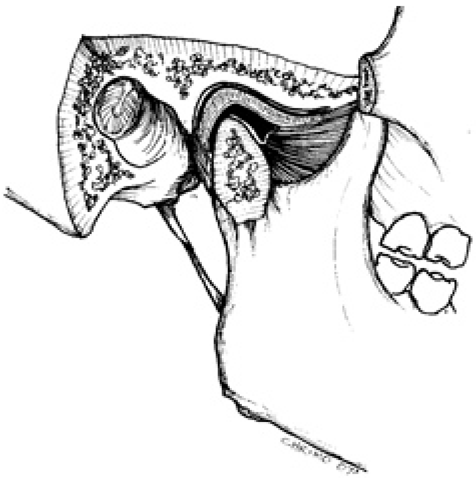
The Temporomandibular Joint

Classification

Synovial modified hinge variety

Articulating surfaces

- Head of mandible **(3)**
- Mandibular fossa of temporal bone **(1)**
- Articular tubercle of squamous temporal bone
- Articular disc **(2)**



Capsule

Thin and attaches to margins of articular surfaces

Stability factors

Ligaments

Principal:

Lateral temporo mandibular joint

Accessory:

Sphenomandibular
Stylomandibular

Relations

Superficial	Anterior	Medial
• Parotid gland • Temporal and zygomatic branches of facial nerve • Transverse facial vessels • Superficial temporal artery and vein	• Tendon of lateral pterygoid • Masseteric nerve and vessels • Posterior • Parotid gland	• Tympanic part of temporal bone • Spine of sphenoid • Chorda tympani nerve • Auriculotemporal nerve

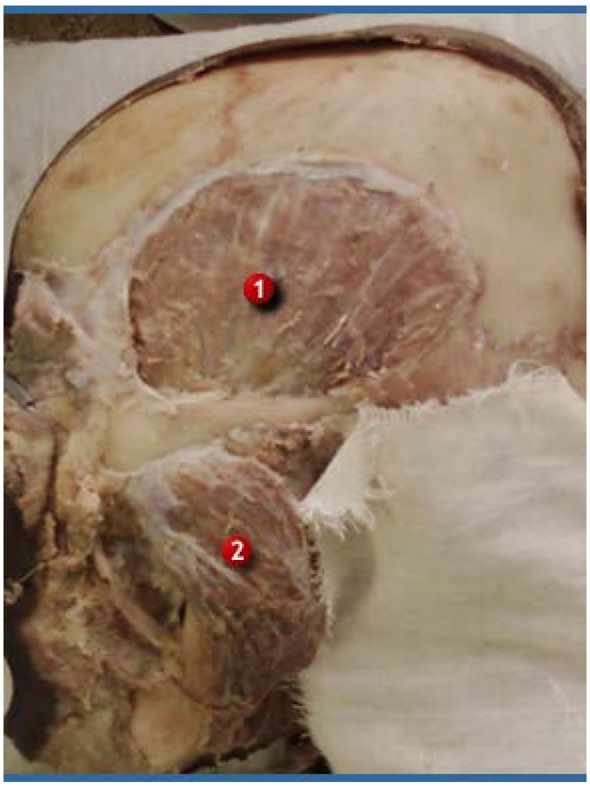
• Auriculotemporal nerve	• Auriculotemporal nerve	• Middle meningeal artery • Mandibular nerve • Accessory meningeal artery • Lesser petrosal nerve
Blood supply	• Superficial temporal artery • Muscular branches of maxillary artery	
Innervation	• Auriculotemporal nerve • Masseteric nerve	

Parotid region

Introduction

Part of the face infront of the ear and below the zygomatic arch . Principal structures in this area are:

- Massetter
- Parotid



Masseter Muscle

A muscle of mastication.

Origin: Lower margin of the zygomatic arch

Insertion: Lateral surface of the mandibular ramus.

Blood supply: Branches of facial , maxillary and superficial temporal arteries

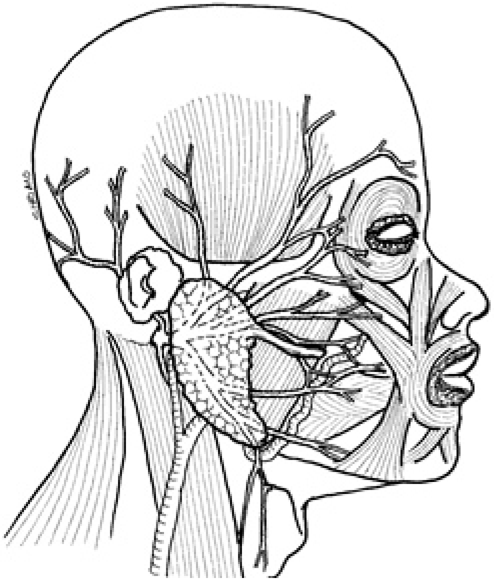
Innervation: Masseteric branch of mandibular nerve

Action: Elevates and draws forwards the angle of the mandible when the jaws are approximated.

Parotid gland

Position:

- Side of the face
- Anterior to the ear
- Extents from the zygomatic arch to the upper part of the neck
- Below the external auditory meatus on to the mastoid process
- Overlies masseter muscle



Surfaces & Relations

Lateral (superficial) surface:	Postero superior	Medial:	Posteromedial surface:	Anteromedial surface:
covered by skin and superficial fascia.	• External auditory meatus	• Styloid apparatus • Carotid sheath and it contents • Facial nerve trunk	• Mastoid process, • Sternocleidomastoid muscle • Posterior belly of digastric muscle.	• Posterior border of mandibular ramus • Masseter muscle • Medial pterygoid muscle

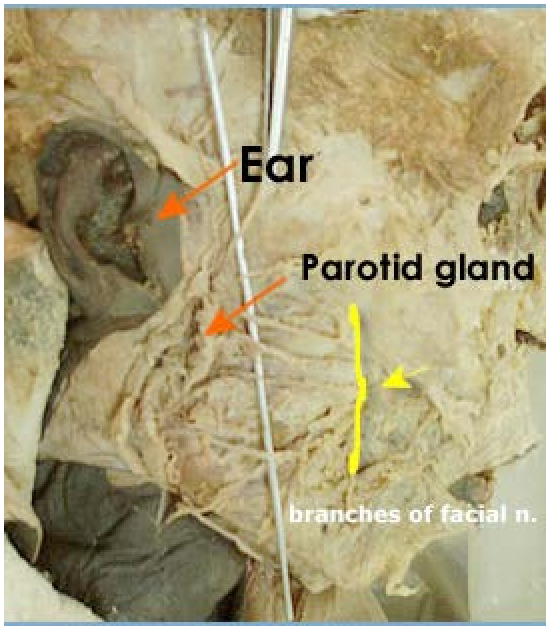
Parotid bed

The deep lamina of the gland lies on it.

It comprises of:

- **mastoid process and the sternocleidomastoid muscle**
- **the ramus of the mandible and the masseter muscle**
- **the styloid apparatus**
- **the EAM grooves the upper border**

Structures traversing the gland



1. external carotid artery
2. facial nerve
3. retromandibular vein
4. parotid (pre ocular) lymph nodes

The Parotid Duct (of stensen)

Course

- Across masseter
- Pierces buccinator
- Lies on the middle third of a line between the intertragic notch of the auricle and the midpoint of the philtrum

Termination

- Mucous membrane opposite the second upper molar tooth.

Blood supply

- Branches of superficial temporal artery
- Some twigs from maxillary
- Veins drain to the retromandibular vein

Lymphatic drainage : nodes

- Pre auricular
- Post auricular
- Sub mandibular
- Upper deep cervical

Nerve supply

Parasympathetic

- Preganglionic fibres arise from cell bodies in the **inferior salivary nucleus** in the medulla,
- Fibres travel by way of the glossopharyngeal nerve, its tympanic branch, the tymphanic plexus and the lesser petrosal nerve
- Synapse in otic ganglion.
- Post ganglionic fibres travel through auriculo temporal nerve

General sensory

- Auriculo-temporal nerve
- Greater Auricular nerve

Symphathetic

- Superior cervical ganglion by way of the plexus on the external carotid and middle meningeal arteries.

24.3 Infratemporal region

Boundaries:

Laterally: The ramus fo the mandible.

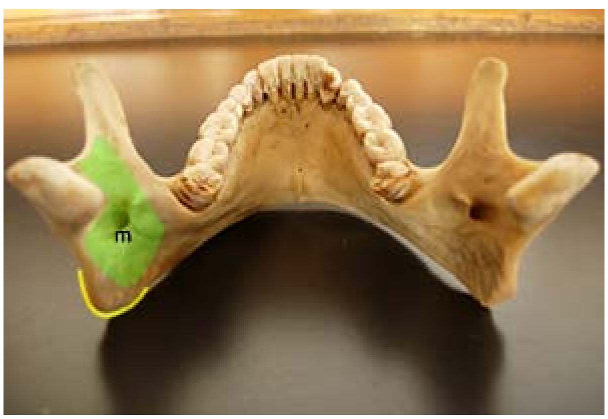
Medially: Lateral pterygoid plate **(B)**.

Anteriorly: The infratemporal surface of the maxilla (limited by inferior orbital fissure superiorly and the pterygomaxillary fissure medially)

Posteriorly: Anterior surface of the condylar process of the mandible and the styloid process of the temporal bone.

Roof (Superior): Inferior surface of the greater wing of the sphenoid. Foramen ovale is located in the roof of the infratemporal fossa.

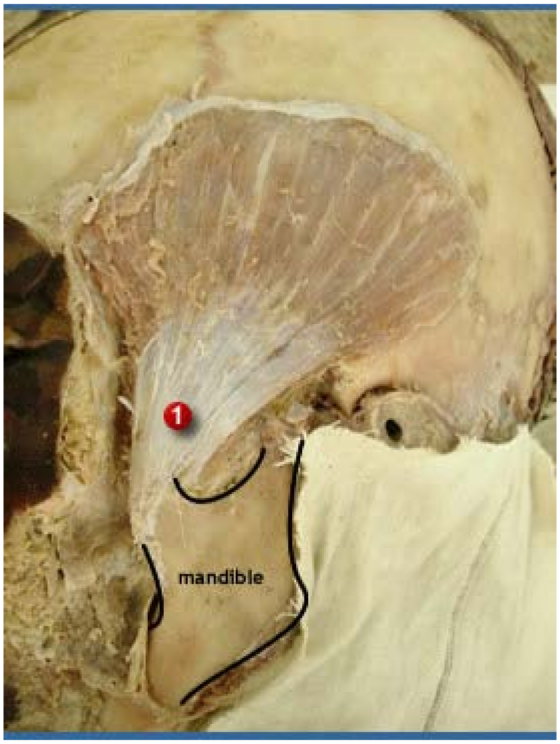
Inferiorly: Angle of the mandible **(M)** and continues in to the sub-mandibular fossa.



Contents:

Muscles:

- Inferior part of temporalis muscle.
- Medial and lateral pterygoids.



Vessels:

Pterygoid venous plexus:

Lies on the lateral pterygoid muscles.

Connections:

- Facial vein , via deep facial vein.
- Cavernous venous sinus by an emissary vein passing through the foramen ovale.
- Inferior opthalmic vein
- Pharyngeal venous plexus and muscular veins.

These communications are important for spread of infections and for collateral circulation.

The pterygoid muscles and other muscles of mastication pump the blood from this plexus and are considered a "peripheral heart". Chewing or yawning increases venous return.

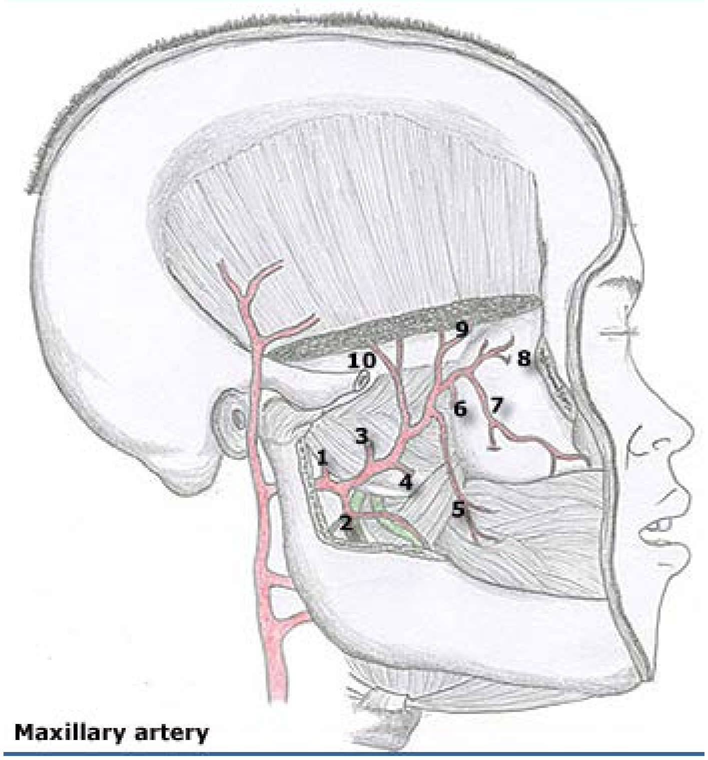
Maxillary artery.

Origin

- Terminal branch of the external carotid artery ,

Course

- It commonly lies superficial to the lateral pterygoid muscles but may be deep to it.
- It is divided into three parts by the lateral pterygoid muscle.

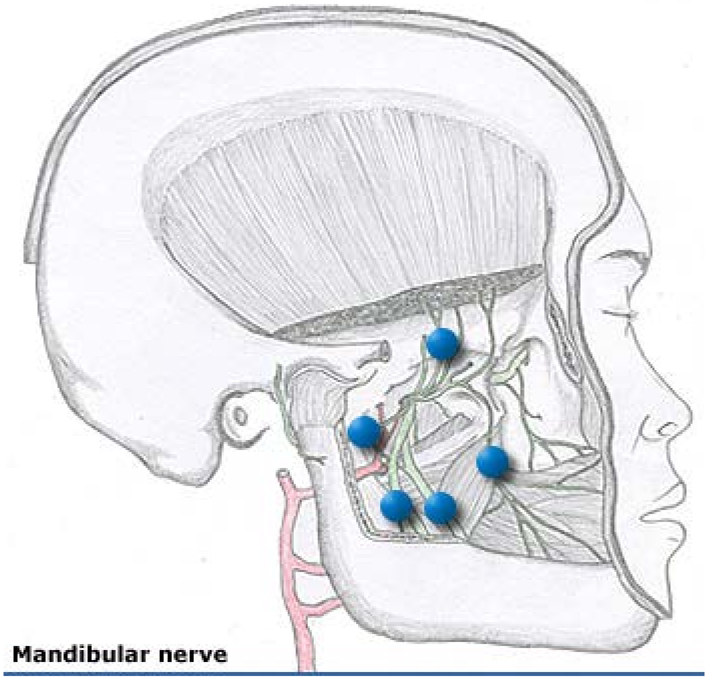


See table below for parts, branches and distribution

Part	Branch	Distribution
Part 1	Deep auricular **(1)**.	External acoustic meatus
	Anterior tympanic,	Tympanic membrane.
	Middle meningeal**(3)**	Dura and skull (middle cranial fossa).
	Accessory meningeal	Meninges and skull.
	Inferior alveolar .**(2)**	Mandibular teeth and gums
Part 2	Masseteric:**(4)**	Masseter muscle.
	Anterior**(9)** and posterior **(10)** Deep temporal:	Temporalis.
	Pterygoid:.	Pterygoid muscles
	Buccal:.**(5)**	Buccinator
Part 3 Branches:		
	Posterior superior alveolar **(7)**.	Maxillary molars gums
	Middle superior alveolar.	Maxillary Pre-molars and gums
	Infraorbital **(8)**.	Faces
	Descending palatine:	Palate
	Artery of the Pterygoid canal.	Pharynx
	Pharyngeal	Naso-pharynx
	Sphenopalatine:	Nasal cavity and incisive teeth

Mandibular Nerve

Hover over the hot spots to show nerve names



These are mainly branches of the **Mandibular nerve** (V3), together with associated parasympathetic hitch hikers.

a) Branches to the muscles of mastication are named according to the muscles they supply. In addition to the muscle of mastication, the mandibular nerve also supplies: -

- Tensor palati.
- Tensor tympani.
- Mylohyoid and anterior belly of digastric.

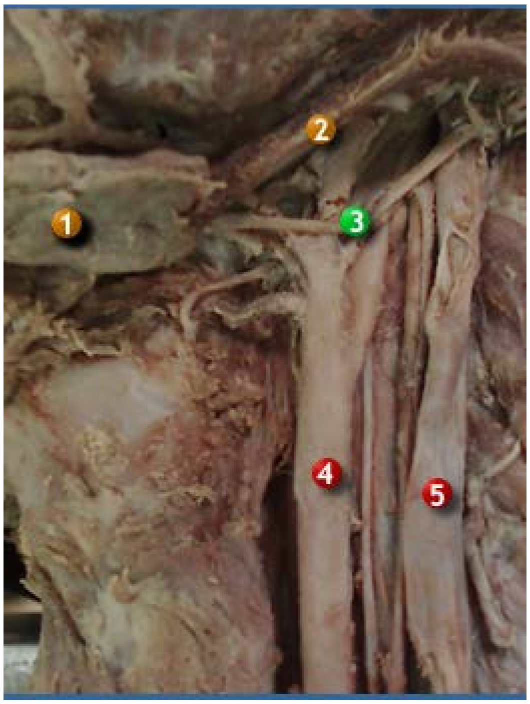
b) Sensory branches:

Auricolotemporal	Buccal	Inferior alveolar nerve:	Lingual nerve:
• Auricle and temporal region. • Auricular fibres to the temporo-mandibular joint. • Post-ganglionic parasympathetic fibres to the parotid gland.	• Skin and mucous membrane of the cheek. • Mandibular buccal gingiva in the molar region.	• Teeth and gums in the mandible. • Continues as mental nerve (at about 2 nd premolar) • Lower lip, chin. • Gingiva of mandbular incisors.	• General sensation to the anterior two-thirds of the tongue, the floor of the mouth and the gingivae. • It is joined by chorda tympani which carries: • Preganglionic parasympathetic fibres to the submandibular ganglion. • Taste fibres from the anterior two-thirds of the tongue.

24.4 Submandibular region

Introduction

This region lies deep to the body of the mandible , and is also called the suprahyoid region.

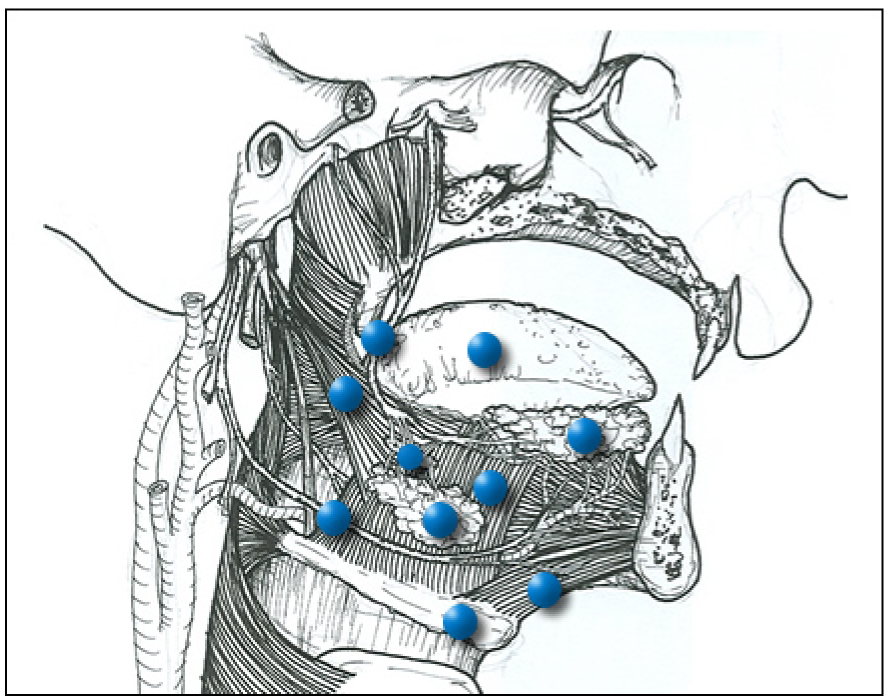


Contents

The main contents in this region include:-

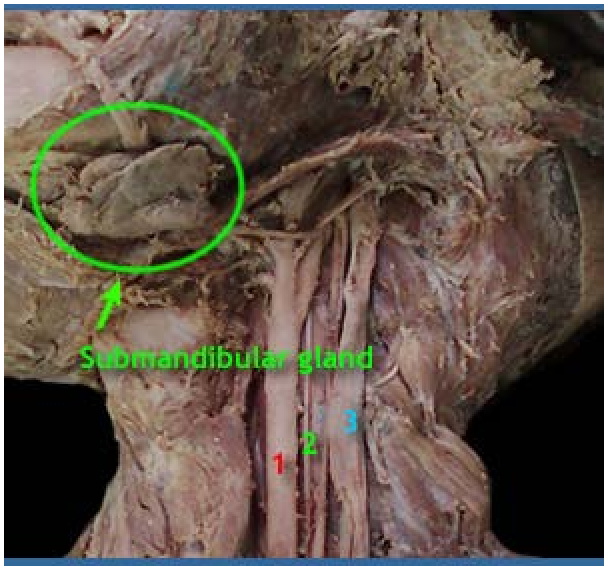
- submandibular and sublingual glands
- lingual nerve and vessels
- hypoglossal nerve
- submandibular ganglion
- suprahyoid muscles (digastric, stylohyoid, mylohyoid and geniohyoid)

Hover over the hot spots below to show the names



submandibular gland

Consists of a large superficial part and a small deep part which are Continous with one another around



the free posterior margin of mylohyoid.

Position

- Deep to and extending below body of mandible
- Found in submandibular triangle
- Extends to carotid triangle
- Between two bellies of digastric muscle

Surfaces and relations

Superficial part has three surfaces:

Medial surface	Inferior or superficial surface:	Lateral Surface
• Mylohyoid, and hyoglossus muscles, • Lingual nerve, • Hypoglossal nerve • Facial artery	• Skin, Platysma, Investing fascia • facial vein • cervical and marginal mandibular branches of facial nerve	• Body of mandible • Medial pterygoid • Facial artery • Masseter

The deep part extends forwards for a variable distance between the mylohyoid and hyoglosus, below the lingual nerve and above the hypoglossal nerve.

Submandibular duct of Wharton

Course

- Emerges from the superficial part of the gland near the posterior border of mylohyoid.
- Runs with the deep part forwards and slightly upwards
- Between the mylohyoid and hyoglossus
- Between sublingual gland and genioglossus muscle~
- Lies on hyoglossus
- Crossed laterally by the lingual nerve

Termination

- Floor of the mouth on the sublingual papilla beside the frenulum of the tongue

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Blood supply

- Submandibular branches of facial artery and corresponding veins

Lymph drainage

Submandibular lymph nodes

Nerve supply

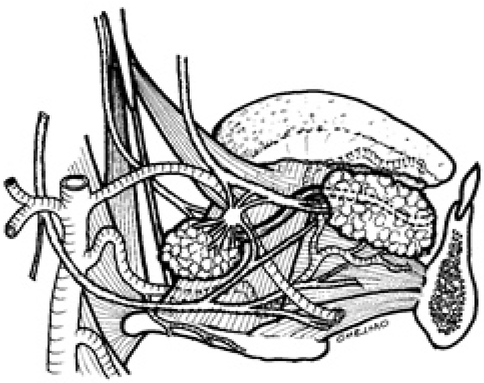
Parasympathetic

- Preganglionic fibres **superior salivary nucleus** in the pons
- **Nervous intermedius**, **chorda tympani** and **lingual nerve**.
- **Submandibular ganglion**
- Postganglionic fibres are direct to the gland

Sympathetic (vasoconstrictor) fibres come from the plexus around the facial artery.

General sensory: Lingual nerve

Sublingual gland



Position

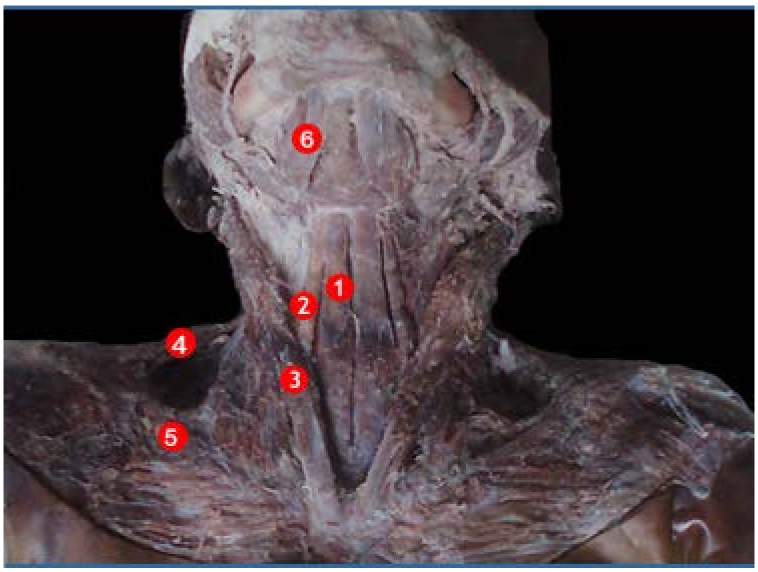
- In the submandibular region beneath the mucosa of the floor of the mouth
- Occupies the sublingual fova
- Above mylohyoid nerve

Relations

Superior:	Medial :	Lateral	Anterior	Posterior
• Mucosa of tongue	• Genio glossus muscle • Submandibular duct • Lingual nerve	• Mandible • Inferior • Mylohyoid nerve	• Genioglossus muscle • Its fellow	• Deep part of submandibular gland

Blood supply	• Sublingual artery- lingual • Submental artery- facial • Veins correspond to the arteries
Lymphatic drainage	• Submandibular nodes • Submental nodes
Innervation	See submandibular gland

suprahyoid muscles.

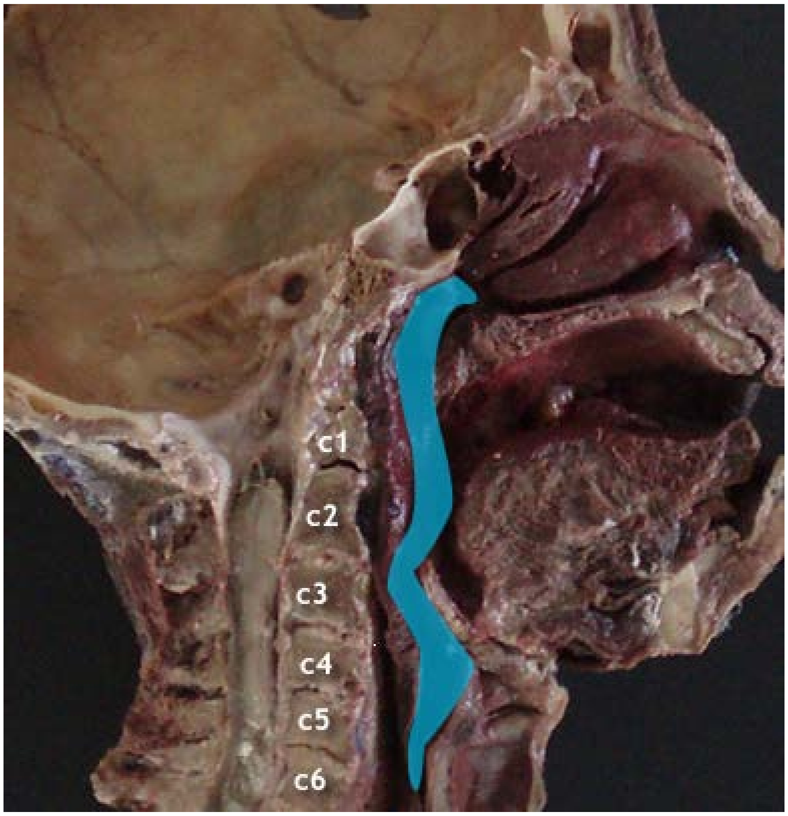


task **Identify the structures labelled 1-6**

MUSCLE	ORIGIN	INSERTION	ACTION	INNERVATION
Digastric	• Digastric notch, • medial surface of base of mastoid process	• Digastric fossa	• Depress the mandible	• Posterior belly: facial nerve • Anterior belly:nerve to mylohyoid
Stylohyoid	• Back of styloid process near the base of skull	• By two slips into the junction between the greater horn and body of hyoid bone	• ELevate hyoid bone	• Facial nerve
Mylohyoid	• Whole length of mylohyoid line of its	• Anterior ¾: into each other	• Forms a mobile but stable floor of	• Mylohyoid nerve

	own side on the inner aspect of the mandible from medial to the third molar tooth to below the mental spines	(interdigitation) • Posterior ¼: anterior surface of the body of hyoid bone	the mouth	
Geniohyoid	• Inferior mental spine	• Upper border of the body of hyoid bone.	• Protracts and elevates the hyoid bone in swallowing or if the hyoid is fixed to depresses the mandible.	• C1(superior root of ansa cervicalis)

25.1 Organisation of the pharynx



Extents:

- 12 cm long
- from base of skull to body of C6

Relations:

- Anteriorly:
  - Nasal cavity
  - Nasal septum
  - Oral cavity
  - Larynx
- Posteriorly:
  - Seperated from prevertebral fascia by retropharyngeal space containing loose areolar tissue and pharyngeal venous plexus.
- Laterally:
  - Neurovascular bundle of the neck and styloid apparatus.

Pharyngeal wall

Has 5 layers:

- Mucous membrane:

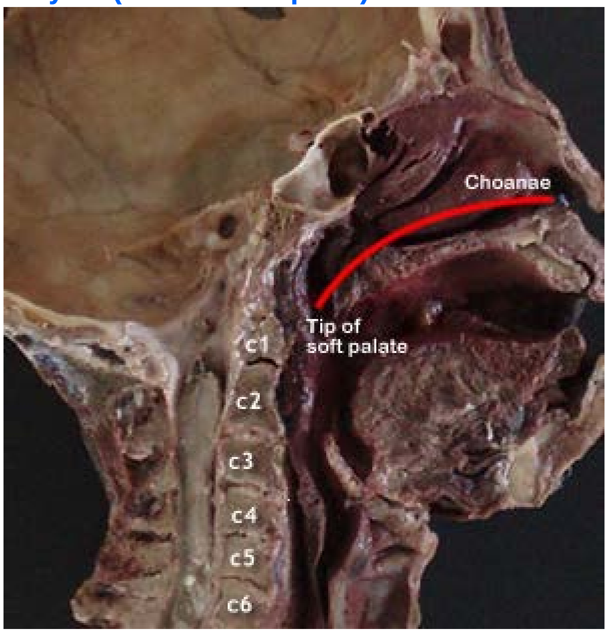
1. Epithelium is pseudostratified columnar ciliated epithelium in the nasal part, stratified squamous non keratinised in the other parts,
2. Subepithelial collections of lymphoid tissue.The large ones form tonsils.
3. Lamina propria contains elastic tissue and mucous glands

- Submucosa: Also contains elastic tissue, glands, blood vessels and nerves.
- Pharyngobasilar fascia: Lines the internal surfaces of the pharyngeal muscles and attaches the pharynx to the base of the skull, auditory tubes and to the lateral margins of the posterior nasal apartures. Also fills the gap between the skull and superior constrictor.
- Pharyngeal muscles: Pharyngeal constrictors, circular (intrinsic) - and longitudinal (extrinsic). What are the attachments?
- Bucopharyngeal fascia:

Divisions:

- Nasopharynx
- Oropharynx
- Laryngopharynx

Nasopharynx (Postnasal space)



Relations and Boundaries:

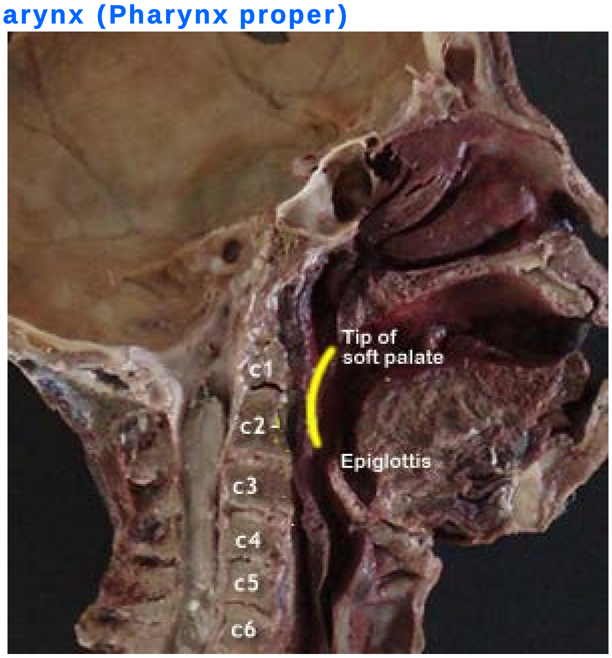
- *Roof:* Body of sphenoid and basi-occiput
- *Floor:* Soft palate
- *Posterior:* Upper cervical vertebrae (C1, C2)
- *Anterior:* Nasal cavity
- *Laterally:* Eustachian tube, pharyngeal recess (fossa of Rosenmuller). Note the tubal and pharyngeal tonsils.

Blood supply: Pharyngeal branch of maxillary artery.

Innervation: Pharyngeal branch of maxillary nerve

Clinical importance: Common site of tumors (post nasal space of tumors). *What are the possible effects?*
enlarged pharyngeal tonsils (adenoids)
What are the possible effects?

Oropharynx (Pharynx proper)



Relations and Boundaries:

- Anterior: Oral cavity – palatoglossal and palatopharyngeal arches, palatine tonsils between these.
- Superior: Soft palate.
- Inferior: Epiglottis.
- Posterior: C2, 3.
- Lateral: Neurovascular bundle of neck.

Blood supply: Pharyngeal branches of external carotid and maxillary lingual artery.

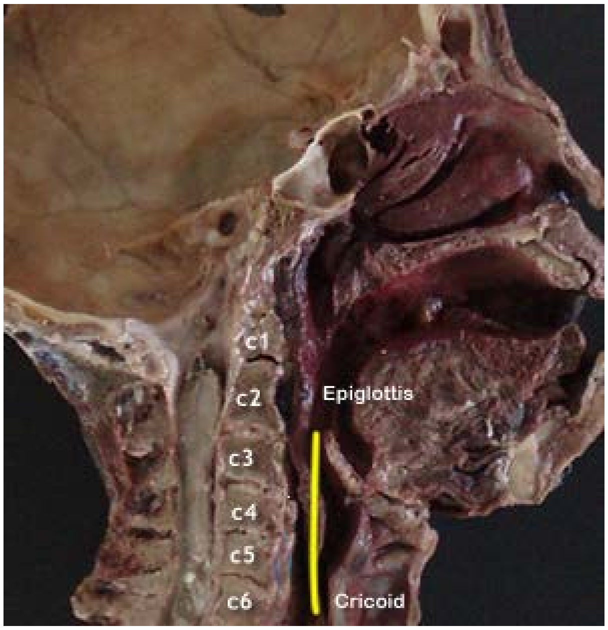
Innervation: Glossopharyngeal.

Clinical importance: Tonsillitis.

Laryngopharynx

Relations and boundaries:

- *Anterior:* Larynx, note piriform recess.
- *Posterior:* c4,5,6
- *Superior:* Oropharynx
- *Inferior:* Esophagus
- *Lateral:* Neurovascular structures of the neck



Blood supply: Ascending pharyngeal, superior thyroid arteries

Innervation: Vagus nerve

Clinical importance: Foreign bodies in the piriform recess, pharyngeal diverticulae.

Applied Anatomy

Post nasal space tumors

- Occur in nasopharynx
- Among **commonest** head and neck tumors
- Usually start from the **pharyngeal recess**
- Block choane and present with breathing difficulty
- Compress the lower cranial nerves
- Present with difficulty in swallowing (**dysphagia**) and **dysphonia**

Adenoids

- These are enlarged **pharyngeal tonsils**
- Common in children
- Obstruct choane
- Impair nasal breathing
- Block **eustachean tube** and cause giddiness

Tonsillitis

- Inflammation of the **palatine tonsils**
- A **common ENT** problem
- Pain often referred to the ear because of common innervation by **glossopharyngeal nerve**
- Present with pain and difficulty in swallowing
- Causes inflammation of **submandibular** and especially **jugulo-digastric** (tonsillar) nodes

Killihans Dehiscence

- A weak part between the **thyropharyngeus** and the **cricopharyngeus** (considered by others to exist between the inferior constrictor and esophagus).
- **Pharyngeal mucosa** can herniate through this part and enlarge to form a **pharyngeal diverticulum** .
- The pouches or diverticulae are impotant clinically because:

(+) Food particles can lodge here
(+) Gastroscope can enter and perforate.

Piriform Recess

- A recess in the lateral aspect of **laryngo-pharynx**
- **Foreign bodies** e.g. fish bones, pea nuts can lodge there.
- Favourite hiding place for tumours.
- **Internal laryngeal nerve** in the wall can be injured.

Cancer of the tongue

- Commonly spreads via **lymphatics** and hence the importance of studying the pattern of lymphatic drainage

Palate

- The mucosa is tightly adherent to bone therefore 'pimples' are very painful
- A site of **congenital malformations - cleft palate**

Swallowing problems

- These can arise from

  a) Local problems in the **food passages** - pharynx and esophagus

  b) **Adjacent areas/ structures** e.g. enlarged thyroid, retropharyngeal abscess and tumors

  c) Damage to **cranial nerves**: 9,10, 12

  d) **Brain stem** lesions

Anatomical spaces delineated by fascial planes represent potential vertical highways for spread of pathological processes

Pharyngeal mucosal space

- Located superficially along pharyngeal mucosal walls
- Includes mucosa of pharynx, waldeyers ring, cartilaginous Eustachian tube. Pharyngobasilar fascia, levator and constrictor muscles
- Represents superficial layer in which tumors often develop before they spread to deeper structures

Parapharyngeal space

- Extends from skull base to hyoid bone
- Contains **fat**, branches of **trigeminal nerves** and **pterygoid veins**
- Tumors in this space spread very rapidly

Carotid space

- Major vertical highway
- Extends from skull base to aortic arch
- Contains **carotid arteries**, **internal jugular vein**, **cranial nerves 9-11** and **deep cervical nodes**
- Encasement of carotid arteries may tender tumors inoperable

Retropharyngeal space

- Potential midline space
- Extends from skull base to T3

Nasopharyngeal carcinoma

- Arises from the **fossa of Rossen Mueller**
- Presents with **unilateral otitis media** or **mastoiditis**
- Spreads along s**pinal accessory chain of nodes** in posterior triangle of neck

Symptoms

Symptom	Anatomical basis
A lump in the neck	Lymph node involvement Direct spread
Hearing Loss or ringing sounds in the ear	Blocked auditory tubes
Fluid collection in the ear	Blocked auditory tube
Blocked stuffy nose	Choanal obstruction
Blood stained nasal discharge	Discharge from tumor in nasopharynx
Numbness in face	Cranial nerve compression
Difficulty in swallowing	Compression of palate, oropharyx
Change in voice e.g. hoarseness	Compression of vagus nerve
Double vision	Compression of cranial nerve 3,4,6

Review Questions

1. Give an account of the attachments, innervation (motor and sensory) blood supply and lymphatic drainage of the tongue.
2. Describe the location, relations, blood supply, innervation and lymphatic drainage of the palatine tonsil.
3. Describe the extents, relations, blood supply, lymphatic drainage and innervation of the various parts of the pharynx.
4. Give an account of the parts, relations and sites of muscle attachments on the mandible.
5. Briefly describe the process of chewing.
6. Describe the events, muscles and nerves involved in swallowing. Add notes on neural control of the process
7. Give an account of the muscles, nerves, blood vessels of the palate. Add brief notes on cleft palate

Chewing

Action	Muscles	Nerve supply
Biting off food with incisors	Masseter, temporalis, medial pterygoid	V3
Tearing with canines	Temporalis	V3
Grinding movements:		
• **Elevation**	Masseter, temporalis, medial pterygoid	V3
• **Depression**	Digastric, Mylohyoid, Geniohyoid	V3,V3 C1 (Ansa cervicalis)
• **Forward**	Lateral pterygoid	V3
• **Backward**	Temporalis (posterior fibres)	V3
• **Molar movements**	Alternate the above, one side to the other	V3
Storing, filling and emptying vestibule	Buccinator	vii

Salivation from:

• Parotid gland	ix
• Submandibular gland	vii
• Sublingual gland	vii

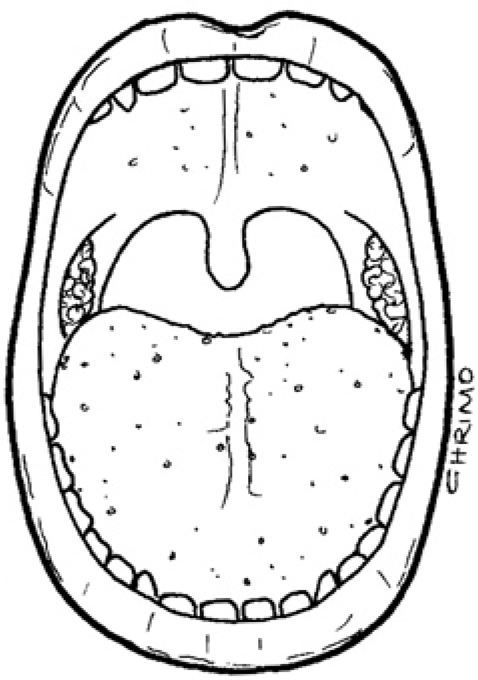
Swallowing

Tip of tongue pushes bolus posteriorly	Genioglossus; superior longitudinal and transverse intrinsic muscle	xii
Elevate tongue	Styloglossus, palatoglossus	xii, Pharyngeal plexus
Tense soft palate against passavant's ridge	Tensor palati	V3
	Stylopharyngeus	ix
Hyoid moves anteriorly to open pharynx	Geniohyoid	C1 (ansa cervicalis)
Larynx raised	Thyrohyoid	C1(ansa cervicalis)
Epiglottis tipped down	Stylopharyngeus	ix
Stripping wave on posterior pharyngeal wall	Palatopharyngeus	Pharyngeal plexus
Oropharynx closed off	Superior constrictor	Recurrent laryngeal nerve
Larynx closed	Aryepiglottis	
Hyoid pulled back	Infrahyoids	Ansa cervicalis (C1,2,3)

Bolus pushed down by supero-inferior wave	Constrictors (three) especially cricopharyngeus	Pharyngeal plexus

25.1 Organisation of the pharynx

The tongue



Position:

- Floor of the mouth

Parts:
Roof:

- Portion attached to floor of the mouth

Body:

- Part in the oral cavity

Tip:

- Apex pointing anteriorly

Surfaces & Features

Dorsum

- Divided by V-shaped sulcus terminalis into anterior pre-sulcal part and posterior post-sulcal part.
- Apex of the V points backwards. Foramen caecum is at the apex

Roughened by:

- **Circumvallate papillae** infront of sulcus terminalis
- **Foliate papillae** on each side of the tongue

- **Conical papillae** parallel and posterior to sulcus terminalis
- **Fungiform papillae** over tip and sides
- **Filiform papillae**, covering presulcal part
- Post sulcal part has elevations consisting lingual tonsils

Ventral / inferior surface

Shows the following features

- Frenulum linguae- median mucosal fold connecting the tongue to the floor
- Deep lingual vein on each side parallel to the midline
- Plica fimbriata lateral to the vein turning towards the apex

Muscles of the tongue

Intrinsic muscle- alter the shape of the tongue:

- Inferior and superior longitudinal
- Transverse
- Vertical

Extrinsic muscles of tongue

Muscle	Origin	Insertion	Action
Genioglossus	Superior genoid tubercle of mandible	• Substance of corresponding half of tongue • Hyoid bone	• Lower fibres protrude • Tongue depression
Hypoglossus	Greater horn and body of hyoid	• Posterior half of side of tongue • Interdigitate with styloglossus	Draws side of tongue downwards
Styloglossus	Styloid process Stylohyoid ligament	Whole length if side of tongue Intedigitates with hyoglossus	Draws side of tongue upwards and backwards

Palatoglossus	Lower surface of palatine aponeurosis	Posterior part of the side of the tongue	Bilaterally pull tongue upwards to constrict fauceal isthmus

Blood supply

Arterial

- Deep lingual artery- body and tip
- Dorsal lingual- pharyngeal part and dorsum
- Unilateral supply
- Little anastomosis across midline

Venous

- Dorsal lingual veins
- Deep lingual veins
- These join to form lingual vein- common facial vein or internal jugular vein

Innervation

Taste

- Anterior 2/3- Facial nerve (**Chorda tympani**, CN VII).
- posterior 1/3- **Glossopharyngeal nerve** (CN IX)

General sensation

- Anterior 2/3- **Lingual nerve** which is a branch of V3 of the Trigeminal nerve CN V.
- Posterior 1/3 -**Glossopharyngeal nerve** (CN IX).

Muscles

- All intrinsic and extrinsic muscles of the tongue are supplied by the **Hypoglossal nerve** (CN XII),
- Except for one of the extinsic muscles, **palatoglossus**, which is inervated by **pharyngeal plexus**.

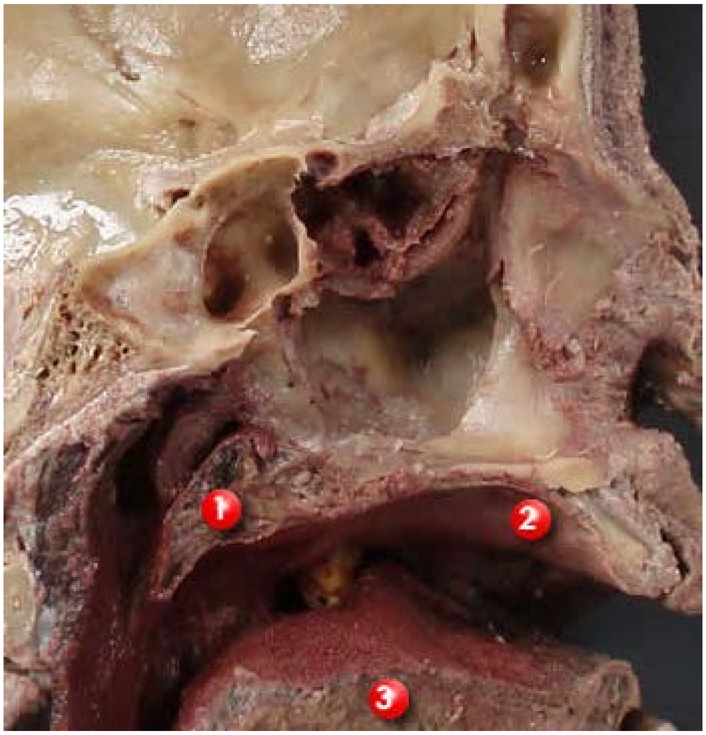
Lymphatic drainage

Part	Nodes
Tip and ventral surface	• Sub mental • Sub mandibular • Jugulo digastric
Side of presulcal part	• Submandibular • Jugulo-omohyoid • Jugulo-digastric
Post sulcal part (Bilateral drainage)	• Jugulo-digastric • Sub mandibular • Retropharyngeal

OGanatomy J. Ogengo palsoftweblink

Learning points | Core anatomy | Applied anatomy | Review questions

Hard Palate



Hover to show names

Components	Arteries	Veins	Innervation	Lymphatics
Hard Palate				
• Palatal process of maxilla • Horinzontal plate of palatine bone	• Greater palatine artery from maxillary	• Correspond to artery • Pterygoid plexus • Pharyngeal plexus	• Maxillary nerve • Greater palatine • Nasopalatine	• Retropharyngeal nodes • Deep cervical nodes
Soft Palate				
• Palatine aponeurosis • Attached muscles	• Lesser palatine from maxillary artery • Ascending palatine from	• Pharyngeal venous plexus • Pterygoid venous plexus		• Retropharyngeal nodes • Upper deep cervical nodes

facial artery
- Palatine branches of ascending pharyngeal

Muscles of hard palate

Muscle	Origin	Insertion	Action
Tensor palati	• Scaphoid fossa • Lateral side of auditory tube • Spine of sphenoid	• Palatine aponeurosis	• Tense palatine aponeurosis
Levator Palati	• Inferior surface of petrous temporal bone • Medial side of auditory tube	• Palatine aponeurosis	• Pull palate upward and backward
Palatoglossus	• Palatine aponeurosis	• Side of tongue interdigitating with styloglossus	• Raises tongue • Narrow transverse diameter of isthmus
Palatopharyngeus	• Anterior head from hard palate and palatine aponeurosis • Posterior head from palatine aponeurosis	• Lateral wall of pharynx • Merge with inferior constrictor • Thyroid lamina	• Elevates larynx and pharynx
Muscularis uvulae	• Posterior nasal spine of palatine bone	• Mucosa of uvula	• Palatopharyngeal muscle

Pharyngeal plexus of nerves

Contributors:

- Vagus nerve (motor and sensory)
- Glossopharyngeal (sensory)
- Sympathetic nerves from superior cervical ganglion.

Location: Surface of pharynx

Distribution: Palate and pharynx (constrictors)

Piriform recess (fossa)

Location: Each side of pharynx.

Clinical importance:

- Foreign bodies e.g. fish bones, pea nuts can lodge there.
- Favourite hiding place for tumours.
- Internal laryngeal nerve in the wall can be injured.

Retropharyngeal space

Location: Behind the pahrynx.

Relations:

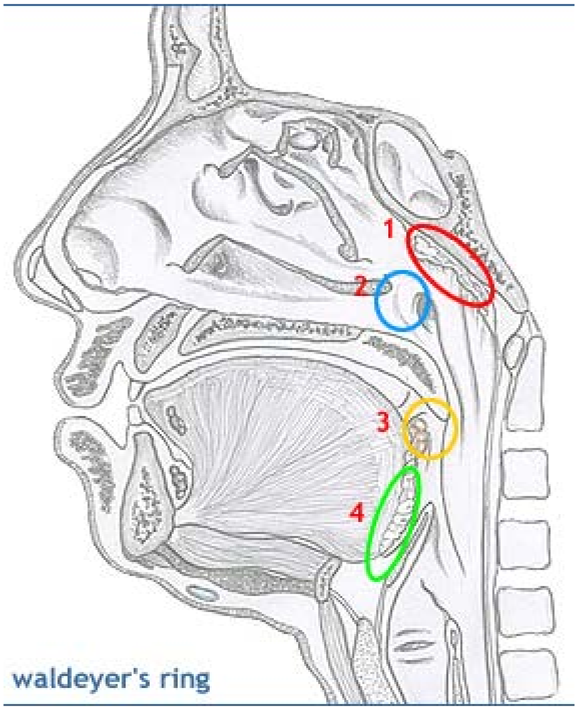
- Anterior: Posterior wall of pharynx.
- Posterior: Prevertebral fascia.
- Laterally: Carotid sheath and sympathetic chain.
- Contents: Loose areola tissue and retro pharyngeal lymph nodes.
- Clinical importance: Retropharyngeal abscess, from infection.

Waldeyer's lymphatic ring

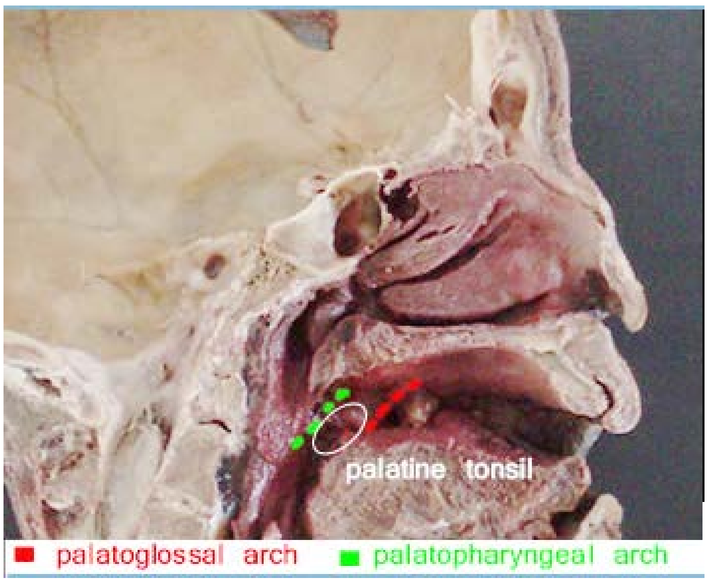
Components: Pharyngeal, tubal, palatine and lingual tonsils. They have no afferents.

Connections: Retro pharyngeal, styloid, lateral pharyngeal, jugular chain, submandibular, submental.

Function: Protection.



Palatine tonsils



Location: Lateral wall of pharynx.

Relations:

Anterior: Palatoglossal fold

Posterior: Palatopharyngeal fold

Superior: Soft palate

Inferior: Dorsum of tongue

Lateral: Superior constrictor, facial and lingua; arteries

Blood supply:

- **Tonsilar branches** of:

  (+) Facial
  (+) Lingual
  (+) Ascending pharyngeal
  (+) Maxillary.
  (+) Palatine

  Most of these enter the lower half of the tonsil but the descending palatine enter the upper pole and may cause troublesome hemorrhage.

Veins form **tonsilar plexus** which enters **pahryngeal plexus** to internal jugular and therefore communicate with the **cavernous sinus.**

The external palatine vein descends from soft palte and can cause troublesome bleeding.

Lymphatic drainage: Superior deep cervical especially jugulodigastric and retro pharyngeal nodes.

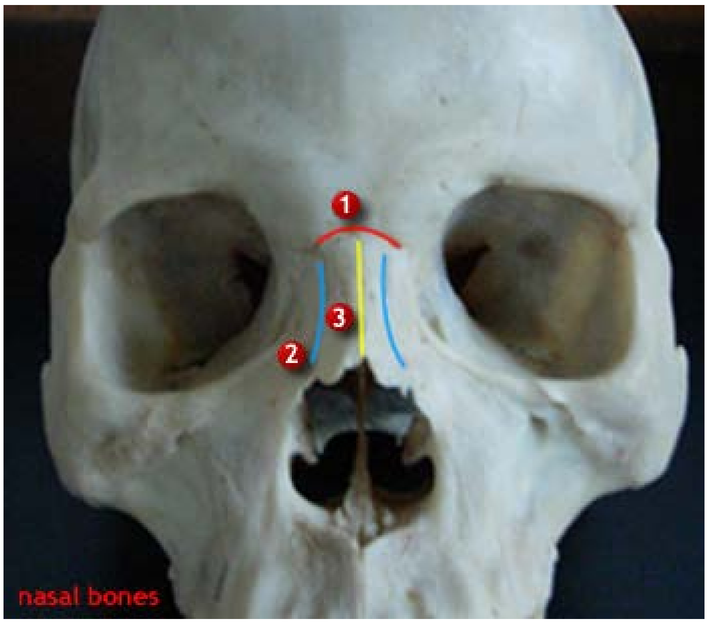
Innervation: Glossopharyngeal and lesser palatine.

Clinical importance: Tonsilitis, tonsillectomy, tonsillar abscess, referal pain to the ear; retro pharyngeal abscess.

Organization of the Nose and Paranasal Sinuses

External nose

Skeleton



- Frontal process of maxilla
- Nasal part of frontal bone
- Nasal bones
- Nasal cartilages

Parts

Root: part and continous with forehead.

Apex: Tip.

Dorsum Nasi: crest between the root and tip.

Ala: Flaved lower part of the side of the nose.

Skin

Tightly adherent to the cartilage over the tip and alae but loose elsewhere.

Innervation

Mainly the opthalmic nerve.

Blood supply

Angular, Dorsal nasal, superior labial branches of the facial artery.

Applied Anatomy

- **Epistaxis** is a common problem due to vessel rupture in the **Little's area** in the antero inferior part of the nasal septum and site of anastomosis between superior labial, spheno palatine and anterior ethmoidal. Usually treated by cauttery or ligation of the vessels.
- **Rhinitis**: Inflammation of the nasal mucosa. Could be caused by allergy and infection. Treatment is by treating the cause, anti-inflammatories and anti-histamines
- **Endoscopic sinus surgery**: The site of opening of the sinus in to the meatus is important during introduction of instruments into the sinuses during endoscopic surgery.
- Infections in the nose commonly spreads to the sinuses through openings in the meati. This causes sinusitis.
- **Sinusitis**, inflammation of the sinus is a common ENT problem. The mucosa of the paranasal sinuses gets inflamed and the sinus filled with fluid. Presentation is severe pain around the eye since the sinuses sorround the orbit.

Nasal cavity

Osteomeatal complex

Comprises of :

1. Infindubulum
2. Uncinate process
3. Ethmoidal bulla
4. Hiatus semi-lunaris
5. Middle meatus
6. Middle conchae

Represents a common drainage point for the anterior sinuses namely:

1. Frontal
2. Ethmoid
3. Maxillary

Strategic point at which **lesion** can **obstruct** the **anterior sinuses**.

The Nasal Cavity and Paranasal Sinuses

Review Questions

---

1. Give an account of the location , relations , blood supply , innervation , lymphatic drainage and applied anatomy of the maxillary air sinus
2. Give an account of the location , relations and innervation of the other sinuses
3. Give an account of the blood supply , lymphatic drainage and innervation of the various walls of the nasal cavity . Add brief notes on the various structures that open into the three meati in the lateral walls of the nasal cavity .

The Nasal Cavity and Paranasal Sinuses

Learning points | Core anatomy | Applied anatomy | Review questions

Case Stories

CASE

A 21-year-old fell off his motorcycle and struck the side of his face on the murram road. When seen at the Emergency clinic, he was found to have a bruised and swollen left cheek. There was a subconjuctival hemorrhage in the left eye, and the lower orbital margin and maxilla were tender. Sensation, over the left cheek was normal. The initial radiograph taken at the clinic did not show a fracture of the maxilla, but there was a fluid level of blood in the left maxillary air sinus. He was therefore presumed to have a fracture involving the maxilla. It is important to examine the sinuses of radiographs of injured patients, because sometimes an opaque sinus will be the only clue to bony injury. His facial swelling subsided during the subsequent weeks, and further radiographs failed to show the fracture. The floor of the orbit was stable and he did not develop double vision. Sensation remained normal over the cheek, indicating that the Infraorbital nerve had not been damaged. The student should test for double vision and cheek sensation whenever he is presented with an injury to the front of the face. A repeat radiograph 6 weeks after the injury showed that the blood had cleared from the maxillary sinus.

CASE

A 40-year-old nurse, caught a cold from her ward. She remained in bed for a week and then decided to start work again. She developed a severe left-sided frontal headache, and pain below the left eye. When seen at the local health center, she had pyrexia and was tender over both the left maxillary and left frontal sinuses. A radiograph showed that the left maxillary sinus was opaque and that there was a fluid level in the left frontal air sinus. She was given a course of antibiotics, and made some improvement. Over the course of the next few weeks, the frontal sinusitis cleared, but the maxillary sinus remained full. She was referred for proof puncture and antral lavage. (Maxillary air sinus is often called antrum by the ENT surgeon). Proof puncture was done under local anaesthetic. A trocar and cannula were driven through the thin bone beneath the inferior turbinate into the maxillary sinus. The trocar was removed, and a syringe attached to the cannula.

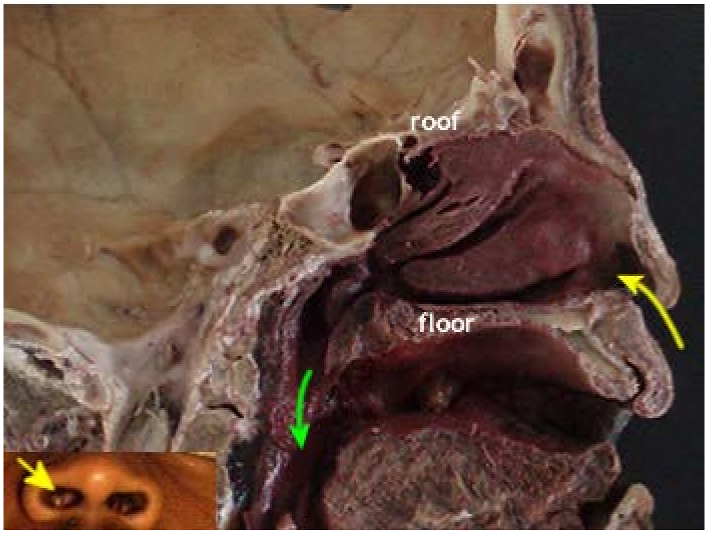
Pus was aspirated and a specimen sent for culture and antibiotic sensitivity. A syringe was then attached to the cannula and the sinus was washed out with sterile saline at body temperature. This procedure blew open the opening of the maxillary sinus and washed out the sinus. At the end of the operation, a polythene tube was inserted through the cannnula into the sinus and left in place. The nursing staff washed out the maxillary antrum3 times daily for the following 2 days, by which time it was clear.

CASE

A 46-year-old chronic alcoholic vagrant, presented himself at the emergency unit with a swollen and inflamed forehead. On examination, there was bony tenderness of the forehead and both maxillae. He was pyrexial. A radiograph showed that both maxillae were opaque; there was also opacity of the left ethmoidal and frontal sinuses. The frontal bone had a fluffy appearance, indicating spread of infection from the sinus to bone. He therefore had frontal osteomyelitis (inflammation of bone).He was admitted for an intensive course of antibiotics and for rehabilitation. He was discharged after 3 weeks of treatment in a reasonably fair state of health, but was seen a few weeks later in the emergency with hepatitis.

The Nasal Cavity

Extent



External opening: Nostril

Posterior opening: Choanae

Inferior: Hard palate

Superior: Anterior part of cranial base

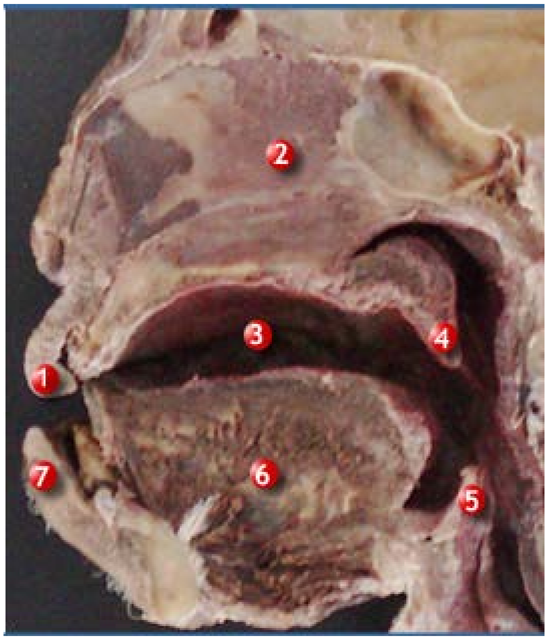
Subdivisions of each nasal cavity

- Vestibule : Between the alae and septum. Lined by skin with vibrissae to filter coarse particles.
- Respiratory portion : Most of the nasal cavity lined by respiratory epithelium
- Olfactory portion: Area over superior concha and superior part of nasal septum. Lined by olfactory epithelium.

What are the microscopic differences between olfactory adn respiratory epithelium?

Walls of nasal cavity

- Floor: The palate
- Roof: Frontal bone, nasal bone, cribriform plate of ethmoid, body of sphenoid.
- Medial wall: Nasal septum
- Lateral Wall:
  - Bones: Nasal, lacrimal, maxilla (alar and lateral cartilages)
  - Conchae: Superior and middle are parts of the ethmoid bone. Inferior is a separate bone.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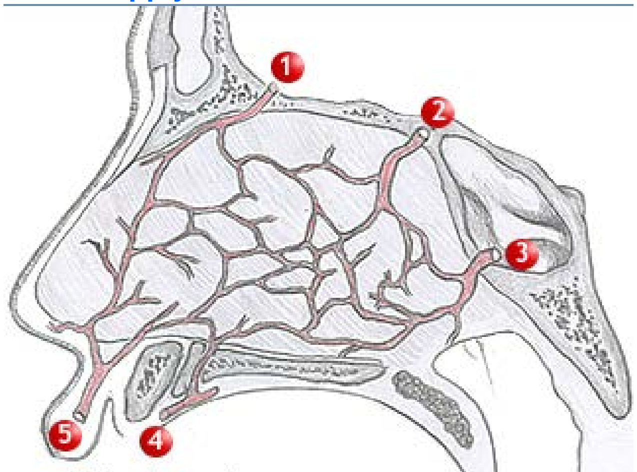
The Nasal Cavity

Blood supply



nasal blood supply

Arteries:

Hover over the hot points in the diagram to get the names of the arteries

- There is an extensive anastomosis in the anteroinferior part of the nasal septum. This is called Little's area. It is a frequent site of nasal bleeding (epistaxis).
- More serious bleeding from the nose may arise while vessels are large, just after they have entered the nasal cavity.

The Veins:

- They drain from a venous plexus, especially well developed over the inferior concha.They accompany the arteries for most part.
- Plexus sometimes communicates with the superior sagittal sinus through emissary veins passing through foramen ceacum.

Vessels of the nasal cavity

The arteries are derived from the opthalmic (stemming from the internal carotid) and maxillary (stemming from the external carotid).

Opthalmic artery:

- Anterior ethmoidal artery.It supplies the lateral wall and the septum.

Maxillary artery:

- Sphenopalatine artery. It supplies the lateral wall and septum.

The veins accompany the arteries

An emissary vein to the superior sagittal sinus inside the cranium sometimes connects the venous plexus. The emissary vein traverses foramen ceacum when the latter is patent.

Lymphatics

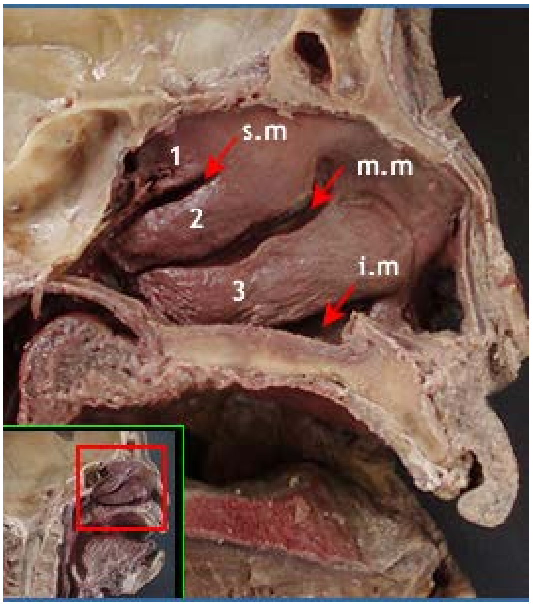
This is via the following nodes:

- Deep cervical

Submandibular

- Retropharyngeal

Nasal conchae



Three conchae

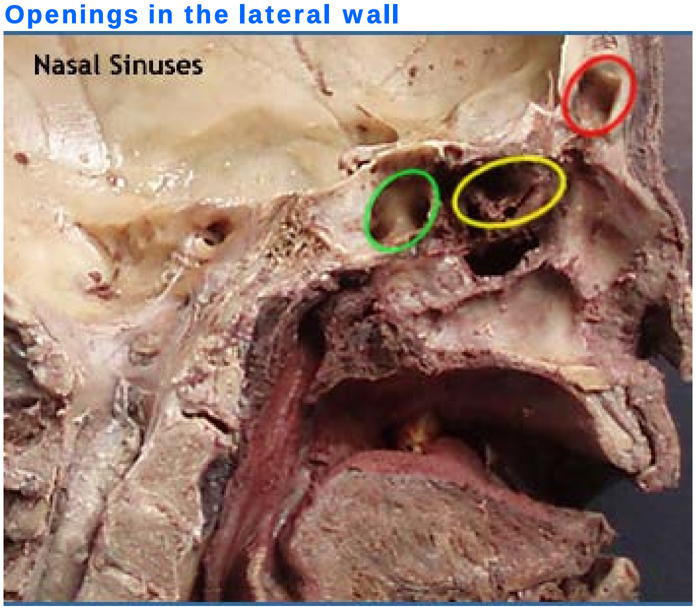
- Superior (1)
- Middle (2)
- Inferior (3)

Superior and **middle** are parts of **ethmoid**. The inferior one is a separate bone.

Between the conchae are **meatuses** with openings of the **paranasal sinuses.**

- Superior meatus (s.m)
- Middle meatus (m.m)
- Inferior meatus (i.m)

Openings in the lateral wall



Superior meatus:	Middle meatus:	Inferior meatus:
• Sphenoidal sinus • Posterior ethmoidal cells	• Frontal • Anterior ethmoidal • maxillary • middle ethmoidal	Nasolacrimal duct

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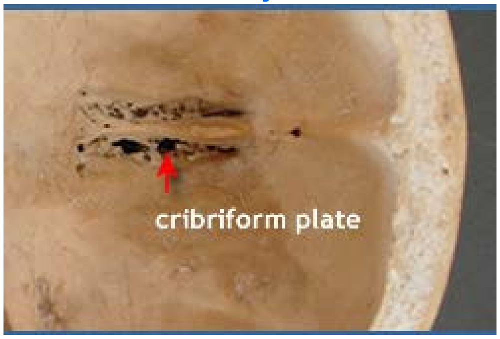
Lining of the nasal cavity

- The walls and septum are lined with mucosa except the vestibule, which is lined with skin.
- The mucosa is closely adherent to the periosteum or perichondrium. The fused layers form either the **mucoperiostium** or **mucoperichondrium**, which may easily be stripped off bone or cartilage .
- The mucosa contains numerous glands and venous plexuses.
- The veins tend to become engorged when irritated and then tend to block the nasal passages.

Nerves of the nasal cavity



Special sensation: The olfactory region is supplied by **olfactory nerves**. They run a short course, passing through the **cribriform plate** to reach the olfactory bulb.

26.2 Paranasal Sinuses

Location

Four paired sinuses

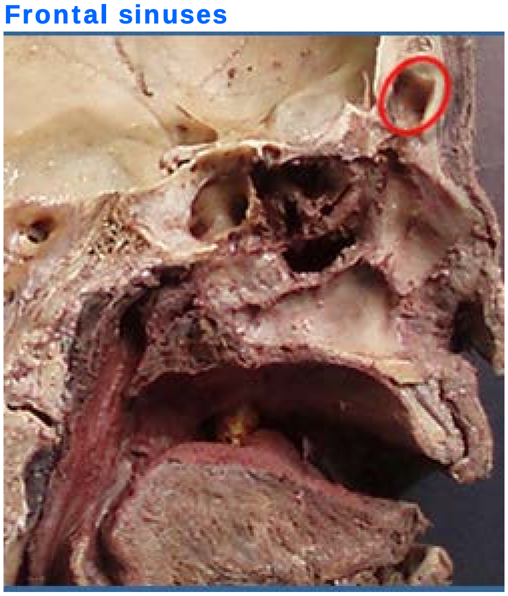
- Maxillary
- Ethmoidal
- Frontal
- Sphenoidal

The cavities are in the facial bones and communicate with the nasal cavity

Functions

- Contribute to the warming and humidifying of inspired air
- Allow enlargement of the viscerocranium thus minimizing increase in bone mass
- Determine position of eyes and nose

Frontal sinuses



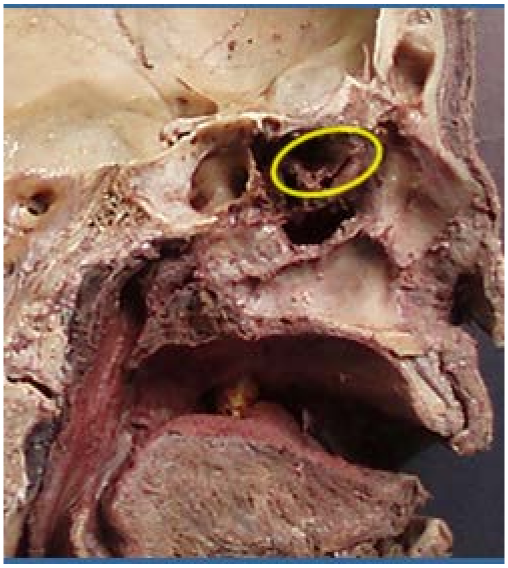
- Irregular cavity extending up into the diploe of the frontal bone.
- The left and right separated by a thin bony septum separates the two.
- May extend backwards into the roof of the orbits
- Each drains via the infundibulum into the middle meatus

Ethmoidal air cells

- In the ethmoid bone
- Three sets of air cells:

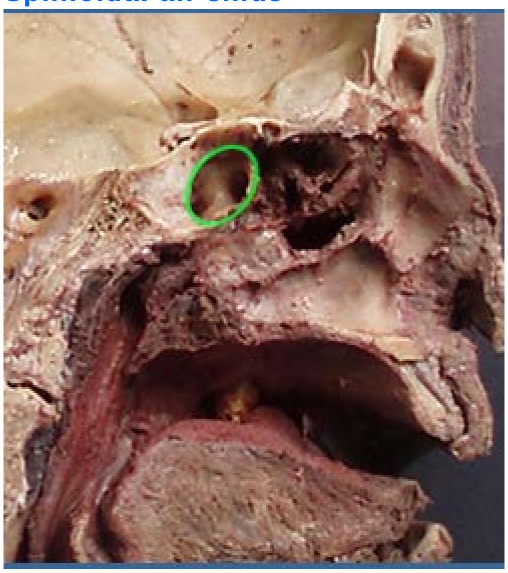
1. anterior,
2. middle and
3. posterior ethmoidal air cells.

- Anterior and middle opens in to middle meatus



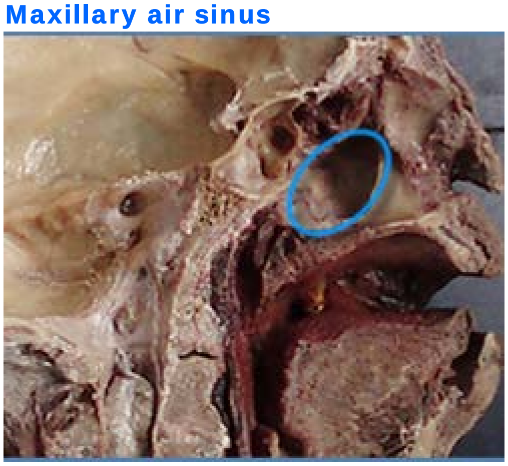
- Posterior opens in to superior meatus

Sphnoidal air sinus



- Lies within the body of the sphenoid bone
- Divided into two halves by a bony septum
- Each opens into superior meatus

Maxillary air sinus



- Pyramidal cavity in the **body of the maxilla**,
- Below the **floor of the orbit**.
- Base is formed by the **lateral wall of the nasal cavity**
- Apex lies in the **zygomatic process of the maxilla**.
- The anterior and posterior walls are the corresponding walls of the maxilla.
- The roots of maxillary teeth lie just beneath the floor. They may even penetrate the bony floor to lie beneath the mucosal lining of the sinus.
- The **opening near roof**, so that in the anatomical position **drainage is hindered by gravity.**
- It **opens** in the posterior part of the **middle meatus.**

Summary of relations

Relation	Maxillary	Frontal	Ethmoidal	Sphenoidal
Superior	• Orbit & Contents	• Anterior cranial fossa	• Frontal and Lacrimal bone	• Pituitary gland
Inferior	• Alveola of maxilla	• Orbit	• Cribriform plate	• Roof of nasopharynx
Medial	• Nasal cavity	• Septum separating from its fellow	• Nasal cavity	• Separated from fellow by septum
Lateral	• Zygoma	• Greater wing of sphenoid	• Orbit	• Carvenous sinus and its contents
Anterior	• Cheek	• Forehead eyebrow	• Nasal bone	• Orbit
Posterior	• Infratemporal pterygopalatine fossae	• Lesser wing of sphenoid	• Body of sphenoid bone	• Posterior cranial fossa and pons
Condition at Birth	• Present	• Absent	• Present	• Present
Time of appearance		2nd year		

Summary of neurovascular supply

Sinus	Arteries	Veins	Lymph nodes	Nerves
Maxillary	• Facial, • Maxillary, • Infraorbital • Greater palatine	• Facial • Pterygoid	• Sub-mandibular	• Infraorbital • Superior alveolar
Frontal	• Supraorbital • Anterior Ethmoidal	• Superior ophthalmic	• Submandibular	• Supraorbital
Ethmoidal	• Supraorbital	• Superior	• Submandibular	• Supraorbital

	• Anterior ethmoidal • posterior ethmoidal • sphenopalatine	ophthalmic	• Retropharyngeal	• Anterior ethmoidal • Posterior superior nasal, • Orbital twigs from pteryngopalatine ganglion
Sphenoidal	• Posterior ethmoidal	• Superior ophthalmic • Carvenous sinus	• Retropharyngeal	• Posterior ethmoidal •

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task ***Tabulate each sinus, blood supplies, innervation and lymphatic drainage***

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palsoftweblink

The Larynx and the Ear

Learning points | Core anatomy | Applied anatomy | Review questions

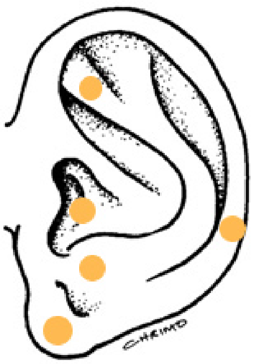
The organization of the ear

The external ear

onsists of the auricle and the external auditory meatus

Hover over the parts

The Auricle : **Parts**



Functions

Collects sounds waves, and directs them into the external auditory meatus.

Neurovascular supply of Auricle

Arteries	Veins	Lymphatics	Innervation
• Superficial temporal artery • Posterior auricular artery.	• Superficial temporal vein • Posterior auricular vein • Drain into the external jugular vein.	• Superficial parotid lymph nodes • Retro auricular lymph nodes • Deep cervical lymph nodes • Superficial cervical nodes	• Auricular branches of facial, glossopharngeal and vagus • Auriculotemporal • Great auricular

Applied Anatomy

External auditory meatus

- The external acoustic meatus is narrow at the medial end of its cartilaginous portion. This constriction is called the **isthmus** . **Foreign bodies** e.g. beans inserted in the meatus usually become lodged in this isthmus.
- Because of its *sigmoid shape*, instruments are most steadily inserted into the EAM by **pulling** the auricle **posterior superiorly**. This pulling straightens the EAM.
- The lateral third is lined by **skin**, while the medial 2/3 is lined by stratified squamous epithelium. Both are **tightly adherent** to the cartilage and bone. Therefore **pimples** in the EAM are **painful**.
- The EAM has **ceruminous glands**, which produce waxy material (cerumen). This prevents maceration or softening of the EAM.
- **Cleaning** of the **EAM** stimulates the vagus nerve and may cause **bradycardia and / or vomiting.**

Tympanic membrane

- **Perforation** of the tympanic membrane may result from foreign bodies, excessive pressure, or infection. **Deafening** may occur.
- **Skull fractures**, may be accompanied by **meningeal tear** and perforation of tympanic membrane. In this case, severe bleeding and/or escape of CSF through the ruptured membrane, and external auditory meatus (**CSF otorrhea**) occur.
- Sometimes, a fracture may involve the bony part of the external auditory meatus, and cause bleeding and/or loss of CSF via external auditory meatus, even when the tympanic membrane is intact.
- When the **tympanic membrane**, has to be **incised** e.g. to drain pus from the tympanic cavity; the incision is made postero inferiorly . This is because the superior part is more vascular, and the **chorda tympani** nerve and ear ossicles may be damaged.
- Inflammation in the tympanic cavity is called **otitis media**. It (the infection) may spread to the **mastoid antrum**, or through **meningitis and / or cerebritis** and even a **brain abces**s. Through veins, the infection may also reach the superior petrosal, sigmoid, and the other **venous sinuses**.
- **Ear ache**, may be **referred** from distant sites from distant sites e.g.:
  - The **oral cavity**-tongue, dental abcess e.t.c, via the Mandibular nerve
  - **Pharynx**, including palatine tonsils via the glossopharyngeal nerve.
  - **Larynx**, via the vagus nerve.

Earache due to **otitis media** is not worsened by **movements of tragus** in adults (it may be in infants and children). However, because the cartilage in the tragus is continous with that in the external acoustic meatus; the pain of otitis externa is made much worse by movement of tragus.

The **auditory tube** forms a route through which **infections** may pass from the **nasopharynx** to the **tympanic cavity**, especially in babies.

Swelling of its **mucous membrane** easily blocks the auditory tube. When this happens, residual **air in the tympanic cavity** is usually absorbed into the mucosal blood vessels. This results in lowering of pressure in the tympanic cavity; retraction of the tympanic membrane, and interference with its movement. This **affects hearing**. Fluid may exude into the tympanic cavity (**serous otitis**).

Outstanding Auricle / Bat Ear

These are **unduly prominent ears**. This feature becomes less prominent with development of mastoid process. In marked cases. Plastic surgery is performed.

Congenital Aural Fistulae

This is an opening usually found in the helix or tragus. It leads to a fine blind canal. It is a **remnant of the 1st branchial cleft**. It may block and lead to a cyst or abscess. Treated by excision

Hematoma of auricle

Results from injury. **Blood** accumulates under the **perichondrium** forming a swelling on the lateral or anterior surface of the auricle. Considerable pain is experienced. Inflammation may result in destruction of cartilage and finally swelling of the auricle

Otitis Externa

- A **diffuse inflammation** of the **external auditory meatus**. Most common mode of infection is by scratching / poking the ears with contaminated fingers/ objects. Common also with ill fitting hearing aids

- Because of tight adherence of skin to the cartilage/ bone, the condition is very painful
  A sense of heat is felt owing to the increased vascularity Soon thee walls of the meatus begin to weep, giving some relief to the pain

Impacted wax

Ear wax is sufficiently fluid to be removed at each washing. Accumulation is precipitated by:

- Undue **narrowness** of the passage
- Presence of **infection** in the meatus
- Excessive or **abnormally thick secretion**
- Presence of **foreign body**
- **Abnormal body / cartilaginous growth** causing blockage
- **Irregular / inappropriate cleaning** of ears.

Foreign bodies in the ear

- These are usually introduced by patients themselves especially children. They include:
- Inanimate objects such as beans and peas which swell with moisture or beads, buttons and shells which do not swell with moisture.
- Care must be taken when attempting removal as this may push them deeper. They may be harmless and remain there for years if the ear drum is not damaged.
- On the other hand, they may block the meatus and cause deafness or trigger inflammation. Some get badly infected.
- Animate foreign bodies include insects and maggots.
- Meatal Atresia and Stenosis
- Usually congenital but can be caused by chronic inflammation

Tympanic membrane

Traumatic rupture may be caused by:

1. Accidentaly pushing in objects
2. When attempting to clean
3. Fall on side of head
4. Slapping
5. Unskillful attempts to remove foreign bodies
6. A kiss on the ear
7. Forceful and careless syringing

Middle Ear

Otitis media refers to inflammation of the middle ear. Infection frequently spreads to middle ear from the pharynx through auditory tube. From the middle ear the infection can spread in various directions:

1. To the mastoid process to cause mastoiditis
2. To cranial cavity and cause meningitis, encephalitis and brain abscess
3. To the jugular vein leading to venous thrombosis
4. To the inner ear and cause labyrinthitis
5. To bone and cause osteomyelitis
6. Pharyngeal abscess secondary to otitis media may develop in two ways:

   Directly from tympanic auditory tube
   Indirectly through mastoid air cells or from an extradural abscess – the pus first forming in the suboccipital regiona deep to digastric muscle
   Caries of the ossicles: Caries and necrosis of the ossicles may occur in chronic otitis media

Tympanoplasty

Plast reconstruction of middle ear to overcome conduction deafness resulting from complications of otitis media

Otalgia

This is an ear ache. It can occur when ear is healthy. Because the ear is supplied by twigs from fifth, seventh, nineth and tenth cranial nerves, painful stimuli from the ear cause pain to be experienced in the ear for example:

- Disease of lower molars
- Throat diseases like tonsilits
- Diseases in the posterior cranial fossa
- Affections of sphenoidal sinuses
- Geniculate ganglionitis

Larynx

Injury to laryngeal nerves

Caused by

- Surgery such as thyroidectomy
- Compression by tumors
- Compression from goitre

Leads to:

- Weakening or paralysis of laryngeal muscles with consequent impaired voice production
- Anaesthesia of laryngeal mucosa, impairing protective reflexes. Foreign bodies may then easily enter the larynx

Cancer of larynx

- Common in smokers
- Presents with persistent hoarseness often associated with ear ache and dysphagia

Laryngectomy

- Removal of larynx may be performed in severe cases of laryngeal cancer
- Vocal rehabilitation is then accomplished by the use of electrolarynx, a tracheo-esophagel prosthesis or esophageal speech (regurgitation of inspired airs)

Age changes in the larynx

1) At puberty in boys because of testosterione the larynx enlarges due to :

- Enlargement of allcartilages
- Doubling of anteroposterior diameter doubles
- lengthening and thickening of Vocal folds

This growth accounts for pubertal voice changes

2) In **old age** say after 60 yrs, the large cartilages even **ligaments** may **ossify**. This may explain the voice changes occurring in old age/

Fractures of laryngeal skeleton

- These may occur in traffic accidents or sports
- Produce submucous hemorrhage and edema, respiratory obstruction, hoarseness and temporary inability to speak.

Laryngitis

Acute inflammation due to viral or bacterial infection or allergy may cause mucosal edema severe enough to cause dysphagia or aphonia (loss of voice)

The Larynx and the Ear

Review Questions

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1. Give an account of the various cartilages, ligaments, muscles and their actions of the larynx . Add notes on the blood supply, lymphatic drainage and innervation of the larynx.
2. Give an account of the parts, blood supply, innervation and lymphatic drainage of the external ear.
3. Describe the boundaries, relations, contents, communications, blood supply, innervation and lymphatic drainage of the tympanic cavity. Add notes on the applied anatomy of this cavity

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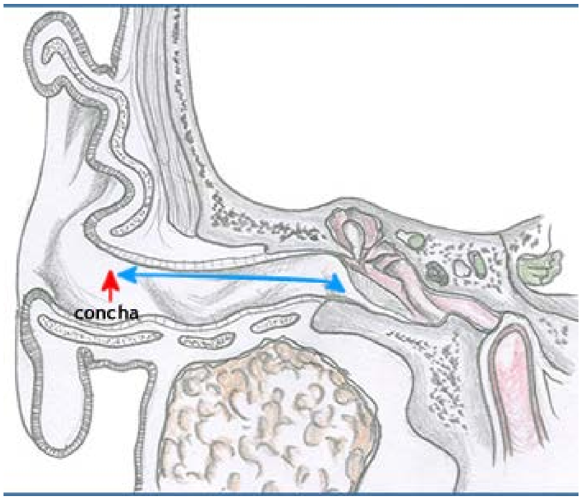
The external auditory meatus



- Extends from the concha to the tymphatic membrane.
- It is sigmoid.
- Lateral 1/3 is cartilaginous, whereas the medial 2/3 is bony. It is almost entirely cartilaginous in the infant.

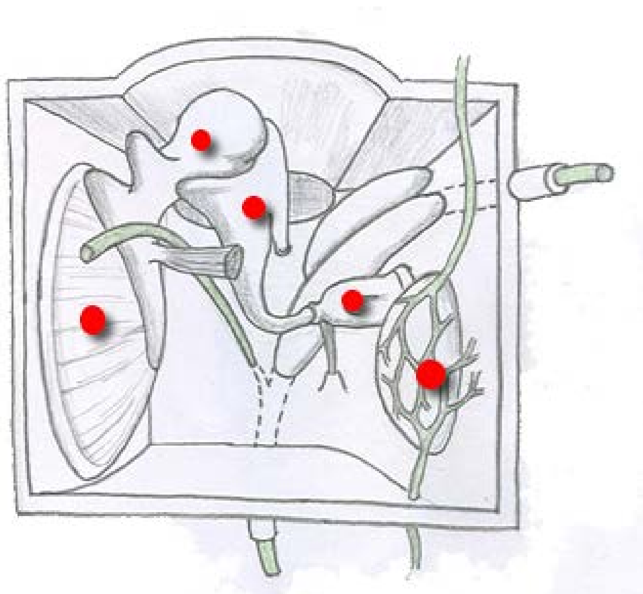
Neurovascular Supply

Arteries	Veins	Lymphatics	Innervation
• Posterior auricular artery, from the external carotid artery • Deep auricular branch of the maxillary artery • Auricular branches of the superficial temporal artery	• Posterior auricular vein • Deep auricular • Superficial temporal vein • Drain to external jugular and pterygoid venous plexus.	• Superficial parotid lymph nodes • Retro auricular lymph nodes • Deep cervical lymph nodes • Superficial cervical nodes	• **Posterior wall and floor:** Auricular branch of vagus (with contribution from the glossopharyngeal and facial) . • **Anterior wall and roof:** Auriculotemporal branch of Mandibular nerve.

The Middle Ear (Tympanic cavity)

- Is a cavity in the petrous temporal bone.
- It is shaped like a narrow, six-sided box, with convex medial and lateral walls.

Boundaries



Hover over the hotspots to show name

- **Roof (tegmental wall):** A thin plate of bone, called tegmen tympani; which separates the tympanic cavity from the dura matter of the middle cranial fossa cavity.
- **Floor (jugular wall):** Formed by a layer of bone, which separates the tympanic cavity from the superior bulb of the internal jugular vein
- **Lateral wall (membranous wall):** The tympanic membrane.

Medial wall (labyrinthine wall):	Posterior (mastoid wall):	Anterior (Carotid wall):
Separates the tympanic cavity from the inner ear. This wall has important features, namely: • The promontory: Is formed by the first turn of the cochlea. • Tympanic plexus: Of nerves lying on the promontory is formed by fibres of the facial, and glossopharyngeal nerve. • Two openings: Fenestra vestibuli and fenestra cochleae.	Separates the cavity from the mastoid antrum air cells. It has the following openings: • Aditus to the mastoid antrum or aditus ad antrum- mastoid antrum or air cells. • Pyramidal opening: For tendon of stapedius • Posterior chorda tympani canaliculus: Transmits the chorda tympani nerve.	Separates the cavity from the carotid canal, with its contained internal carotid artery. It has two openings: • Communicating with tensor tympani muscle canaliculae • Auditory tube (pharyngo-tympanic or Eustachian tube)

Contents

Nerves:

- Tympanic plexus: Formed by the fibres from facial and glossopharyngeal nerves.
- The general sensory fibres supply the tympanic cavity and the tympanic membrane.

- Chorda tympani: A branch of the facial nerve. Has two components:
  - Taste from the anterior 2/3 of the tongue
  - Parasympathetic fibres-SUBMANDIBULAR GANGLION-submandibular sublingual and small glands (via lingual nerve)

Muscles:

- The **stapedius**, attached to the stapes and the **tensor tympani** attached to the handle of the malleus.

- These muscles are innervated by the **facial** and **Mandibular nerves** respectively. They restrict movements of the ossicles, tense the tympanic membrane and **dampen loud sounds**.
- The auditory ossicles are malleus, incus and stepes.

The tympanic membrane:

- This is am thin, fibrous membrane, separating the external auditory meatus from the tympanic cavity.

- Covered with thin skin externally, and mucous membrane internally, it slopes inferomedially.

- Shows a concavity towards the meatus, with a central depression called the umbo.

- It moves in response to air vibrations.

Blood supply

- Deep auricular branch of the maxillary artery.

- Stylomastoid branch of the posterior auricular artery.

- Veins on the external surface – external jugular vein.

- Veins on the internal surface- transverse sinus, sigmoid sinus.

Innervation

- Internal surface: Tympanic plexus

- External surface:

  - Auriculotemporal nerve (upper part)
  - Auricular branch of vagus (with facial and glossopharyngeal)

The Larynx and the Ear

The Auditory (Pharyngotympanic) tube

Function

Equalize pressure in the middle ear, with atmospheric pressure by allowing free movement of the tympanic membrane.

Blood supply

- Ascending pharyngeal artery
- Middle meningeal artery
- Artery of the pterygoid canal

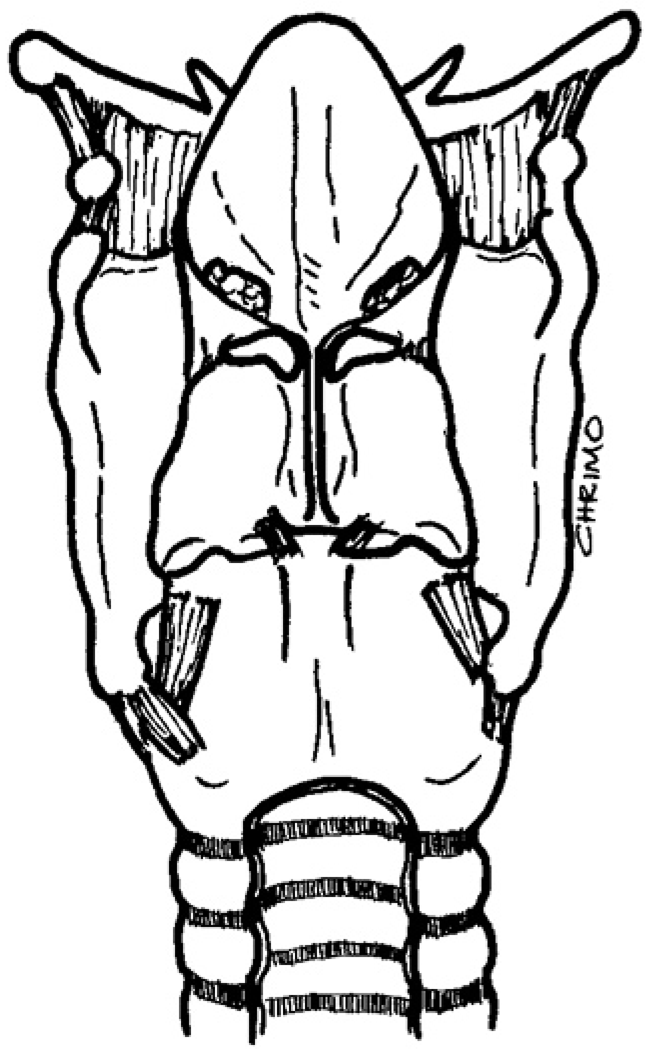
*Veins – pterygoid plexus.

Innervation

- Tympanic plexus
- Pterygopalatine ganglion

The cartilaginous part of the tube remains closed, except during swallowing or yawning. The tube is opened by simultaneous contraction of the tensor paliti and salpingo pharyngeus muscles, which are attached to opposite sides of the tube.

Larynx



Position

- Midline
- Antero superior neck
- Extends from root of tongue to trachea
- C3- C6
- Continues from oropharynx into trachea

Relations

Anterior : Skin, fascia, platysma, anterior jugular veins
Posterior: Laryngopharynx
Lateral:

- Lobes of thyroid
- Carotid sheath

Skeleton

Anterior wall:

(+) Epiglottis
(+) thyroid and cricoids cartilages
(+) hyoid bone

Posterior wall:

(+) Cricoid and arytenoids cartilages
(+) Small cartilages: Corniculate, cuneiforms and articial

Ligaments and membranes

- Thyrohyoid membrane
- Lateral and median thyrohyoid ligaments
- Cricothyroid membrane
- Cricotracheal ligament

Muscles of larynx

Extrinsic	Intrinsic	Anterolateral	Deep muscles

• Infrahyoid muscles • Suprahyoid muscles • Stylopharyngeus	• Oblique arytenoideus • Transverse arytenoids • Aryepiglottic	• Cricothyroid • Lateral cricoarytenoid	• Thyroarytenoid • Thyro epiglottic • Vocalis

Movements in the larynx

Movement	Muscle	Joint
Abduction of vocal fold	Posterior cricoarytenoid	Cricoarytenoid
Adduction of vocal fold	Lateral cricoarytenoid	Cricoarytenoid
Stretching of vocal fold	Cricothyroid	Cricothyroid
Shortening of vocal fold	Thyroarytenoid vocalis	Cricoarytenoid
Closure of laryngeal inlet	Transverse and oblique arytenoids, aryepiglottic	Cricoarytenoid

Cavity of the larynx

The inlet is called laryngeal aditus
Two folds namely vestibular fold/ false vocal cord superiorly and vocal folds (true vocal cords)
Space between vestibular folds is called Rima Vestibula
Space between vocal folds is called rima glottidis

The two folds divide cavity into three parts

- Vestibule: between aditus and vestibular folds
- Laryngeal vestibule: between vestibular and vocal folds
- Infraglottic cavity, between vocal folds and beginning of trachea

Neurovascular supply of larynx

Innervation	Arteries	Veins	Lymphatics
Motor All other muscles – *Recurrent laryngeal nerve* Cricothyroid muscle- *External laryngeal* **Sensory**	• Superior laryngeal artery- superior thyroid • Inferior laryngeal artery- Inferior thyroid	• Veins correspond to arteries and drain to: • Internal jugular vein • Brachiocephalic vein	• Prelaryngeal nodes • Pre tracheal • Paratracheal nodes • Deep cervical

Supraglottic – *internal laryngeal nerve* Infraglottic- *Recurrent laryngeal nerve*			nodes

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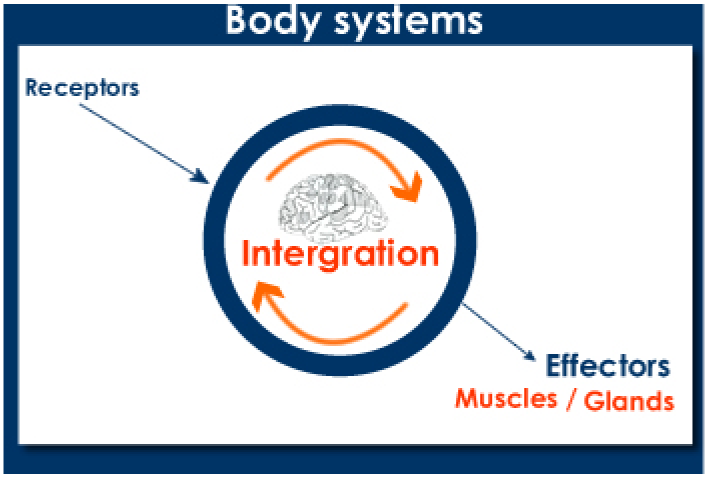
INTRODUCTION TO NEUROANATOMY

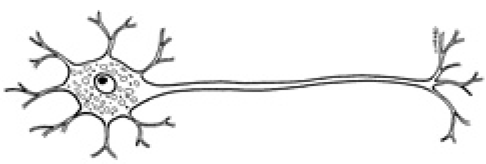
Learning points | Core anatomy | Applied anatomy | Review questions

The need for a nervous system



- The nervous system is designed to **coordinate** & **integrate** functions of all body systems to maintain the organism in an **optimal state** .
- Receives sensory input from **external environment** and all the **systems**.
- It elicits the response through muscles and glands in these systems
- The coordination and integration function are shared with the endocrine sytem

The components of the nervous tissue



Hover to show names

Neurons:

- **Structural and functional units**
- **Characterized by:**

  Excitability - ability to be activated.
  Conductivity- ability to propagate the impulse

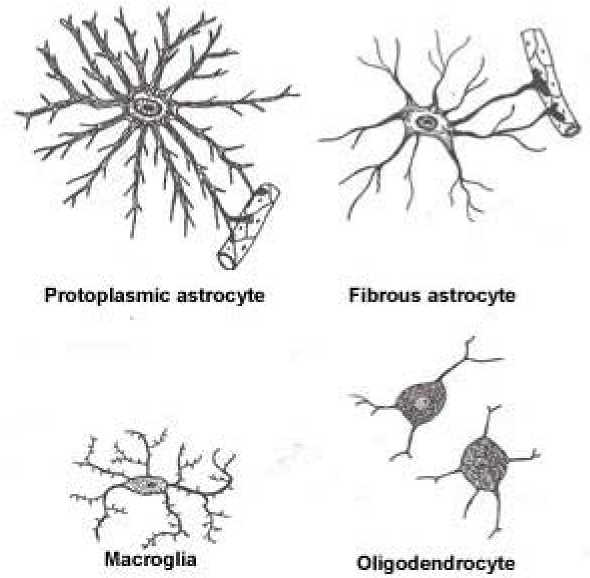
- Consists of three functional domains:
  receptive- dendritic system
  integration & trophic - cell body
  transmission - axon

Neurons and neuroglia

Neuroglia:

- Provide **physical** and **metabolic** support to the neurons.
- Comprise:

1. **Astrocytes;**



2. **Oligodendrocytes,**
3. **Microglial ependymal** cells.
4. **schwann** cells
5. **Neuro satellite** cells

INTRODUCTION TO NEUROANATOMY

Applied anatomy

Neurological disorders are common all over the world including in developing countries like Kenya. They arise from:

1. **cerebrovascular accidents** (stroke);
2. **Trauma,**
3. **Infections** e.g. meningitis,
4. **Degenerative** conditions.

Some of them may cause preventable deaths, but almost invariably cause serious disability.

There is need for careful history taking, thorough physical examination, appropriate choice of investigations in order to arrive a rational diagnosis of the problem. This will facilitate choice of treatment and prediction of the outcome. This is the basis of patient care.

Accordingly, there is need for every medical practitioner to have a certain basic minimum amount of knowledge of neuroanatomy.

Support and protection of the CNS

- Skull and vertebral column
- Meninges: Dura, arachnoid and pia
- Cerebro spinal fluid
- Blood vessels

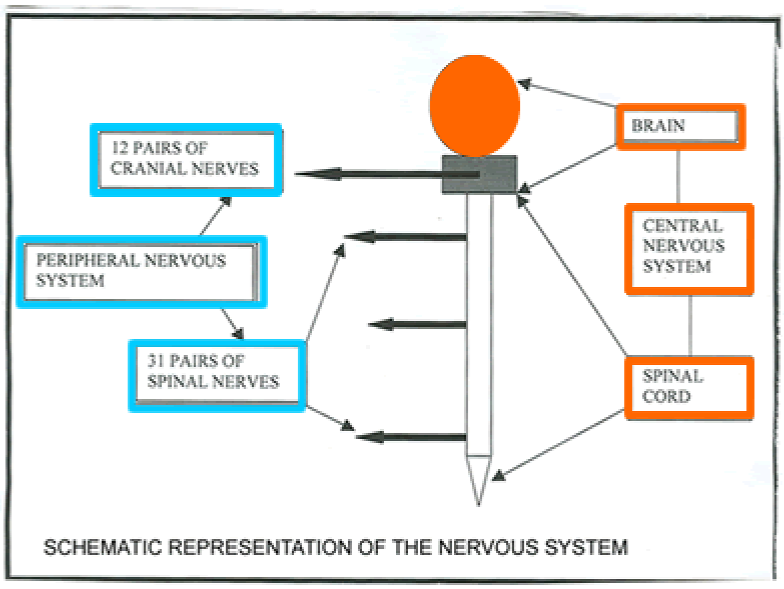
INTRODUCTION TO NEUROANATOMY

Review questions

---

1. Describe the general organization of the nervous system
2. Describe in general the functional roles of the different components in coordination of body functions
3. List the causes and general effects of damage to the spinal system

Divisions and Subdivisions of the nervous system

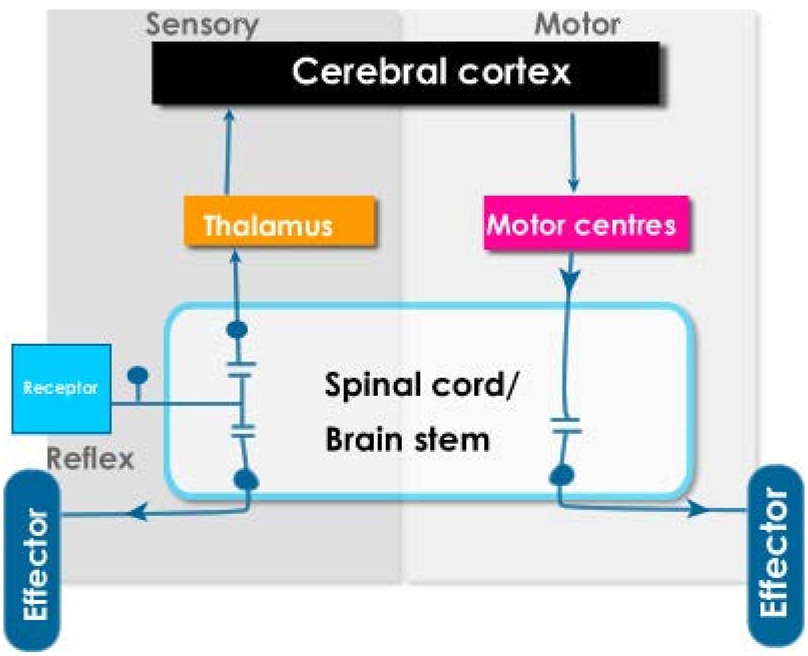


Divided into two:

- **The central nervous system** (CNS) consisting of: the brain and spinal cord.
- The **peripheral nervous system** (PNS) consisting of cranial and spinal nerves.

INTRODUCTION TO NEUROANATOMY

Functional organization of the nervous system



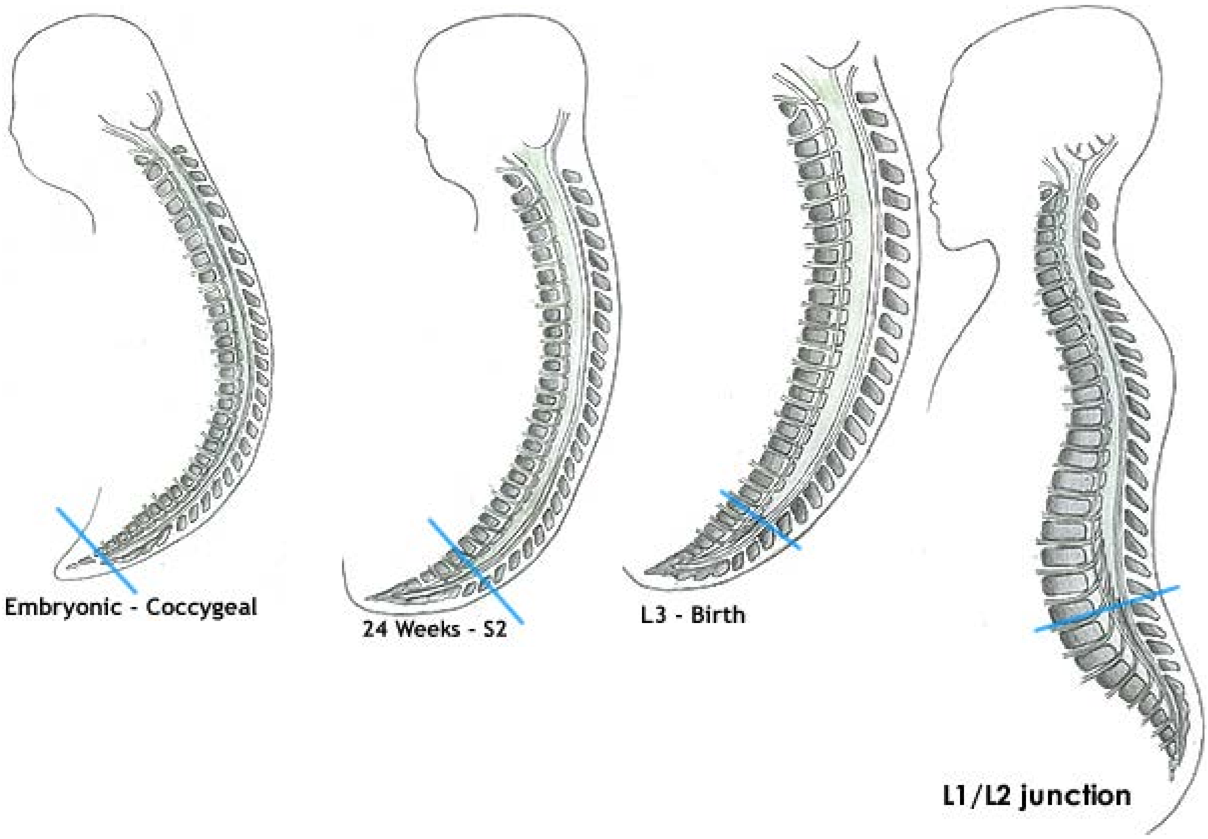
- **Receptors** convert environmental stimuli into nerve impulses
- **Afferent neurons** transmit the impulse to the spinal cord/ brain stem
- This impulse can either invoke a **reflex response** or be transmitted to the brain
- In the brain impulses are appreciated, **interpreted**, **coded** and **stored** in memory
- From the brain, impulses travel to the spinal cord or brainstem and from there influence muscle activity through **efferent neurons**
- The sensory (input) and motor (output) are **integrated** in the brain

INTRODUCTION TO NEUROANATOMY

Support and protection of the CNS

- Skull and vertebral column
- Meninges: Dura, arachnoid and pia
- Cerebro spinal fluid
- Blood vessels

Extents:



From foramen magnum to:

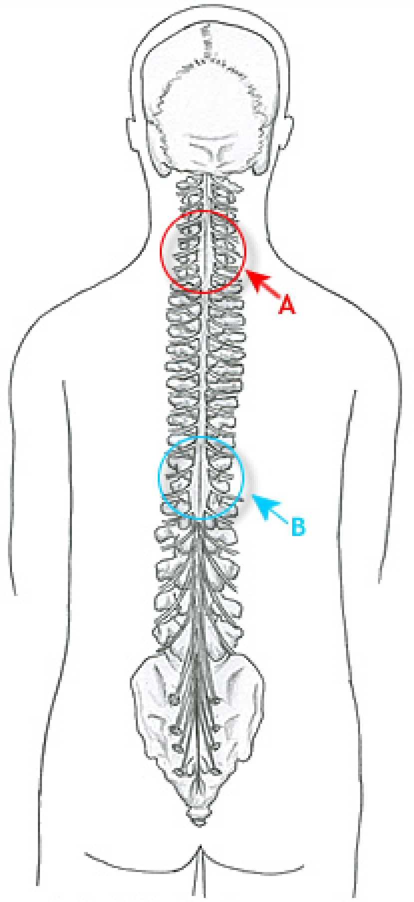
- *Embryonic period* - Coccygeal
- *24 weeks* - S2
- *Birth* - L3
- *Adult* - L1 / L2 junction

Embryonic basis: Faster growth of the vertebral column than the spinal cord.

The conical of the spinal cord is called the conus medullaris. After the termination, the spinal nerves follow the lumbar and sacral curves. These together with filum terminale form cauda equina.

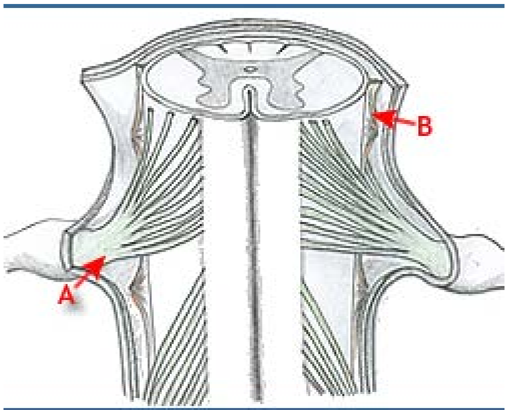
Enlargements:

1. **Cervical enlargements** (C4-C8) corresponding to origin of the brachial plexus.
2. **Lumbrosacral enlargement** (L2-S3) corresponding to origins of the lumbar and lumbrosacral plexi.



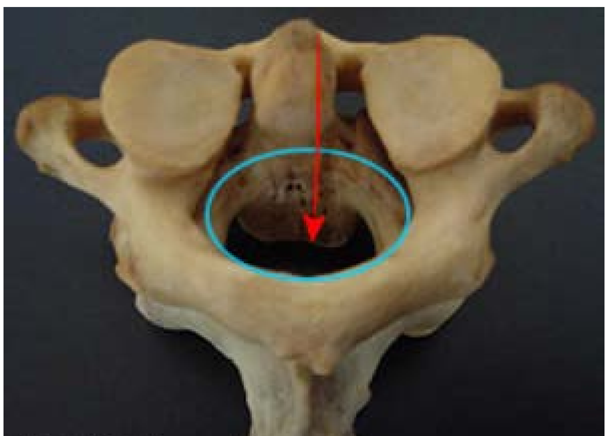
Spinal Cord enlargements

Anchorage:



Protection

- Vertebral column
- Spinal meninges
- Cerebrospinal fluid



Spinal Canal

Support and anchorage

- Spinal nerves
- Continuation with brain stem
- Denticulate ligaments

Applied Anatomy

Vulnerable spinal segments

These are cord segments which receive blood supply predominantly from one source, and would suffer vascular insufficiency if the source is occluded. The upper thoracic (T1-T2) and first lumbar spinal segments are among the most vulnerable regions. The intercostal arteries do not interconnect with other arteries, in the same way as the arteries of the cervical and lumbar regions do. Thus occlusion of one intercostal artery in a vulnerable region can result in spinal cord infarction.

Spread of malignancy to the central nervous system

There are free venous connections between the **external segmental veins** and the **internal vertebral** venous **plexus** which is devoid of valves. Therefore, malignancies for example of the **prostate**, the **breast** and the **thyroid** may freely spread haematogenously, to the vertebral column, and central nervous system, including the brain.

Localization of spinal cord lesions

Can be done in two ways:

A) Testing for impairment or **loss of cutaneous sensation** . Cutaneous areas supplied by adjacent spinal nerve overlap. For example, the upper half of the area supplied by T6 is also supplied by T5, while the lower half of this area is also supplied by T7.

b) Reflex contraction of muscles . The segments involved in the more commonly tested stretch or tendon reflexes are as follows:

- Biceps reflex, C5 and C6;
- Triceps reflex, C6 through C8;
- Quadriceps reflex, L2 through L4;
- Gastrocnemius reflex, S1 and S2.

Lumbar puncture

Insertion of a needle into the **subarachnoid space** in the lumbar region. Commonly done to obtain a sample of cerebrospinal fluid, for diagnosis of **meningitis**. There is little danger that the spinal puncture needle will damage the cord if it is inserted between the **arches** of the **third and fourth lumbar vertebrae**. It may also be done to introduce drugs, dyes, air etc.

The needle traverses the following structures

- Skin and subcutaneous tissue
- Thoracolumbar fascia
- Supraspinuous and interspinuous ligaments

- Epidural space
- Dura and arachnoid matter

Only a small amount of CFS should be withdrawn to avoid creating negative pressure in the lumbar region which may cause herniation of cerebellum and medulla down foramen magnum.

Vascular lesions

In **anterior spinal artery (ASA) syndrome,** occlusion of the ASA, affects **ventral horns** and tracts in the ventral and lateral columns. These include **corticospinal** and **spinothalamic** tracts. Its features include:

- Bilateral lower motor neuron deficits
- Bilateral upper motor neuron deficits
- Sensory deficits

Cauda equina Syndrome (CES)

This results from **compression of the cauda equina**. It presents with:

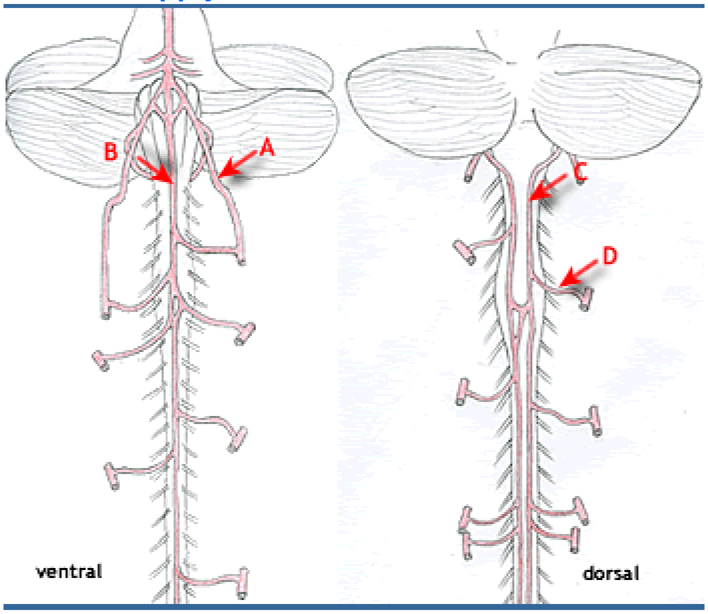
- Low back pain
- Bilateral lower limb pain with motor and sensory deficits
- Perineal sensory and motor deficit
- Genitourinary dysfunction with overflow incontinence or retention
- Fecal incontinence

Review Questions

1. Give an account of the extents and blood supply to spinal cord
2. State anatomy of lumbar puncture. Add notes on its indications, procedure and complications
3. State the communications of the epidural venous plexus and indicate clinical importance.

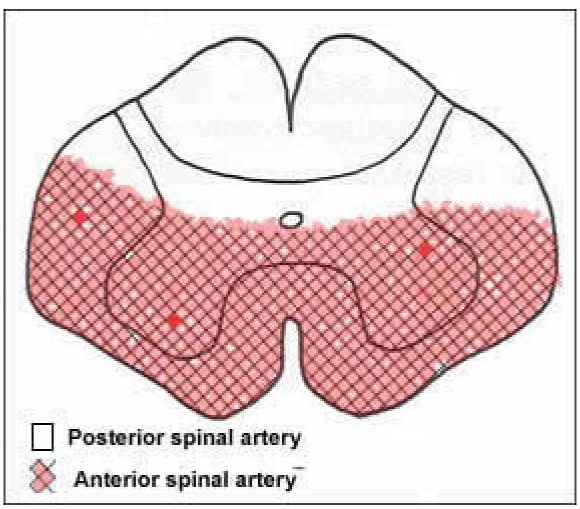
Blood supply:

Arterial supply



- Single anterior spinal artery
- Two posterior spinal arteries.
- Radicular arteries originating from (*Inferior thyroid, Vertebral, Ascending pharyngeal, Intercostal arteries and Lumbar segmental*).

Largest radicular artery – artery of lumbar enlargement is called **radicularis magna.** Arises from lower intercostals, usually T10.



The **Anterior spinal artery** supplies:

Anterior 2/3rds which includes:

- The anterior horn
- The lateral horn
- The central gray
- The basal part of the posterior horn
- Anterior and lateral funiculi

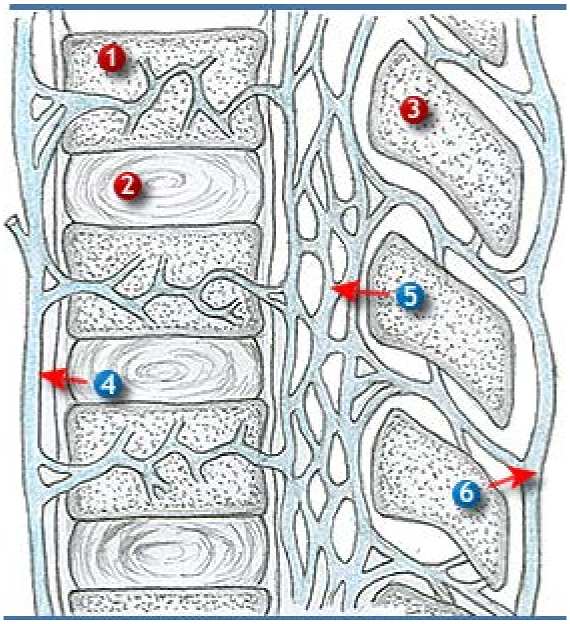
The **Posterior spinal artery** posterior 1/3rd mainly the posterior funiculi

Spinal veins

Spinal veins drain in to the **internal vertebral (epidural) plexus**

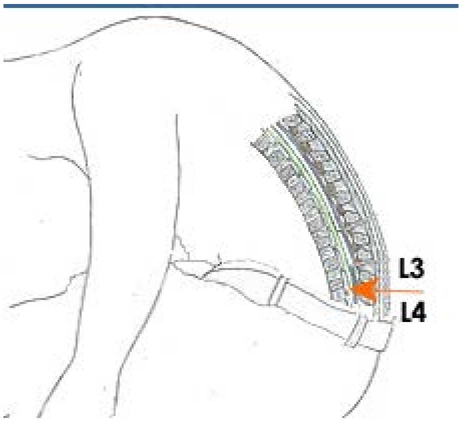
Communications of epidural venous plexus:

1. External vertebral plexus
2. Intra cranial dural sinuses
3. Inferior vena cava



4. Azygous venous system

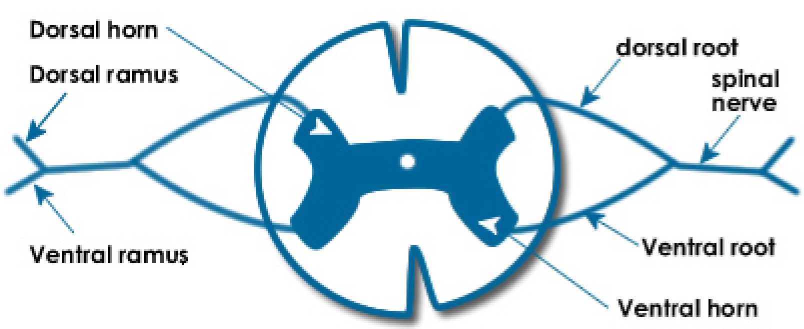
Lumbar cistern:



- Enlarged subarachnoid space after cord termination.
- Contains cauda equina.
- Usual site for lumbar puncture.

Organization of Spinal Nerves

- There are 31 pairs of spinal nerves.
- Each spinal nerve is formed by union of the **dorsal** (sensory) **root** ; and a **ventral** (motor) **root** .
- It divides into dorsal and ventral **rami** .



Functional components

1. **General somatic efferents (GSE)-** motor to skeletal muscle.
2. **General visceral efferent (GVE) -** autonomic
3. **General somatic afferent (GSA)** -sensory to somatic structures.
4. **General visceral afferent (GVA)** - sensory to visceral structures.

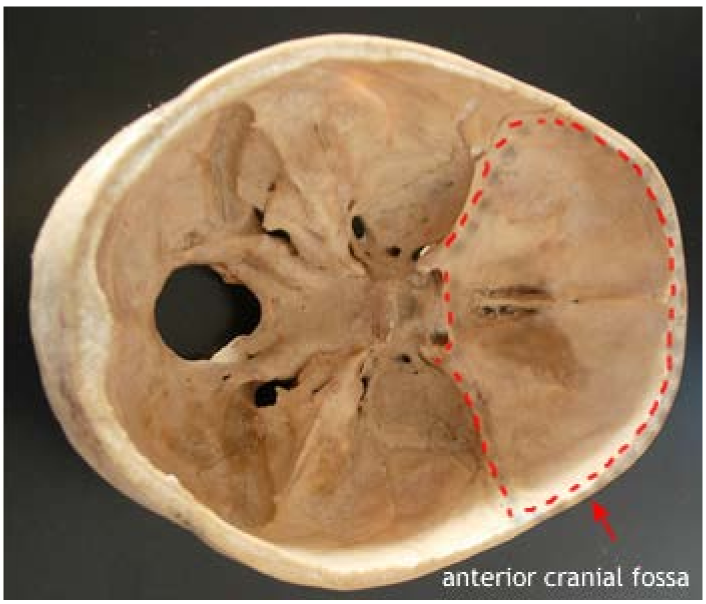
The Cranial Cavity

Divided into 3 fossae e.e

- Anterior
- Middle
- Posterior

Anterior Cranial Fossa

Boundaries:



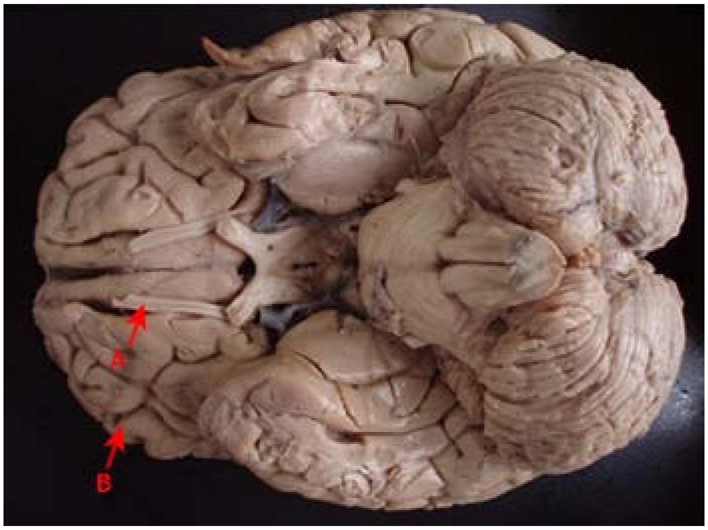
Roof and lateral wall:

Squamous frontal bone

Floor:
Orbital plate of frontal bone, lesser wing of sphenoid, abd cribriform plate of ethmoid bone.

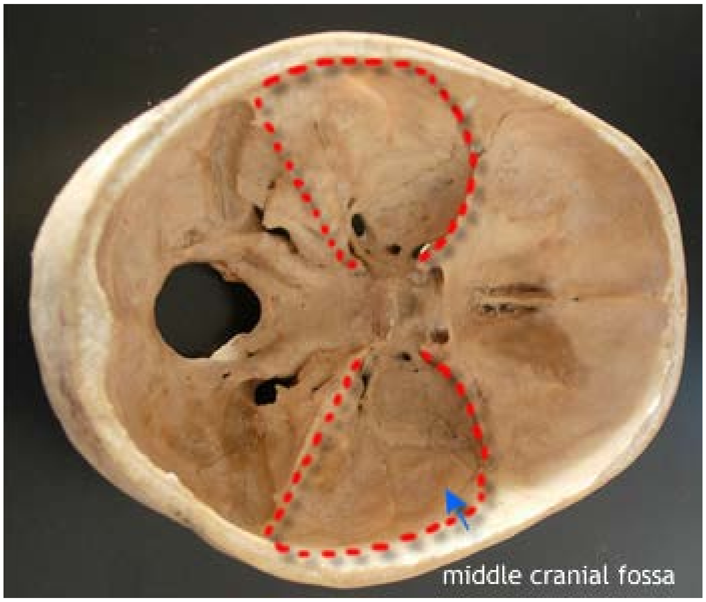
Contents

- Frontal lobe
- Olfactory bulbs and tracts



Middle Cranial Fossa

Boundaries



Anterior: Wings of sphenoid

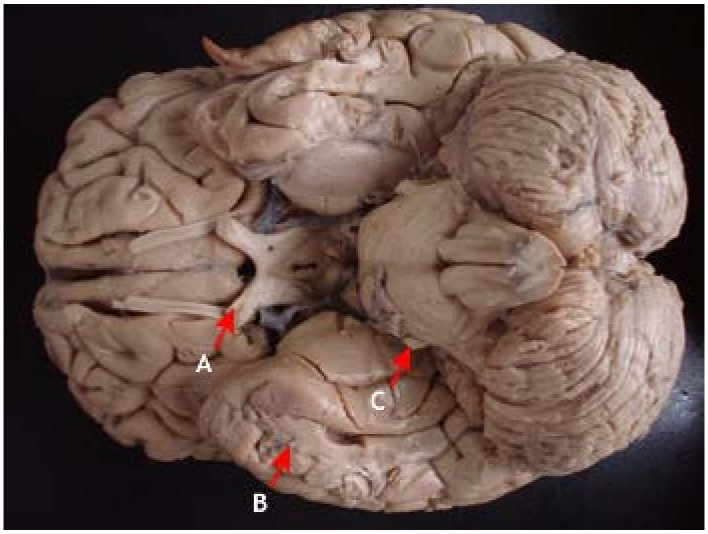
Medial: Body of sphenoid bone

Posterior: Petrous temporal bone

Lateral: Squamous temporal bone

Hover over hotspot to show name

Contents



- *Temporal lobes of brain*
- *Hypophyis cerebri*
- *Parietal lobe*
- *Trigeminal ganglion*
- *Optic nerve and chiasma*
- *Cranial nerves*
- Oculomotor

What foramina open into the middle cranial fossa ?

Applied anatomy

See respective sections

Review Questions:

1. Describe the position, relations, contents , communications and applied anatomy of the cavernous sinus

2. Describe the boundaries, contents and openings into the middle cranial fossa

3. Describe the organization, blood supply, innervation and applied anatomy of the cranial dura

4. Write short notes on:

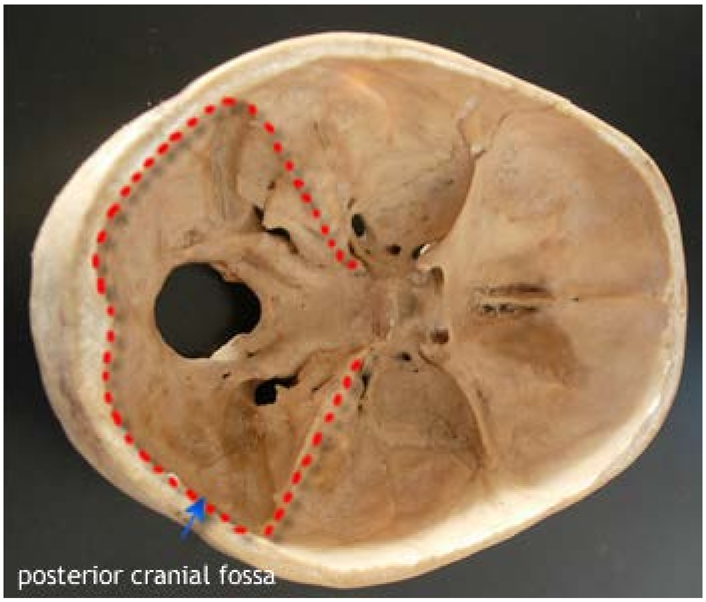
a) Cranial meningeal extensions

b) Superior sagittal sinus

c) Dural reflections

Posterior Cranial Fossa

Boundaries



Posterior: Squamous occipital bone.

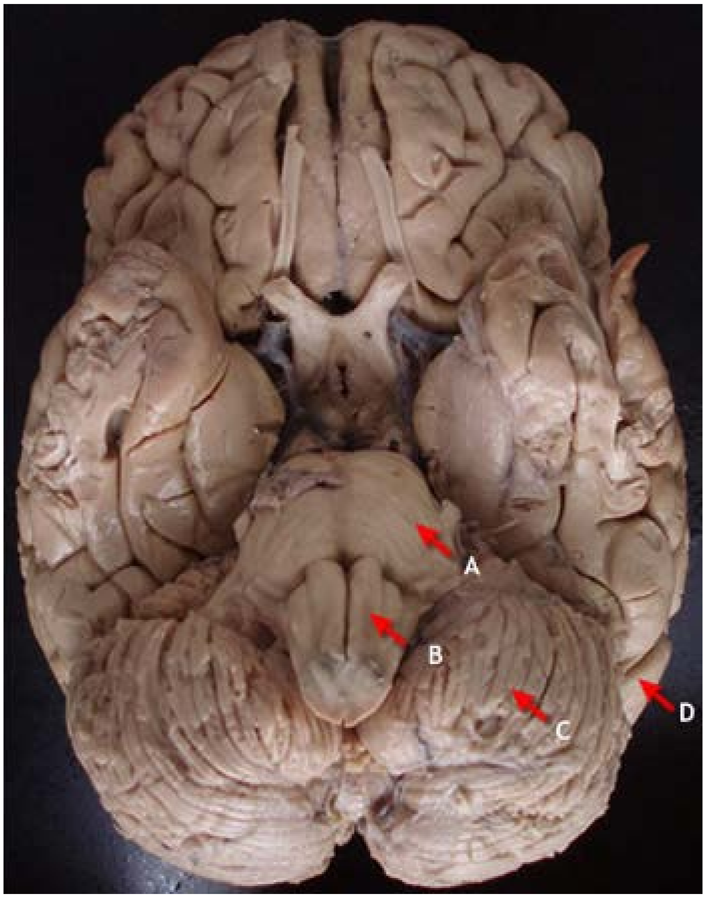
Anterior: Basi occiput, petrous temporal.

Superior: Tentorium cerebelli.

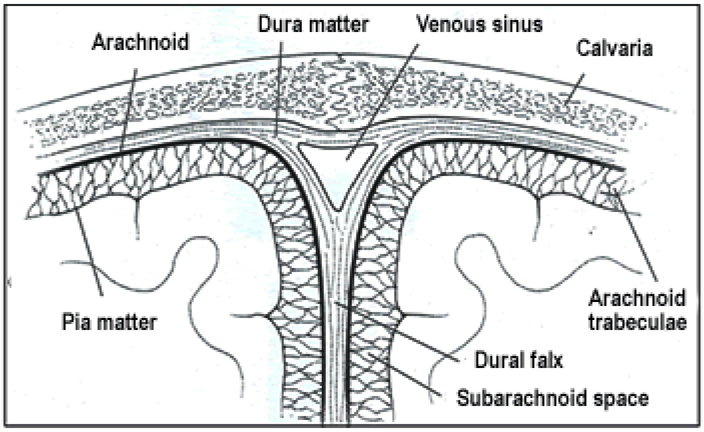
Inferior: Squamous occipital bone.

Contents:

- Occipital lobe
- Pons
- Medulla
- Cerebellum
- Cranial nerves:
  - Facial
  - Vestibulocochlear
  - Glossopharyngeal
  - Accessory


A
B
C
D

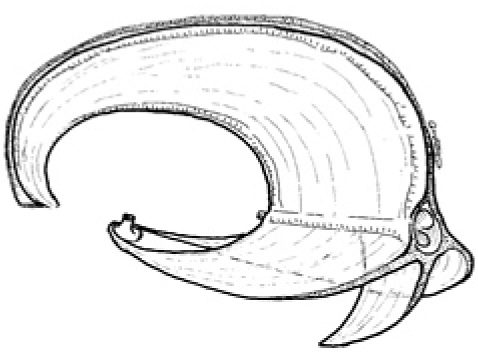
Dura:

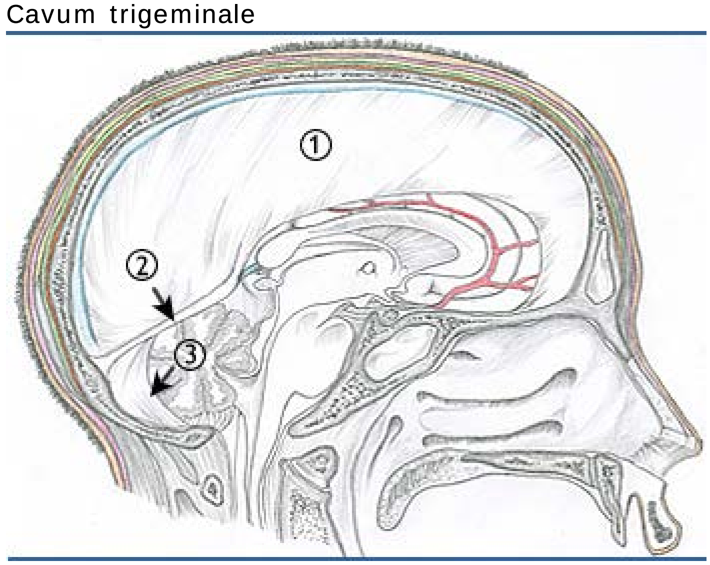


The dura mater has two layers namely an outer **endosteal layer** adherent to the inner surface of the cranium, and an inner **meningeal layer** . At various sites, these layers separate and form large **dural venous sinuses** .

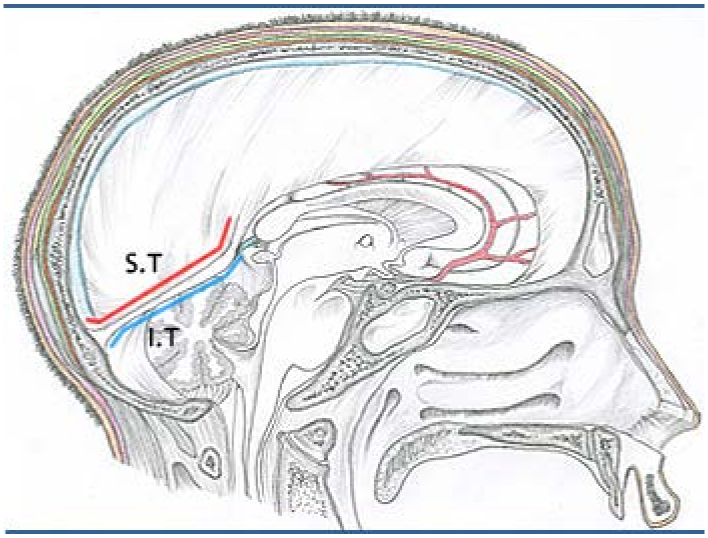
Reflections:

1. Falx cerebri
2. Falx cerebelli
3. Tentorium cerebelli
4. Diaghragma sella
5. Cavum trigeminale





Compartments of cranial cavity



Tentorium cerebelli divides into

1. Supratentorial [**S.T**]
2. Infratentorial [**I.T**]

Supratentorial compartment divided by falx cerebri into right and left.

Diaghragma sella covers hypophyseal compartment.

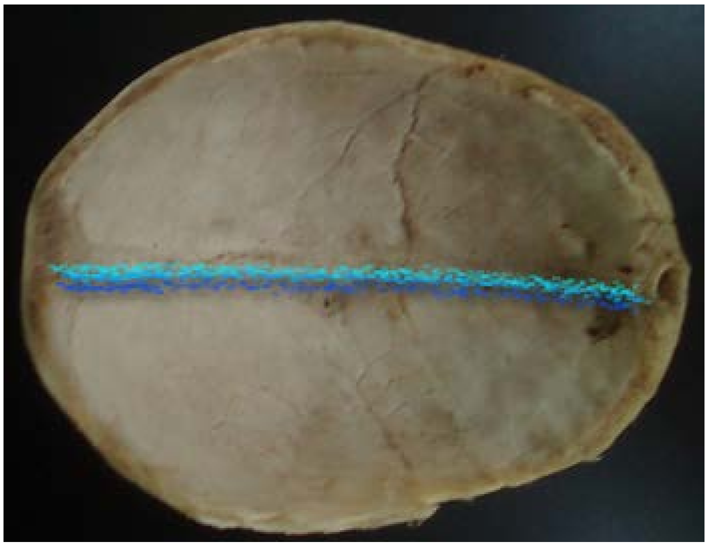
Cavum trigeminale covers trigeminal ganglion.

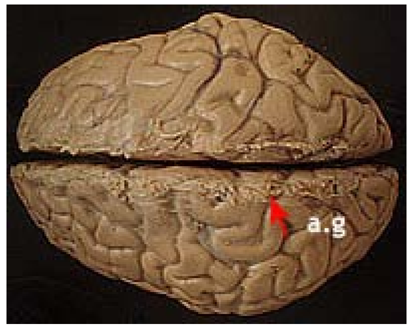
The infratentorial is divided by falx cerebelli into the left and right.

Locations of the venous sinuses

Communications

Superior sagittal sinus

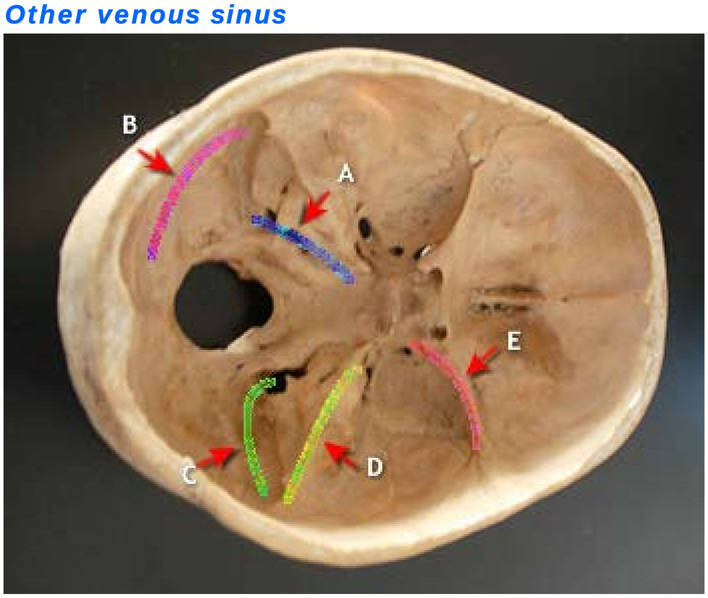




Communicates with

1. the nasal cavity and paranasal sinuses through Frontal emissary veins.
2. Usually right transverse but could go to left.
3. Subarachnoid space through arachnoid granulations.

Other venous sinus



These include

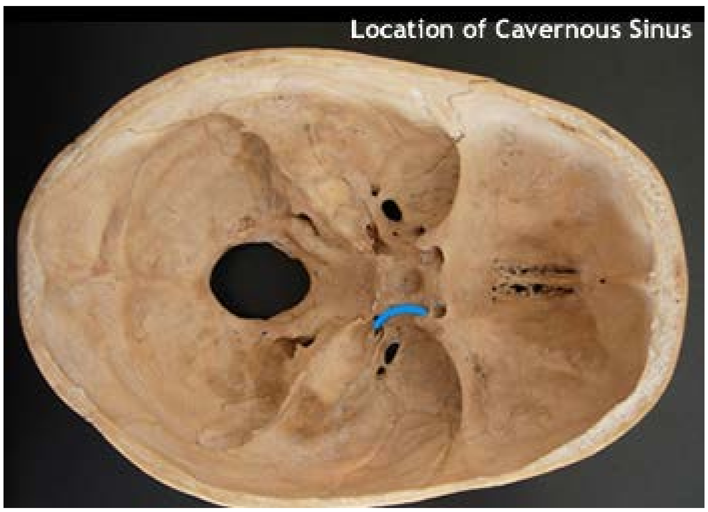
1. Inferior sagittal sinus
2. Sphenoparietal sinus
3. Superior petrosal sinus
4. Inferior petrosal sinus
5. Transverse sinus
6. Sigmoid sinus
7. Basilar sinus
8. Intercavenous sinus

The Cavernous Venous Sinus

This is clinically very important on account of the following:

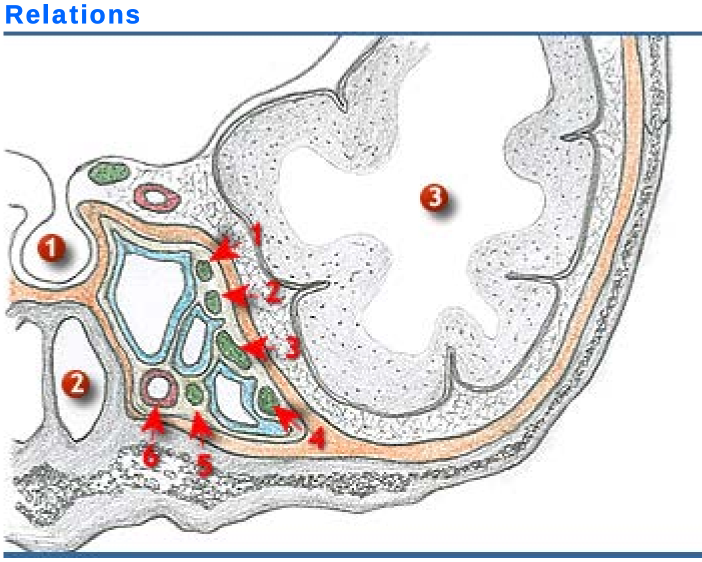
- It's numerous extracranial and intracranial communications.
- The structures contained within it and its walls.
- Its proximity to the pituitary gland.

Location



- It is found on each side of the sella turcica and the sphenoid body.
- Extending from the superior orbital fissure to the apex of the petrous temporal bone.
- The cavum trigerminale is located lateral to it.

Relations



Medially: Pituitary gland(1) and sphenoidal air cells(2).

Superiorly: Temporal lobe of the brain(3).

Laterally: Trigerminal ganglion and nerve.

Anteriorly: The contents of the superior orbital fissure and the optic nerve.

Posteriorly: Petrous temporal bone.

Within: Lateral wall - Oculomotor, trochlear, ophthalmic and maxillary nerves.

In it: Carotid siphon with its associated sympathetic plexus, the abducens nerve and venous blood.

Inter-cranial communications

- Superficial middle cerebral vein.

Intercavernous sinuses connect the two sides.

- Sphenoparietal sinus.
- Superior petrosal sinus connects it to the transverse sinus or sigmoid.
- Inferior petrosal sinuses connect it to the internal jugular vein.

Extracranial communications

- Superior and inferior ophthalmic veins.
- The pterygoid venous plexus Via emissary veins.
- The pharyngeal venous plexus.

Note that the facial vein communicates through the ophthalmic veins and the pterygoid plexus.

Clinical correlates on the cavernous venous sinus

Spread of infections

Danger area of the face

Infections from here spread to cavernous sinus via opthalmic veins

---

Cavernous sinus thrombosis

A common effect of infection of in a venous sinus is thrombosis. The risk is higher in the cavernous sinus due to the slow movement of blood. The effects are usually:

- Back-flow into the connecting veins, for example ophthalmic veins leading to exopthalmos and engorged

conjuctiva (chemosis)
- Compression of the nerves to the extraocular muscles leading to ophthalmoplegia and impaired sensation in the area of supply of Cranial V1 and V2.

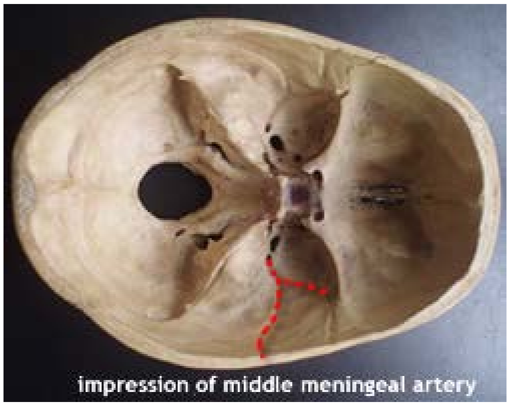
Arteriovenous fistula

This may be produced by fractures of the bases of the skull, in which the internal carotid artery tears within the cavernous sinus. Arterial blood rushes in to the sinus, enlarging it and forcing blood out of it through the communicating veins. This causes exophthalmos and chemosis on the side of the injury. In these circumstances, the bulging eye pulses in synchrony with the radial (or any other) pulse. This condition is called pulsatile exophthalmos.

Others

Infections spreading to the sinuses may affect the pituitary and the many cavernous sinus communications may provide alternative routes for spread of malignancies.

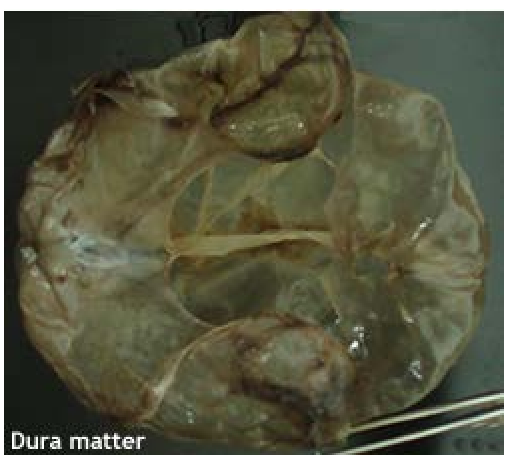
Blood supply to dura



The meningeal veins accompany the meningeal arteries.

Anterior cranial fossa:	Middle cranial fossa:	Posterior cranial fossa:
• Ethmoidal • Lacrimal branches of the ophthalmic artery.	• Middle meningeal • Accessory meningeal branches of maxillary artery from the external carotid.	• Branches of: • Vertebral • Occipital • Ascending pharyngeal.

Innervation of the dura



- Mainly from branches of the Trigerminal e.g ethmoidal, lacrimal and nervous spinosum .
- It also gets sensory twigs from Vagus
- Cervical nerves C1-C2, Facial and Glossopharyngeal.

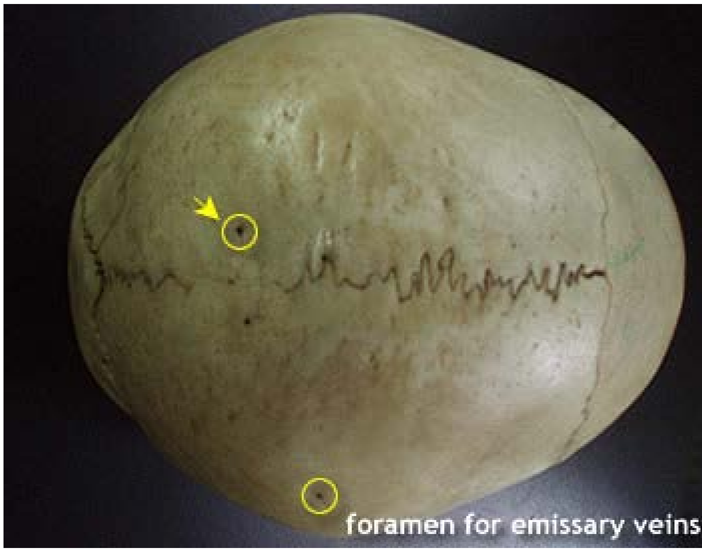
Note: Sensory endings are more numerous at:

- Each side of the superior sagittal sinus and tentorium cerebelli.
- Where arteries and veins pierce the dura mater.

Clinical note:

- The brain is insensitive to pain, but the cerebral dura is very sensitive, especially around the venous sinuses.
- Many **headaches** are of **dural and/or vascular origin**
- Indeed, one of the commonest presentations of meningitis is **severe headache** and n**eck stiffness**.
- **Irritation of C1-C2** in **meningitis** causes posterior neck muscles to contract causing the stiffness.

Emissary Veins

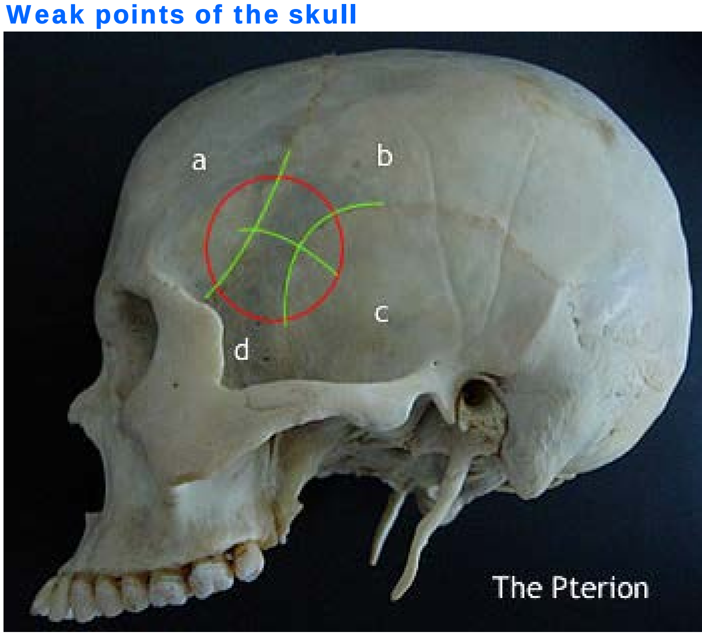


These connect extracranial and intracranial venous systems. They form routes for spread of infection and malignancies. Also provide alternative route for venous blood.

- Frontal
- Parietal (shown in the image)
- Mastoid
- Condylar

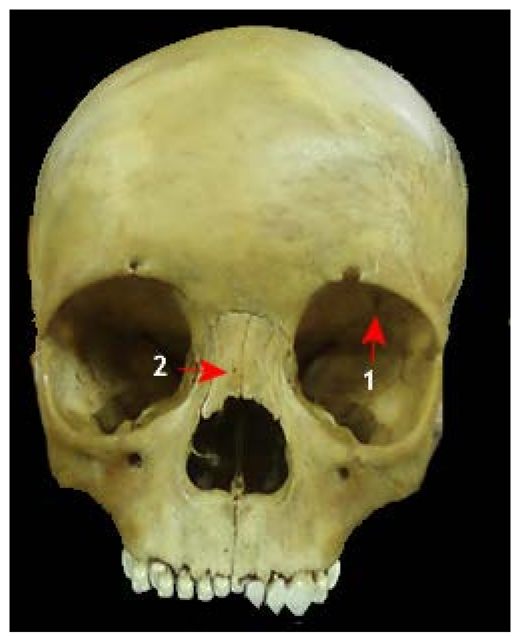
task **Locate the foramina for these veins.**

Weak points of the skull



- Pterion
- Squamous temporal
- Orbital walls
- Nasal walls

task ***Identify the bones forming the pterion on the skull shown***



Cranial meningeal extensions

The most important one clinically, is that surrounding the **optic nerve**.

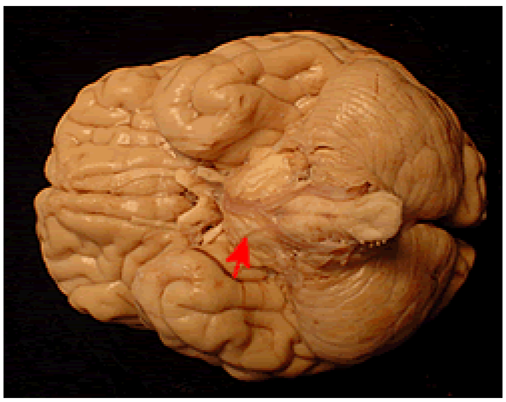
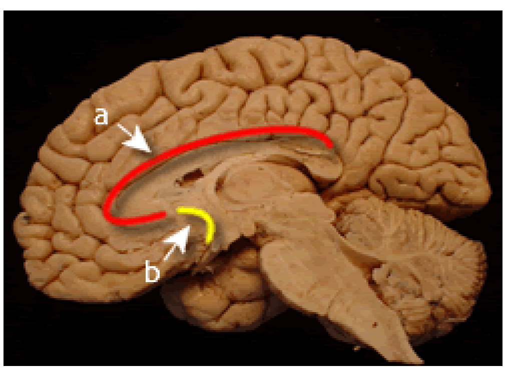
By presence of this extension, the optic nerve and central

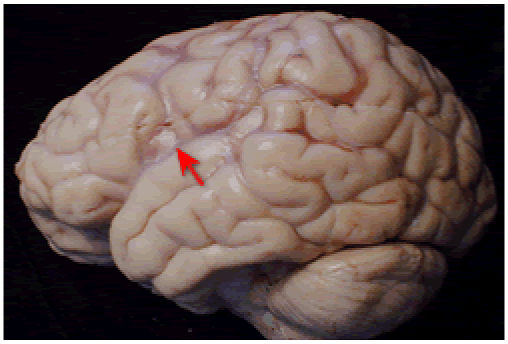
vessels of retina may be compressed in increased intracranial pressure. This causes oedema of the retina especially the papilla or disc.

This is called papilloedema.

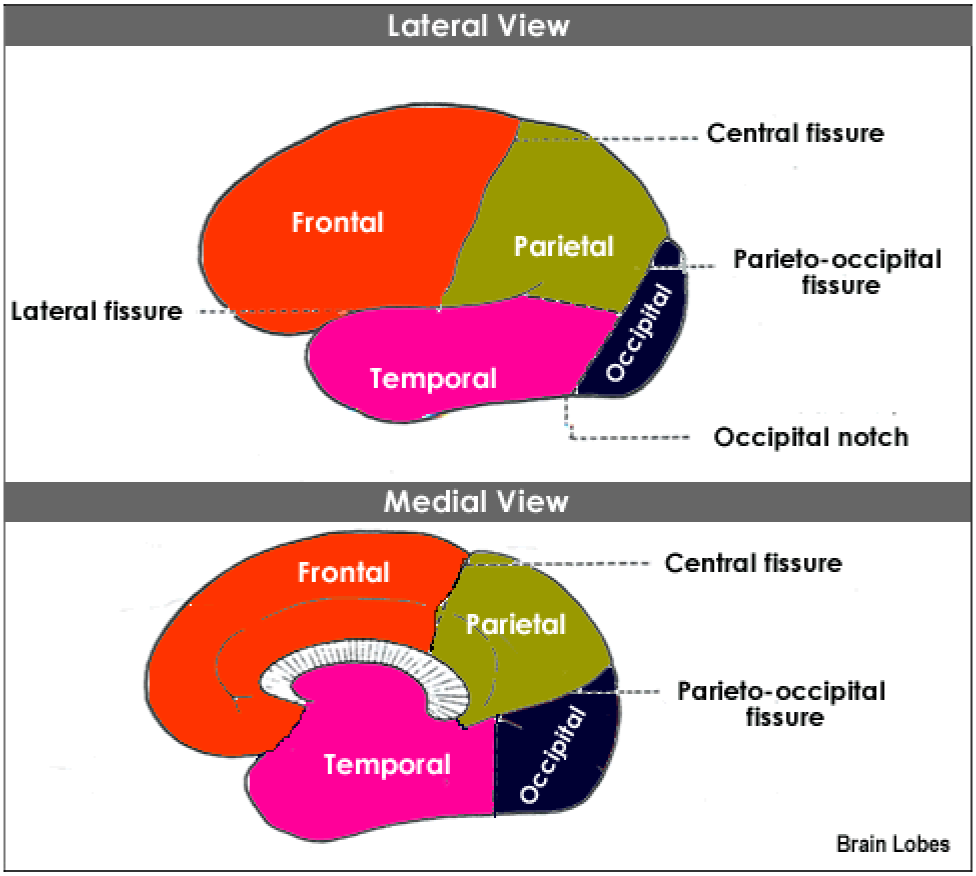
subarachnoid cisterns

Regions of the subarachnoid space containing more substantial amounts of fluid are called **subarachnoid cisterns** . Important cisterns include:

	Cistern	Location
	**Cerebellomedullary cistern** (cisterna magna)	Found between the medulla and the cerebellum
	Pontine cistern	On the basal part of the pons, containing the basillar artery
	Interpeduncular cistern	In the interpeduncular fossa region
	Chiasmatic cistern	Over the optic chiasma
	Cisterna ambiens	Sorrounding the posterior, superior and lateral surfaces of the midbrain. This cistern contains the great vein of Galen and the posterior cerebral and superior cerebellar arteries
	**Cistern of the lamina terminalis**	A continuation of chiasmatic cistern, which continues into the corpus callosum.
	Cistern of the corpus callosum	Above the anterior commissure
	The cistern of the lateral fissure	Corresponding with the Sylvian fissure

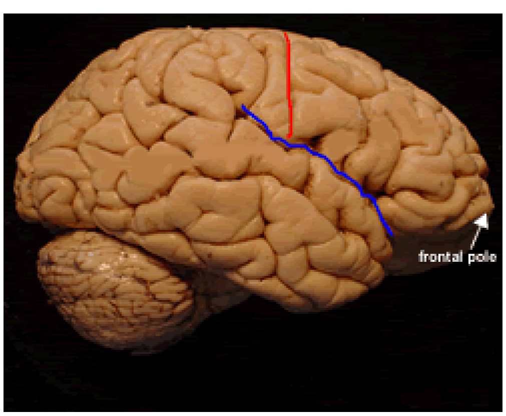


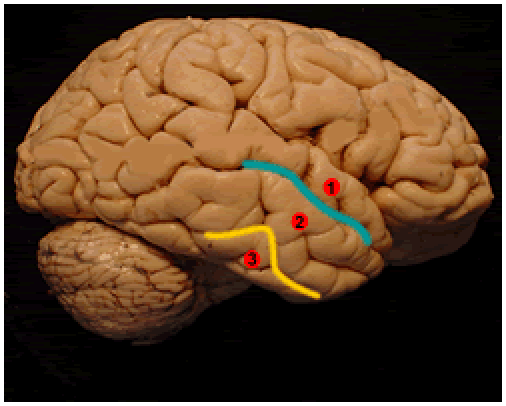
The Lobes of the Brain



Cerebral lobes

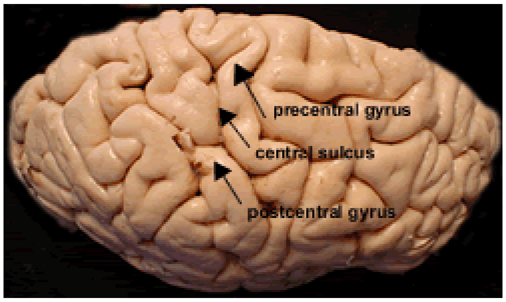
Lobe	Extents
Frontal	• ***Anterior:*** Frontal pole • ***Inferior:*** Lateral fissure • ***Superior:*** Median longitudinal fissure • ***Posterior:*** Central sulcus





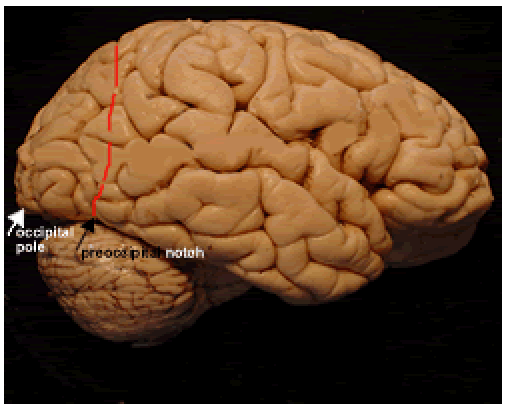
Temporal

- ***Anterior:*** Temporal pole
- ***Medial:*** Lateral fissure
- ***Posterior:*** Temporo-occipital line



Parietal

- ***Anterior:*** Central sulcus
- ***Posterior:*** Parieto-occipital line and medially parieto-occipital sulcus
- ***Inferiorly:*** Lateral sulcus
- ***Medially:*** Median longitudinal fissure



Occipital

- ***Anterior:*** Parieto-occipital sulcus medially
- ***Posterior:*** Occipital pole
- ***Inferior:*** Tentorium cerebelli
- ***Medial:*** Median longitudinal fissure

EFFECTS OF CEREBRAL LESIONS

The sensory association cortex

It receives fibres from somesthetic area. Data pertaining to the general senses are integrated, permitting a comprehensive assessment of the characteristics of an object held in the hand and its identification without visual aid.
Lesions of this area without involvement of the somesthetic cortex leaves intact the general awareness of the general senses, but the significance of this information on the basis of previous experience is elusive. This condition is called ***agnosia***.

There are several types of agnosia depending on the sense most affected. Damage to these areas also causes ***asteriognosia*** , in which there is lack of recognition of the opposite side of the body. It is characterized by cortical neglect in which the patient ignores and even denies the existence of one side of the body. This is sometimes called ***hemineglect***.

The visual area

This is more extensive than seen on the surface. It is also called striate cortex because of the lines of Gennari. The lateral geniculate body forms the main course of input to this area.

Visual association cortex: They receive fibres from the area, the lateral geniculate nucleus and have reciprocal connections with other cortical areas and with the pulvinar of the thalamus.

These areas function mainly to process complex aspects of vision including the relating of present to past visual experiences, with recognition of what is seen and appreciation of its significance. Lesions of the visual association cortex causes ***visual agnosia***.

Bilateral lesions involving the superior parts of ***area 19***, cause disorientation, loss of coordination of the eye movement and inability to carry out visually directed movements of the hands.
Inferior temporal and lateral occipitotemporal gyri also form visual association cortex. Stimulation of these areas causes visual hallucinations of scenes from the past, indicating a role of this cortex in the storage or recall of visual memories.
Bilateral lesions lead to ***prosopagnosia*** - impaired recognition of previously known familiar faces.

The total exposure of **the association cortex** in the parietal lobe is responsible (along with association cortex in the frontal lobe) for many of the unique qualities of the human brain. Engrams or memory traces are laid down over the years, possibly as macromolecular changes in neurons throughout the cortex. These form the basis for learning at intellectual level.

Recently acquired information is not consolidated into long-term memory when the forebrain is extensively damaged, as in **Alzheimer's diseases**, or bilateral lesions of the limbic system.
Neocortex of the frontal lobe has a special role in motor activities in the attributes of judgment and foresight, and in determining mode or “feeling tone”.

The body representation is inverted in the **primary motor area** and when stimulated causes contractions of muscles that make up a functional group. Lesions of this area cause **voluntary paresis**.

The **secondary motor area** is on the **medial surface of area 6**, and therefore a part of the pre-motor area with special properties.
Loss of function of the sensory area causes **spasticity of muscles** paralyzed as a result of an upper motor neuron lesion. In humans, there is an increased blood flow in the supplementary motor area during the mental processes that precede the execution of a movement.

Bilateral lesion of this area causes profound paralysis, as well as **mutism**.

The **pre-motor area (area 6)** receives input from the anterior ventral lateral thalamic nuclei, which in turn receives input from the corpus striatum. This area contributes to motor functions in two ways:

- Direct contribution to the pyramidal system.
- Direct influences on primary motor cortex.

Functionally, it elaborates programs for motor routines necessary for skilled voluntary action, both when a new program is established and when a previous established program is altered.
In general, the primary motor cortex is the area through which commands are channeled for the execution of movements. In contrast, the pre-motor area programs skilled motor activity and thus directs the motor area in its execution.
The term **apraxia** refers to results of a cerebral lesion characterized by impairment in the performance of learned movement, in the absence of paralysis. When the impairment involves writing, it is called **agraphia.**

The **prefrontal eye field** comprises the **lower part of the area 8**. It controls voluntary conjugate movement of the eyes. Lesions cause deviation of the eyes to the opposite side.

The **prefrontal area (9, 10, 11, and 12)** is well developed in primates and in man. Its functions include:-

- Determination of effective reactions on the basis of past experience.
- Monitoring behavior and exercising control based on such higher mental facilities as judgment and foresight.

The use of language is a peculiarly human accomplishment, requiring special neural mechanism in association areas of the cortex. Two cortical areas have specialized language functions located in the dominant hemisphere (usually the left, with a few exceptions).

Sensory language areas - auditory association cortex of “Wernicke's” occupying part of the posterior region of the superior temporal gyrus and part of the parietal lobe around the ascending posterior part of the lateral sulcus. It is also called **receptive language area** .

Motor speech (Broca's) area on the postero-inferior part of the frontal lobe, just anterior to the pre-motor area. It is also called the **expressive speech area**.

These two areas are connected through the **superior longitudinal fasciculus**.

Lesions involving the language areas or their connections cause **aphasia** . There are several types of aphasia depending on the area affected:

- Receptive aphasia
- Expressive aphasia
- Global aphasia

Alexia is loss of ability to read and occurs with or without other aspects of aphasia. Pure alexia may result from lesions involving the white of the occipital lobe on the dominant side and splenium of the corpus callosum, severing the connections between visual cortices and unilaterally situated language areas.

Dyslexia is an incomplete alexia, and characterized by an inability to read more than a few lines with understanding.

Review Questions

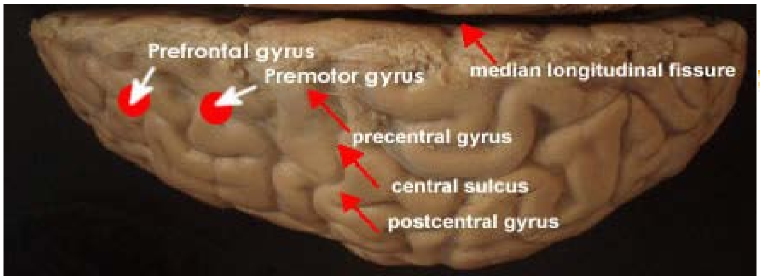
1. Give an account of the extents, subdivisions and functional localization of each of the cerebral lobes.

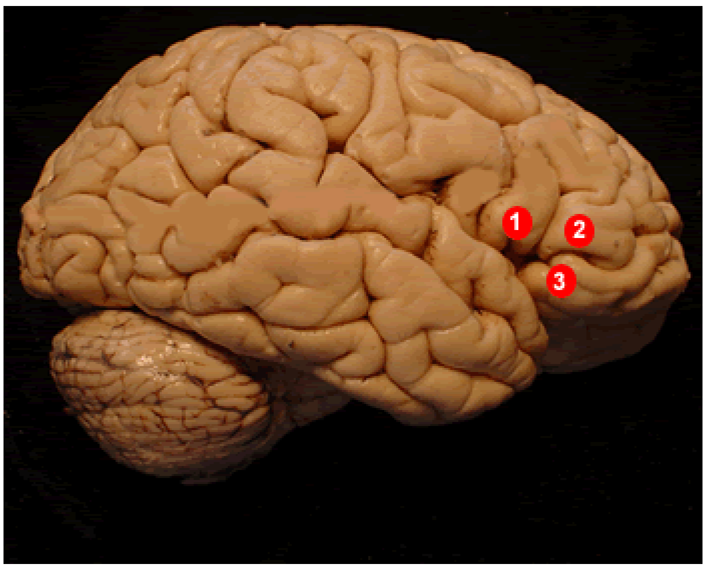
2. Name the exact gyri on which these functions are localized – motor speech, sensory speech, olfaction, taste, somatosensory etc.

3. State the effects of enlarging epidural haematoma deep to the pterion.

Sulci and gyri

Frontal lobe





The dorsolateral surface of the frontal lobe is divided into three regions, namelY:

1. **Precentral gyrus (motor gyrus): Immediately anterior to the central sulcus and posterior to the pre-central sulcus**
2. **Premotor gyrus, anterior to the pre-central sulcus**
3. **Prefrontal area anterior to the premotor sulcus**

The prefrontal regon is divided into three by the superior and inferior frontal sulci.

- **Superior frontal gyrus**
- **Middle frontal gyrus**
- **Inferior frontal gyrus**

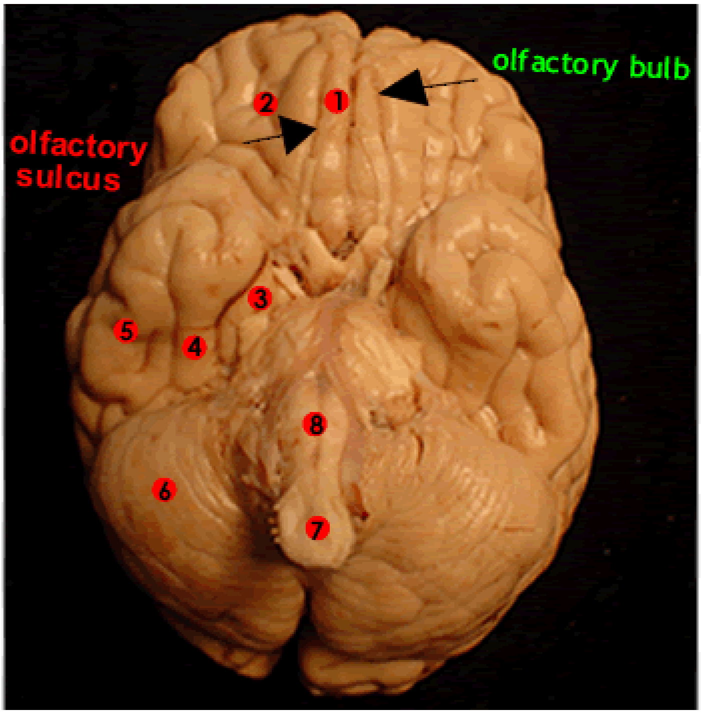
The inferior frontal gyrus is divided into three by the anterior ascending rami of the lateral sulci into

- **Pars opercularis (1)**
- **Pars triangularis (2)**
- **Pars orbitales (3)**

The inferior surface of the frontal lobe

- **Olfactory sulcus, contains olfactory bulb and tract.**
- **Medial to the olfactory sulcus is the gyrus rectus (1)**
- **Lateral to the olfactory sulcus is the orbital gyrus (2)**
- **The olfactory tract posteriorly divides into medial and lateral olfactory striae.**
Caudal to this division is the olfactory trigone and anterior perforated substance.

. task **Name the stractures labelled 3-8.**



Functional specialization of the frontal lobe

Area of frontal lobe	Function (s)
The pre-motor and pre-central (primary motor) areas:	Regulation and coordination of fine somatic motor activity, especially of the distal muscles
The inferior frontal gyrus: • **Pars opercularis** • **pars triangularis**	Motor speech (Broca's) area: the regulation of production of speech.
The prefontal areas	Higher 'cognitive' function regulation including: • Intelligence • Initiative • Determination • Inhibition • Memory • Reasoning e.t.c.
Olfactory (olfactory striae)	Olfactory function
olfactory cortex, cingulate gyrus	Limbic

Parietal Lobe

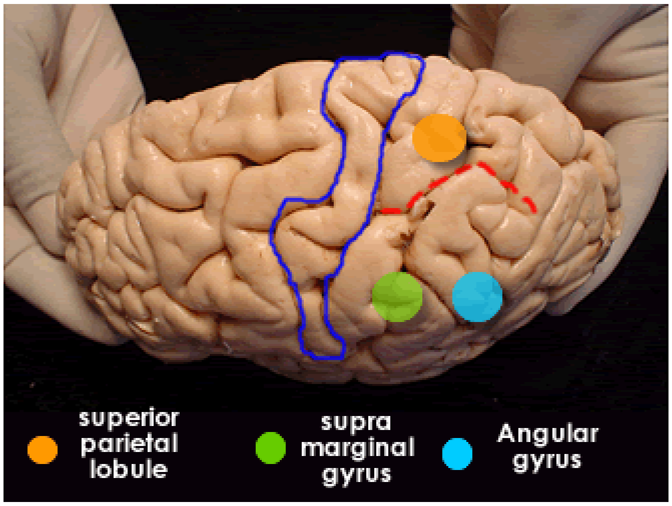
Three parts of the parietal lobe are:

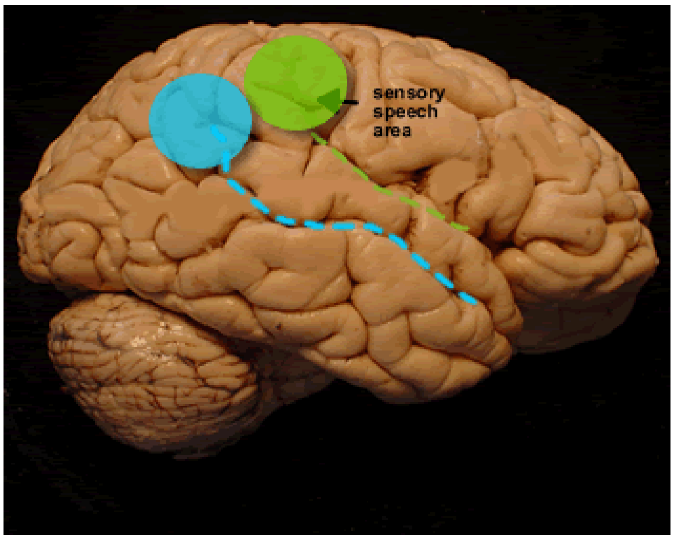
- ***Post central gyrus*****,** lies between the central and post central sulci. It is usually not continuous, but broken up into superior and inferior segments and

  The parts of the parietal lobe caudal to the post central gyrus are divided by a horizontally oriented sulcus, the intra-parietal sulcus into two parts i.e.:

  - Superior parietal lobule
  - Inferior parietal lobule, which consists of two gyri.

- ***The supramarginal***, about both banks of an ascending





ramus of the lateral sulcus

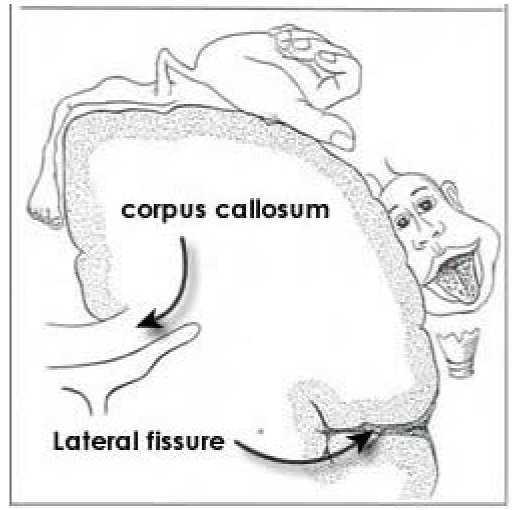
- ***The angular gyrus*** , which surrounds the ascending terminal part of the superior temporal sulcus.

Parietal Lobe

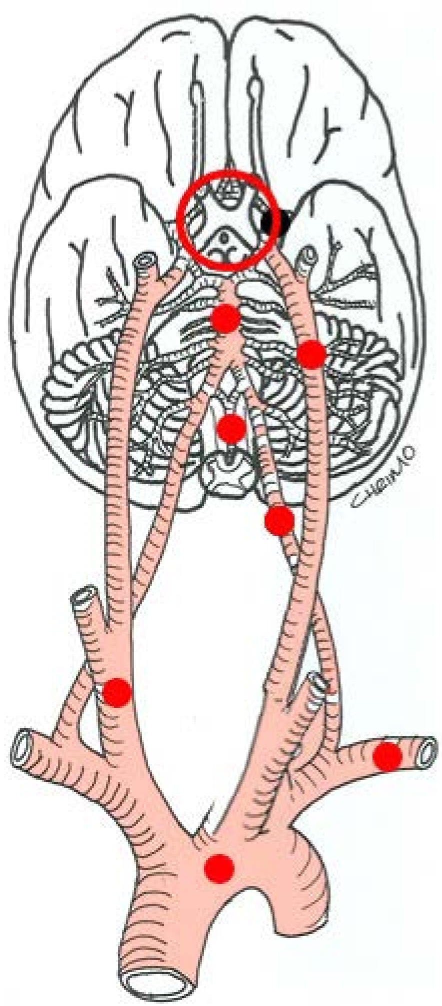
Area of parietal lobe	Function (s)
Supramarginal gyrus.	**Sensory speech (Wernicke's) area**
post central gyrus	**Primary somatic sensory**
inferior parietal lobule	**Sensory association**
inferior part of the parietal lobe, posterior to the general sensory areastriae)	**The gustatory area**
cingulate gyrus	**Limbic**

Homunculus

- This is the **inverted** map of the body on the cerebral cortex
- On both **sensory** and **motor** gyri, the body is **differentially** represented. More sensitive parts, and those requiring fine control have larger representation
- In this motor homunculus the body is arranged over the surface of pre central gyrus in a coronal section of cerebral hemisphere. Note the **large** area devoted to the **hand** and **face**.


corpus callosum
Lateral fissure

Sources of Blood supply



Aortic arch

- **The vertebral basilar system - from subclavian artery** (posterior circulation)
- **The internal carotid system (**anterior circulation**)**

Anastomose in **the arterial circle of Willis**.

Hover to show names

Vascular Lesions of the Brain

Brain stem vascular lesions

Occlusion of the ***anterior spinal artery*** causes medial medullary syndrome, presenting with inferior alternating hemiplegia.

- Ipsilateral paralysis of tongue.
- Contralateral hemiplegia.
- Contralateral sensory deficits.

Occlusion of the ***posterior inferior cerebelllar artery*** causes lateral medullary syndrome featured

- Contralateral hemianaesthesia of the body below the head.
- Ipsilateral hemianaesthesia of the face.
- Cerebellar dysfunction.
- Speech and swallowing disorders.
- Horners syndrome.

Occlusion of the ***paramedian branches*** of the basilar arteries causes middle alternating hemiplegia.

- Contralateral hemiplegia.
- Medial deviation of the eyeball.

Obstruction of the ***short circumferential arteries*** from the basilar artery cause

- Ipsilateral cerebellar dysfunction
- Autonomic disturbances
- Contralateral hemianaesthesia

Occlusion of the ***mesencephalic branch*** of the posterior cerebral artery causes **Weber's syndrome**

- Contralateral hemiplegia
- Ipsilateral lateral deviation of the eyeball

Cerebral Cortical Vascular Lesions

Occlusion of the ***anterior choroidal artery*** causes a triad of:

- Contralateral hemiplegia
- Hemianopia
- Hemi hyperacusis

Occlusion of ***anterior cerebral arteries*** may cause

- Contralateral hemiplegia
- Contralateral hemianaesthesia (both mainly affect the lower limb)
- Agnosia
- Personality changes

Occlusion of the ***calcarine artery*** causes homonymous hemianopia with macular sparing (**Tunnel vison**)

Occlusion of the ***middle cerebral artery*** near the origin of its cortical branches causes

- Contralateral hemiplegia , most marked in the upper extremity and face.
- Contralateral loss of position sense and discriminatory touch.
- Global aphasia if its on the dominant side.
- Partial deafness.

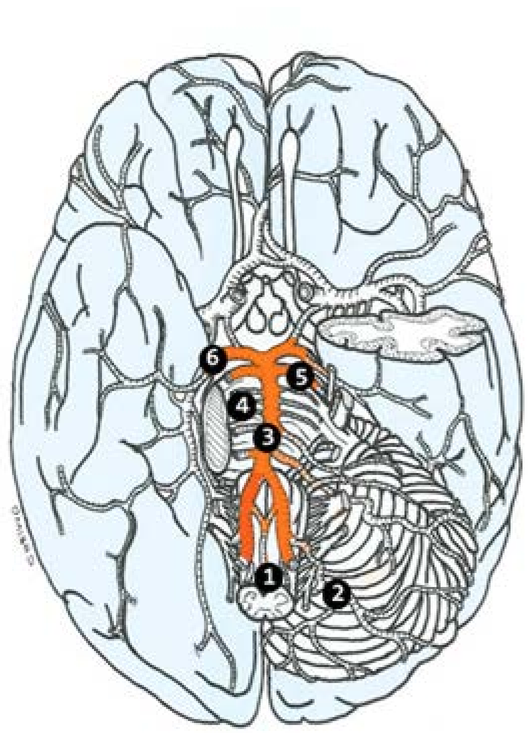
Review Questions

1. Outline the formation of the circle of willis
2. Explain the formation and significance of the carotid siphon.
3. State 3 factors that influence the effect of occluding an artery in the brain.
4. Name the main structures affected in the superior, middle and inferior alternating hemiplagia
5. Name the tributaries of the great cerebral vein.
6. State the termination of the superficial middle cerebral vein.
7. Describe the distribution of the main cortical arteries and state the effects of their occlusion

Branches and distribution of the vertebral arteries

The intra-cranial part of each vertebral artery usually gives rise to five arteries followed caudo-cranially:

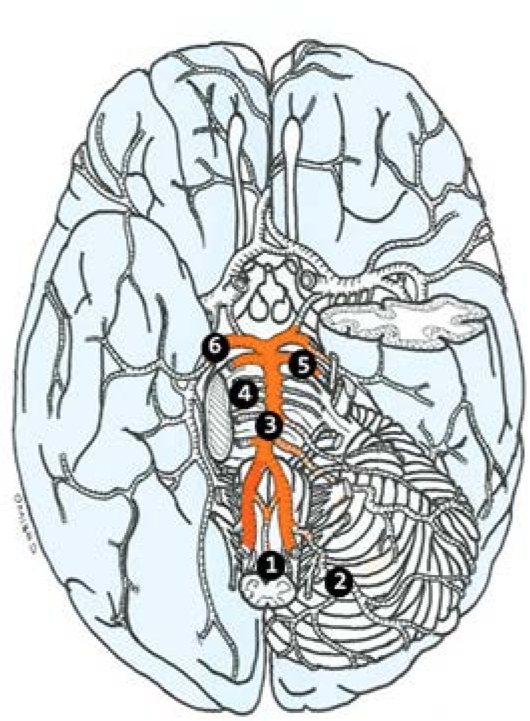
Branch	Distribution
The posterior spinal artery	1. The spinal cord 2. Posterior aspect of the medulla 3. The caudal and dorsal portions of the inferior cerebellar peduncle.
The anterior spinal artery	The two usually unite to form the single anterior spinal artery that supplies: 1. Anterior two thirds of the spinal cord. 2. A paramedian region of the medulla oblangata
The posterior inferior cerebellar artery	• Lateral medullary region
The posterior meningeal artery	• Meninges of the ventral parts of the posterior cranial fossa.
Bulbar branches of the vertebral artery	• Ventral parts of the medulla oblangata.



1: Anterior spinal artery
2. Posterior inferior cerebellar artery
3. Basilar artery
4. Pontine arteries
5. Superior cerebellar arteries
6. Posterior cerebral arteries

Branches and distribution of the basilar artery

Anterior inferior cerebellar	• Caudal parts of the pontine tegmentum • Inferior surface of the cerebellum • Choroid plexus of the fourth ventricle
Labyrinthine arteries	• facial • vestibulocochlear nerves • inner ear.
Pontine arteries	• **Paramedian:** supply a medial pontine region and the ventromedial parts of the pontine tegmentum. • **Short circumferential:** supply the adjacent anterolateral part of the pons, and variable parts of the overlying tegmentum. • **Long circumferential:** supply lateral parts of the middle cerebellar peduncle, as well as most of the pontine tegmentum.
The superior cerebellar artery	• A medial branch supplying the superior cerebellar vermis and adjacent regions • A lateral branch whose rami convey blood to the superior surface of the cerebellar hemisphere.
The posterior cerebral arteries	• Perforating arteries from these branches supply the deep cerebellar nuclei and choroid plexus of the fourth ventricle.



1: Anterior spinal artery
2. Posterior inferior cerebellar artery
3. Basilar artery
4. Pontine arteries
5. Superior cerebellar arteries
6. Posterior cerebral arteries

The Internal Carotid Artery

Summary of the branches

1. Hypophyseal branches to the hypophysis cerebri
2. Ophthalmic artery
3. Posterior communicating artery
4. Anterior choroidal artery
5. Middle cerebral artery
6. Anterior cerebral artery

Learning points | Core anatomy | Applied anatomy | Review questions

Formation of Circle of Willis

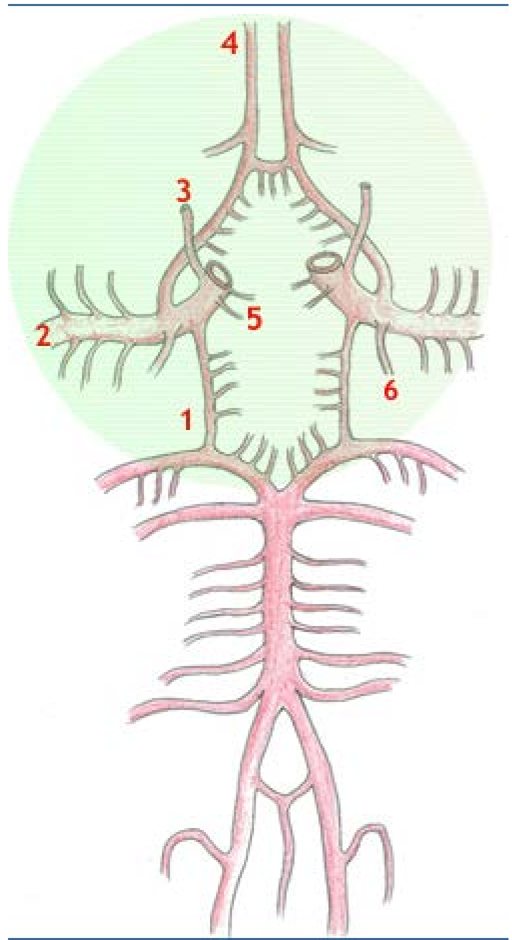
This is the communication between vessels about the **interpeduncular fossa**.

It encircles the optic chiasma, tuber cinereum and interpeduncular region.

Formed by these arteries:

- Posterior cerebral
- Internal carotid
- Posterior communicating
- Middle cerebral
- Anterior cerebral
- Anterior communicating

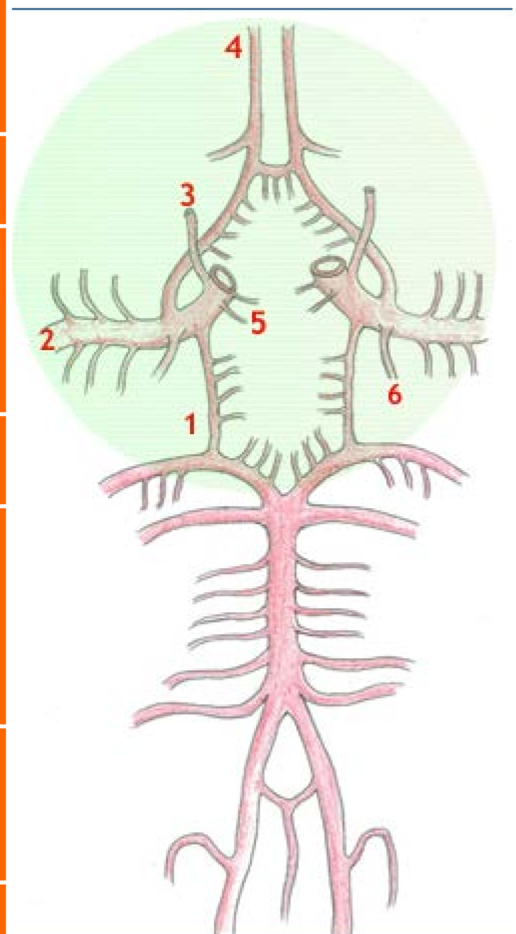
Links the internal carotid and vertebral basilararterial systems.



Distribution of central arteries

Central arteries, arise from the arterial circle and proximal portion of the principal arteries, penetrate the substance of the brain and supply the deep structures. The main groups of central arteries are:

Artery	Structures Supplied
Anterolateral arteries	• Anterior hypothalamus, • Pre-optic area • Supra-optic region
Posteromedial arteries	• Hypothalamus • Mammillary bodies • Subthalamic regions • Medial nuclei of the thalamus. • Midbrain tegmentum • Crus cerebri.
Posterolateral arteries,	• Caudal half of the thalamus.
Medial striate artery (recurrent artery of Heubner)	• Head of the caudate nucleus and • Putamen • Internal capsule
The lateral striate arteries	• Globus pallidus
The posterior choroidal arteries	• Tectum • Choroid plexus of the third ventricle • Superior and medial surfaces of the thalamus
lateral posterior choroidal arteries	• Choroid plexus in the lateral ventricle • Anterior choroidal artery
Anterior choroidal	• The hippocampus • Globus pallidus • Posterior limb of the internal capsule • Parts of the optic tract



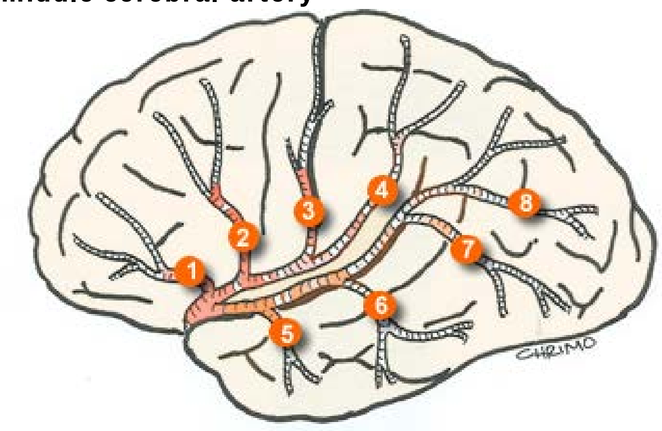
artery,	• Amygdaloid complex • The neostriatum • Ventrolateral parts of the thalamus

Blood supply to subcortical structures

Region	Arteries
Head of the caudate nucleus:	anterolateral ganglionic arteries
Putamen (striatum):	recurrent artery of Heubner
Globus pallidus (pallidum):	anterolateral ganglionic arteries, anterior choroidal artery
Thalamus:	posteromedial and posterolateral ganglionic arteries, anterior and posterior choroidal arteries
Subthalamus:	posteromedial and anterolateral ganglionic arteries
Hypothalamus:	anteromedial, posteromedial, and anterolateral ganglionic arteries
Pineal body:	posterolateral ganglionic arteries
Internal capsule:	anterolateral and posterolateral ganglionic arteries, anterior choroidal artery; recurrent artery of Heubner
Amygdala, uncus and hippocampal formation:	anterior choroidal artery, temporal branches of posterior cerebral artery
External capsule and claustrum:	anterolateral ganglionic arteries

Branches and distribution of cortical arteries

middle cerebral artery



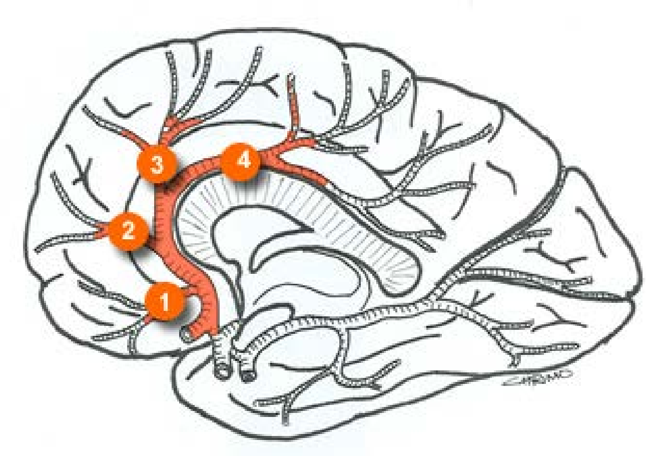
Branches

- **Orbitofrontal (1)**
- **Pre-rolandic (2)**
- **Rolandic branches (3)**
- **Anterior and posterior parietal branches (4)**
- **Anterior temporal (5)**
- **Posterior temporal (7)**
- **Angular artery**
- **Lenticulostriate arteries (central arteries)**

I

Anatomical areas supplied	Functional areas supplied	Effects of occlusion
• Lateral parts of the orbital gyri • Inferior and middle frontal gyri • Most of the pre-central • Post central gyri • Superior and inferior parietal lobules • Superior and middle temporal gyri.	• The motor and pre-motor areas • The somato-sensory • Auditory areas • Motor speech • Sensory speech • Pre-frontal area	• A severe contralateral hemiplegia, most marked in the upper extremity and face • Contralateral sensory impairement worse in the upper part of the body • Severe global aphasia

Anterior Cerebral artery



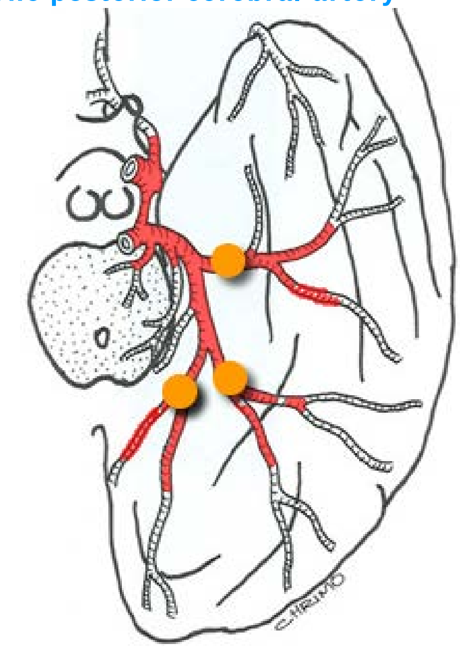
Branches

- The **medial striate (recurrent artery of Heubner)**
- **Orbital branches (1)**
- **Frontopolar artery (2)**
- **Callosomarginal artery (3)**
- **Pericallosal artery (4)**

Anatomical areas supplied	Functional areas supplied	Effects of occlusion
• Orbital and medial surfaces of	• Motor and sensory for lower	• **contralateral hemiplegia**,

the frontal lobe. • Paracentral lobule • Cingulate gyrus. • Medial surface of the parietal lobe	limb • Higher cognitive in pre-frontal areas • Cognitive impairment	which is greatest in the lower limb. • Impaired sensation in the lowe limb

The posterior cerebral artery

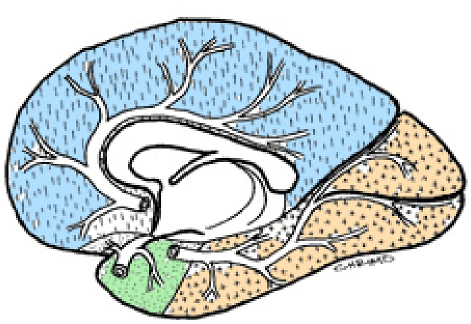


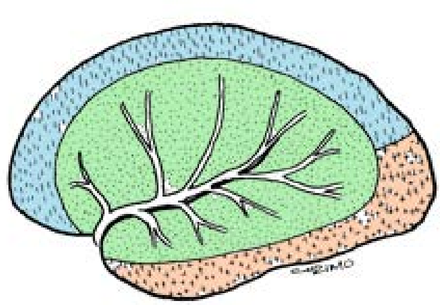
Branches

- Long quadrigeminal
- Thalamogeniculate
- parieto-occipital
- Calcarine
- Posterior temporal
- Anterior temporal
- Mesencephalic

Anatomical areas supplied	Functional areas supplied	Effects of occlusion
• Inferior temporal gyrus • Occipital lobe • Midbrain • Choroid plexus of the third and lateral ventricles • Splenium of the corpus callosum.	• The visual cortex • Crus cerebri • Limbic lobe	• Peripheral blindness with macular area sparing • Superior alternating hemiplegia • Limbic dysfunction

Summary of cortical blood supply





Region

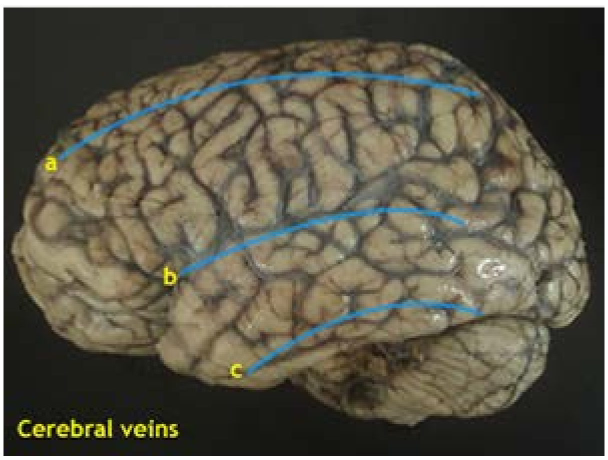
Anterior cerebral artery

Middle cerebral artery

Posterior cerebral artery

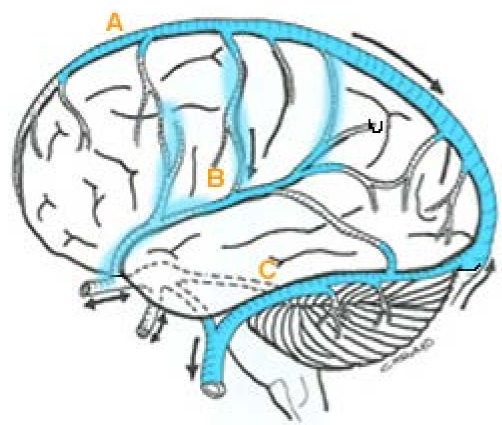
Cerebral Veins

- Consist of deep and superficial groups
- Devoid of valves.
- Superficial veins draining the cortex and subcortical white mater empty into the **superior sagittal** or **basal sinuses.**
- The **deep cerebral vein**s, draining the choroid plexus, periventricular regions, diencephalon, basal ganglia, and deep white mater, empty into the **internal cerebra**l and **great cerebral veins**.
- Numerous anastomotic channels interconnect deep and superficial veins



The **superficial cerebral veins**

1. Superior cerebral veins(a)
2. Superficial middle cerebral vein (b)
3. Inferior cerebral veins (c)
4. Anterior cerebral vein

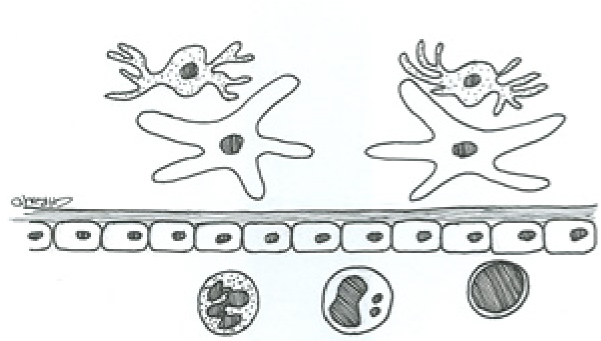


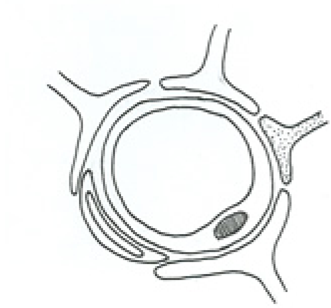
The **deep cerebral veins**

1. **Internal cerebral vein**
2. **Basal vein**
3. **Great cerebral vein**

Learning points | Core anatomy | Applied anatomy | Review questions

The Blood Brain Barrier





Components of the BBB

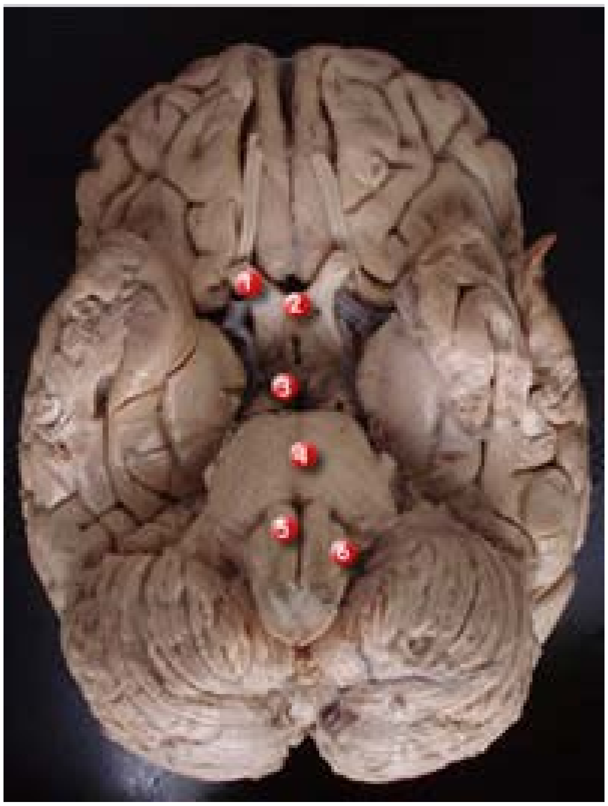
- Tight junctions between the capillary endothelial cells
- Continuous homogenous basement membrane
- Numerous astrocytic processes

Parts devoid of Blood Brain Barrier - circumventircular organs (CVO).

1. The pineal body
2. The subcommissural organ
3. The subfornical organ
4. The organum vasculosum of the lamina terminalis (supra-optic crest)
5. The median eminence
6. The neurohypophysis
7. The area postrema

Hover to show files

External anatomy of the base of brain



Structures identifiable on the ventral surface of the base of brain include:

- Optic chiasma, optic tracts.
- Mamilary bodies, infundibulum
- Crus cerebri, oculomotor nerve attachment.
- Basilar part of pons.
- Pyramids, olivary eminence.

The Cranial Nerves

No	Name		Main supply area	Function
1	Olfactory		Nasal Mucosa	Smell
2	Optic		Retina	Vision
3	Oculomotor		Eye muscles	Eye movements
4.	Trochlea		Eye muscles	Eye movements
5.	Trigeminal	Ophthalmic	Eye and forehead	Sensory

		Maxillary	Face over maxilla	Sensory
		Mandibular	Face over mandible Muscles of mastication	Sensory,Jaw movements
6	Abducens		Eye muscles	Eye Movements
7	Facial		Face muscles	Facial expression
8.	Vestibulocochlea		Inner ear	Hearing & balance
9	Glossopharyngeal		Tongue, pharynx	Sensory
10	Vagus		Larynx, Pharynx Thoracic and abdominal viscera	Motor, sensory and parasympathetic
11	Accessory		Trapezius and Sternocleidomastoid	Neck movements
12	Hypoglossal		Tongue Muscles	Tongue Movements

Applied Anatomy

Cerebello-Pontine angle tumors

Tumors at the CP angle compress CN VII and VIII, together with the pyramid and cerebellum. They present with CN VII/VIII defects together with motor deficits.

Interpenduncular fossa tumors may compress the:

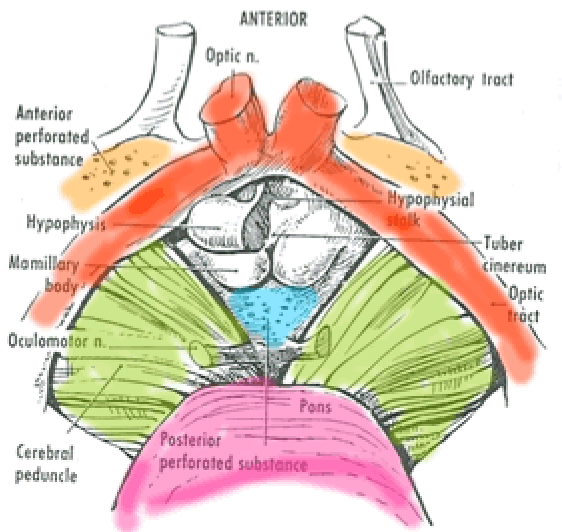
a) Hypothalamus
b) Oculomotor nerve
c) Crus Cerebri

The **circle of willis** is a frequent site of **berry aneurysms**

Review Questions:

1. State the position, relations, contents and clinical importance of the cerebellopontine angle
2. State the position, relations, contents and clinical importance of the inter penduncular fossae
3. State the site of attachement of cranial nerves to the brain stem and indicate the clinical relevance of this

- **The interpeduncular fossa**



The crus cerebri embraces a midline depression called the **interpeduncular fossa** .

Boundaries include:

Its boundaries are caudally the

Laterally : crus cerebri

Caudally: basal pons laterally theand

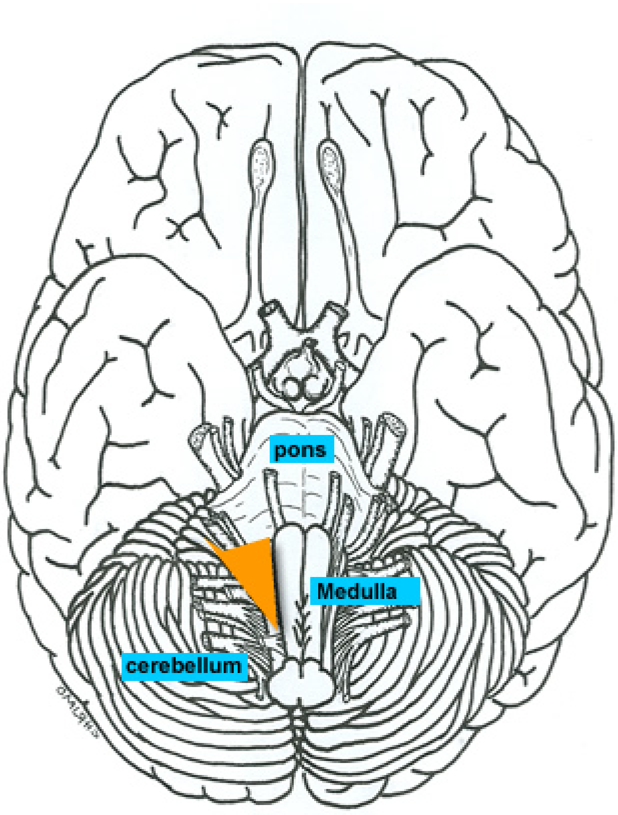
Rostrally: Optic chiasma and optic tracts.

Contents

- the mammillary bodies
- the oculomotor nerve
- the tuber cinereum
- the infundibular stalk

Task: Identify the structures labelled 1-4

Cerebello-Pontine Angle



Cerebello-pontine angle

Location

At to the caudal margin of the pons between the pons and the cerebellum.

Boundaries

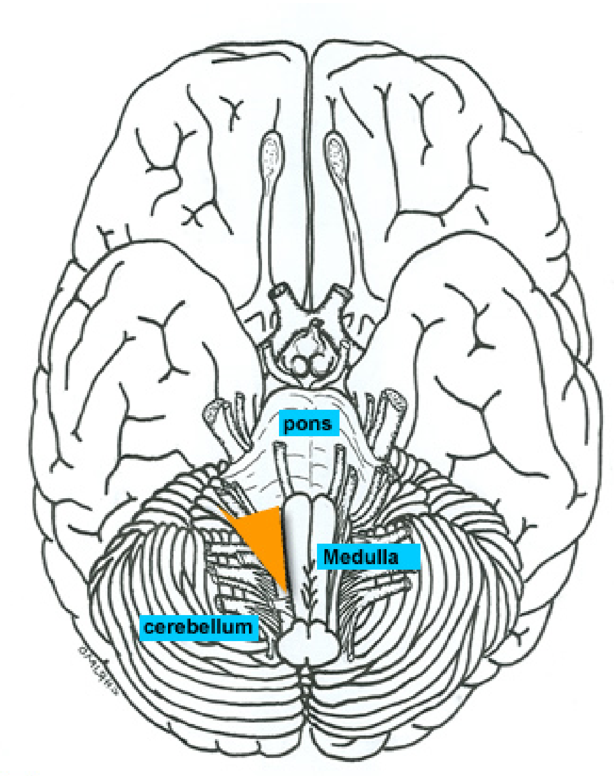
This space is bounded by:

a) the pons rostrally
b) the medulla caudally
c) and the cerebellum laterally.

Contents

1. facial nerve
2. vestibulocochlear nerve
3. Labyrinthine artery

Cranial Nerve	Site of attachement
Olfactory	Forebrain
Optic	Forebrain
Oculomotor	Midbrain - Ventral
Trochlear	Midbrain - Dorsal
Abducens	Medullo-pontine junction: Ventral
Facial	Cerebello-pontine angle
Vestibulocochlear	Cerebello-pontine angle
Glossopharyngeal	Medulla: Dorsal to olives
Vagus	Medulla: Dorsal to olives
Spinal Acessory	With Vagus
Hypoglossal	Medulla: Between olives and pyramids



Cerebello-pontine angle

Medial aspect of the brain

Hover to show names

The medial aspect of the brain shows the following structures:

a) Corpus callosum

b) Septum pellucidum

c) Fornix

d) Cingulate gyrus

e) Paracentral lobule

e) Third ventricle

f) Fourth ventricle

Clinical Anatomy

See respective sections

Review Questions:

1. Describe the parts, relations, blood supply, functions and disorders of corpus callosum

2. Describe the extents, blood supply and functions of cingulate gyrus

3. Write short notes on:

a) Fornix

b) Paracentral lobule

c) Septum pellucidum

OGanatomy J. Ogengo palsoftweblink

Learning points | Core anatomy | Applied anatomy | Review questions

Corpus callosum

- Most prominent and largest of the commissural fibres
- Reciprocally interconnects broad regions of the opposite hemisphere
- Forms the roof of the lateral ventricles
- Lies below cingulate gyrus
- Connected to fornix by septum pellucidum
- Has the following parts:

a) Rostrum **(1)**
b) Genu **(2)**
c) Body **(3)**
d) Splenium **(4)**

- Receives blood supply from pericallosal branches of anterior cerebral artery and the posterior cerebral artery.

- It plays an important role in inter-hemispheric transfer of learned discriminations, sensory experience and memory.

Functional Localization in the Corpus Callosum

1. Anterior midbody transfers motor information
2. Posterior midbody transfers somatosensory information
3. Isthmus transfers auditory information and the splenium transfers visual information

Other Commissures

Anterior Commissure	Fornical commissure	Habenular commissure	Commissure of the colliculi	Posterior commissure
Crosses the midline rostral to the columns of the fornix It splits into: 1. A small anterior/ olfactory portion:	Connects the two crura of the fornix.	Connects the habenular nuclei	Connect the corresponding colliculi	Transition between brainstem and diencephalon Has fibres from

Connect the olfactory bulbs

2. A larger anterior portions: Connect the medial temporal gyri.

a) Pretectal nuclei

b) Nuclei of posterior commissure

c) Interstitial nucleus

d) Nucleus of darkschwitch

Applied Anatomy

Split Brain Syndrome

Definition:

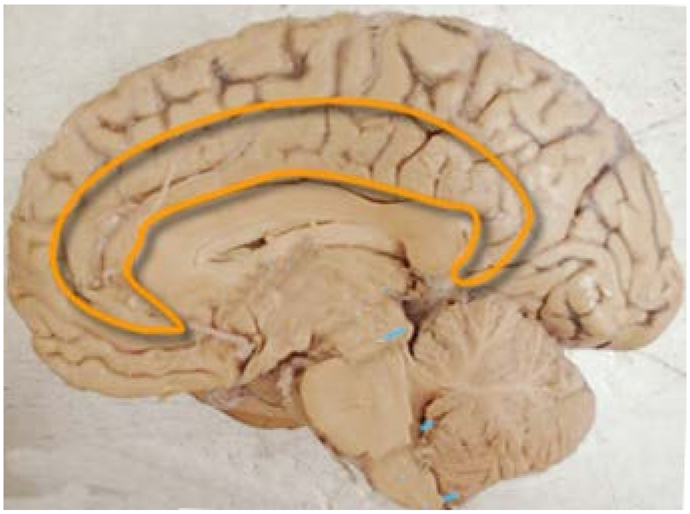
collection of signs and symptoms seen/observed in patients with partial or complete absence of corpus callosum.

Causes:
1) Underdevelopment or agenesis in the corpus callosum
2) Surgical severance of corpus callosum
3) Callosal injuries

Affected Functions

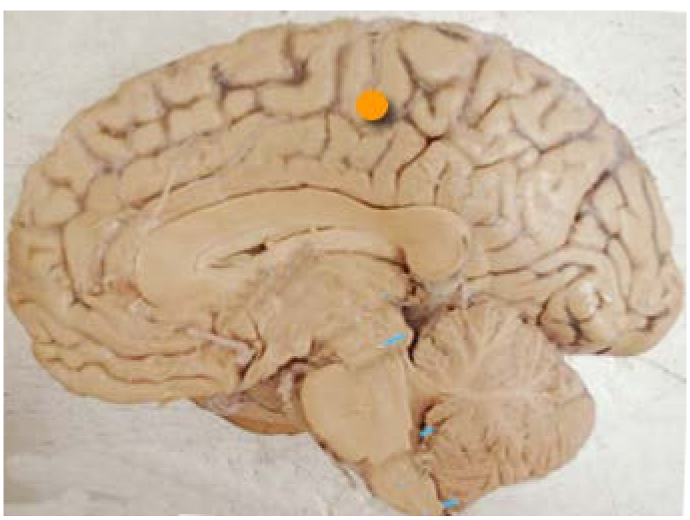
- Memory and cognition
- Motor Control:

Gingulate Gyrus



- Lies between **corpus callosum** and **cingulated sulcus**
- Cingulate cortex overlies the **cingulum**, the largest association bundle
- The part posterior to splenium of corpus callosum is called **isthmus** of cingulate gyrus
- Beyond isthmus, it imperceptibly becomes **parahippocampal gyrus**
- Receives blood supply from cingulated branches of **anterior cerebral** and **pericallossal** arteries
- Main **function** is **limbic**

Paracentral Lobule



- Sorrounds the medial end of the **central sulcus**
- Abuts on the falx cerebri
- Lodges **sensory** and **motor** functions of the **lower limb**
- Supplied by **anterior cerebral artery**
- Damage to it causes **paraplegia**

Fornix

Origin: Hippocampal formation

Course:

Lateral wall of lateral ventricle
Superior and medial to choroid plexus

Parts:

Alveus
Fimbria
Crura
Body
Columns

Termination

Septal areas
Mamillary bodies

Function:

Major association bundle of limbic system

Septum pellucidum

- Extends between **corpus callosum** and **fornix**
- Separates anterior horns of left and right ventricle
- Has **two fused layers**
- May contain a cavity- **cavum septum pellucidum** (5th ventricle)
- Implicated in **pleasure**, **mood**, **rage** and **sexual gratification**

Damage or **abscence** causes:

1. Hypothalamic dysfunction
2. Hypopitituarism
3. problems of vision, coordination and intelligence
4. Sham rage

Functions: it is implicated in pleasure, mood, rage, and sexual gratification.

Pineal Gland

Diverticulum of ependyma in the roof of 3rd ventricle between habenular and post commissures

Recesses

- Habenular
- Infundibular
- Suprapineal
- Optic

Blood supply

•Part of Circumventricular organs
•Posterior choroidal artery

•Drainage: internal cerebral veins; basal veiinns of Rosenthl; vein Galen s andinus recti

Functions

•Antigonadotrophic: delayed pubescence and precocious puberty
•Neuroendocrine transducer
•Control endocrine activity- thyrotropin RH; LHRH, somatostatin
•Endocrnie gland: melatonin, serotonin, norepinephrine by sympathetic neurones

• Biological clock mechanisms: circadian rhythms

Applied anatomy

Tumors can compress the pineal gland and lead to various presentations such as:

•Aqueductal compression obstructive hydrocephalus: H,N V

•Superior colliculus- infiltration/ compression: vertical gaze palsy (Parinaud`s syndrome), pupillary or oculomotor nerve paresis

•Posterior commisure: consensual light reflex

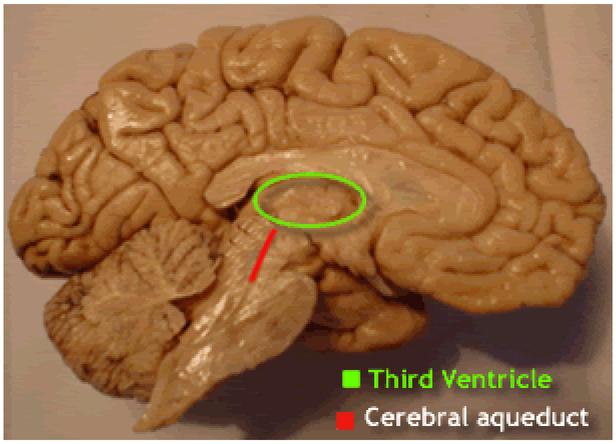
•periaqueductal gray region: mydriasis, convergence spasm, pupillary inequality, and convergence or retractory nystagmus

•Ventral midbrain: impairment of downgaze

superior cerebellar peduncle- ataxia and dysmetria

•**Endocrine malfunctions**
–Pseudoprecautious puberty caused by beta human chorionic gonadotropin- bhCG
–Secondary amenorrhea in over 12year old girls

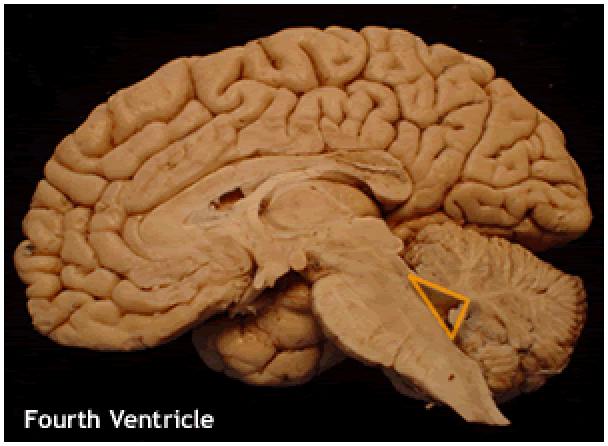
Third Ventricle



Boundaries	Recesses:
• Roof: Covered by membrane stretching between habenular nuclei and stria medullaris. • Lateral wall: Thalamus and hypothalamus. ◦ The two thalami joined by interthalamic adhesion. • Floor: Parts of hypothalamus.	• Pineal • Chiasmatic • Suprachiasmatic

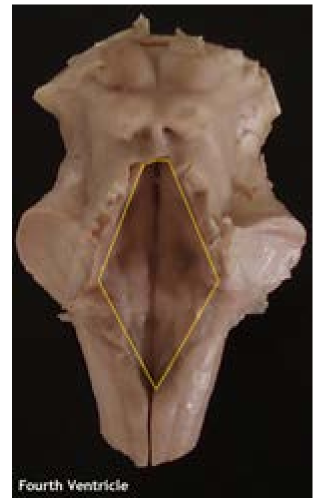
The Fourth Ventricle

Boundaries:

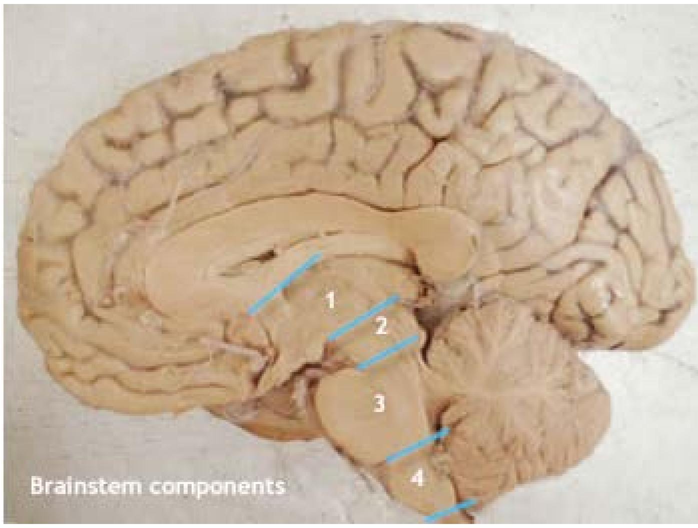


- Roof: Cerebellum, superior medullary velum.
  Lateral wall: cerebellar peduncles.
- Floor:
  Caudal dorsal pons
  Rostral dorsal medulla which contains the

1. Facial colliculi
2. Vestibular triangle
3. Stria medulare,
4. Hypoglossal trigone
5. vagal trigone.



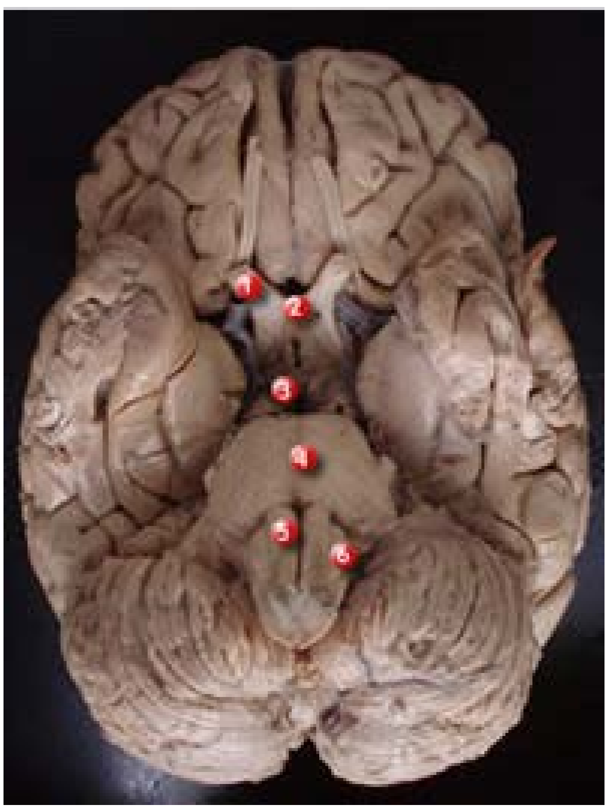
ANATOMY OF THE BRAINSTEM



The components of the brainstem include:

1. Diencephalon (thalamus, epithalamus, hypothalamus, subthalamus)
2. Midbrain
3. Pons
4. Medulla oblongata

External anatomy of the brainstem



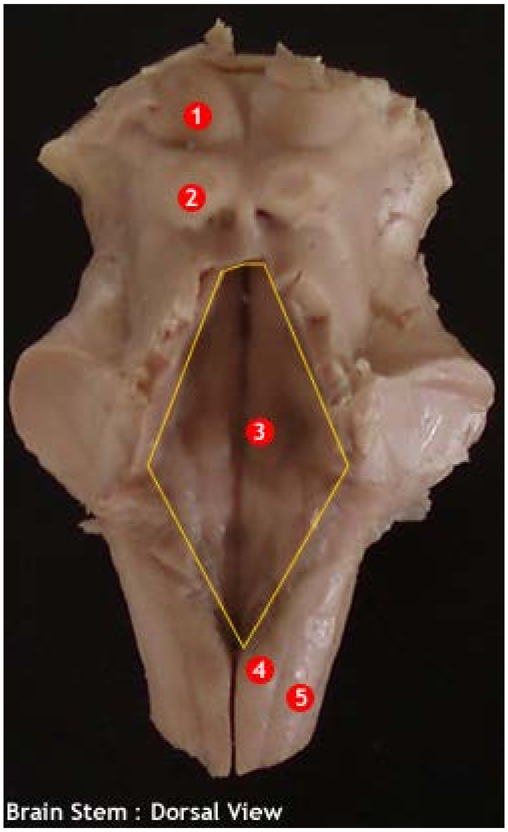
Structures identifiable on the ventral surface of the brainstem include:

- Optic chiasma, optic tracts.
- Mamilary bodies, infundibulum.
- Crus cerebri, oculomotor nerve attachment.
- Basilar part of pons.
- Pyramids, olivary eminence.

The transition from the medulla to spinal cord characterized by:

- Anterior median fissure appears
- The pyramid disappears
- Reduction in size
- Appearance of spinal nerves

task ***What occurs in the spinomedullary junction histologically?***



On the dorsal aspect, the following parts of the brainstem are identifiable:

- Thalamus (with the caudal part, pulvinar overlying part of the midbrain).
- Epithalamus (pineal, habenular, stria medullaris).
- Superior colliculi and brachium.
- Inferior colliculi and brachium.
- Trochlear nerve emerging caudal to inferior colliculi.
- Rhomboid fossa overlying pons/medulla.
- Cuneate and gracile tubercles.

Clinical Anatomy

See respective sections

Review Questions:

1. Give an account of the external features, relations, nuclei , tracts, blood supply, connections and applied anatomy of.

   a) medulla oblongata
   b) pons
   e) mid brain

2. State the changes that occur at the spinomedullary junction.

3. Write short notes on:

   a) Nucleus ambigous

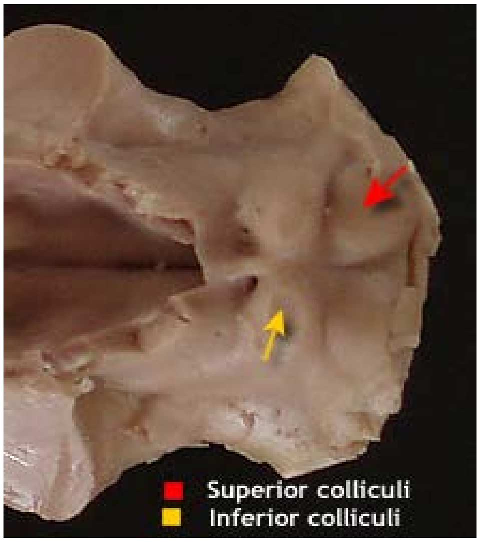
   b) Alternating hemiplegias

   c) Medial longitudinal fasciculus

   d) Anterior perforated substance

   e) Circumventricular organs

The Midbrain



The central aqueduct is distinctive. Dorsal to this is the tectum with four colliculi.

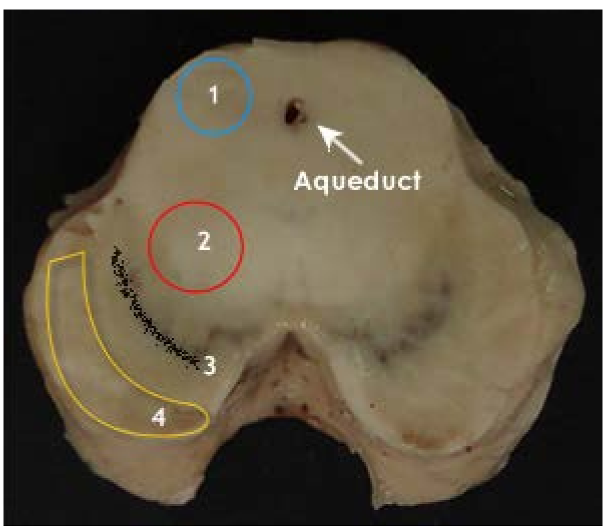
- Superior colliculi process visual sensations.
- Inferior colliculi process auditory sensations.

Red nucleus is most distinctive in the midbrain tegmentum. It integrates information from cerebrum and cerebellum (involuntary motor control)

Its fibers to the spinal cord (rubrospinal) transmit impulses that facilitate flexor muscle tone.

Structures dorsal and lateral to the red nucleus form the midbrain reticular formation.

task ***What do you consider to be the main functions of the reticular formation?***



The mibrain consists of four main parts:

- Tectum(1)
- Red nucleus(2)
- Substantia nigra (3)
- Crus cerebri (4)

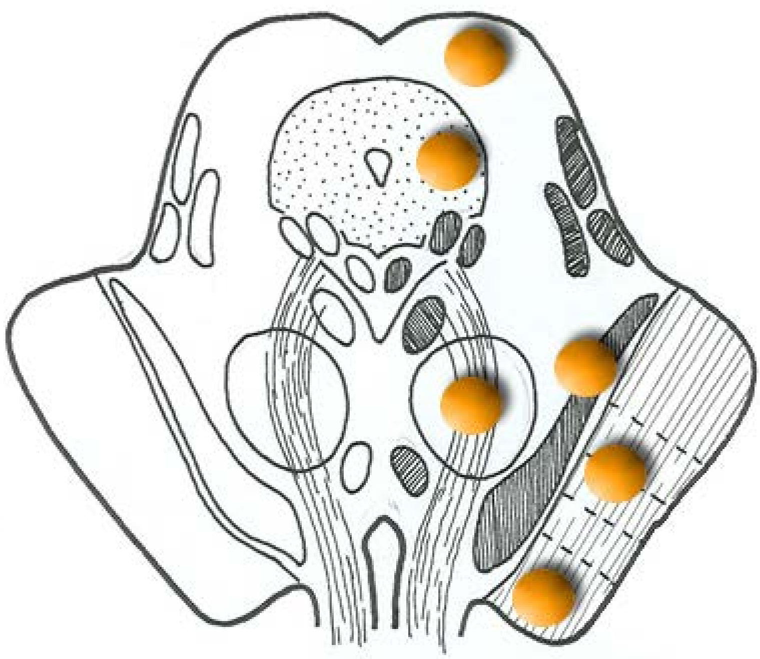
Around the aqueduct is the periaqueductal gray. It contains nuclei of oculomotor and trochlear nerves.

The most prominent structure in the tegmentum is the red nucleus but the tegmentum, also contains ascending tracts.

The substantia nigra consits of melanin containing neurons tha regulate motor output of cerebral cortex

Crus cerebri represents a bundle of projection fibers.

Click on hot spots to show names



\- cross section of the midbrain.

- Mesencephalic nucleus.
- Medial lemniscus.
- Decussation of superior cerebellar peduncle.
- **Inferior / superior Colliculi.**
- Descending fibers from motor cortex.
- Nuclei of cranial nerve and gray matter.
- **Periaqueductal gray**
- Oculomotor/trochlear nucleus
- Edinger Westphal
- **Red nucleus**
- **Substantia nigra**
- Mesencephalic reticular formation

Cranial nerve nuclei include

1. **Oculomotor nuclei** and **accessory oculomotor nucle**i (Edinger Westphal).
2. **Trochlea nuclei** at the level of the inferior colliculi.
3. **Mesencephalic tract** and **nucleus of CN V**.

b) **Other nuclei include**

Nucleus	Function	Main connections
Red nucleus	- Control of pattern of movement - Postural reflexes	- Cerebellum, reticular formation, spinal cord - Sensori motor corlex
Substantia Nigra	Control of movement	- Sensorimotor cortex, - Corpus striatum - Reticular formation
Superior colliculus	Visual reflexes	- Retina - Spinal cord
Pre-tectal nuclei	Pupillary reflex	- Retina - Accessory CN III
Inferior colliculus	Auditory reflex	- Cochlear nuclei

		- Spinal cord
Reticular formation	- Motor control - Cortical activation	- Spinal cord - Cerebral cortex - Thalamus

c) Fibre tracts

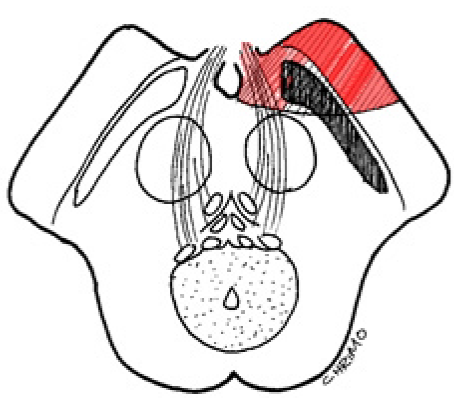
Crus cerebri	corticospinal, corticnuclear and corticopontine fibres
Medial lemniscus	from nucleus Gracilis and cuneatus (dorsal columns)
Spinal lemniscus	spinothalamic and spinotectal
Lateral lemniscus	auditory from cochlear nuclei

d) Mid brain decussations

Decussation of superior cerebellar peducles:	Fibres arise form cerebellar dentale nucleus and end in the contalateral red nucleus (Dentantorubral)
Tectospinal decussation (posterior tegmental)	Contralateral fibres from superior colliculus to cervical cord.
Rubrospinal decussation (Anterior tegmental)	Fibres from red nucleus to contralateral anterior horn cells. These fibres relay also in the reticular formation.

Blood supply to the midbrain
Most of the blood supply is derived from branches of the basilar artery.

1. Posterior cerebral
2. Superior cerebellar
3. Posterior communicating
4. Anterior choroidal



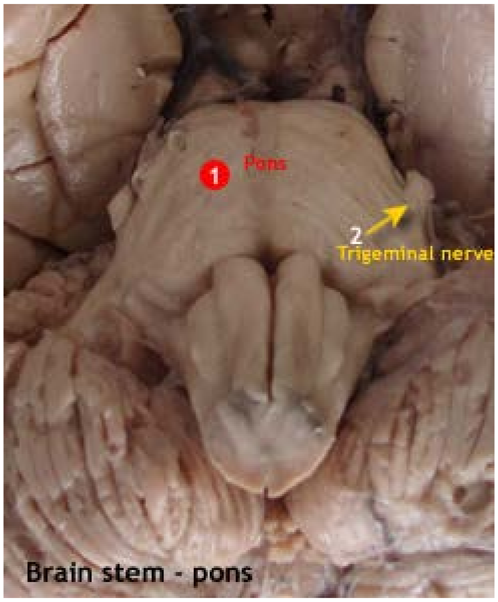
Red area: shows area of vascular lesion involvement

Vascular lesions of the midbrain include:
Weber's syndrome, which involves the basal portion of the midbrain due to occlusion of a **mesencephalic branch of the posterior cerebral artery**.

Area of infarction involves:

1. **Pyramidal fibres**- contralateral hemiparesis.
2. **Oculomotor nerve** - ipslateral paralysis of the ocular muscles except the lateral rectus and superior oblique.

The Pons



The pons consists of two parts i.e

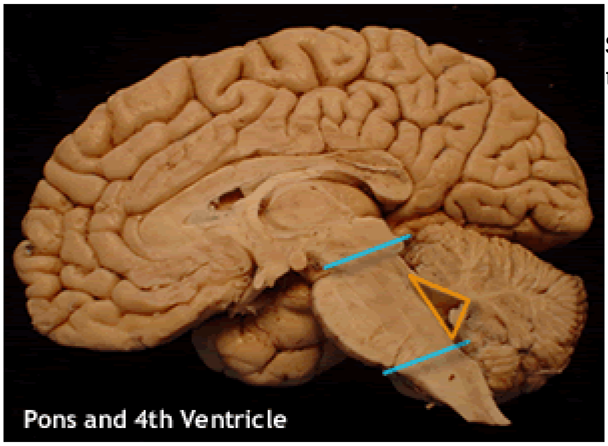
- Ventral basal pons
- Dorsal pontine tegmentum

The basal pons makes a ventral bulge with a median basilar sulcus which lodges the basilar artery.

The pons contains cranial nerve nuclei, ascending and descending tacts, many pontine nuclei including an extensive reticular formation.

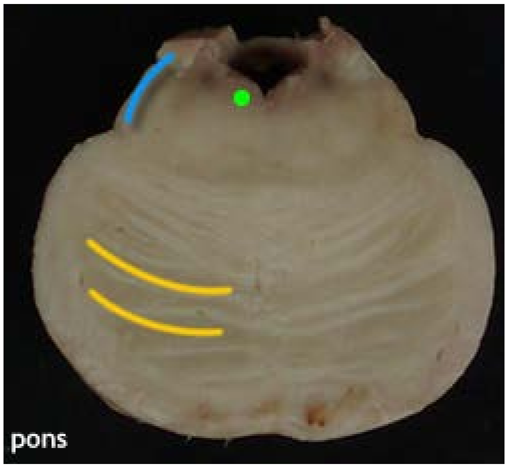
Cranial nerves attached close to the pons include:

- Trigeminal: Junction of pons and middle cerebellar peduncle.
- Abducent: Junction of pons and pyramid.
- Facial: Junction of pons with olive.
- Vestibulocochlear: Crebellopontine angle.



Sections through the pons and pontine tegmentum characterized by the presence of the following:

- Dorsal fourth ventricle - dorsal.
- Longitudinal descending fibers - ventral.
- Transverse fibers to the cerebellum - ventral.
- Pontine nuclei - ventral.
- Reticular formation - dorsal.
- Medial lemniscus fibers - dorsal.
- Vestibular nuclei - dorsolateral.
- Spinothalamic fibers.
- Nuclei of trigeminal, abducent, facial nerve.
- Trapezoid body and nucleus.
- Locus ceruleus.



The cranial nerve nuclei include

- abducens
- Facial
- Motor part of trigeminal
- Chief sensory nucleus of trigeminal
- Vestibular nerve

Other nuclei include the following

- **Pontine nuclei**. These relay information from the neocortex to the cerebellum. **Corticopontine fibres** terminate in the pontine nuclei, and **pontocerebellar fibres** arise from these nuclei and enter the cerebellum as the middle cerebellar peduncle.
- **Dorsal nucleus of trapezoid body** (superior olivary). This acts as a relay station for some fibres of the cochlea projection. Some of the axons eventually synapse in trochlear an oculomotor nuclei.
- **Pontine reticular formation nuclei**. These control lacriminal glands (lacriminal nucleus) or salivary glands (superior salivatory) or control cardiorespiratory function.

Fibre tracts include the following

- **Corticospinal** continuing into the pyramid
- **Corticonuclear** terminating on CN, V, VI and VII.
- Corticopontine
- **Trapezoid** body which eventually forms lateral lemniscus
- **Ascending tracts** – spinothalamic, medial lemniscus
- Interconnecting fibres such as medial longitudinal fasciculus (MLF)

Blood supply to pons

This is mainly from pontine branches of the basilar artery.

These are grouped into 3:

i) **Paramedian branches** which supply the medial pontine region encompassing:

(+) Pontine nuclei
(+) Corticopontine

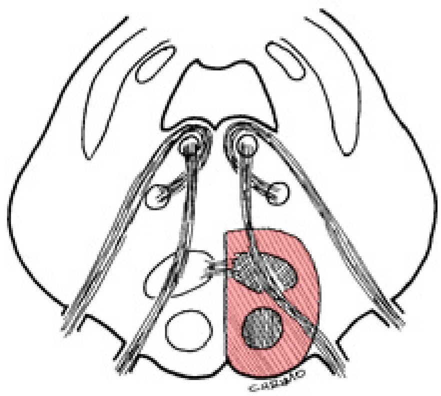
(+) Corticospinal
(+) Corticobulbar tracts

ii) **Short circumferential arteries** supplying adjacent anterolateral part of the pons and variable parts of the overlying tegmentum.

iii) **Long circumferential arteries**, which supply lateral parts of middle cerebellar peduncle, and most of the pontine tegmentum.

iv) **Anterior inferior cerebellar artery** supplying caudal pontine tegmentum.

Vascular lesion



Vascular lesions of the pons may result from occlusion of a pontine branch of the basialr artery.

The area of infarction may involve the following structures and hence the respective disorders:

a) **Corticospinal fibres**: contralateral hemiparesis.
b) **Abducens nerve**: Paralysis of ipsilateral rectus muscle with medial strabismus or squint.

Cerebello Pontine Angle

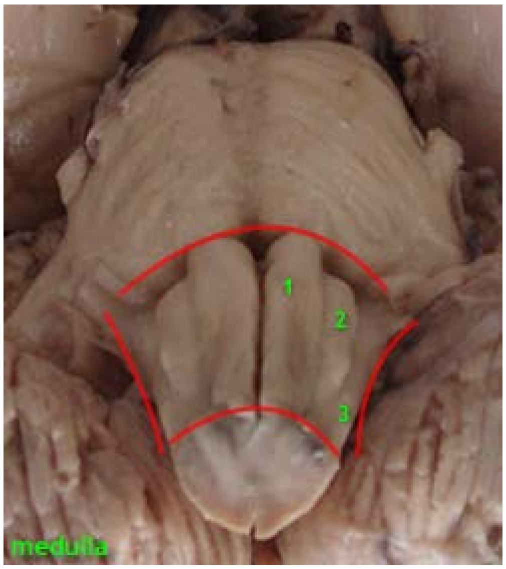
- Angle between the pons and the cerebellum.
- Bounded by:

  (+) Pons - rostrally
  (+) Medulla - caudally
  (+) Cerebellum -laterally

- Two nerves found in that interval i.e. the **facial** and **vestibulocochlear**.

Tumors at the CP angle compress CN VII and VIII, together with the pyramid and cerebellum. They present with CN VII/VIII defects together with motor deficits

Medulla Oblongata

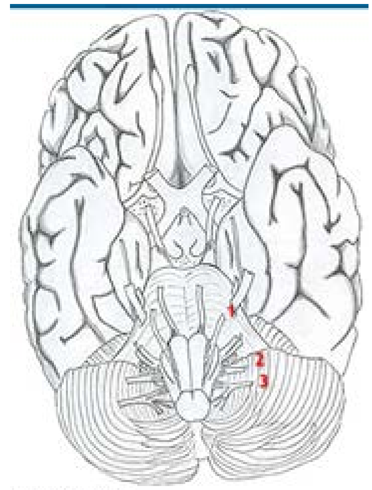


The medulla extends from **foramen magnum** to **pons.**

Transition from spinal cord to medulla is characterized by:

- Obliteration of median fissure by pyramidal decussation
- Appearance of gracile and cuneate tubercles
- Appearance of cranial nerves
- Appearance of fourth ventricle
- Dissapearance of spinal nerves
- Cranial nerves associated with the medulla include:
  - Hypoglossal - between pyramid and olive.
  - Glossopharyngeal post -olivary sulcus.
  - Vagus post - olivary sulcus.
  - Accessory post - olivary sulcus.
  - Vestibulocochlear - cerebellopontine angle.

The caudal medulla is closed but the cranial half is open dorsally (fourth ventricle).



cranial nerves

Its external appearance is characterized by the **pyramid** anteriorly, **olive** anterolaterally, **tuberculum cinereum** posterolaterally , **gracile** and **cuneate** tubercles dorsally and the attached nerves

The medulla relays sensory information to thalamus and contains major regulatory centers in its reticular formation

It also a number of nuclei:

- Relay nuclei - gracilis, cuneatus, olivary.
- Sensory and motor nuclei of cranial nerves vestibulocochlear, glossopharyngeal, vagus, accessory and hypoglossal nerves).

The internal anatomy of the closed and open medulla demonstrates the following structures .

- Fourth ventricle and central canal and central gray

Nuclei:

- Hypoglossal
- Cuneate and accessory cuneate
- Gracile
- Trigeminal (spinal)
- Ambiguus (for IXN, XN, XIN)
- Dorsal motor nucleus of vagus
- Vestibular
- Olivary
- Reticular

Fiber bundles

- Fasciculus gracilis
- Fasciculus cuneatus
- Pyramidal
- Spinal tract of trigeminal
- Medial lemniscus
- Internal arcuate
- Hypoglossal fibers
- Inferior cerebellar peduncle
- MLF

Blood supply to the medulla oblongata

Four main arteries supply the medulla oblangata

• **Anterior spinal arteries** supplying the antero-medial structures namely

- Pyramids

- Medial lemniscus

- Hypoglossal nucleus

- Medial Longitudinal fasciculus

- Solitary and vagal nuclei

• **Posterior spinal** arteries supplying the fasciculus and nucleus gracilis and cuneatus

• **Posterior inferior cerebellar artery** supplying the retro-olivary region, including

- Spinothalamic tract

- Spinal trigeminal nucleus

- Nucleus ambiguus

Hypothalamo spinal tracts

• **Bulbar branches** of the vertebral artery supplying the pyramids, hypoglossal, nucleus, and inferior olivary nuclear complex.

Tracts of the Medulla Oblangata

The medulla oblangata contains all the tracts ascending to the brain, and those descending to the spinal cord. Key among them are

Ascending tracts	Descending tracts
• Medial lemniscus • Fasciculus cuneatus • Fasciculus gracilis • Spinocerebelar tracts • spinotectal tracts • ventral spinothalamic	• Rubrospinal • Vestibulospinal • Reticulospina • lSpinal tracts of the trigeminal • Cortico-spinal tract

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Nuclei of the Medulla Oblangata

Nucleus	Function	Main connections
Solitarius (Gustatory)	Taste	Thalamus, CN VII, IX, X
Gracilis and cuneatus	Proprioception and fine touch	Fasciculus gracilis and cuneatus, Thalamus, Cerebellum
Inferior olivary	Control of muscle Activity	Spinal cord, Cerebellum
Inferior salivatory	Control of parotid gland	Gustatory nucleus ,CN IX
Reticular formation: vasomotorand respiratory centres. Chemoreceptor trigger zone	Control of ardiorespiratory and GIT functions.Control of motor activity	Vagal nuclei, nuclei of phrenic and intercostals nerves. Spinal cord. Brain stem.

Applied anatomy

Medial medullary syndrome results occlusion of a anterior spinal artery or bulbar branches of the vertebral artery.

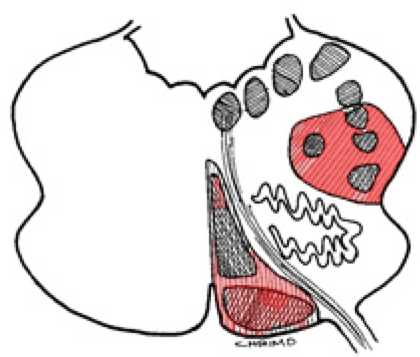
Structures normally included in the area of infarction are:

i) Medial lemniscus

ii) Pyramid

iii) Hypoglossal nerve

Sensations of **position, movement, discriminative touch** and **vibrations** on the opposite side of the body



Lateral medullary syndrome

Results from occlusion of the posterior inferior cerebellar artery or a medullary branch of it.

Lesions normally includes the following structures with the respective deficits:

i) **Spinal trigeminal tract and nucleus** : Ipsilateral loss of pain and temperature in the areas of distribution of the trigeminal nerve.

ii) **Spinal lemniscus** : loss of pain

(interruption of medial lemniscus) and **ipsilateral paralysis of the tongue** due to the involvement of the hypoglossal nerve.

This disorder forms an example of a crossed or alternating paralysis in which the body is affected on the opposite side, but the muscles supplied by the cranial nerve affected are on the same side. This particular condition is known as " **alternating hypoglossal hemiplegia** " or **inferior alternating hemiplegia** .

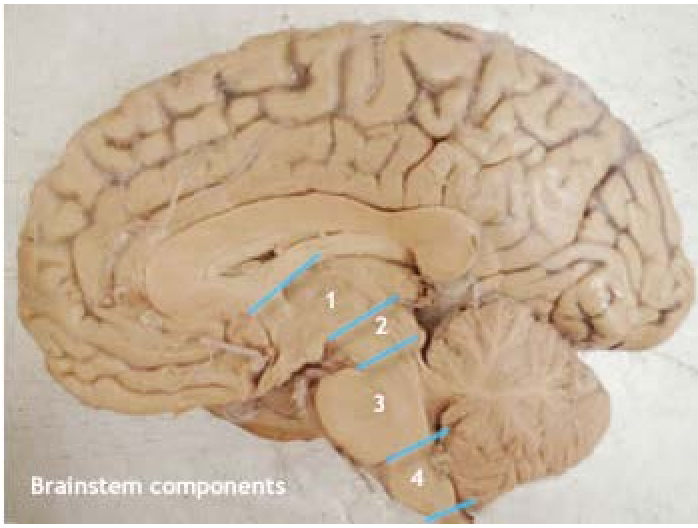
and temperature sensibilities on the opposite side of the body. Touch is diminished rather than lost (explain why).

iii) **Nucleus ambiguus:** ipslateral paralysis of the muscle of the palate in swallowing and phonation (explain why).

iv) **Hypothalamospinal tract** : Horner's syndrome characterised by small pupil, ptosis (drooping of eyelids) and anhidrosis (explain why).

Vi) **Inferior cerebellar penduncle and vestibular nuclei** : if included caused dizziness, cerebellar ataxia and nystagmus.

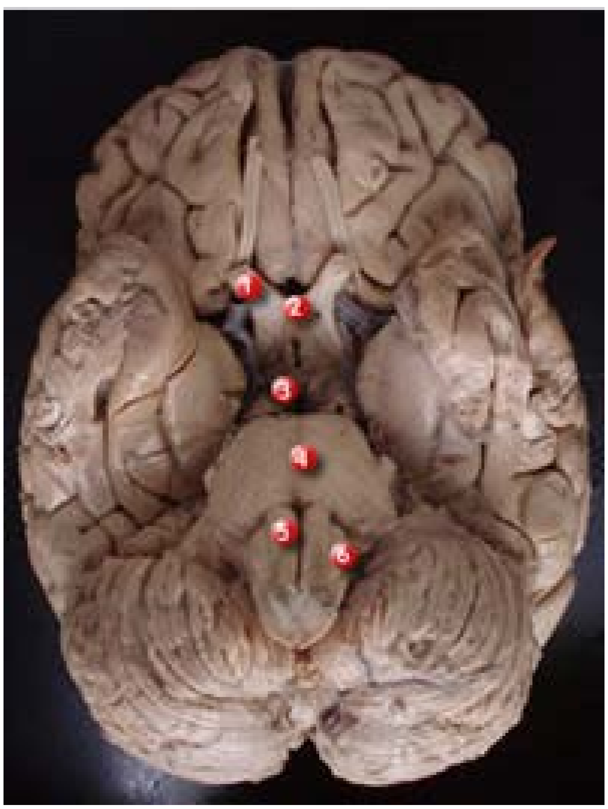
ANATOMY OF THE BRAINSTEM



The components of the brainstem include:

1. Diencephalon (thalamus, epithalamus, hypothalamus, subthalamus)
2. Midbrain
3. Pons
4. Medulla oblongata

External anatomy of the brainstem



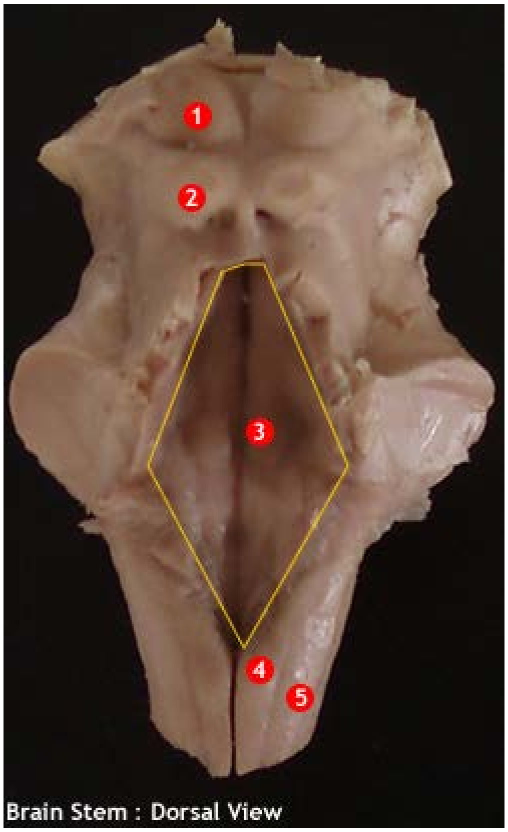
Structures identifiable on the ventral surface of the brainstem include:

- Optic chiasma, optic tracts.
- Mamilary bodies, infundibulum.
- Crus cerebri, oculomotor nerve attachment.
- Basilar part of pons.
- Pyramids, olivary eminence.

The transition from the medulla to spinal cord characterized by:

- Anterior median fissure appears
- The pyramid disappears
- Reduction in size
- Appearance of spinal nerves

task ***What occurs in the spinomedullary junction histologically?***



On the dorsal aspect, the following parts of the brainstem are identifiable:

- Thalamus (with the caudal part, pulvinar overlying part of the midbrain).
- Epithalamus (pineal, habenular, stria medullaris).
- Superior colliculi and brachium.
- Inferior colliculi and brachium.
- Trochlear nerve emerging caudal to inferior colliculi.
- Rhomboid fossa overlying pons/medulla.
- Cuneate and gracile tubercles.

Clinical Anatomy

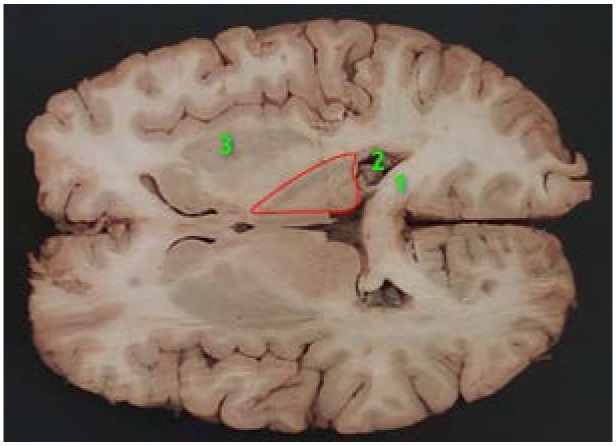
See respective sections

Review Questions:

1. Give an account of the external features, relations, nuclei , tracts, blood supply, connections and applied anatomy of.

   a) thalamus
   b) hypothalamus

The Diencephalon



This part of the brainstem has the following relations:

- Medially, third ventricle.
- Laterally, internal capsule and caudate nucleus.
- Superiorly, lateral ventricle, corpus callosum, fornix.
- Rostrally, interventricular foramen and lamina terminalis.

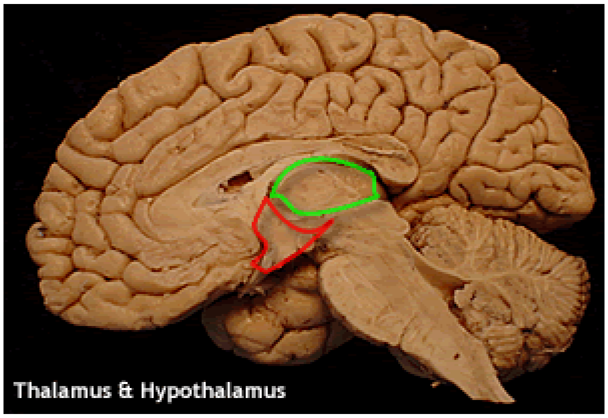
Subdivisions of the diencephalon:

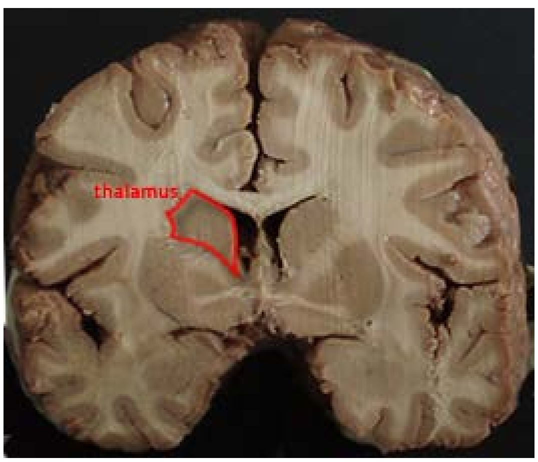
- Epithalamus (pineal gland, habenular nuclei, striae medullaris)
- Thalamus
- Hypothalamus
- Subthalamus

palsoftweblink

Learning points | Core anatomy | Applied anatomy | Review questions

The Thalamus





An egg shaped mass whose extent is:

- **Foramina of Monroe** to the **posterior commissures**.
- The third ventricle to the posterior limb of internal capsule.

The posterior enlarged part (pulvinar) overlies the midbrain.

Structures related to its dorsal surface include:

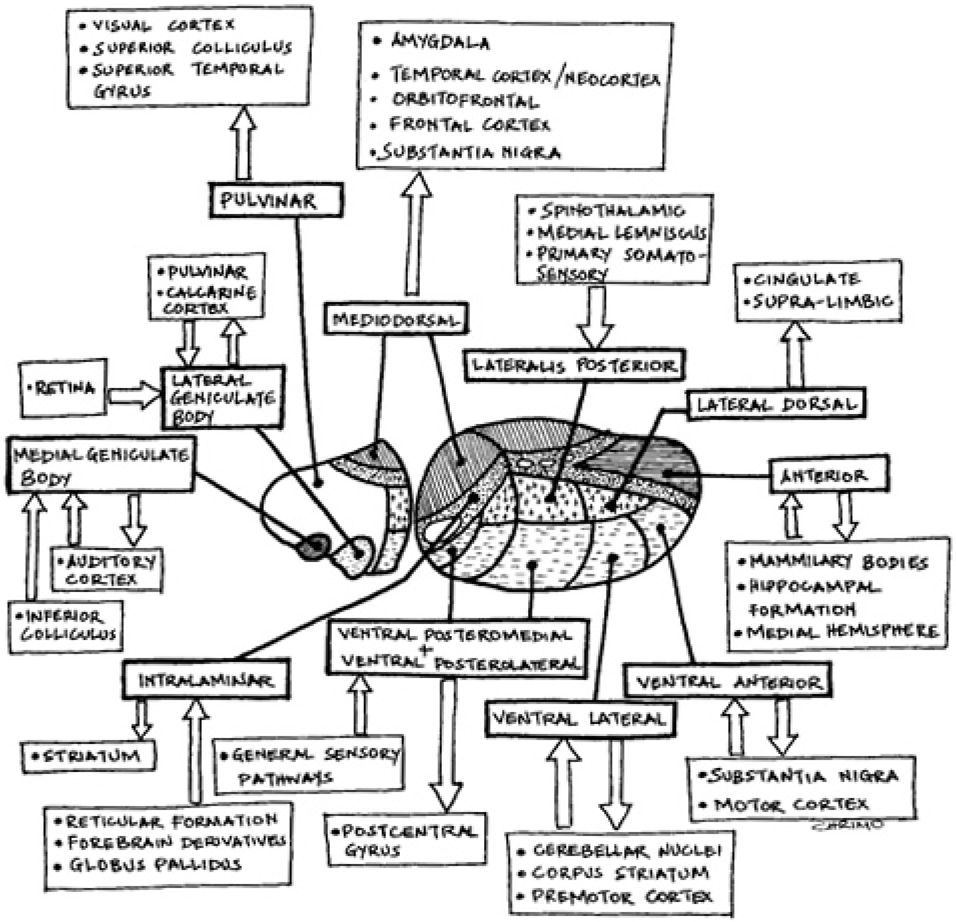
- Striae terminalis
- Terminal vein
- Striae medullaris

It is joined with the opposite medially by interthalamic adhesion.

The internal medullary lamina divides the thalamus into nuclear groups:

- Anterior
- Medial
- Lateral
- Ventral
- Nuclei within the he lamina are termed intralaminar.

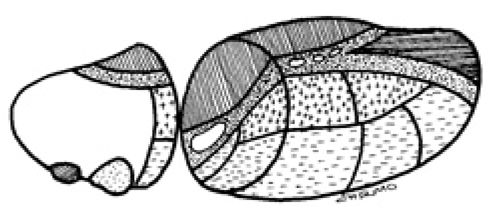
Connections



Functions:

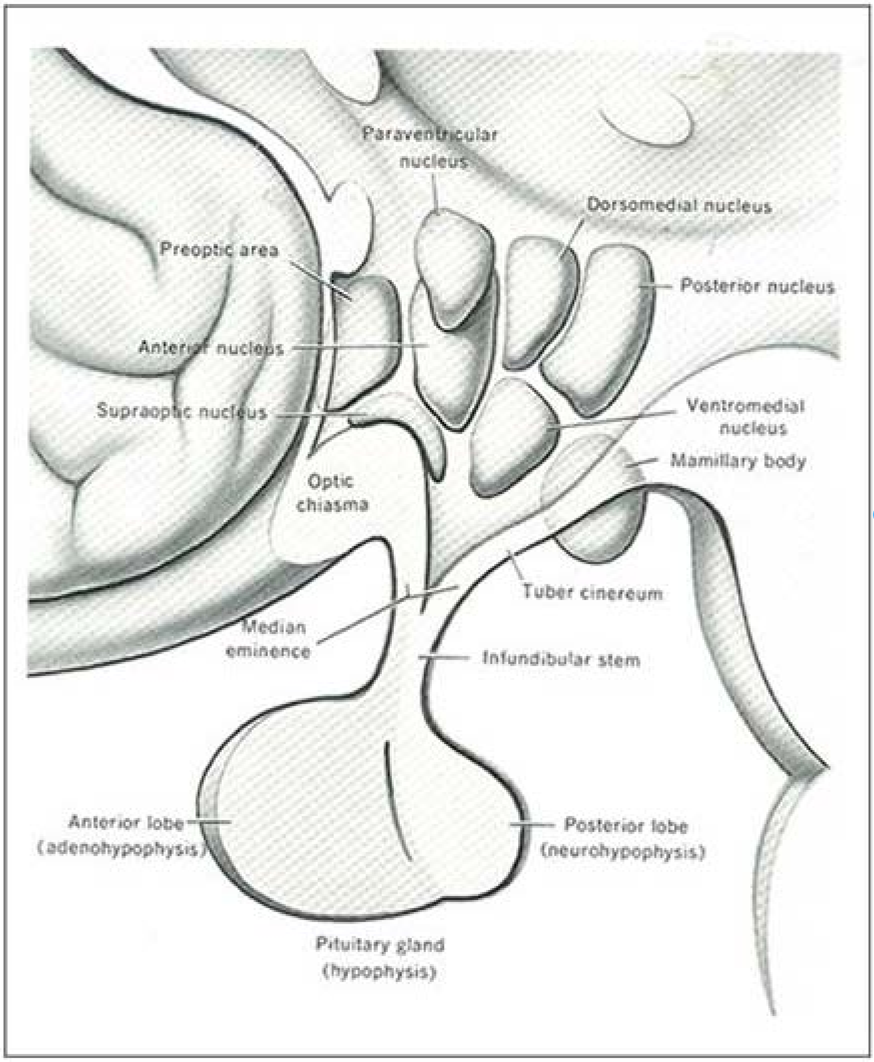
- Relay/processing/filtering center for sensory information
- Distribution of most afferent input to cortex.
- Control of electrocortical activity of the cortex (attention, alertness, consciousness).
- Integration of motor functions (relays inputs to cerebellum, striatum etc).

Functions of specific nuclei:



- **Anterior group:** part of limbic system (mamillothalamo-cortical sytem).
- **Medial group:** integrate sensory data for projection to frontal lobe.
- **Ventral group:** integrate sensory data for projection to primary sensory cortex (VPL, VPM).
- **Posterior LGB** project visual information to occipital cortex.
- **Posterior MGB** project auditory information to auditory cortex.
- **Intralaminar / midline** receive from brainstem reticular formation and project diffusely to cortex.

The Hypothalamus



- It forms the lateral wall and floor of third ventricle.
- Parts of the hypothalamus visible on the base of the brain include the infundibulum, tuber cinerium and mamillary bodies.
- Tuber cinerium is the floor between the the infundibulum and mamillary.
- The hypothalamus is divided by fibers of the fornix into medial and lateral nuclear groups.
- Three rostrocaudal regions: Supraoptic, Tuberal and Mamillary are described.
- The zone forming the floor of the third ventricle is the median eminence.

Connections of hypothalamus

- Medial forebrain bundle
- Hippocampal-hypothalamic fibres.
- Commissural fibers of fornix.
- Amygdalo-hypothalmic fibers (striae terminalis)
- Brainstem recicular afferents.
- Retinohypothalamic fibers.
- Mamillary efferents.
- Descending hypothamic fibres.
- Efferents to suprachiasmatic.
- Supraoptic-hypophysial.

Functions of hypothalamus:

- Control of involuntary actions, expressions, behaviour associated with emotions, rage, pain, sexual arousal, feeding.
- Coordination of parasympathetic autonomic function.
- Coordination of sympathetic autonomic function.
- Control of temperature (mechanisms for this include dissipation and production of heat, in anterior and posterior regions).
- Body water balance.
- Coordination of activities of anterior pituitary gland.
- Secrete hormones e.g. ADH, oxytocin, releasing hormones.
- Regulation of satiety – destruction may be associated with hyperphagia and obesity.

Connections of the hypothalamus

Input:	**Output**
Neural	**Neural**
1. From the hippocampal formation via the formix. 2. Amygdaloid nucleus (ventral amygdaloid path) 3. Orbitalfrontal cortex 4. Mid-line thalamic nuclei 5. Retina 6. Basal fore brain and septal region (via medial fore brain bundle) 7. Reticular formation 8. Cerebellum **ii)**	1. The anterior thalamic neuclei (mamillothalamic tract) 2. Mid brain reticular formation (Mamillotegmental tract) 3. Amygdaloid nucleus (the ventral amygdaloid path) 4. Brain stem and spinal cord autonomic centres (hypothalamo-bulbar/spinal) 5. Cerebellum.
Humoral	**Humoral**
This is **vascular**. Through this, various hypothalamic neurons get stimulated chemically (e.g. by glucose or hormones) or physically (e.g. by temperature)	This influences the endocrine system directly, by secretion into the general circulation, and indirectly by secretion into the hypophyseal portal system.

Functions of specific nuclei:

Nucleus	Function
Supraoptic	Production of ADH
Paraventricular	Production of Oxytocin
Medial/anterior	Coordination of parasympathetic activity.
Lateral/posterior	Body temperature regulation.
Preoptic	Production of releasing hormones to pituitary
Tuberal	Control of heart rate and blood pressure.
Autonomic center	Control of feeding, continues with grey regions of basal olfactory.
Mamillary	Region, septal region and substantia innominata.
Suprachiasmatic	Receives inputs from retina

Reproduction and sexual functions are influenced by preoptic and ventro medial nuclei.
Eestrogen – sensitive and androgen – sensitive neurons in these areas elicit the production of appropriate hormones that regulate production and release of pituitary gonado tropins. **Hypothalamic lesions can cause menstrual cycle disturbances or precocious puberty**.

Sleep and the sleep-wake cycle are influenced by several areas. The suprachiasmatic nucleus, which receives input from the retina is the **biological clock** that plays a role in **circadian rhythms** of approximately 24 hours. The pre-optic area can induce sleep and lateral hypothalamic area is involved in cortical arousal.

The expression of emotions such as anger, fear, embarrassment, occurs through hypothalamic connections with appropriate brain stem and spinal cord centres.The hypothalamus has reciprocal connections with the nuclei associated with behaviour such as the amygdaloid nuclei and the medial dorsal thalamic necleus.

The Epithalamus

- Forms part of the roof of third ventricle.
- The pineal gland is posterior and secretes melatonin.
- The gland regulates day-night cycles with secondary effect in reproductive function.
- It also produces serotonin, norepinephrine.
- Flactuations of melanin are related related to daily cycle of photic(light) input.
- It is connected to the suprachiasmatic nucleus of hypothalamus.
- The habenular nuclei are sites of convergence of limbic pathways that carry impulses to midbrain.
- They receive striae medullaris and give rise to the fasciculus retroflexus.

The subthalamus

- The subthalamus is bounded above by thalmus, medially by hypothalamus, and laterally by the internal capsule.
- Its main nuclear group is the subthalamic nucleus
- Rostral and dorsal to the subthalamic nucleus is the zona incerta (Fig)
- Its main concern is somatic control of some somatic motor function
- Fiber systems pass though this area
- Main concern: somatic motor function.

Pitituary Gland

Position

- Hypophyseal fossa in the midline of the sphenoidal body
- Middle cranial fossa at the base of the skull
- Covered by diaphragm sella

Relations

Superior	Lateral	Anterior	Posterior	Inferior
• Tuber cinereum of hypothalamus • Infindibulum • Optic chiasma	• Cavernous venous sinus • Its collaterals	• Tuberculum sella • Sphenoidal air sinus	• Dorsum sella • Pons • Intercavernous sinus	• Sphenoidal air sinus

Clinical anatomy

Surgical approach

- Sub frontal
- Through anterior cranial fossa by elevating the frontal lobe of the brain
- Trans sphenoidal
- Through sphenoidal air sinus.
- This is entered either via the ethmodial air cells after raising the periosteum from the medial wall of orbit or by elevating nasal mucosa from nasal septum

Pitituary enlargement

- Presents with features of raised intra cranial presseure
- Widens the pitituary fossa and erodes clinoid process and petrous crest.
- Compresses the optic chiasma causing bitemporal hemianopia

Pitituary tumors

- If they involve chromophils, can cause endocrine dysfunction together with compression effects
- Chromophobe adenomas only cause pressure effects and intracranial pressure.

Review Questions

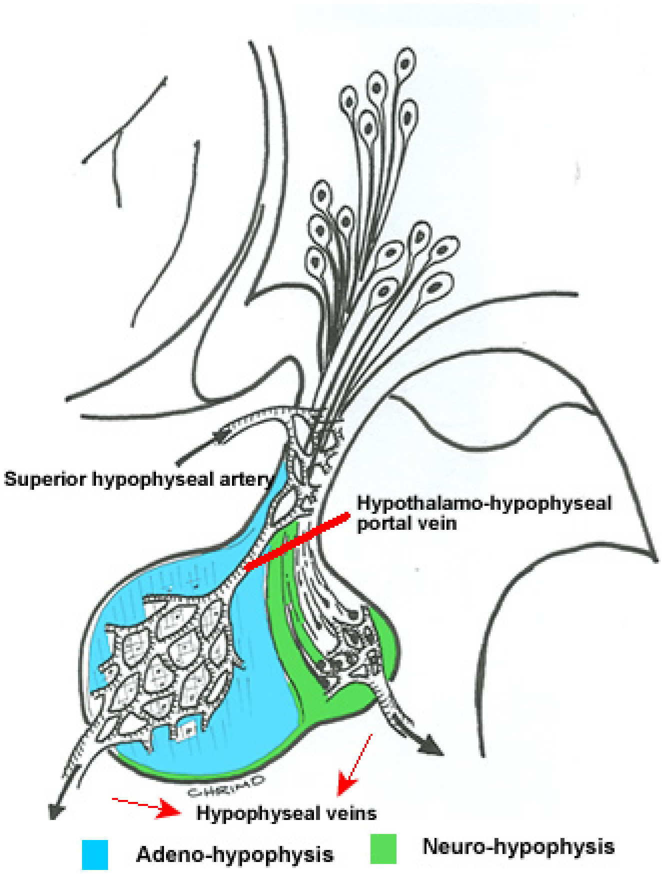
1. Describe the position, relations and applied anatomy of the hypophysis cerebri
2. Write short notes on:

   a) Effects of pituitary enlargement

   b) Parts and subparts of hypophysis cerebri

   c) Hypothalamo- hypophyseal system

Divisions



Neurohypophysis

- Pars nervosa
- Infindibular stalk
- Median eminence

Adenohypophysis

- Pars distalis
- Pars intermedia
- Pars tuberalis

Blood supply

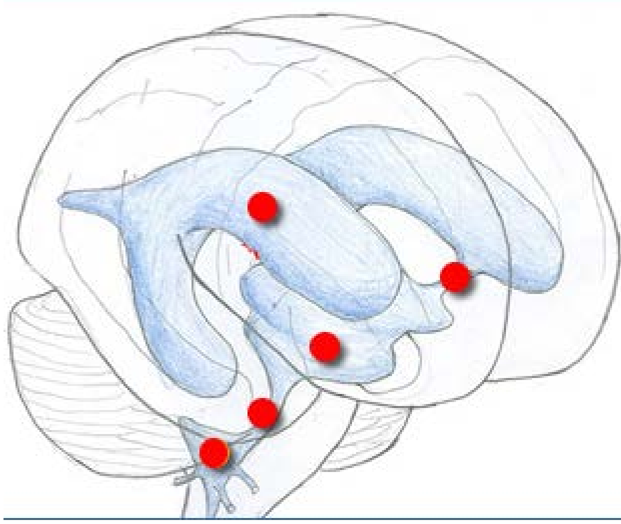
- A single inferior and several superior hypophyseal
- branches of internal carotid arteries
- Twigs from anterior cerebral arteries
- Hypothalamo-hypophyseal portal system
- Veins drain to the cavernous sinus

Temporal Lobe

THE CEREBROSPINAL FLUID & ITS PATHWAY

General organization of the ventricular system

Hover over the hot spots to show names



Comprises **ependymal-lined cavities** of the brain.

- **Lateral ventricles** in the cerebrum .
- The **3 rd ventricle** in the diancephalon
- **Cerebral aqueduct** in the midbrain.
- The **4 th ventricle** in the hind gut

Functions of the CSF:

- Cushions the brain and spinal cord against trauma.
- Supports brain, which weighs 1400g in air but only 50 g in CSF.
- Transports nutrients, chemical messengers and waste products.
- Integrates the brain and peripheral endocrine functions.
- Influences the microenvironment of neurons & neuroglia.

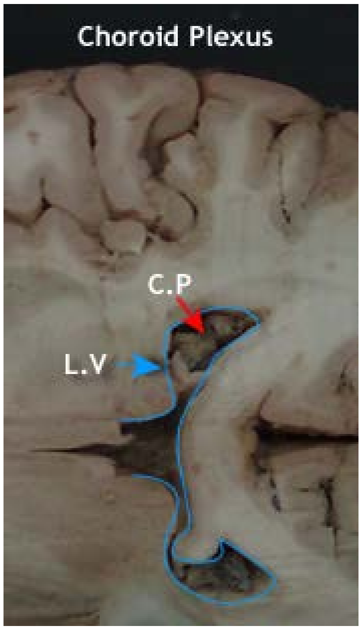
CSF composition

- Contains less cells, protein, K^+ , Ca^{++}
- Contains more Na^+, Cl^-, Mg^{++}

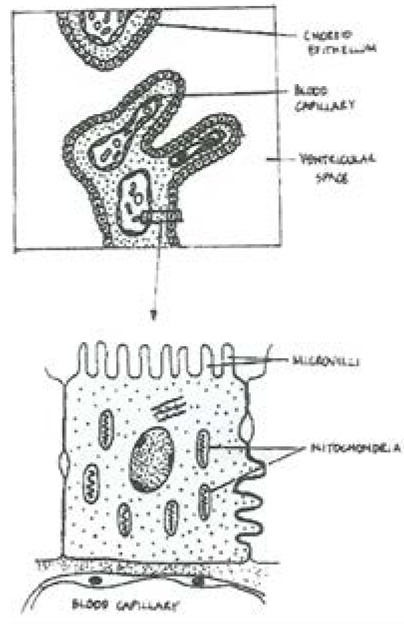
Note

- The CSF rate of formation is 400-500 mls/day.
- The total volume is 140-150mls (25mls in ventricles, 75mls in subarachnoid space).
- The CSF total volume is entirely replaced in 8 hours.

CSF formation



- Active and passive mechanisms
- Formed in choroid plexuses found at the
  - Roof of **third ventricle**
  - Floor of **lateral ventricle**
  - Roof of **4 th ventricle** then projects between cerebellum and pons
- The choroids epithelium:
  - Cuboidal cells
  - Basal infoldings and
  - Apical microvili
  - Tight junctions
  - Fenestrated subepithelial capillaries



Clinical Anatomy:

Hydrocephalus

- When there is excess of CSF, the condition is known as **hydrocephalus**.
- **External hydrocephalus**, in which the excess is mainly in the subarachnoid space, is found in senile atrophy of the brain.
- **Internal hydrocephalus** refers to dilation of the ventricles.

The increase of pressure within the cranial cavity compresses the brain and unconsciousness develops.

Hydrocephalus may **develop following**:

- Increased production (choroids plexus papilloma)
- Reduced rate of absorption (bockage of arachnoid apparatus)
- Obstruction of flow (mesencephalic aqueduct, Monroe, Luschka, Magendie foramina, tumors, cysts, developmental).
- Inadequate drainage

The **effects of increased CSF** include:

- Ventriculomegaly
- Increased intracranial pressure
- Expansion of sutures

The commonest sites of obstruction include

- Cerebral aqueduct
- Exit Foramina from 4th ventricle
- Interventricualr foramen (of Monro)
- CSF flow can also be obstrucated in subarchnoid space following post-infection adhesions

Hydrocephalous can be eased by treating the cause where possible. When not possible, CFS is drained from the ventricles either to the blood (**venticulo auricular shunting**) or body cavities (**ventriculoperitoneal shunting**).

CSF Sampling

Diseases of the CNS and its membranes are often reflected in alternations of the cells, which are normally found in CSF or in alternations in the concentration of its chemical constituents. The determination of these alternations and variations is of service in diagnosis.

CSF is usually obtained through **lumbar puncture**. Other areas from which samples of CSF can be obtained include the cerebellomedullary cistern (**cisternal puncture**) and also in some circumstances the ventricles (**ventricular puncture**).

Review questions

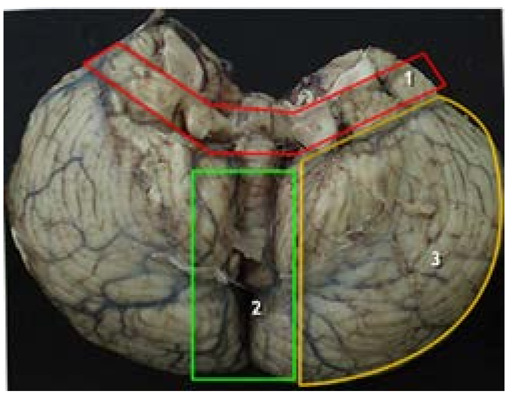
1. Describe the mechanisms of formation, circulation and reabsorption of CSF. Add short notes on hydrocephalus
2. Describe the respective walls of the various parts of the ventricular system.
3. Write short notes on the indications, procedure and complications of lumbar puncture

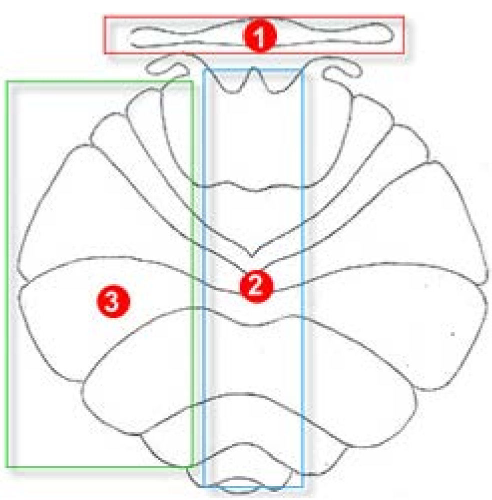
Learning points | Core anatomy | Applied anatomy | Review questions

The Cerebellum

Position

- In the **posterior cranial fossa**, partly ventral to the occipital pole.
- Covered superiorly by the **tentorium cerebelli.**
- It lies dorsal to the medulla and the pons.
- It is separated from the temporal lobe by the tentorium cerebelli (tent of the cerebellum).
- The two hemispheres are separated by the **falx cerebelli** .





Phylogenic subdivisions

Archicerebellum (1)

- Also called **vestibulocerebellum**
- Made of **flocculonodular lobe** and the uvula
- Main input from the **vestibular system**

Paleocerebellum (2)

- Also known **spinocerebellum**
- Made up of **vermis** and paravermal regions
- Main input from **spinal cord**
-

Neocerebellum (3)

- Also known as **cerebro-cerebellum**
- Comprises **cerebellar hemispheres**
- Main input from **cerebral cortex** through contralateral **pontine nuclei**

Clinical Anatomy

Cerebellar Lesions

The general principle that pertain to most of the disturbances resulting from cerebellar lesions include the following:

- Cerebellar lesions produce **ipsilateral disturbances**
- Cerebellar disturbances occur as a **constellation** of intimately related phenomena
- Cerebellar disturbances due to **non-progressive** pathology undergo gradual attenuation with time
- Disturbances resulting from cerebellar lesions are the **physiological expression of intact neural structures** deprived of controlling and regulating influences

a) **Neocerebellar lesions** are the best understood **.** These lesions affect primarily voluntary and associated movements (i.e. movements related to the corticospinal system). The symptoms/signs include the following:

• **Hypotonia** : The tendon reflexes are diminished and the muscles are weak and flabby (asthenia) and also tire easily.

• **Asynergia** : Severe disturbances of coordinated movements, in which the range, direction, and force of muscle contractions are inappropriate. Distances are frequently improperly gauged (**dysmetria**) and fall short of the mark or exceed it (**past-pointing**).

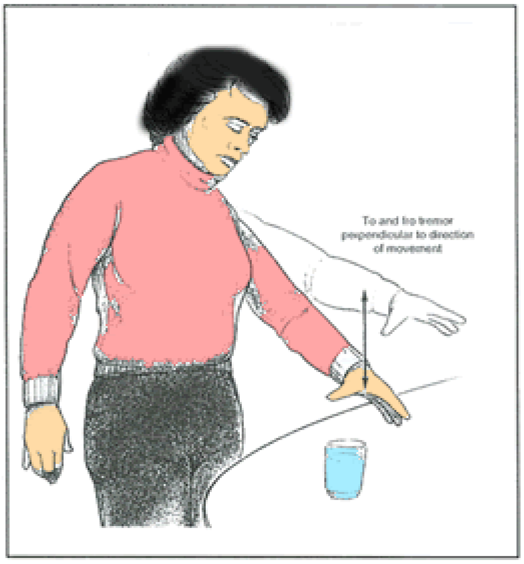
(+) Rapid successive movements, such as alternately supinating and pronating the hands and forearms are poorly performed (**dysadiadochokinesia**).

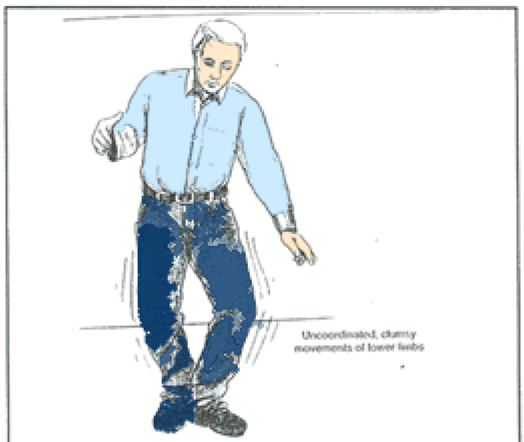
(+) The patient is unable to adjust to changes of muscle tension, so that, for example, when forearms is flexed at the elbow and held flexed against resistance, a sudden release of resistance causes the forearm to strike the chest. This is an example of the **rebound phenomenon** .

(+) The patients also demonstrate a **decomposition of movement** , in which phases of complex movements are performed as a series of successive single simple movements.

• **Tremors** : These are **intention tremors** , because they are not present at rest.

• **Ataxia:** It results in a bizarre distortion of voluntary and associated movements. It involves particularly the axial muscles, and groups of muscle around the shoulder and pelvic girdles.





Anterior lobe syndrome: Gait ataxia: Clumsy movements of lower limbs

- **Nystagmus** : This disturbance consists of an oscillatory pattern in which the eyes slowly drift in one direction and then rapidly move in the opposite direction to correct the drift.

- **Speech disturbances** : The speech syllables are unnaturally separated. There is slurring of speech, and some words are uttered in an explosive manner.

- **Archicerebellar lesions:** These lesions involve mainly portions of the posterior cerebellar vermis (i.e. floculonodular lobe and the uvula, and constitute the **archicerebellar syndrome** . They produce disturbances of locomotion and equilibrium bilaterally thus:

- The patient is unsteady in standing position and shows considerable swaying of the body.

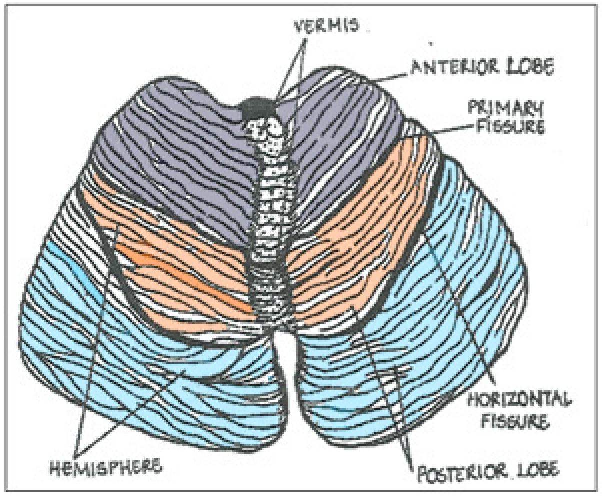
- On attempting to walk, there is staggering and a tendency to fall to one side or backwards

- The gait is jerky, uncoordinated and resemble that of a drunken individual.

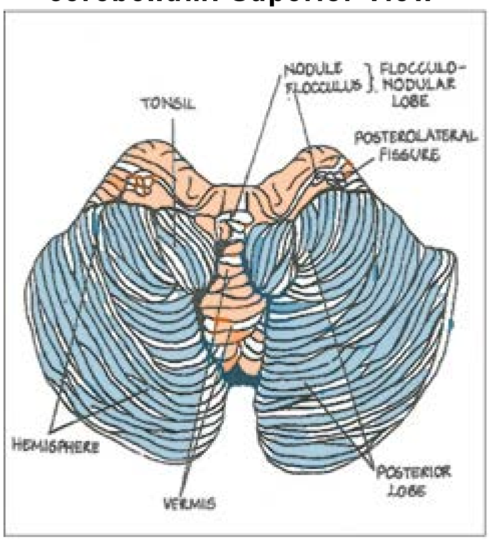
- The muscle tone is not significantly altered, and no tremor or asynergic disturbances are seen in extremities.

Review Questions

1. State the sources of the arteries that supply the cerebellum.
2. Explain these observations:
   a. Cerebellar tumors may cause hydrocephally.
   b. Otitis media may be complicated by cerebellar abscess.
3. Name the main cerebellar efferents through through the inferior cerebellar peduncle.
4. Give an account of the position, relations, connections development and microscopic features of the cerebellum. Add notes on cerebellar dysfunction.



cerebellum: Superior View



Cerebellum: Inferior view

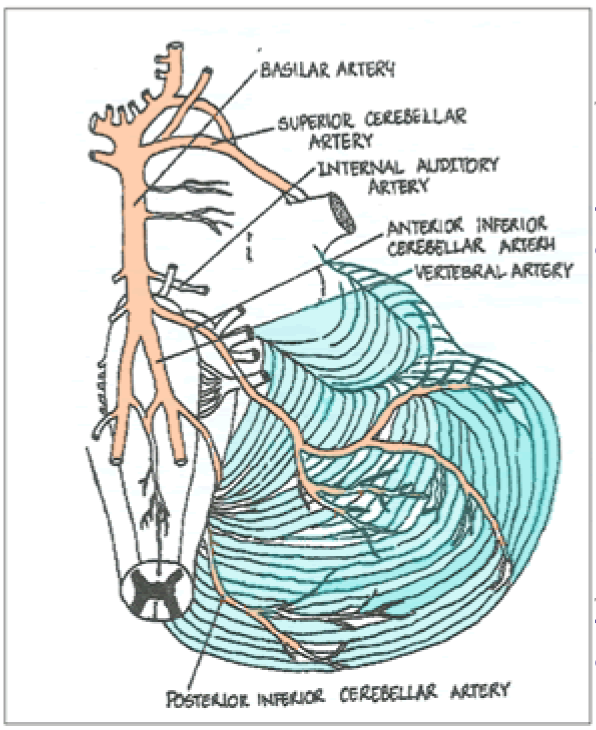
Lobes and Fissures of Cerebellum

- ***The anterior lobe*** is seen on the superior surface of the cerebellum is replaced from the posterior lobe by a v-shaped primary fissure.
- ***The posterior (middle) lobe*** lies between the primary fissure and the posterolateral (uvulonodular) fissure.
- ***The flocconodular lobe*** lies posterior to the uvulonodular fissure.

A deep horizontal fissure separates the superior and inferior surfaces of the cerebellum.

Other fissures outline further subdivisions of both the vermis and the hemispheres into lobules.

Blood supply



The superior cerebellar artery

- Arises near the terminal **bifurcation of the basilar artery**
- Supplies

  1) cortex

  2) The medullary center

  3) Central nuclei of the cerebellum

  4) Part of the pons, superior cerebellar peduncles and the inferior colliculi.

The anterior inferior cerebellar artery (AICA)

- Arises from the **caudal end of the basilar artery**.
- **It supplies:**
  1) The cortex of the inferior surface of the cerebellum anteriorly

  2) The underlying white matter

  3) Central cerebellar nuclei as well as upper medulla and the lower pons.

The posterior inferior cerebellar artery (PICA)

- Largest branch of the **vertebral artery**.
- It courses between the medullar and the cerebellum
- **Supplies:**

  1) Posterior part of the cerebellum

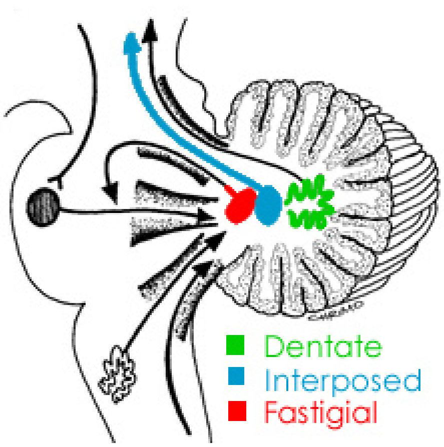
2) Choroids plexus of the fourth ventricle.

2) Gives branches to the dorsolateral region of the medulla.

Intracerebellar nuclei

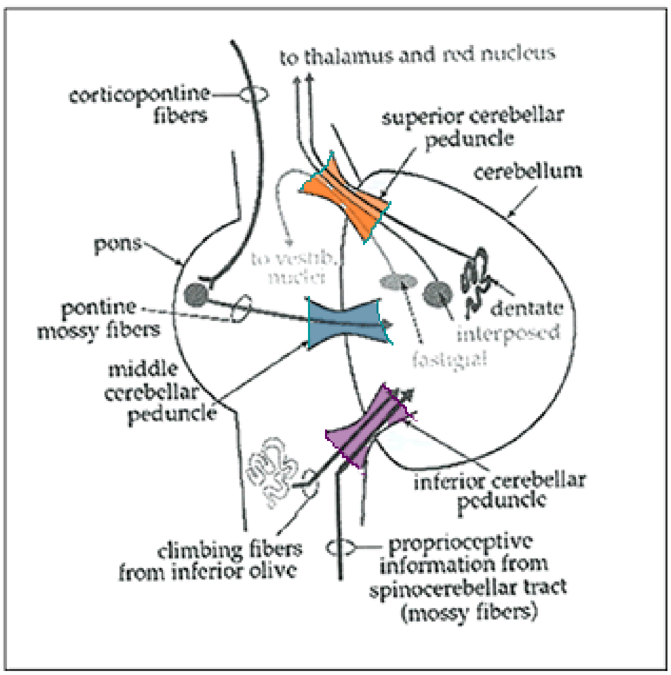
From medial to lateral direction these are:

- Fastigial nucleus
- Globose nucleus
- Emboliform nucleus
- Dentate nucleus.



Cerebellar peduncles

The cerebellum is attached to the brain stem through three pairs of cerebellar peduncles or fibre trunks - the **superior cerebellar peduncle,**the **middle cerebellar peduncle** and the **inferior cerebellar peduncle.** These structures contain all the fibres entering the cerebellum (cerebellar afferents) and all the fibres leaving the cerebellum (cerebellar efferents) thus:



a) Superior	Middle	Inferior
• dentatothalamic • dentatorubral • fastigioreticular • fastigiovestibular • Ventral spinocerebellar	• Pontocerebellar	• Dorsal spinocerebellar • Rostral spinocerebellar • Cuneocerebellar • Olivocerebellar tracts • Reticulocerebellar • Cerebelloreticular • Vestibulocerebellar fibres • Cerebellovestibular fibres

Function:

- **Control of movements**

Each of the three functional regions of the cerebellum influences a different parameter of motor function, and each uses the corresponding cerebellar nuclei i. e.

- The **cerebrocerebellum** is involved in **planning** and initiation of motor function
- The **spinocerebellum** oversees the **actual execution** and the coordination of motor event
- The **vestibulocerebellum** functions during the execution of the motor activity to **maintain** and **adjust body posture**.

Motor plasticity and Learning

- The word learning as used in this case refers to the ability to modify motor responses or sequences to a new situation, or changes in the surrounding conditions.
- Although many movements are reflex responses, and are preprogrammed in the central pattern generators (CPG's), motor actions are normally very plastic and adaptable to change.

Modifications of stretch reflex

- When dorsiflexion of the foot is produced by tilting the floor, and not the body, reflex contraction of the gastrocnemius causes the individual to fall back.
- In this reflex, **cerebellar afferents** enter the spinocerebellum as **mossy fibre afferents**.
- Afferents also reach the cerebral cortex. Signals from the cerebral cortex project to the cerebellum via the **inferior olivary nucleus**, and **climbing fibre system**.
- These are the signals that are responsible for the adaptive changes. With repeated stretching of the muscles, the stretch reflex response becomes diminished, i.e. it becomes altered to meet the current environmental circumstances.

Regulation of autonomic activity

- The cerebellum is active in the **planning**, **coordination** and **execution** of somatomotor activity.
- The hypothalamus is among the chief modulators of visceromotor activity.
- The **hypothalamocerebellar** and **cerebellohypothalamic** pathways provide direct connections between the integrative centres for visceromotor and somatomotor activity.

- Through these direct connections, the **visceromotor systems** , can anticipate the **visceromotor needs** of somatic tissue and continuously monitor the demands of new steady states, i.e. metabolic and vasoregulatory requirements of specific muscle groups during somatomotor activity, in progress or anticipated

---

BASAL GANGLIA

Definition: Collections of interconnected nuclei deep to the white mater of the cerebrum

They modify and execute the motor commands of the cerebral cortex, thereby (together with the cerebellum) modifying movements on a minute to minute basis.

Components

Hover to show names

- Caudate nucleus
- Lentiform nucleus (globus pallidus + putamen)
- Nucleus acumbens
- Sub thalamic nucleus
- Substantia nigra

Other functionally related nuclei may be include:

- Ventral thalamus
- Red nucleus.

Phyllogenetic (Functional) subdivision

a) The **neostriatum** formed by the putamen and caudate nuclei
b) The **palleostriatum** , formed by the globus pallidus (pallidum I and II)
c) The **archistriatum** composed predominantly of the amygdaloid nuclear complex.

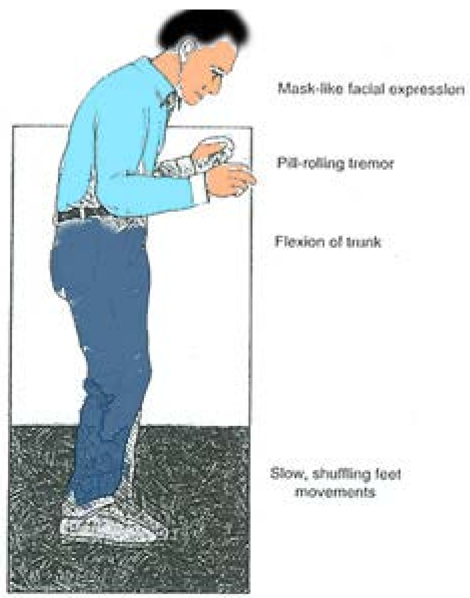
Applied Anatomy:

Deficits of basal ganglia function fall into one of the two categories:

- Presence of extraneous unwanted movements.
- Absence of, or diffficulty with intended movements.

Examples

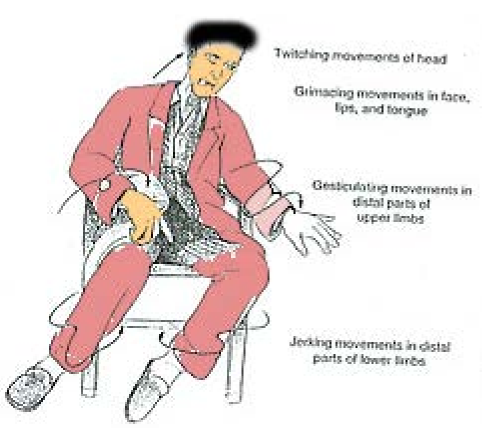
Parkinson's disease



Caused by loss of **dopaminergic neurons** of the **substantia nigra**. Presents with three main symptoms:

- Tremor, most apparent at rest.
- Rigidity.
- Bradykinesia or akinesia.

Huntington's disease



- Results from degeneration of the **caudate** and **putamen**. It may be hereditary.
- There is continous slow writhing vermicular involuntary movements of the face and limbs. The movements blend with each other to give the appearance of a continous mobile spasm.
- When the movements involve axial muscles, they produce severe torsion of the neck, shoulder and pelvic girdle.

Chorea

- This is a brisk, graceful series of successive involuntary movements of considerable complexity. They resemble fragments of purposeful voluntary movements.
- The movements involve distal portions of the extremities, the muscles of the facial expression, the tongue and muscles of swallowing.

Ballismus

- This is invariably associated with lesions of the **sub thalamic nucleus**, and its connections.
- This is a violent forceful, flinging movement involving primarily the proximal appendicular musculature, around the shoulder and pelvic girdles.

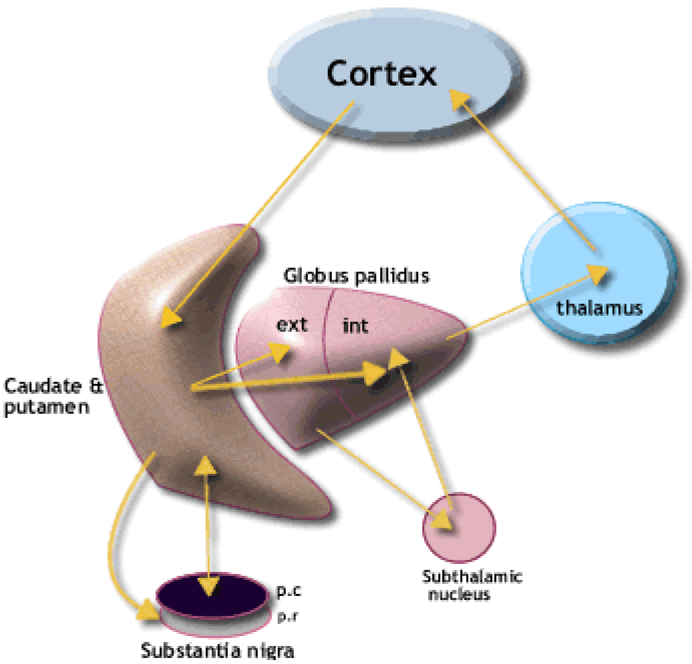
Review Questions:

1. State the main afferents and efferents of the neostriatum.
2.
3. State the sources of blood supply to the neostriatum.

4. State the main features of Parkinson's disease and suggest rational treatment.

5. Describe the position, connections, blood supply and applied anatomy of the principal components of the basal ganglia

Connections



These can be divided into three main categories:-

Afferents

- Corticostriate
- thalamostriate
- Nigrostriate

Main entry point is the **neostriatum**

Efferent

- Pallidothalamic
- Pallido-rubral
- Pallido-reticular

Globus pallidus is the main exit point

Two main bundles :

- Lenticular fasciculus
- Ansa lenticularis..

Reciprocal interconnections among the nuclear masses of the basal ganglia, for example:

- Nigrostriate and strionigral
- Striopallidal and pallidostriate
- Pallido-sub thalamic and subthalamo-pallidal

The direct loop

- Cortical fibres project to the neostriatum
- Striatal efferents project to the globus pallidus
- Efferents from the Globus pallidus to the dorsal thalamus
- Thalamic neurons project to specific areas of the cerebral cortex

The indirect loop

- Cortical fibres project to the neostriatum
- Striatal efferents neurons project to globus pallidus
- Efferents from Globus project to Globus Pallidus (GPi) and / or Substantia Nigra (SNr)
- Efferents from Substantia Nigra / Subthalamic nucleus project to the dorsal thalamus
- Thalamic neurons project to cerebral cortex

Functions

- **To Modulate and execute motor commands initiated by cerebral cortex**

The function of basal ganglia is often described in terms of " **brake hypothesis** ". To sit still, you must put the brakes on all movements except those reflexes that maintain the upright posture. To move, you must apply brakes on some postural reflexes and release brakes on voluntary movements.

- **Integration of neurobehavioral variables**

Basal ganglia are involved in integration of a vast number of neurobehavioral variables such as motivation, memory, olfaction, target location,

---

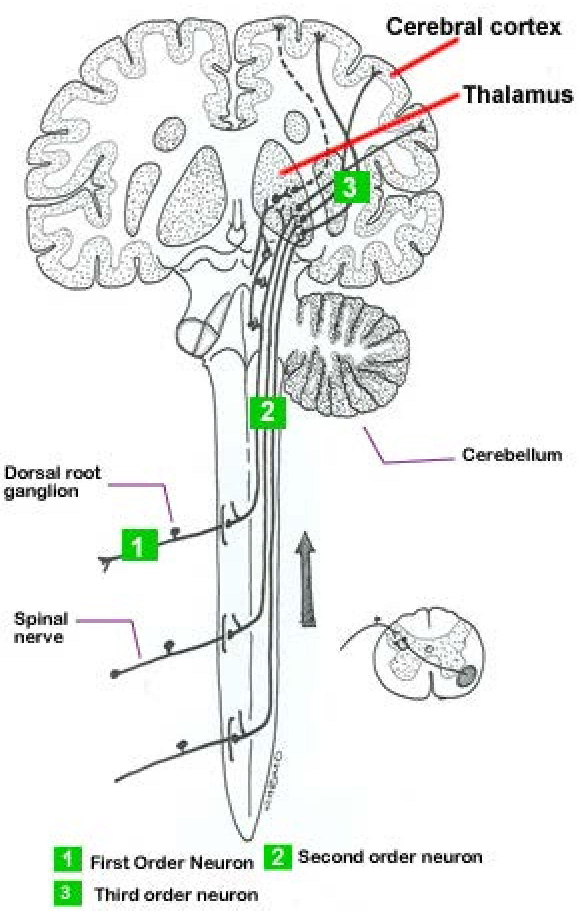
Characteristics of sensory pathways

- Presence of distinct set of **receptors**, distributed over the body.
- A minimum of **3 neurons** between receptor and cerebral cortex
- Obligatory relay in the **thalamus**
- **Feedback** and feed-forward modulating mechanisms along the way especially at relay stations.
- **Collateral projections** to the reticular formation in the brain stem.
- **Topological maps** at the various relay stations and in the cerebral cortex.
- Primary and secondary **sensory areas.**
- Association sensory areas connect with the limbic system via **sensory limbic connections**

PATHWAYS FOR PAIN AND TEMPERATURE

Spinal Sensations

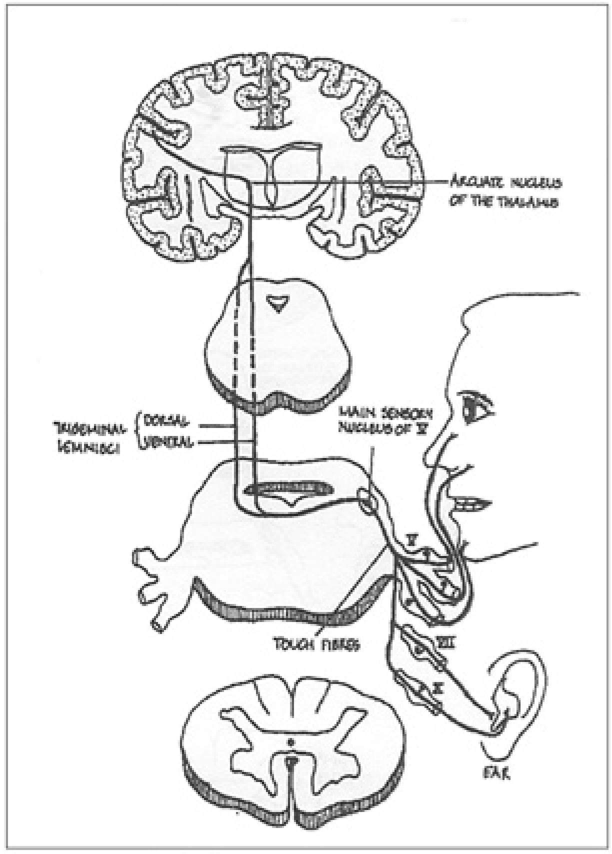
- The **receptors** for pain consist of **un-encapsulated endings of peripheral nerve fibres.**
- The **first order neuron** has cell bodies in the respective **ganglion** . Dendrites run in spinal or cranial nerves
- Axons from the ganglion enter the dorsal horn via **dorso-lateral tracts (of Lissauer)** and terminate directly in **laminae I and II** .
- Cell bodies of **secondary neurons** are situated in the **chief nucleus (nucleus proprius)** of the gray horn.
- Their **axons decussate** through the **anterior white commissure,** then ascend as the **lateral spinothalamic tract.**
- Axons of the spinothalamic tract synapse with tertiary neurons in the **VPLC nucleus of the thalamus .**
- A few collaterals go to the reticular formation.
- **Tertiary neurons** arising from the thalamus pass through the **internal capsule** and **corona radiata** project to the sensory cortical area in the **post central gyrus.**



Note: In the upper part of the medulla oblongata, the **lateral and ventral spinothalamic** tracts and the **spinotectal tracts** are closely associated at this level and throughout the reminder of the brain stem, together, and they constitute **spinal lemniscus** . Spinotectal tract terminates in the superior colliculus while the others go to the reticular formation .

Cranial Sensations

- **First Order neurons** are found in the **trigeminal** , facial , glossopharyngeal and vagus nerves .
- The cell bodies of the **primary sensory** neurons are in the **trigeminal , geniculate** , **superior glossopharyngeal** and **vagal ganglia**.
- The central processes enter the pons through the sensory root and caudally in the **trigeminal spinal tract / nucleus** .
- The **second order** neurons **cross and ascend as trigeminothalamic tract** .
- This tract terminates in the medial part of the **ventral posterior nucleus of the thalamus** (**arcuate or semilunar nucleus)**
- A **tertiary neurons** from the arcuate nucleus traverse internal capsule, corona radiata to terminate in the sensory (somesthetic) cortex



Note: Some fibres from the trigeminal tract are believed to ascend uncrossed

Clinical Anatomy

Clinical note

The pathways described earlier are certainly of considerable clinical importance as follows:

- **Inflammatory** reactions in dorsal roots or **pressure** on spinal roots (as a result of herniated intervertebral discs) can cause **painful sensation** in the areas supplied by the affected roots.
- **Degenerative** processes in the region of the **central canal** of the spinal cord interrupt **pain** and **temperature** fibres as they decussate in the **ventral white commissure**.
- The **spinal lemniscus** may be included in **lateral medullary syndrome**

Refered pain

Pain originating in a visceral organ perceived as originating from a somatic area

Organ	Dermatome
Diaphragm	C3, C4, C5
Heart	T1-T5
Gall bladder	T6-T8
Appendix	T10
Testes and Ovaries	T10-T12
Uterus	T10-T12
Kidneys	T10-L1
Ureters	L1-L2

Review Questions:

1. Describe in detail the pathways for

   a) Pain and temperature
   b) Light touch
   c) Proprioception

   From the middle finger and the face.

2. With examples describe referred pains

3. Explain the sensory effects of

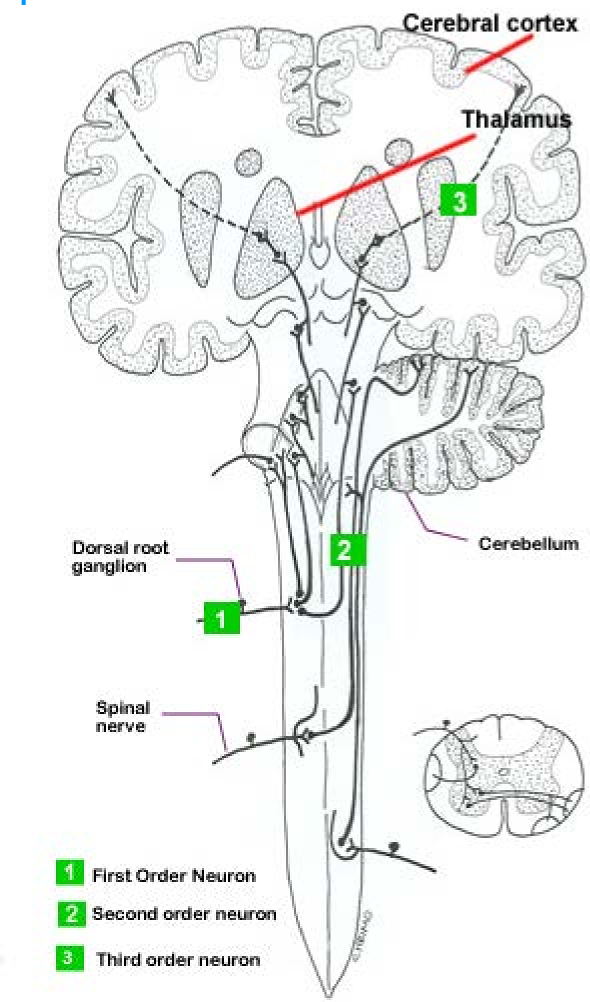
   a) Lateral medullary syndrome

   b) Medial medullary syndrome

   c) Anterior spinal artery syndrome

PATHWAYS FOR SIMPLE (LIGHT) TOUCH AND PRESSURE

Spinal Sensations



- **Receptors** include Merkel's discs, peri-trichial plexuses,Krauss and Ruffini end-bulbs , Meissner's and Pacinian corpuscles
- Dendrites of **first order neurons** travel in **spinal nerves** and cell bodies are found in **dorsal root ganglia.**
- Axons from ganglia pass through the **dorsolateral tract a**nd bifurcate on entering the dorsal white column of the spinal cord.
- The ascending and descending branches give off collaterals to the gray mater.
- Both ascending and descending fibres synapse with tract neurons in Laminae 1,5,6 and 7.
- **Second order tract** neurons decussate, and ascend in the **ventral spinothalamic tract**. Some fibres remain ipsilateral.
- This tract synapses in **nucleus ventralis posterior of the thalamus**.
- **Third order** neurons traverse internal capsule, **corona radiata** to the **somatosensory cortex**.

Note:

Traditionally, in humans, it has been customary to recognize a lateral spinothalamic tract containing fibres conveying pain and temperature information, and a more medial ventral spinothalamic tract containing fibres conveying innocuous tactile information. However, this division has no basis in experimental observation and the two are currently just referred to as the spinothalamic tract.

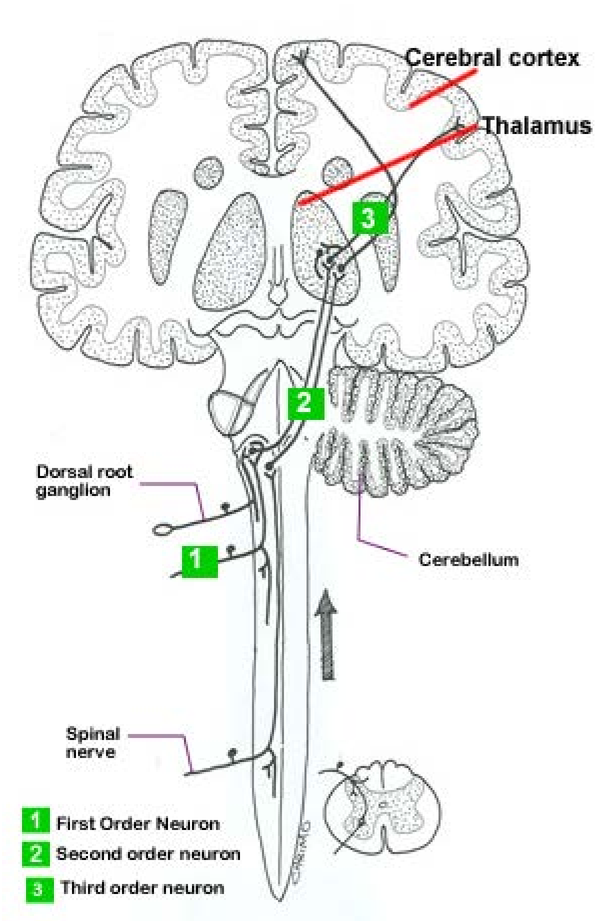
Cranial Sensations

- Primary order neurons travel in the **Trigeminal** , Facial, glossopharyngeal and vagus nerve
- Cell bodies are found in the corresponding ganglia
- The central processes **bifurcate**, one process enters the spinal tract and the other the **Chief nucleus of**

Trigeminal.

- The secondary neurons arising from the trigeminal nucleus decussate and join the **trigerminal thalamic tract** to the thalamus.
- Third order neurons traverse the internal capsule, coronary radiata and terminate in the **sensory cortical area.**

PATHWAYS FOR PROPRIOCEPTION, FINE TOUCH AND VIBRATIONS



- Receptors for discriminative / fine touch are **Meissner's corpuscles.** Proprioceptors consist of **neuromuscular spindles, Golgi tendon organs, pacinian corpuscles and un-encapsulated endings** in joint **capsules and ligaments.**

- Dendrites of **primary neurons** are contained in the spinal nerves. Cell bodies are contained in the dorsal root ganglia.

- The axons entering dorsal column and divide into three

1. One terminates in the gray mater at the same level of the spinal cord
2. A second one descends two or three lower segments and constiute **fasciculus inter-fascicularis**, and **fasciculus septomarginalis.**
3. The third one ascends in the **dorsal columns** towards the brain.

- The long ascending branches arising from mid-thoracic and lower spinal roots ascend in the **fasciculus gracilis.** Those arising from upper thoracic and higher spinal dorsal roots ascend in the **fasciculus cuneatus,** which is therefore only seen above T6.

- The **fasciculus cuneatus and gracilis** form the **dorsal column - lemniscal system**. The fibres in these fasciculi ascend on the **ipsilateral** side of the spinal cord, and synapse in the **gracile and cuneate nuclei** of the medulla oblongata respectively.

- Axons of second order neurons cross in the midline as the **great sensory decussation** and ascend as the **medial leminscus**.

- The medial lemniscus synapses in the **ventral posterolateral nucleus,** pars caudalis (VPLc) of the **thalamus,**

- **Third order neurons**, traverse the internal capsule, corona radiata to end in the sensory cortex.

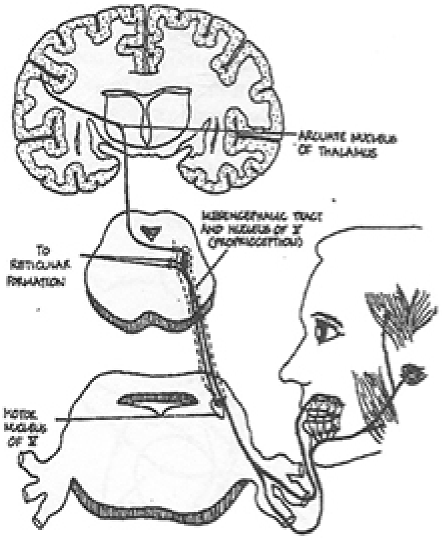
Cranial Sensations:

Discriminative touch

- **Axons of large primary neurons** in the semilunar ganglion synapse in the **chief nucleus of the trigeminal nerve**.

- Axons of second order neurons constitute the crossed **trigeminothalamic tract**.

- **Third order neurons** from the **ventral posterolateral nucleus** terminate in the sensory



cortex

Proprioception

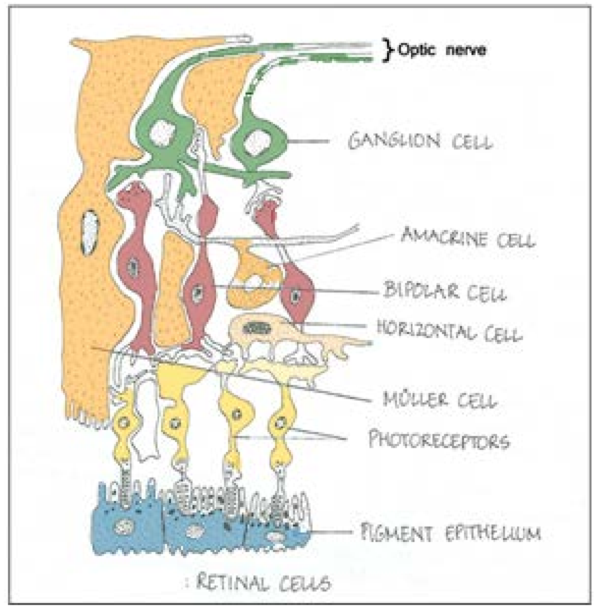
- **Primary sensory neurons for proprioception** have their cell bodies in the **mesencephalic nucleus** of the trigeminal nerve rather than semilunar ganglion.
- They mainly arise from the **temporo-mandibular joint** and the muscles of mastication.
- The central processes make contacts with cells in the **reticular formation.**
- Axons of the latter join the **trigeminothalamic tract**.
- Some are however, involved in the reflex circuits of mastication.

CEREBELLAR ENDING TRACTS

posterior (dorsal) spinocerebellar tract	Anterior / ventral spinocerebellar tract	Cuneocerebellar tract
• An uncrossed tract arising from Clarke's nucleus • Ascends lateral to the corticospinal tract. • In the medulla, become incorporated in the **cerebellar inferior peduncle**. • Terminates in the **cerebellar vermis.** • **coordinates posture and movements** of individual limb muscles.	• Predominantly a crossed pathway. • Originates in **laminae V, VI and VII** in the coccygeal, sacral and lower lumbar segments. • Ascends postero-laterally • Contained in superior cerebellar peduncle • Terminates in cerebellar vermis • Coordinates movement and posture of entire lower limb	• Originates in accessory cuneate nucleus in the medulla. • Contained in inferior cerebellar peduncle • Terminates in cerebellar cortex • Controls posture in individual muscles of upper limb

The Visual Pathways

The Retina



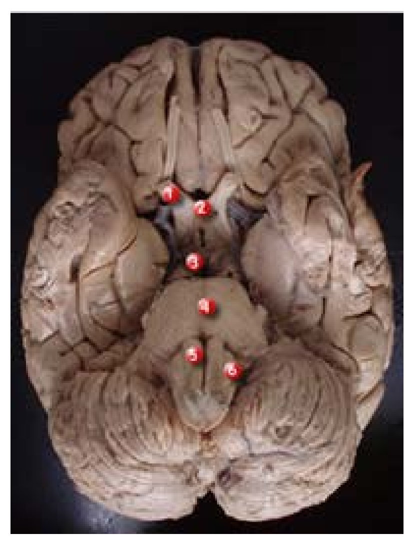
- **Receptors:** Rodes and cones
- **First order neurons:** bipolar cells
- **Second order neurons:** ganglion cells

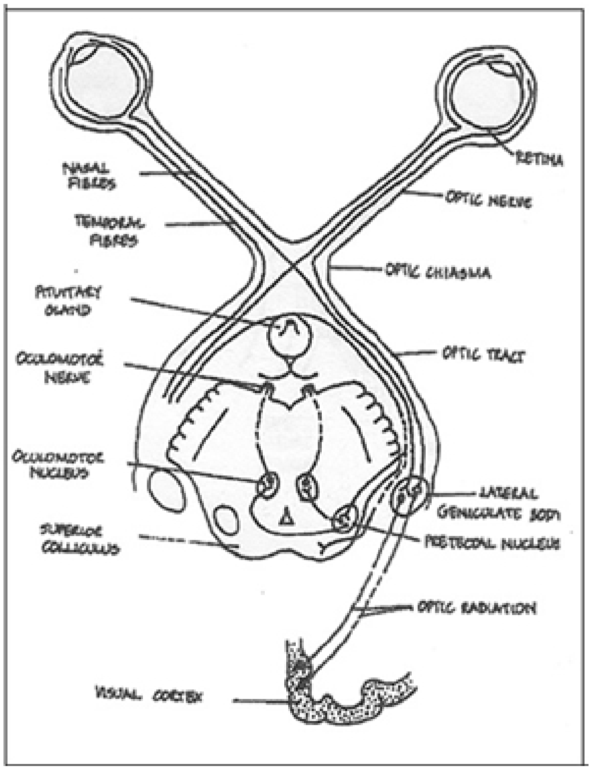
The Optic Nerve and Optic Chiasma

- Axons of ganglion cells form the **optic nerve**, **optic chiasma** and **optic tracts**
- Fibres from the nasal side (with information from the temporal visual field) remain medial and **decussate** at the **optic chiasma**
- Fibres from the **temporal side** (with information from the nasal visual field) remain lateral and ipsilateral.
- Optic tracts projects predominantly to **lateral geniculate body** but also to:

  a) Pre-tectal areas
  b) Superior colliculus
  c) Hypothalamus

- **Third order neurons** project mainly to the **lingual** and **cuneus** gyri around the calcarine sulcus.





- A few project to the superior temporal gyrus

Visual Reflexes

Involuntary Eye Movements

Reflex turning of the eyes

This is towards an object without being conscious of it:

- Afferent arc: Three neurons from the retinal ganglion cells to the superficial layers of superior colliculus, then to the deep layers. Tectobulbar neurons to the nuclei of cranial nerves III, IV, and VI (actually to the medial reticular formation adjacent to cranial nerve nuclei III, IV and VI)
- Efferent arc: One neuron from the cranial nerve nuclei to the extra-ocular muscles.

In simple eye movements, there is often some accompanying turning of the head and neck, which is accomplished by collicular neurons that project to anterior horn cells of the cervical spinal cord via the tectospinal neurons.

The Accommodation - Convergence reflex

This reflex involves three changes:

- Convergence of the eyes due to the action of the medial recti muscles.
- Increased convexity of the lens.
- Pupillary constriction.

Afferent arc: Retino - LGN - striate projection.

Efferent arc: Corticofugal projection to the superior colliculus, and from this visual centre connections to:

- The oculomotor nuclei (for ocular convergence)
- The nucleus of Edinger-Westphal (for pupillary constriction and increased lens convexity). This reflex is spared in Argyll-Robertson pupil.

Fixation reflex :

This for example, occurs when both eyes follow the trajectory of an object in the smooth rather than jerky fashion thus ensuring that any point on an object is projected onto corresponding points of the two retinas.

- Afferent arc: Two neurons: from the retinal ganglion cells to the LGN, from LGN to the striate cortex.
- Efferent arc: From the striate cortex to the superior colliculus and from the superior colliculus to the extra-ocular muscles via the rectobulbar pathways.

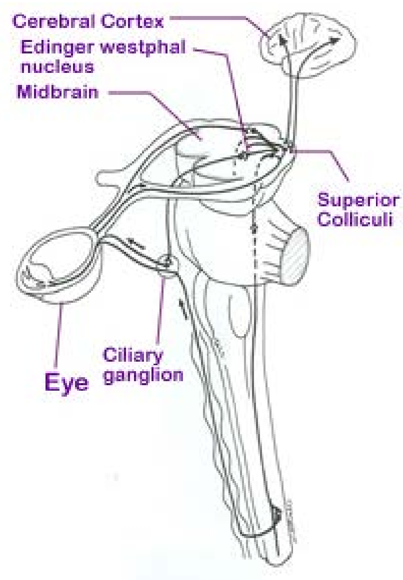
Voluntary eye movements

- Afferent arc: From the retinal ganglion cells to the LGN - from the LGN to the striate cortex via the geniculostriate pathway. From the striate cortex to association visual cortex then to the frontal eye field, which is located in the caudal part of the middle frontal gyrus.
- Efferent arc: Corticobulbar projections, ending within the superior colliculus. The superior colliculus makes connection via tectobulbar pathway with cranial nerve nuclei III, IV and VI. The final projection is to the extra-ocular muscles. This pathway mediates conjugate eye movements of which the individual is aware, such as “movements of command” elicited by instructing a patient to look to the left or to the right.

Pupillary light reflex

This is the reflex constriction of the pupil due to increased light intensity:

- Afferent arc: From the retina to the pretectal area, and from thence bilaterally to the nuclei of Edinger-Westphal.
- Efferent arc**:** Two neurons (parasympathetic) from the nucleus of Edinger-Westphal to the ciliary ganglion and from thence to the pupillary muscles of the eye.



Pupillary dilatation

- Pupillary dilation which can occur in response to a sudden decrease in light intensity, to severe pain or to certain emotional conditions, is due to a different pathway.
- The pathway leads from the thalamus to the hypothalamus, and then to the intermediolateral cell column of the upper thoracic cord through relay in the reticular formation.
- Two neurons pass, to pupillary dilator muscles via the superior cervical sympathetic ganglion.

The Argyll-Robertson pupil

This is a disorder in which the pupils are non-reactive to light shined to the retina. The commonest cause is neurosyphilic affliction of the pretectal nuclei or periaqueductal region, ciliary ganglion, singly or in combination.

The Accomodation-Convergence:

This reflex involves three changes:

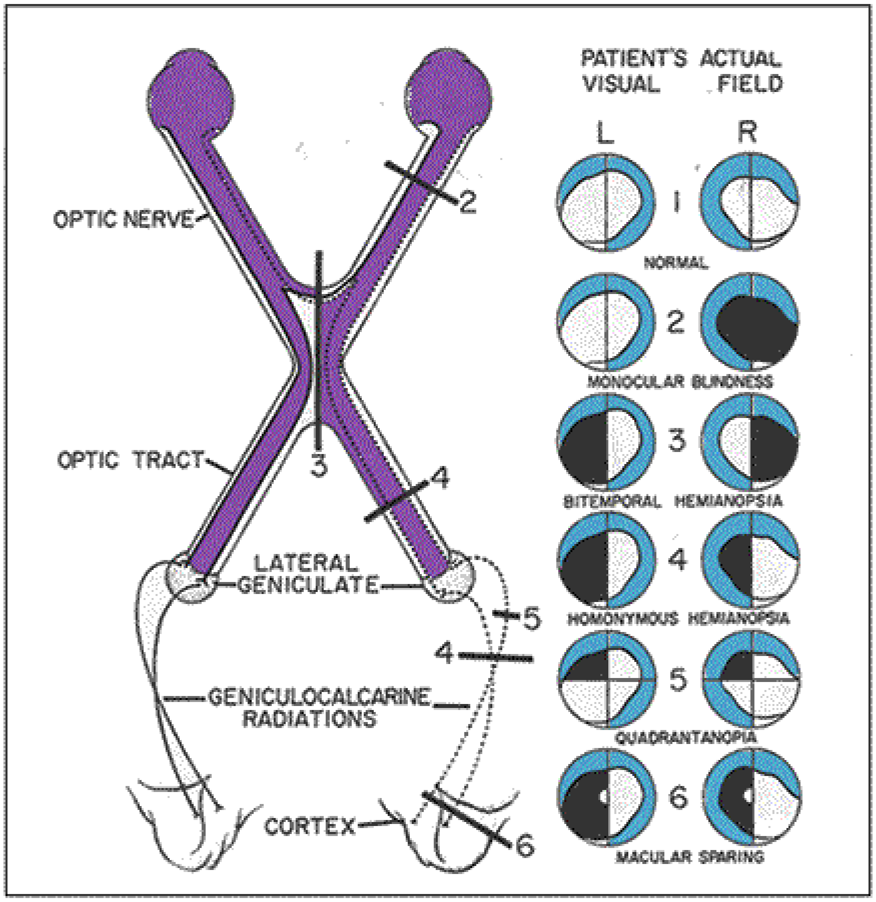
- Convergence of the eyes due to the action of the medial recti muscles.
- Increased convexity of the lens.
- Pupillary constriction.

Afferent arc: Retino - LGN - striate projection.

Efferent arc: Corticofugal projection to the superior colliculus, and from this visual centre connections to:

- The oculomotor nuclei (for ocular convergence) and
- The nucleus of Edinger-Westphal (for pupillary constriction and increased lens convexity). This reflex is spared in Argyll-Robertson pupil.

Clinical Considerations: **Visual pathway**



Injury to any part of the optic pathway produces visual defects whose nature depends on the location and extent of the injury. Visual defects are said to be homonymous when restricted to single visual field, right or left and heteronymous when parts of both visual fields are involved. The lesions can be localized because of the retinotopic organization of each nucleus area or tract in the visual system.

Examples of the lesions include:

- Destruction of ***one eye or cutting of one optic nerve*** produces blindness in that eye. Because of the extensive overlap of visual field representation in the two retinae, loss of one eye eliminates only part of the temporal visual field on the side of the lesion.
- Defects at the ***optic chiasma*** can produce opposite effects.
    - Cutting of the crossing fibres will produce a loss of both the temporal visual fields (nasal retinal fields) in both eyes. This is called bitemporal hemianopia. Such a condition is relatively common and arises from tumors of the pituitary pressing upon, the chiasma.
    - If the lateral surface of the chiasma is pressed upon, uncrossed axons will be damaged and loss of the nasal visual field in one eye will occur. This relatively rare condition may be due to aneurysms of one common carotid artery.

- Destruction of one ***optic tract or of one lateral geniculate body*** will lead to loss of vision in one half the visual field (the half opposite the side of the lesion). This is an example of homonymous hemianopia.
- Destruction of the ***optic radiations*** from the lateral geniculate body to area 17 can produce one of three defects:
    - Cutting of axons on **Meyer's loop** leads to loss of the upper visual field on the side opposite the lesion. Because of this loss of quadrant in the visual field, it is referred to as **quadrantanopia**. This condition occurs most commonly with surgical removal of the temporal lobe.
    - Cutting of the retrolenticular fibres leads to loss of the lower visual field on the side opposite the lesion.

- Cutting all the fibres of the optic radiation (after Meyer's loop axons have joined retrolenticular fibres) produces a **homonymous hemianopia**, just like lesions of the optic tract of the lateral geniculate body.

Lesions of areas 17 usually produce a homonymous hemianopia with macular sparing (representation of the fovea is not affected).

Clinical Considerations: Olfactory pathway

- **Fractures** of the **cribriform plate** of the ethmoid bone or haemorrhage at the base of the frontal lobes may cause tearing of the olfactory filaments, **impairing olfactory sense.**
- The olfactory nerve may be involved as a consequence of **meningitis or abscess** of the **frontal lobe**.
- Unilateral **anosmia** may be of diagnostic significance in localizing intra-cranial neoplasms, especially meningiomas of the sphenoidal ridge or olfactory groove.
- Olfactory "hallucinations" frequently are a consequence of lesions involving or irritating the parahippocampal gyrus, the uncus, or adjoining areas. The olfactory sensations, which these patients experience usually, are described as disagreeable in character and may precede a generalized convulsion. Such seizures are referred to as uncinate fits.
- Changes in **olfactory epithelium** may herald **Alzheimer's disease**.

Clinical considerations: Vestibular system.

Vertigo

Refers specifically to the sensation of turning or rotating, as if the external word were rotating around the individual, or as if the individual were in space.

Vestibular neuritis

This is an acute inflammation of the vestibular labyrinth.

Meniere's disease

This is a disorder of unknown aetiology, characterized by a progressive loss of or fluctuation in hearing, and tinnitus, and, later, by nystagmus, vertigo and nausea.

Applied anatomy: Cochlear nerve

Sensorineural deafness may result from pathology of

a) the receptor organ – the cochlea
b) the cochlea nerve or
c) less often, central lesions involving the auditory pathways.

Involvement of these structures produces an ipslateral hearing loss. If cochlear damage is restricted, the hearing loss may involve only the specific frequencies associated with the affected part.

Review questions

1. Describe the components of the visual pathway. Add notes on effects of damage at various levels

2. Describe the autonomic innervation of intra-ocular muscles

3. Give an account of the pupillary light reflexes. Add notes on Argyll-Robertson pupil

4. Describe the central connections of :

   a) Cochlear nucleus
   b) Vestibular nucleus
   c) Gustatory nucleus

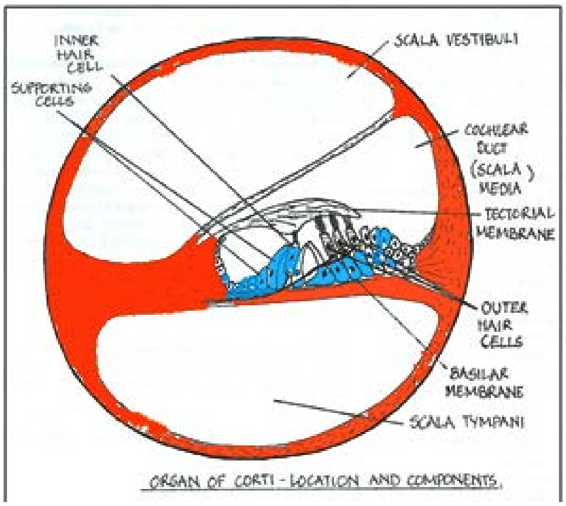
5. Give an account of the organization of the special sensory receptors

6. Describe briefly the following pathways:

   a) Auditory
   b) Gustatory
   c) Olfactory

Vestibulocochlear Sensory System

Cochlear (Auditory) System

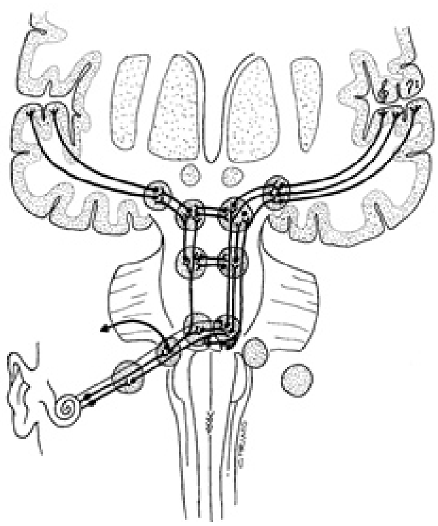


- The receptor cells for the auditory pathway are the **hair cells** of organ of corti in the **scala media** inner ear.

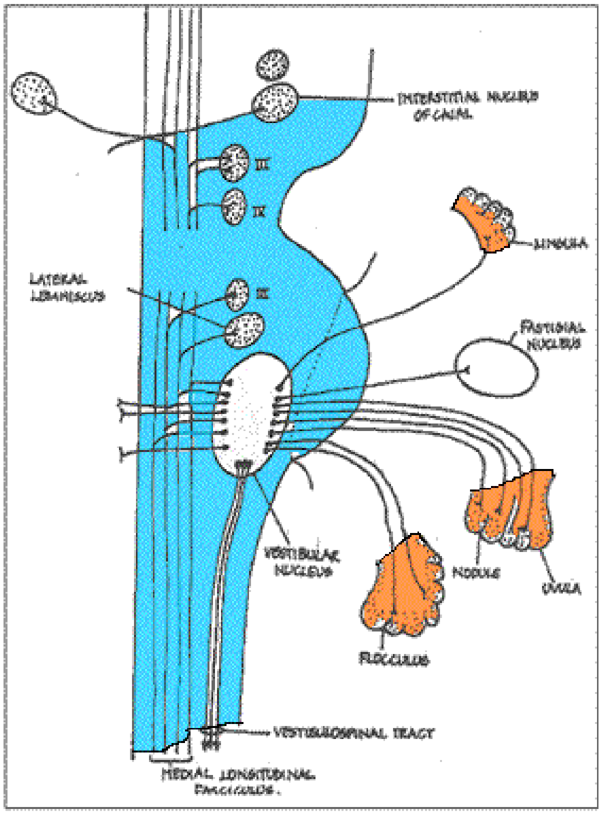
- First order constituting the **cochlear nerve** synapse in the **cochlear nuclei** of the medulla oblongata
- The cochlear nuclei project to at least one of the following:

  a) Inferior colliculus,
  b) Dorsal nucleus of the trapezoid body
  c) Nucleus of the lateral lemniscus

- Whatever the other relay station(s), the Medial Geniculate Body (MGB) is obligatory.
- Before the MGB, the pathway is characterized by **bilateral** projections
- Thalamocortical projection ends in the superior temporal gyrus (**Transverse gyri of Heschl**)



Vestibular System



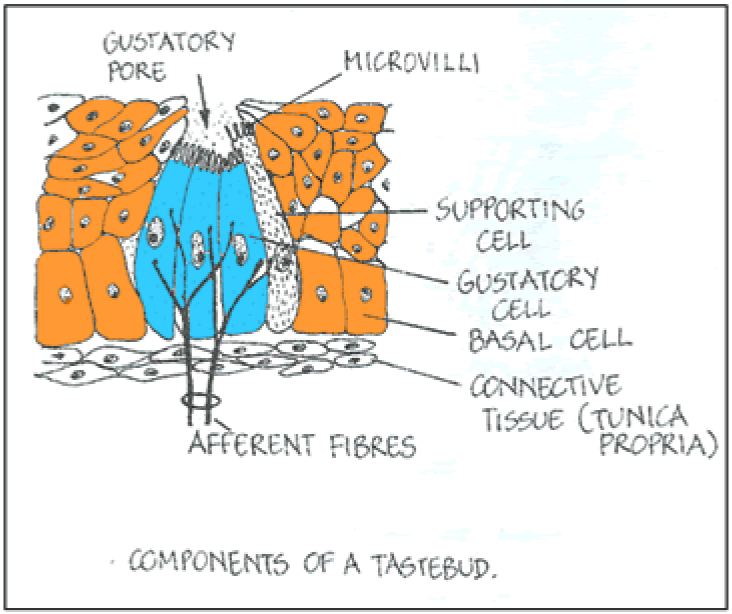
- Receptors are the cristae of **semi-circular canal** and macule of the **saccule** and **utricle**.
- The **first order neurons** constitute the vestibular nerve which accompanies the cochlear nerve to form the **vestibulo-cochlear nerve**
- Some vestibular axons synapse with neurons of **fastigio nucleus** and flocullo-nodular lobe of the cerebellum
- Axons from the **vestibular nuclei** synapse with neurons in:

  a) Cerebellum

  b) Motor neurons of spinal nerves

  c) Motor neurons of cranial nerves (through medial longitudinal fasciculus)

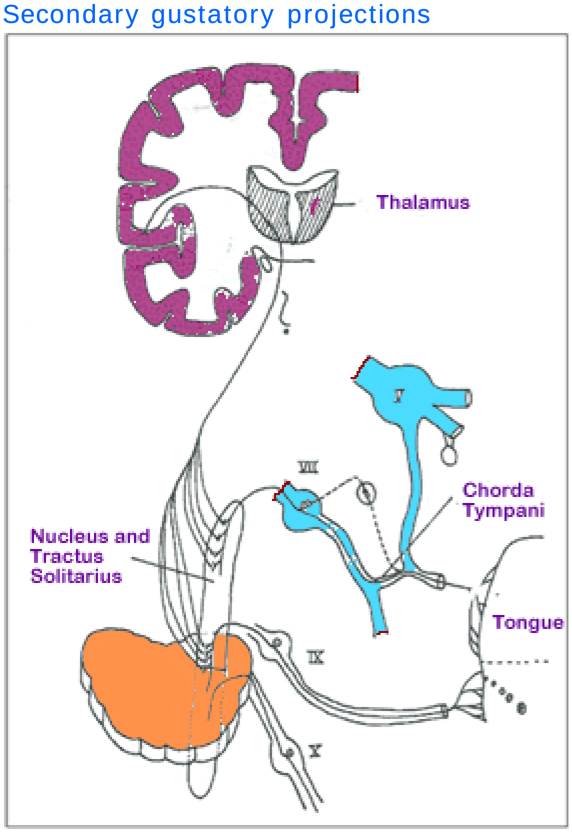
Gustatory (Taste) Pathway



The receptors are gustatory cells of taste buds

- Distributed on the tongue, the epiglottis and palate.
- From the anterior two thirds, nerve fibres join the chorda tympani.
- From the posterior one third, they join the glossopharyngeal nerve.
- The fibres from the extreme pharyngeal part as well as the epiglottis join the vagus nerve (Some fibres e.g. from the palate may be in the trigeminal nerve).

Secondary gustatory projections

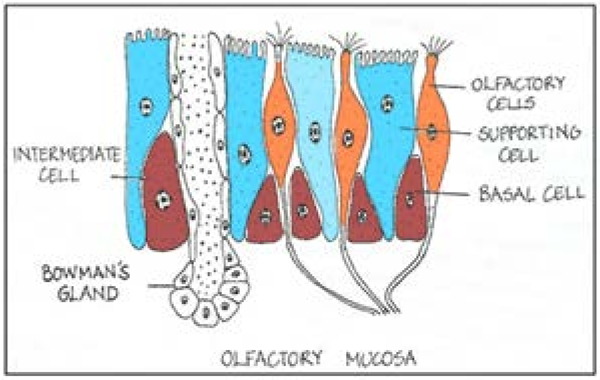


- The **primary order neurons** terminate in the gustatory nucleus
- Secondary fibre systems arising from the gustatory nucleus project to ventral posteromedial nucleus of the thalamus .
- Others project to :

  a) Hypoglossal
  b) Salivatory nuclei
  c) Dorsal motor nucleus of vagus nerve
  d) Phrenic nerve nucleus
  e) Anterior horn cells of thoracic spinal segments
  f) Pontine taste area

- Third order neurons projects to both the insular and parietal opercular cortex.
- **Cell bodies** are located in **geniculate**, **inferior glossopharyngeal** and **vagal ganglia**

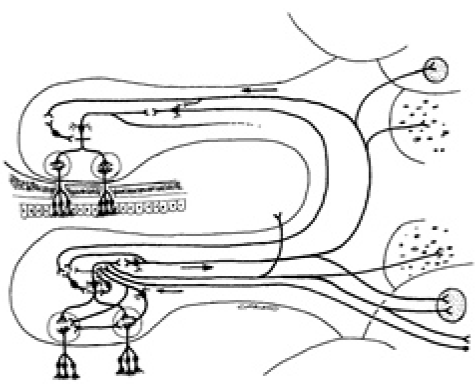
Olfactory Pathways



- Receptors are olfactory cells found in the olfactory epithelium on:

  a) Dorsal surface of the superior conchae
  b) Nasal septum,
  c) Roof of the nasal cavity.

Olfactory Connections



- The axons of the olfactory cells form the fila olfactoria, which passes through the cribriform plate of the ethmoid bone and synapse in the olfactory bulb

- Second order neurons form the **olfactory tract** which divides in to lateral, medial and intermediate olfactory stria

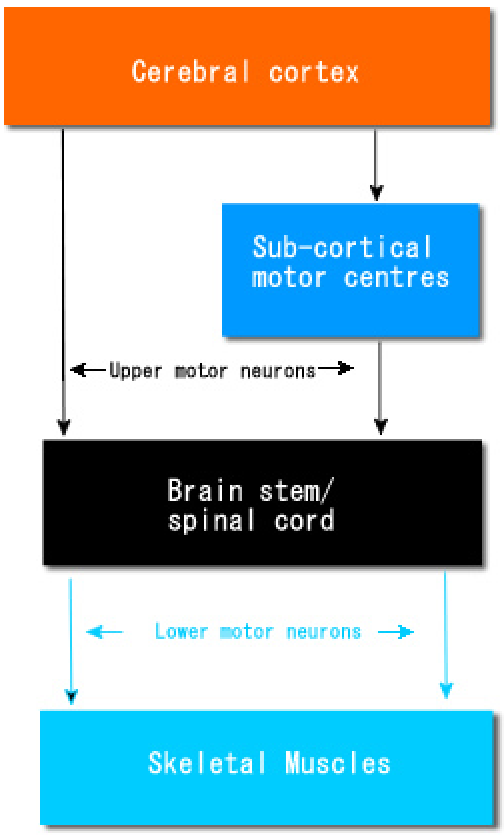
- Fibres in the olfactory striae terminate in the following:

a) Piriform area
b) Amygdaloid nucleus and Peri -amygdaloid areas
c) Entorhinal area:
d) Subcallosal areas
e) Para terminal gyri
f) Septal area
g) Primary olfactory cortex

- Efferent fibres from these project to hippocampal formation and frontal cortex

Learning points | Core anatomy | Applied anatomy | Review questions

Upper and lower motor neuron systems



Lower motor neurons:

- Make direct contact with muscles.
- Form final common pathway for control of muscle activity.
- Comprise all motor cranial and spinal nerves

Upper motor neurons

- Do not make direct contact with muscles.
- Control muscle activity indirectly by driving lower motor neurons
- Comprise descending tracts e.g. corticospinal and vestibulospinal

Effects of lesions

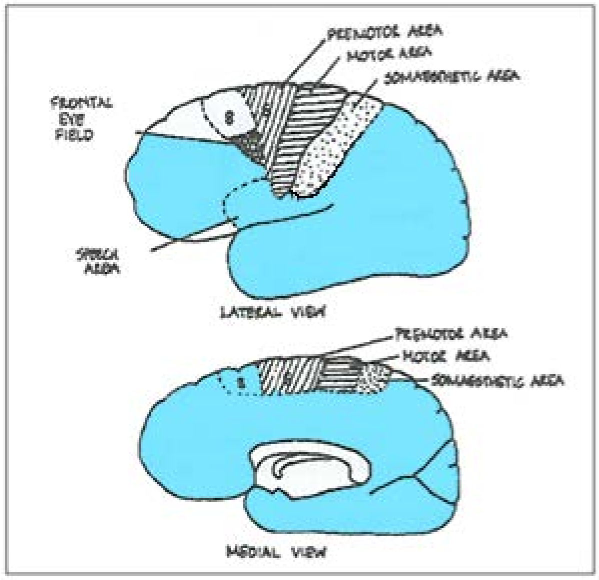
Lower Motor	Upper Motor
1. Total flaccid paralysis of muscles	1. Voluntary Spastic paralysis of muscles.
2. Diminished/absent tendon reflexes	2. Exxagerated tendon reflexes
3. Progressive atrophy of muscles	3. Little or no muscle atrophy
	4. Primitive reflexes e.g. babinski sign

'PYRAMIDAL' PATHWAYS

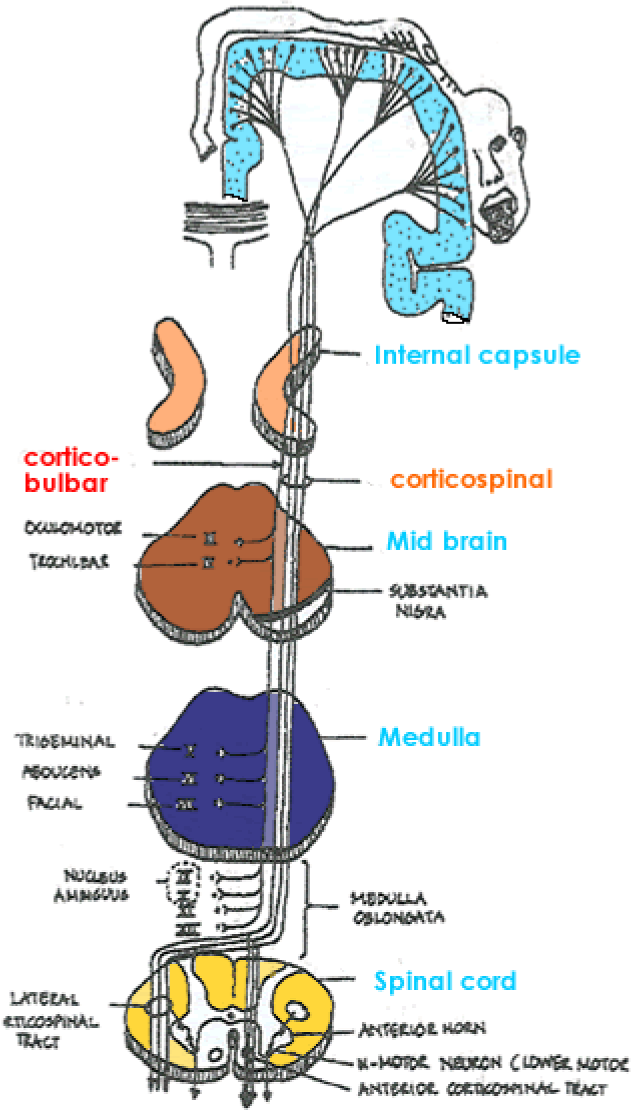
Origin

Giant pyramidal neurons of cortical layer 5 of:

- Primary motor area
- Premotor area
- The frontal eye field
- Somatosensory area



Course , Components and Termination



Course

Cerebrum: Corona radiata, Posterior limb of internal capsule

Mid brain : Middle of crus cerebri

Pons: Basal pons

Medulla: Pyramid, 75-85% pyramidal decussation

Spinal cord: Lateral corticospinal- Lateral funiculus, Ventral corticospinal - ventral funiculus

Components

1. Corticobulbar
2. Corticospinal

Termination

Corticospinal	Corticobulbar
Anterior horn cells (ventral horn) at the following levels: 1. 55% Cervical 2. 20% Thoracic 3. 25% Lumbosacral	Nuclei of: 1. Oculomotor 2. Trochlea 3. Trigeminal 4. Abducens 5. Facial 6. Glossopharyngeal 7. Vagus 8. Hypoglossal

Function

- Control of fine voluntary movements

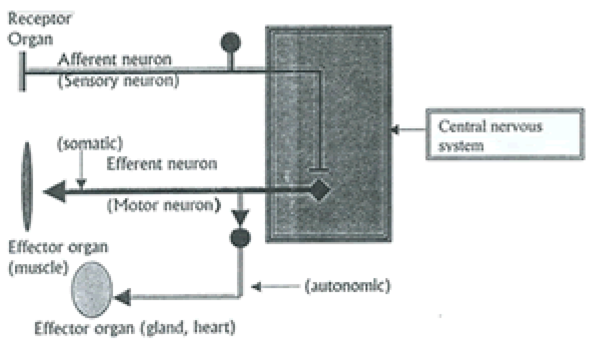
Applied anatomy

1. Upper motor neurons e.g cortico-spinal tract can be involved at various levels in vascular lesions of the brain (Cerebro-vascular accident/ stroke). They present with features of upper motor neuron lesions. The effect depends on the level.
   Capsular and mid brain lesions involve all cranial and spinal nerves
   Medullary lesions involve **hypoglossal nerves** and **spinal cord** (check brain stem lesions)
2. Upper motor lesions are necessarily confined to the central nervous system
3. Lower motor neurons involve the brain stem, brain stem and peripheral nerves and present with typical lower motor deficits.
4. **Extra-pyramidal lesions** tend to be more degenerative in nature such as **parkinsons disease** and **chorea** (check basal ganglia disorders)

eview questions

1. State the causes and presentations of upper and lower neuron lesions
2. Describe the origins, course, termination and disorders of cortico-spinal tract
3. Describe the differences between pyramidal and extra-pyramidal systems including their lesions.
4. Describe the blood supply of the pyramidal tract. Add notes on the effects of vascular lesions.

Reflexes



Components of Basic reflex pathways

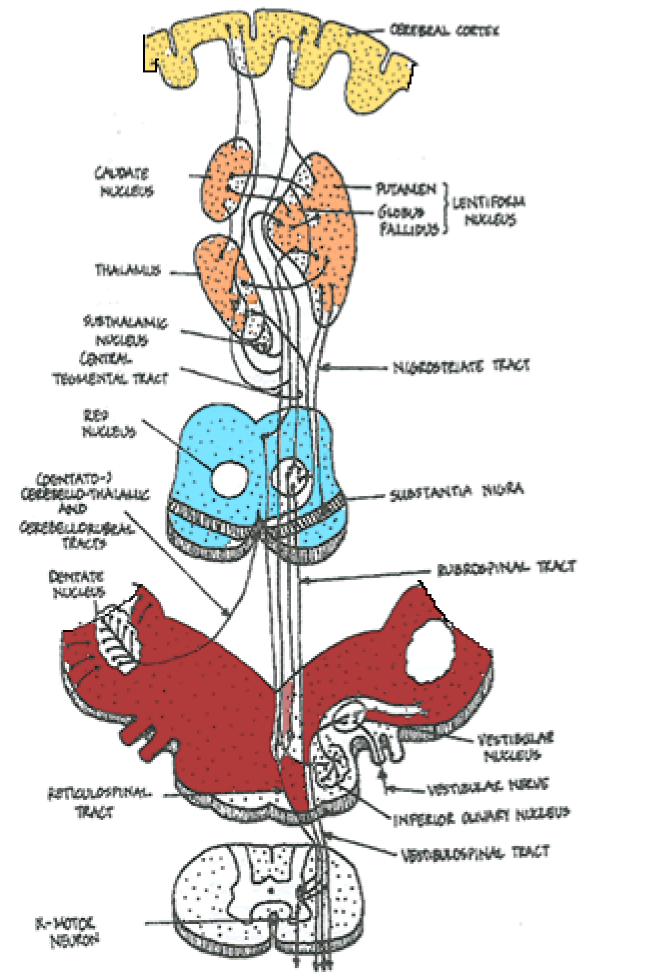
- **Receptor**
- **Afferent (sensory) neuron**
- **Intermediate neuron in spinal cord / brain stem**
- **Efferent (motor) neuron**
- **Effector organs** (skeletal muscle)

Used to test spinal cord / brain stem integrity

Commonly used tendon reflexes are:

Reflex	Cord / brain stem Level
Biceps	C5 and C6;
Triceps	C6 through C8
Quadriceps	L2 through L4;
Gastrocnemius	S1 and S2.
Abdominal	T7 through T12
Jawjerk	Pons
Corneal	Pons
Accomodation	Mid brain
Gag	Medulla

Extrapyramidal Systems



Some components and connections of the extrapyramidal system

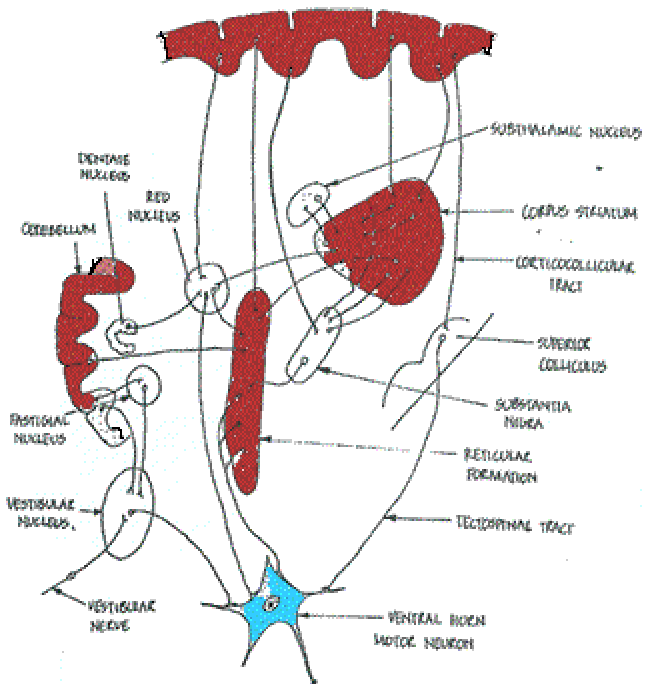
Pathways originate from **subcortical motor** centres such as:

- Corpus striatum
- Anterior thalamus
- Subthalamic nucleus
- Red nucleus
- Substantia nigra
- Tectum
- Vestibular nuclei
- Reticular formation
- Cerebellum

These centres project to each other and to the cerebral cortex directly or indirectly and then some of them project to lower motor neurons.

Lower motor neuron as an integrator

- Lower motor neurons constitute final common pathway to muscles
- It integrates signals from pyramidal, extra-pyramidal and spinal systems then directs them to the muscles



Components of extra-pyramidal system projecting to a lower motor neuron

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The corticoreticulospinal system

Components

- Cortico-reticular
- Reticulo-spinal

Course

- Parallel to cortico-spinal

Function

- Control of voluntary motor activity
- Modulation of segmental and postural reflexes
- Regulation of muscle tone.

Definition

Parts of the central and peripheral nervous systems concerned with innervation of:

- Viscera,
- Glands,
- Blood vessels
- Non-striated muscles.

Components

a) Parasympathetic
b) Sympathetic
c) Enteric system.

Disorders of autonomic function

- **HYPOTHALAMIC AND BRAIN STEM DISORDERS:**

Because the hypothalamus is small, lesions of this regulatory station of autonomic function usually involve several nuclei and pathways. Therefore even small lesions can produce a variety of symptoms, depending on the specific area or areas damaged. Thus the following disorders may occur in various combinations following damage to the hypothalamus:

- **Impaired homeothermy** : Hyperthermia, from the inability to dissipate body heat, is the commonest.
- **Diabetes Insipidus:** characterized by:

  1. Production of **copious amounts of dilute urine** (hyposthenuria)
  2. Insatiable thirst
  3. Incessant drinking of large amounts of water (polydipsia).

  - Results from **insufficient production, or release of vasopressin**

- **Sleep Disorders: e.g:** narcolepsy, insomnia, hypersomnia, and other changes in the normal sleep rhythm.
- **Feeding disorders:** These range from

  1. Bulimia , a ravenous insatiable appetite for food;
  2. Anorexia nervosa, a lack of appetite for food, and an intense fear of becoming fat.

- **Growth and Development Disorders:** These result from malfunction of the adenohypophysis due to abnormalities in production of trophic factors from the hypothalamus e.g. dwarfism, delayed puberty. Adiposogenital dystrophy (Frohlich's syndrome) is a genetic disorder of hypothalamic function, present from birth. It is characterized by a) obesity, especially around the shoulders, and hips and b) a generalized genital hypoplasia and immaturity.

- **Argyll Robertson's pupil:**

  1. This result form damage to the **pretectal area** of the midbrain,
  2. Almost always bilateral.
  3. The pupil can constrict during accommodation, but will not constrict in response to light.

- **Paroxysmal hypertension or orthostatic hypotension:** These may result from damage to the lower brain stem vasopressor and vasodepressor centres. Both are often associated with space occupying lesions of the posterior cranial fossa.

- **Familial dysautonomia (Riley-Day Syndrome):** This is a rare autosomal recessive disorder.

PERIPHERAL DISORDERS OF AUTONOMIC FUNCTION:

Aganglionic megacolon (Hirschsprung's disease):

- Results from a failure of **neural crest cells** to migrate to the distal part of the developing colon and rectum, leading to the absence of Meissner's and Auerbach's plexuses from the distal bowel. The **absence**

of enteric neurons in the lower bowel results both in a lack of muscle tone and peristalsis. These factors combine to produce a distended colon (megacolon) lacking in motility and prone to infarction.

Mydriasis

- Result from loss of parasympathetic innervation to eye, with the sympathetic innervation intact. Under these circumstances, the **pupil dilates** more than normal, and the pupillary light reflex is absent. The **pupillary constriction** that normally accompanies the accommodation reflex is also absent, with the affected pupil remaining dilated while the pupil of the unaffected eye constricts.

Horner's syndrome

This results from an **interruption of the sympathetic innervation** to the head and neck. The interruption of the sympathetic innervation can be due damage to any of the following:

- Post-ganglionic sympathetic from the cervical ganglia (primarily the superior)
- Superior cervical ganglion itself
- Pre-ganglionic fibres in the sympathetic chain
- Descending central pathways en route to the intermediolateral cell column, of the thoracic cord.

The basic symptoms of the syndrome are as follows:

- Miosis: Pupillary constriction, due to the unopposed parasympathetic innervation of the pupillary constrictors.
- Ptosis of the upper eyelid, due to a loss of sympathetic innervation of the superior tarsal muscle.
- Anhydrosis: Lack of sweating, due to a loss of innervation to the sweat glands.
- Facial flushing: Due to a loss of tone in the peripheral blood vessels of the face, leading to passive vasodilatation.

Review questions

1. Describe the autonomic innervation of the head and neck
2. Describe the formation, position, relations and distribution of the cervical sympathetic trunk
3. Compare and contrast, sympathetic and parasympathetic innervation of the GIT
4. Describe the regulation of the autonomic nervous system
5. Describe the causes and effects of two autonomic peripheral nervous system disorders.

Cranial Parasympathetic Outflow

Cranial nerve	Nucleus	Preganglionic nerve	Ganglion	Post ganglionic nerve	Target organ
3	Edinger-Westphal	• Oculomotor	• Ciliary	• Short ciliary	• Sphincter pupillae • Ciliary muscles
7	Superior Salivatory	• Chorda tympani	• Sub-mandibular	• Lingual	Salivary glands: • Submandibular • Sub-lingual • Lingual • Labial • Buccal
		• Greater petrosal	• Pterygo-palatine	• Maxillary	• Lacrimal • Nasal • Palatine • Pharyngeal glands
9	Inferior salivatory nucleus	• Tympanic branch. • Lesser petrosal nerve	• Otic ganglion	• Auriculotemporal nerve,	• Parotid gland
10	Dorsal vagal nucleus	Vagus	Minute ganglia in individual organs.	individual	• Thoracic and abdominal viscera

Sacral Parasympathetic Outflow

Origin

- **Anterior primary rami of the S2, 3 and 4**

Course

- Pelvic splanchnic nerves
- Hypogastric plexus

Ganglia

- In walls of individual viscera

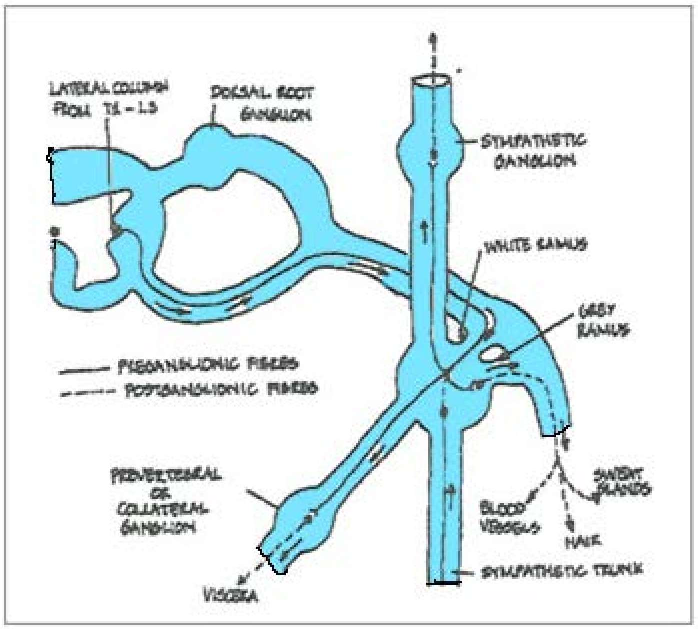
Post ganglionic nerves

- Individual

Target

- Distal transverse colon
- Descending colon
- Sigmoid colon
- Pelvic viscera
- External genital organs

SYMPATHETIC NERVOUS SYSTEM



Origin

- Lateral horns of T1 - L1

Components

- Myelinated fibres emerge through ventral roots of corresponding spinal nerves
- Join spinal nerve trunks
- White rami communicante
- Sympathetic trunks- inter connected ganglia

Distribution of postganglionic fibres

- Plexuses on arteries
- Spinal nerves
- Cranial nerves
- Directly
-

Targets

- Glands
- Smooth / cardiac muscle

Parts of sympathetic trunk

Cervical part

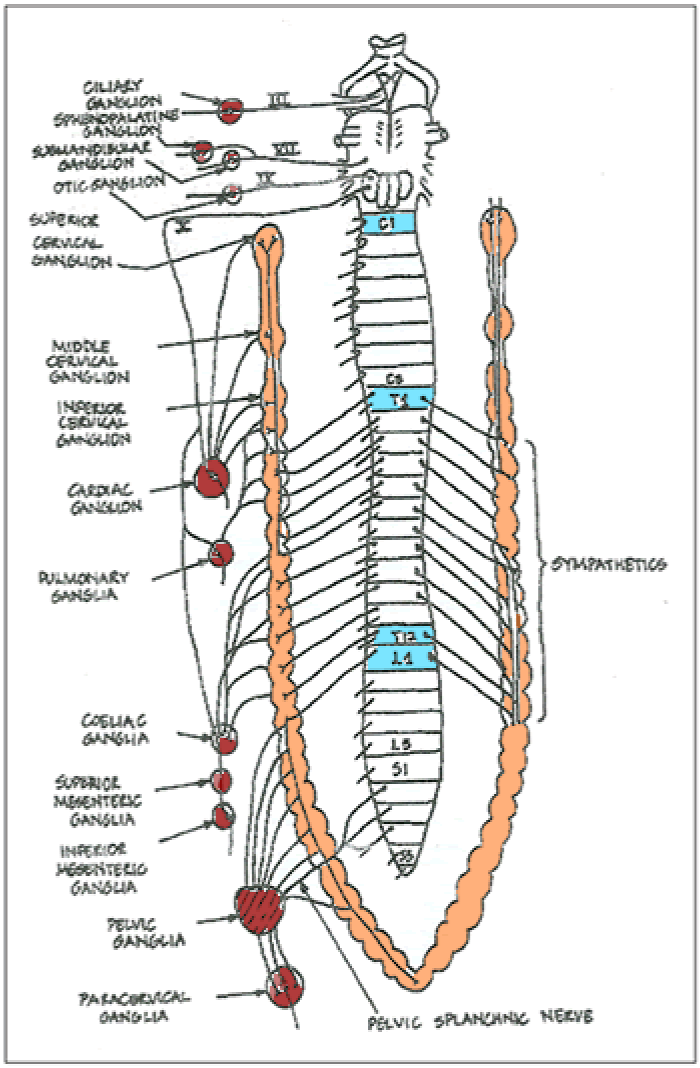
- Receive preganglionic fibres T1- T5
- Lies on the pre-vertebral muscles behind the carotid sheath.
- Three interconnected ganglia respectively known as **superior**, **middle** and **inferior cervical sympathetic ganglia**
- Post ganglionic fibres distributed with neighboring arteries to head, neck and upper limb

Thoracic

- Receives preganglionic fibres T1- T5
- Lies on the necks of the ribs in the upper part of the thorax and the sides of the vertebra in the lower part.
- Behind pleura
- Distributed to thoracic visceral

Abdominal

- T6- T12
- Lies on the anterolateral surface of the lumbar



vertebrae

- Right trunk lies behind the inferior vena cava
- Crosses sacral promontory to become continuous with the pelvic trunk.
- Distributed to abdominal viscera.

The Pelvic

- Pelvic splanchnic L1-L2
- Downwards on the pelvic surface of the sacrum,
- The two trunks usually unite in front of the coccyx and end in a small-unpaired ganglion (**ganglion impar**).

Autonomic ganglia and plexus

Thorax

Cardiac and pulmonary

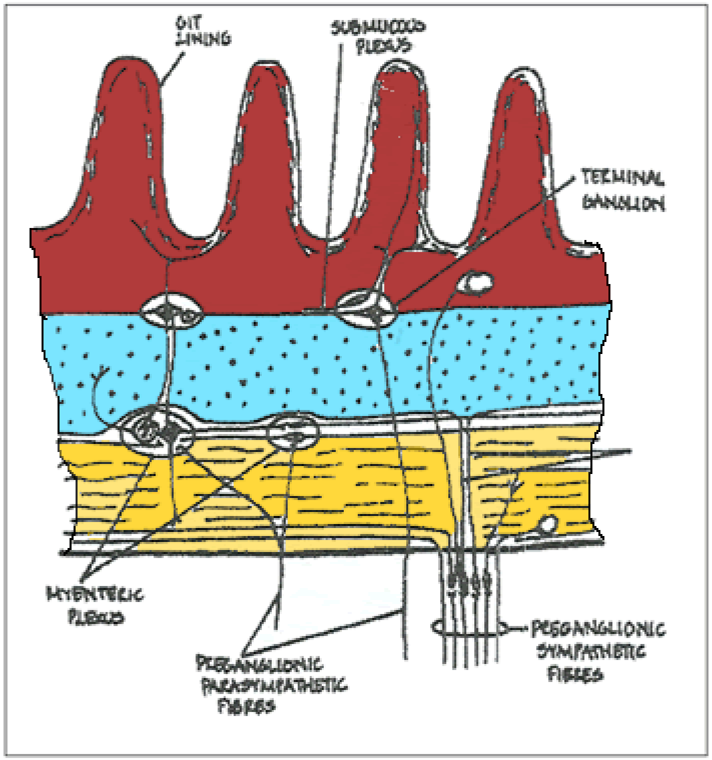
Abdomen

Celiac, superior mesenteric, inferior mesenteric

Pelvic

Hypogastric

The Enteric Nervous System



- Comprises the plexuses in the wall of the GIT namely

  1. The **myenteric plexus** of Auerbach, and
  2. The **submucosal plexus** of Meissner and their efferent and afferent connections.

- **Well recognized subdivision of the autonomic nervous system** because of the following reasons:

  1. It contains more than **post-ganglionic** and **pre-ganglionic components** of the sympathetic and parasympathetic divisions. It, in addition to these, also contains many **interneurons** and **general visceral afferents.**
  2. **Extensive interconnections** occur between the neuronal elements named above
  3. When isolated from the central nervous system, the enteric nervous system continues to **function reflexly**, controlling **peristalsis**, **GIT gland secretion** and blood flow modulation
     .
  4. This network of **ganglionic plexuses** is **isolated** from **surrounding intercellular fluids** in much the same manner, as the brain is isolated within the blood brain barrier.

Note: The enteric nervous system can operate in isolation. However, normally efferent signals from both the parasympathetic and sympathetic divisions drive it, even though these efferent signals are subject to more modulation within the enteric nervous system than in other peripheral ganglionic plexuses of the autonomic nervous system.

Comparison of sympathetic and parasympathetic systems

	Sympathetic	Parasympathetic
Origin	thoracolumbar	Cranio-sacral
Ganglia	Para-vertebral	Peripheral (near target)
Neuro transmitters at target	Adrenaline/ nor-adrenaline	Acetyl-choline
Distribution	Wide spread	Localized
Predominant effect	Fight and flight response	calm body maintenance

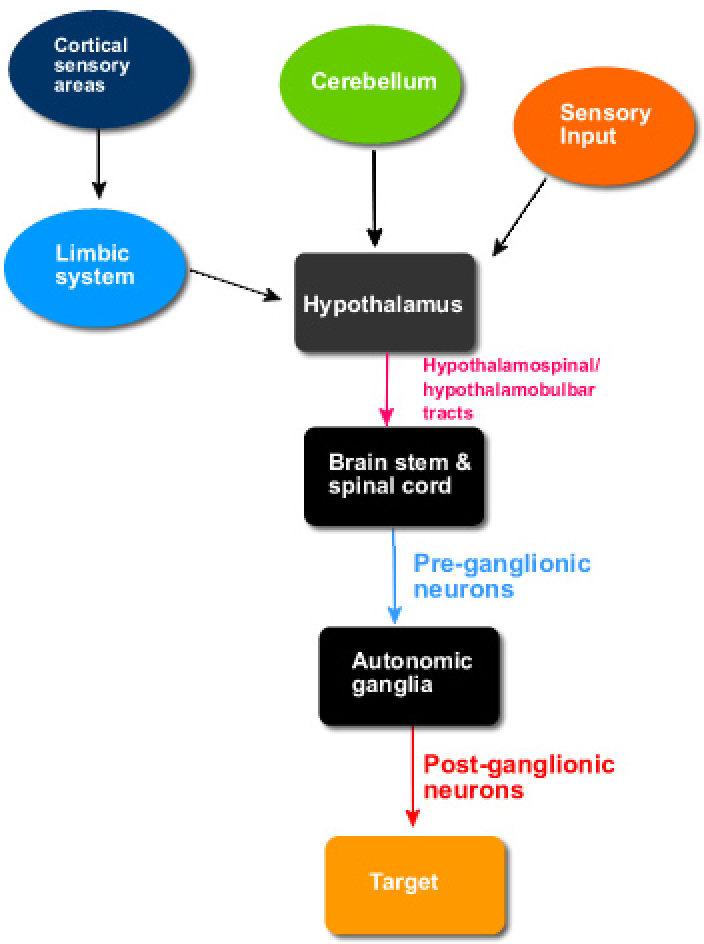
Note:

- Athough generally regarded as antagonistic, a **delicate balance** between the two systems maintains a more or less constant level of visceral activity (**homeostatic**) under conditions that usually prevail.
- The functional effects of the **parasympathetic** division tend to be more **localized** while those of **sympathetic** system are more **generalized**, a difference which rests on two anatomical considerations:

  a) Pre-ganglionic **parasympathetic** axons usually **terminate** on very much **smaller number of post-ganglionic** neurons than do their sympathetic counterparts.

  b) The generalized character of **sympathetic activity** is reinforced by the release of adrenaline and noradrenaline into the circulation from the cells of the **adrenal medulla**, which are innervated directly by pre-ganglionic sympathetic neurons.

Regulation of autonomic function



NOTE:

Cerebellar influence on autonomic activity

The hypothalamocerebellar and cerebellohypothalamic pathways provide direct connections between the integrative centres for visceromotor and somatomotor activity

.

Cortical Modulation of autonomic function

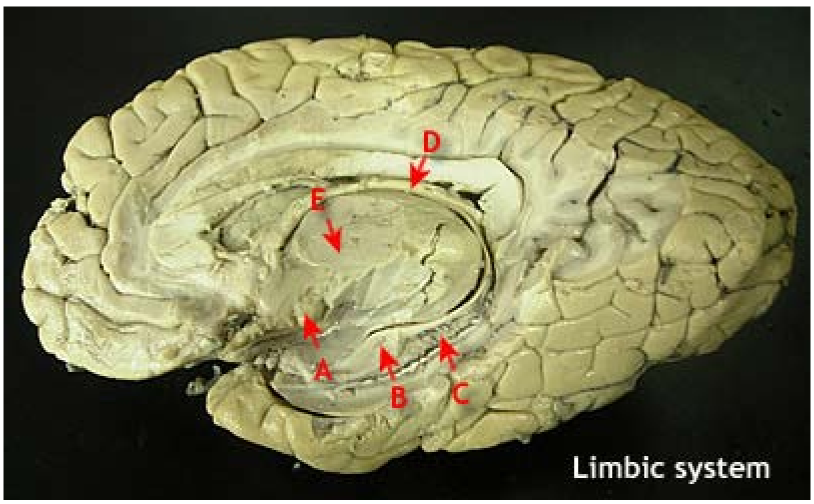
The **human brain** has the capacity to **override** many, if not all, **visceromotor** activities that normally are considered reflexive or involuntary. For example, many **Hindu yogis** are able to exert "**voluntary" control** over such functions as **heart rate, blood pressure**, respiration, gastrointestinal motility, and sphincter control through **intense concentration** and practice.

Definition

A collection of **structurally interconnected** and **functionally integrated cortical and subcortical brain components** concerned with self perpetuation and propagation namely: **feeding, socio-sexual** and **emotional behaviour, learning** and **memory**.

Components:

CORTICAL



Hover over the marked areas to show names

1. Hippocampal formation
2. Areas surrounding the brain stem
3. Cingulate
4. Parahippocampal gyrus
5. Uncus
6. Amygdala
7. Subcallosal gyrus
8. Oribitofrontal
9. Prefrontal association area
10. Superior, middle and inferior temporal gyri

SEPTUM AND FOREBRAIN:

1. Septum pellucidum and septal nuclei
2. Ventral striatum
3. Ventral striatum
4. Putamen
5. Nucleus accumbens
6. Globus pallidus

BRAIN STEM:

1. Hypothalamus
2. Thalamus
3. Anterior nuclear group
4. Lateral dorsal group
5. Habenular nuclei
6. Mesencephalic doperminergic system

CLINICAL CONSIDERATIONS : Disorders of the limbic system

- **Emotional lability** and various forms of psychosis can accompany hippocampal (and other limbic structures) disorders.
- **Eating disorders** : Many disorders from anorexia nervosa to bulimia may involve limbic system pathology.
- **Kluver-Bucy syndrome** – This comprises profound behavior changes in following bilateral removal of the temporal lobe (which houses neocortical areas, parahippocampal gyrus, uncus, and amygdala; and the hippocampal formation). The changes in behavior included:

1. An **increase** in both amount and diversity of **sexual activity** . The hyper-sexuality includes heterosexual, homosexual and auto-sexual behaviors.
2. Increase in **oral activity .**
3. Increased **docility** and loss of **fear.**

- Memory defects

Review Questions

1. Describe the main connections of the limbic system starting with the olfactory tract
2. Name the main components of the Papez circuit
3. Write short notes on:

   a) Fornix

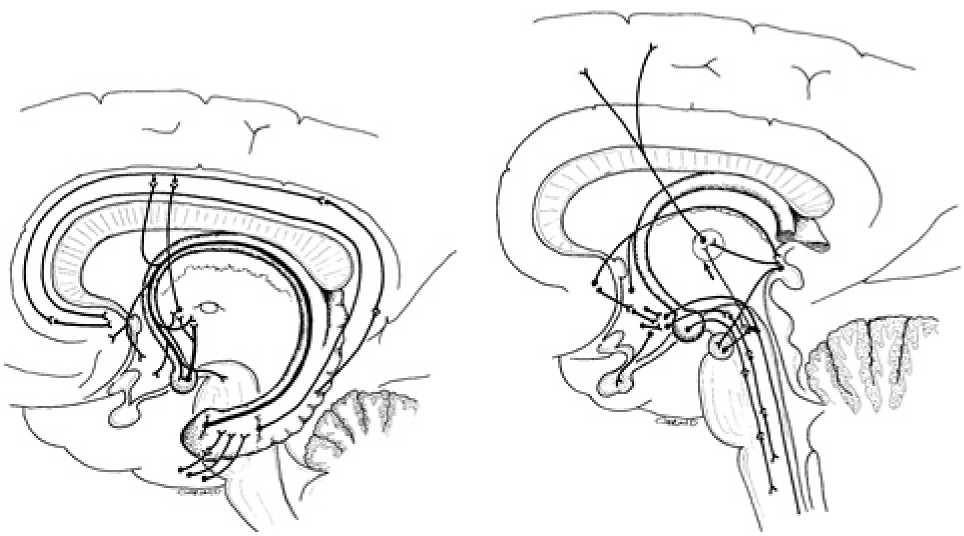
   b) Cingulum

   c) Limbic disorders

CONNECTIONS

- **Numerous pathways** interconnect the widely separated areas of the limbic system.
- Many of these are **reciprocal connections** with the **hypothalamus** and provide the **visceromotor component** of limbic system expression.
- Others are **cortical association pathways**, both within the limbic lobe and between the limbic lobe, and other cortical areas.
- Other pathways interconnect the **basal forebrain areas** within the **limbic lobe** and with the **hypothalamus**.

HIPPOCAMPO-HYPOTHALAMIC CORTICAL PROJECTIONS



FUNCTIONS OF THE LIMBIC SYSTEM

Modulation of:

- Autonomic functions:
- Homeostatic mechanism
- Conditioned reflexes
- Eating behavior

Control of:

- Thirst drive and body fluid regulation
- Adrenocortical activity
- Emotions

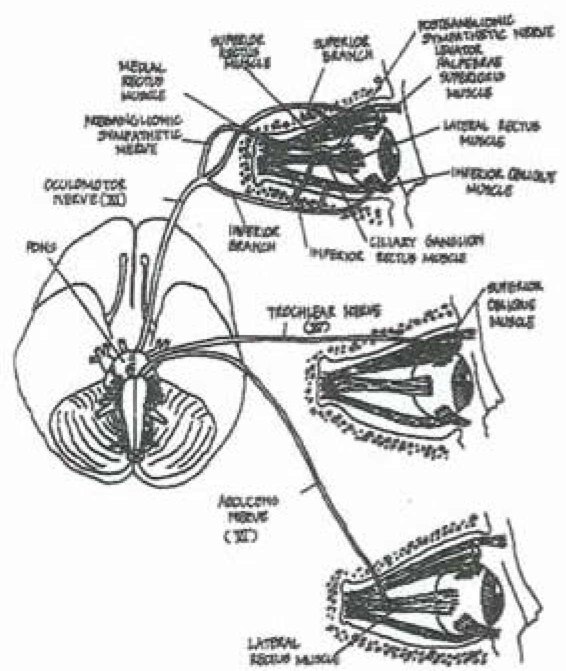
Learning and memory

THE OCULOMOTOR NERVE (CN III)

The Origin(s)

- The **GSE** fibres from **oculomotor nucleus** near the midline of the **midbrain**, at the level of the **superior colliculus**.
- GVE from **Edinger-Westphal** nucleus at the same level

The Course



Oculomotor (III), Trochlear (IV) and Abducens (VI) nerves

- Traverse substance of the **midbrain** and **red nucleus**
- Exit the central nervous system in the **interpeduncular fossa** medial to crus cerebri.
- Lies between the **superior cerebellar** and **posterior cerebral arteries .**
- Pierces dura mater to enter the lateral wall of the **cavernous venous sinus**
- Continues along the lateral and superior margin of the sinus
- Enters the orbit through the **superior orbital fissure.**
- Passes through the **common tendinous ring,** and splits into **superior** and **inferior** division.

Functional Components

- Parasympathetic (GVE) (already discussed)
- Somatic motor
- General somatic afferent from the neuromuscular spindles

Distribution

The oculomotor nerve supplies all the extra-ocular muscles **except** the superior oblique and lateral rectus These are the:

Superior division

- Superior rectus
- Levator palpebrae superioris

Inferior division

- inferior rectus
- inferior oblique
- medial rectus.

Probable cause and sites of injury

- **Vascular lesions of the midbrain** e.g. occlusion of the mesencephalic branch of the posterior cerebral artery (see Weber's syndrome).
- **Aneurysms of the arteries** - posterior cerebral and superior cerebellar
- **Hypothalamic tumors** in the interpeduncular fossa
- **Cavernous sinus thrombosis**
- **Meningeal tumors**
- **Orbital tumors**

The effects of these possible injuries are best understood after the discussion of the other nerves that supply extra-ocular muscles.

See the individual sections of the nerves

Review Questions

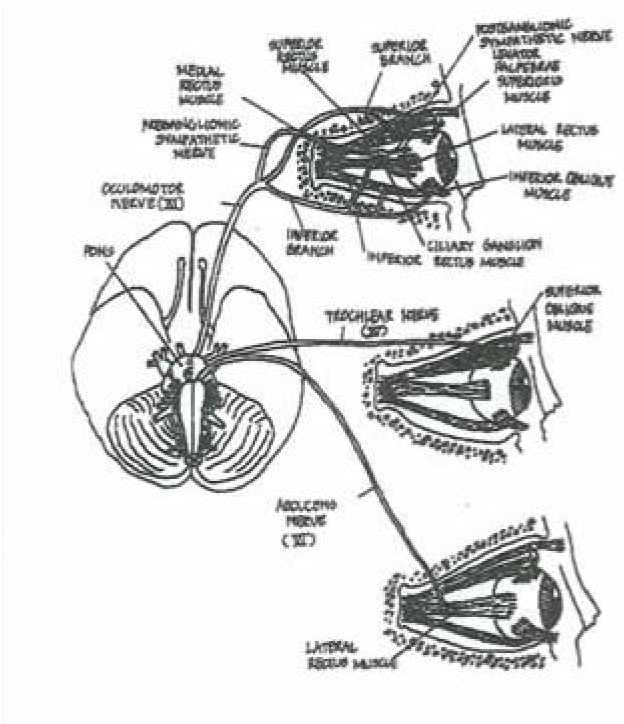
1. Describe the general disposition and connections of cranial nerve nuclei in the brain ste
2. Describe the origins, functional components, course and distribution of respective cranial nerves
3. Outline the sites, causes and effects of injury to respective cranial nerves

THE TROCHLEAR NERVE (CN IV)

The Origin(s)

The GSE fibres arise from the **trochlear nucleus** near nucleus lies near the **midline** of the **midbrain** at the level of the **inferior colliculus.**

The Course



Oculomotor (III), Trochlear (IV) and Abducens (VI) nerves

- Fibres curve laterally and dorsally
- Exit from the **dorsal surface** of the brain stem
- Pass **below** the **inferior colliculus** lateral to the **crus cerebri**
- Pierce the **dura mater** to enter the lateral wall of the **cavernous venous sinus** just below the oculomotor nerve.
- Enters the orbit through the **superior orbital fissure**
- Pass **above** the common **tendinous ring.**
- Within the orbit the trochlear nerve crosses **over** the **levator palpebrae superioris** and **superior rectus** muscles.

Functional Components

- Predominantly **general somatic efferent** (motor) to the superior oblique
- A few afferent fibres from the muscle spindles

Distribution

Despite its size, this nerve supplies only **one muscle -** the **superior oblique.**

Probable cause and sites of injury

Due to its long complicated course, the trochlear nerve is quite vulnerable to injury. Causes include:

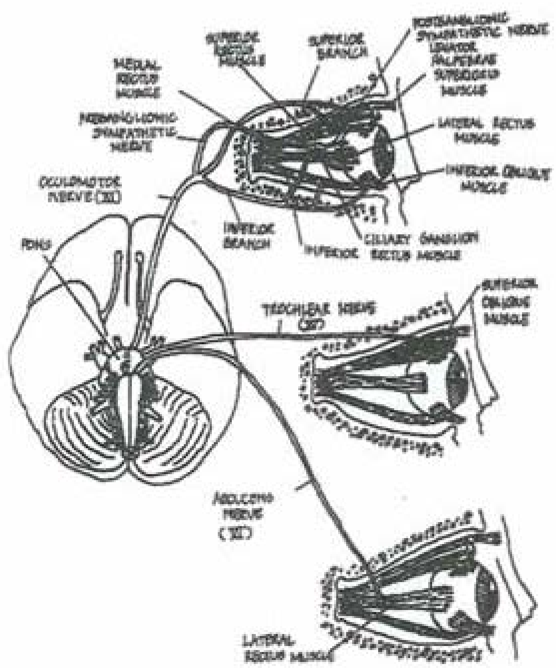
- Midbrain **vascular lesions**
- **Hydrocephalus** with dilatation of the cerebral aqueduct
- **Fracture base of skull**
- **Meningeal tumors**
- **Cavernous sinus thrombosis**
- **Orbital tumors**

THE ABDUCENS NERVE (CN VI)

The Origin(s)

The GSE fibres arise from the **abducens nucleus** near the midline of **pontine tegmentum**.

The Course



Oculomotor (III), Trochlear (IV) and Abducens (VI) nerves

- Efferent fibres arch ventrally
- Exit at the **medullopontine junction** near the ventral midline
- Lie lateral to the **basilar artery**, between the **anterior inferior cerebellar** and l**abyrinthine arteries.**
- Pierces the dura mater to enter **cavernous sinus**
- Courses **within the cavernous sinus** immediately below the internal carotid artery.
- Enters orbit through the **superior orbital fissure**
- Passes **through the common tendinous ring**, lateral to the optic nerve.

Functional Components

- Predominantly somatic motor (GSE)
- Few afferent fibres from the muscle spindle

Distribution

- Distributed to the **lateral rectus** .

Probable cause and sites of injury	• **Pontine vascular lesion**s (see middle alternating hemiplegia) • **Aneurysms** of the **basilar artery** and its branches closely associated with the nerve • **Meningeal tumors** • **Cavernous venous sinus thrombosis** • **Fracture of base of the skull** • **Aneurysms** of the cavernous portion of the i**nternal carotid artery** • **Increased intra-cranial pressure**

Ophthalmoplegias

Paralysis or weakening of extra-ocular muscles is called **ophthalmoplegia**. Ophthalmoplegias are caused by the damage of the nerves that supply the muscles. They are classified according to which nerve is affected.

1) **Oculomotor paralysis or paresis** occurs following damage to the oculomotor nerve. The following features characterize it:

• **External strabismus** . The affected eye is turned down and out, owing to the unopposed action of the lateral rectus and superior oblique muscles.

• **Ptosis** , drooping of the upper eyelid, occurs because of paralysis of the levator palpebrae superioris muscle.

• **Dilated pupil (mydriasis)** with **loss of the pupillary light reflex** occurs due to interruption of the parasympathetic innervation of the pupillary constrictors and unopposed action of the sympathetic innervation of the pupillary dilators.

• **Loss of accommodation reflex** , due to interruption of all the necessary efferent nerves.

2) Trochlear nerve paralysis or paresis occurs following damage to the trochlear nerve. There are two main features, related to each other.

• **External strabismus** , with the eye rotating up and out, is due to paralysis of the superior oblique muscle, and unopposed action of the inferior oblique muscle. Usually the patient compensates by tilting the head (the chin points away from the side of the affected eye) to avoid

• **Diplopia** (double vision). On examination, the patient is unable to move the affected eye downward and outward.

3) Abducens nerve paralysis or paresis , occurs following damage to the abducens nerve and affects only the lateral rectus muscle. The major defect is **internal strabismus,** with the eye tending to deviate toward the nose because of the unopposed action of the medial rectus. The patient is unable to fully abduct the affected eye, and may tend to rotate the head towards the affected side to avoid diplopia. Some limited lateral movement of the eye is noted, because both the superior and inferior oblique muscles have a minor abductive component

Central Ophthalmoplegias

- These are **ophthalmoplegias** due to damage to the **brain stem structures** that **control eye movements.**
- Damage to some of the brain stem areas, **nuclei gaze centres**, and **superior colliculus** often affects b**oth eyes** because the structures are close to the midline.
- Damage to the **superior colliculu**s, among other symptoms, interferes with the **vertical gaze centre**. A loss of conjugate upward movement of the eyes takes place.
- Damage to the **PPRF** may produce an associated loss of **lateral conjugate gaze movements**.
- Similarly, damage to the **MLF** between the abducens nuclei in the pons and the trochlear and oculomotor nuclei in the midbrain alters the lateral gaze response, and leads to a **complex nystagmus** due to the interruption of many of the vestibulo-oculomotor fibres

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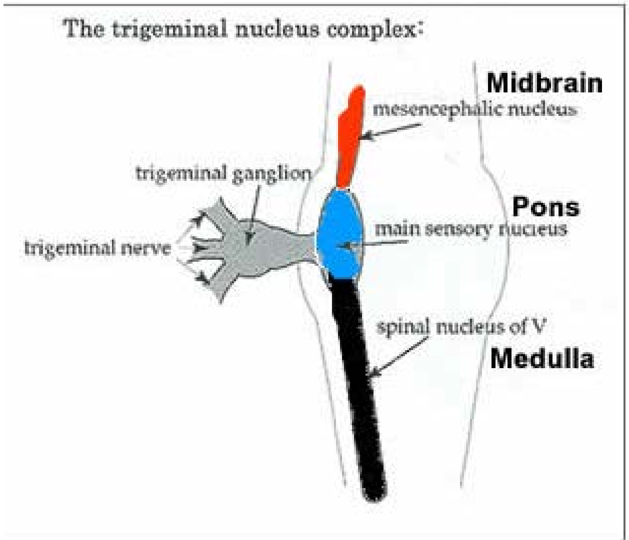
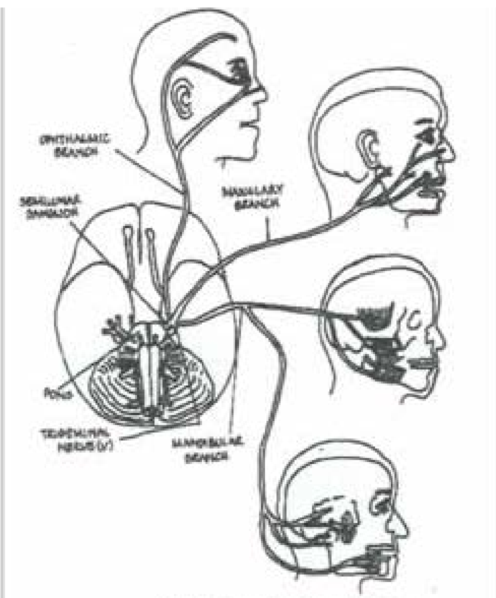
THE TRIGEMINAL NERVE (CN V)

The Origin(s)



The trigeminal nerve has four main nuclei:

- **Spinal nucleus**- medulla oblongata
- **Chief or principal nucleus** - pons
- **Mesencephalic nucleus** - midbrain
- Motor nucleus - pons .



Distribution of the trigemninal nerve

- Leaves the brain stem through the **middle cerebellar peduncle** in a ventrolateral location.
- Within 1 to 2 cm of the brain stem the trigeminal nerve swells to form the very large **trigeminal ganglion**
- This ganglion lies in a depression in the floor of the middle cranial fossa, lateral to the cavernous venous sinus.
- As the fibres exit the CN V ganglion, they form three primary divisions:

1. Ophthalmic
2. Maxillary
3. Mandibular

Division	Course	Branches	Distribution
	Ophthalmic division		

V1	• Enters the lateral wall of the **cavernous sinus** • Runs forward below the trochlear and oculomotor nerves. • Enters the orbit through the superior orbital fissure	**Nasociliary nerve**	External surface of the nose, • Anterior nasal cavity • Ethmoid sinuses • Sphenoidal sinus • Medial eyelids • Eyeball- cornea
		lacrimal nerve	• Lateral part of the upper eyelids, • Conjuctiva • Lacrimal gland. • Cranial dura
		frontal nerve	• Frontal sinuses, • Upper eyelid • Bridge of the nose, • Forehead.

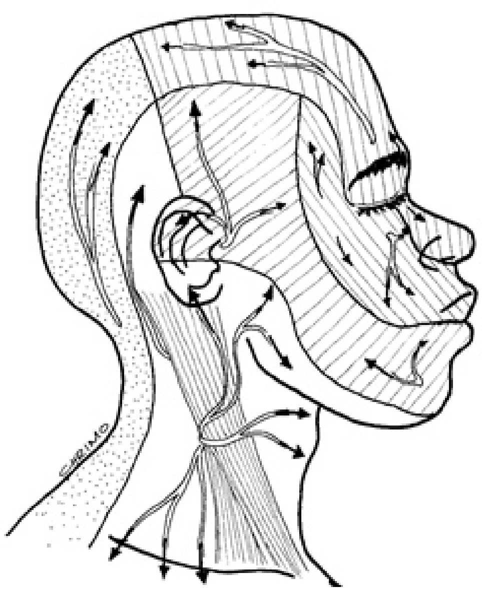
Maxillary division

V 2	• Leaves the trigeminal ganglion and enters the **cavernous sinus** • Exits through **foramen rotundum** • Enters inferior orbital fissure as the **infraorbital nerve.** • Exits through infra-orbital foramen	**zygomatic nerve**	• Area over the zygomatic arch • Lateral forehead, • Anterior temporal area.
		pterygopalatine nerve	• Posterior nasal cavity • Nasal septum, • Palate
		Infraorbital nerve ,	• Upper lip and to the • Medial cheek • Lateral nose • Maxillary air sinus
		Superior alveolar nerves	• Maxillary teeth • Maxillary air sinus

Mandibular division

	Nervous spinosum	• Cranial dura
		• Side of the head and scalp;

V3	- Leaves the cranial vault through **foramen ovale** - Lies anteromedial to the TMJ and close to the origin of the pterygoid muscles as well as the tensor and levator veli palatini muscles.	**auriculotemporal**	- Anterior wall of the external auditory meatus, - External surface of the tympanic membrane.
		Lingual nerve	Anterior two thirds of the tongue.
		Inferior alveolar	teeth of the lower jaw.
		Buccal nerve	mucosa of the mouth.
		Mylohyoid nerve	- Arises from the inferior alveolar nerve, - myohyoid muscle - Anterior belly of the digastric muscle.
		Muscular branches	Muscles of mastication



Summary of distribution

- Face
- Eyelids
- Eyes
- Nose
- Paranasal sinuses
- Ear
- Mandibular
- Maxillary teeth
- Gums
- Cranial dura
- Muscles of mastication
- Tensor tympani
- Tensor veli palatini

Functional Components

a) Branchiomotor to muscles of mastication (SVE)

b) Somatosensory (GSA)

Clinical disorders of the CN V

- **Paralysis or paresis** of muscles of mastication is readily detectable by palpation after the patient clenches the jaw. If the involvement is peripheral, the jaw will deviate towards the side of the lesion.

(+) There is also sensory loss to the area of the face supplied by the **mandibular division** .

(+) The loss in bite strength will be unilateral; the muscles will be flaccid, and the muscle mass will atrophy with time. If it is an upper motor neuron lesion, the jaw reflex will be exaggerated.

(+) A bilateral weakness may be apparent even with unilateral lesion, because the corticobulbar projections are a combination of crossed and uncrossed fibres.

- **Trigeminal Neuralgia :**

(+) This is one of the most common clinical problems of the trigeminal nerve.

(+) It is characterized by periods of **severe shooting pain** in the **area of supply of the trigeminal nerve**.

(+) The pain **localizes to the side of the face**, and involves the areas of innervation of one or more of the divisions of CN V - usually the maxillary or mandibular divisions.

(+) The origin of the pain is unknown. In severe cases however**, severing of the spinal tract of the trigeminal nerve** in the lower medulla below the level of the inferior olivary nucleus, offers **relief**.

(+) In localizing injury to branches of the trigeminal nerve, the integrity, or the lack thereof, of the autonomic innervation to salivary glands and lacrimal glands is valuable information.

If damage occurs peripheral to the hitchhikers joining the nerve, an autonomic loss accompanies the sensory loss.

- **Herpes Zoster :**

(+) As with other sensory ganglia, the **trigeminal ganglion** is vulnerable to this infection.

(+) This viral infection results in considerable **pain** and **ulceration** of the skin and mucous membranes supplied by the affected fibres. The **ophthalmic divisio**n is **most frequently affected**.

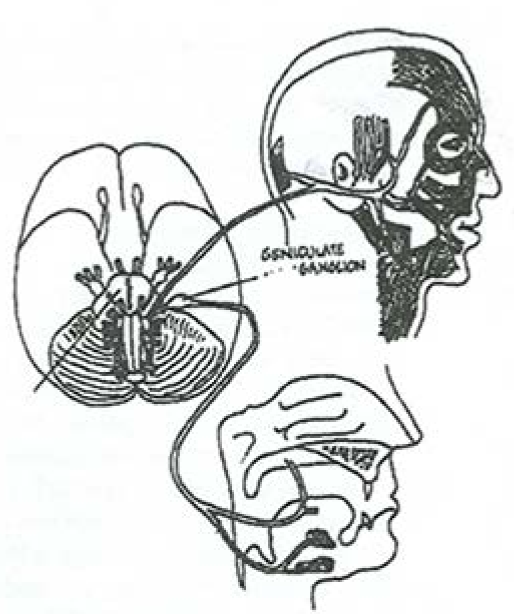
(+)There are a wide host of causes and effects of injury to the individual branches of the three divisions of CN V, which you will meet in your gross anatomy studies of the neck.

THE FACIAL NERVE CN VII

The Origin(s)

- **Facial nucleus** - pons
- **Superior salivary nucleus**- pons
- **Gustatory nucleus** - medulla oblongata
- **Spinal nucleus of the trigeminal nerve** - medulla oblongata

The Course and distribution



Distribution of the facial nerve (VII)

- Exit the brain stem through **cerebello pontine angle**
- Passes through the **internal auditory meatus** together with **vestibulocochlear nerve** and **labyrinthine artery**.
- Has the **geniculate ganglion** containing cell bodies of the primary GSA, GVA, and SVA neurons
- Runs in the **facial canal** between tympanic cavity and mastoid antrum
- Exits through **stylomastoid foramen**
- Enters **parotid gland** running between deep and superficial laminae

Part / location	Branch	Distribution
In the facial canal	Greater petrosal nerve	• Pterygopalatine ganglion
	Nerve to stapedius	• Stapedius muscle

	chorda tympani	• Taste to anterior two thirds of the tongue • Sub mandibular ganglion
Before parotid	Auricular nerve	• Auricular muscle • Occipital belly of occipito-frontalis muscle
	Nerve to digastric muscle	• Posterior belly of digastric muscle • Stylohyoid muscle
In the parotid gland	Temporal nerve	• muscles in the upper face • the orbicularis oris • frontalis muscles
	Zygomatic nerve	• middle portion of the face
	Buccal nerve	• cheek muscles • buccinator muscle
	Marginal Mandibular nerve	• Muscles of the lower face
	Cervical nerve	• Muscles below the chin • platysma muscle

Functional Components

- **Branchiomotor** (SVE) to muscles of facial expression; and also to digastric and stylohyoid. These fibres are in the facial nerve proper.
- **General visceral efferent, GVE** (parasympathetic) to the submandibular and sublingual and lingual gland; to the lacrimal, palatine, pharyngeal, nasal and oral glands.
- **General visceral afferent (GVA)** from the nasal cavity; the sinus cavities, and part of soft palate.
- **Special visceral afferent, SVA (taste)** from the anterior 2/3 of the tongue
- **General somatic afferent (GSA)** from the pinna of the ear and the external auditory meatus.

Probable cause and sites of injury

- Brain stem **vascular lesions**
- **CP angle lesions** e.g. acoustic neuroma
- **Facial canal oedema**
- **Geniculate ganglion** herpes zoster
- **Otitis media / mastoiditis**

Birth trauma e.g. during forceps delivery

Clinical disorders of the facial nerve

- Motor innervation of the muscles of facial expression is the principal function of the facial nerve.Accordingly, the most common symptom from damage to the nerve, nucleus or corticobulbar projections is a paralysis or paresis of these muscles. Involvement of the components of the intermediate nerve serves to **localize** the point of damage to the facial nerve.

- **Facial palsy** is an impairment (paresis) or total paralysis of some or all of the muscles of facial expression. With damage to the facial nerve or facial nucleus, the paralysis is **ipsilateral** to the insult, and **flaccid** i.e. lower motor neuron damage. The following features are usually noticed:

(+) **Normal facial folds**, wrinkles and creases due to the insertion of the muscles into the skin disappear, giving the affected side a smooth and expressionless appearance.

(+) The **corner of the mouth tends to droop**, and there is a tendency for the patient to drool out of that of the corner of the mouth

(+) The patient is **unable to close the affected eye**. If there is a lack of tearing the cornea tends to dry out.

(+) With time, the **muscles on the affected side** tend to **atrophy**

(+) **Food accumulates** in the **vestibule** of the affected side

- Damage to only certain of the terminal branches of the facial nerve leads to a loss of only those muscles innervated.

- Similarly nuclear lesions, if partial, may involve selected muscle groups because specific subnuclei of the facial nucleus innervate specific target muscles or muscle groups.

- The term **Bell's palsy** describes a facial palsy resulting from damage to the facial nerve, at some point at or beyond the nerve's exit from the skull through the stylomastoid foramen. Typically, Bell's palsy does **not** involve the components of the intermediate nerve.

Supranuclear facial palsy, has a very characteristic feature, **sparing of the upper muscles of facial expression** (above the level of the palpebral fissure). Corticobulbar projections of facial neurons innervating the upper muscles of facial expression are both crossed and uncrossed, whereas those to neurons innervating the lower muscles of facial expression are all crossed. Hence, lesions affecting the corticobulbar projections produce **contralateral** paralysis of the lower muscles of facial expression, and spare the upper muscles. Patients are able to close both eyes and wrinkle both brows. In addition, because it is an upper motor neuron lesion, there is no accompanying atrophy of the muscles and there is a retention of facial reflexes i.e. the patient's ability to smile reflexly or show other emotional expressions.

Loss of taste in the anterior 2/3 of the tongue in combination with a facial palsy indicates damage to the facial nerve central to the exit of chorda tympani nerve. Also, the loss of the pre-ganglionic parasympathetic fibres to the submandibular ganglion causes **diminished salivation** (However, this sign may be difficult to detect, because the parotid gland is functional). The loss of taste over anterior 2/3 of the tongue and diminished salivation, **without motor palsy** suggest involvement only of the chorda tympani nerve. When **anaesthesia of the anterior 2/3 of the tongue** accompanies the loss of taste and diminished salivation, an involvement of the lingual nerve is likely.

An accompanied **loss of tearing** (lacrimal gland innervation) occurs only if the facial nerve lesion is central to the geniculate ganglion. Lacrimal gland innervation is via the greater petrosal nerve.

Hyperacusis, an increase in auditory sensitivity on the affected side, often occurs if there is paralysis of the stapedial muscle. This indicates injury to the facial nerve central to nerve to stapedius.

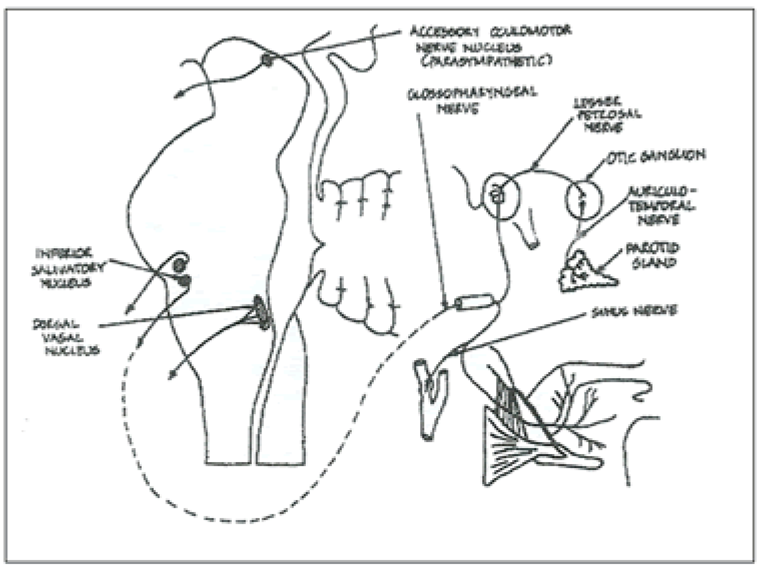
Herpes zoster infection of the geniculate ganglion primarily affects the regions with sensory supply from the facial nerve. The motor components are affected by the oedema. The collection of the effects comprises **Ramsay-Hunt syndrome.**

THE GLOSSOPHARYNGEAL NERVE (CN IX)

The Origin(s) and functional components

- **Gustatory nucleus: SVA** fibres from the **posterior third of the tongue** and rudimentary taste buds in the pharynx.
- **Solitary nucleus: GVA** fibres from the posterior third of the **tongue**, **pharynx** and **carotid sinus.**
- **Spinal nucleus of the trigeminal nerve: GSA** fibres from the **pinna of the ear** and the **external auditory meatus**.
- **Nucleus ambiguus: SVE**, branchiomotor, fibres to the **stylopharyngeus muscle**
- **Inferior salivatory nucleus:** pre-ganglionic parasympathetic, **GVE** fibres, to the **parotid gland**.

The Course and distribution



- Emerges from the brain stem as a series of five or six small nerve rootlets, immediately **dorsal to the inferior olive**.
- Rootlets emerge **rostral to the vagus nerve** rootlets
- Exits through the **jugular foramen** and emerges immediately posterior to the styloid process.
- It has two ganglia **superior** (GSA) , and the **inferior** (GVA and SVA).

Branches	Distribution

Tympanic nerve	• Tympanic cavity • Auditory tube • Otic ganglion
Auricular branch	• Small area on the pinna of the ear • External auditory meatus.
Nerve to stylopharyngeus (SVE)	• Stylopharyngeus muscle
Carotid sinus branch (GVA)	• Carotid sinus • Carotid body
Pharyngeal nerve	• posterior third of the tongue, providing both SVA (taste) and GVA innervation. • Oro-pharyngeal mucosa

Functional Components

Clinical disorders of Glossopharyngeal nerve

A lesion affecting only the glossopharyngeal nerve is rare. It is characterised by:

- The **loss of** (or reduction in) **the gag reflex** usually elicited by stroking the lateral wall of the pharynx near the tonsilar fossa.
- **loss of taste** sensation on the ipsilateral **posterior third of the tongue**
  ,
- marked reduction in the **serous secretion of the ipsilateral parotid gland**.

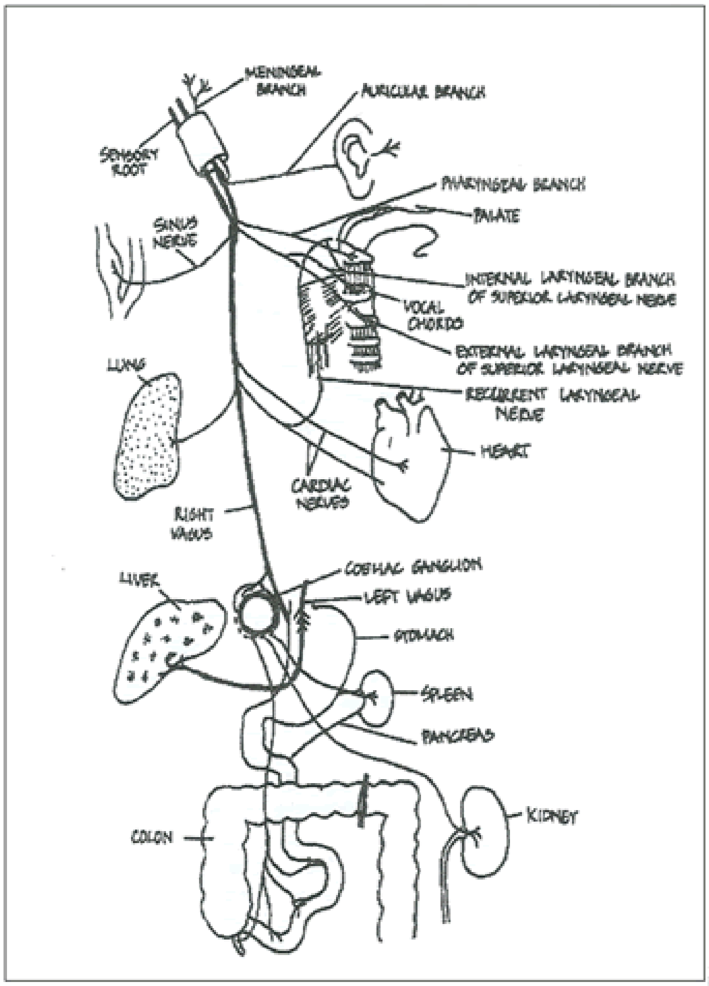
THE VAGUS NERVE (CN X)

The Origin(s), Functional components and Distribution

Nucleus	Components	Distribution
Dorsal vagal nucleus:	pre-ganglionic parasympathetic (**GVE**)	• Mucous glands of the larynx • Visceral contents of the entire thorax and most of the abdomen.
Nucleus ambiguus:	Motor neurons (**SVE**)	• Muscles of the **pharynx** and of the **larynx,** except the stylopharyngeus (glossopharyngeal) and tensor veli palatini (trigeminal) muscles.
Nucleus tractus solitarius:	sensory (**GVA**)	Fibres from the mucosal linings of the: • pharynx • larynx, • soft palate.
dorsal sensory nucleus	GVA	• Carotid sinus
The spinal nucleus of CN V:	General sensory (**GSA**) fibres.	• Pinna of the ear • External auditory meatus • Meninges
Gustatory nucleus:	Special visceral affarent (**SVA**)	• Taste fibres from the epiglottis.

The Course

- Emerges from the **brain stem** as a series of rootlets just **dorsal to the inferior olive**.



- Passes **caudal** to the **glossopharyngeal nerve** and **rostral** to the **spinal accessory nerve**.
- Exits through the **jugular foramen**.
- Initially courses with the spinal accessory nerve
- Has two sensory ganglia: **superior (jugular) ganglion** (GSA) and **inferior (nodose) ganglion** (SVA and GSA)
- Descends in the neck, within the **carotid sheath** ,
- **Posterior** and **between internal carotid** and **common carotid arteries** and internal jugular vein.
- Remains in the **carotid sheath** until it enters the thoracic cavity.

Branches and Distribution

Branch	Distribution
Auricular nerve	• Pinna • External auditory meatus.
meningeal nerve	• Dura of the posterior cranial fossa.
Pharyngeal nerves	• Muscles of the pharynx and soft palate except the stylopharyngeus and tensor veli palatini muscles • GVE pre-ganglionic parasympathetic innervation to glands in the pharyngeal mucosa.
superior laryngeal nerve:two branches **a) internal laryngeal nerve**	• Sensory innervation (GVA) to the mucosa of the larynx down to the level of the vocal cords
b) external laryngeal nerve	• Inferior pharyngeal constrictor and Cricothyroid muscles
Recurrent laryngeal nerve	• Intrinsic muscles of the larynx (SVE), except the cricothyroid muscle.

- Laryngeal mucosa below the vocal cords,
- Trachea
- Oesophagus.

Clinical Disorders of vagus nerve

The vagus nerve can be injured by :

- Expanding CP angle lesions;
- Hydrocephalus;
- Cerebellar tumors or meningiomas
- Aneursyms of carotid arteries
- Neck surgery
- Brain stem vascular lesions e.g. PICA syndrome
- Other brain stem lesions e.g. amyotrophic lateral sclerosis, poliomyelitis, and brain stem tumors

This leads to:

- **Persistent hoarseness in the voice**
- **Drooping of the soft palate** on the affected side
- **Deviation of the uvula** away from the injured side
- **Dysphagia** with food passing into the nasopharynx and trachea
- **Loss of gag reflex**
- **Hyperacidity** and **Gastric ulceration.**

Damage only to the **recurrent laryngeal nerve** may occur during:

- Thyroid surgery
- Tracheostomy
- Oesophageal surgery
- Tracheobronchial lymph node enlargement
- Bronchogenic carcinoma
- Esophageal carcinoma

The GSA neurons in the vagus nerve form the **auricular nerve** to the external auditory meatus, which makes reflex connections with the dorsal motor nucleus of the vagus. Thus, stimulation of the external ear can cause **coughing, nausea** and even fainting.

SPINAL ACCESSORY NERVE (CN XI)

The Origin and functional components

Spinal accessory nucleus. C1- C5

GSE

The Cours and distribution

- Course **dorsomedially**
- Take a 180° bend to exit the **spinal cord laterally** between the **dorsal** and **ventral roots**.
- **Ascend parallel** to the spinal cord
- Enter the cranial vault through **foramen magnum**
.
- Curves downward to exit the skull through the **jugular foramen** .
- Descends in the neck in the **company** of the **internal jugular vein.**
- Enters the **medial surface** of the **sternomastoid muscle.**
- Joined by sensory fibres from **upper cervical nerves**
- Traverses the **posterior cervical triangle** before entering the lower portion of the **trapezius muscle**.

Distribution

- Innervates **sternocleidomastoid** and **trapezius**

Clinical Disorders of spinal accessory nerve

Damage to the nerve

Can be **caused** by :

- Poliomyelitis
- Spinal injuries
- Meningiomas
- Neck wounds and tumors
- Surgery in the posterior cervical triangle

Results in:

Weakness in **rotating the head down and away** from the side of injury(sternomastoid muscle weakness)

- Droop of the affected shoulder and an inability to shrug that shoulder
-
- Reduced force when elevating the arm and shoulder against pressure
- Inability to elevate shoulder above the horizontal plane.

THE HYPOGLOSSAL NERVE (CN XII)

The Origin(s) and functional components

- **GSE**
- **hypoglossal nucleus,**

Course

- Exits brain stem between the inferior olive and the medullary pyramids as a row of small fascicles of fibres
- These fascicles collate, forming the **hypoglossal nerve**
- Exits the cranial vault through the **hypoglossal canal.**
- Descends in the neck to about the level of the **hyoid bone**.
- Curves forward between the **stylohyoid** and the **hyoglossus muscles** to lie on the latter.
- **Enters** the **tongue** to innervate the muscles
- Joined by **first** and **second cervical nerves**, postganglionic sympathetic fibres from cervical ganglia

Distribution

- Intrinsic muscles of the tongue
- Extrinsic muscles of the tongue except palatoglossus

Applied anatomy

Damage to the hypoglossal nerve may be due to:

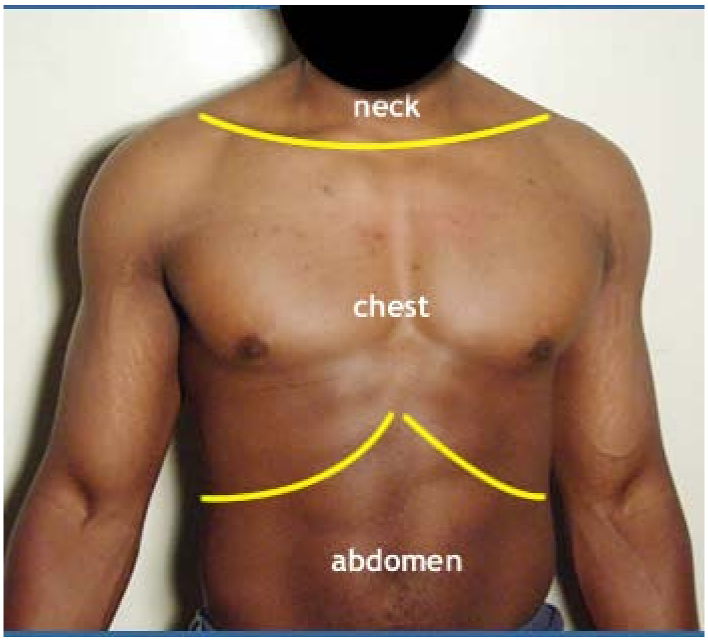
- Brain stem vascular lesion (see medial medullary syndrome)
- Bulbar polio
- Brain stem or cerebellar tumors
- Mandibular and/or tongue tumors/surgery.

The symptoms are typical of **lower motor** neuron damage. If the damage if unilateral, the **tongue always deviates toward the side of the lesion**, when protruded.

Upper motor neuron lesions produce a **contralateral** paralysis of the **tongue musculature**, because the descending corticobulbar fibres cross en route to the hypoglossal nucleus.

THE THORAX

Is the region of the body between the neck and the abdomen



Can be divided into:

- The thoracic wall
- Thoracic cavity

The thoracic wall encloses the thoracic cavity, which lodges:

1) Heart
2) Great vessels
3) Lungs on the sides

Applied Anatomy

Extra ribs

1. **Cervical ribs**

+) These develop from persistent costal elements of c7
+) Articulate with the seventh cervical vertebra.
+) May be bony, cartilaginous or fibrous.
+) May compress (or overstretch) the subclavian artery and or lower trunk of the brachial plexus

2. **Lumbar ribs**

+) Are more common than cervical ribs.
+) They articulate with the first lumbar vertebra or are attached to tips of the transverse process.
+) May confuse the identification of vertebral levels in radiographs.
+) May be erroneously interpreted be intepreted as a fracture of a lumbar transverse process.

Bifid ribs : Can cause confusion in rib count

Fused ribs are uncommon, and are often associated with a vertebral abnormality e.g. a hemi vertebra

Rib Fractures:

- Commonest site just anterior to the angle: area of greatest change in curvature
- Becausef the ribs in infants and children are elastic, they do not often fracture.
- Broken ends may be driven inwardly and injure the thoracic and or abdominal organs- lungs, spleen and liver
- The middle ribs are the most commonly fractured. The first two ribs (which are partially protected by the clavicle) and the last two (which are free and movable) are the least commonly injured.
- Fractured ribs are very painful because of their movements during respiration, coughing and sneezing. Patients experience considerable pain in the region of the fracture, when asked to take a deep breath. Careful palpation along the broken rib often reveals tenderness even when the fracture may not be visible on a radiograph.
- When a sizeable segment of the anterior or lateral chest wall is freely movable, because of multiple rib fractures; this is called flail chest (‘ stove in chest'). The loose segment of the chest wall moves paradoxically i.e. inward in inspiration; and outward in on expiration.

Thoracotomy: This is opening of the thoracic wall e.g. to remove a collection of pus or fluid in the pleural cavity

Sometimes a piece of rib is used for **autogenous bone grafting** e.g. for reconstruction of the mandible following excision of a tumor. Following the operation, the rib defect generates from the remaining periosteum

The costal cartilages of young people provide resilience to the thoracic cage, preventing many crushing injuries or direct blows from fracturing the ribs and or sternum. Adults loose this protection, when the cartilage ossifies

Separation of a rib refers to dislocation of the costochondral junction between the rib and its costal cartilage; and not the lack of continuity in the shaft.

Sternum :

1. **Fracture of the sternum** is uncommon except in automobile accidents, and when drivers' chest is driven into the steering wheel. In this case, the body of the sternum is commonly fractured in the region of the **sternal angle** and is often a comminuted fracture (broken into pieces). Fortunately, the ligaments coverings confine the fragments in most cases so that compound (open) fractures are prevented. In severe accidents, the body of the sternum **seperates from the manubrium** at the manubrosternal joint and is driven posteriorly, **rupturing the aorta and or injuring the heart and liver**. Such injury may kill from excessive loss of blood or damage to the myocardium

2. Men in their early forties, when they suddenly detect their ossified xiphoid process, may consult the doctor for fear that they developed a cancer in the stomach.

3. The sternum contains readily accessible bone marrow, which can be obtained by inserting a wide bone needle through the cortex of the sternum and aspirating. The needle goes through the skin , superficial fascia and periosteum of the sternum. This is called sternal puncture and is a potentially dangerous procedure which must be done carefully otherwise the needle may go as far deep and injure the aorta and or the heart

4. Access to the anterior mediastinum may be gained by splitting the sternum in the median plane. This is called median sternotomy**.**

5. The sternum develops as two separate Sternal bauds, which unite in the middle. The union may be incomplete, causing cleft sternum . Extensive cleft sternum may lead to exposure of the heart (which is commonly abnormal). This is called ectopic cordis and is fortunately rare.

6. More commonly, is a sternal foramen, which care must be taken not to confuse it with a bullet wound. Otherwise such a foramina when small are of no clinical consequence

7. The sternum may protrude out, like a pigeon chest (pectus carinatum) or project inferiorly and posteriorly like a funnel (pectus escavatum). These abnormalities are usually congenital and by altering the geometry of the chest, may interfere with normal respiratory movement. Pectus carinatum, for example is more subject to trauma.

Related to respiratory movements

1. During respiration, there is considerable movement of the various joints of the thorax (costovertebral; costochondral and sternocostal). Hence any disorder that reduces the mobility of these joints interferes with respiration.

2. A number of areas of the thoracic cage are affected by **age changes**, which compromise the normal respiration in the elderly. These include:

   - Partial or complete ossification of the costal cartilages
   - Fusion of the manubriosternal joint
   - Ossification of the xyphoid process and its fusion with the body of the sternum
   - Osteoarthritic changes in the costovertebral joints

3. The shape of the thorax may be distorted by abnormalities of the chest wall- sternum, ribs or vertebral column e.g. **pectus carinatum , pectus cavum , scoliosis , kyphosis**. These result in a considerable

change in the shape of the thorax.

4. Congenital or acquired abnormalities of the diaphragm affect breathing movements. Paralysis of half of it does not affect the other half because each half has a separate nerve supply.

Lungs

1. Because the **apex** of the **lung extends into the neck**, infections , trauma or wounds in the posterior triangle of the neck may involve the lung. In addition, auscultation of the lungs must include the root of the neck superior to the medial third of the clavicle, in order that sounds in the apex of the lung may be heard.

2. Knowledge of the **branching of the bronchial tree** is necessary to determine the appropriate postures for **draining infected areas** of the lung e.g. when a patient with brochiectasis (dilation of bronchi) is positioned in bed on his or her left side, secretions from the right lung and bronchi flow towards the carina of the trachea. Since this is a sensitive area, the cough reflex is stimulated and the patients brings up *purulent sputum* , clearing the right bronchial tree. Alternatively, persons with bronchiectasis of the lingula of the left superior lobe, drain into it by lying on the right side. The basal bronchi may be cleared by the patient standing on his or her head for several minutes every morning to promote drainage of the lungs. In the prone position (face downwards), the trachea slopes downwards and promotes drainage while the usual supine position one assumes in bed with the head slightly elevated by a pillow is poor for lung drainage.

3. **Bronchogenic carcinoma**, is one of the most common cancers in men. It is highly positively associated with cigarette **smoking**, and environmental **pollution**. The arrangement of the lymphatics is such that these tumors may metastasise to the pleura; hila of the lungs; the mediastinum and from there to distant sites.

   Involvement of the closely related **phrenic nerve** by the tumour results in paralysis of half of the diaphragm.

   in the lower neck, involvement of the **sympathetic chain** and **brachial plexus** causes Pancoas's syndrome.

   Because of the intimate relationship of the recurrent laryngeal nerve to the apex of the lung, this nerve may be involved in apical lung cancers resulting in **hoarseness of the voice** owing to paralysis of a vocal fold.

   common sites of hematogenous metastasis of cancer cells from a bronchogenic carcinoma are the:

   - **Brain**
   - **Bones**

- **Suprarenal glands**

4. **Supraclavicular lymph nodes** are enlarged and hard when a patient has a **carcinoma of the bronchus** (or of the stomach) owing to metastasis from the primary tumour. The supracavicular lymph nodes are commonly referred to as *sentinel nodes* because enlargement of them alerts the examiner to the possibility of malignant changes in the thoracic and or abdominal organs. A tumor may invade the pleura and produce a pleural effusion. This exudate may be bloody and contain exfoliated cancer cells.
5. **Pulmonary embolism** may occur, for example following fracture or other injury of the **lower limb**. It is a frequent cause of death. Embolic obstruction of a pulmonary artery produces a sector of lung which is ventilated but not perfused. A large embolus may occlude the pulmonary trunk or one of its main branches. The patient suffers acute respiratory distress, and may die in a few minutes. A medium sized embolus may block an artery to a bronchopulmonary segment producing an infarct. In healthy young people, collateral circulation may prevent this infarction. But in sick people, with already compromised pulmonary circulation, infarction is almost always the result.

   Because an area of visceral pleura is also deprived of blood, it becomes inflamed (pleuritis) and rough resulting in pleuritic pain and friction rub.

Pleura

---

1. The copolae of pleura, and the **apices of the lungs**, project superiorly into the **neck**, posterior to the sternocleidomastoid muscles and into the posterior triangle of the neck. Medially, these are related to the roofs/trunks of the **brachial plexus** and the **sympathetic chain**. Consequently, apical bronchogenic carcinoma can compress these structures giving both autonomic and somatic neurological deficits. This is the

   Pancoast's syndrome. Additionally, such cancers can also compress the structures in the thoracic inlet, leading to the **thoracic inlet syndrome**. By its extension into the neck, wounds in the posterior triangle of the neck can affect the pleural cavity and the lung, and infections may also spread upwards. In "radical" block dissection of the neck for tumor, care must always be taken not to open the pleural cavity.

2) The pleurae descend inferior to the costal margin in three regions.

- The **right infrasternal angle.**
- The **left costovertebral angle**.
- The **right costovertebral angle**.

At these sites, an **abdominal incision** might inadvertently **enter a pleural sac**. In cases where the 12 th rib is very short, the pleura lies inferior to the posterior costal margin after crossing the 11 th rib, and is therefore in surgical danger.

3)Fluid in the pleural cavity

- **Empyema thoracis/pyothorax**- pus .
- **Hemothorax** - Air occur, a condition known as
- **Haemopneumotorax**- blood and air
- **Chylothorax**-chyle

4) Fluid can be drained from a pleural cavity by inserting a wide-bore needle through an intercostal space- usually i

n the posterior axillary line in the seventh intercostal space. The procedure of aspirating fluid from the pleural cavity is called a **pleural tap** . Sometimes, a canula may be retained in the pleural cavity for continous drainage of

the fluid. The canula is usually connected to an **under water seal bottle**.

5) Sometimes, to prevent troublesome recurrent spontaneous pneumothorax due to lung disease, the visceral and

parietal layers of pleura may be purposely fused. The surgical procedure of surgically fusing the pleurae is called **pleural poudrage** . In this procedure, adherence of the two layers is induced by covering the opposing pleural surfaces with a slightly irritating powder.

6) **Inflammation** of the pleura (**pleuritis or pleurisy**) causes the pleural surfaces to become thickened and/or rough. During breathing, a **friction rub**(pleural tub) may be heard with a stethoscope. Pleuritis, usually leads to formation of **pleural adhesions** between the parietal and visceral pleurae. In extreme cases, in chronic inflammation of the pleurae may cause the adhesion of the two layers, with subsequent thickening . Calcification of

this thickened pleura is known.

7) Irritation of the parietal pleura causes pain, worse on inspiration. The **pain is usually referred** to the thoracoabdominal wall due to common innervation by the **intercostal nerves**; or to the shoulder and the side of the neck due to shared spinal cord segments with the **phrenic nerve(C3,4,5)**.

Bronchopulmonary segments

- Benign bronchial and pulmonary disorders tend to be localised in individual segments.
- Each segment is amenable to independent surgical removal except in malignancy and TB

Chapter 28: The Chest Wall and Pleura

Review Questions

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1. Give an account of the movements that bring about breathing.

2. Describe the landmarks, parts, recesses, blood supply, innervation and lymphatic drainage of parietal pleura. Add notes on applied anatomy.

3. Describe the morphology, surface landmarks,relations, blood supply, lymphatic drainage and innervation of the right and the left lung.

4. Describe the blood supply, lymphatic drainage and innervation of the chest wall.

5. Write short notes on:
   - Internal thoracic artery
   - Typical rib
   - Sternum
   - Root of the lung
   - Thoracic inlet

6. Describe the organization, neurovascular supply and applied anatomy of visceral pleura.

7. Describe the position, relations and applied anatomy of the lung apex

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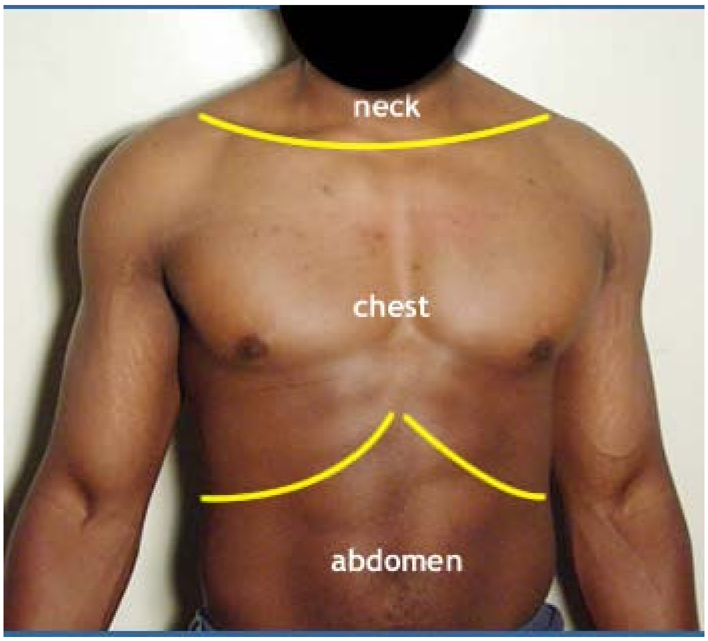
THE THORAX

Is the region of the body between the neck and the abdomen



Can be divided into:

- The thoracic wall
- Thoracic cavity

The thoracic wall encloses the thoracic cavity, which lodges:

1) Heart
2) Great vessels
3) Lungs on the sides

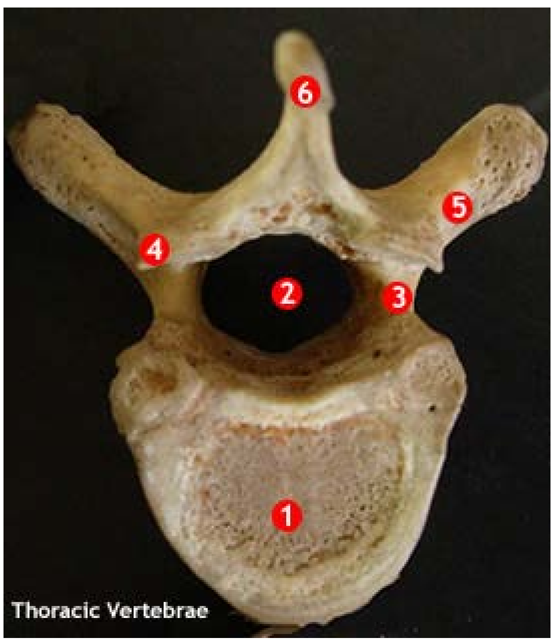
The Chest Wall

Composed of the following bones:

- Thoracic vertebra
- Sternum
- Ribs

Hover to show names

Features of a thoracic vertebra



- Long transverse processes with **articular facets** for **ribs**
- **Long spinous processes** that point postero-inferiorly
- Articular facets on the bodies for articulation with the ribs
- **Oval vertebral canal**

Note:

(+) Each of the T1- T10 has a **single costal face**, part of which is on the body, and the other part on its **pedicle**.

(+) T11 and T12 have a single facet on their pedicles.

(+) Each vertebrae has a **superior** and **inferior articular facet**.

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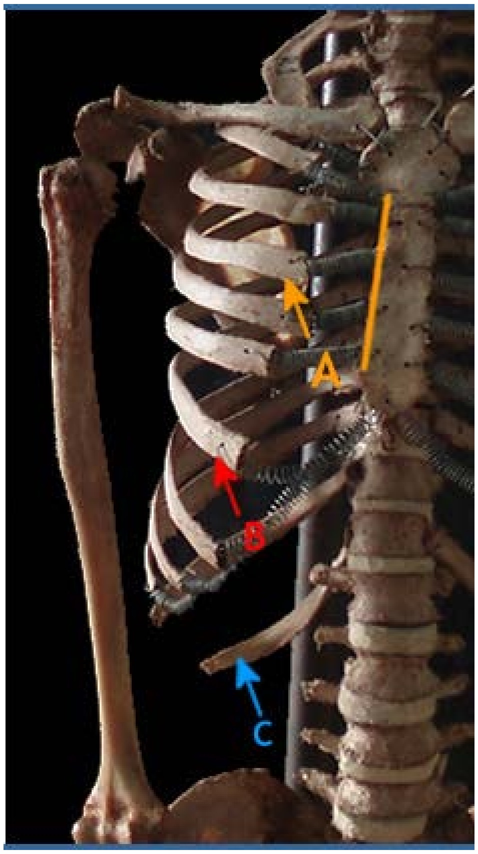
Organization of the ribs



Are long, thin-curved slightly twisted arches of bone.

- 12 pairs of ribs
- Three categories:

  a) vertebrosternal: 1-7, Extend from vertebrae to the sternum

  b) Vertebrocostal**:** Run between vertebrae and common costal cartilage

  c) vertebral: 11 and 12 , sometimes called floating ribs, free anterior ends

Atypical ribs

1st rib:

- Short, Broad,C-shaped
- 2 surfaces- superior and inferior
- 2 borders- lateral and medial
- has only one articular facet for articulation with the T1 vertebra
- A prominent scalene tubercle on the superior surface

2nd rib:

- Has a curvature similar to the one of first rib, but is thinner , much less curved and about twice as long as the first rib
- Has a broad rough eminence, the tuberosity for the serratus anterior muscle

11th and 12th ribs:

- Are short
- Are capped with cartilage
- Have a single facet on their heads
- Have no neck
- Have no tubercle
- The 11 th rib has a slight angle and a shallow costal groove

The sternum

Hover on highlighted areas to show names

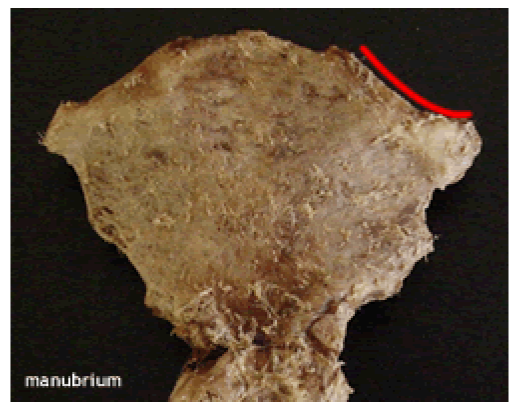
- Is an elongated flat bone
- Resembles a short broad sword or dagger

Parts

1. Manubrium
2. Body
3. Xiphoid process

The manubrium:

- Slopes inferiorly and anteriorly.
- Superiorly it has the jugular or suprasternal notch, and lateral to this are the clavicular notches.
- The inferior margin articulates with the body at manubrosternal joint- a secondary cartilaginous joint.



Note: The manubro sternal joint forms the sternal angle- articulation of second rib

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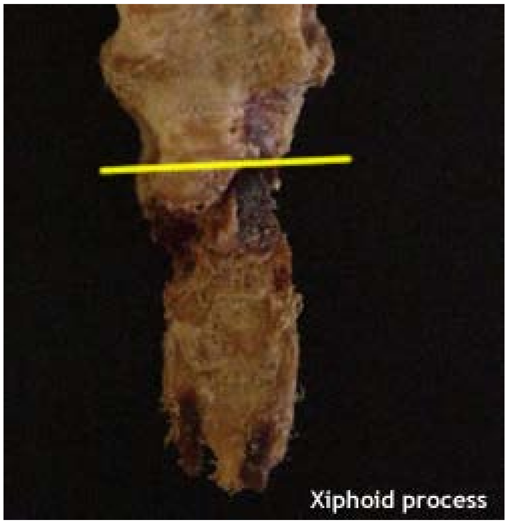
The body:

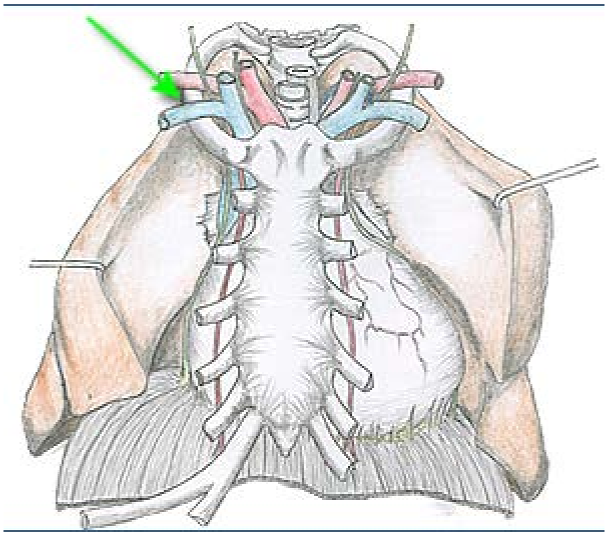
- Is the longest part.
- Is thinner and narrower than the manubrium.
- Broadest at the level of the 5 th sternocostal joints and then gradually tapers inferiorly
- Anterior surface may have three transverse ridges.

Xiphoid Process

- A thin, sword shaped process.
- Varies in shape
- Usually ossifies and unites with body of sternum around 40 th year.



Boundaries of the thoracic inlet



Posterior:	Body of T1 vertebrae
Antero laterally:	Medial borders of first ribs and their costal cartilages
Anteriorly:	Superior end of the manubrium of the sternum

Contents: Structures joining thorax to upper limb and neck

- **Ducts** : Trachea, esophagus, thoracic ducts
- **Vessels**:Common Carotid and Subclavian arteries, Internal jugular and sub clavian veins
- **Nerves** : Vagus, Phrenic, recurrent laryngeal and sympathetic chain
- Apex of lungs and pleura

The inferior thoracic aperture

Boundaries:

Posteriorly:	T12 vertebra
Anterolaterally:	12 th pair of ribs and its costal cartilages
Anteriorly:	xiphisternal joint

Note:

Through this wide aperture (thoracic outlet), the thoracic cavity communicates with the abdomen. In the living, this outlet is closed by the thoracic diaphragm, which is pierced by the structures running between the abdominal and thoracic cavities.

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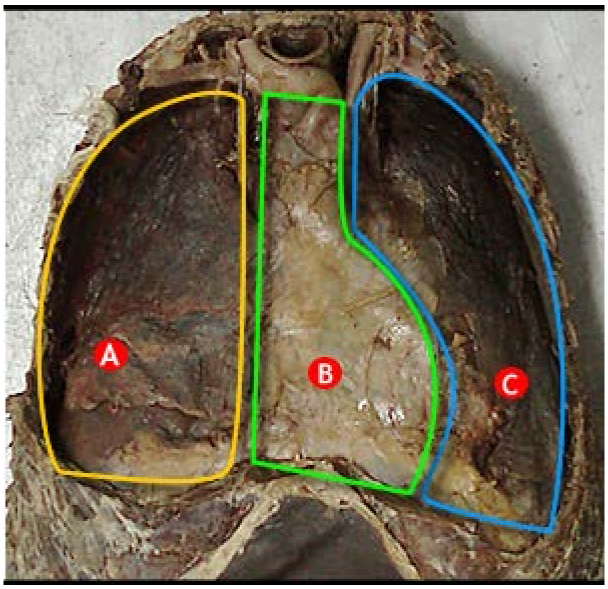
The Thoracic Cavity

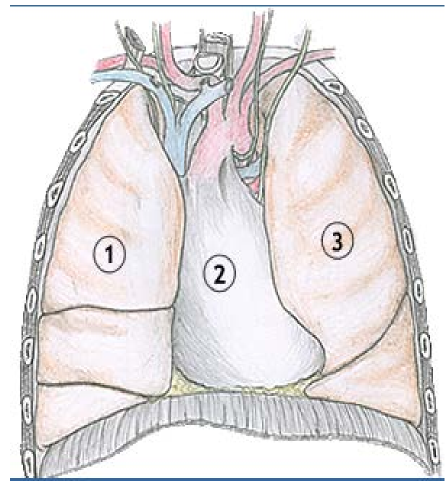


Divided into three major divisions:

A. The right pleural cavity

B.The mediastinum

C. The left pleural cavity



The pleura and pleural cavities

This is a thin membrane that lines the lungs and the chest wall. It consists of two layers:

- Parietal pleura: Lines thoracic cage, mediastinum and superior surface of the thoracic diaphragm. Also projects above the 1 st rib and the clavicle into the neck.
- Visceral pleura : Lines the lungs

Parts of parietal pleura

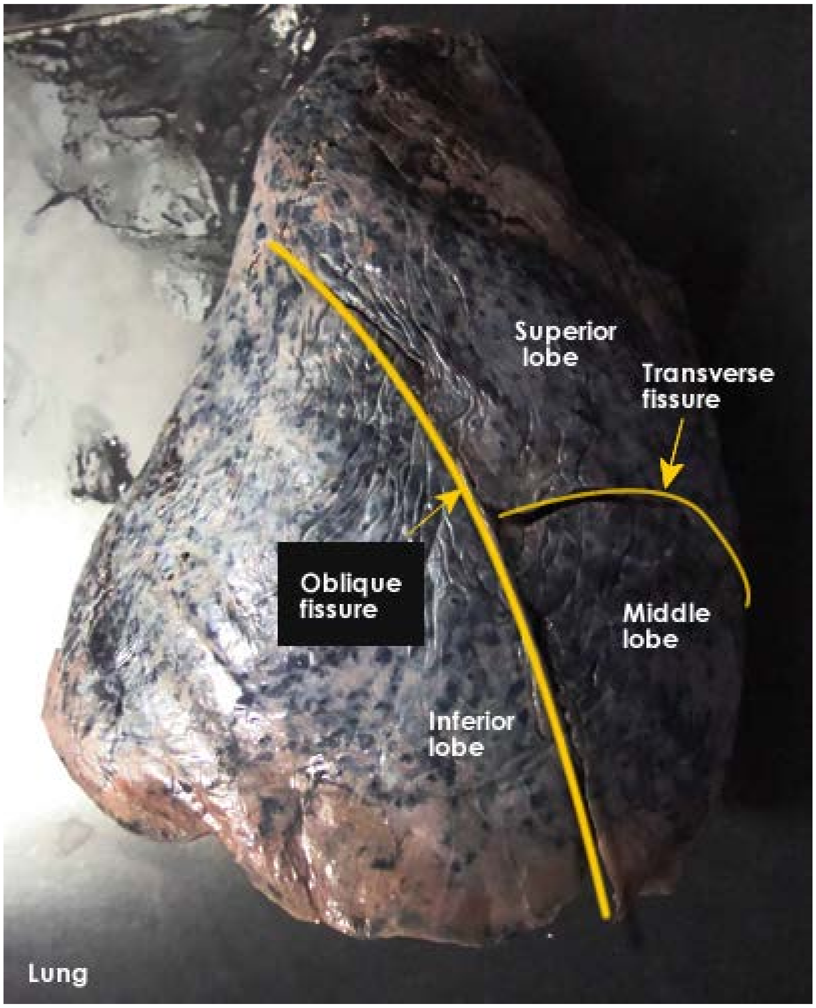
Named according to the structures they cover:

1. **Costal pleura**:
2. The **mediastinal pleura**
3. The **diaphragmatic pleura**:
4. The **pleural cupola:** or **cervical pleura**.

Lines of pleural reflection

- The sternal pleural reflection
- The costal pleural reflection:
- Vertebral pleural reflection:
- Mediastinodiaphragmatic pleural reflection

Lungs



Conical in shape and has,

1. An apex
2. Base
3. Medial surface
4. Costal surface
5. Anterior border
6. Inferior border
7. Hilus

Apex

- Rises above 1st rib anteriorly but is below the posterior aspect of this rib.

Base

- Diaphragmatic surface
- Right dome of diaphragm higher than left
- Right lung overlies liver
- Left lung overlies stomach, liver and spleen.

Costal surface

- marked by ribs

Medial surface – 2 parts

1. **vertebral** – posterior border rounded, occupies paravertebral gutter
2. **mediastinal** - hilus and cardiac impression.

Surface anatomy

- Lower borders of lung related to 6th, 8th and 10th ribs.
- Anterior border between body of sternum and pericardium

LOBES AND FISSURES

Oblique fissure

Completely cuts through costal, diaphragmatic and mediastinal surfaces as far as the root it then follows line of the 6th rib from 4th thoracic vertebrae to the 5th intercostals space anteriorly.

Horizontal fissure

- Lies at the level of the 4th costal cartilage
- Meets the oblique fissure at the mid-axillary line.

The **Right lung** is therefore divided into 3 lobes:

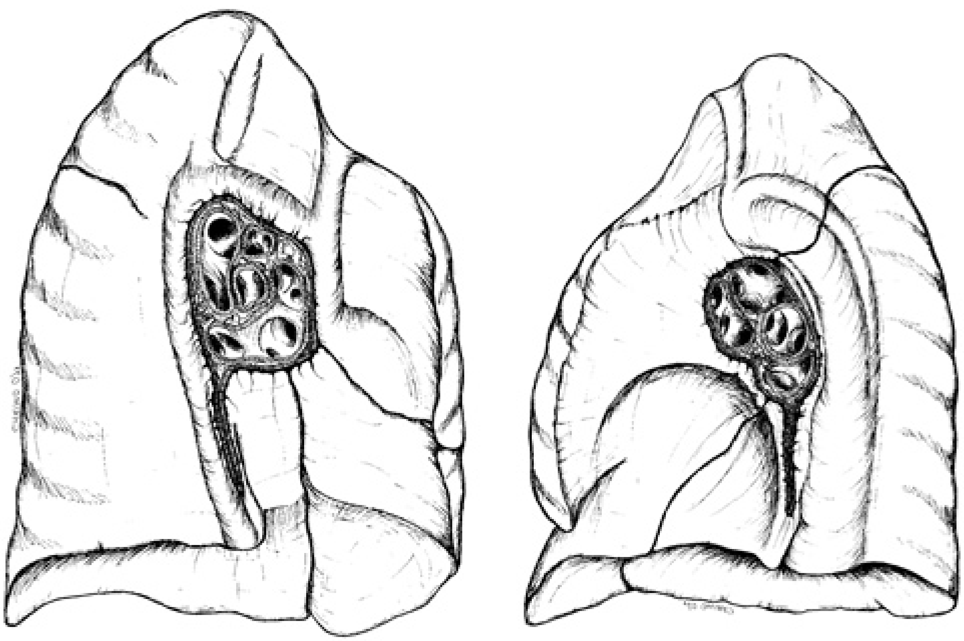
1. upper
2. middle
3. lower

Left lung: 2 lobes

1. upper
2. lower

Impressions on Surface of Lung

Click on hot spots to show names

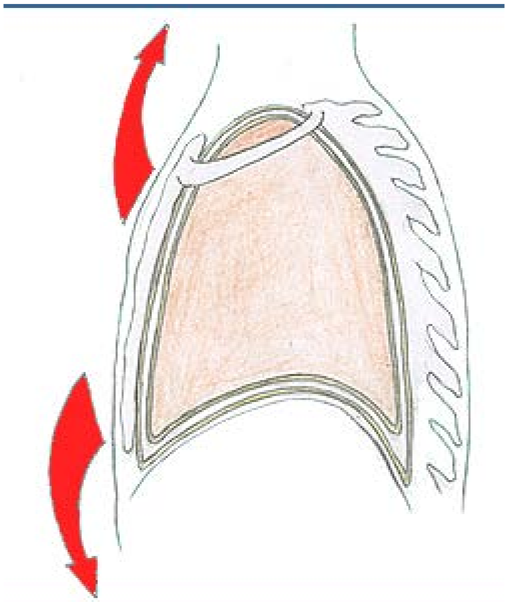


Respiratory movements

Result from change in the dimensions and therefore volume of the thoracic cavity. The resulting change in pressure results in inspiration and expiration. The chest can increase in diameter in three dimensions to increase the volume of the thorax:

- Vertical
- Transverse
- Anteroposterior

In **inspiration**, thoracic volume increases and thoracic pressure decreases.



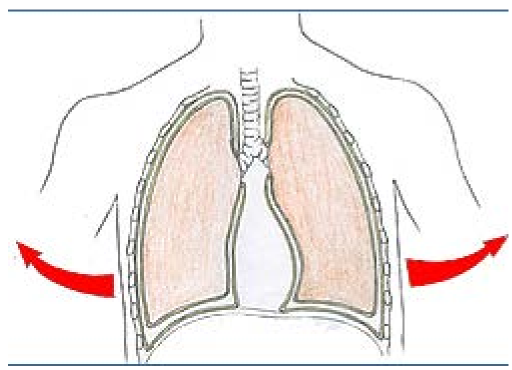
The vertical diameter is increased mainly by:

- Contraction and flattening of the thoracic diaphragm.
- Raising of the ribs by external intercostals.

The transverse diameter is increased by:

- Ribs swinging outwards (bucket handle movement)
- Elevation of the ribs
- Elevation of the sternum

This is achieved mainly by the contraction of the external intercostals muscles



The anteroposterior diameter of the thorax is increased by:

- Raising of the ribs.
- Raising of the sternum

Note: *Movement at the costovertebral joints through the long axes of the necks of the ribs results in raising and lowering their anterior ends- the "pump handle movement."*

During **expiration:**

- Elastic recoil of the lungs
- Reduction in intra thoracic volume by decrease in all three diameters.
- Increase in intra thoracic pressure

Accessory muscles of respiration: Required in forced ventilation

a) All muscles attached to the ribs and sternum such as scalene muscles and sternocleidomastoid muscles in the neck

b) Pectoralis major and minor, subclavius and serratus anterior on the chest wall

c) Abdominal wall muscles.

d) Internal intercostal muscles

Applied Anatomy

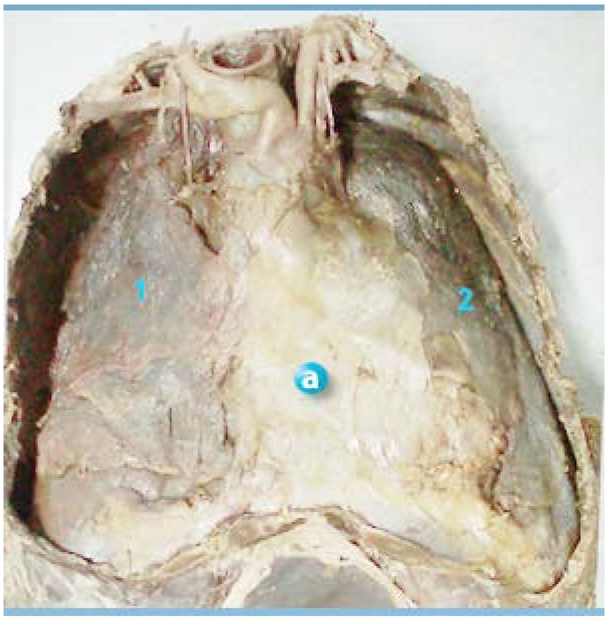
Review questions

over overhotspot to show information

The Mediastinum

This is the region of the thoracic cavity **between** the **two pleural cavities**. It is what is left after the lungs and the pleura have been removed from the thoracic cavity.

Extents and boundaries



- The mediastinum **(a)** extends from the **superior thoracic inlet** superiorly, to the **thoracic diaphragm** inferiorly .
- **Boundaries**

Anteriorly	Sternum and costal cartilages
Posteriorly	Thoracic vertebrae and their associated intervertebral discs and anterior longitudinal ligaments.
Laterally	pleural cavities, containing the lungs.

- The root of the lungs connects the mediastinum to the lungs.

Sub-divisions of mediastinum

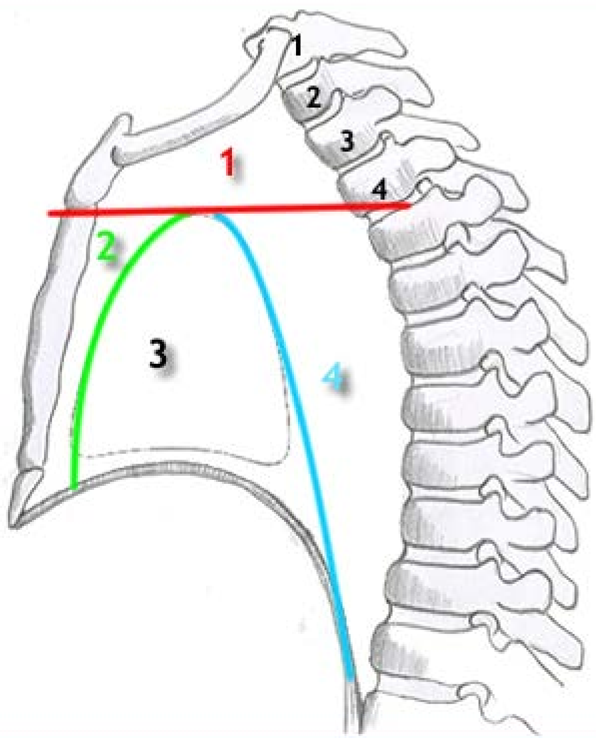
The mediastinum is divided by a plane passing from the **sternal angle to T4-T5** into:

- **Superior mediastinum (1)** and
- **The inferior mediastinum** (2,3.4)

The inferior mediastinum is further subdivided into three regions namely:

- **Anterior mediastinum**
- **Middle mediastinum**
- **Posterior mediastinum**

These divisions are for descriptive purposes, merge into each other inpercleptibly. There are no distinct boundaries between them.



Contents of Superior Mediastinum

Thymus

- In the neonate its very large extending from the thyroid gland to the pericardium.
- Grows slightly until puberty then regresses
- Plays an important role in regulating the body's immunity
- In the adult it is pinkish/ yellowish elongated body consisting of asymmetrical right and left lobes connected by areolar tissue
- Enclosed in a fibrous capsule

Thoracic duct

- At the level of **T4/ T5/ T6** it inclines towards the left crossing the midline behind the esophagus
- Lies on the left of the esophagus deep to arch of aorta
- **Terminates** by entering the **left brachiocephalic vein**.

  Tributaries

- (+) Posterior mediastinal nodes
- (+) Small intercostals nodes
- (+) Left bronchomediastinal trunk
- (+) Left subclavian trunk
- (+) Left jugular trunk

Receives all the lymphatics below the diaphragm and the left side above the diaphragm.

Thoracic trachea

Review the anatomy of the cervical trachea

Relations

Numerous tracheal and trachea bronchial nodes are associated.

Anterior	Posterior	Right	Left
• Cardiac plexus • Aortic arch • Manubrium sterni • Left brachiocephalic vein	• Esophagus	• Azygos • Right vagus	◦ Aortic arch ◦ Left common carotid ◦ Left subclavian arteries ◦ Left recurrent laryngeal nerve

Phrenic nerves

- Motor to the diaphragm
- Contain sensory fibres from its more central part and from the related pleura and peritoneum

  Thoracic course

  Enters the thorax by passing behind the subclavian vein

Course and Relations

Right phrenic nerve	Left phrenic
• Inclines medially and crosses anterior to the right internal thoracic artery • Descends on the lateral side of the right brachiocephalic vein and superior vena cava • Then between the pleura and pericardium Infront of the root of the lung • Pierces the diaphragm to supply it on its deep surface	• Inclines medially and crosses the left internal thoracic artery • Comes to lie anterior to the left subclavian artery • Under the cover of the origin of the left brachiocephalic vein • Crosses the left vagus just above the aortic arch • Crosses the arch infront of the vagus • Descends infront of the root of the lung, between the pleura and pericardium • Pierces the diaphragm to supply it and its covering peritoneum from below.

- **Branches**
  Branches to the diaphragm supply it on its abdominal surface
  Sensory branches are given to:

1. Diaphragm
2. Pleura
3. Pericardium

4. Peritoneal ligaments of the liver
5. Inferior vena cava
6. Supra renal glands

Aortic arch

Course

- Begins behind the 2nd right sternochondral joint in the **sternomanubrial plane**
- Arches upwards, backwards and to the left across the left side of the **bifurcation of the trachea**.
- Passes **behind the left main bronchus** to end in the same plane it began, on the left side of the lower border of the body of T4

Relations

Anteriorly	Posterior
• Thymus • Anterior reflections of both pleurae • Left brachiocephalic vein	• Cardiac plexus • As it passes to the left, the trachea and esophagus are on its right with the right recurrent laryngeal nerve in the groove between them and thoracic duct on the left of the esophagus. • On its left are the left phrenic and vagus nerves • The left superior intercostals vein crosses the arch deep to the phrenic nerve but superficial to the vagus. • Below the arch the pulmonary trunk bifurcates, the superficial cardiac plexus intervening. • Ligamentum arteriosum is attached to the lower border. The left recurrent laryngeak nerve hooks behind and to the left of the arch. • The arch lies above the left main bronchus

Branches of aortic arch

- Brachiocephalic trunk
- Left common carotid artery
- Left subclavian artery

Variations in the branches of the aortic arch

- Two subclavian and the two common carotid arteries may arise independently from the arch
- Three or all four of the main arterial branches may arise by a common trunk e.e.g a common trunk for the two common carotids (bicarotid artery) or for the two left arteries or a common trunk for the right subclavian and the two common carotids.
- The aortic arch may be right sided or even double (left and right sided), A double aortic arch may forma ring like constriction around the esophagus and trachea, necessitating surgical relief
- Additional arteries may spring from the aortic arch especially the right or left vertebral artery and less commonly an accessory artery to the thyroid gland, the thyroide ima.

Brachiocephalic trunk

- The first and largest branch of the arch
- Arises opposite the centre of the manubrium sterni
- In front of the trachea
- As it ascends it inclines to the right to reach the posterior aspect of the right sternoclavicular joint.
- There if bifurcates into right subclavian and right common carotid arteries.
- Between it and the manubrium are the left brachiocephalic vein, thymic remnants and lower attachments of sternothyroid and sternohyoid.
- Upper portion is medial to the right brachiocephalic vein
- The right vagus is lateral to it then passes behind it to reach the right side oft he trachea.

Left common carotid artery

- Second branch of the aortic arch
- Arises behind manubrium sterni and ascends to a point behind the left sternoclavicular joint
- Has a short thoracic course in the superior mediastinum

Chief relations in the thoracic portion
Anterior

- Left brachiocephalic vein

Posterior

- Trachea
- Recurrent left laryngeal nerve
- Oesophagus
- Thoracic duct

Left

  - Left pleura
  - Left phrenic
  - Vagus nerves
  - Left subclavian artery

Left subclavian artery

- Arises in the thorax as the third branch of the aortic arch behind the left edge of the manubrium sterni.
- Its root is behind and to the left of the root of the left common carotid artery
- Short course in the superior mediastinum

Chief relations of thoracic portion
Anterior

- Left brachiocephalic vein
- Left phrenic nerve
- Left vagus nerve
- Left common carotid artery
- Posterior
- Left pleura

Right

- Trachea
- Left recurrent laryngeal nerve
- Oesophagus
- Thoracic duct

Left

  - Left pleura

Superior vena cava

- Formed by two large tributaries- the right and left brachiocephalic veins
- Each brachiocephalic vein is formed in turn by two large tributaries, the subclavian vein bringing blood from the upper limb
- The internal jugular drains the head and neck.
- In addition to these veins the superior vena cava receives azygous vein draining the thoracic and upper abdominal walls.
- Thus the superior vena cava is the great channel draining blood from the head and neck both upper limbs, thoracic wall and the upper part of the abdominal wall.
- Formed at the lower border of the 1st costal cartilage
- Ends opposite the 3rd costal cartilage by entering the right atrium
- Upper half lies in the superior mediastinum and lower half which is intrapericardial in the middle mediastinum
- It is devoid of valves

Relations

Left

- Overlapped anteriorly by the ascending aorta
- Beginning of aortic arch

Right

- Right pleura
- Right phrenic nerve

Posterior

- Trachea
- Right vagus
- Root of right lung

Tributaries

    - Two brachiocephalic trunk
    - Azygous vein

Brachiocephalic trunk

- First and largest branch of the arch
- Arises opposite the centre of the manubrium sterni infront of the trachea
- It inclines to the right to reach the posterior aspect of the right sternoclavicular joint
- There it bifurcates into right subclavian and right common carotid arteries

Between it and the manubrium are:

- Left brachiocephalic vein
- Thymic remnants
- Lower attachments of sternothyroid and sternohyoid

Upper portion is medial to right brachiocephalic vein

Right vagus is lateral to it and then passes behind it to reach the right side of the trachea.

Clinical Anatomy:

Pericarditis*:* Inflamation of the pericardium can be:

- Infective,
- Degenerative
- Malignant.

It can occur on its own or as a part of a heart condition as in **rheumatic pericarditis**. The pain is felt diffusely posterior to the sternum i.e. **substernal pain**. It commonly **radiates to** the **shoulder**, side of **neck** and to the **submandibular** regions.

Pericardial effusion*:* Fluid in the pericardial sac may be due to inective pericarditis , trauma, degenerative disorder or malignancy. If extensive the fluid may embarass the action of the heart by compressing it. This is called **cardiac tamponade**. Circulation may fail completely causing death. When the IVC and SVC are compressed the veins in the periphery swell and show on the surface with edema. The organs like the liver e.t.c. get engorged and may fail, and brain edema may cause neurological deficits

Pericardiocentesis : Drainage of fluid from the pericardial cavity may be done for diagnostic purposes or to ease the compression of the heart. A wide bore needle may be inserted through the **5 th or 6 th intercostal space** near the sternum or through the infrasternal angle directed towards the left. Care must be taken not to injure the internal thoracic artery.

Coronary Arteries

The branches of the coronary arteries are end arteries in the sense that they supply regions of cardiac muscle

without significant overlap, from other large branches. Although there is a rich anastomosis between arteries, this

blood supply is inadequate for the requirements of cardiac muscle when there is sudden occlusion of a major branch.

Consequently, the region supplied by the occluded branch becomes infarcted (rendered bloodless and soon undergoes necrosis.

An area of myocardium that has undergone necrosis is called an infarct.

Chapter 29: The Middle Mediastinum, Heart and Pericardium and the Superior Mediastinum

Review Questions

1. Give an account of the attachments, sinuses, layers, blood supply, innervation and lymphatic drainage of the pericardium

2. Give a detailed account of the blood supply, conducting system and innervation of the heart. Add a note on any variations in the pattern of branching and distribution of coronary arteries, and on extra cardiac anastomoses.

3. Write short notes on :

   a) Coronary sinus
   b) Inter ventricular septum

4. Describe the internal features and inlets of the right atrium

5. Describe the surfaces, borders and surface anatomy of the heart

J. Ogengó

palsoftweblink

The Middle Mediastinum, Heart and Pericardium and the Superior Mediastinum

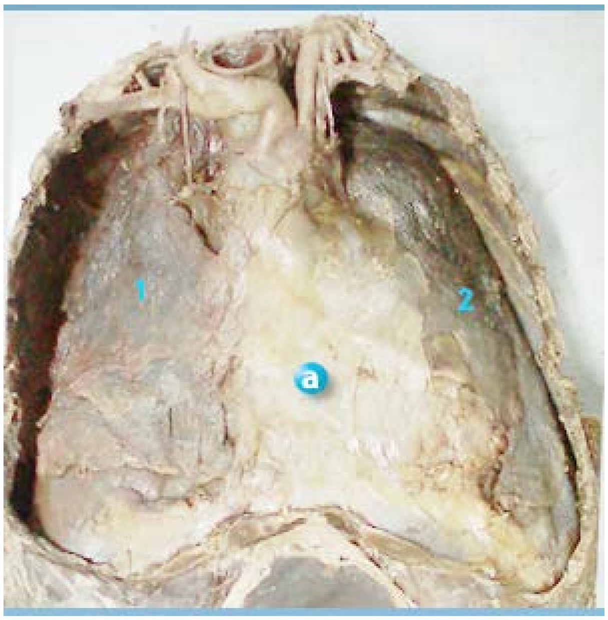
Learning points | Core anatomy | Applied anatomy | Review questions

The Mediastinum

This is the region of the thoracic cavity between the two pleural cavities. It is what is left after the lungs and the pleuca have been removed from the thoracic cavity.

Hover over the letters to show names

Extents and boundaries



- The mediastinum extends from the **superior thoracic inlet** superiorly, to the **thoracic diaphragm** inferiorly .
- **Boundaries**

  Anteriorly - sternum and costal cartilages

  Posteriorly - thoracic vertebrae and their associated intervertebral discs and anterior longitudinal ligaments.

  Laterally- pleural cavities, containing the lungs.
- The root of the lungs connects the mediastinum to the lungs.

Sub-divisions of mediastinum

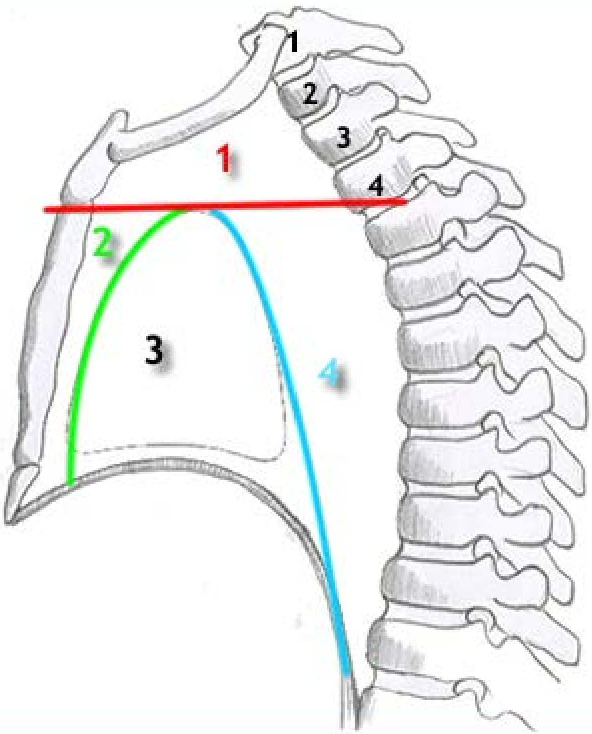
The mediastinum is divided by a plane passing from the **sternal angle to T4-T5** into:

- **Superior mediastinum** and
- **The inferior mediastinum** (2,3.4)

The inferior mediastinum is further subdivided into three regions namely:

- **Anterior mediastinum**
- **Middle mediastinum**
- **Posterior mediastinum**

These divisions are for descriptive purposes, merge into each other inperclеptibly. There are no distinct boundaries between them.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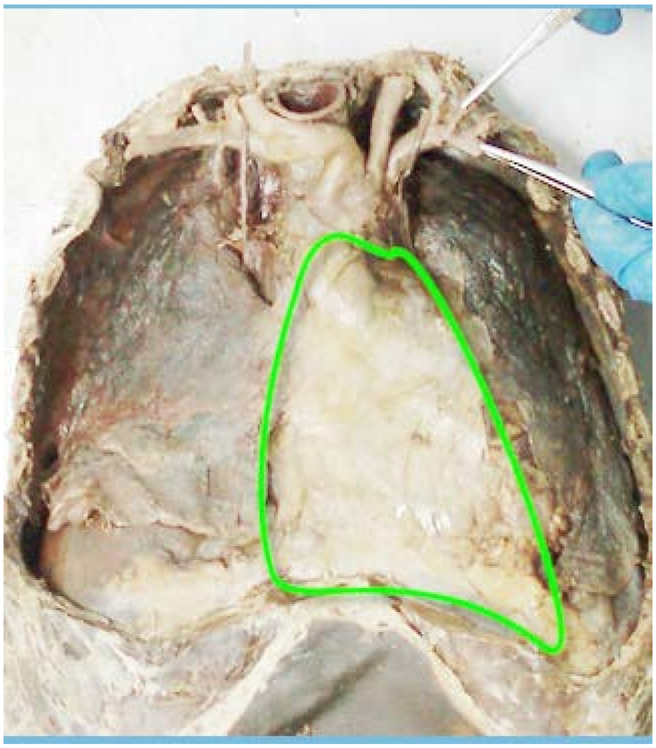
The Middle Mediastinum

The pericardium:



Double walled fibroserous sac

Encloses:

- Heart
- Roots of pulmonary trunk and aorta
- Termination of pulmonary veins and vena cavae.

Location:

- Middle mediastinum
- Posterior to the body of the sternum and th 2 nd to 6 th costal cartilages
- Anterior to T5-8 vertebrae.

Relations

Superior:Pierced by the

- Aorta,
- pulmonary trunk
- Superior vena cavae.
- In children it is related to the thymus

Inferiorly:

- Separated from the liver and fundus of the stomach by the central tendon of the diaphragm with which it fuses.

Anteriorly:

- Seperated from the body of sternum and 2 nd to 6 th costal cartilages by pleura with the lungs except at the cardiac notch.
- The internal thoracic vessels and parasternal nodes run along the lateral borders of the sternum.
- In the midline it is attached to the sternum by sternopericardial ligaments

Posteriorly*:*

- The contents of the posterior mediastinum

Laterally*:*

- The phrenic nerve
- Periocardiophrenic vessels
- Mediastinal surface of the lungs and their covering visceral pleura(what structures are found at the hilum of the lungs?)

Organization of the pericardium

Consists of two layers:

- The **fibrous** - tough aponeurosis-like outer indistensible jacket
- The **serous** - moist inner lining with two layers

(+) **Parietal** layer lining the inside of the fibrous pericardium
(+) **Visceral** pericardium intimately lining the heart surface.

The space between the visceral and parietal pericardium is called **pericardial cavity**. It contains a thin film of fluid allowing **frictionless movement** of the heart

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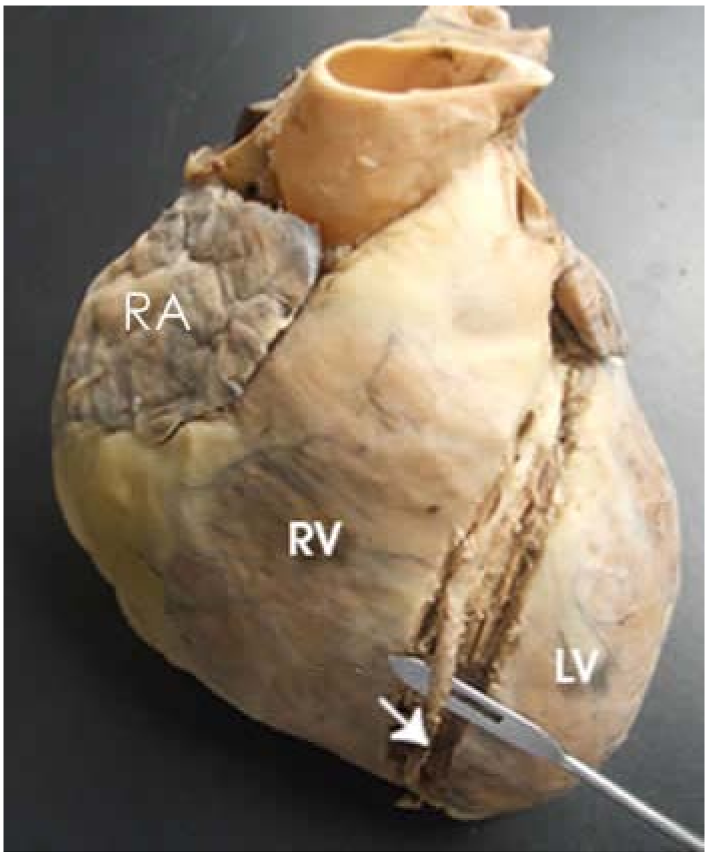
The Heart

Surfaces and Borders



The apex of the heart is formed by:

- Tip of the left ventricle, which points inferiorly, anteriorly and to the left.

The sternocostal (anterior) surface is formed by:

- Right ventricle
- Right atrium
- Left ventricle
- Left atrium lie more posteriorly, and form only a small strip on the sternocostal surface.

The diaphragmatic (inferior) surface

- It is formed by both ventricles (mainly the left).
- Separated from the liver and stomach by the diaphragm on which it rests.
- Divided by the posterior interventricular groove or sulcus into a right one third, and a left two-third.
- This sulcus contains the posterior interventricular artery .

The base of the heart (posterior surface), is formed by:

- The atria, mainly the left one.

The ascending aorta, the pulmonary trunk and the superior vena cava emerge from it

Notice at this point that the *heart does* **NOT** *rest on its base; the term 'base' derives from the conical shape of the heart, the base being opposite the apex .*

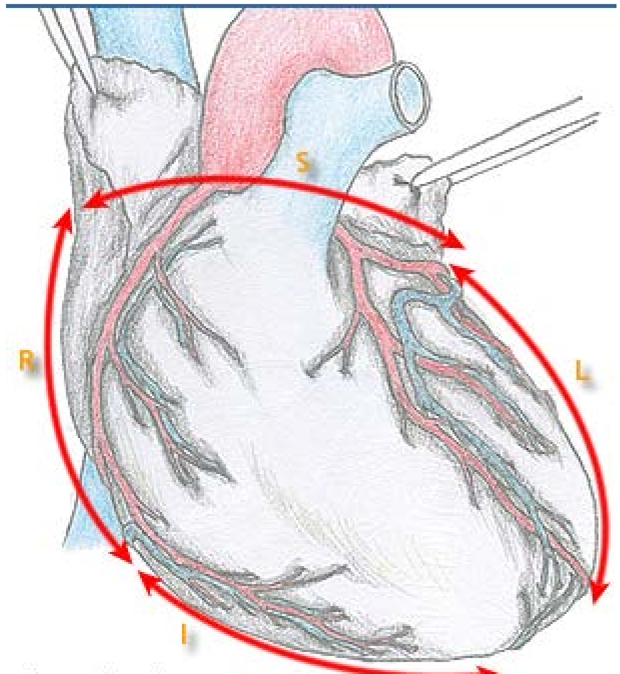
The heart has four borders:

(a) The right border (R) is formed by the right atrium and is in line with the superior and inferior vena cavae.

(b) The inferior border (I) , thin and sharp, nearly horizontal. It is formed mainly by the right ventricle, and slightly by the left ventricle near the apex.

(c) The left border (L) , formed by the left ventricle and very slightly by the left auricle.

(d) The superior border (S) is where the great vessels enter and leave the heart. It is formed by both atria.



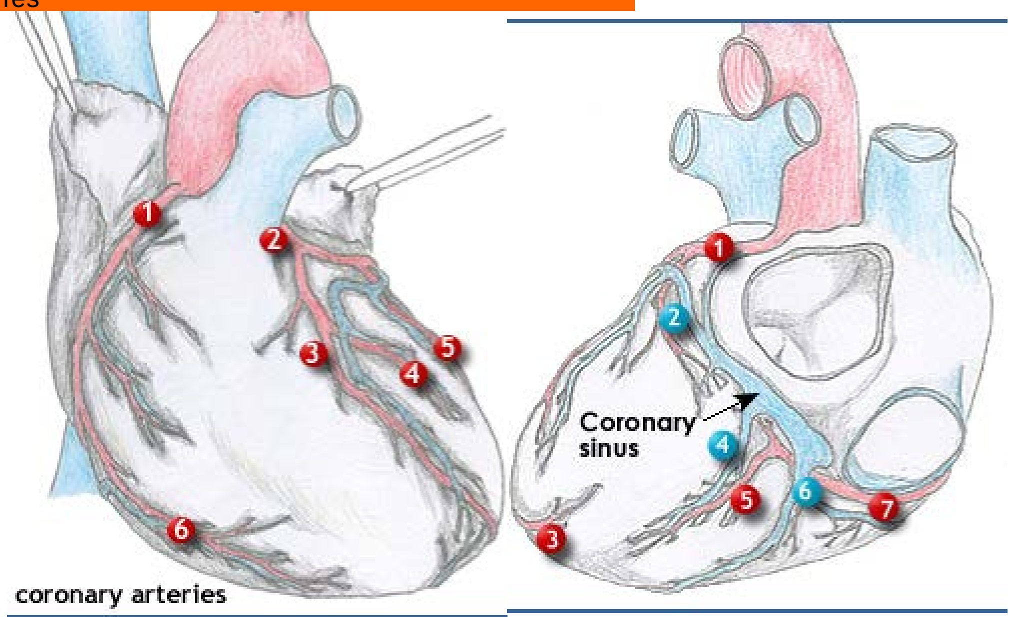
Heart borders

Chapter 29: The Middle Mediastinum, Heart and Pericardium and the Superior Mediastinum

The blood supply of the heart

Supplied by the left and right coronary arteries which originate From the left and right coronary sinuses of the aorta respectively.

Hover to show names



Branches and distribution

Artery	Branches	Distribution
Right coronary artery	• Posterior interventricular • Marginal • AV modal artery	• Right atrium • Right ventricle • AV node and bundle • SA node • Variable amount of left atrium and ventricle
Left coronary artery	• Anterior interventricular • Circumflex	• Both ventricles, and the interventricular septum. • Left atrium • Sino Atrial node

Variations in coronary arteries:

- In about 50% the cases, the right coronary artery is **dominant** i.e. it crosses to the left side, and supplies the **left ventricle**, and the **interventricular septum**.
- In about 20% of cases, the left coronary artery is dominant. In addition to supplying the left ventricle, and the interventricular septum, it sends branches to the right ventricular wall.
- In about 30% of the cases, the coronary arterial pattern is balanced. There may be only one coronary artery.
- In about 4% of hearts, there are accessory coronary arteries
- A 3rd coronary artery may be present in upto 35% of individuals

There is thus, no sharp line of demarcation between the ventricular distribution of the coronary arteries.

Extracardiac Anastomosis

- The anastomosis between the coronary arteries and extra-cardiac vessels exist e.g.

  pericardial arteries,
  internal thoracic
  superior phrenic
  bronchial

The cardiac skeleton

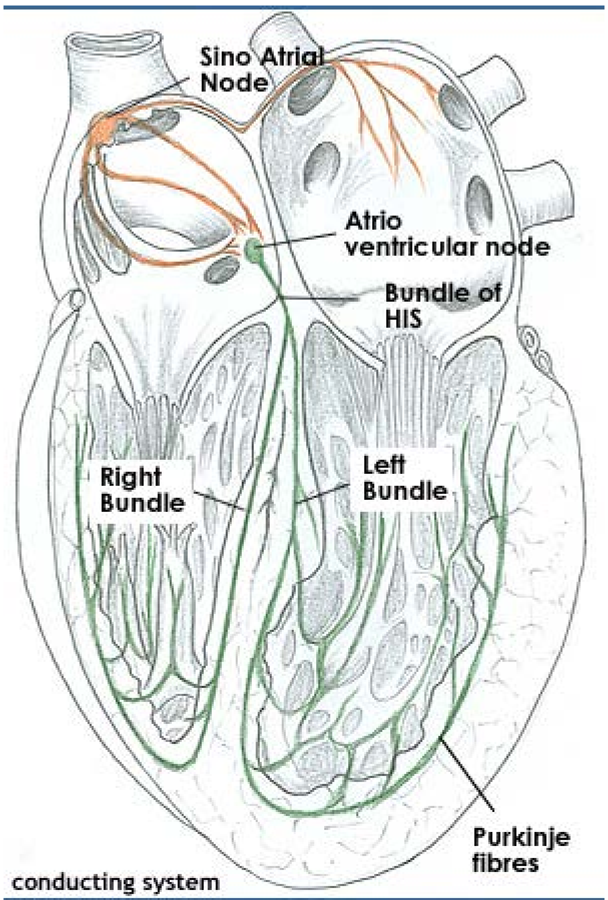
Components

- **Fibrous rings** surround the atrioventricular canals and the origins of the aorta and pulmonary trunk**.**
- Membranous inter-ventricular septum

Functions

- Attachment to the valves
- Insertion for the cardiac muscle fibres.

The conducting system of the heart



- Consists of specialized cardiac muscle fibres
- *Initiate* the normal heart beat
- *coordinate the contractions* of the heart chambers.
- Gives the heart its automatic rhythmic beat.
- It consists of the following components:

  a) **Sino Atrial Node** : In the wall of right atrium: superior end of crista terminalis to the right of superior vena cava opening

  b) **Atrio ventricular node**: Postero-inferior part of intra-atrial septum, superior to opening of coronary sinus

  c) **Atrio ventricular bundle of HIS** : Runs anteriorly to membranous part of inter ventricular septum, lies inferior to septal cusp of tricuspid valve

  d) **Right and Left bundle branches:** Straddle the muscular parts of inter ventricular septum

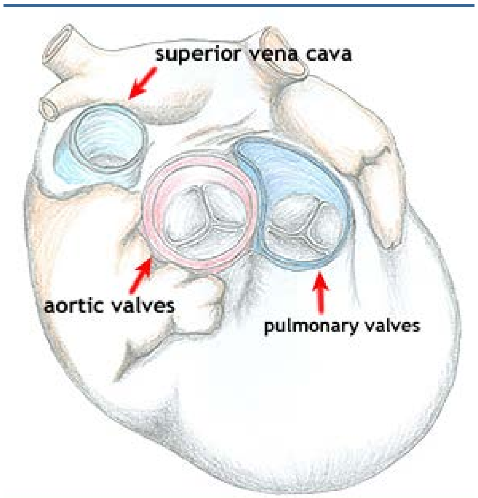
  e) **Purkinje fibres**

Functioning of the impulse conducting system

- The SA node initiates the impulse, which is rapidly conducted to the cardiac muscle fibres of the atria, causing them to contract.
- The impulse enters the AV node.
- It is then transmitted through the AV bundle to
- Its branches to the papillary muscles, then throughout the walls of the ventricles.

Although the heart has its own intrinsic rythmicity , this is subject to the influence of the autonomic nervous system.

The Heart Valves



Pulmonary valve	Aortic Valve
• Guards the outflow tract of the right ventricle, and lies above the infundibulum (conus arteriosus). • Consists of three semi-lunar cusps namely: (+) Anterior *(+) Right* *(+) Left* • The pulmonary trunk is dilated above each of the semilvnar cusps to form three sinuses of valsava.	• Guards the outlet of the left ventricle • Found at a lower level than the pulmonary valve It Consists of three semilunar cusps whose structure is similar to those of the pulmonary cusps. The cusps are named: • Posterior • Right • Left

Mitral valve	The Tricuspid valve
This guards the left atrioventricular orifice. It has two cusps • Anterior cusp (larger) • Posterior cusp Two papillary muscles in the left ventricle: • Anterior • Posterior The chordae from each muscle insert into points on both cusps of the mitral valve. •	• Guards the right atrioventricular orifice. The leaflets of the tricuspid valve are termed: *(+) Septal* *(+) Anterior* *(+) Posterior* • Leaflets held in place by **papillary muscles** and their attached **chordae tendinae.** • There are **two main papillary muscles** – anterior and posterior

Chapter 29: The Middle Mediastinum, Heart and Pericardium and the Superior Mediastinum

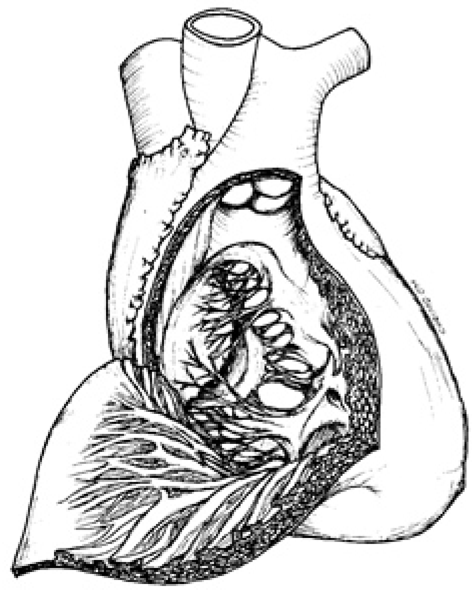
Heart Chambers

Right Atrium

- Presents at its apex a small conical auricular appendage
- Receives the superior and inferior vena cavae
- The sulcus terminalis extends between the two veins.

The interior of the right atrium shows several distinctive features:

- The posterior part is smooth walled (sinus venarum).
- The anterior part is rough with fine muscular ridges called musculi pectinati .
- Between these two parts is a definite ridge called the crista terminalis.
- It receives the following:
  a) The SVC
  b) IVC open into the smooth part.
  c) coronary sinus.
- The septal wall is oblique, has depression called fossa ovalis.
- The edge is known as limbus fossae ovalis .
- The posterior (non-coronary) aortic sinus abuts the upper part of the interactrial septum, and creates a bulge called torus aorticus.



Right Ventricle

Several of the internal features of the right ventricle are important.

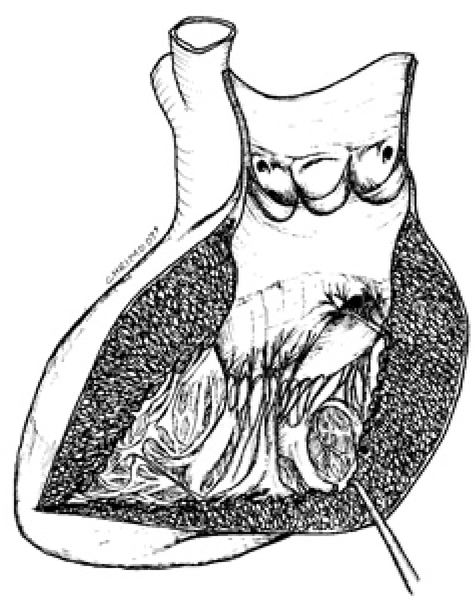
- Between the tricuspic and pulmonary valves, the wall presents a thick muscular ridge called the supra ventricular crest**.**

- Below the crest, the wall is marked by massive irregular muscular ridges called trabeculae carneae. Three types of trabeculae are described:

  - Ridges on the ventricular wall

  - Those with free central parts, like bucket handles. One of these " bucket handles " trabeculae is particularly large and is known as the septomarginal trabecular or the moderator band . It extends from the septal wall to the base of the anterior papillary muscle, and contains part of the conducting system of the right bundle branch.

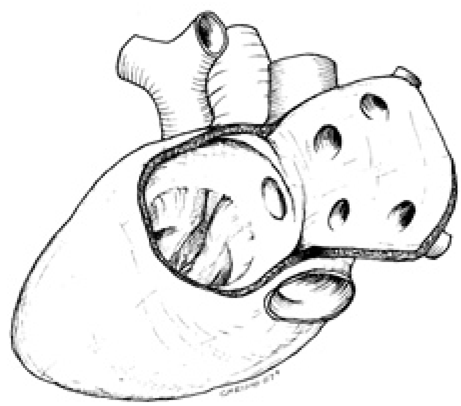
  - Papillary muscles. These form comical projections from the ventricular and septal walls. Chordae tendineae attach to their sides and apices, and fan towards the tricuspid valve



leaves.

- The outflow tract of the right ventricle, above the supra ventricular crest, is smooth-walled and is called the infundibulum or conus arteriosus.

Left Atrium



The walls of the left atrium are thicker than those of the right atrium.

It has a small auricular appendage, which covers the origin of the left coronary artery and abuts the left side of the pulmonary trunk.

The Interior has few features of note:

- Musculi pectinate are limited to the auricular appendage. The rest of the cavity is smooth walled, reflecting a development from the foetal pulmonary veins.

- A depression can often be found on the interactrial wall corresponding to the site of ostium secundum of the fetal heart.
- The inflow channels are four pulmonary veins, two on each side, but the two veins on the left may enter the cacity by a single opening.

The Left Ventricle

Wall thickness 8-12 mm

Interventricular septum bulges to the right

Internal features:

- The wall is ridged by trabeculae carneae

- Close to the aortic orifice, there is a round area of interventricular septum which is membranous in nature. Its fibres are continuous with the fibious supports for the cusps of the aortic valve.

- Two papillary muscles in the left ventricle, an anterior and a posterior muscle.

- The types of chordae found in the left ventricle present similar features to those of the right chamber.

Two rough zone chordae, however, are particularly thick in the left ventricle, and are called strut chordae. They arise from the tips of the anterior and posterior papillary muscles, and insert into the anterior leaflet of mitral valve.

Posterior Mediastinum and posterior chest wall

Applied Anatomy

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1. **Cancer of the esophagus** is a common affliction which presents with progressive difficulty in swallowing
2. Because the esophagus is a site of **portosystemic anastomis**, raised portal pressure e.g due to liver cirrhosis causes opening up of the anastomosis. The veins in the esophageal submucosa dilate and become tortuos i.e varicose. They are called **esophageal varices**. In extreme cases, these may rupture causing **hematemesis** (vomiting blood)
3. Because the left atrium is related to the esophagus, hypertrophy of the atrium as in mitral valve stenosis may cause compression
4. The normal **anatomical constrictions** of the **esophagus**:

   (+) May be confused for pathological narrowing.

   (+) Sites of relative stasis and may be starting point for cancer.

   (+) May be perforated during esophageal instrumentation.

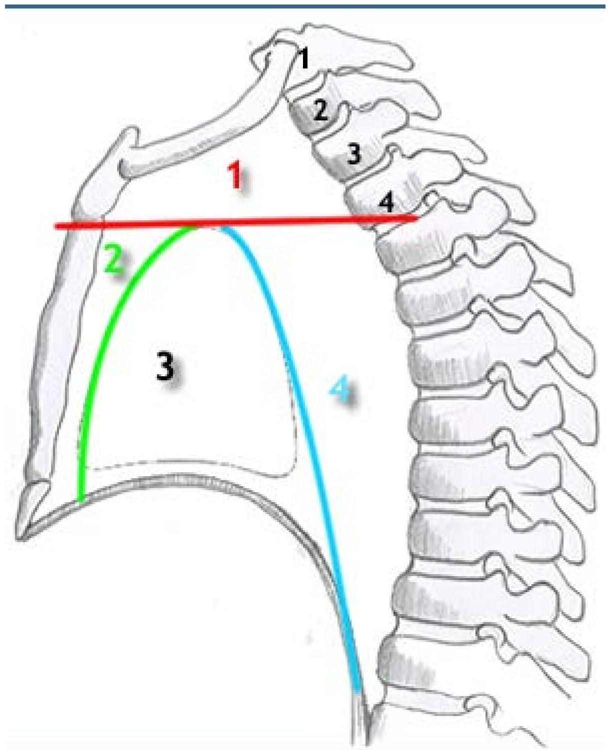
Posterior Mediastinum and posterior chest wall

Review Questions

---

1. Describe in detail the extents, course, relations, constrictions, blood supply, lymphatic drainage and innervation of the esophagus. Add notes on the applied anatomy of the organ
2. Describe clearly the formation, course and territory of drainage of the azygous venous system.
3. Describe the formation, relations and termination of the thoracic duct.
4. Describe the course, relations and branches of the descending aorta.

Organization of posterior mediastinum



Position and Extent:

It's the portion of the mediastinum posterior to the heart and pericardium.

Boundaries

- ***Superior:*** the plane joining the sternal angle to T4/5
- ***Inferiorly:*** the thoracic diaphragm
- ***Anteriorly:*** the heart and pericardium
- ***Posteriorly:*** the inferior 8 thoracic vertebrae (T5-T12)

Contents:

- The thoracic aorta
- Part of the thoracic esophagus and the related vagus nerve
- The azygous venous system
- The thoracic duct

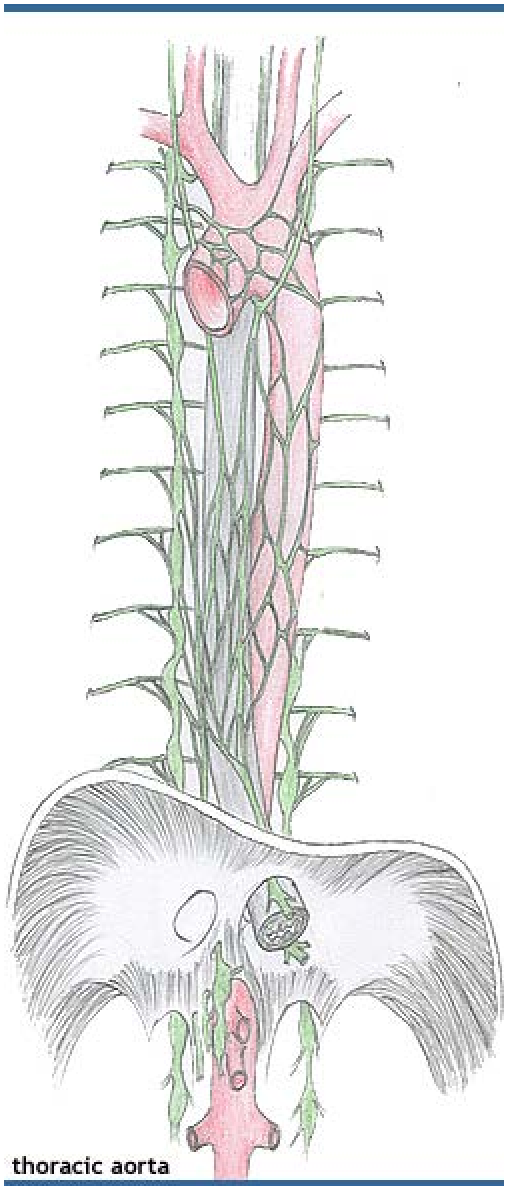
The thoracic aorta

Extents

T4/5, to T12,

Course and Relations

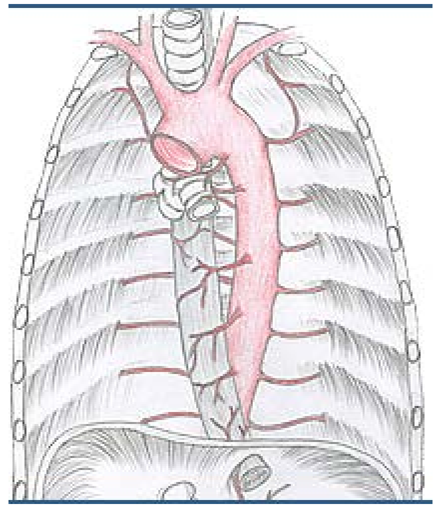
- At first it lies on the left of the bodies of T5-6, then inclines medially over the front of T7, displacing the esophagus to the right .
- Further down the aorta passes behind the espophagus
- It descends posterior to the root of the left lung and the pericardium in contact with the medial surface of the left lung
- The thoracic duct and azygous vein ascend on the right of the aorta



The hemiazygous and accessory hemiazygous are related to it on the right.

Branches

- The bronchial
- The posterior intercostals
- Esophageal
- Pericardial
- Subcostal arteries
- Esophageal arteries
- Pericardial branches
- Mediastinal branches
- Superior phrenic arteries



Esophagus

Extents:

From T4/5 to T10.

The esophagus runs downwards to the right then to the left of the aorta. It is the continuation of the cervical and superior mediastinal part.

Relations

Superior mediastinum

- ***Anteriorly:*** the trachea and left subclavian artery. The left recurrent laryngeal nerve runs in the tracheoesophageal groove.
- ***Posteriorly:*** bodies of T1-4, with longus coli in the upper part.
- ***On the right:*** the right pleura and the arch of the azygous vein.
- ***On the left:*** the thoracic duct, left pleura and the arch of the aorta. It crosses behind the principal bronchus and the right right pulmonary artery.

Posterior mediastinum

- ***Anteriorly:*** left atrium, part of the left ventricle and lower down the thoracic diaphragm.
- ***Posteriorly:*** the right posterior intercostal arteries; thoracic duct, azygous, accessory hemiazygous and hemiazygous veins, and lower down, the descending aorta.
- ***On the right:*** the right pleura.
- ***On the left:*** the descending aorta and below that, the left pleura

Constrictions

It is related anteriorly to the heart and pericardium and can be dented in enlargement of the right atrium. Its normal constrictions are at the pharyngo-esophageal junction where it is crossed by the left principle bronchus and where it goes through the thoracic diaphragm at T10, are clinically important. The vagal plexus surrounds it, before reconstituting into anterior and posterior vagal trunks.

Blood supply

It is vascularized by a longitudinal anastomosis to which several vessels contribute. These include:

- Inferior thyroid
- Bronchial
- Aorta
- superior phrenic
- left gastric

The veins drain both to the portal vein and azygous system. The esophagus therefore constitutes a site of portosystemic anastomosis.

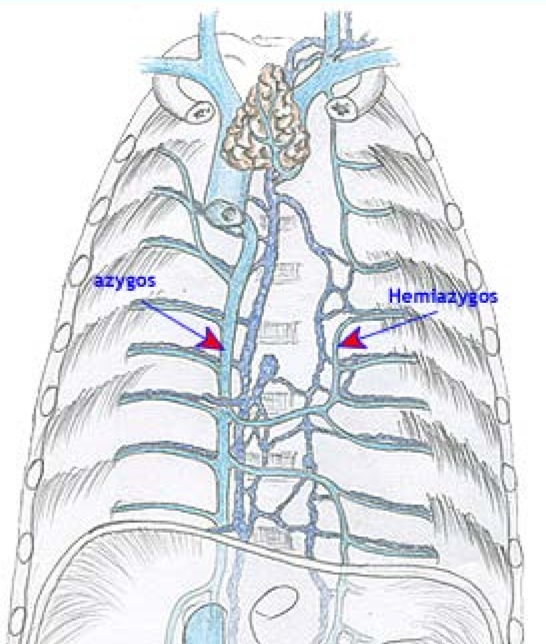
Lymphatic Drainage

Mediastinal lymph nodes
Supradiaphragmatic nodes

Innervation

Vagal trunks and sympathetic from sympathetic chain

Azygous venous system



Azygous venous system

Formation

Union of left ascending lumbar and right sub costal veins

Components

- Azygous vein
- Hemiazygous veins
- Accessory hemiazygous veins.

Tributaries and territory of drainage

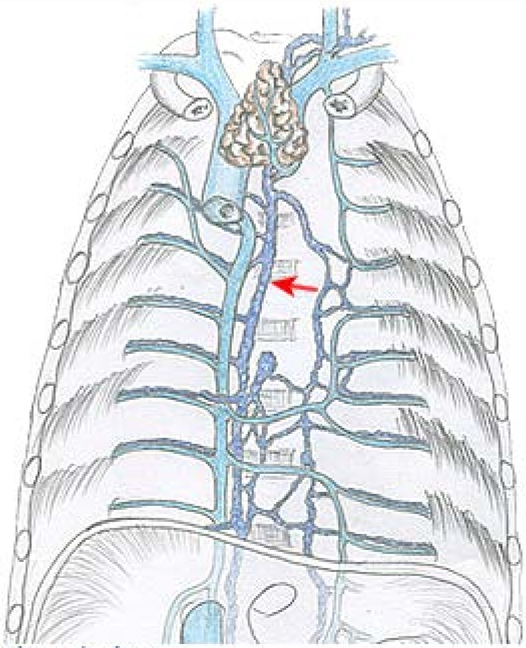
- The intercostal veins on the right drain into the azygous vein; while those on the left drain into the hemiazygous and accessory hemiazygous.
- Drains thoracic and abdominal walls
- Connects superior and inferior vena cava

Termination

- It joins the superior vena cava at the level of the sternal angle.

Posterior Mediastinum and posterior chest wall

The thoracic duct



thoracic duct

Origin

- Cisterna chyli in the abdomen

Course and relations

- Traverses diaphragm with aorta at T12
- Runs between thoracic aorta and esophagus
- Crosses from right to left at sternal angle

Tributaries

- Posterior mediastinal nodes
- Small intercostals nodes
- Left bronchomediastinal trunk
- Left subclavian trunk
- Left jugular trunk

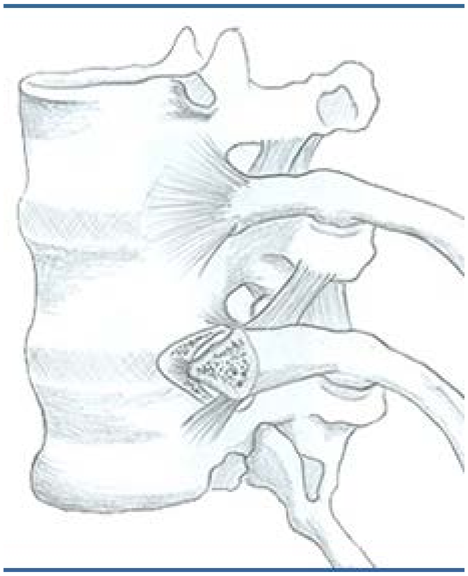
Territory

- All structures below thoracic diaphragm
- Structures on left side of body above thoracic diaphragm

Termination

- Junction of internal jugular and sub clavian veins

Posterior thoracic wall



The costovertebral joint from the front:

A typical rib articulates with the vertebral column at two joints:

- **Costotransverse joint** between the tubercle of the rib and the tip of the transverse process
- The **head of the rib** articulates with:

  (+) Part of the body of the corresponding vertebra
  (+) Adjacent intervertebral disc
  (+) Lower part of the vertebral body above.

Each joint of the head of the ribs has a fibrous capsule, uniting the margins of the articular facets and lined with synovial membrane.

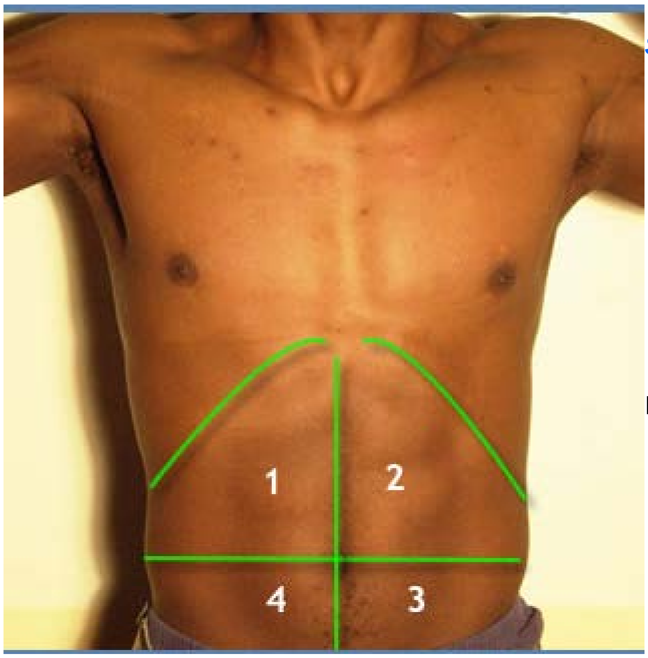
The **radiate ligament** connects the head to:

- The body above
- The body below
- The disc between them

The **intra articular ligament** joins the transverse crest on the head to the disc, dividing the joint cavity into separate upper and lower compartments.

Organization of the antero-lateral abdominal wall

Boundaries



Superiorly:

- Xiphoid process.
- Costal cartilages of the 7th and 10th ribs.

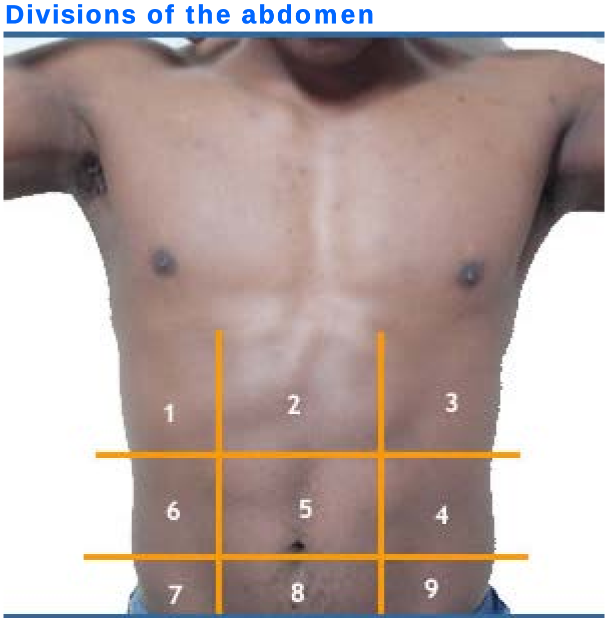
Inferiorly:

- Iliac crest.
- Anterior superior iliac spine.
- Inguinal ligament.
- Pubic tubercle, pubic crest and pubic symphysis.

Divided into 4 quadrants i.e

1. Right and left upper quadrants
2. Right and left lower quadrants

Divisions of the abdomen



Can be Divided into 9 regions.

- Two vertical planes- **midclavicular**
- Two horizontal planes:
  - **Subcostal plane** – joining the most inferior points of the costal margins, and passing at L3.
  - **Transtubercular plane**, joining the tubercles of the iliac crest.

Note the 9 regions.

- Right and left hypochondrial regions **(1and 3)**
- Middle epigastric region **(2)**
- Right and left lumbar regions **(6 and 4)**
- A middle umbilical region **(5)**
- Right and left iliac (inguinal) region **(7and 9)**
- A middle hypogastric or suprapubic region **(8)**

Layers of anterior abdominal wall

- Skin
- Superficial fascia: Fatty and membranous
- Deep fascia
- Muscles:
- Extra peritoneal tissue
- Peritoneum.

Skin

- Shows 'creases' which represent the lines of orientation of collagen fibres in the dermis- **Langer's lines**.
- These lines are surgically important – incisions along them heal better leaving a thin scar; while those across them leave big scars.
- In pregnant women, obese people and those with abdominal distention from whatever cause, there are dark elongate lines called striae gravidara.
- The skin is very sensitive to touch, and quickly when touched, the muscles contract.

Superficial fascia

Consists of two layers;

- Fatty layer (Camper's fascia) containing variable amounts of fat, more in females and in the lower abdomen.
- Membranous layer (Scarpa's fascia).

  (+) Contains fibrous tissue and very little fat.
  (+) Fuses with fascia lata below inguinal ligament)
  (+) Continuous with the superficial perineal fascia (Colle's fascia) and with that investing the scrotum and penis.

Deep fascia

Unremarkable

The muscles

There are 4 main muscles to note:

- **External oblique**
- **Internal oblique**
- **Transversus abdominis**

- **Rectus abdominis**

Note the attachment and innervation of these muscles.

Functions of the muscles:

- **Support and protection** for abdominal viscera
- **Movement** of the **trunk** – flexion, extension, twisting and lateral bending.
- Maintenance of **posture**
- Increase **intra abdominal pressure** in functions such as defecation, micturition and parturition etc.

Anterior Abdominal Wall and the Peritoneum

Applied Anatomy

A) Incisions in the anterior abdominal wall

Midline

Because the vessels mainly approach the linear alba from the sides, the **linear alba** is a "**water shed**" area. Besides

the composition of connective tissue (fibro elastic) with a low metabolic turn-over, does not necessitate very profuse

vascularization. Consequently, incisions here do not cause troublesome bleeding. However, union is slow, and therefore

either non-absorbable or long staying suture material is required when closing up. Otherwise deficits will remain, and be

potential sites for hernia (incisional hernia).

Paramedian

Usually, the **rectus abdominis** is **retracted laterally**, to avoid detaching its nerve and vessels. It is unwise to cut the muscle longitudinally.

These incisions, do not meet many blood vessels. The epigastric vessels (inferior and superior) are usually easy to identify.

Horizontal incision

Especially in the lower abdomen (Pfanesteil) may encounter the inferior and superficial epigastric vessels. If these can be guarded, handled, the incision heals rapidly, leaving thin scars.

Gridiron incision

It is mentioned under appendix

B) Hernias

A hernia is an abnormal protrusion of structures from one anatomical region to another (internal) or from the body cavity to the exterior (external).

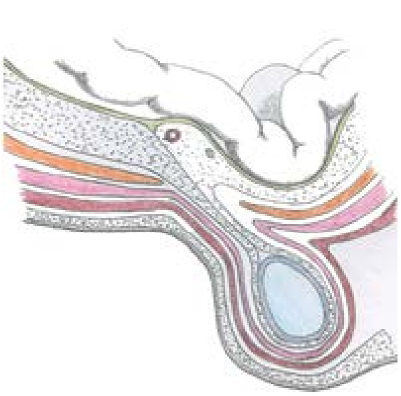
Internal Herniae	External Herniae

Hiatus hernia
- Other diaphragmatic herniae
- Herniae into the peritoneal recesses e.g. Para-duodenal, retro-caecal, through epiploic foramen

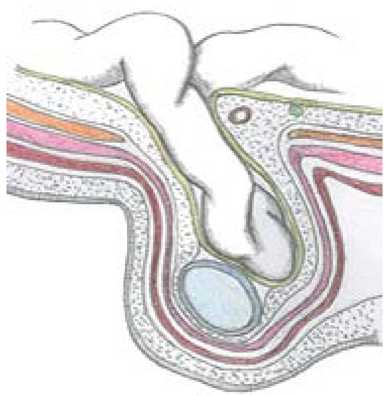
- Epigastric
- Umbilical
- Inguinal
- Femoral

Inguinal Hernias

Direct	Indirect



- Less common type
- more likely in older men (over 40).
- Protrudes anteriorly through the posterior wall of inguinal canal
- Medial to inferior epigastric artery.
- passes through inferior part of inguinal triangle.
- Does not pass through the deep inguinal ring, but pass through superficial ring.
- Usually results from weakening of the Conjoint tendon



- More common type,makes 75% of all.
- more common in male children,
- Takes the path taken by testis through inguinal canal
- Leaves lateral to inferior epigastric artery.
- Passes outside inguinal triangle.
- Passes through the deep inguinal ring and superficial ring to enter the scrotum
- More likely in patent processus vaginalis

Venous engorgement in anterior abdominal wall

Caput medusae:

- Distended veins radiating from the umbilicus
- Suggest portal hypertension.
- They arise because para umbilical veins communicate with the portal veins through potential veins in the ligamentum teres.

Enlargement of the veins on the sides may suggest obstruction of one of the vena cavae.

Anterior Abdominal Wall and the Peritoneum

Review Questions

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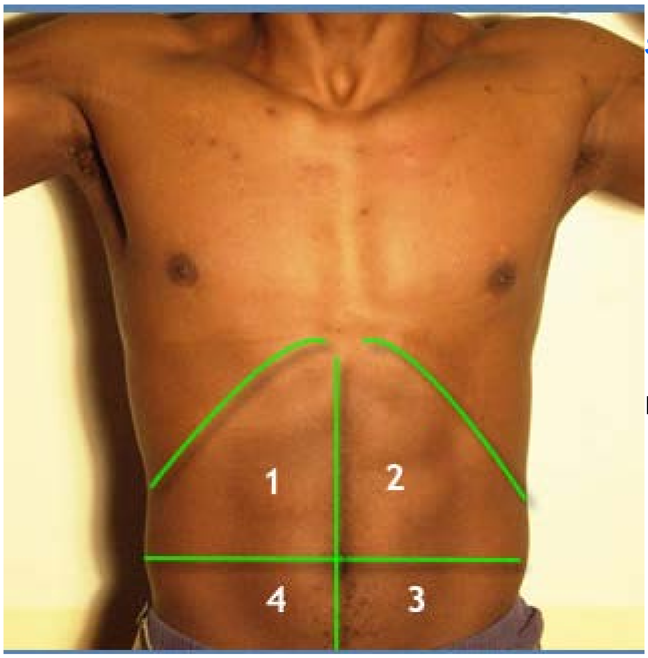
1. Describe the muscles, blood supply, lymphatic drainage and sensory innervation of the anterior abdominal wall
2. Discuss the formation and contents of the inguinal canal. Add notes on the distinction between direct and indirect inguinal hernias. List six structures that must be safeguarded during hernial repair
3. Describe the formation and contents of the rectus sheath
4. Outline the general organization of the superficial fascia of the anterior abdominal wall, and the perineum. Add clinical notes on the implication of this organization
5. Describe in detail the pattern and clinical significance of the blood supply of the anterior abdominal wall.
6. State the advantages and disadvantages of the various incisions in the anterior abdominal wall.

Organization of the antero-lateral abdominal wall

Boundaries



Superiorly:

- Xiphoid process.
- Costal cartilages of the 7th and 10th ribs.

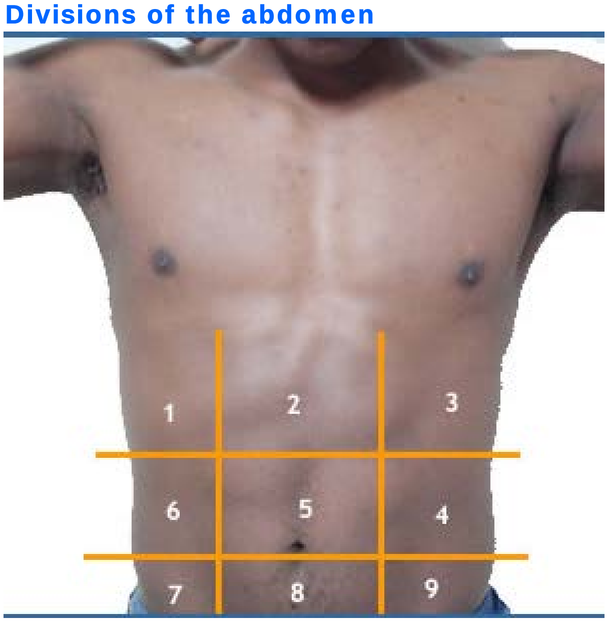
Inferiorly:

- Iliac crest.
- Anterior superior iliac spine.
- Inguinal ligament.
- Pubic tubercle, pubic crest and pubic symphysis.

Divided into 4 quadrants i.e

1. Right and left upper quadrants
2. Right and left lower quadrants

Divisions of the abdomen



Can be Divided into 9 regions.

- Two vertical planes- **midclavicular**
- Two horizontal planes:
  - **Subcostal plane** – joining the most inferior points of the costal margins, and passing at L3.
  - **Transtubercular plane**, joining the tubercles of the iliac crest.

Note the 9 regions.

- Right and left hypochondrial regions **(1and 3)**
- Middle epigastric region **(2)**
- Right and left lumbar regions **(6 and 4)**
- A middle umbilical region **(5)**
- Right and left iliac (inguinal) region **(7and 9)**
- A middle hypogastric or suprapubic region **(8)**

Layers of anterior abdominal wall

- Skin
- Superficial fascia: Fatty and membranous
- Deep fascia
- Muscles:
- Extra peritoneal tissue
- Peritoneum.

Skin

- Shows 'creases' which represent the lines of orientation of collagen fibres in the dermis- **Langer's lines**.
- These lines are surgically important – incisions along them heal better leaving a thin scar; while those across them leave big scars.
- In pregnant women, obese people and those with abdominal distention from whatever cause, there are dark elongate lines called striae gravidara.
- The skin is very sensitive to touch, and quickly when touched, the muscles contract.

Superficial fascia

Consists of two layers;

- Fatty layer (Camper's fascia) containing variable amounts of fat, more in females and in the lower abdomen.
- Membranous layer (Scarpa's fascia).

  (+) Contains fibrous tissue and very little fat.
  (+) Fuses with fascia lata below inguinal ligament)
  (+) Continuous with the superficial perineal fascia (Colle's fascia) and with that investing the scrotum and penis.

Deep fascia

Unremarkable

The muscles

There are 4 main muscles to note:

- **External oblique**
- **Internal oblique**
- **Transversus abdominis**

- **Rectus abdominis**

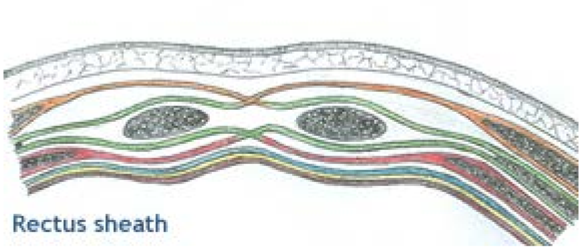
Note the attachment and innervation of these muscles.

Functions of the muscles:

- **Support and protection** for abdominal viscera
- **Movement** of the **trunk** – flexion, extension, twisting and lateral bending.
- Maintenance of **posture**
- Increase **intra abdominal pressure** in functions such as defecation, micturition and parturition etc.

Anterior Abdominal Wall and the Peritoneum

The Rectus Sheath



Location

- Fibrous compartment for rectus abdominis muscle in the paramedian abdominal wall.s

Formation

- Formed of the aponeurosis of abdominal muscles.
- It has a posterior layer and anterior layer.

Proximal 1/3rd

- The anterior layer joins the aponeurosis of the external oblique to form the anterior wall of the rectus sheath.
- The posterior layer joins with the aponeurosis of the transversus abdominis to form the posterior wall of the rectus sheath.

Middle 1/3 rd

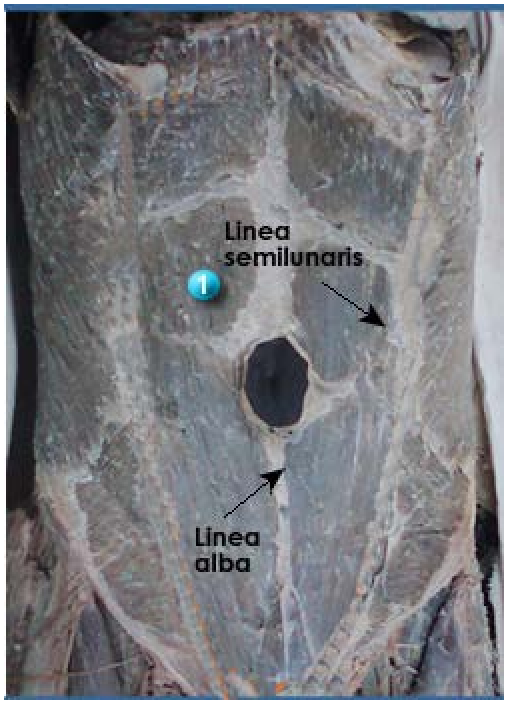
- Aponeurosis of internal oblique joins external oblique aponeurosis to form anterior wall.
- Posterior wall is formed by aponeurosis of transversus abdominis muscle

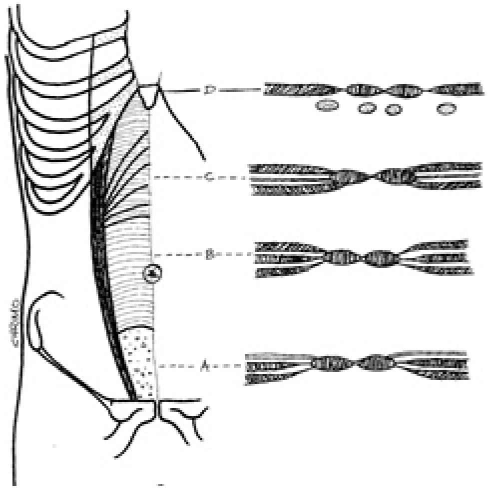
Distal 1/3 rd

- Mid way between umbilicus and pubic crest all three aponeurosis form the anterior layer
- The posterior layer is formed only by fascia transversalis
-

Note:

1. The anterior and posterior layers fuse in the midline to form the **linear alba**, a fibrous





intersection extending from the xiphoid process to the pubic symphysis.

2. The inferior ¼ of the rectus sheath is deficient posteriorly. The limit of the posterior wall is marked by the **arcuate line**

3. The lateral margin of rectus sheath is called **linea semilunaris**

Contents of Rectus Sheath

- Rectus abdominis muscle
- Inferior and superior epigastric vessels
- Terminal parts of the lower five intercostal nerves, and the Subcostal nerve.
- Fibro fatty connective tissue
- Occasionally lymph node(s)

Extra peritoneal fascia

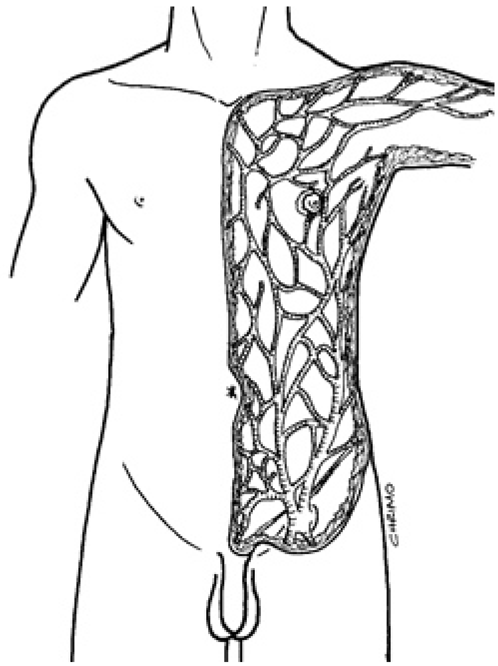
- Transparent 'membrane' which lines the inside of the abdominal wall.

- Its parts are named according to what it lines e.g.

  (+) diaphragmatic fascia;
  (+) iliac fascia;
  (+) psoas fascia.
  (+) fascia transversalis (part covering the muscle transversus abdominis).

Blood supply to the anterior abdominal wall

Arteries



- Inferior epigastric : External iliac
- Superficial circumflex iliac : Femoral artery
- Deep circumflex iliac : femoral artery
- Superior epigastric : internal thoracic
- Lower intercostal : Abdominal Aorta
- Subcostal arteries : Abdominal aorta

Veins

The veins correspond to the arteries, but:

- Inferior epigastric vein anastomoses with lateral thoracic vein.
- Superficial epigastric vein anastomoses with lateral thoracic vein.

These two unite the veins of the upper and lower halves of the body (of the azygous system).

Lymphatic Drainage

Superior to the umbilical level:

- Axillary nodes
- Parasternal nodes

inferior to the umbilical level:

- Superficial Inguinal lymph nodes
- Deep inguinal nodes
- External iliac nodes
- Lumbar nodes

Innervation

- The lower intercostals and subcostal
- Segmental with T10 Para umbilical.

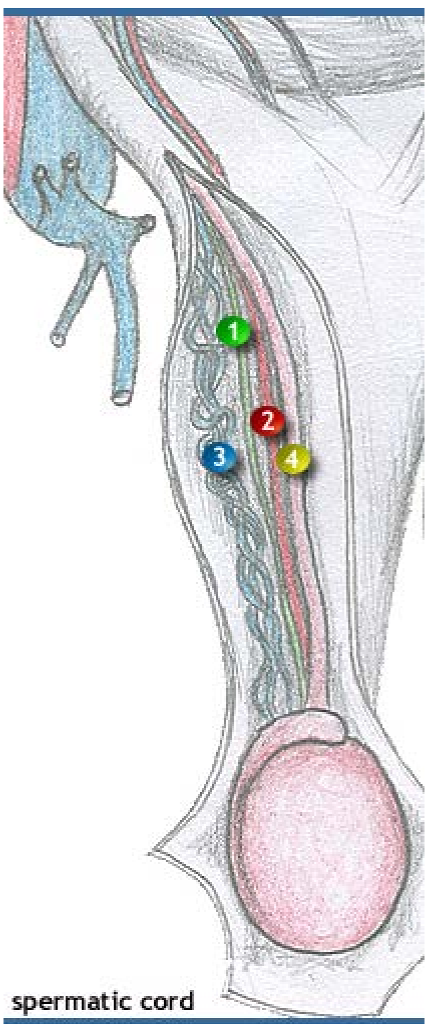
Anterior Abdominal Wall and the Peritoneum

Inguinal triangle

Bounded by:

- **Medially:** Linear semilunaris (lateral edge of Rectus abdomis)
- **Inferiorly:** Inguinal ligament
- **Supero-laterally:** Inferior epigastric artery

Spermatic Cord



Comprises of structures running **to** and **from** the **testis**, surrounded by structures derived from the **anterior abdominal wall**. Traverses entire **inguinal canal**

Coverings

- Internal spermatic fascia - from transversalis fascia
- Cremasteric fascia - from fascia of internal oblique
- Cremaster muscle - from internal oblique abdomen
- External spermatic fascia - from external oblique

Contents

- 1.Autonomic nerve plexus
- 2.Testicular artery; artery to ductus deferens, cremasteric artery
- 3.Pampiniform plexus of veins
- 4.Ductus deferens
- Lymph vessels
- Remnants of processus vaginalis

Cremasteric reflex

- Genital branch of genitofemoral nerve supply cremasteric muscle.
- **Stroking** the area of supply of the femoral branch (**superomedial thigh**) stimulates the muscle, **pulling up the testis** – this is the cremasteric reflex.
- Easy to demonstrate in children, but gets weaker with age.

Organs of supra colic compartment

Applied Anatomy

The Peritoneum

Review Questions

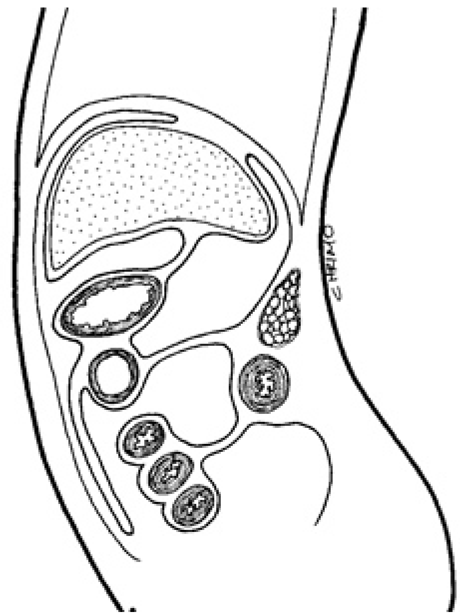
OGanatomy J. Ogeng'o palsoftweblink

The Peritoneum

Learning points | Core anatomy | Applied anatomy | Review questions

THE PERITONEUM

Hover to show names



- A large **serous** membrane that lines the **interior of the abdominopelvic walls** and the **viscera**
- Consists of: a single layer of flat mesothelial cells, supported by an underlying layer of loose connective tissue.
- A thin layer of fluid covers the peritoneal surfaces. It is derived from interstitial fluid and from adjacent capillaries.

- Peritoneum comprises two layers:

  (+) **Parietal** lines the body walls

  (+) **Visceral** covers the body organs

peritoneal folds

- Peritoneal folds are reflections of the peritoneum between the body wall and viscera and between the viscera themselves.
- Some types of folds:

  (+) 'Ligaments'
  (+) Mesenteries
  (+) Omenta

- A mesentery is a double-layered fold of peritoneum that suspends viscera from the parietes.
- One thick fold of peritoneum hangs from the stomach over the viscera of the mid-abdomen, and is called the greater omentum (Latin for cover or apron).
- The lesser omentum is a double layer of peritoneum that runs between the stomach and liver

Lesser omentum: (LO)

A double layered peritoneal fold connecting the **lesser curvature** of the **stomach** and the adjoining upper edge of the **duodenum** to the **liver.**

It consists of two ligaments:

- **Hepatogastric**
- **Hepatoduodenal**

The two layers of the lesser omentum are continuous with the serous coats of:

(+) **Liver**
(+) **Stomach**
(+) **Duodenum.**

The right edge of the lesser omentum is free and contains:

- Common bile duct on the right.
- Hepatic artery on the left.
- Portal vein behind and between the two.

To the left of this trio, the right and left gastric arteries run between the two layers.

The lesser omentum also contains:

- Nerve plexuses which accompany the arteries
- Lymphatics
- Lymph nodes and fat.

The Peritoneum

The greater omentum:

A double apron like fold peritoneum which hangs from:

- Greater curvature of the stomach
- Lower part of the first part of the duodenum.

Contains:

- Extraperitoneal fat
- Gastroepiploic vessels and their nerve plexuses
- Lymph vessels and nodes

Parts

- **Gastrosplenic ligament** containing:
    - Short gastric vessels and their nerve plexus
    - Lymph vessels and nodes
    - Fat.
- **Gastrophrenic ligament**
- **Gastrocolic ligament** containing mainly fat, lymphatics and lymph nodes

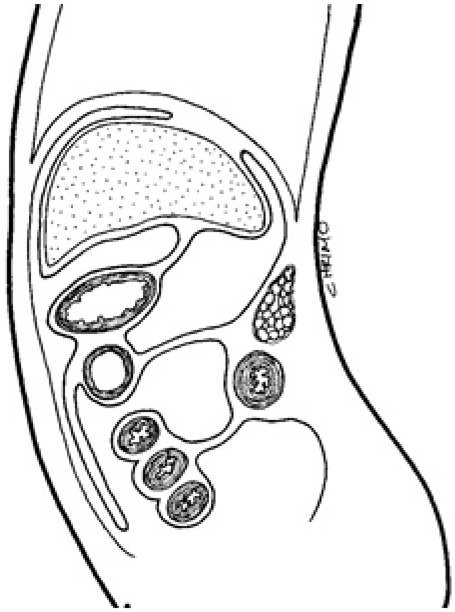
Functions:

- Fat depot
- Mechanical cushion
- Protective “policeman” of the abdominal cavity – tends to adhere to any areas of inflamed peritoneum, with which it may come into contact, and thus often prevents the escape of the contents of a hollow viscus which may have perforated.
- It contains defence cells such as macrophages and lymphocytes

Divisions of the peritoneal cavity

- Two peritoneal sacs:
- Greater sac
- Lesser sac.
- The peritoneal sac entered through the anterior body wall is the greater sac.

- The lesser sac lies behind the stomach,lesser omentum and liver



Subdivisions

The **greater omentum**, **transverse colon** and **transverse mesocolon** form a shelf dividing the greater sac into **supracolic** and **infracolic** compartments.

Supra colic compartment

Sub divided into smaller spaces:

- The right and left **subphrenic recesses** separated by the falciform ligament.They lie between the lower surface of the diaphragm and the upper surfaces of the right and left lobes of the liver.
- The **hepatorenal recess** lies between the inferior surface of the right lobe and the right kidney.

Infra colic compartment

- Is subdivided by the obliquely lying mesentry into right and left infra colic spaces.
- Because of the obliquity of the partition, the right infra colic space is above to the right and the left infra colic space is below and to the left.

Smaller peritoneal recesses

- They are of practical importance because a viscus may intrude into such a recess, producing an **internal hernia** which may become impacted.
- The surgeon must recognize the danger of cutting such a vascular fold in his attempt to free the impacted viscus.

Smaller recesses occur in three regions:

Near the duodenal flexure	Near the ileocecal junction	At the sigmoid mesocolon

Inferior duodenal recess

- Superior duodenal recess (sometimes under a vascular fold)
- Paraduodenal recess (behind a vascular paraduodenal fold)
- Retroduodenal recess
- Mesocolic recess

Superior ileocecal recess

- Inferior ileocecal recess
- Retrocecal recess

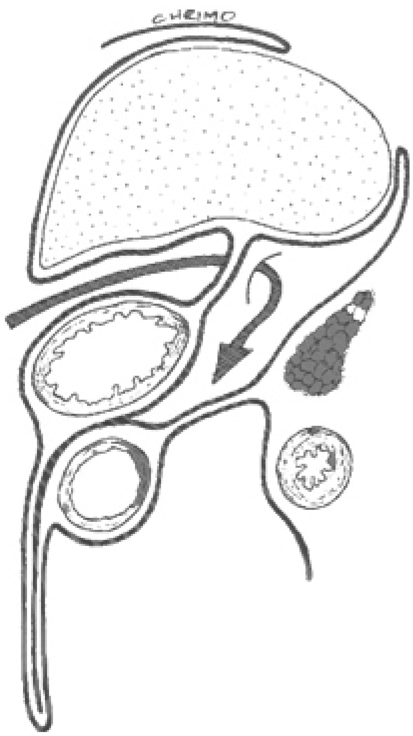
The intersigmoid recess

Lesser sac

- The lesser sac is also called the **omental bursa**.
- It lies behind the stomach and facilitates its movement

Epiploic / Omental foramen

Forms the entrance into omental bursa



Subdivisions

Vestibule – lies behind stomach and lesser omentum

Superior recess- behind the liver

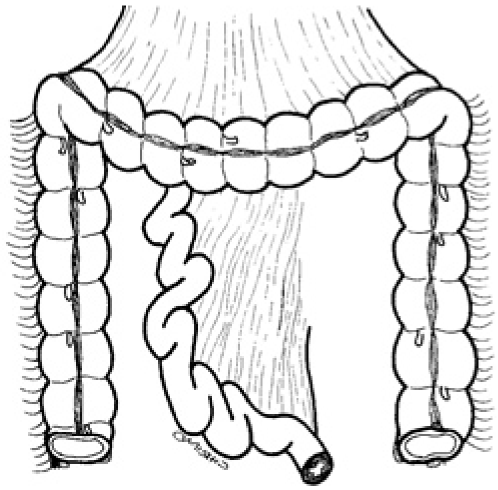
Inferior recess- behind the stomach

Splenic recess- anterior to spleen.

Superior	Anterior	Posterior	Inferior
Caudate lobe of liver	Free edge of lesser omentum containing: • Common bile duct • Hepatic artery proper • Portal vein	Inferior vena cava	First part of duodenum

The Peritoneum

The mesentry



This is a peritoneal fold that suspends the intestines from the posterior abdominal wall.

Parts of the intestine with mesentry

- Jejunum
- Ileum
- Appendix: **Meso-appendix**
- Transverse colon : **Transverse mesocolon**
- Sigmoid colon : **Sigmoid mesocolon**

Mesentery of the small intestine

Extents

- Directed obliquely and inferiorly and to the right
- From the left side of L2 to the right sacroiliac joint.

Structures crossed

- Horizontal part of the duodenum
- Aorta
- Inferior vena cava
- psoas major muscle
- Right ureter
- Right testicular or ovarian vessels
- Genitofemoral nerve

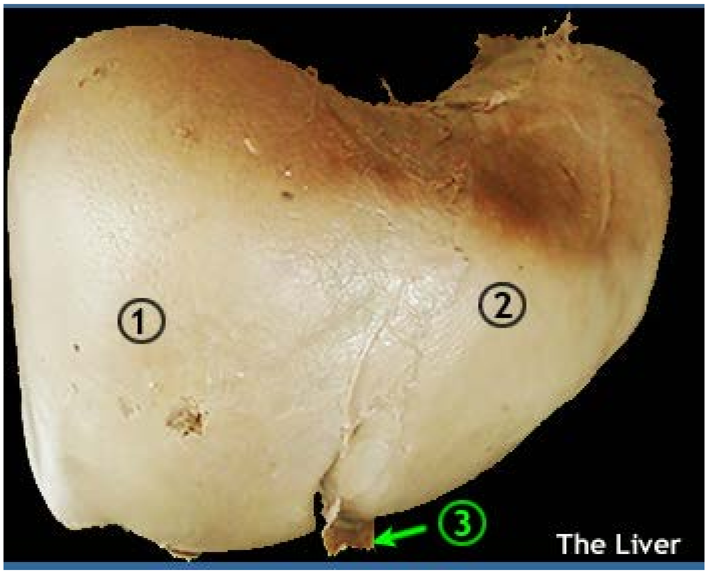
Contents

- Jejunal and ileal blood vessels
- Mesenteric nodes and lymph vessels
- Nerves
- Extraperitoneal fatty tissue.
- Superior mesenteric artery and vein

Organs of the supracolic compartment

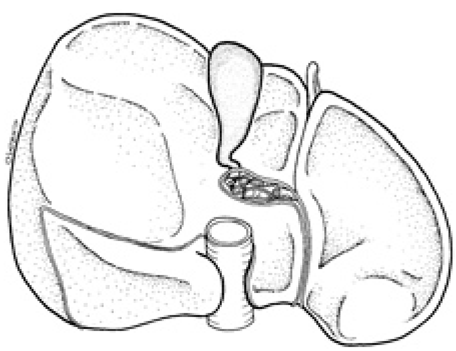
THE LIVER AND BILLARY APPARATUS

Position



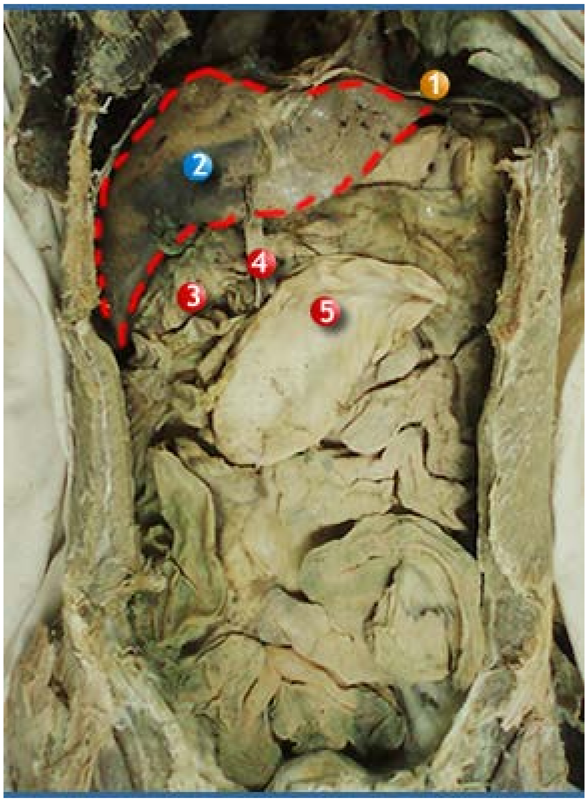
- Extends between the right hypochondrium and epigastric regions.
- Pyramidal in shape, with its base on the right side.
- it has only two surfaces, diaphragmatic and visceral.

Visceral relations of the liver



- **Visceral surface** faces downwards, posteriorly and to the left.
- This surface is related to:

(+) Anterior wall of the stomach
(+) Pyloric part;
(+) Superior part of the duodenum;
(+) Right colic flexure,
(+) Upper pole of the right kidney and
(+) Right suprarenal.
(+) Oesophagus
(+) Gall bladder



- The most obvious structure on the visceral surface of the liver is the portal hepatis .

This contains/transmits;

- Hepatic artery
- Portal veins
- Common hepatic duct
- Lymphatics, lymph nodes
- Autonomic nerve plexus

The diaphragmatic relations

The diaphragmatic relations surface is moulded to the undersurface of the diaphragm separating it from:

- Pericardium and heart
- Right Lung and pleura
- Right costodiaphragmatic recess.

Peritoneal relations

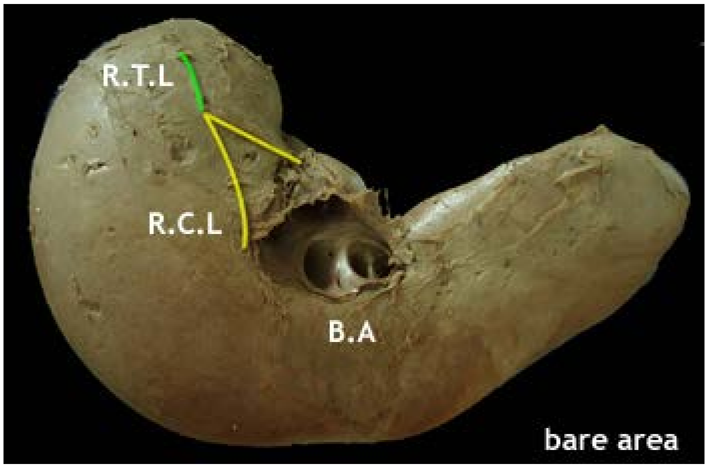
- Two layers of the falciform ligament connect the diaphragm and upper anterior abdominal wall to the diaphragmatic surface, just to the right of the median plane.

- The falciform ligament contains ligamentum teres and the paraumbilical veins**.**

- At the reflection onto the liver, the layers of the falciform ligament separate.

- To the right it forms the upper leaf of the right triangular ligament (coronary ligament) on the left, it continues as the left triangular ligament.

Bare area of liver



- The liver is in direct contact with the diaphragm between the leaves of the right **triangular ligament.**
- This part of the liver is called the **bare area of the liver.**
- It is a peritoneum-free triangular area, between the two layers of the **coronary ligament**, and is loosely attached to the diaphragm.

note: RCL: Right coronary ligament

RTL: Right triangular ligament

BA: Bare area,

Organs of supra colic compartment

Applied Anatomy-(Gall bladder)

1. Gall stones block the cystic or common bile duct and cause obstructive jaundice.
2. Inflammation of the gall bladder is called cholecystits. This can be chronic or acute. Chronic cholecystitis, and especially due to stones is managed by surgical removal of gall bladder - cholecystectomy.
3. Accidental injury to gall bladder in surgery can result from failure to appreciate the variations in blood supply, and the extrahepatic duct system.
4. Carllot's triangle
5. Some narrow billiary channels (accessory hepatic ducts) may run from the right lobe of the liver into the anterior surface of the body of the gall bladder These may be a cause of bile leakage following cholesystectomy. Such leakage may be contained by careful coutery of the gall bladder bed. Many surgeons now patch the bed with omental material.A small pouch may exist from the right wall of the neck of the gall bladder. This is called Hartmann's pouch. And usually projects inferiorly and posteriorly towards the duodenum. Gall stones may easily lodge in this pouch.
6. Murphy's sign
7. Pain of gall bladder origin is referred to right shoulder, right side of neck and mandibular region because of phrenic nerve
8. The technique of visualizing gall bladder by introduction of radiopaque dye is called cholecystography, and the dye could be given intravenously; orally; or into the duct.

Spleen

1. The spleen is not normally palpable. When enlarged, it is palpable below the left costal margin.
2. Enlargement of the spleen is called splenomegaly and can occur due to:

   (+) Tropical parasitic infestations
   (+) Blood Malignancies
   (+) Glycogen or lipid storage disorders.

   Massively enlarged spleen can rupture spontaneously.
3. Traumatic rupture of spleen can occur in abdominal or thoracic trauma. This is common and is treated by surgical removal- Splenectomy. During this procedure the tail of the pancreas must be guarded. If the rupture is massive several pieces of splenic tissue may be seeded into the peritoneum. This is called splenosis.

4. Following splenectomy in children, a piece of splenic tissue should be buried in the peritoneum to continue function.

5. Small accessory spleens or spleniculi may be found in the neighborhood of the spleen, being especially common in the Gastrosplenic ligament and greater omentum.

Organs of supra colic compartment

Review Questions

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1. Describe the position, relations, peritoneal relations, supporting structures, blood supply, lymphatic drainage and innervation of each of the following

- Liver
- Stomach
- Spleen
- Gallbladder

2. Subdivide the abdominal cavity into 9 regions, and list the contents of each. Outline the clinical relevance of this information, with special reference to pain and masses in the various regions

3. A 75 year old male presents to the outpatient clinic with deep obstructive jaundice, back pain, distended fluidy abdomen, leg oedema, distended abdominal veins filling from above, caput medussae. Examination and investigations reveal a supracolic mass. Discuss the primary pathology that would cause the features described above

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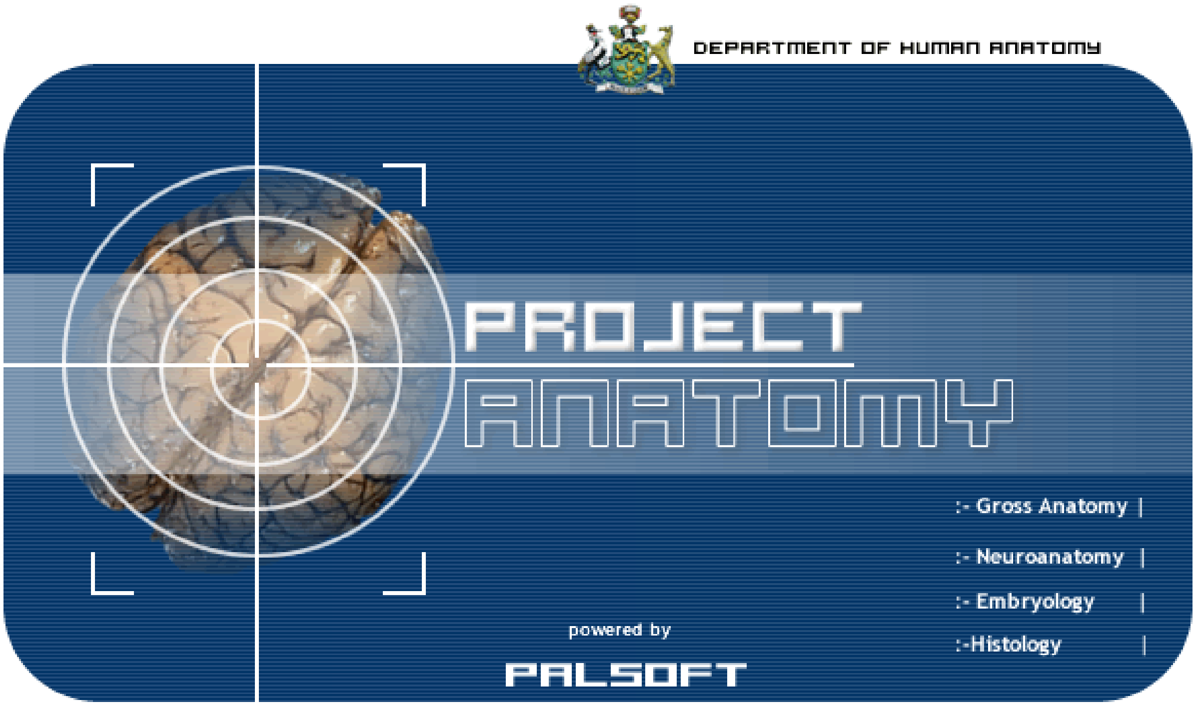


Welcome

ProjectAnatomy is an online learning project by the Department of Human Anatomy, University Of Nairobi tailored for students taking a course in anatomy.

Course Work

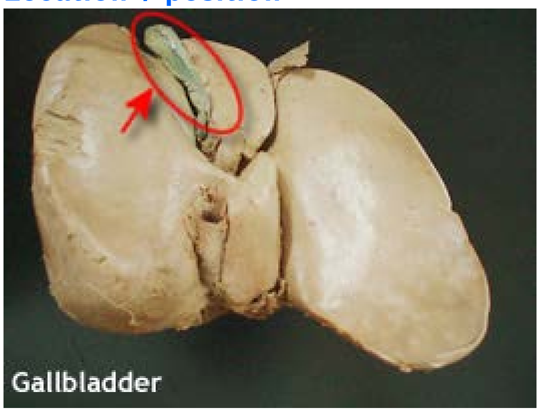
The course work on this site is organised as per the teaching schedule followed at the University of Nairobi College of Health Sciences with the material subdivided into Neuroanatomy, Gross Anatomy, Embryology and Histology. Gross anatomy is taught on a topographic basis while Histology and Embryology are taught on a sytemic basis. To jump to a specific location select the subject from the links below.

Select subject

Organs of supracolic compartment

THE GALL BLADDER AND BILE DUCTS

Location / position



- Right hypochondrium
- Tip of the 9 th costal cartilage in the mid-clavicular line
- where the linear semilunaris meets the costal margin.
- Visceral surface of liver
- Along right edge of the quadrate lobe of the liver.

Relations

Superior surface is in contact with the **liver**.

Its inferior and fundus in contact with:

- **Transverse colon**
- Superior part of the **duodenum**
- Anterior **abdominal wall**.

The neck of the gall bladdes tapers towards the **porta hepatis**.

The **epiploic foramen** lies immediately to its left.

Peritoneal relations

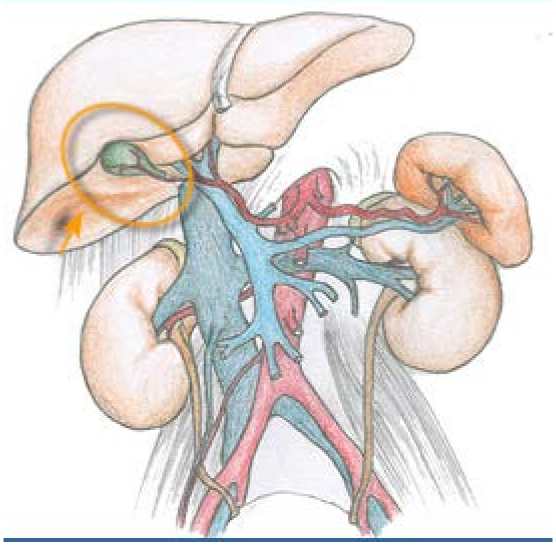
- Covered on the posterior and inferior surfaces by peritoneum.
- Occasionally, the gall bladder is completely invested with peritoneum, and may be connected to the liver by a short mesentry.

Blood supply

Arterial :

Cystic artery – commonly a branch of the right hepatic between hepatic duct and cystic duct. The origin and course of this artery is variable. It may arise from:

- Common hepatic
- Left hepatic
- Superior epigastric



- Left gastric
- Left hepatic
- Gastroduodenal
- Superior mesenteric
- Coeliac trunk

It commonly runs posterior to hepatic duct, but may run anterior .

Veins :

Those from the ducts and neck of gall bladder join veins which connect the

- Gastric
- Duodenal
- Pancreatic
- Portal vein
- Some go to the liver directly.

Lymphatics

1. Cystic node at the neck of the gall bladder.
2. Node of epiploic foramen – hepatic nodes – coeliac lymph nodes

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Innervation

1. Sensory innervation - phrenic nerve
2. Sympathetic - coeliac plexus
3. Parasympathetic - vagus

THE STOMACH

This is the widest part of the GIT, connecting esophagus and the duodenum.

Position :

- Supra colic
- Extends from Epigastric to Left hypochondrial regions .
- Above transpyloric plane

Parts

- Cardiac part
- Body.
- Fundus.
- Pylorus

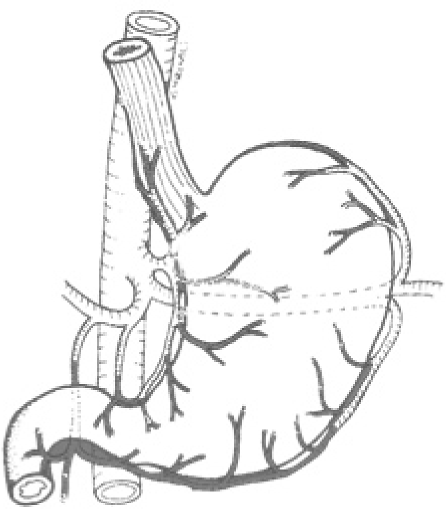
Surfaces

- Anterior and posterior surfaces,
- These meet along the lesser curvature and along the greater curvature.

Relations :

Anteriorly:	Posteriorly:
• The thoracic diaphragm • Left and quadrate lobes of the liver. • The anterior abdominal wall.	Separated by omental bursa from **stomach bed** containing: • Diaphragm above. • Spleen. • Left kidney and suprarenal. • Splenic artery. • Pancreas. • Transverse mesocolon. • Transverse colon and left colic flexure.
	Hover to show names

Blood supply



Arteries:

On the **lesser curvature**:-

- Right gastric, from **hepatic artery**
- Left gastric, from **coeliac trunk.**

On the **greater curvature**:-

- Right gastroepiploic, from the **gastroduodenal artery**.
- Left gastroepiploic, from the **splenic artery**.

At the **fundus**:-

- Short gastric arteries from the splenic artery.

These arteries anastomose extensively.

- **Posterior gastric artery** – frequently from the splenic artery.

Venous drainage

The veins of the stomach accompany the arteries for some distance.

- The right gastro epiploic vein joins the **superior mesenteric**

vein.

- The left gastro epiploic vein joins the **splenic vein**.
- Right gastric and left gastric join the **portal vein**.

Lymphatic drainage

The lymphatics of the stomach tend to follow blood vessels and drain four main areas, with overlap:

- Both surfaces of the upper body drain to left gastric nodes.
- Fundus and lower left part of the body reach pancreatico splenic nodes close to the hilum of the spleen.
- Lower right part of the greater curvature pass to the right gastro epiploic nodes.
- Pylorus drains into pyloric, left gastric and hepatic nodes.

The valves of the lymphatics are arranged so that lymph tend to pass from the right part of the stomach towards the lesser curvature; and from the left part of the stomach towards the greater curvature.

Innervation :

The stomach receives both sympathetic and parasympathetic innervation.

- Sympathetic fibres are derived mainly from the coeliac plexus and travel along the branches of the coeliac artery. Occasional branches also reach the stomach from the left phrenic plexus, and sympathetic trunks. These fibres are probably vasomotor. Sensory fibres carrying pain follow these sympathetic pathways to the spinal cord.
- Parasympathetic supply is from the vagus.

The Spleen

Position

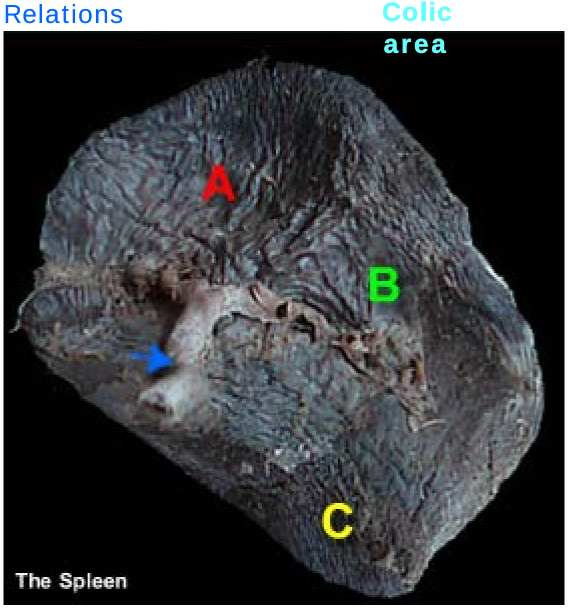
- In the supracolic compartment of the abdominal cavity:
- left hypochondrium,
- mid-axillary line,
- related to ribs 9, 10, 11.
- Its long axis corresponds to that of the 10 th rib.

Borders of spleen

- Superior pole
- Inferior pole
- Anterior border
- Posterior border

Relations

Colic area



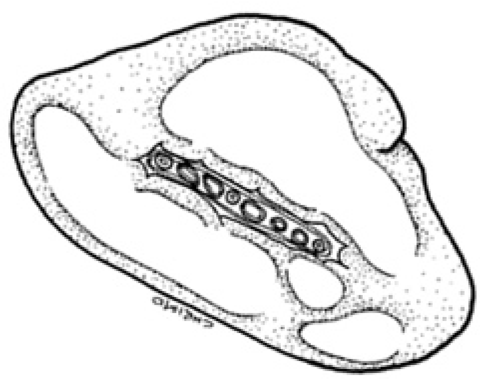
There are two surfaces;

Diaphragmatic surface:

- fits into the concavity of the diaphragm opposite **ribs 9, 10, and 11.**
- The costo diaphragmatic recess intervenes between.
- The **lungs** and **pleura** are important relations.

The visceral surface is related to the following organs:

- Left kidney
- Left supra renal gland
- Splenic flexure of colon
- Stomach anteriorly
- Tail of pancreas



Peritoneal relations

- covered by peritoneum except at hilum

Ligaments of the spleen (peritoneal folds)

- **Gastrosplenic** ligament (Contains short gastric vessels)
- **Splenorenal** ligament (Contains splenic vessels)

Blood supply

- The splenic artery divides into five or more segmental branches which enter the hilum.
- The splenic vein starts as 5-6 tributaries in the hilum of the spleen.
- It joins with superior mesenteric vein to form the portal vein.

Lymphatic drainage

Lymphatics end in the pancreatico-splenic lymph nodes.

Innervation

- Innervated by vagus nerve
- Greater splanchnic through celiac plexus

Organs of supra colic compartment

Applied anatomy(appendix)

1. Since afferent fibres from the appendix are carried in the lesser splanchnic nerve, and impulses enter T10; pain from the appendix is initially referred to the **periumbilical region** . Later, the pain may localize in the right lower quadrant - due to irritation of perietal peritoneum. If the appendix is long and enters the pelvis, acute appendicitis may resemble raptured ectopic pregnancy.
2. Since the appendix crosses the psoas major, the patient flexes the right thigh to relieve pain. If this thigh ishyperextended (psoas test), there will be pain because it stretches the muscle and its inflamed fascia.
3. MC Burney's point -joint between lateral 1/3; and medial 2/3 of a line between anterior superior iliac spine and umbilicus. This is the point of maximum tenderness in appendicitis. The Gridiron incision is made perpendicular to the line at this point, in appendicectomy.

Organs of supra colic compartment

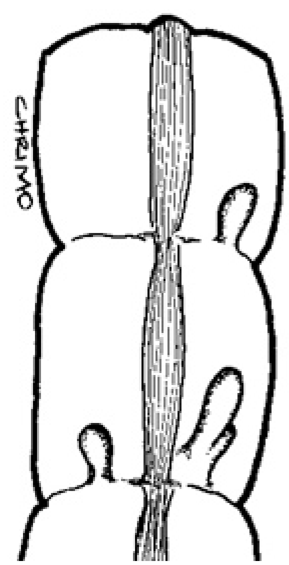
Review questions

1. Describe the position, relations, blood supply and lymphatic drainage of cecum
2. Describe the positions, relations, blood supply, lymphatic drainage and innervation of the appendix. Add notes on variant positions and blood supply
3. Describe the position, relations, blood supply, lymphatic drainage and innervation of sigmoid colon. Add notes on the mesentry of the sigmoid colon.
4. Write short notes on:

   a) Transverse meso colon
   b) Colic flexures
   c) Marginal artery
5. Describe the position and relations of the ascending and descending colons.

Differences between Small and Large Intestines

The small gut can be distinguished from large by the following features.

	Small Intestines	Large intestines
Position	• Central	• Peripheral
Mobility	• Moves freely on its stalk, the mesentery;	• Fixed except for **transverse** and **sigmoid** colons which have mesentry.
Contour	• Even cylindrical contour	• Pinched up by a series of constrictions into **haustrations or sacculations.**
External muscle coat	• Uniform outer coat of longitudinal muscle	• Three broad thickened longitudinal bands of smooth muscle called **taeniae coli**.
Appendices epiploicae	• Fat is limited to the mesenteric border	 • Each is a small rounded evagination of the serous coat, containing a little extraperitoneal fat. • Appendices epiploicae are absent from the caecum, appendix and rectum.

The Jejunum and Ileum

General arrangement:

- The jejunum and ileum together measure about 6m in length in adult.
- The upper two-fifths comprise the jejunum;
- the lower three-fifths the ileum.
- The jejunum and ileum are massed into numerous coils which occupy the major part of the infracolic compartment of the greater sac.
- They are covered to a varying extent by the greater omentum.
- They extend into the pelvic cavity and rest on the pelvic viscera, occupying the various recesses between them.
- The coils have a varying degree of mobility, depending on the length of their mesentery. The first part of the jejunum and the last part of the ileum are shorter stalks and are therefore less mobile than the intervening coils.

External differences between jejunum and ileum

It is sometimes necessary to distinguish between jejunum and ileum by external features, as follows:

	Jejunum	Ileum
Position:	• More to the left and above;	• Right and below.
Appearance	• Redder and wider.	• Paler and narrower
Feel:	• Thicker • Numerous plicae circulares, which can be felt through the bowel wall.	• Thinner • Fewer plicae
Aggrated lymphatic follicles:	• Fewer and smaller in the jejunum.	• More and larger
Messenteric	• Less fat in the mesentery of the jejunum near the gut, so that translucent ‘windows' are visible	• Such areas are absent from the mesentery of

fat :	when the mesentery is held against the light.	the terminal ileum.
Arterial arcades	• Arteries form a greater number of arcades than do the ileal arteries. .	• Form fewer arcades- Receives shorter terminal branches from tertiary or quaternary arcades

The Descending Colon

- Connects the left colic flexure to the sigmoid colon.
- About 25 cm long, and is narrower than the ascending colon.
- Ascends on the posterior abdominal wall to the iliac crest and then inclines medially on iliacus and psoas major to the pelvic brim where it becomes continuous with the sigmoid colon.
- Related posteriorly to the diaphragm and quadratus lumborum, but the subcostal vessels and nerve and the iliohypogastric and ilio-inguinal nerves intervene between it and quadratus.
- Beyond the femoral and genitotemoral nerves, gonadal vessels and external iliac vessels are between it and psoas major.

The sigmoid colon

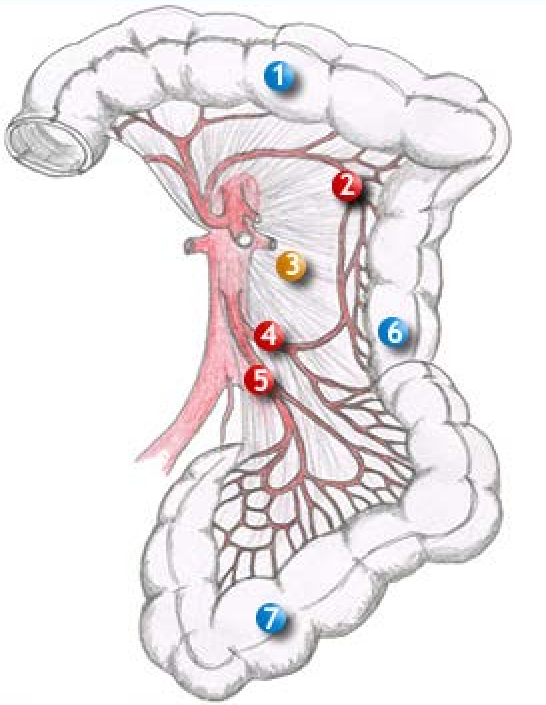
- Forms a sinous loop about 40 cm long
- Extends from the pelvic brim to the middle piece of the sacrum where it becomes the rectum.
- Occupies the rectovesical fossa in the male and the recto-uterine fossa in the female

Rectum

- About 12.5 – 15 cm long.
- Commences in front of the middle piece of the sacrum, at the rectosigmoid junction
- Distinguished from the sigmoid colon by its lack of mobility – it lacks a mesentery.
- Its **upper third** is invested with peritoneum anteriorly and laterally
- its **middle third** is invested with peritoneum anteriorly only
- **Lower third** lies below the forward reflection of peritoneum (on to uterus or bladder as the case may be.
- The lower third follows the line of curvature of the sacrum and ends below the level of the coccyx by becoming continuous with the **anal canal**.

Blood-supply of the large intestine

Hover to show name



inferior mesenteric artery

- **The proximal part** of the large bowel – caecum, appendix, ascending and two-thirds of the transverse colon – is supplied by the **superior mesenteric artery,** the artery of the midgut.
- **The distal part** – left third of transverse colon, descending colon, sigmoid colon and rectum – is supplied by the **inferior mesenteric artery**, the artery of the hindgut.
- Branches of these arteries anastomose to form the **marginal artery of Drummond.**

Lymphatic drainage of the large intestine

Lymph drains successively to the :

- Colic nodes (on the colonic wall)
- Paracolic nodes along the inner margin of the colon)
- Mesocolic nodes (in the mesenteries).

The lymphatics run alongside the arteries and finally join the intestinal lymph trunks which empty into cisterna chyli.

The nerve supply of the large intestine

Parasympathetic:

- The **proximal hal**f of the large intestine, as far as the middle third of the transverse colon, receives its parasympathetic fibres from the **posterior vagal trunk** (it nerve-supply being similar to that of the small intestine.
- The **distal half** receives fibres from the **inferior hypogastric plexus**, derived from the pelvic splanchnic nerves from S2,3 and 4.
- Some of these fibres ascend in the **hypogastric nerves** to reach the inferior mesenteric plexus, while others ascend the parietal peritoneum to reach the colon independently.

Sympathetic:

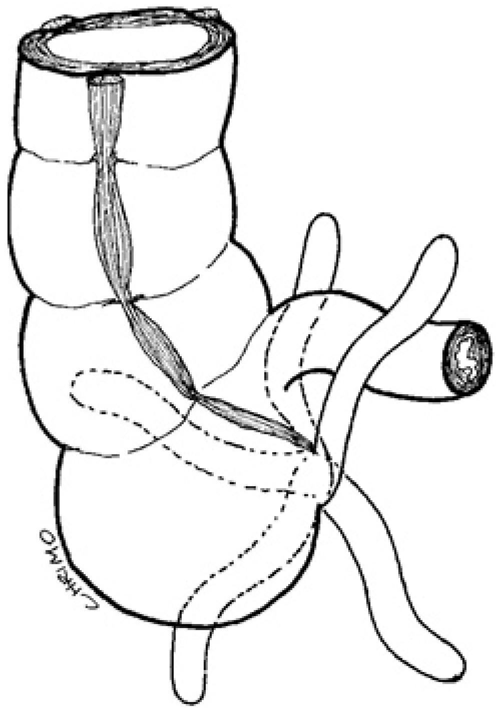
- The larger bowel receives fibres from the **plexus** on its **arteries**
- Derived from the **aortic plexus** the superior and **inferior hypogastric plexuses** and also from **medial** branches of the **sacral** part of the **sympathetic trunks**.
- The preganglionic fibres originate in segments **L1** and **L2.**

The Appendix

Position/location

Usually in the right iliac fossa. Its position varies. Could be on the left side in situs inversus.

- Retrocecal
- Retrocolic
- Subhepatic
- Pelvic



Relations

Posteriorly : psoas major

Medial (post): ureters and iliac vessels

Anteriorly : caecum

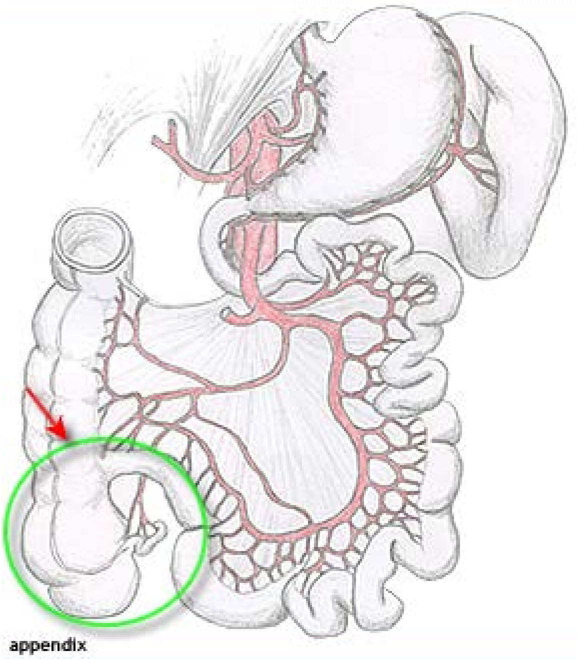
Superiorly : coils of ileum (and ascending colon).

Anteriorly : may be separated from the anterior abdominal wall by intestines.

Peritoneal relations — Surrounded by peritoneum, and has mesoappendix.

blood supply

Appendicular branch of **ileocolic artery** – a branch of the superior mesenteric artery.



The **appendicular tributary** of **ileocolic vein** takes the blood to the superior mesenteric vein.

Lymphatics

Nodes in the mesoappendix – ileocolic artery.

Nerves

Parasympathetic : vagus

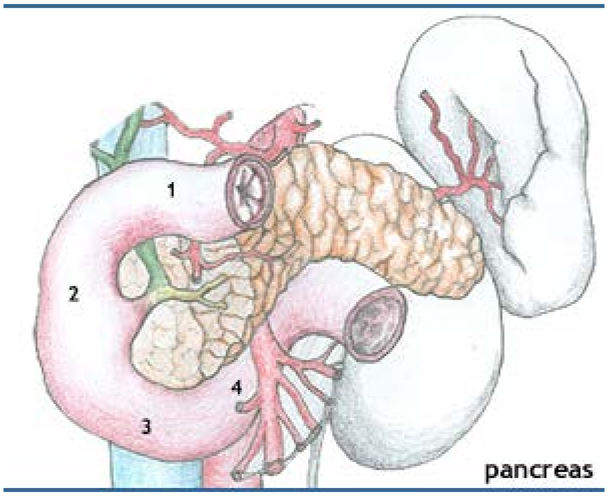
Sympathetic : superior mesenteric plexus

THE PANCREAS

Position

- Pancreas is **retro-peritoneal**
- Extends from the the **epigastric** region to the **left hypochondrium**
- Lies across the posterior abdominal wall along **transpyloric plane** over bodies of L1/ L2
- It runs from the concavity of duodenum to hilum of spleen

Parts



- Head
- Neck
- Body
- Tail

These parts have different relations all important, and are best studied separately.

task ***Name parts 1-4 of the duodenum***

The head :

Lies in curve of the duodenum and anteriorly, is separated from the stomach by the lesser sac.

Posteriorly: it is related to

- Inferior vena cava
- Right renal vessels
- Left renal vessels
- Common bile duct (sometimes embedded)

The head has a prolongation called the uncinate process which lies between the superior mesenteric vessels and the aorta.

Notice, that by virtue of this relationship(s) cancer of head of the pancreas causes

1. Obstruction to the bile duct – obstructive jaudice
2. Obstruction of the IVC – oedema of the lower extremity.

The neck :

Anteriorly covered by peritoneum and related also to the **pylorus of the stomach.**

Posteriorly grooved by **superior mesenteric vessels**. The superior mesenteric vein is joined by the splenic vein posterior to the neck of the pancreas to form the portal vein.

The posterior surface is in contact with

- Aorta
- Superior mesenteric artery
- Let supra renal gland
- Left kidney and its vessels
- Intimately related to the splenic vein

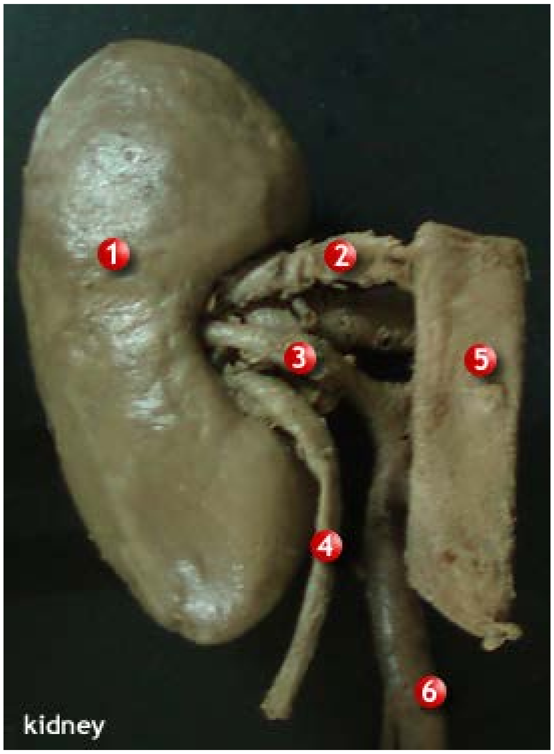
The tail :

- Passes between the two layers of the lienorenal ligament, together with the splenic vessels
- Its tip contacts the hilum of the spleen.

Retroperitoneal organs

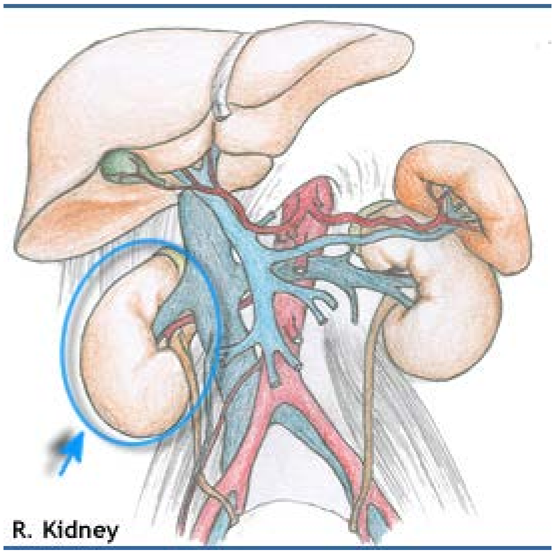
The Kidneys

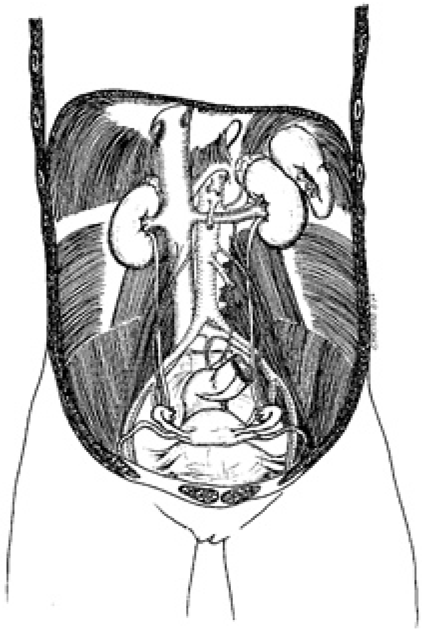
Position



- **Lumbar regions**, in the superior of **paravertebral gutters**.
- From T12 – L3. The right kidney being a little lower (due to liver)
- Lie against psoas major muscle.
- Superior poles are protected by 11 th and 12 th ribs.
- The hila lie along the **transpyloric plane**.

Peritoneal relations





The posterior relations are common

Muscles:

- psoas major
- Transversus abdominis
- quadratus lumborum
- diaphragm

Nerves

- subcostal nerve
- iliohypogastric nerve
- ilioinguinal nerve

Vessels:

- subcostal

Anterior relations vary from left to right

On the left

- left suprarenal
- stomach
- spleen
- pancreas
- jejunum
- descenbding colon

On the right

- liver (from which it is separated by the hepatorenal recess).
- right supra renal
- duodenum
- right colic flexure
- small intestine

Coverings (from inside)

- Fibrous renal capsule
- Perirenal fat (fatty renal capsule) – relatively less anteriorly.
- Fibro areolar tissue called renal fascia. This also encloses the suprarenal
- Pararenal fat – outside the renal fascia.
- The fat supports the kidney, but allows considerable mobility

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Blood supply

Arterial supply

The **renal arteries**, branches of the aorta.

Note that the kidney develops in the pelvis, and “ascends” to lumbar region. The original blood supply is in the pelvis, the caudal vessels degenerates as it acquires vessels from the higher regions. This is the basis for some **“polar” vessels** which may originate from the:

- Internal iliac:
- Common iliac

These polar vessels are important as they must be ligated and cut during nephrectomy, and if they are damaged, may cause infarction of the area they supply.

Note: the artery may divide before the hilum and there may be multiple renal arteries.

Venous Drainage

- The renal veins carry the venous blood.
- The left renal vein is longer since the IVC is more to the right.
- It frequently receives the left gonadal vein.
- The left renal vein may also anastomose with the splenic vein (porto-systemic anastomosis).

Lymphatics

- Lateral aortic nodes.

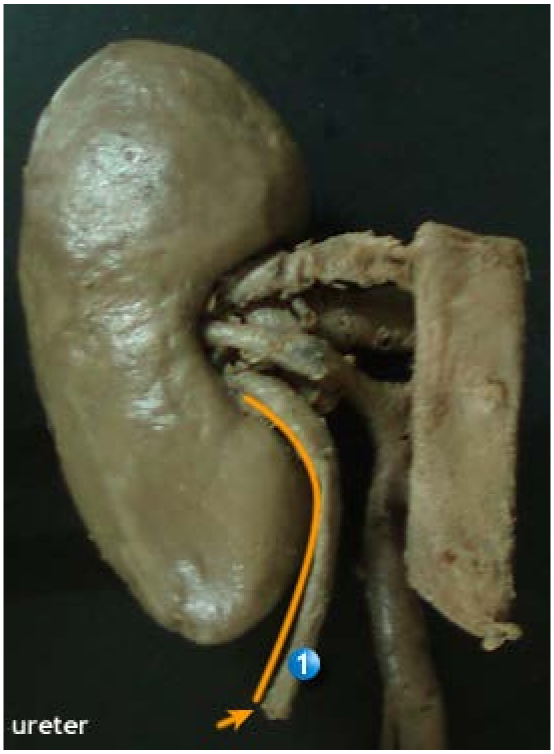
Innervation

- From the renal plexus – lesser and lowest splanchnic and the vagus.

Retroperitoneal organs

The Ureters

Position and Relations



- Run from the pelvis, posterior to the vessels at the level of the transverse process of L2 –L5.
- It is retroperitoneal throughout and has important relations.
- Anterior to psoas major muscles and the common iliac vessels.
- Posterior to the colic vessels and the mesenteric vessels in the mesentery.
- It is first lateral, then medial to the gonadal vessels, all the time posteriorly (the gonadal vessels cross it from medial to lateral, anteriorly)
- The right ureter is in close relationship to the IVC (on the right, the lumbar lymph nodes and the sympathetic trunk.

Blood supply

A longitudinal anastomosis contributed to by branches of

- renal
- aorta
- Common iliac
- Vescical
- Uterine

Others may be

- Gonadal
- Internal iliac
- Mesenteric vessels

The veins correspond.

Lymphatics

Superior part :lateral aortic

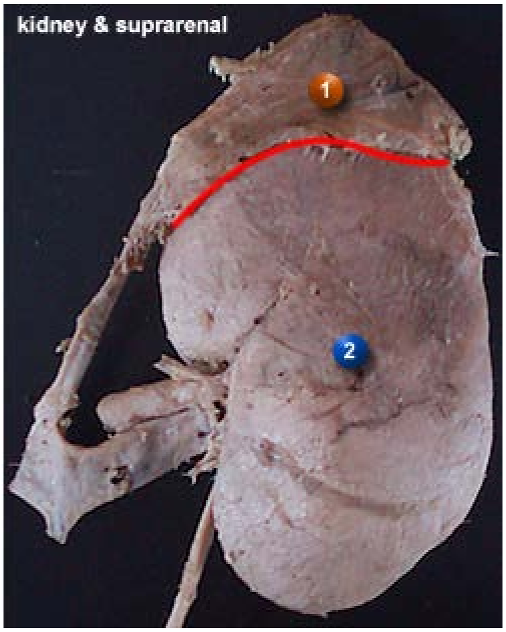
Middle part : common iliac nodes

Inferior part : common, external or internal iliac nodes.

Innervation Same as the kidneys

Retroperitoneal organs

The Suprarenal Glands



Position

- They lie on each side of the vertebral column, against the superomedial surface of the corresponding kidney.
- They are enclosed with the kidney, within the renal fascia.
- A little fat separates it from the superior pole of the kidney.

Relations of the supra-renal gland

	Right Supra-renal gland	Left Supra-renal gland
Inferior	• Right kidney	• Left kidney.
Superior	• Liver	• Spleen
Posterior	• Thoracic diaphragm • Inferior vena cava	• Thoracic diaphragm
Anterior	• Hepatic flexure of the colon	• Stomach • pancreas

Blood supply

3 arteries

- Superior suprarenal from the inferior phrenic
- Middle suprarenal from the aorta
- Inferior suprarenal from the renal artery

1 large central vein

- the right - inferior vena cava
- the left - left renal vein

Innervation

Autonomic from the coeliac plexus – medulla

Cortex has no nerve supply.

Lymphatics

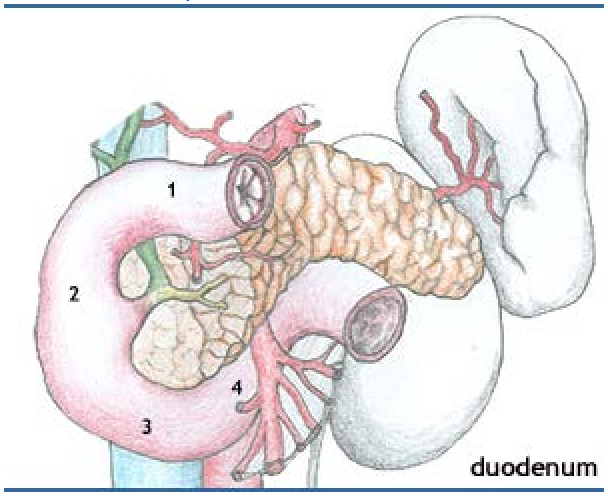
Aortic lymph nodes

A tumor of the suprarenal medulla called **pheochromocytoma** is usually associated with a very rich blood supply. Abdominal aortography is frequently employed as a diagnostic procedure.

Retroperitoneal organs

THE DUODENUM

Location and position



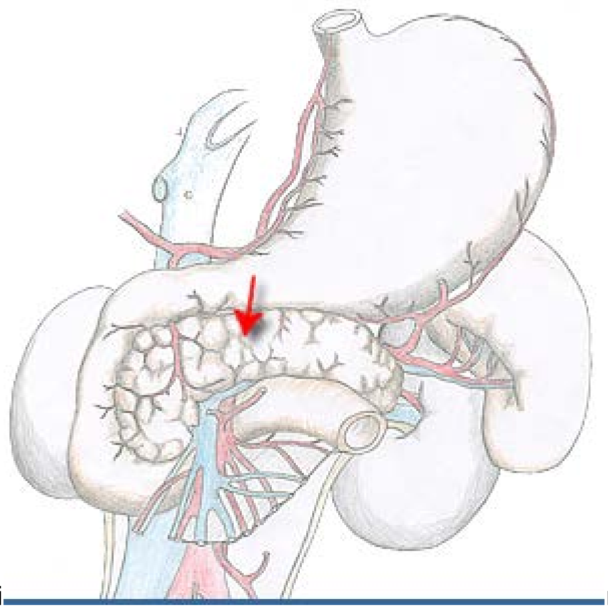
- Epigastric region:
- Extends a little into the right hypochondrium and right lumbar.
- Joins the pylorus of the stomach to the jejunum
- Moulded around the head of the pancreas.
- Mostly retroperitoneal, from L1 –l3.

Parts

- Superior (first part), anteriolateral to the body of L1.
- Descending (second part) to the right of L1, L2 and L3.
- Horizontal (third part) anterior to L3.
- Ascending (fourth part) to the left of the body of L3.

These parts have different relations, mentioned below:

Superior part



Its proximal part has a mesentery. The greater omentum and hepatoduodenal ligament are attached to it - It is free to move.

Relations

Anterior relations	Posterior	Superior	Inferior
• Peritoneum • Gall bladder • Quadrate lobe of the liver	• Bile duct • Portal vein • Inferior vena cava • Gastroduodenal artery	• Neck of gall bladder	• Pancreas

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Descending part :

1. Retroperitoneal
2. Parallel and to the right of inferior vena cava.

Anterior	Posterior	Medial
• Transverse colon • Transverse mesocolon • Some coils of jejunum	• Hilum of right kidney • Renal vessels • Ureter • Psoas major muscle	• Head of pancreas • Pancreatic duct • Bile duct

---

Horizontal part : Retroperitoneal and adherent to the posterior abdominal wall.

Posterior relations:	Superior relations:
• Right psoas major muscle • Inferior vena cava • Aorta • Right ureter •	• Pancreas • Superior mesenteric vessels.

Ascending part :

- Its distal end is covered by peritoneum, and is movable.
- Most of it is retroperitoneal and adherent to the posterior abdominal wall.
- Ascends to the left of the aorta to L2.

Anterior relations	Posterior relations:	Medially:
• Root of mesentery and coils of jejunum.	• Left psoas major muscle • Left margin of aorta.	• Head of pancreas

- At its termination, the ascending part of the duodenum becomes continuous with the jejunum at the duodenojejunal junction.
- The duodenojejunal flexure is supported by a fibro muscular band called the **suspensory ligament** (muscle) of the duodenum.
- This ligament connects the duodenum, and the duodenojejunal flexure to the right crus of the diaphragm close to the esophagus opening.

This structure serves two functions

- supports the duodenojejunal flexure
- widens the angle of the flexure, thereby facilitating movement of its contents.

Peritoneal relations of duodenum

- The initial and terminal parts of the duodenum are covered by peritoneum
- The superior part of the duodenum is attached to the liver by the **hepatoduodenal ligament**.

The rest of the duodenum is **retroperitoneal.**

The **recesses** associated with the duodenojejunal junction include;

- Superior duodenal recess
- Inferior duodenal recess

- Retroduodenal recess
- Paradeudenal recess. .

These recesses are potential sites of internal hernia.

Blood supply

- Dual blood supply.
- **Proximal half**: Gastro- duodenal artery from common hepatic
- **Second half**: Duodenal branches of the superior mesenteric, pancreatico-duodenal branches of the superior mesenteric.
- The veins correspond and drain to the superior mesenteric and portal veins

Lymphatic drainage

- Pancreatico duodenal lymph nodes
- Celiac lymph nodes
- Superior mesenteric nodes

Innervation

- Vagus
- Greater splanchnic through celiac plexus

Retroperitoneal organs

Review questions

1. Describe the position, relations, blood supply of the pancreas. Add notes on the clinical significance of the relations
2. Give an account of the anatomical organization, relations and peritoneal recesses of the duodenum
3. Describe the position and relations of the left kidney
4. Describe the position, relations, blood supply of the right supra renal gland

Blood supply to GIT

BLOOD SUPPLY

Summary of Blood Supply to the GIT

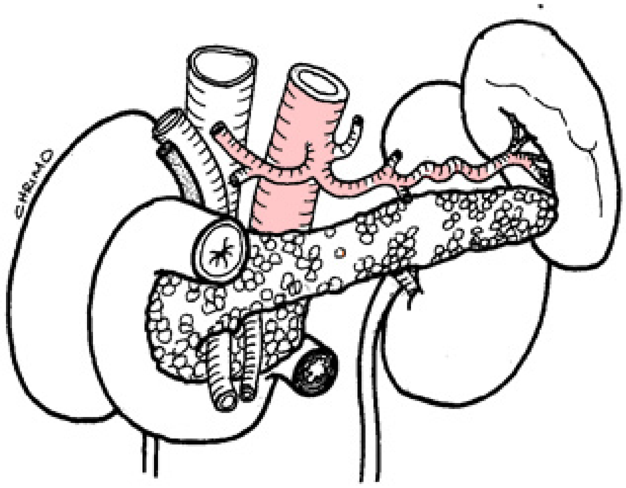
Branch	Level of origin	Embryonic part of the gut supplied	Adult gut supplied
Coeliac Trunk	T12	Foregut	• Esophagus, • Stomach, • Liver • Gall bladder • Proximal duodenum, • Spleen, • Pancreas
Superior Mesenteric	L1	Midgut	• Distal duodenum • Part of pancreas • Jejunum, • ileum; • caecum, • Appendix, • Ascending colon, • Right transverse colon
Inferior mesenteric	L3	Hindgut	• Left transverse colon • Descending colon • Sigmoid colon • Rectum

Hover to show labels

The coeliac trunk

- Artery of the foregut
- Supplies the alimentary canal from the **lower third of the oesophagus** to the **middle of the descending part of the duodenum**
- Also supplies related gut derivatives

(+) Liver
(+) Gall bladder
(+) Pancreas



(+) Spleen.

- It arises opposite the **body** of **L1**, and just below the aorta hiatus.
- It runs forwards for about **1cm**
- **Divides** into **three arteries** to supply the three large organs of the upper abdomen - the liver, stomach and spleen.

Branches of the coeliac trunk

Branch	Course	Branches	Distribution
Left gastric artery	• Runs upwards and slightly to the left towards the caradiac orifice of the stomach • Turns downwards to follow the lesser curvature where it forms an anastomosis with the right gastric artery.	**(+) Esophagel branches**	• Esophagus • Stomach
Common hepatic artery	• Runs to the right, along the upper border of the head of the pancreas, behind the lesser sac • crosses in front of the inferior vena cava in the right gastropancreatic fold. • Passes below the omental foramen • Ascends in the free edge of the lesser omentum, as the hepatic artery proper . • The bile duct lies on its right side and portal vein behind it.	**(+) right gastric** **(+) gastroduodenal** **which gives off.** ***#) superior pancreaticoduodenal*** ***#)* Right gastroepiploic** **(+) Left hepatic** **(+) Cystic artery**	• Stomach • Liver • Gall bladder • Duodenum
	• The third branch of the coeliac	**(+) Left gastro-epiploic artery**	• Spleen

Splenic artery	trunk. • Runs to the left along the upper border of the pancreas, behind the omental bursa. • Often passes under cover of the upper border of the pancreas at certain points in its course. • It is tortuous. • Traced to the left, it runs across the left suprarenal and left kidney. It enters the splenorenal ligament and so reaches the hilus of the spleen.	**(+) Short gastric arteries** **(+) Pancreatic branches**	• Pancreas • Fundus of the stomach • Greater omentum

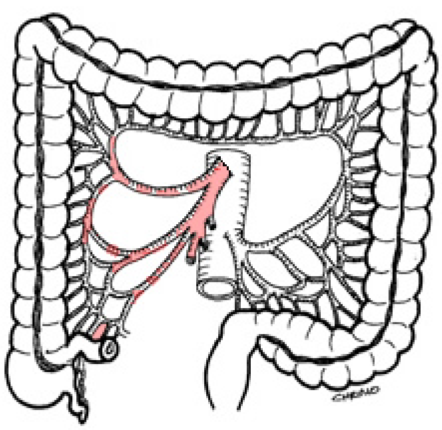
Blo

Applied anatomy

Blood supply to GIT

Hover to show names

Superior mesenteric artery (SMA)



- Found in the root of the mesentery near the midline, just below coeliac trunk.
- Most of its branches arise from its left side.
- The branches to the small intestines are called **jejunal** and **ileal** branches respectively.
- There are anastomotic arcades between adjacent branches
- These form secondary, tertiary and in the more distal parts even quaternary **arcades.**
- **Vasa recta** which arise from the peripheral row of arcades and pass alternatively to either side of the bowel.
- The SMA anastomoses with its ileocoloc branch on its right.
- The ileocolic artery runs towards the ileocolic angle and divides into **ascending** and **descending branches**.
- It gives the **appendidular** artery, to the appendix.

Other branches of the SMA

Right colic artery

- Runs horizontally to the right
- Divides ascending and descending branches

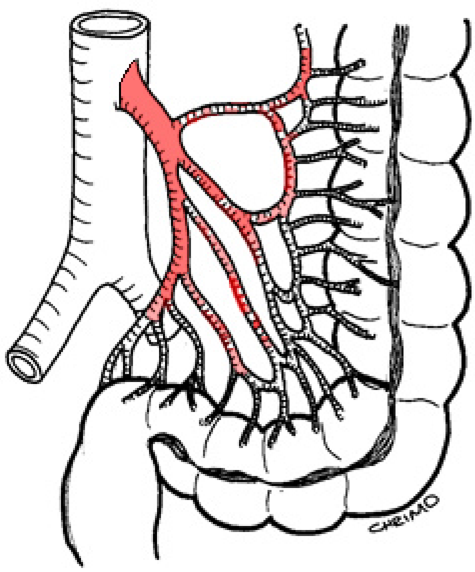
Middle colic artery

- Arises from the right side of the superior mesenteric
- It gives off the most proximal branch, the inferior pancreatic coduodenal artery .
- Enters the root of the transverse mesocolon.
- Descends in the mesocolon to the upper border of the transverse colon, where it divides into right and left branches.

Note that the superior mesenteric artery is the **artery of the midgut**. The midgut extends from the **greater duodenal papilla** (where the bile duct enters) to the **transverse colon near the left colic flexure**.

Inferior mesenteric artery

Hover to show names



- The inferior mesenteric artery is the artery of the **hindgut**
- Supplies the bowel from the **left third of the transverse colon** to the **upper part of the anal canal**.

Course and Relations

- It arises from the front of the aorta at the level of the body of L3 (the **subcostal plane**).
- It appears from under the **horizontal** part of the **duodenum**
- It descends obliquely to the left, towards the middle of the left common iliac artery.
- From the middle of the left common iliac artery, the inferior mesenteric artery descends in front of the **left sympathetic trunk** and **psoas major**
- It enters the apex of the **sigmoid mesocolon** as the s**uperior rectal artery**.
- The inferior mesenteric vein lies on its left side

Branches and Distribution

- The branches of the inferior mesenteric artery come off its left side.
- They form an anastomotic trunk alongside the colon- marginal artery (of **Drummond**) that extends from the **ileocaecal junction** to the distal end of the **sigmoid colon**.
- The anastomosis between the left colic (of the inferior mesenteric) is usually a good one.

Branches of inferior mesenteric artery

Left colic artery

- Arises 2.5-5 cm below the upper end of the trunk
- It may lie superficial or deep to the inferior mesenteric vein.
- Near the descending colon, it divides into ascending and descending branches, which take part in the

formation of the marginal artery.

The ascending branch

- Ascends to anastomose with the left branch of the middle colic artery.
- The descending branch anastomoses with the ascending branch of the highest sigmoid artery.

Sigmoid arteries

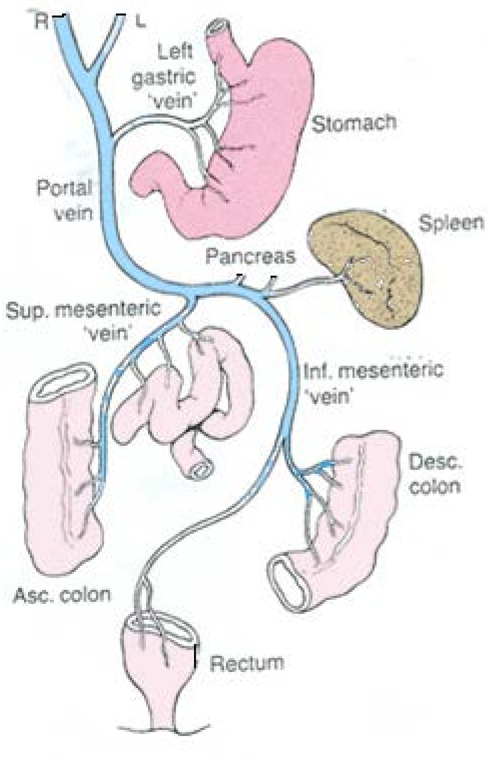
- Two or three in number
- Descend obliquely to the left.
- Each divides into ascending and descending branches which contribute to the marginal artery,
- The descending branch anastomoses with the superior rectal artery.

superior rectal artery

- Pelvic continuation of the inferior mesenteric artery below the middle of the left common iliac artery.
- curves medially in the sigmoid mesocolon and, reaching the upper end of the rectum
- Divides into right and left branches. The right branch divides into anterior and posterior branches.

Blood supply and lymphatic drainage of Gastro intestinal system

Venous Drainage of the GIT



The portal circulation.

The branches of the arteries correspond to the tributaries of the veins.

The **main tributaries to the portal vein**

- Splenic vein;
- Superior mesenteric vein
- Inferior mesenteric vein
- Left gastric vein
- Right gastric vein

OGanatomy

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Blood supply to GIT

Learning points | Core anatomy | Applied anatomy | Review questions

Review questions

Posterior abdominal wall and diaphragm

Diaphragm

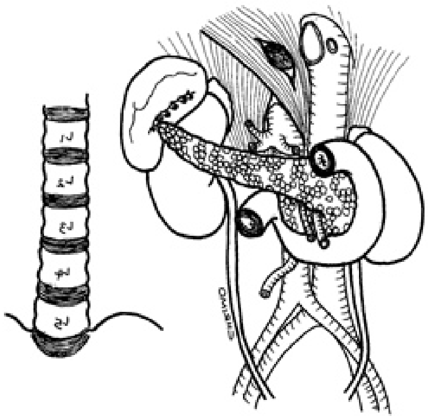
Origins

(A) Three distinct origins – lumbar, costal and sternal

Lumbar Attachments	Coastal Attachments	Sternal Attachments	Central Attachment
• Bodies of L1-L3 : **Crura** • **Median arcuate ligament** opposite the **discs T12 & L1** infront of aorta. • **Medial** and **lateral arcuate ligaments**: Fascial thickenings over the upper parts of the **psoas major** and **quadratus lamborum** respectively.	• Lower **six costal cartilages**, interdigitating with transversuss abdominis.	• Back of the **xiphoid process**.	• Lower surface of the **fibrous pericardium**.

Orifices related to the diaphragm

Hiatus	Vertebral Level	Contents
Aortic hiatus (1)	T12.	**(+) Aorta** **(+) Thoracic duct** **(+) Azygous vein** **(+) Two intercostal lymph trunks.**
Oesophageal hiatus (2)	T10	**(+) Esophagus** **(+) Anterior and posterior vagal trunks** **(+) Esophageal branches of the left gastric vessels.**



Foramen for the inferior vena cava (3)	T8	(+) Inferior vena cava (+) Branches of the right phrenic nerve (+) Few lymphatics from the liver to the mediastinal nodes.

Posterior abdominal wall and diaphragm

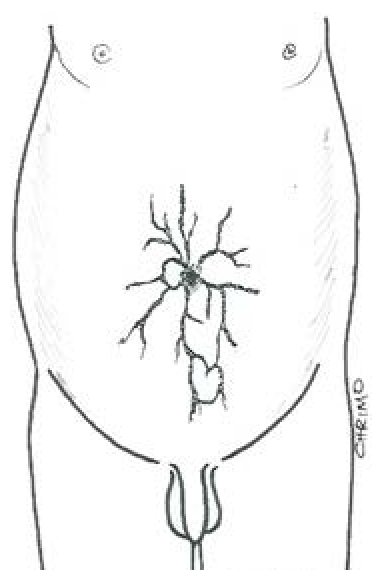
Applied anatomy

Rupture of the abdominal aorta can occur in **abdominal trauma**. This presents with **massive hemo peritoneum** usually severe enough to cause death.

Infra renal segment of the aorta is the commonest site of **aortic aneurysms.** These can present with:

- Pulsatile abdominal mass
- Abdominal pain radiating to the groin
- Tender abdominal mass
- Parietal GIT obstruction
- Limb ischaemia
- GIT bleeding.

Portal hypertension -portal venous pressure above 20 cm H2O



Caput medussae

A) May be caused by:

- Suprahepatic causes e.g. heart failure
- Intrahepatic causes e.g. cirrhosis
- Infrahepatic causes e.g. portal vein thrombosis or tumor compression of the portal vein

B) Commonly results in:

- **Esophageal varices**
- **Caput medussae** around umbilicus
- **Rectal piles** of haemorrhoids around anal canal
- **Esophageal varices** in the lower esophagus

Retroperitoneal organs

Review Questions

Abdominal Aorta

Extents

- From: Lower border of **body** of **T12**
- To: Lower part of the **body** of **L4** in the **intercristal plane**

Relations: Sorrounded by aortic plexus

Anterior	Posterior	Laterally
• Coeliac plexus • Body of pancreas • Splenic vein • Left renal vein • Unicinate process of the pancreas • Horizontal part of duodenum Right side • Inferior vena cava below • Crus of the diaphragm above level of renal vein	• Bodies of L1 and L2 • Cisterna chylii • Azygous vein	• Lumbar lymph nodes

Branches: Unpaired and Paired

Unpaired	Distribution
Coeliac trunk	Visceral- fore gut derivatives
Superior mesenteric	Visceral – mid gut derivatives
Inferior mesenteric	Visceral – hind gut derivatives
Median sacral	Visceral – rectum Parietal – sacrum

Paired	Distribution
Inferior Phrenic	Visceral- supra renal and esophagus Pariteal- thoracic diaphragm
4 lumbar	Parietal- posterior abdominal wall
Middle supra renal	Visceral – supra renal gland
Renal	Visceral- kidneys and supra renal
Gonadal	Visceral – testis and ovary
Common iliac	Visceral – pelvic viscera Parietal – pelvic walls

Posterior abdominal wall and diaphragm

Inferior vena cava

Formation

Union of common iliac veins

Extents

From: Lower border of **L4** in the inter tubercular plane
To: **T7**

Termination: Right atrium

Course and relations

- On the right- psoas major
- To the right of the abdominal aorta
- May groove or tunnel liver
- Traverses IVC hiatus of diaphragm
- Pierces fibrous pericardium

Anterior relations	Posterior relations
• Horizontal part of duodenum • Head of pancereas • Epiploic foramen • Right and caudate lobes of the liver	• Right sympathetic trunk • Right lower lumbar arteries • Right renal artery • Right crus of diaphragm

Tributaries

- Mainly correspond to the branches of the abdominal aorta

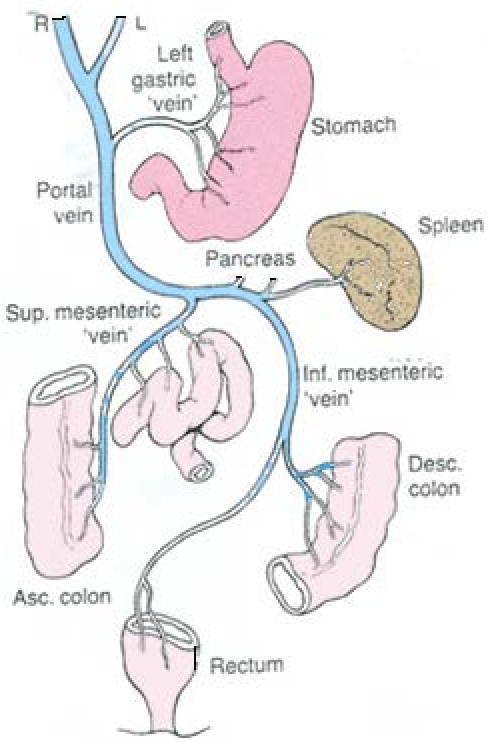
Note: Left and right and occasionally middle hepatic vein

Territory of drainage

- The body below the thoracic diaphragm

Posterior abdominal wall and diaphragm

The Portal vein



The portal circulation.

Formation:

Union of superior mesenteric and splenic veins

Course and relations

Formed behind the neck of pancreas

Anteriorly	Posteriorly
• Neck of pancreas • Superior part of duodenum • Hepatic artery • Common bile duct	• Inferior vena cava • Omental foramen

Tributaries and Territory of drainage

Tributaries	Territory of drainage
• Splenic vein • Superior mesenteric vein • Left gastric vein • Right gastric vein • Cystic veins • Para umbilical veins	• All GIT **except:** (+) Lower part of the anal canal (+) Pancreas (+) Gall bladder (+) Spleen

Posterior abdominal wall and diaphragm

Sites of porto caval anastomosis

Site	Veins
Lower esophagus	Esophageal tributaries of left gastric vein Esophageal tributaries of azygous vein
Anal canal	Superior rectal vein- inferior mesenteric vein Middle and inferior rectal veins- internal iliac and pudendal veins
Pelvis	Rectal venous plexus communicates with • Vesical plexus • Prostatic plexus • Uterine plexus • Vaginal plexus
Umbilicus	Epigastric veins and left branch of portal vein along ligamentum teres
Bare area of liver	Hepatic venules and veins of diaphragm and thorax
Intestine and spleen	Colic and splenic twigs communicate with renal and lumbar veins

Posterior abdominal wall and diaphragm

Cisterna chyli

Expanded lower end of thoracic duct

Position and relations

- Medial and posterior to the right crus of the diaphragm
- Right side of the front of bodies of L1 and L2
- Between aorta and azygous veins
- Infront of upper two right lumbar arteries

Tributaries	Territory
Lumbar lymph trunks	• Lower limbs • Pelvic and abdominal walls • Viscera except digestive organs and spleen
Intestinal lymph trunks	• Digestive organs • spleen via celiac and mesenteric nodes
Descending intercostals lymph trunks	• Thoracic walls.

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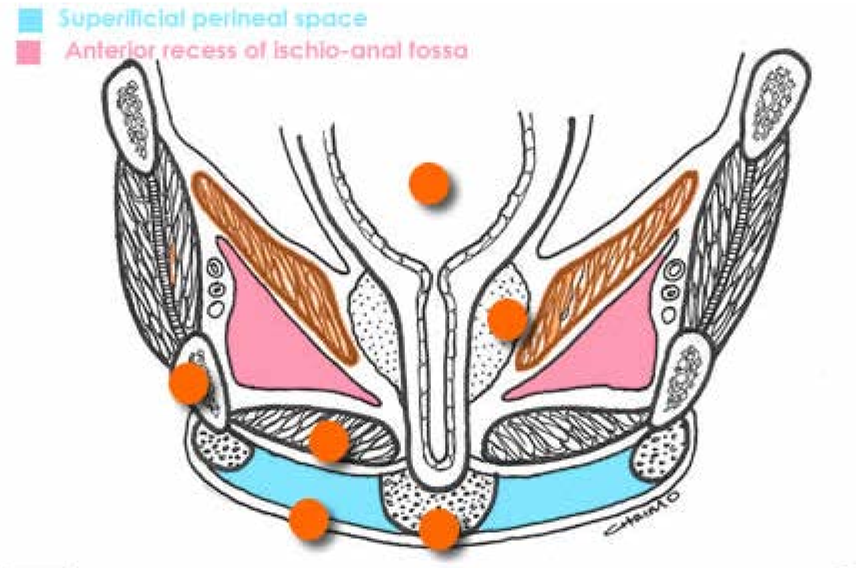
Learning points | Core anatomy | Applied anatomy | Review questions

Perineal fascia and pouches

Superficial perineal space

Hover to show names

Boundaries

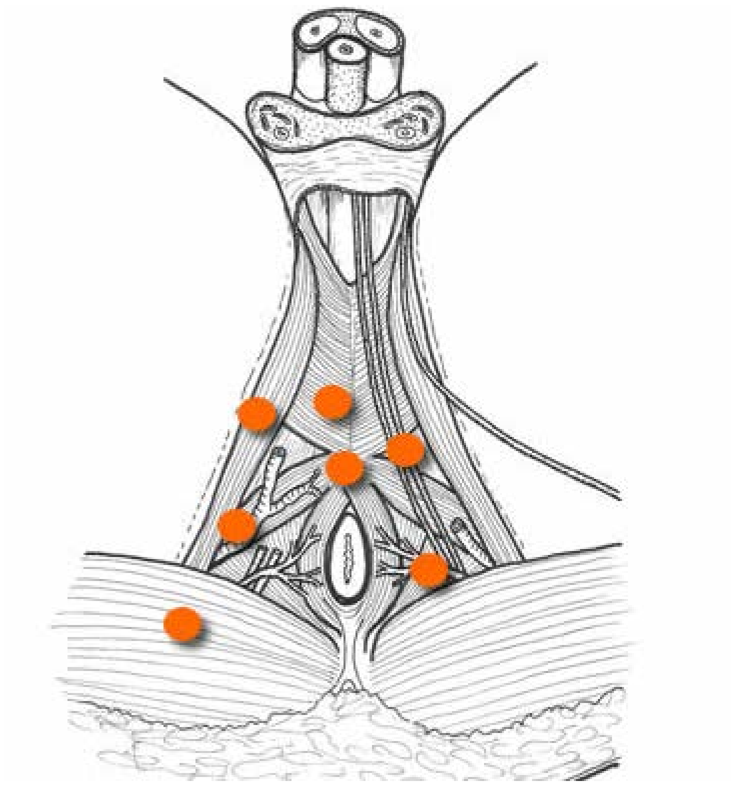


- Superficial perineal fascia inferiorly
- Inferior fascia of the urogenital diaphragm superiorly.

Hover to show names

Contents

- Root of the penis
- Muscles of the penis – the bulbospongiosus and ischiocavernosus
- Spongy urethra
- Branches of the internal pudendal vessels, and pudendal nerve.
-
- Superficial transverse perinea muscles



Deep perineal space

Boundaries

Encloses by superior and inferior fasciae of the urogenital diaphragm

Contents

- Sphincter urethrae
- Deep transverse perineal muscles
- Bulbo urethral glands
- Membranous urethra
- Internal pudendal vessels and branches of the pudendal nerve

Applied anatomy

Damage to the pelvic diaphragm

May be caused by

- Damage during un assisted delivery
- Episiotomy
- Nerve damage/ nerve injury

Weakens support for pelvic viscera.These viscera may herniate out e.g.

- **Cystocele**; herniation of the urinary bladder
- **Cystourethrocele**; herniation of the urinary bladder and urethra
- **Rectocele**; herniation of the rectum
- **Uterine prolapse**; herniation of the uterus

When mild: the support of the urethra and ano-rectum is impaired even though the organs **may not herniated.**

This results in **stress incontinence** of both urine and stool, more for the urine, whenever the intra abdominal pressure is raised .e.g. during coughing or sneezing.

Ischio anal abscess

A collection of pus in the fossa due to infection

Infection may reach this fossa

1. Following infection in the anus
2. From extension of a pelvi-rectal abscess
3. Following a tear in the anal mucosal membrane
4. From a penetrating wound in the anal region.

Are **best managed** by **surgical incision** and **drainage**. If this is not done, the abscess may spontaneously open into;

- Anal canal
- Rectum

- Skin in the perineum
- Spread to opposite side

Pundendal block anaesthesia.

- Pundendal blocks are done to **relieve pain** in the **perineum**, e.g. during **labor** and especially when an **episiotomy** is required.
- A local anaesthetic agent is injected into the tissues surrounding the **pundendal nerve** in the **pundendal canal**.
- The injection is usually made where the nerve crosses the **lateral aspect** of the **sacrospinous ligament** near its attachment to the **ischial spine**, which is good landmark.

Review Questions

1. Describe the formation and contents of :

a) Deep perineal space / pouch

b) Superficial perineal pouch/ space

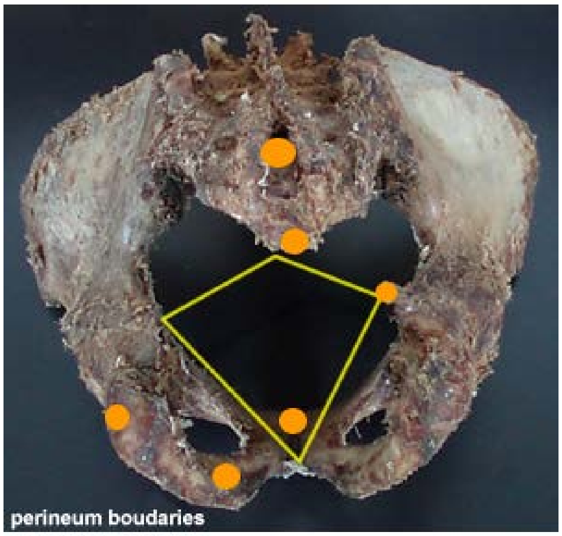
2.Name the structure attached to the central tendon of the perineum and state its obstetric importance

3. State the boundaries, contents and clinical significance of the ischio-anal fossa.

SUMMARY OF THE ORGANIZATION OF THE PERINEUM

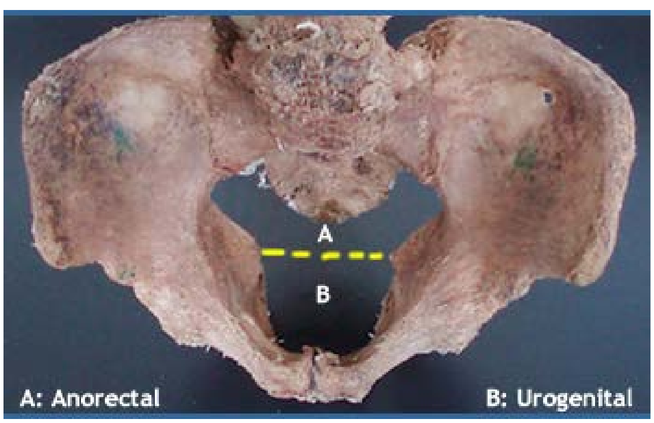
Boundaries

Hover to show names



1. The Pubic Symphsis
2. The Inferior pubic rami
3. The Ischial rami
4. The Ischial tuberosities
5. Sacrotuberous ligaments
6. The coccyx

Divisions



The line joining the two ischial tuberosities divides the perineum into two triangular parts

- The **anal triangle (A)**

  Posterior to this line
  contains the anus

- The **urogenital region (B)** ,

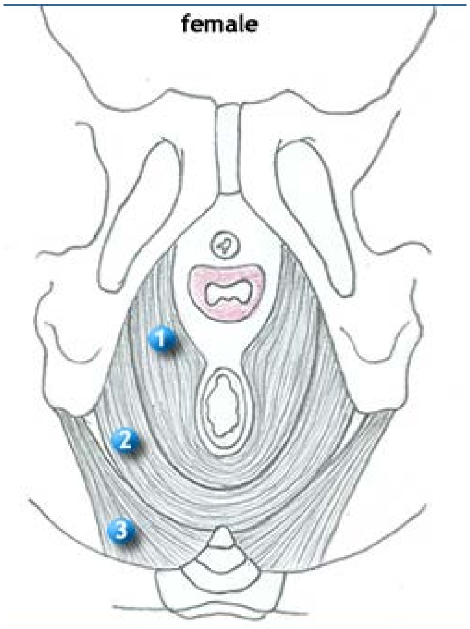
  Anterior to this line
  Contains the scrotum
  Root of the penis (or the vulva in the female)

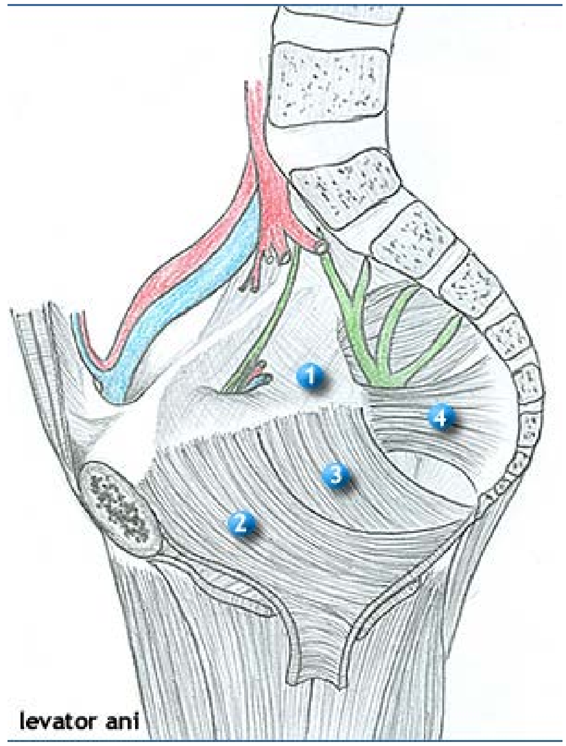
The Pelvic Diaphragm

Components

- Lavetor ani
- Coccygeous muscles

Levator Ani





Attachments of the lavetor ani

Origins

- The pelvic surface of the body of the pubis
- Tendinous arch, formed by a thickening of the parietal pelvic fascia over the obturator internus muscle.
- Ischial spine

Insertions

- Central perineal tendon
- The wall of the anal canal
- Anococcygeal ligament
- Coccyx

Parts of Levator Ani

Pubococcygeous	Puborectalis	Lavetor prostatae
The main part. - Arises from the pubis - Inserts into the coccyx, and the Anococcygeal ligament. It is located between the anal canal and the tip of the coccyx encircles the: a) Urethra b) Vagina c) Anus	- Part that loops around the anorectal junction - Arises from the pubis.	- Anterior fibres that run inferior to the prostate. - In the females, these fibres constitute the pubo vaginalis.

- Merges into the central perineal tendon.

Functions of the lavetor ani

- Constitutes the pelvic floor for the containment/**support of the pelvic viscera** – resisting inferior thrust during e.g. coughing, deep expiration e.t.c.
- They **raise the pelvic floor**, assisting the anterior abdominal wall muscles in compressing the viscera e.g. in coughing, deep expiration, vomiting, urinating
- Support of the prostate and the vagina providing **sphincteric action** sto the latter, and urethra
- The puborectalis holds the anorectal junction anteriorly, **increasing angulation** between the rectum, and anal canal. This **prevents passage of feces** from the **rectum** into the anal canal when defecation is not desired, or is inconvenient.
- The gutter arrangement **facilitates the rotation of the baby's head** during **parturition**, in accordance with the pelvic diameters.
- **Supports the fetal head** (while cervix is dilating during parturition)

The coccygeus:

- Continuous with the iliococcygeous muscle
- Forms the posterior and smaller part of the pelvic diaphragm.
- Arises from the pelvic surface of the ischial spine and sacrospinous ligament
- Inserts on the lateral margins of the 5th sacral vertebra and coccyx.
- The fibres support the coccyx, and pull it anteriorly, after it has been pressed posteriorly during child-birth

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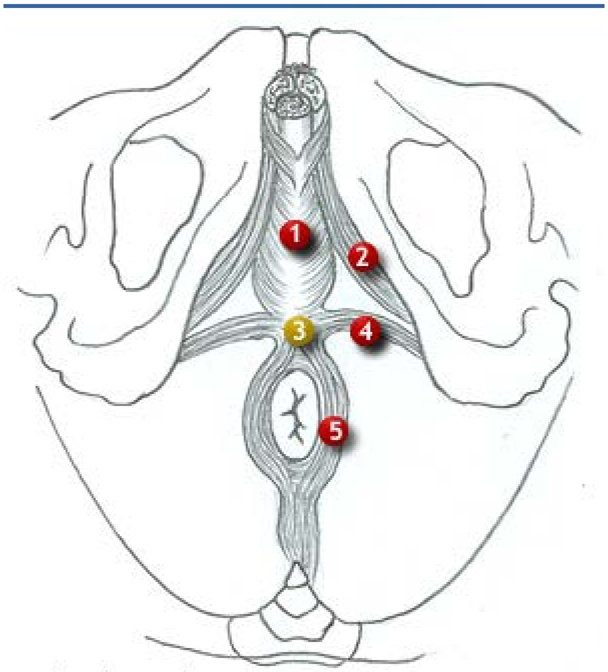
Structures piercing the pelvic diaphragm

- Anus
- Urethra
- Vagina (in females

Central tendon of perineum

Hover to show names



perineal muscles

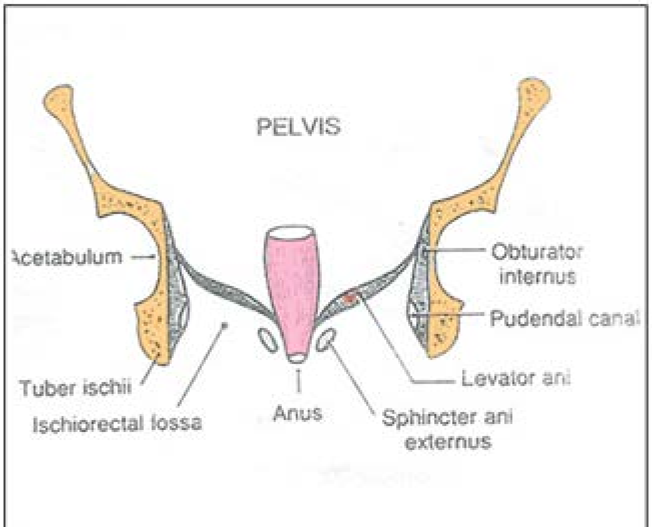
A fibrous septum which extends from the posterior labial comissure/scrotal raphe to the anal region

Attached structures

- Lavetor ani
- External anal sphincter
- Deep and superficial transverse perinea muscles
- Bulbospongiosus
- It is crucial to the **integrity of the perineum** – both pelvic and urogenital diaphragm
- Its damage impairs this integrity with the effects similar to those following damage to the pelvic diaphragm
- It can be badly torn during un-aided parturition
- Care must be taken not to cut it or else it must be repaired securely.

Ischio anal fossa

Boundaries



Ischioanal fossa

- **Laterally** -The ischium, and inferior part of the obturator internus.
- **Medially** – Rectum, and the anal canal, with their associated lavetor ani and sphincter ani muscle.
- **Posteriorly**- Sacrotuberous ligament and the overlying gluteus maximus muscle.
- **Anteriorly**-Base of the urogenital diaphragm
- **Inferiorly**- Skin and deep fascia of the perineum
- **Apex** – Between obturator fascia and lavetor ani

Contents

- **Ischiorectal pad of fat**

  (+) Transversed by many tough fibrous bands of septa.

  (+) This pad of fat supports the anal canal
  It is readily displaced to allow feces to pass.

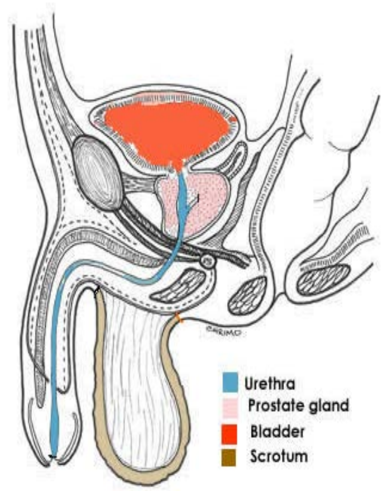
- Internal pudendal vessels, and pudendal nerve
- Inferior rectal vessels and nerves
- Perforating branches of S2 and S3
- Perineal branch of S4

Male external genitalia

Hover to show name

Scrotum

- A cutaneous outpouching of the skin of the abdomen
- contains the testis



The skin

- Thin, dark colored, and rugose
- The scrotal raphe indicates the bilateral origin of the scrotum (from the labioscrotal swellings)

Superficial fascia

- Devoid of fat
- Contains smooth muscle called **dartos muscle**, which helps regulate temperature
- It is **continuous anteriorly** with the **membranou**s layer of **superficial fascia** of the anterior abdominal wall

Coverings of the testis

Coverings of the testis are continuous with the coverings of the spermatic cord

- The external spermatic fascia – external oblique aponeurosis
- Cremaster muscle and cremasteric fascia – internal oblique aponeurosis
- Internal spermatic fascia – transversalis fascia
- Tunica vaginalis – peritoneum (processus vaginalis), visceral and parietal.

Blood supply of the scrotum:

- Scrotal branch of the internal pudendal artery
- External pudendal branches of the femoral artery
- Cremasteric branch of the inferior epigastric artery

Nerve supply of the scrotum

- Genital branch of the genitofemoral nerve; sensory to the anterior and lateral surfaces of the scrotum.
- Ilioinguinal nerve; sensory to the anterior surface
- Perineal branch of the pudendal nerve – posterior surface
- Perineal branch of the posterior femoral cutaneous – inferior surface

Lymphatics of the scrotum

1. Superficial inguinal lymph nodes
2. Deep external iliac or the lumbar nodes

Applied anatomy

Scrotum

- **Hydrocele** – This is the presence of excess fluid in the processus vaginalis after birth. Infants may accumulate fluid in the cavity of the tunica vaginalis testis. This is called **non-communicating hydrocele**. This fluid usually absorbs during the first year.

- If the **processus vaginalis** remains patent, peritoneal fluid fluid may be forced into it, forming a communicating hydrocele. This is often associated with **indirect inguinal hernia.**

- The proximal and distal ends of the stalk of the processus vaginalis may obliterate, leaving an intermediate cystic area called a hydrocele of the cord.

- There are several other conditions that can cause hydrocele e.g. trauma, filarial worm infections .e.t.c.

Testis, spermatic cord and testis

Varicocele

- Varicosity of the **Pampiniform plexus**.

- More common on the left side, and often results from defective valves in the testicular vein. They may temporarily disappear when the person lies down and the scrotum is elevated.
- Rarely, a Varicocele may result from blockage of the renal vein owing to a tumor in the left kidney.

Hematocele of testis

- Collection of blood in the cavity of the tunica vaginalis, often due to trauma.

The difference in **lymphatic drainage** of the **testis** and **scrotum** is important; Cells from a testicular tumor may spread through lymphatics to the lumbar lymph nodes; those from the scrotum to the superficial inguinal nodes.

Vasectomy is a contraceptive procedure in which the vas deferens is ligated and cut, so that sperms can no longer pass into the urethra.

Review Questions

1. Describe the organization, blood supply, lymphatic drainage and innervation of the scrotum
2. Describe the anatomical organization, blood supply, lymphatic drainage and innervation of penis. Add notes on penile tumescence and detumescence
3. Describe the anatomical organization of the female vulva including details of blood supply, innervation and lymphatic drainage

The penis

Male organ of copulation, which serves as the common outlet for urine and semen

Organization

Hover to show names

Consists of three cylindrical bodies of cavernous tissue.

- **Corpus spongiosum penis**

  (+) Ventral
  (+) Containing the urethra
  (+) Distal end dilates into the glans of the penis, which has the urethral opening.

- **Corpus Cavernosum**

  (+) Two bodies

  (+) Arranged side by side, in the dorsal part of the organ.

  (+) Enclosed in a dense white fibrous tissue called the tunica albuginea.

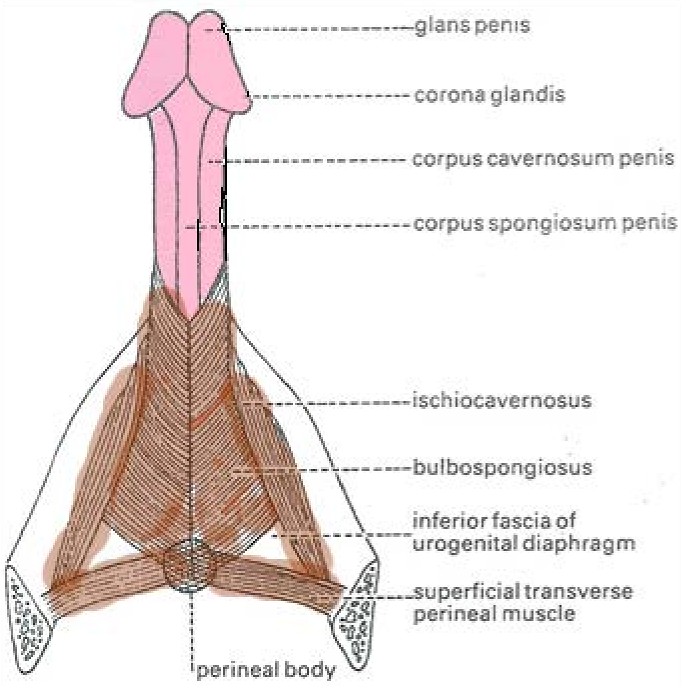
Superficial to the **tunica albuginea** is the **deep fascia of the penis**, which forms a common covering for all the three bodies.

The skin is thin, dark and loose.

The **prepuce** covers the glans penis

Parts and surfaces

- There are two surfaces – the dorsal surface which faces posterosuperiorly when the penis is erect, and



—Superficial muscles of male urogenital triangle

anteriorly, when the penis is flaccid.

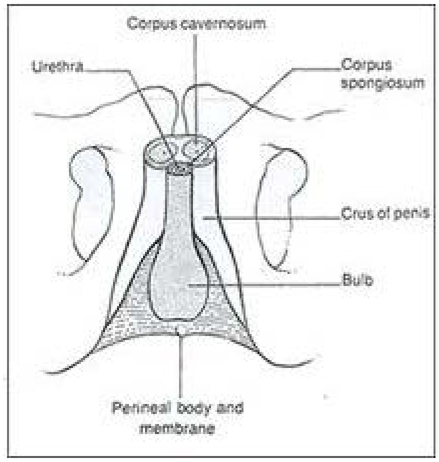
- This surface is continuous with the anterior abdominal wall.
- The opposite surface, continuous with the scrotum is the ventral or urethral surface.

The **root of the penis**

The attached part.
Consists of:

(+) Two crura of the penis
(+) Bulb
(+) Associated muscles with them.

The bulb, located between the crura, is penetrated by the urethra posteriorly.



1. The **body of the penis**

   Free part of the penis
   consists of the corpora cavernosa and corpus spongiosum.

The prominent margin of the **glans penis** is called the **corona of the glans**. The corona of the glans overhangs the neck of the penis.

Penile support

- **Fundiform ligament**

  (+) Arises from the inferior part of the linear alba

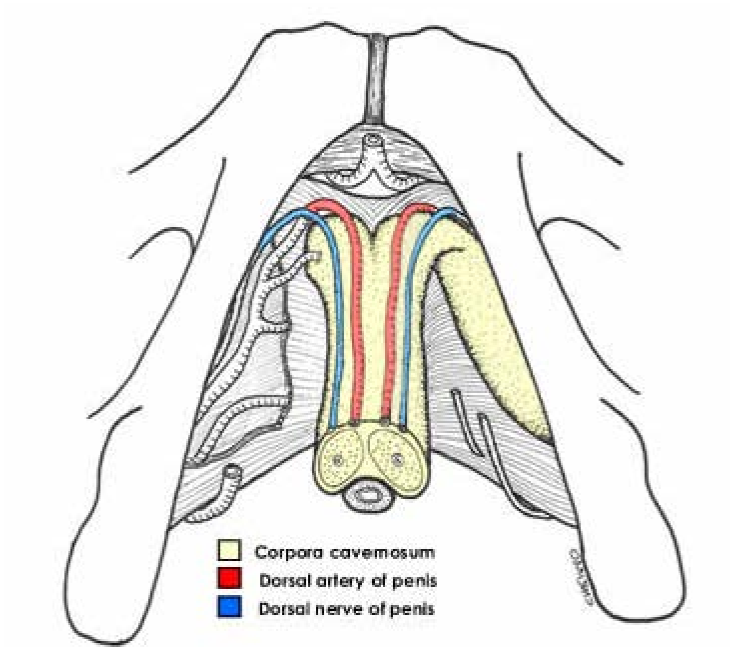
  (+) Splits into two parts which pass on each side of the penis.

- The **suspensory ligament**

  (+) A condensation of the superficial fascia, arising from the anterior surface of the sypmphisis pubis, and passes inferiorly splitting to attach to the deep fascia of the penis.

Arteries to the penis

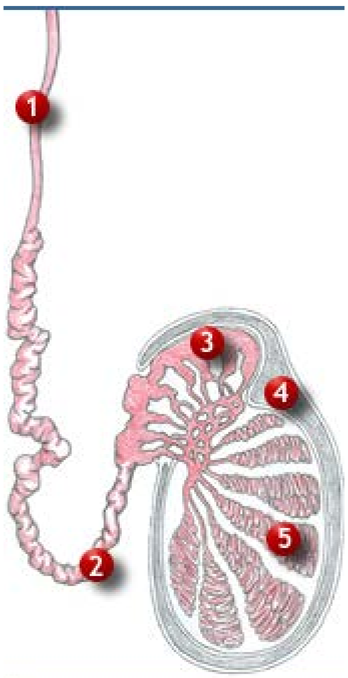
- Dorsal arteries
- Deep arteries



Nerves of the penis

- Autonomic nerves, on vessels plexuses from the hypogastric plexuses.
- Dorsal nerve of the penis from the pudendal nerve

Testis & Epididymis



Hover to show name

Testis

- **Produce spermatozoa**
- **suspended in the scrotum by the spermatic cords**
- **Covered by the tunica vaginalis except where it is attached to the epididymis.**

The epididymis

- **A coma-shaped structure**
- **Applied to the superior and postero-lateral surfaces of the testis**
- **Consists of a head, a body, and a tail.**
- **The tail is continuous with the ductus deferens.**

Blood supply to the testis

1. Testicular artery, a branch of the aorta at about L2
2. Other sources are minor and include the scrotal vessels, contributions from the artery to the vas deferens and cremasteric artery.

The veins correspond. The testicular vein is formed from the pampini form plexus

Lymphatics of the testis

- These mainly go to the lumbar lymph nodes.
- A very small percentage may go to the inguinal and iliac nodes

The spermatic cord

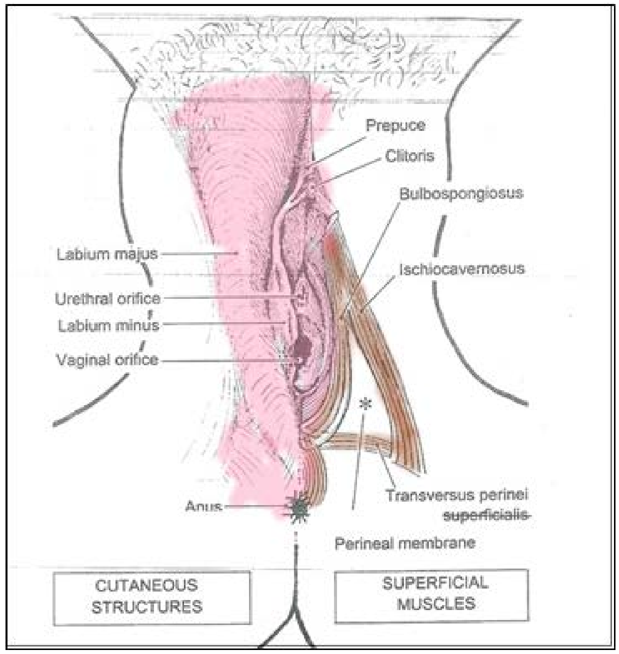
- Passes through the inguinal canal
- Emerges at the superficial inguinal ring to descend into the scrotum.

Review the spermatic cord under the inguinal triangle

Female external genitalia

These comprise:

- Mons pubis
- Labia majora
- Labia minora
- Vestibule of the vagina
- Clitoris
- Bulb of the vestibule
- Greater vestibular glands



Mons pubis

- Rounded median elevation infront of pubic symphysis.
- Accumulation of fat
- Coarse hair covers the skin over it after puberty.

Labia Majora

- Two elongated folds which run downward and backward from the mons pubis
- Eclose between them the median pudendal cleft
- Outer aspects covered by skin with many sebaceous glands
- Coarse hair covers the skin after puberty.
- The inner aspects are smooth and hairless
- Subcutaneous tissue consists mostly of fat.
- It is continous behind with the subcutaneous tissue of the urogenital region and in front with that of the mons pubis.
- They contain:

  a) Terminations of the round ligaments,
  b) Some bundles of smooth muscle fibres
  c) Nerves
  d) Blood and lymphatic vessels.
  e) Homologous with the scrotum of the male.

Labia minora

- Two small folds of skin between the labia majora at either side of the opening of the vagina.
- Join the medial aspects of the labia majora
- In the virgin they are connected with each other by a transverse fold called the frenulum of the labia or fourchette.
- They are devoid of fat
- Skin covering them is smooth, moist and pink.
- Are hidden by labia majora except in children and in women in menopause.

Vestibule

External urethral orifice

Vaginal orifice

- Larger than the urethral orifice.

• Cleft between the labia minora • Contain openings of : 1. Vagina 2. Urethra 3. Ducts of greater vestibular glands	• Situated behind the clitoris immediately infront of the vaginal orifice. • Usually a median cleft, the margins slightly averted.	• Size and appearance depend on the size of the hymen. • The two ducts of the greater vestibular glands open on each side of the vaginal orifice between it and the labia minora. • Smaller openings for the lesser vestibular glands are in the vestibule between the urethral and vaginal openings.

Crura	Corpora cavernosa	Glans clitoris
• Most of it is hidden by labia minora • Arises from the body of pelvis by two crura. • Near the lower margin of the pubic symphysis the crura turn downwards.	• The corpora carvenosa which together form the body of clitoris. • Are enclosed by the densely fibrous envelope and are separated from each other by an incomplete septum.	• Glans of the clitoris is the small rounded elevation on the free end of the body. • Also consists of erectile tissue and is highly sensitive. • Suspensory ligament of the clitoris connects it to the front of the pubic symphysis.

Bulb of vestibule	Clitoris	Greater vestibular glands
• Paired elongated masses of erectile tissue which lie at the sides of the vaginal openings under cover of bulbospongiosus muscle. • Broad behind but very narrow infront • Unite with each other anteriorly to form a thin strand which passes along the lower surface of the body of the clitoris to the glans	• Consists mainly of erectile tissue • Capable of enlargement as a result of engorgement with blood • Not traversed by urethra • Located behind the anterior commissure of the labia majora	• Two small rounded / ovoid bodies located immediately behind the bulb of the vestibule. • Duct of each gland opens into the groove between the labium minus and attached margins of the hymen. • Greater vestibular glands are homologous with the bulbo-urethral glands of the male. • Compressed during coitus and secrete mucus, which lubricates the lower end of the vagina.

OGanatomy J. Ogengo palsoftweblink

Summary of Pelvic Viscera

Learning points | Core anatomy | Applied anatomy | Review questions

Pelvic viscera

Hover to show names

The rectum

Location

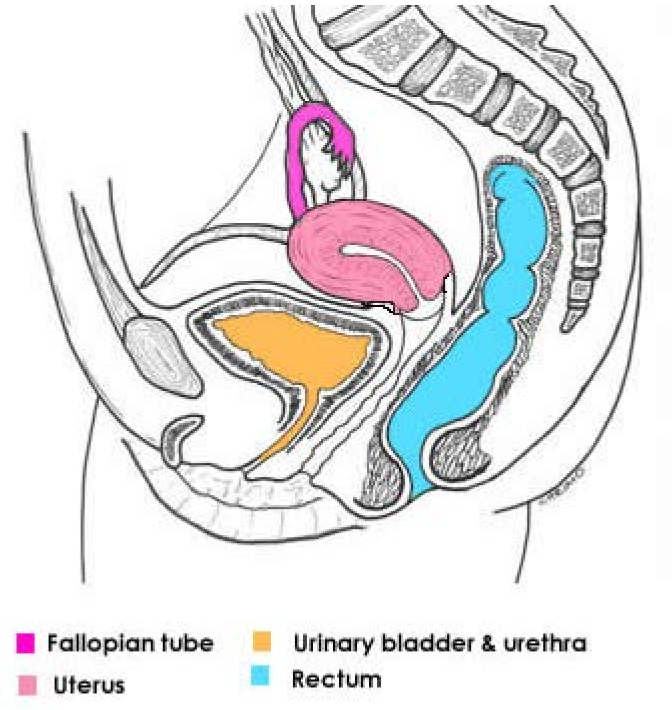
- True pelvis
- Extends From S3 to beyond tip of coccyx

Shape

- Follows the curves of the sacrum and coccyx
- S shaped in coronal section

Peritoneal relations

- Superior 1/3rd covered anteriorly and laterally
- Middle 1/3rd is covered only anteriorly
- Inferior 1/3rd is not covered
- In male- rectovesical pouch
- In female- recto uterine pouch of Douglas
- The pouches permit rectal distention



Relations

	Male	Female
Anteriorly	• Base of urinary bladder • Terminal parts of ureter • Ductus deferens • Seminal vesicals • Prostrate gland	• Cervix • Vagina • Rectovaginal pouch • Recto uterine pouch
Posteriorly	• Distal sacrum • Coccyx • Anococcygeal ligament • Branches of superior rectal artery • Termination of sympathetic chain	
Laterally	• Sacral plexus • Branches of internal iliac artery • Piriformis muscle • Ischiorectal fossa	

Blood supply

- Superior rectal artery a branch of inferior mesenteric artery
- Middle rectal arteries branches of internal iliac
- Inferior rectal arteries- branches of internal pudendal artery
- The veins correspond
- An important site for porto-systemic anastomosis
- The rectal venous plexus is joined to the vesical venous plexus and the utero vaginal plexus.

Lymphatic drainage

- Para rectal lymph nodes- inferior mesenteric nodes from the superior part
- Inferior part- internal iliac, common iliac and aortic lymph nodes

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Innervation

- Autonomic from inferior hypogastric plexus

Applied anatomy

Rectum

- Colorectal carcinoma may spread thro lymphatics or blood secondaries are more likely to be found in the inferior left vascular segment of the liver… why?
- The malignancy may spread to involve the closely related structures e.g cervix, vagina, prostate, urinary bladder e.t.c
- Hemorrhoids (Rectal piles): internal hemorrhoids are varicosities of the tributaries of the tributaries of the superior rectal veins are covered by mucous membrane
- External hemorrhoids are varicosities of the tributaries of the inferior rectal veins and are covered by skin
- As there are multiple anastomoses between the venous plexuses of the rectal veins, these communicating veins may also be dilated
- Hemorrhoids prolapsing through the external anal sphincter may be compressed impeding the blood supply. They consequently tend to ulcerate and strangulate
- The cause of most hemorrhoids is not known but they constitute an important sign of possible portal hypertension e.g. in liver cirrhosis

Rectal Examination

Digital rectal examination is useful in examining nearby structures such as:

- Prostate
- Cervix
- Sacrum, coccyx, ischial spine, ischial tuberosity
- Ureter
- Internal iliac nodes
- Contents of recto uterine, recto vesical and ischiorectal fossae

The rectum can be examined by a **rectoscope** in which case its normal curvatures must be born in mind

Rectocele: Herniation of the rectus

- Can occur in parasitic worm infestations such as Trichuris trichuria in malnourished children. In the females it occurs when there is a weakness of the fibromuscular layer of the posterior wall of the vagina.
- The vagina tends to bulge through the vaginal orifice with the attached wall of the rectum
  It may also occur due to weaknening from whatever cause of the pelvic diaphragm

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Anus

Anorectal malformations

- Anal atresia
- Imperforate anus
- Rectovaginal/ rectovesical fistulae

Fissure / Fissure in ano

- In chronically constipated persons, the anal valves may be torn by hard fecal material and the anal mucosa may also be torn. The tear is called anal fissure. It is usually inferior to the anal valves and is very painful because this region is supplied by somatic inferior rectal nerve

Peri- anal abscess

- It may follow infection of the anal fissure and the infection may spread to the ischio rectal fossae or into the pelvis forming ischio rectal and pelvi rectal abscesses respectively.

Anal fistulae

- This may develop as a result of the spreas of an infection. One end of the fistulae opens into the anal cana. The other end opens into an abscess in the ischio rectal fossa or into the peri anal skin

Prolapse of the uterus

- This condition is rare. The uterus descends to an abnormally inferior level in the pelvis and in advanced cases the cervix protrudes through the vagina and pudendal cleft. Such prolapse usually results from severe stretching or tearing of the pelvic floor during child birth.

Bi manual palpation of the uterus

- In this procedure , two fingers of the right hand are passed high in the vagina, whule the other hand is passed inferiorly and posteriorly on the hypogastric region of the anterior abdominal wall, just superior to the pubic symphysis. The size and characteristics of the uterus can be determined this way.

Hegars sign

- Softening of the uterus isthmus. During early pregnancy the cervix feels as though it were separate from the body of the cervix during bimanual pelvic palpation.

Gardners duct / cyst

- The part of the mesonephric duct which forms the ductus deferens and the ejaculatory duct in the male may persist in the female as a duct of Gardner. It lies between the layers of the broad ligament along the lateral wall of the uterus or in the wall of the vagina.. Vestigial remnants of the mesonephric ducts may also give rise to Gartners ducts cysts.

Cervical dilatation

- The cervical os is pin hole in size especially in nulliparous ladies. During labor, the cervix softens and dilates. It is capable of thinning upto 10cm. This softening and dilatation is an indicator of the progress of labor and is determined by digital vaginal examination but can also be done per rectum

Hysterectomy

- This is surgical removal of the uterus and it is done due to severe uterine rupture, uterine cancer or uterine fibroids.

Tubal blockage- Leading cause of female infertility.

- Commonly due to infection e.g gonorrhoea. The patency may be determined by injecting a radio opaque dye through the uterus then seeing if it enter the peritoneal cavity by radio graphic technique. This is called hysterosalpingograpgy

Tubal ligations

- A common method if contraception. When both tubes are ligated through minilaparatomy or vaginally, the oocytes and sperms do not meet. The sperms die and are absorbed.

Spread of infections:

- Because the female genital tract is in direct communication with the peritoneal cavity via the abdominal ostia of the uterine tubes, infection of the vagina, uterus and tubes may result in peritonitis. Conversely inflammation of the uterine tubes, salpingitis may result from infections that spread to the peritoneal cavity.

Fluid collection in the fallopian tubes

- Pus- pyosalpinx
- Blood- hemosalpinx
- Serous fluid- hydrosalpinx.

Tubal pregnancy-

the most common type of ectopic pregnancy. The usual result is tubal rupture, hemorrhage into the abdominopelvic cavity and death of the embryo during the first 8 weeks of pregnancy.

Ovaries

Ovulation pain (mittelschmerz)

- At ovulation some women experience paraumbilical pain due to stretching of the ovarian wall. As afferent impulses from the ovary reach the CNS at T10 the pain is referred to the T10 dermatome (of pain of appendicitis).

Ovarian cysts:

- Are common and of varying size. They may be so large as to necessitate removal of the ovary. If both ovaries are removed. Not only is the woman for ever infertile but the source of estrogen is removed. She will definitely require hormone replacement treatment.

Prostate, Urethra and bladder

- Because of the close relationship of the prostate to the urethra. Enlargement of the prostate commonly obstructs the urethra by compressing it. This causes urinary retention.

Urethral rupture and urine extravasation.

- The spongy urethra is unprotected superiorly, the wall is thin and distensible.
- It can be torn on falling astride over objects like iron bars (straddle injuries).
- Because it extends into the superficial perineal pouch, urine may extravasate into this space and spread around the scrotum, penis and anterior abdominal wall.

Urethral constriction

- The external urethral orifice and Membranous urethra are normal constrictions.
- The external urethral orifice is the narrowest part.

Urethral curves

- Membranous part runs inferiorly and anteriorly as it passes through the uro genital diaphragm/
  The prostatic part is concave anteriorly as it transverses the prostate. These curves must be born in mind

during urethral cathetirisation.

- Urethral strictures: This is the narrowing of the urethra, due to scar tissue. It may result from external trauma or infection.
  The urethra can be dilated by passing instruments called sounds. The procedure is called passage of sound.

The autonomic bladder:

In spinal cord injury/ diseases, the innervation of the external bladder sphincter is absent. It will contract reflexly on filling and expel the urne. The bladder is autonomous of voluntary control.

Crystostomy:

- This is the creation of an opening in the urinary bladder. It may be done through the anterior abdominal wall to drain the bladder in urinary retention due to urethral stricture. A catheter may be introduced through the opening to drain urine.

Urinary bladder rupture.

- Because of the high position of the distended bladder, it may be ruptured by injuries to the inferior part of the anterior abdominal wall, or by fractured bones of the pelvis. This may result in escape of urine extra peritoneally or intra peritoneally. The majority of the tears are extra peritoneal.

- Rupture of the superor part of the urinary bladder frequently tears the peritoneum resulting in extravasation of urine in the peritoneal cavity.

Bladder examinations:

- A cystoscope can be introduced into the bladder through the urethra or by the suprapubic approach.
- A dye can also be introduced into the bladder through the urethra or by the supra pubic approach.
- A dye can also be introduced into the bladder and the latter viewed radiographically. The picture is called a cystogram.

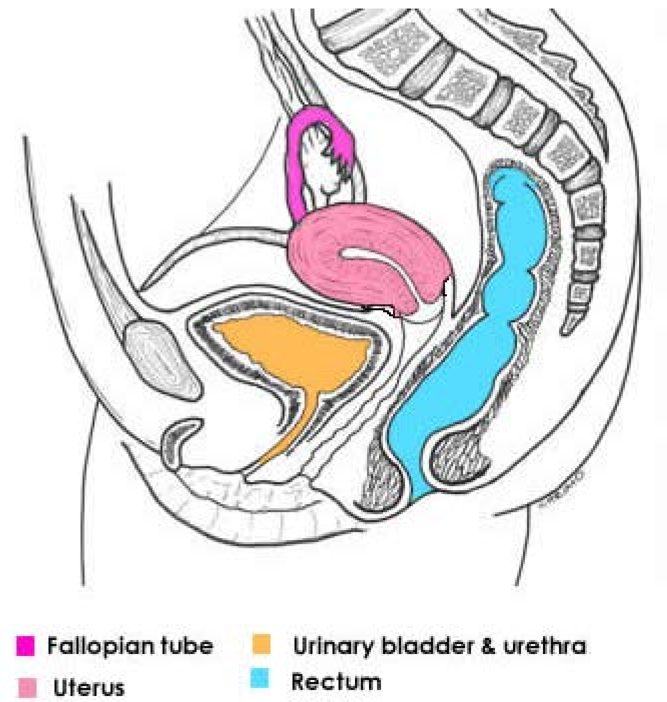
Review questions

1. Describe the position, relations, support factors and lymphatic drainage of the uterus
2. Describe the relations, lymphatic drainage and blood supply of the rectum. Add brief notes on hemorrhoids
3. Describe the relations, blood supply and lymphatic drainage of:

   a) Urinary bladder
   b) Prostate
4. Describe the general organization of the anal canal. Add special notes on sphincters and blood supply

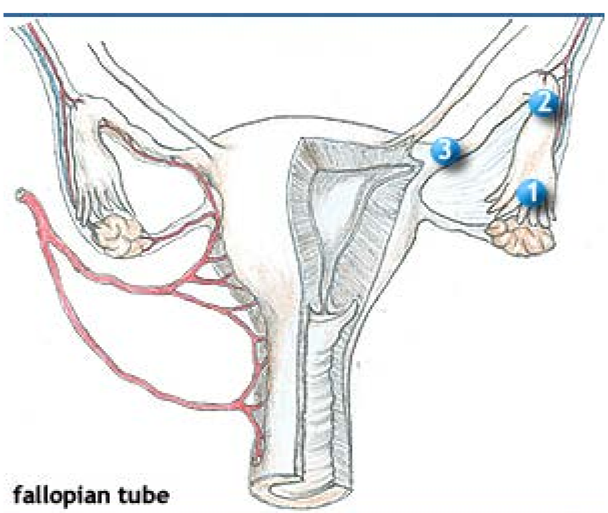
Summary of Pelvic Viscera

Uterine tubes



- Ducts extending from the uterine cornua to open into the peritoneal cavity
- They are the site of fertilization (the ampulla).
- They transport the oocyte and the sperms to the site of fertilization.
- It has a uterine ostium and abdominal ostium
- Provide communication between the peritoneal cavity and the exterior through the vagina.
- By this communication infections from the vagina can spread to the peritoneal cavity and cause peritonitis.

Parts



- **Infindubulus** with a fimbriated end.
- **Ampulla**- the longest and widest part
- **Isthmus**- narrow thick walled part which joins the horn of the uterus
- **The uterine / intramural part**- a short segment passing through the uterine wall.

Peritoneal relations

- Lies in the free edges of the broad ligament, attached to the latter by the mesosalpinx

Blood supply

- Tubal branches of the uterine and ovarian vessels
- Veins join to the ovarian and uterine veins

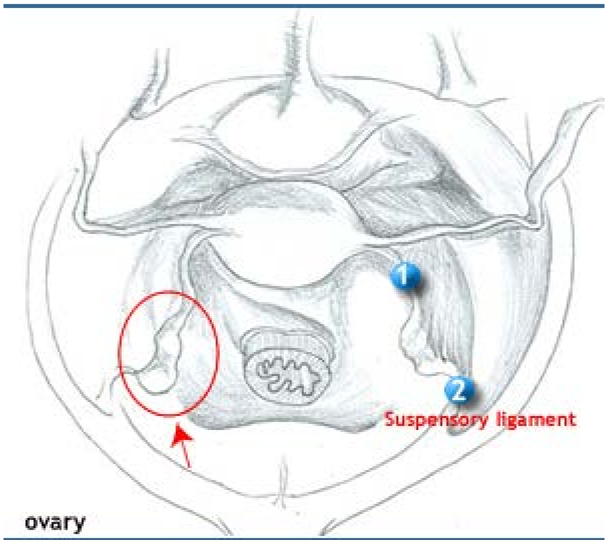
Lymphatics

Vessels run with those of the uterine fundus to the lumbar lymph nodes

Summary of Pelvic Viscera

The ovaries

Location



- Ovarian fossa , a recess close to the lateral wall of the pelvis minor.
- The ovarian fossa is bounded:

  Anterioly by the medial umbilical ligament or umbilical artery
  Posteriorly by the ureter and internal iliac artery

Attachments

- By ovarian fimbria of the fallopian tubes
- To the broad ligament by the meso varium
- To the pelvic brim by suspensory ligament of the ovary

Peritoneal relations

- The surface of the ovary is not covered by peritoneum. Hence during ovulation the oocytes are expelled into the peritoneal cavity.

Blood Supply

The ovarian artery from the abdominal aorta at the level of L2.

- It anastomoses with the uterine artery.
- The veins form a pampiniform plexus which drains into the ovarian vein and communicates with the uterine plexus.
- Uterine artery
- Rectal artery
- The vaginal plexus drains into the internal iliac veins

Lymphatics

- The vessels ascend with the ovarian veins to the lumbar lymph nodes

---

Innervation

- Autonomic
- Sympathetic from T10- T12
- Parasympathetic- vagus
- Affarent fbres travel with the sympathetic to T10

Summary of pelvic viscera

The uterus

Hover to show names

Parts

Body

- Expanded superior 2/3rd
- Fundus- rounded superior part
- Cornu- part of the body where the uterine tubes insert

Isthmus

- A narrow cone
- Transition between the body and the cervix
- Most obvious in nulliparous women

Cervix

- Cylindrical inferior 1/3rd of the uterus
- Supravaginal part
- Infra vaginal part
- Internal/ external os

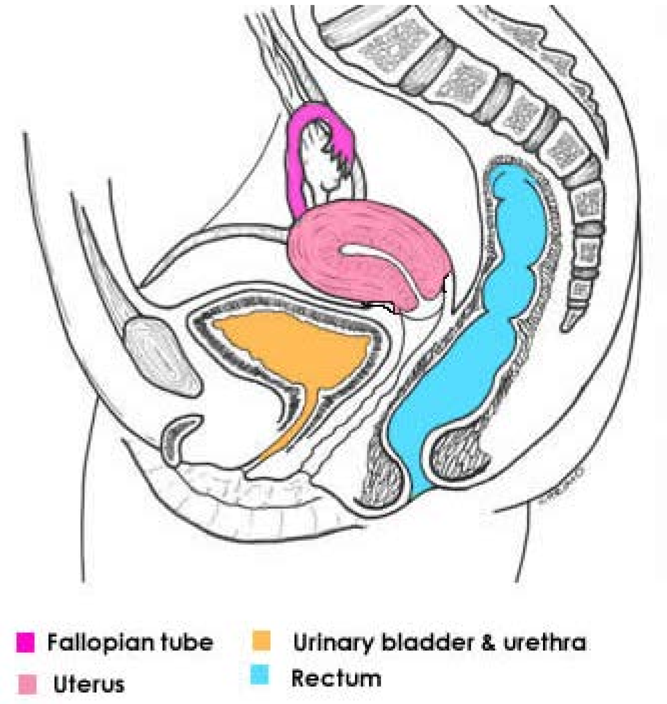
Position

Anteflexed: Uterus is bent anteriorly over the bladder between the cervix and the body

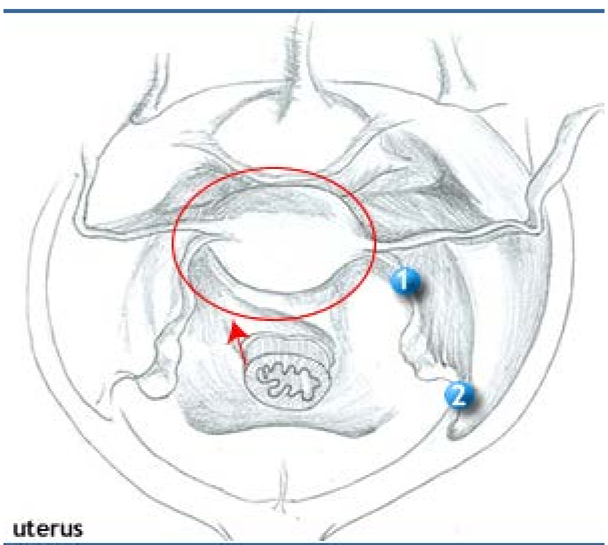
Anteverted: The entire uterus is bend anteriorly with respect to the vagina

Sometime especially in older women, the uterus may be bent posterioly (**retroversion**)

Note: When the urinary bladder fills, the uterus is straightened into line with the vagina.



Peritoneal relations



- Peritonioum covers , posterior, superior and anterior surfaces of the uterus, except vaginal part of cervix
- Peritoneum is reflected anteriorly onto the bladder and posteriorly onto the rectum
- A double layered peritoneal sheet - the broadligament- extend from the sides of the uterus to the lateral walls, and the floor of the pelvis.

Relations

Anteriorly

- Separated from urinary bladder by the vesico uterine pouch
- This pouch is normally empty when the uterus is in the normal position.
- When the uterus is retroverted the pouch contains a loop of intestine.

Posteriorly

- A layer of peritoneum and the peritoneal cavity separate the posterior part from sigmoid colon.
- The recto uterine pouch separates the uterus from the rectum.

Superiorly

- The coils of small intestine

Laterally:

- The broad ligaments and their contents

Uterine support

- The principal supports of the uterus are the pelvic floor and the pelvic viscera surrounding the uterus and its continuity with the vagina
- The broad ligaments hold the uterus in its relatively normal position.
- The body of the uterus is freely mobile. The cervix is not very mobile because it is held in position by several ligaments (Thickenings of the endopelvic fascia).

  (+) Transverse cervical (Cardinal) ligaments
  (+) Utero sacral ligaments (recto uterine),
  (+) Pubocervical

Blood supply

- Uterine arteries from the internal iliac
- Ovarian arteries from the aorta
- These two anastomose
- The uterine veins form a uterine venous plexus on each side of the cervix. Their tributaries drain into the internal iliac veins.
- This plexus is connected with the superior rectal veins forming a porto systemic anastomsis

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Lymphatics

- Aortic (lumbar) nodes.
- Superficial inguinal nodes.
- Body- para uterine lymph nodes thence to the external iliac nodes
- cervix – internal iliac and sacral lymph nodes.

Innervation

- Autonomic from the inferior hypogastric plexus largely from the uterovaginal plexus in the broad ligament.
- Most of the efferent fibres ascend through the hypogastric plexus and the spinal cord via T10- L1 spinal nerves

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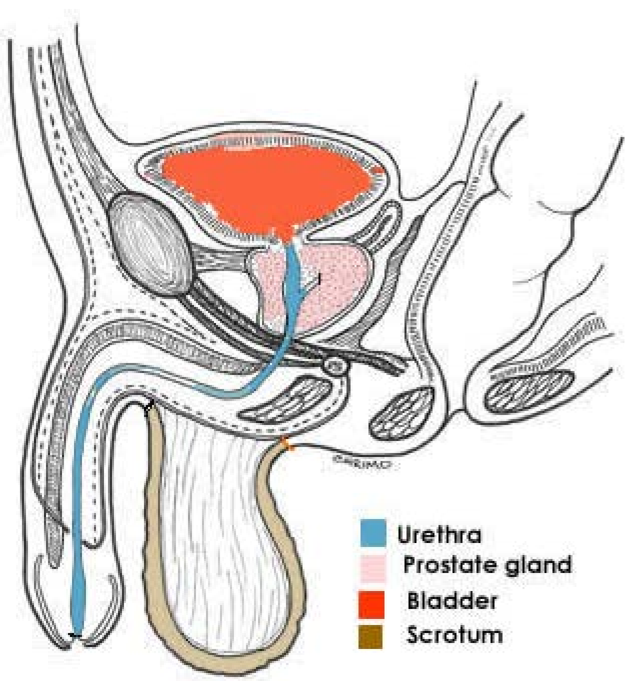
The male urethra

Parts



About 15-20 cm long and conveys both urine and semen
Has three parts

1. **Prostatic part**

   (+) Star shaped
   (+) Enclosed by the prostate gland.
   (+) The is the most dilatable part.
   (+) The prostatic ducts and ejaculatory ducts , opens into it.

2. **Membranous part:**

   (+) Shortest, least dilatable.
   (+) Apart from external urethral orifice, the narrowest part of the urethra.
   (+) Descends from the prostate to the bulb of the penis
   (+) traverses the sphincter urethrae muscle and inferior fascia of the urogenital diaphragm.
   (+) Bulbo-urethral glands are found on its side.

- **Spongy (Penile part)**

  (+) The longest part
  (+) runs the full length of the corpus spongiosum.
  (+) It has two dilatations.

  a) Bulb of urethra in the bulb of the penis
  b) Navicular fossa, in the glans penis

  (+)Two glands open into it.

  a) Bulbo urethral glands
  b) Mucus secreting urethral glands.

Blood supply

- Arteries derived from the structures it traverses
- Prostatic arteries from internal pudendal
- Artery of the bulb
- Urethral artery

Lymphatics

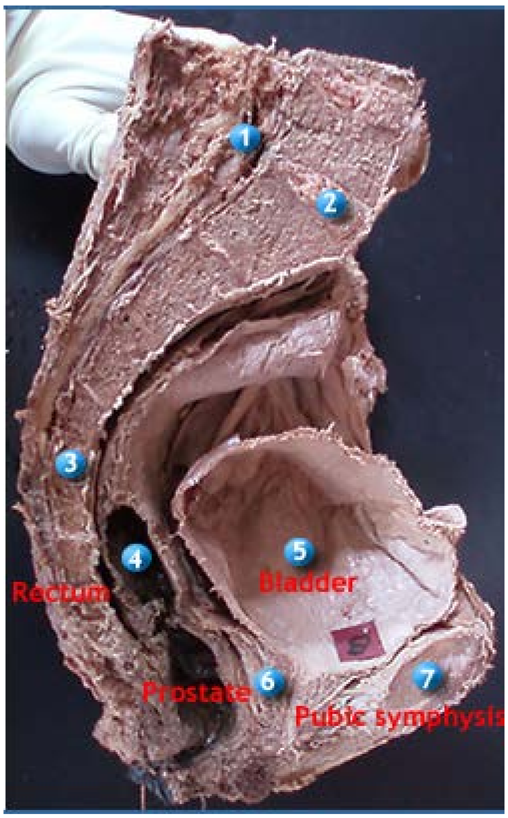
- With the glans penis – deep inguinal nodes, some to superficial inguinal
- From the upper part- internal iliac (a few sacral)

Innervation

- Branches of the pudendal nerve
- Autonomic from the inferior hypogastric plexus.
- Affarent fibres run in pudendal nerve and in pelvic splanchnic nerves.

The Urinary bladder

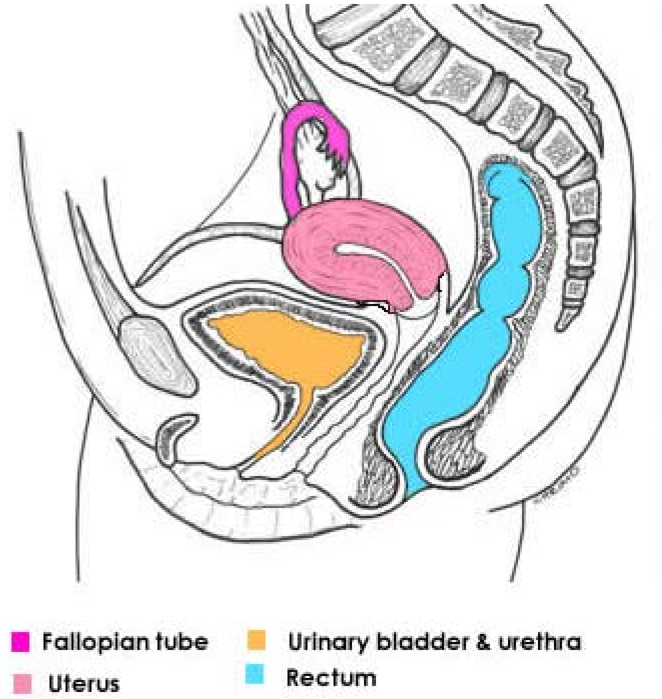
Location

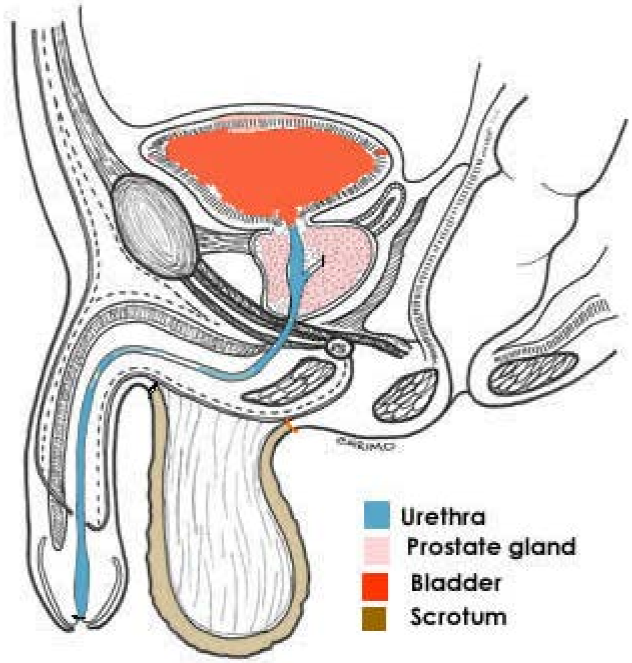


- In the adult, the bladder lies in the minor pelvis, posterior to the pubis.
- It is separated by the retropubic space with fat.
- In infants and children, the bladder is in the abdomen, beginning to enter the pelvis major at about 6yrs.
- It reaches the pelvis at puberty.
- The shape, size, positions and relations vary with the amount of urine it contains and with age.

Peritoneal relations

- The superior part is covered posteriorly, cranially and anteriorly
- vesico uterine pouch in the females and the recto vesical pouch in the male.





Relations

	Female	Male
Anteriorly	• Retropubic pad of fat • Levator ani • Obturator internus	• Pad of fat • Levator ani • Obturator internus
Posteriorly	• Uterus • Vagina	• Vas deferens • Seminal vesicles • Rectum
Superiorly	• Coils of small intestine (when full) • Body of uterus (when empty)	• Coils of small intestine
Inferiorly	• Pelvic • Urogenital diaphragm	• Urogenital diaphragm • Pelvic diaphragm • Prostate surrounds the urethra

Surfaces

- Superior surface, facing upwards

- Two inferior lateral surfaces, facing inferiorly
- Posterior surface facing posteriorly and inferiorly. This is also called the base
- Where the base and infero lateral surfaces converge, is called the neck of bladder.
- This is where the lumen of the bladder opens into the urethra and rests on the prostate gland in the male.

support

- The entire organ is enveloped by vesical fascia, a layer of loose connective tissue in which there is the vesical venous plexus
- The neck is held firmly by pubo prostatic ligaments in males and the pubo vesical ligament in the female.
- Major support is derived from the pelvic and urogenital diaphragms.

Blood supply

- Superior vesical arteries from the umbilical artery
- Inferior vesical arteries from the internal iliac
- Small branches from obturator and inferior gluteal arteries
- In females, uterine and vaginal arteries give branches to the bladder.
- The veins correspond to the arteries. From the vesical venous plexus and are tributaries of the internal iliac vein.
- Note: The vesical venous plexus in males envelopes the base of the bladder and prostate. The seminal vesicles, ductus deferens and inferior ends of the ureters
- It is connected to the prostatic venous plexus
- It may drain via sacral veins into the vertebral venous plexus
- In females it envelopes the pelvic part of the urethra and the bladder neck. It receives blood from the dorsal vein of the clitoris.
- It communicates with the vaginal plexus

Lymphatics

- From the superior part – external iliac nodes
- From the inferior part- internal iliac nodes
- Some from the neck- sacral and / or common iliac nodes

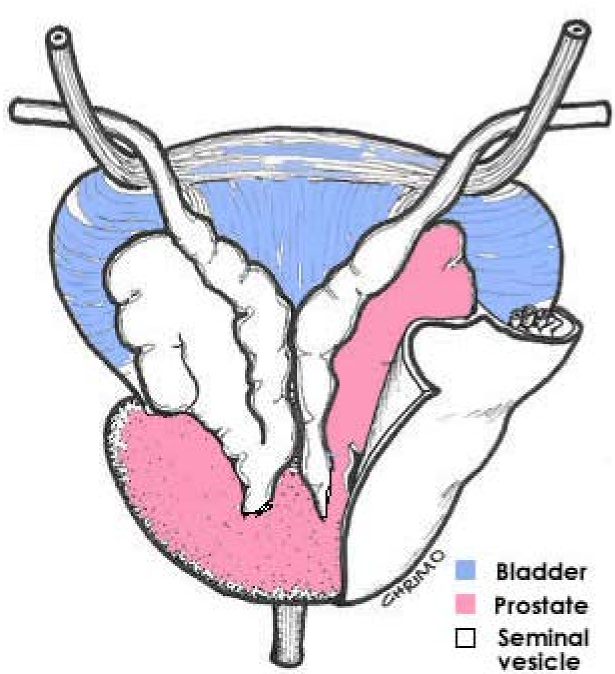
Innervation

- Parasympathetic fibres from the pelvic splanchnic nerves are motor to the detrusor muscle and inhibitory to the internal sphincter of the bladder
- Sympathetic fibres are derived form T11- L2.
- These fibres are inhibitory to the bladder and excitatory to the internal sphincter muscles.
- The nerves form a vesical plexus consisting of both sympathetic and parasympathetic fibres. It is continuous with the inferior hypogastric plexus.
- The external sphincter with other perineal muscles is supplied by pudendal nerve.

Summary of Pelvic Viscera

Learning points | Core anatomy | Applied anatomy | Review questions

The prostate gland.



- Largest accessory gland of the male reproductive system.
- Has a rich fibro muscular stroma

Location

At the bladder neck, surrounding the initial portion of the urethra

Prostatic sheath

This is the fascial sheath of the prostate
It is continous with:
a) Superior fascia of the urogenital diaphragm inferiorly.
b) Recto vesical septum posteriorly.

Relations

Superiorly	• Urinary bladder

Inferiorly	• Urogenital diaphragm
Anteriorly	• Pubis
Posteriorly	• Seminal vesicles • vas deferens • Rectum
Through it	• Prostatic urethra.

Surfaces

- Base, facing upwards, apex facing downwards
- Posterior and anterior
- Infero lateral

Lobes

- The prostatic urethra and the ejaculatory ducts divides the prostate into the median and lateral lobes.
- The median is antero superior to the ejaculatory ducts.
- The lateral lobes, form the mai mass of the gland are continuous posteriorly and are separated by the prostatic urethra.

Blood supply

- Internal pudendal
- Inferior vesical
- Middle rectal

The veins from the prostatic venous plexus, located between the capsule of the prostate and the prostatic sheath. The plexus drains into the internal iliac veins. It also communicates with :
- vesical venous plexus
-vertebral venous plexus

Lymphatics

- Mainly from the internal iliac and sacral lymph nodes. Some go the external iliac lymph nodes.

Innervation

- Autonomic , from inferior hypogastric plexys.

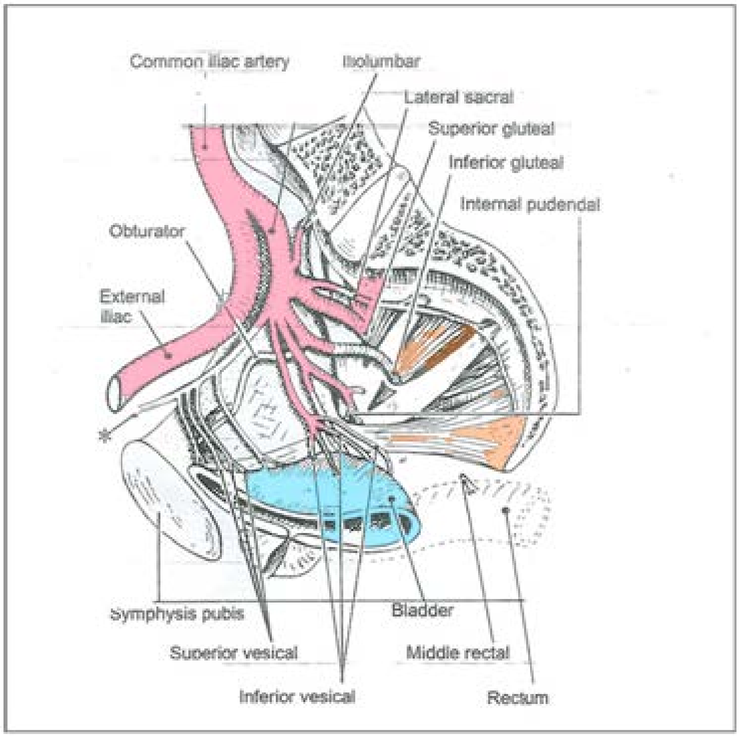
Clinical correlates

Benign prostatic hypertrophy occurs in many old men, and is among the commonest causes of urinary retention in old men. Prostatectomy, removal of the prostate is the surgical treatment.

Cancer of the prostate is one of the most commost tumors of men. It spreads via both blood and lymoh vessels It metastatises to the vertebral column (and CNS) and pelvis through the valveless venous communications between the prostatic venous plexus and vertebral venous plexuses.
The cancer cells can also reach the inferior vena cava and spread to all parts of the body.

Rectal examination of the prostate is the preferred method since the posterior surface of the prostate is in contact with the rectum. Only the anterior rectal wall and the rectovesical septum intervene.

Internal iliac artery



Origin

- It furnishes most of the blood supply to the **pelvis**.
- Arises from the **common iliac** at the level of the **inter vertebral disc** between the **fifth lumbar** vertebrae and the **sacrum**.

Surface marking

- Upper point of trisection between the anterior superior iliac spine and pubic symphysis.
- About 4cm long.

Relations

- Crossed infront by the ureter
- Separated from the sacro iliac joint behind by the internal iliac vein and lumbosacral trunk.
- In upper part, external iliac vein and psoas major are lateral to it.
- In the lower part the obturator nerve is lateral.

Distribution

- The major branches, **direct a**nd **indirect** may be divided into **parietal** and **visceral.**

Parietal branches.

Artery	Branches	Distribution
Iliolumbar arterty	**Iliac branch**	• Nutrient branch to ilium • Iliacus muscle.
	Lumbar branch	• psoas major,

		• Quadratus lumborum
Lateral sacral artery	Spinal branches	• Contents of the sacral canal
Obturator artery	muscular branches	• Obturator internus • Obturator externus
	nutrient branch to the ilium	• Ilium
	pubic branch	• Pubis
	acetabular branch	• Fat in the acetabular fossa • Ligament of the head of the femur
Superior gluteal artery		• Gluteal muscles
Inferior gluteal artery		• Gluteal muscles
Internal pudendal artery	Inferior rectal artery	• Rectum
	Posterior scrotal/ labial branches	• Scrotumm • Labia majora
	Perineal artery	• Perineum
	Artery of the bulb of the penis	• Penis
	Urethral artery	• Urethra
	Deep and dorsal arteries of the penis or clitoris.	• Penis • Clitoris
Visceral Branches		
Umbilical arteries	Superior vesical artery	• Upper part of the bladder • Medial umbilical ligmanet • Lower part of the ureter.

	Artery of the ductus deferens-	• Seminal vesicles • Back of bladder • Urethral branches to the ureter.
Inferior vesical artery		• Lower parts of the bladder • Prostate, • Seminal vesicles, • Ductus deferens • Lower part of ureter.
Uterine artery		• Uterus, • Upper part of vagina, • Medial part of uterine tubes, • Round ligament of uterus • Ligament of the ovary
Vaginal artery	Anterior and posterior azygous artery of the vagina	• Front and back of the vagina
	t	
	Small branches	• Bladder, • Rectum • Bulb of vestibule.
Middle rectal artery		• Rectum • Prostate • Seminal vesicles • Ductus deferens

Collateral circulation

The collateral circulation that develops after obstruction of an internal iliac artery results from anastomoses

1) with branches of the opposite internal iliac,

2) between parietal branches and branches of the femoral artery in the thigh, and

3) between the superior and middle rectal arteries.

The collateral circulation may be demonstrated by arteriography. The collateral channels also supply the lower part of the abdomen if the abdominal aorta is obstructed, and the lower limb if the femoral artery is obstructed.

Three other arteries enter the pelvis

a) Median sacral

b) Inferior mesentric

c) Ovarian artery

Internal Iliac Vein

- A short trunk, which unites with the external iliac to form the common iliac vein.
- Its **tributaries correspond** in general to the **branches of the internal iliac artery**, with the **exception** of the **umbilical** and the **iliolumbar** arteries.
- Each of the viscera within the pelvis is surrounded by a network of relatively large, **thin-walled veins**, which have **few valves**.
- These **plexuses communicate freely** with each other and give rise to the visceral tributaries of the internal iliac vein.
- They also communicate with the parietal tributaries, and thereby provide easy pathways for the spread of infections.
- The plexuses are named as follows:

1) The **Rectal venous plexus**

2) The **Vesical venous plexus**

3) The **Prostatic venous plexus**

4) The **Uterine venous plexus**

5) The **Vaginal venous plexus**

6) The **Sacral venous plexus**

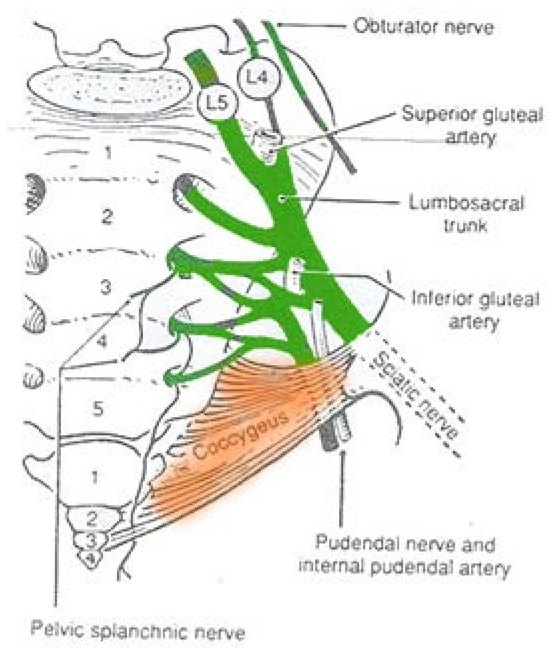
Clinical Anatomy

See preceding chapter

Review questions

1. Describe the origin, course and distribution of the internal iliac artery. Add notes on anastomosis
2. Describe the lymphatic drainage of pelvic viscera and perineum. Add notes on clinical significance
3. Describe the somatic and autonomic innervation of pelvic viscera. Add notes on surgical importance of this paattern.

Nerve supply



Sacral plexus and related vessels

- Derived from sacral and coccygeal spinal neres
- Pelvic part of autonomic nervous system
- Each of the five sacral nerves divides into a dorsal and ventral ramus within the sacral canal
- The dorsal rami of the first four sacral nerves pass backward through the dorsal sacral foramina.
- Those of the fifth sacral and coccygeal emerge from the sacral canal through the sacral hiatus
- The ventral rami of the first four sacral nerves emerge from the sacral canal through the pelvic sacral foramina.
- The third and fourth sacral and occassionaly the second or fifth also, give off the pelvic splanchnic nerves which help form the autonomic plexus within the pelvis.

Sacral plexus

- Formed by the ventral rami of the fourth and fifth lumbar and first four sacral nervers.
- Ventral ramus of the fourth lumbar divides into upper ad lower parts.
- The lower division joins the ventral ramus of the fifth lumbar nerve to form the lumbosacral trunk
- The lumbosacral trunk descends and joins the ventral ramus of the fourth sacral also has upper and lower divisions.
- Its upper part joins the third sacral, its lower part the fifth sacral.
- With the exception of the fourth sacral, each ventral ramus first divides inot ventral and dorsal branches before entering into the formation of the sacral plexus.

Relations

- Lies infront of piriformis
- Separated from the internal iliac vessels and ureters anterioly by the parietal pelvic fascia
- Superior gluteal vessels pass between the lumbosacral trunk and the ventral branches of the first and second or second and third sacral nerves
- The internal pudendal vessels run between the sciatic and pudendal nerves.

Distribution

- The sacral plexus had twelve branches.
- Seven of these supply the buttock and lower limb, the rest supply structures belonging to the pelvis. These are.

Nerve	Root value	Course and Distribution
Buttock and Lower Limb		
Superior gluteal nerve	L4,5,S1	• Accompanies superior gluteal vessels into the buttocks where it is distributed
Inferior gluteal nerve	L5, S1, 2	• Supplies gluteus maximus
Nerve to quadratus femoris	L4,5,S1	• Supplies inferior gamellus • quadratus femoris • Hip jointy
Nerve to obturator internus	L5, S1, 2	• Superior gamellus • Obturator internus
Posterior femoral cutaneous	S1,2,3	• Cutaneous
Perforating cutaneous |	S2, S3	• Skin • Subcutaneous tissue of the lower part of buttock
Sciatic nerve	L4, 5, S1, 2, 3	• The largest in the body • Peroneal and tibial bound together • Leaves pelvis through greater sciatic foramen

Pelvis

Nerve to piriformis	S1, S2	• Piriformis muscle
Nerve to levator ani and coccygeus	S3, 4	• Levator ani • Coccygeys
Nerve to sphincter ani externus	S4	• sphincter ani externus as well as the surrounding and subcutaneous tissue
Pelvic splanchnic nerves	S2, 3,4,5	• Contain parasympathetic preganglionic and sensory fibres • Supply sigmoid colion
Pudendal nerve	s2, 3,4	• Furnishes most of the perineum. • It has motor and sensory fibres post ganglionic sympathetic fibres

COCYGEAL PLEXUS

- Formed by ventral rami of the fifth sacral and the coccygeal nerve which join the lower division of the ventral ramus of the fourth sacral
- It supplies the sacrococcygeal joint, the coccyx, and the skin the coccyx.

PELVIC PART OF AUTONOMIC NERVOUS SYSTEM

The symphathetic part of the autonomic nervous system reaches the pelvis by two different routes.

- The downward continuation of the sympathetic trunk, and
- The downward continuation of the aortic plexus

Lymphatic drainage

- Lymph nodes are variable in size, number and location
- Four main groups
- Named according to the arteries which tjeu are associated
- Some small nodes lie in the connective tissue along the pathways of various branches of the internal iliac artery.

Sacral nodes	Internal iliac nodes	External iliac nodes	Common iliac nodes
• Lie in the hollow of the sacrum • Receive vessels from pelvic, perineal and gluteal regions • Drain to the internal iliac or common iliac nodes	• Arranged around the internal iliac artery • Receive vessels from pelvic viscera, perineum and buttock • Drain to common iliac nodes	• Arranged around the external iliac artery • Receive vessels from superficial and deep inguinal nodes, some pelvic viscera and abdominal wall below umbilicus • Drain to common iliac nodes	• Receive drainage from external and internal iliac nodes and sacraol nodes • Drain into the lumbar group of nodes

Summary of pelvic viscera drainage

ORGAN	Node (s)
Ovary (along ovarian a.)	Lumbar
Uterine tube (except part near uterus) (along ovarian a.)	Lumbar
Uterus Upper part of the body Lower part of the body	Lumbar

Cervix Region near uterine tube (along round ligament) Vagina Upper part (along uterine a.)	External iliac, External iliac, internal iliac, and sacral Superficial inguinal External and internal iliac
Middle part (along vaginal a.) Lower part Part below hymen (with those from vulva and skin of perineum)	Internal iliac Internal iliac Sacral and common iliac Superficial inguinal
Testis and epididymis (along testicular a.)	Lumbar
Seminal vesicle	External and internal iliac
Ductus deferens (pelvic portion)	External iliac
Prostate	Internal iliac mainly; sacral and external iliac
Scrotum	Superficial inguinal
Penis (clitoris) Skin and prepuce Glans	Superficial inguinal Deep inguinal and external iliac
Ureter (lower part)	External or internal iliac
Bladder Superior and inferolateral aspects Base	External iliac External iliac mainly; internal iliac
Neck	Sacral and common iliac
Urethra Female (along internal pudendal a.) Male prostatic and membranous parts (along internal pudendal) Spongy part	Internal iliac mainly; external iliac Internal iliac mainly; external iliac Deep inguinal mainly; external iliac
Rectum Upper part Lower part	Inferior mesenteric Sacral, internal iliac, and common iliac
Anal canal Above pectinate line (along inferior rectal and internal pudendal) Below pectinate line	Internal iliac

Superficial inguinal

University Of Nairobi
Department Of Human Anatomy

TEACHING SCHEDULE

LECTURE HALL

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WEEK	DAY	TIME					
5		8.00 – 10.00 a.m.	10.00-11.30 a.m.		11.30-1.00pm	2.00- 3.00pm	3.00-5.00 p.m.
Mon							Group A Dissection Dr. Ogeng'o /Dr. Awori/Gikenye
Tuesday 29/11/2005						Group A Dissection Dr. Odula/Kaisha	
Wednesday 30/11/2005						Group B – Dissection	
Thursday 01/12/2005		Introduction to body organs (Histology) Dr. Ndung'u				Group B – Dissection Dr. Odula/Githaiga	
Friday 02/12/2005		Blastula formation and implantation Prof. Malek	Gluteal region, back of the thigh & Popliteal fossa Dr. Odula	Gluteal region, back of the thigh & Popliteal fossa Dr. Odula			

Week 6 Dec 5 th -9th	Day	8-10.00 a.m.		10.00- 11.30 am	11.30- 1.00 pm		2.00 – 3.00 pm	3.00 – 5.00 pm

Week 7 Dec 12 th - 16th					
Mon				Femoral triangle & anteromedial thigh (B) JWG	Dissection (A)
Tues				Organization of hip joint (A) JWG	Dissection (A)
Wed				Femoral triangle & anteromedial thigh (B) JWG	Dissection (B)
Thurs	Organization of cell membrane & membrane bound organelles Dr. Ogeng'o	Histology practical (BPharm / A1) JAO / Kiama	Histology practical (A2) JAO / Kiama Dissection (B)	Histology Practical (A2) JO / Kiama	Histology Practical (A2) JO / Kiama
Frid	Bilaminar disc & Gastrulation Prof. Malek	Organization of the Hip and the rest of the thigh Dr. Gikenye	Organization of the Hip and the rest of the thigh Dr. Gikenye	Anatomy Review SHS Oral Biology AM	
DAY	8.00 – 10.00	10.00 – 11.30 am	11.30 – 1.00 pm	2.00 – 3.00 pm	3.00 – 5.00 pm
Mon				Dissection Knee & leg (B)	Dissection Knee & leg (A)
Tues				Dissection Knee & leg (B)	Dissection Knee & leg (A)
Wed				Dissection Knee & leg (B)	Dissection Knee & leg (B)
Thurs	Organization of nucleus & cytoplasm Dr. Ogeng'o	Histology practical BPharm / A1 JAO / Kiama Dissection Knee & leg (B)	Histology practical (A2) JAO / Kiama Dissection Knee & leg (B)	Histology Practical (B1) JO / Kiama	Histology Practical (B2) JO / Kiama
Frid	Gastrulation & Neurulation Prof. Kimani	Organization of Knee and leg Dr. Awori	Organization of Knee and leg Dr. Awori	Progressive assessment test 2 SHS Oral Biology AM	

Week 8 Jan 9 th - 13th Week 9 Jan 16th- 20th	Day	8-10.00 am	10.00- 11.30 am	11.30- 1.00 pm	2.00 – 3.00 pm	3.00 – 5.00 pm
Mon				Dissection Knee & leg (A)	Dissection (A) Ankle joint & Dorsum of foot	
Tues				Dissection (A) Ankle joint & Dorsum of foot	Dissection (A) Ankle joint & Dorsum of foot	
Wed				Dissection (B) Ankle joint & Dorsum of foot	Dissection (B) Ankle joint & Dorsum of foot	
Thurs	Cell Functional Specialization Dr. Ogeng'o	Histology practical (BPharm / A1) JAO / Kiama Dissection (B) Ankle joint & Dorsum of foot	Histology practical (A2) JAO / Kiama Dissection (A) Ankle joint & Dorsum of foot	Histology Practical (B1) JO / Kiama	Histology Practical (B2) JO / Kiama	
Frid	Fetal membranes I Prof. Kimani	The Foot and the ankle Dr. Githaiga	The Foot and the ankle Dr. Githaiga	Anatomy Review SHS Oral Biology AM		
DAY	8.00 – 10.00	10.00 – 11.30 am	11.30 – 1.00 pm	2.00 – 3.00 pm	3.00 – 5.00 pm	
Mon				Dissection (A) The Foot	Dissection (A) The foot	
Tues				Dissection (A) The Foot	Dissection (A) The Foot	
Wed				Dissection (A) The Foot	Dissection (A) The Foot	
Thurs	Organization of epithelial tissue	Histology practical BPharm / A1	Histology practical (A2)	Histology Practical (B1)	Histology Practical (B2)	

	Dr. Saidi	JH / BN Dissection (A) The Foot	JH / BN Dissection (A) The Foot	JH / BN	JH / BN	
Frid	Placenta & Twinning Prof. Kimani	Neurovascular supply of the lower limb Dr. Ndung'u	Neurovascular supply of the lower limb Dr. Ndung'u	Progressive assessment test 3 SHS Oral Biology AM		
Week 10 Jan 23 rd - 27th Week 11 Jan 30 th – 3rd 2006	Day	8-10.00 am	10.00- 11.30 am	11.30- 1.00 pm Welocome	2.00 – 3.00 pm	3.00 – 5.00 pm
Mon				Dissection (A) Neurovascular lower limb anatomy	Dissection (A) Neurovascular lower limb anatomy	
Tues				Dissection (A) Vertebral column / back / scapula region	Dissection (A) Vertebral column / back / scapula region	
Wed				Dissection (B) Neurovascular lower limb anatomy	Dissection (B) Neurovascular lower limb anatomy	
Thurs	Organization of glands; The mammary gland – Prof. Hassanali	Histology practical (BPharm / A1) PG / JH Dissection (B) Vertebral column / back / scapula region	Histology practical (A2) PG / JH Dissection (B) Vertebral column / back / scapula region	Histology Practical (B1) PG / JH	Histology Practical (B2) PG / JH	
Frid	Free Revision	Truncal erectness, back, vertebral clouman & scapula region Dr. Saidi	Truncal erectness, back, vertebral clouman & scapula region Dr. Saidi	Free revision Free Revision		
1 st Quarter		1 st Quarter Examinations		1 st Quarter		

Examinations		**Examinations**	

JAO- Dr. Ogeng'o BN- Dr. Ndung'u JK – Prof. Kimani AM – Dr. Muriithi JH- Prof. Hassanali JWG – Dr. Githaiga
SHS – Dr. Saidi PG- Dr. Gichangi PO – Dr. Odula GG – Dr. Gikenye

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CHAPTER 18 : The Joints of the wrist , hand and fingers

objectives

1. To examine the relation , capsule , ligaments , blood vessels , movements and bones of the wrist joint and mid-carpal joint
2. To examine the relations , capsule ligaments , blood vessels , movements and bones of the 1 st carpometacarpal joint
3. To examine the relations , capsule , ligaments , blood vessels , movements and bones and joints of the fingers .
4. to examine the movements and normal ranges of the movements of the joints named above

Chapter 32: The Peritoneum and the Organs of the Gastrointestinal System

Objectives:

1. To describe the position, relations (organ and peritoneal) , and support structures of organs of the GIT ; namely the liver , spleen , stomach , pancreas , duodenum.
2. To state the parts , distinguishing features and relations of the small and large intestines
3. To state and define the main differences between the large and small intestines

Objectives

1. To define the vertebral level of origin, course and branches of distribution of the celiac trunk, superior mesenteric and inferior mesenteric
2. To describe the pattern of blood supply to the small and large intestines, especially the formation of arcades, and the marginal artery
3. To describe the pattern of blood supply including venous drainage of the various organs of the gastro-intestinal tract and relate this to the embryonic origin.
4. To localise the various lymph node groups in the abdomen, and understand which organs they drain
5. To outline the distribution of the vagus and splanchnic nerves; and sacral parasympathetic outflow to the organs of the gastro-intestinal tract.

The organs of the GIT receive arterial blood supply from three arteries:

- Coeliac trunk for foregut
- Superior mesenteric artery for midgut
- Inferior mesenteric artery for hindgut

The veins drain into the **portal vein** and from thence to the liver and ultimately inferior vena cava.

Lymph drains into local mesenteric nodes, then para-aortic nodes then to the thoracic duct.

The vagus nerve supplies parasympathetic innervation upto the proximal 2/3rd of the transverse colon where it hands over to the sacral outflow. Sympathetic innervation is derived from the greater, lesser and least splanchnic nerves (T6-T12). Sensory fibres run with the sympathetic.

Chapter 34: The Retroperitoneal Structures Posterior Abdominal Wall and Thoracic Diaphragm

Objectives

1. To state the position, extents, coverings, relations and blood vessels of the kidney
2. To describe the location, relations and blood supply of the suprarenal glands
3. To define the course and relations of the ureter and understand the pattern of its blood supply.
4. To display the abdominal aorta and inferior vena cava and their branches/ tributaries
5. To display the muscles and nerves of the posterior abdominal wall.
6. To display the costal and vertebral attachments, openings and relations of the thoracic diaphragm

Chapter 35: The Male Reproductive System and The Perineum

Objectives

1. To display the scrotal contents i.e. the testis and its coverings; its blood vessels and nerves
2. To display the coverings and contents of the spermatic cord
3. To display the pattern of the epididymis
4. To display the parts, muscles, vessels and nerves of the penis
5. To understand the organization of the fascia of the urogenital triangle; and the formation of the perineal pouches.
6. To understand the formation, and display the contents of the perineal pouches.
7. To display the boundaries and ischio rectal fossa.
8. To understand the innervation, blood supply and lymphatic drainage of the perineum

Chapter 36: Female Reproductive System and the Contents of the Female Pelvis

Objectives

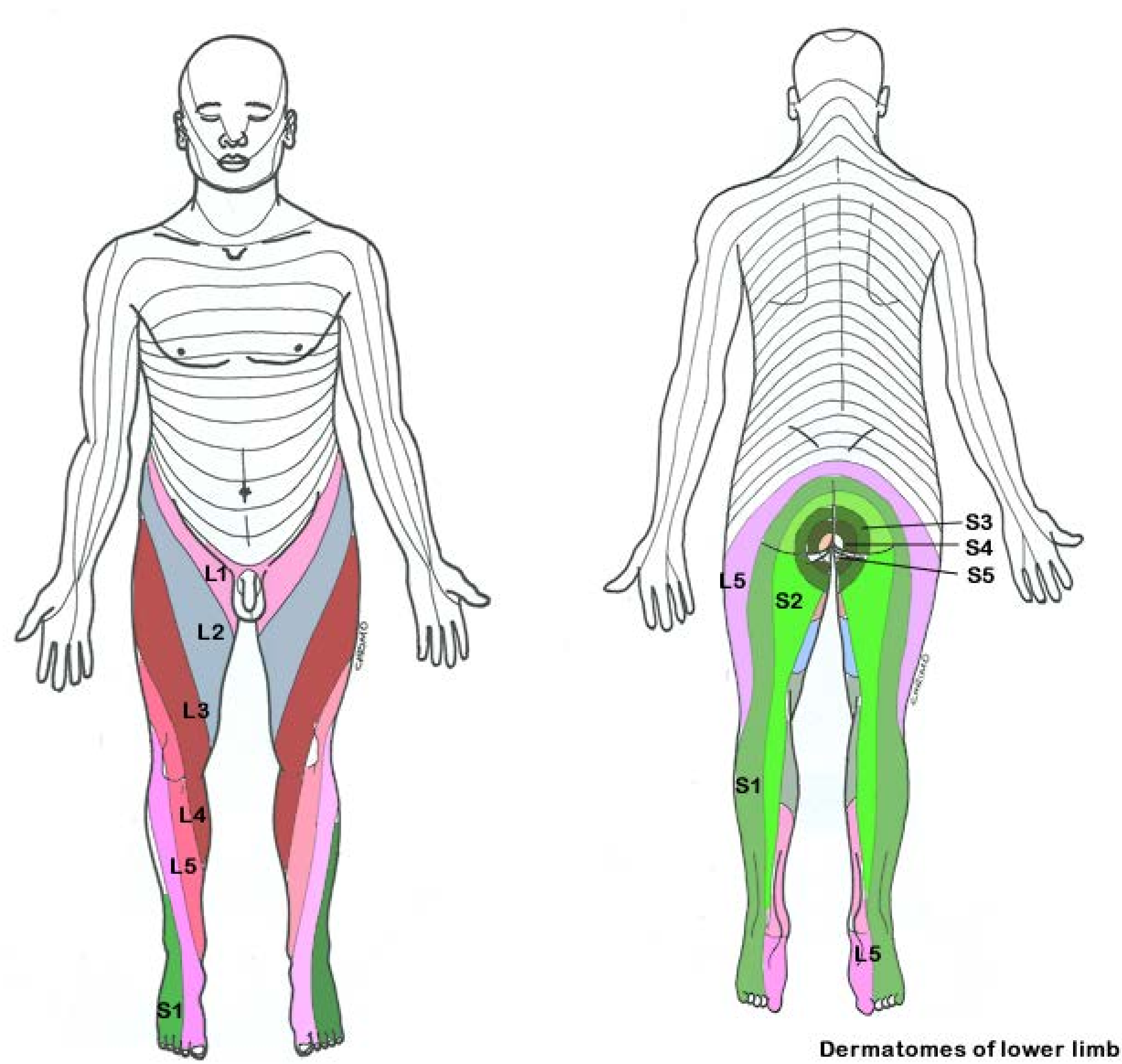
1. To identify the parts of the female external genitalia and to learn their blood supply, lymphatic drainage and innervation
2. To display the contents of the perineal pouches in the female
3. To review the boundaries and contents of the ischiorectal fossa
4. To display and understand the organization of the peritoneum in the female pelvis
5. To study the parts, stability factors, relations, support structures, blood supply, lymphatic drainage and innervation of the urinary bladder and urethra
6. To display and study the position, relations, blood supply, lymphatic drainage and innervation of the rectum and anal cana

Chapter 37:The Structures of the male pelvis and pelvic diaphragm

Objectives

1. To display and study the internal male reproductive organs namely the prostate, the seminal vesicles, vas deferens
2. To examine the relations, blood supply and lymphatic drainage of the organs named above
3. To examine the position, relations, blood supply, lymphatic drainage and innervation of the rectum and anal canal in males
4. To examine the relations, blood supply, lymphatic drainage and innervation of the urinary bladder in males.
5. To display the origin and branches of the internal iliac artery and follow their distribution
6. To display the branches of the sacral plexus
7. To display the components and attachments of the pelvic diaphragm and appreciate its functions, innervation and blood supply.

organization of thigh

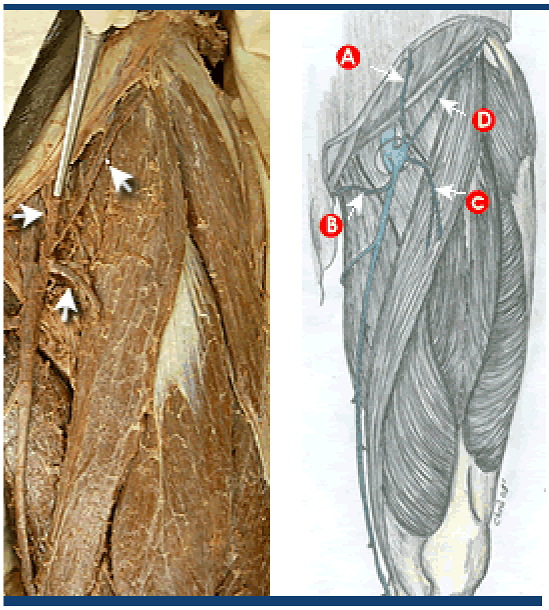


Dermatomes of lower limb

e Great (Long) Saphenous Vein

Tributaries:

- Superficial circumflex iliac (**D**)
- Superficial epigastric (**A**)
- Superficial external pudendal (**B**)
- Occasionally the accessory saphenous vein (anterior cutaneous vein of the thigh) (**C**)



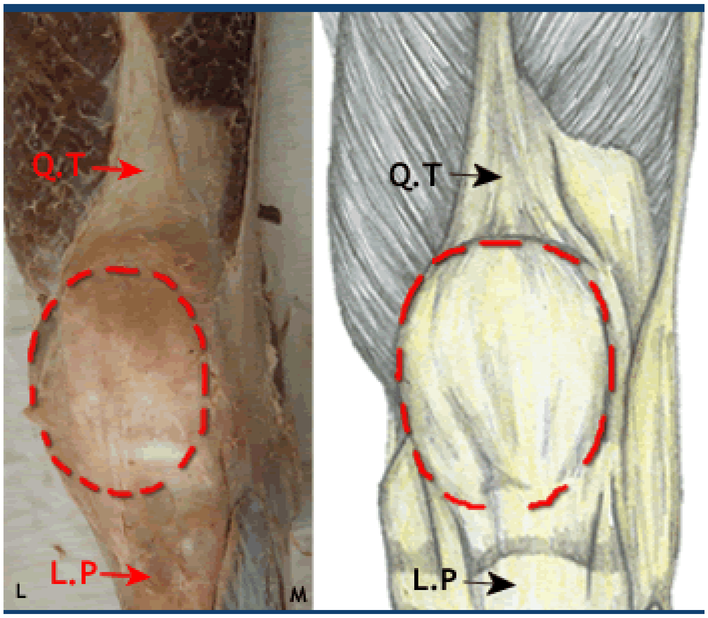
task ***What is the origin of the long saphenous vein?***

Termination

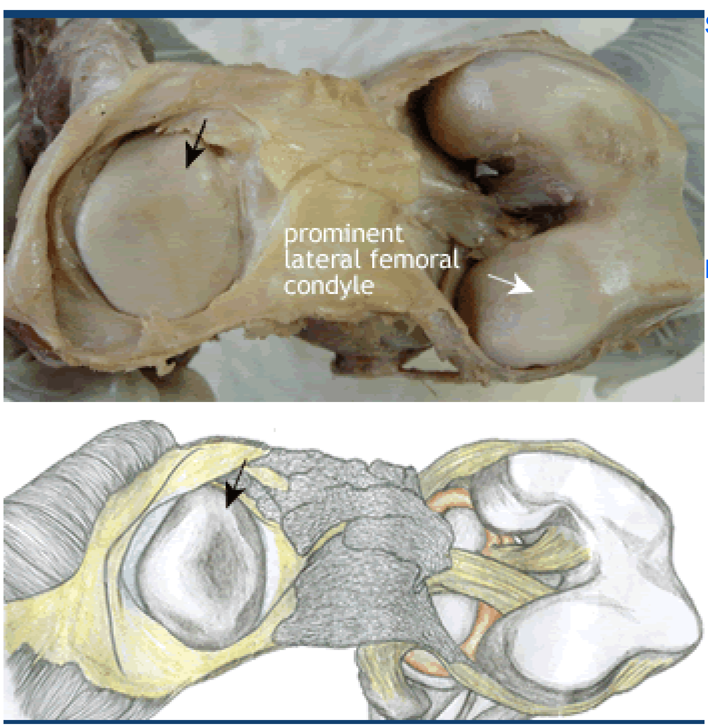
- Passes through saphenous opening to join the femoral vein.

task ***What is meant by the term venous cutdown?***

Patella:



- Sesamoid bone in the quadriceps tendon
- Articulates with femur by two surfaces separated by a crest.
- Lateral surface larger than medial
- Due to the oblique pull of quadriceps, it tends to be drawn laterally.



Stability of patella:

- Horizontally oriented fibres of the vastus medialis
- Tension of the medial patellar retinaculum
- Forward prominence of lateral femoral condyle.
- Ligamentum patellae

Functions of the patella:

- Stabilize and protect the knee joint anteriorly
- Align the pull of quadriceps into a straight extensor pull .
- Increase mechanical advantage of the quadriceps

Applied anatomy of patella:

- Patella ossifies from two centres. The segments may not fuse. This gives rise to a bipartite patella, which may be confused for fracture.
- Patella when fractured into two fragments, they may be screwed together. When broken into many fragments, they may be removed.

Dorsum of Foot

Cutaneuos nerves

Medial margin : Saphenous nerve

Lateral margin: Sural nerve

Dorsum Centre: Superficial peroneal

1st Interdigital cleft: Deep peroneal

Dorsalis Pedis artery

Origin:

Continuation of anterior tibial artery

Course:

- At the base of first inter-metatarsal space
- Lateral to tendon of extensor hallucis longus
- Crossed by tendon of extensor hallucis brevis
- Palpable lateral to EHL on a line from midpoint between the two malleoli and first toe cleft.

Branches

Lateral tarsal artery: Runs beneath extensor digitorum brevis

Arcuate artery: Beneath extensor digitorum brevis over bases of metatarsals

1st dorsal metatarsal artery

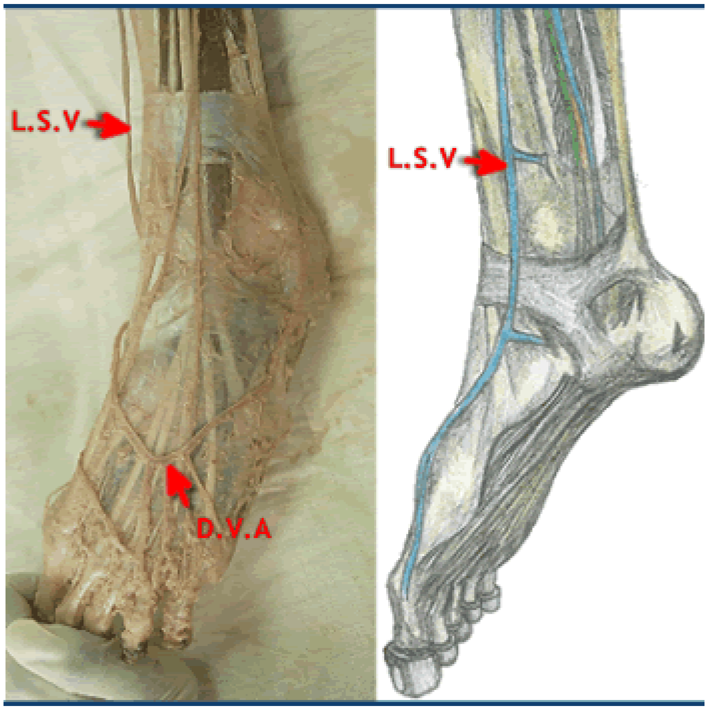
Termination and anastomosis

- Enters plantar foot through 1st inter-metatarsal space
- Joins lateral plantar artery to complete plantar arch

Distribution

- Soft tissues on dorsum of foot
- Tarsals, metatarsals and phalanges
- Plantar aspect of foot

Dorsal venous arch



Lies over the heads of metatarsals
Receives most of its blood from:

1. Marginal and interossseous tributaries from the sole of the foot
2. Dorsal digital veins

Joins medial dorsal digital vein medially to form great saphenous vein

Laterally drains into small saphenous vein

(Dorsal Venous arc [D.V.A] forming the long saphenous vein [L.S.V] on the medial side of the foot)

Inferior extensor retinaculum

- Y –shaped thickening of deep fascia
- Arises from upper surface of calcaneus
- Upper limb attaches to medial malleolus
- Lower limb blends with plantar aponeurosis
- Prevents bow-stringing of the extensor tendons as they pass across the ankle joint.

Inferior Extensor Retinaculum **(IER)**

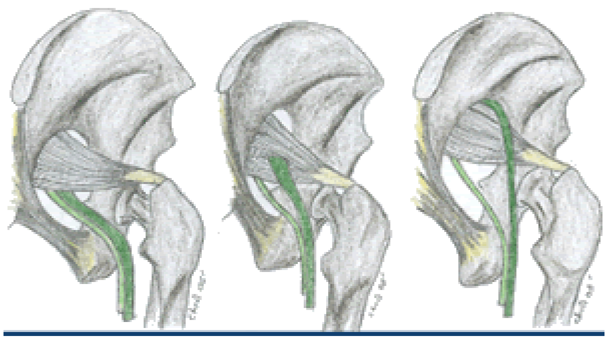
Superior Extensor Retinaculum **(SER)**

task ***Identify the structures labelled A, B, C***.


a.
b.
c.
SER
IER

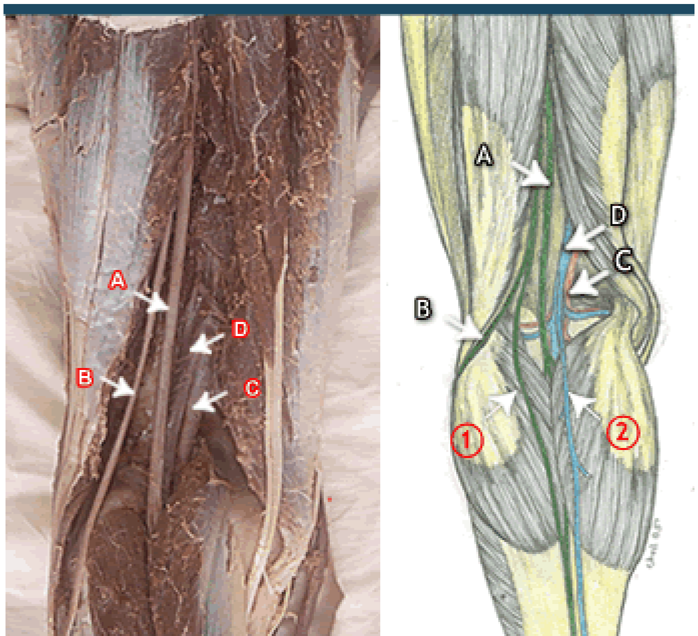
Common peroneal nerve (common fibular nerve)

Origins



Branch of sciatic nerve (L4-S2) .*(note the different modes of division of the sciatic nerve into tibial and common peroneal nerves)*

Course:



- see sciatic nerves
- The common peroneal nerve [B] skirts laterally in popliteal fossa, medial to biceps femoris tendon.
- Winds over neck of the fibula, where it divides into superficial and deep branches.

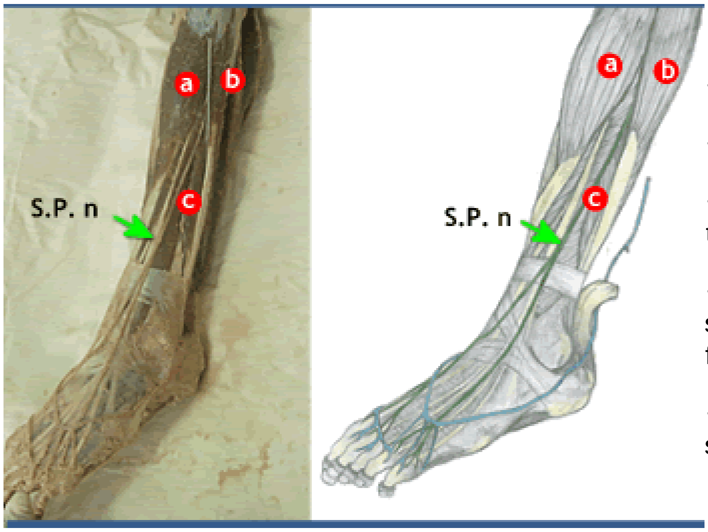
Palpable over lateral condyle of femur, head and neck of fibula

task ***at what points in the common peroneal nerve most likely to be injured ? what are the effects of injury to the common peroneal nerve.***

Branches:

- Muscular to short head of biceps femoris
- Articular to proximal tibiofibular joint
- Sural communicating nerve
- Lateral cutaneous nerve of the calf

a) The superficial peroneal nerve (S.P.n)



- Branches off common peroneal at the neck of fibula
- Descends through the peroneal muscles supplying them
- Becomes subcutaneous at junction of middle and lower thirds of the leg
- Its medial and intermediate dorsal cutaneous nerves supplies skin in the lower part of the leg and dorsum of the foot.
- Each divides into two dorsal digital nerves of the foot to supply the digits except the first interdigital cleft.

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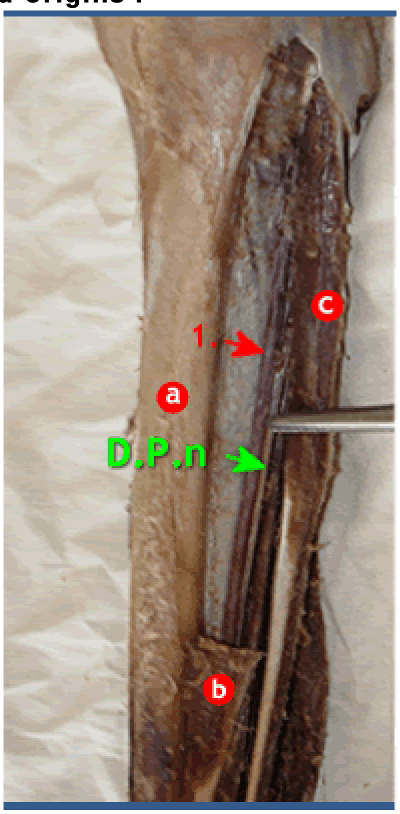
b) deep peroneal nerve

Course and origins .



- Arises between the neck of the fibula and peroneus longus
- Pierces anterior intermuscular septum and extensor digitorum longus and descends in the anterior compartment of the leg with anterior tibial vessels.
- Runs on the interosseus membrane between tibialis anterior and extensor digitorum longus.
- Lower down near the ankle it is crossed by superficially by extensor hallucis.
- At the ankle it lies between FHL and FDL

Branches & Distribution

Medial branch to first interdigital cleft

Lateral branch to extensor digitorum brevis

Muscular: to extensors, dorsiflexors of the ankle
Articular: ankle joint
Cutaneous: 1 st interdigital cleft
Injury: causes *foot drop*

Dorsum of Foot

Muscle	Origin	Insertion	Action
Tibialis Anterior	• Upper 2/3rds antero-lateral tibia • Inter-osseus membrane Fascia cruris	• Medial cuneiform Base of first metacarpal	• Ankle dorsiflexion • Inversion • Maintain medial longitudinal arch
Extensor hallucis longus	• Middle half of anterior fibula • Inter-osseus membrane	• Base of terminal phalanx of hallux	• Hallux dorsiflexion • Ankle dorsiflexion
Extensor digitorum longus	• Upper ¾ of anteromedial fibula • Lateral tibial condyle Interosseus membrane	• Lateral 4 toes through dorsal extensor expansion	• Dorsiflexion lateral 4 toes
Peroneus Tertius	• Lower third of fibula	• Base of 5th metatarsal	• Dorsiflexion Eversion
Extensor digitorum brevis	• Upper surface of calcaneus • Inferior extensor retinaculum	• Base of proximal hallux • Dorsal extensor expansion	• Toe dorsiflexion

Joints of the foot:

Subtalar joint:

talus plantar view   calcaneus dorsal view

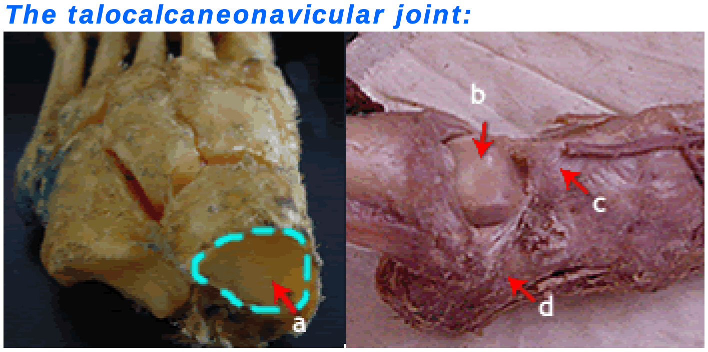
Synovial planar between inferior surface of the body of the talus and the facet on the middle of the upper surface of the Calcaneous

- Capsule attached to the margins of the margins of articular surfaces.
- Capsular ligaments include medial and lateral *talocalcaneal ligament* attaches to the sulcus tali and the sulcus calcanei.
- Main movements are **inversion** and **eversion**. Gliding and rotatory movements are also possible.

Mid-Tarsal (Transverse tarsal) joints:

Made of the talocalcaneonavicular joint, calcanoefibular joint and calcaneocuboid joints.

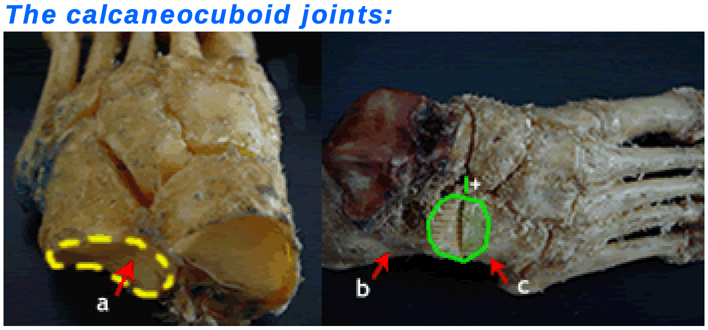
The talocalcaneonavicular joint:



(articular surface for talocalcaneonavicular joint)

Synovial ball and socket joint between head of the talus (ball) and calcaneus, navicular and spring ligament (socket). The spring ligament is covered by fibrocartilage on the superior aspect.

The calcaneocuboid joints:



(articular surface for calcaneocuboid joint)

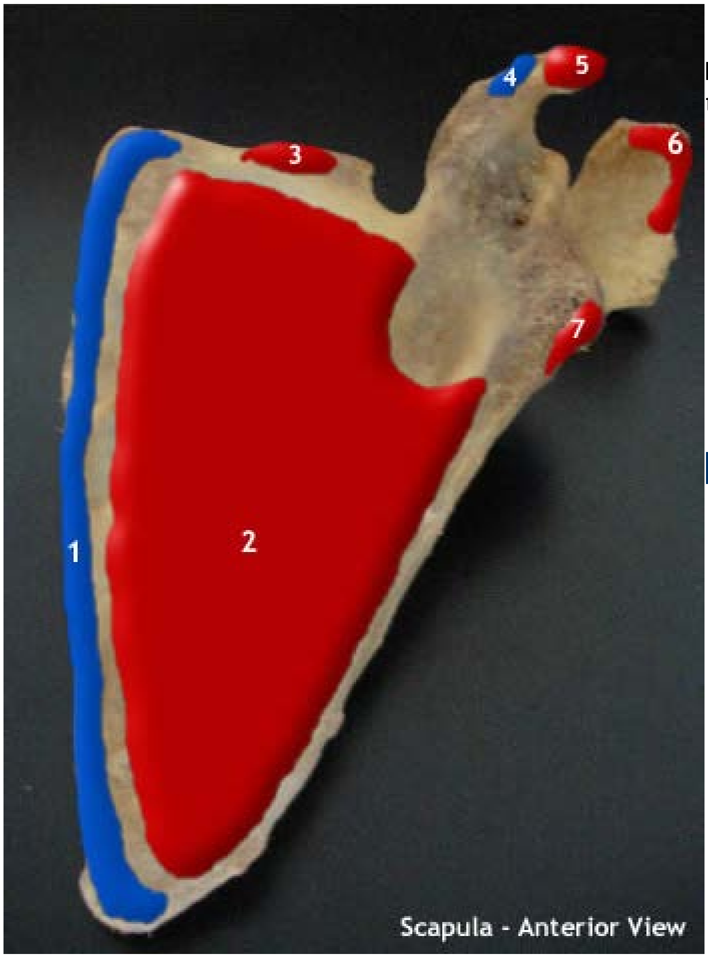
Synovial plane variety. The enclosing capsule is strengthened dorsally by the bifurcated ligament and the long and short planter ligaments inferiorly.

The main movements are *inversion* and *eversion*, but some *rotatory* and gliding movements also occur.

Refer to textbooks for other joints of the foot.

Sites of muscle attachments on the scapula

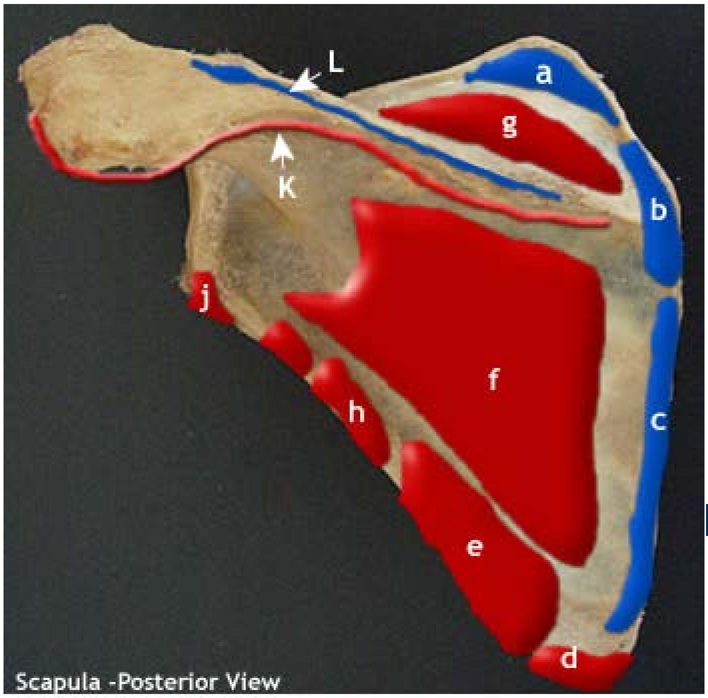
The Scapula: Anterior



Review the main parts and sites of muscle attachments onto the scapula

Hover over hotspot to show name

The Scapula: Posterior



Hover overhotspot to show information

CHAPTER 13: Back and Scapula Region

Muscles attached onto the scapula:

task ***Review the attachments, actions and innervation of the muscles attached onto the scapula.***

Muscle	Origin	Insertion	Innervation	Action
Trapezius	• External occipital protuberance • Along the medial sides of the superior nuchal line • Ligamentum nuchae (surrounding the cervical spinous processes) • Spinous processes of C1-T12	• Posterior, lateral 1/3 of clavicle. • Acromion. • Superior spine of scapula.	• Spinal accessory (efferent) • Ventral ramii C3, C4 (afferent)	• Elevates scapula • Upward rotation of the scapula (upper fibres). • Downward rotation of the scapula (lower fibres) • Retracts the scapula.
Lattisimus dorsi	• Spinous process of T7-L5 • Upper 2-3 sacral segments • Iliac crest • Lower 3 or 4 ribs	Lateral lip of the intertubercular groove	Thoracodorsal nerve C6,7,8.	• Adduction of humerus • Medial rotation of the humerus • Extension from flexed position • Downward rotation of the scapula
Deltoid	• Lateral, anterior 1/3 of distal clavicle. • Lateral border of acromion • Scapula spine	Deltoid tuberosity of humerus	Axillary nerve C5,6.	• Abducts the arm • Flexion and medial rotation (anterior fibres). • Extension and lateral rotation (posterior fibres).
Levator scapulae	Transverse processes of C1-C3 or C4	Superior angle of scapula toward the scapular spine	• Nerves off cervical plexus, C3,4 • Dorsal scapular	• Elevates the scapula. • Extends and/or laterally flexes the head.

			nerve, C5	
Rhomboid major	• Spinous processes of T2-T5 • Supraspinous ligament	Medial scapula from the scapular spine to the inferior angle	Dorsal scapular nerve, C5	Retract scapula
Rhomboid minor	• Spinous process of C7 & T1 • Ligamentum nuchae • Supraspinous ligament	Medial margin of the scapula at the medial angle	Dorsal scapular nerve, C5, [C4]	Retract scapula
Subscapularis	Subscapular fossa	Lesser tubercle of humerus	Upper & lower subscapular nerves, C5,6	• Medial rotation of the humerus • Stabilizes the glenohumeral joint
Teres major	Inferior, lateral margin of the scapula.	Crest of lesser tubercle (just medial to the insertion of latissimus dorsi)	Lower subscapular nerve, C5,6	• Assists in adduction of arm. • Assists in medial rotation of arm. • Assists in extension from an flexed position.
Teres minor	Middle half of the scapula's lateral margin	Lowest of three facets of the greater tubercle of humerus	Axillary nerve, C5,6	• Lateral rotation of the humerus. • Stabilizes the glenohumeral joint
Supraspinatus	• Supraspinous fossa • Muscle fascia	Uppermost of three facets of the greater tubercle of humerus.	Suprascapular nerve, C5,6	• Abduction of arm (first 15-20°) • Stabilizes glenohumeral joint
Infraspinatus	• Infraspinous fossa • Muscle fascia	Middle facet of greater tubercle of humerus	Suprascapular nerve, C5,6	• External rotation of the humerus. • Stabilizes the glenohumeral joint.
Pectoralis minor	Outer surface of ribs 2-5 or 3-5 or 6.	Medial aspect of coracoid process of the scapula.	Medial pectoral nerve, C8,T1	• Depresses & downwardly rotates the scapula. • Assists in scapular protraction from a retracted position.

- Stabilizes the scapula.

Articulations of the clavicle

The sternoclavicular joint

- **Synovial joint**, structurally plane, but **functionally ball and socket**.
- Formed between the **medial end of the clavicle**, clavicular notch of **manubrium** and adjoining **first costal cartilage**.
- Bony surfaces are lined by **fibrocartilage** not the usual hyaline cartilage.
- The capsule is thickened by **anterior and posterior sternoclavicular ligaments.**
- The major stability factor is the **costoclavicular** and **sternoclavicular ligaments**
- The **brachiocephalic vein** is formed immediately **behind** the joint
- **Movements** at this joint contribute to the **increase the range of movement of the upper limb**.

More info on the sternoclavicular joint

Acromioclavicular joint

- Synovial plane joint between lateral endms of the **clavicle** and the **acromion**.
- **Articular surfaces** are lined by **fibrocartilage** instead of hyaline cartilage.
- An incomplete **intracapsular fibrocartilage disc** hangs down into the upper part of the joint cavity.
- A **capsule** surrounds the articular surfaces, and is thickened superiorly by the **acromioclavicular ligament**
- Main stability factor is the **coracoclavicular** ligament, with its two parts **conoid** and **trapezoid**.
- The joint is innervated by the **suprascapular nerve**.
- Allows **passive movements** of prortraction/retraction; rotation; elevation/depression

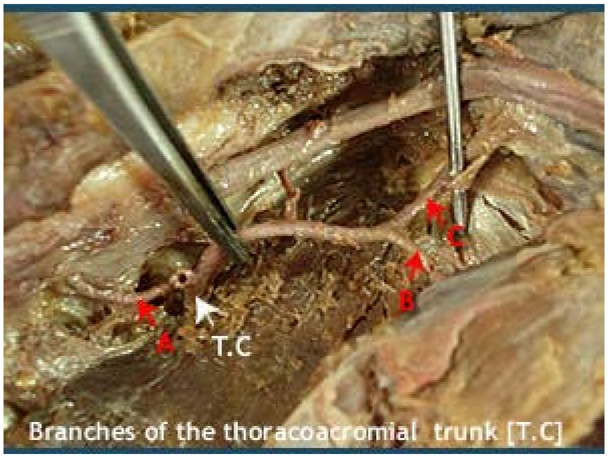
More info on the acromioclavicular joint

Weight/Force transmission along the clavicle

Forces from the humerus are transmitted via the glenoid cavity to the clavicle by the trapezoid ligament and from the clavicle to the first rib through the costoclavicular ligament.

Thus a fall on the outstretched hand or elbow puts no strain on either end of the clavicle at the joints. If the clavicle fractures as a result, it always does so between these ligaments.

Blood supply to the clavicle



Branches of the thoracoacromial trunk [T.C]

The clavicle receives blood supply from the ***clavicular [A]*** and ***acromial*** branches of the ***thoracoacromial* [T.C]artery**.

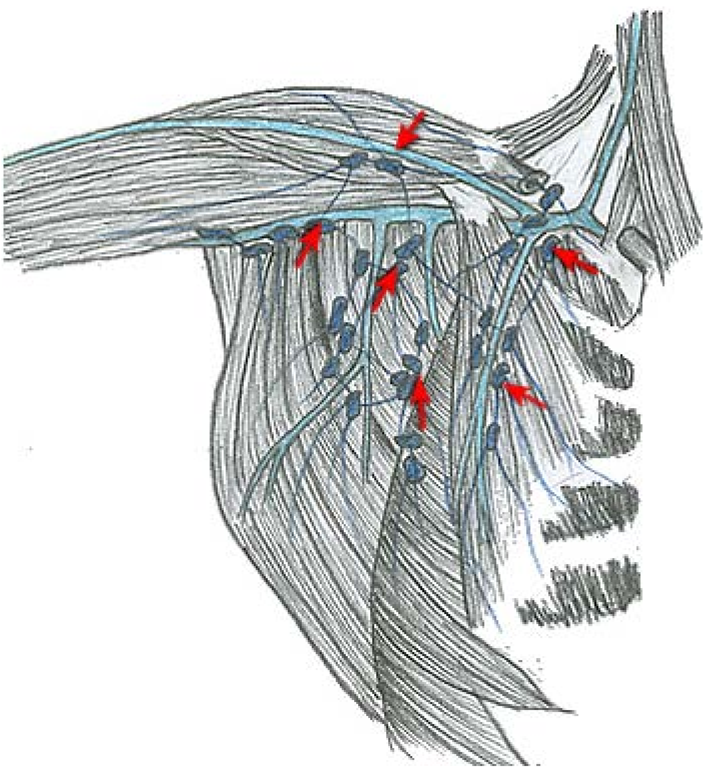
Note: *Thoracoacromial trunk [T.C] and its branches :- Clavicular [A], Pectoral [B] and Deltoid*

task ***What is the pattern of blood supply to the clavicle and what the importance of this in clavicular fractures?***

Applied Anatomy Of The Clavicle

CHAPTER 14: THE PECTORAL REGION AND THE AXILLA

Axillary lymph nodes



They number 20-30,and drain lymph from the following:

1. Lateral quadrants of the breast
2. Superficial lymph vessels from thoracoabdominal walls above the umbilicus
3. The back
4. Upper limb
5. Lower neck

They are arranged in 6 groups:

Group	Location	Drainage
1) Anterior (pectoral group)	*Along lower border of pectoralis minor*	• Lateral quadrants of breast • Anterolateral abdominal wall
2) Posterior scapular) group	*In front of subscapularis*	The back down to the iliac crest
3) Lateral group	*Medial side of axillary vein*	Upper limb except superficial vessels from lateral side
4) Central group	*Axillary fat in the center*	From the above three groups
5) Infraclavicular (deltopectoral)	*Between pectoralis major and deltoid*	Superficial lateral hand, forearm

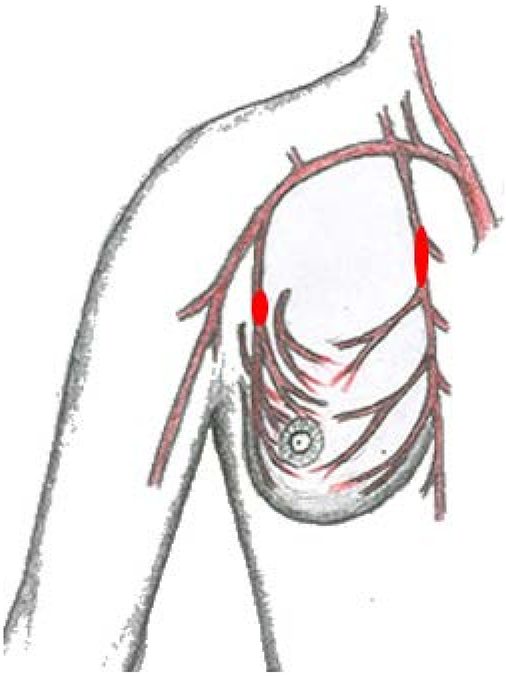
group		and arm
6) Apical group	*Apex, at lateral border of the first rib*	All the other axillary nodes

Efferents

The apical nodes drain into the **subclavian trunk.** On the left side, this trunk drains into the **thoracic duct**; on the right side, it drains into the **right lymphatic trunk**. The lymph trunks may drain directly into one of the large veins at the root of the neck.

CHAPTER 14: THE PECTORAL REGION AND THE AXILLA

Blood supply



The breast receives its blood supply from the following arteries:

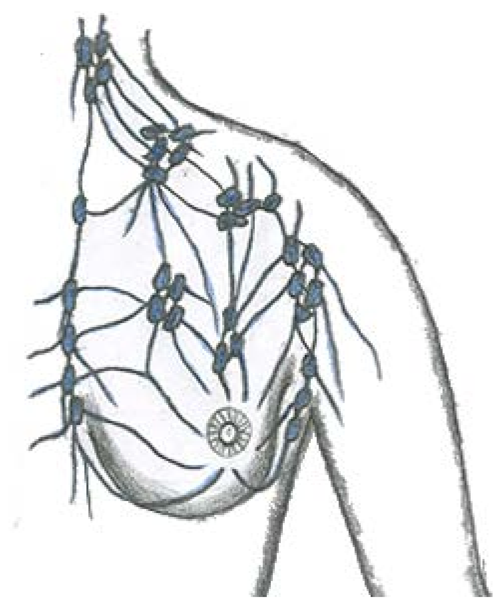
1. *Lateral thoracic*
2. Perforating branch of *internal thoracic*
3. Perforating branch of *posterior intercostal* arteries
4. Twigs from *superior thoracic* and *pectoral branch of tharacoacromial.*

Veins correspond and end in the ***axillary vein***, or ***subclavian vein*** directly.

Veins which accompany the intercostal veins, end in the ***azygous venous system***.

The intercostal veins communicate with the external and from thence to the internal ***vertebral venous plexus***.

Lymphatic drainage



There are two plexuses of lymphatic vessels i.e. the *subareoalar* and the *perilobular.* These anastomoses freely. Their efferents are shown.

1. 78-80% to the ***axillary lymph node***s
2. 20% to the ***parasternal nodes***

Communicate with:

- Opposite breast
- ***Infraclavicular*** and ***supraclavicular nodes***
- ***Subperitoneal*** and ***subdiaphragmatic nodes***

task ***What is the importance of the lymphatic drainage in breast cancer metastasis?***

Brachial Plexus

Part	Branch	Distribution
Roots	Dorsal scapular (c5)	• Levator scapulae • Rhomboids
	Long thoracic (C5, 6,7)	• Serratus anterior
	Phrenic (C3, 4, 5)	• Thoracic diaphragm
Trunks	Nerve to subclavius (C5, 6)	• Subclavius muscle
	Suprascapular (c5, 6)	• Supraspinatus • Infraspinatus
Lateral cord	Lateral pectoral (C5,6,7)	• Pectoralis major
	Musculocutaneous (C5,6,7)	• Biceps brachii, coracobrachialis, brachialis
	Lateral root of median nerve	• See median nerve
Medial cord	Medial pectoral (C8, T1)	• Pectoralis major and minor
	Medial cutaneous nerve of the arm (C8-T1)	• Medial arm
	Medial cutaneous nerve of the forearm (C8-T1)	• Medial forearm
	Medial root of median nerve (C8-T1)	• See median nerve
	Ulnar nerve (C8-T1)	• Forearm and hand
Posterior cord	Upper Subscapular	• Subscapularis

Lower Subscapular	• Subscapularis and teres major
Axillary nerve	• Deltoid, teres minor, shoulder joint, skin over deltoid
Thoracodorsal	• Latissimus dorsi
Radial nerve	• Extensor muscles of arm and of forearm • Sensory back of arm, forearm and hand

Communications of the brachial plexus

- Sympathetic from the inferior cervical ganglion
- Intercosto-brachial nerve from T2
- Phrenic nerve
- Cervical plexus

Spaces in the upper arm

Quadrangular space

Boundaries

Medially: Long head of triceps brachii
Laterally: Surgical neck of Humerus
Superioly: Teres minor
Inferiorly: Teres major

Contents

Posterior circumflex humeral artery
Axillary nerve

Significance

Contents liable to injury in shoulder dislocation of fracture surgical neck of Humerus

Upper triangular space

Boundaries

Superior: Teres minor

Inferior: Teres major

Laterally: Long head triceps

Contents:

Circumflex scapular artery

Lower triangular space

Boundaries

Medially: Long head triceps brachii
Laterally: Radial groove
Superiorly: Teres major

Contents

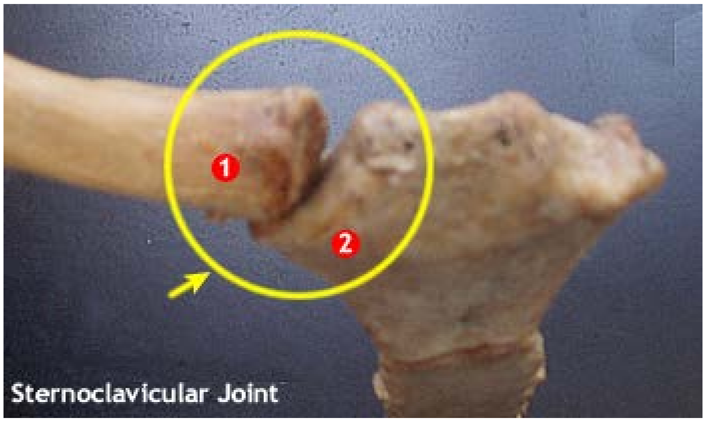
Profunda brachii artery (PBA)
Radial nerve

Significance

Injury to radial nerve and PBA in fracture humeral shaft

Sternoclavicular Joint

Classification

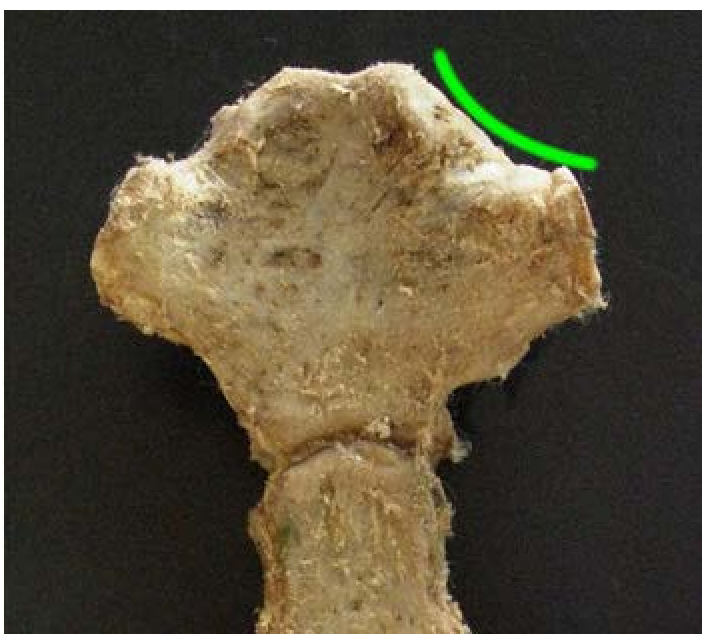


This is a **synovial joint** of the saddle type between the medial end of the clavicle ***(1)*** and the shallow notch of the manubrium of the sternum ***(2)***. Functionally ball and socket

Articulating Surfaces

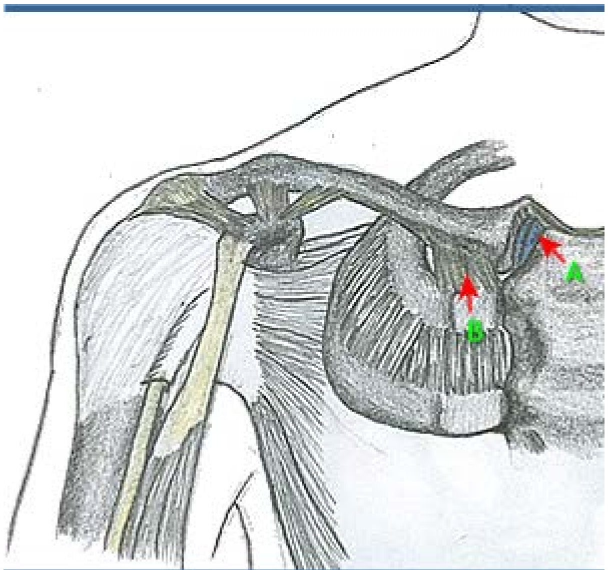
The **clavicular notch** at the superolateral angle of manubrium sterni. It is slightly convex anteroposteriorly, and slightly concave vertically.

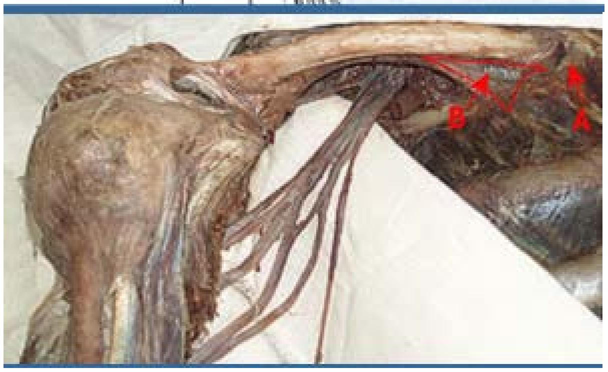
The **sternal end of the clavicle**, shaped reciprocally but much larger.



The **medial end of the upper surface of the 1 st costal *cartilage***, continuous with the sternal facet

Capsule and Ligaments





The fibrous capsule unites the articular margins.

Ligaments

- **Anterior and posterior sternoclavicular ligaments**
- **Interclavicular ligament**

The joint has an inter-articular disc

The **articular disc** ***(A)*** **divides** the joint cavity into medial and lateral compartments.

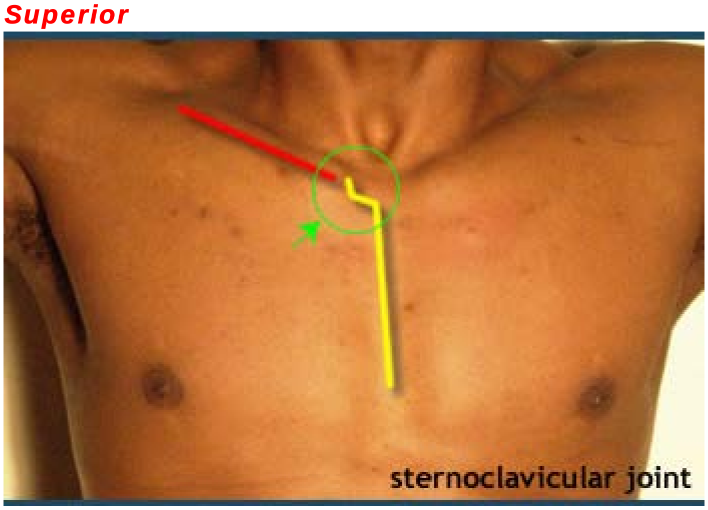
Synovial membrane

The synovial membrane lines the capsule and both surfaces of the disc

---

Relations

Superior



Subcutaneous tissue and skin

Anterior

The sternal head of sternocleidomastoid, and below that, pectoralis major.

Posterior

The sternohyoid and the sternothyroid muscles.

The brachiocephalic artery bifurcates behind the right joint, and the left brachiocephalic vein intervenes between the left joint and the left common carotid and subclavian arteries

---

Blood-supply And Innervation

Blood Supply

Twigs from the internal thoracic and suprascapular arteries

Innervation

The medial supraclavicular nerves and the subclavian nerve

Movements

Movement is free, almost as in a ball-and-socket joint.

Upward and downward movements of the clavicle take place in the lateral compartment.

Upward movement tightens the costoclavicualr ligament, but the ligament is so close to the fulcrum that considerable amount of elevation is allowed.

Downward movement tightens the disc and the interclavicular ligament.

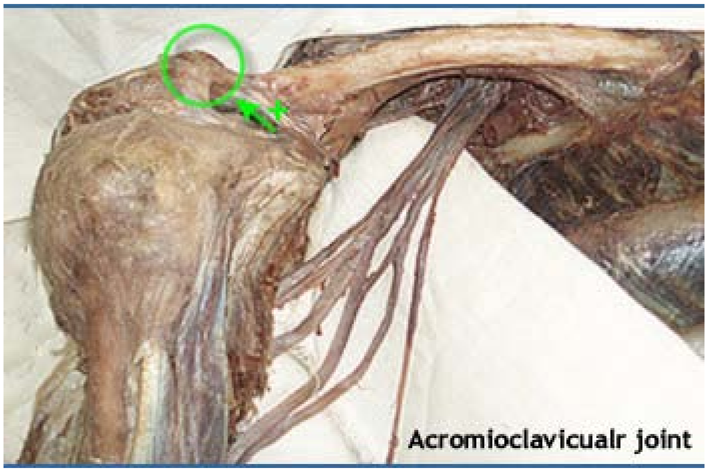
Backward and forward movements take place in the medial compartment, and are checked by the costoclavicualr ligament.

In free movements of the upper limb, as in throwing or bowling or when the limb is used for traction, the clavicle

tends to be avulsed from the sternum. This is resisted by the costoclavicular ligament, the interclavicular ligament and subclavius.

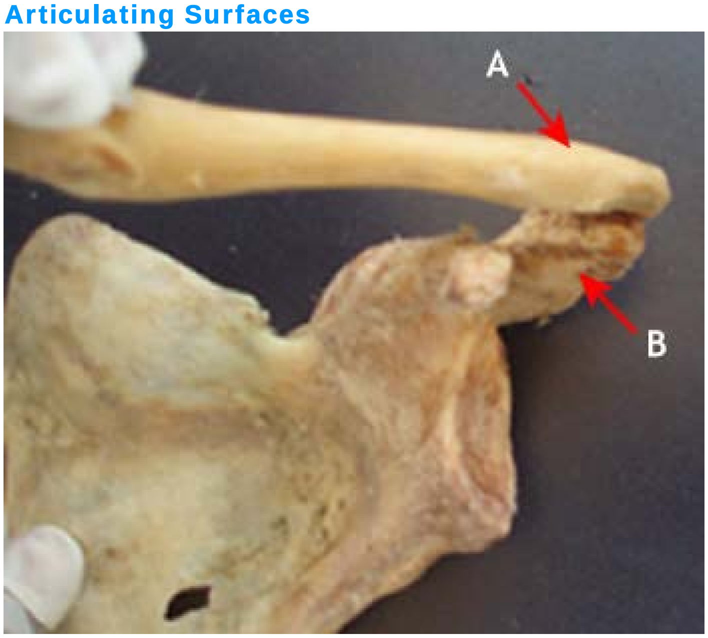
The Acromioclavicular Joint

Classification



The acromioclavicular joint is a **synovial joint of the plane or gliding type** .

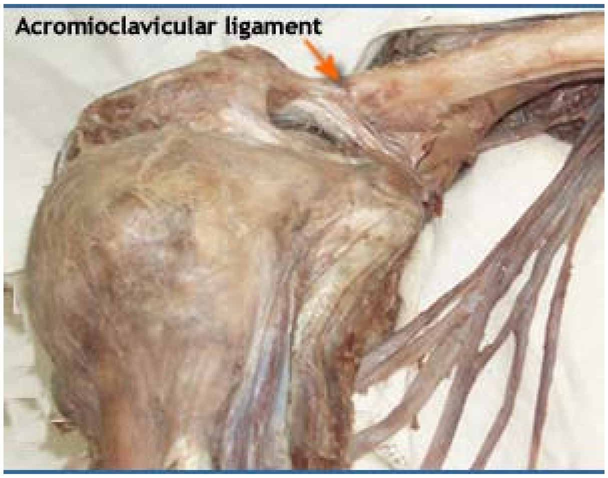
Articulating Surfaces



Both of the articular surfaces involved are flat and oval. The ***facet on the acromial end of the clavicle*** faces downwards and laterally
The ***facet on the medial edge of the acromion*** faces upwards and medially

Capsule

The **fibrous capsule** unites the articular margins. It is thickened above to form the ***acromioclavicular ligament***, which resists the tendency for the clavicle to glide laterally.
An **intra-articular disc** is usually present.



Synovial membrane

Lines the capsule and both sides of the disc.

Relations

Superior

The joint is subcutaneous above. Fibres of the deltoid and of trapezius are attached to the capsule. The deltoid extends on to the anterior surface and trapezius on to the posterior surface.

Anterior

The coraco-acromial ligament is attached just in front of the scapula.

Inferior

The subacromial busa separates it from supraspinatus.

Blood-supply And Innervation

Blood Supply

Derived from branches of the suprascapular and thoraco-acromial arteries.

Innervation

suprascapular nerve

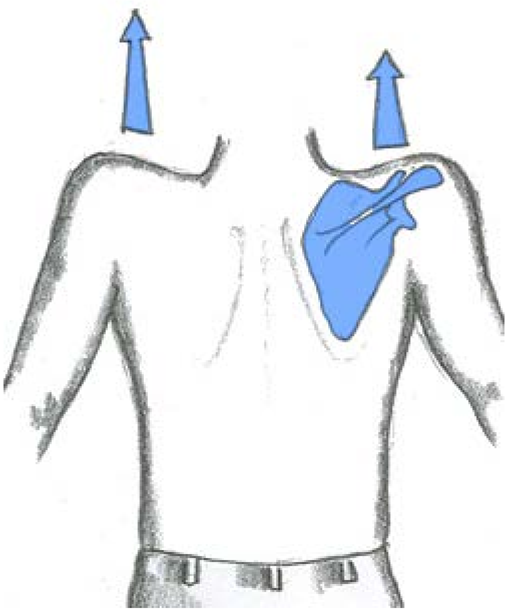
Movements

Forward and backward gliding movements can occur and the scapula can rotate in its own plane.
These movements are important as part of the total mechanism of the pectoral girdle, when the scapula swings on the coracoclavicular ligament and the clavicle moves at the sternoclavicualr joint.

Scapulo Thoracic Joint

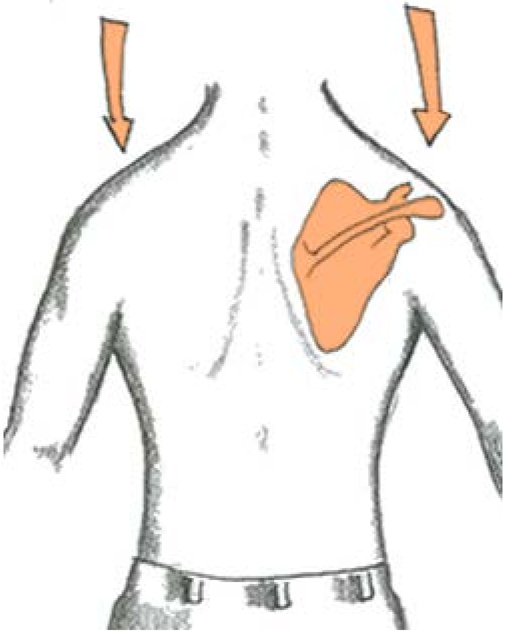
This is the connection of the scapula to the thoracic wall mainly muscular and fascial connection. The muscles are best classified according to the movements which they bring about on the scapula.

Elevation of the scapula



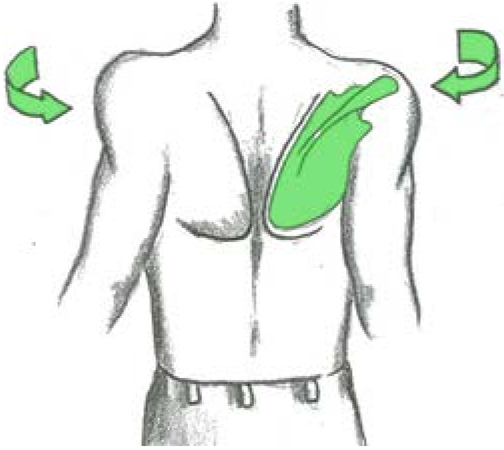
- Upper part of trapezius
- Levator scapulae
- Rhomboideus major and minor

Depression of scapula



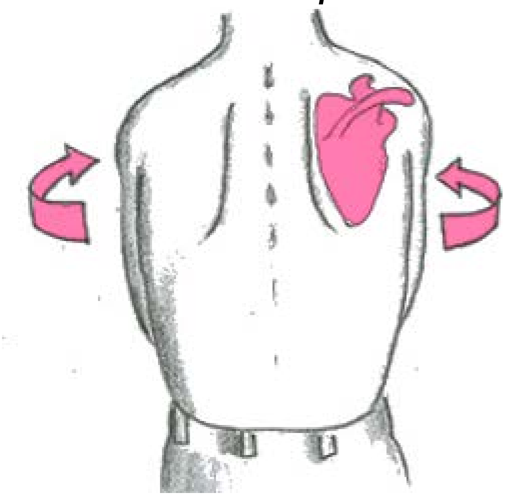
- Weight of upper limb
- Pectoralis major,
- latissimus dorsi, (Sternocostal head)
- Lower part of trapezius

Retraction of the scapula



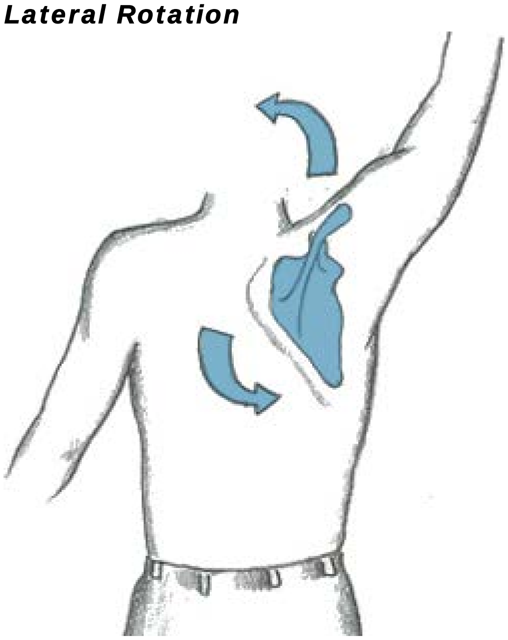
- Rhomboid muscles
- Middle part of trapezius

Protraction of the scapula



- Pectoralis minor
- Serratus anterior

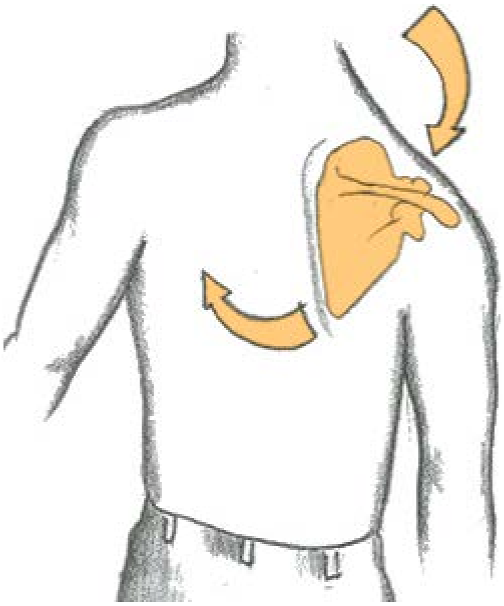
Lateral Rotation



- Upper part of trapezius
- Lower part of the trapezius
- Lower 4 digitations of serratus anterior

Medial Rotation

- Pectoralis minor
- Latissimus dorsi,
- Sternocostal head of the pectoralis major.



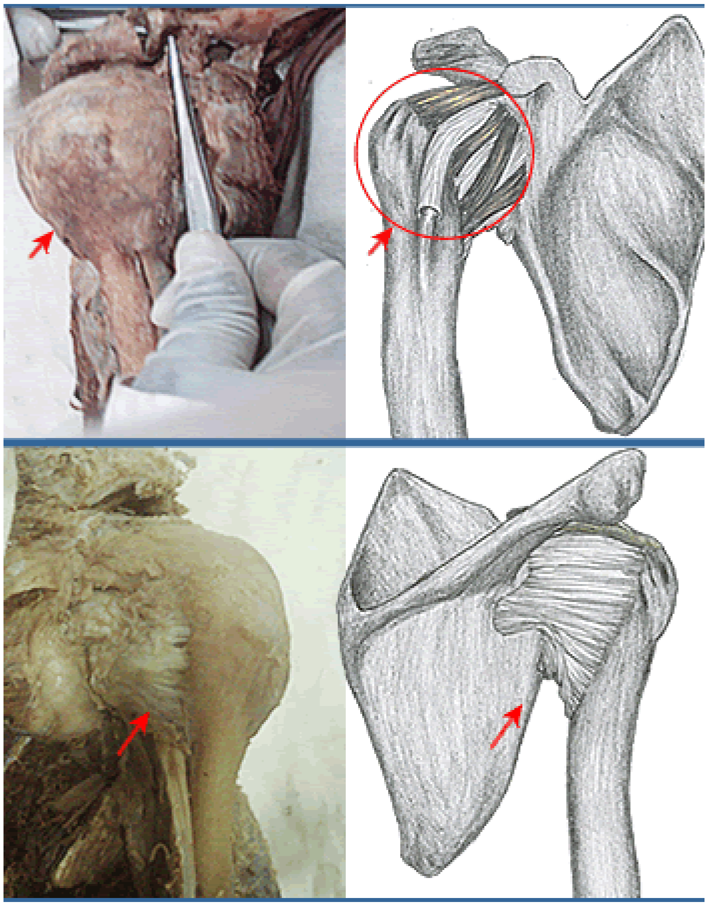
Coracoclavicular Joint

The coracoclavicular ligament maintains apposition of clavicle to acromium. It has two parts:

- **Trapezoid**
- **Conoid**

4.3 The Capsule and ligaments

4.3 a) Fibrous Capsule



The fibrous capsule is attached :-

- Proximally to the *margin of the glenoid cavity*, except where it deviates above to enclose the supraglenoid tubercle.
- Distally, it is attached to the *anatomical neck of the humerus* and the *transverse humeral ligament*, which bridges the sulcus between the greater and lesser tubercles.

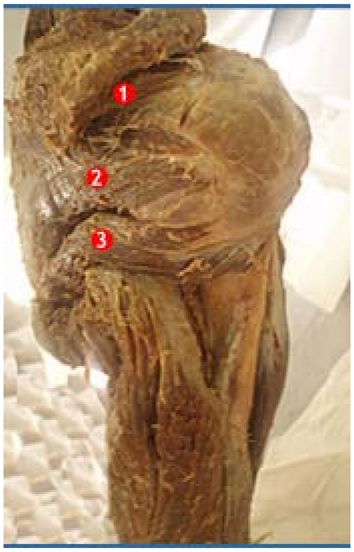
Anteriorly and posteriorly, the distal attachment diverges from the articular margin of the head reaching 1 cm below the articular margin.

The latter fact is important as infection occurring in the humeral metaphysis has direct access to the interior of the shoulder joint

4.3 b) Rotator Cuff

The capsule is strengthened by the fusion with it, of the tendons of **subscapularis** ,***supraspinatus*** , ***infraspinatus***, and ***teres minor***. These form the ***rotator cuff***

(note on the right the supspinatus [1], infraspinatus [2] and teres minor [3] tendons fusing with the joint capsule)



4.3 c) Coracohumeral ligament

It reinforces the shoulder joint above.
it is attached

1. To the *lateral edge of the coracoid*, deep to the coraco-acromial ligament, and
2. To the *anatomical neck* close to the tubercles of the humerus.

   Just below it is a communication between the synovial cavity and the *subtendinous bursa of subscapularis*.

4.4 d) Glenohumeral ligaments

These consist of the *superior*, *middle* and *inferior* parts

Note the following about the capsule:

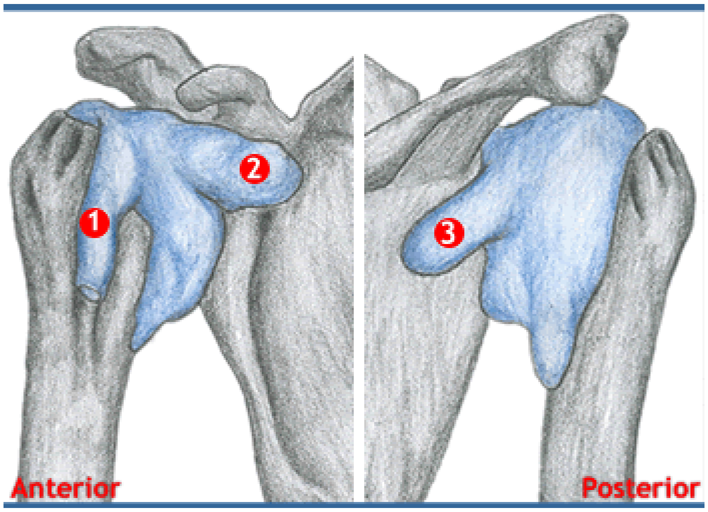
1. Generally lax and confers little stability to the joint
2. Allows the articulating surfaces to be separated from each other more than 2.5 cm *(an evident provision for that extreme freedom of movement which is peculiar to this articulation .)*

4.5 The synovial membrane

Lines the fibrous capsule.

It ensheathes the ***tendon of the long head of biceps*** ***(1)*** completely,

It protrudes to form: ***subscapularis bursa*** ***(2)*** and ***infraspinatus bursa*** ***(3)***

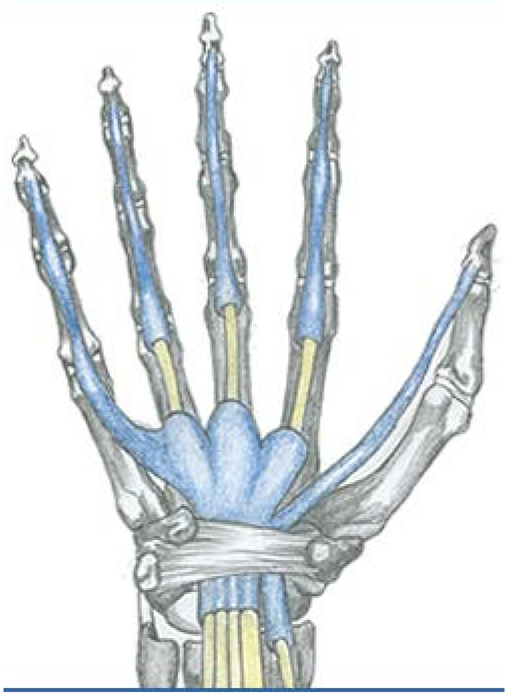

1
2
3
Anterior
Posterior

CHAPTER 18 : The Joints of the wrist , hand and fingers

Applied anatomy

CHAPTER 18 : The Joints of the wrist , hand and fingers

Fibrous and Synovial Flexor sheaths



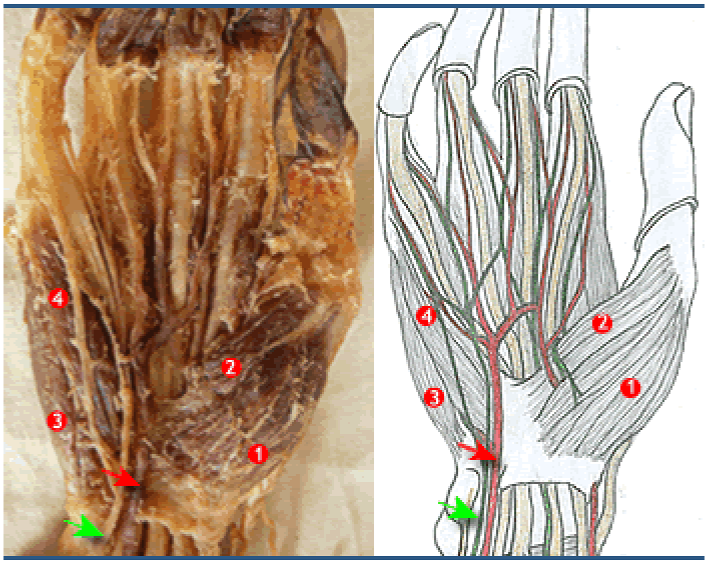
- Fibrous flexor sheaths form **tunnels for digital tendons**. Each tunnel holds the deep and superficial flexor tendons except the pollex where the tunnel contains only the flexor pollicis longus.
- The sheaths are alternately dense (**annular pulleys**) and lax (c**ruxiform pulleys**) along the fingers.
- Tendons within the carpal tunnel are invested with synovial sheath that extend proximally about 3cm in lower part of the forearm.
- Tendon of superficialis and profundus are enclosed together in a sheath incomplete on the radial side
- This common sheath is only extended to the terminal phalanx of the small digit
- The sheath ends beyond the flexor retinaculum for the index, ring and middle finger. However a separate synovial sheath lines the fibrous flexor tunnels.
- The tendon of flexor pollicis longus has its own sheath that continues from the carpal tunnel to the distal phalanc of the pollex. These sheaths communicate with the common sheath for the profundus and superficialis in about 50% of individuals.

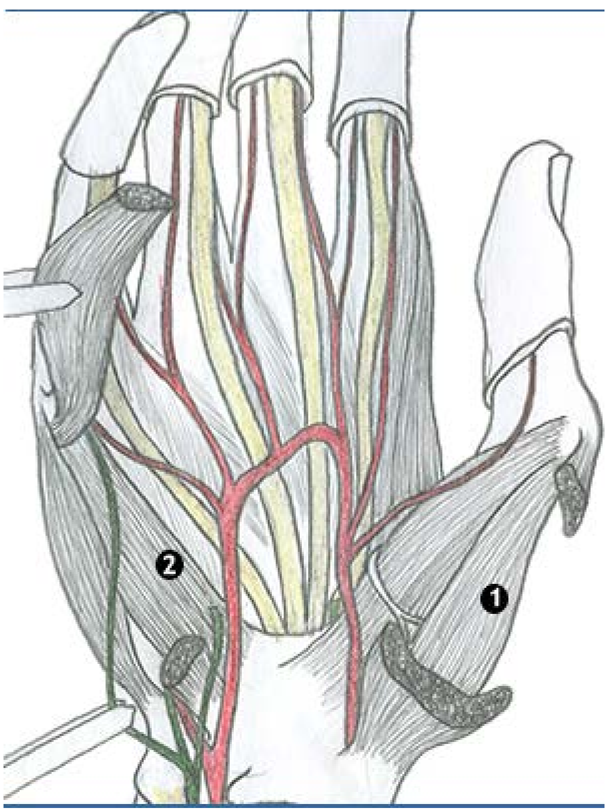
Home | OG anatomy | Gross Anatomy | Topic index | Chapter 17

CHAPTER 17 : Radioulnar Joints and the Wrist Region

Learning points | Core anatomy | Applied anatomy | Review questions

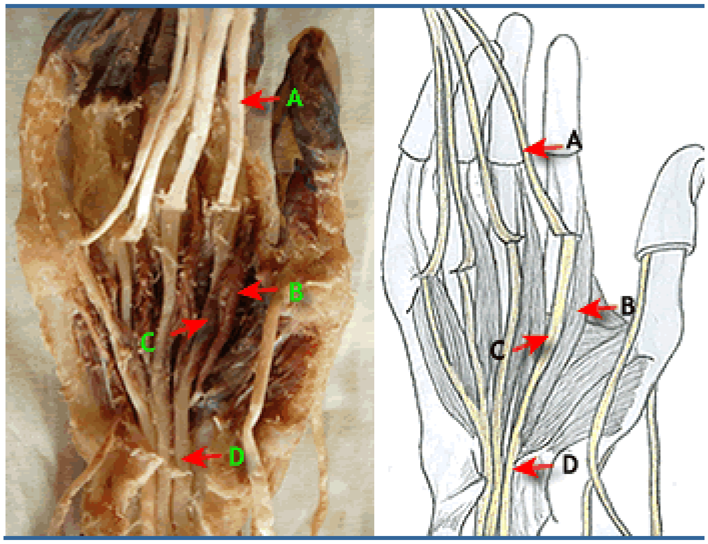
Hand Muscles





1. Opponens pollicis

2.Opponens digiti minimi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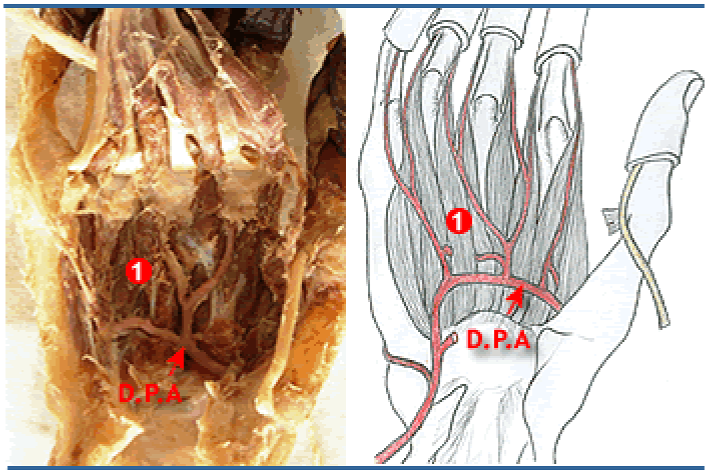
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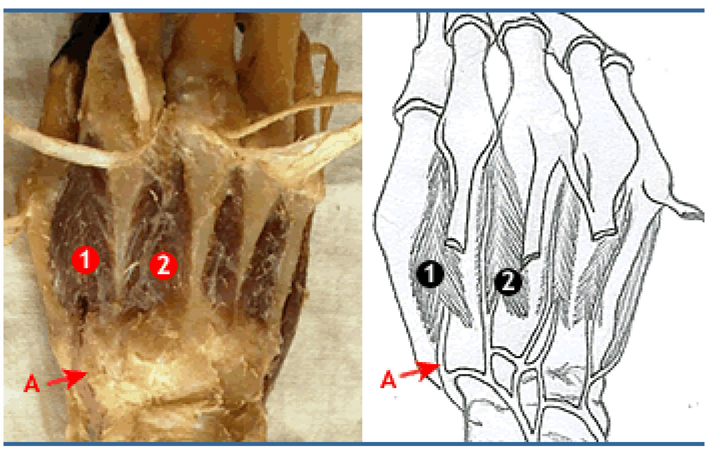
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CHAPTER 18 : The Joints of the wrist , hand and fingers

Muscles of the hand

Muscle	origin	insertion	Nerve supply	Action(s)
Abductor pollicis brevis	Flexor retinaculum, tubercle of scaphoid	Radial side base of proximal phalanx , FPL	Recurrent branch of Median	Abduction of thumb ***(Can you demonstrate this movement?)*** , Assist thumb extension
Flexor pollicis brevis	Flexor retinaculum, trapezium, trapezoid, capitate	Radial Sesamoid of thumb/proximal phalanx	Recurrent branch of Median/variable	Thumb flexion (thumb drawn across palm)
Opponens pollicis	Flexor retinaculum, trapezium	Radial border of first metacarpal	Recurrent branch of Median	Opposes metacarpal of thumb. ***Can you demonstrate this movement?***
Abductor digiti minimi	Pisiform, tendon of FCU	Ulnar side of base proximal phalanx	Deep branch of ulnar nerve (T1)	Cupping of the palm/ assist in hand grip
Flexor digiti minimi brevis	Flexor retinaculum, hook of hamate	Ulnar side of base proximal phalanx	Deep branch of ulnar nerve (T1	Cupping of the palm/ assist in hand grip
Opponens digiti minimi	Flexor retinaculum, hook of hamate	Ulnar border of 5 th metacarpal	Deep branch of ulnar nerve (T1	Cupping of the palm/ assist in hand grip
Palmar interrossei (3)	Middle finger side of index, ring and ring finger metacarpals	Extensor expansion and proximal phalanx of respective finger	Deep branch of ulnar nerve (T1	Finger adduction
Dorsal interrossei (4)	Arise by two heads from adjacent metacarpal bones	Extensor expansion and proximal phalanx of respective finger	Deep branch of ulnar nerve (T1	Finger abduction
Lumbricals	Tendons of flexor digitorum profundus	Extensor expansion	Median Ulnar	Flexes MP joint, extend IP joint

Palmaris brevis

Be sure you can demonstrate the following thumb movements;

- Palmar abduction,
- Radial abduction
- Ulnar adduction,
- Flexion adduction and
- Opposition (see Last)

Also note the hand grips firm, hook and pinch grips.

---

objectives

1. Examine the bones of the forearm and learn their parts and sites of muscle attachments on them
2. Examine the configuration of the articular surfaces , classification , and relations of the radioulnar and wrist joints and appreciate the movements and their functions at these joints
3. Examine the muscles of the forearm
4. Examine the structures that hold the radius onto the ulna
5. Identify the carpal bones
6. Examine the boundaries , relations and contents of the carpal tunnel and appreciate the clinical importance of the tunnel

CHAPTER 18 : The Joints of the wrist , hand and fingers

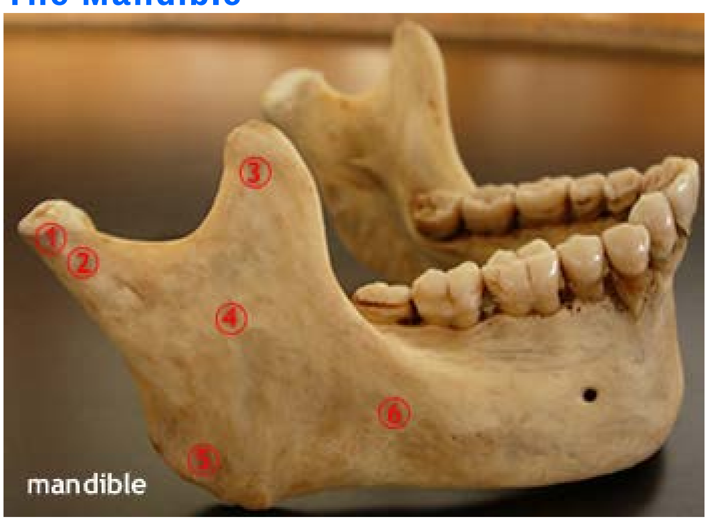
The Palatine Bone

- Separates oral and nasal cavities
- Right and left joined by inter-palatine suture
- Parts
  - Horizontal
  - Vertical
- Foramina
  - Greater palatine
  - Lesser palatine

The Lacrimal Bones

- Form part of medial orbital wall
- Medial surface forms a small portion of the nasal passage
- Posterior lacrimal crest divides this surface into an orbital plate and the lacrimal sulcus.

The Mandible



- **Parts:**
  - Body
  - Angle
  - Ramus
  - Coronoid
  - Condylar
  - Alveolar
- **Foramina**
  - Mandibular
  - Mental
  - Lingual
- **Tubercles**
  - Superior and inferior geniod tubercles
- **Fossae and Grooves**
  - Submandibular
  - Submental

Crest

- Mylohyoid

OG anatomy J. Ogeng'o palsoftweblink

Learning points

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1. **Carrying angle and Cubital fossa**
2. **Elbow joint and arm**
3. **Bones**
4. **Muscles of forearm**
5. **Vessels of forearm**
6. **Nerves of forearm**

- **Radial**
- **Ulna**
- **Median**

6. **Radio-ulnar joint**
7. **Anatomical snuffbox**
8. **Applied Anatomy**

TIP

You can either use the navigation buttons to go through the entire content or the learning points links for specific content

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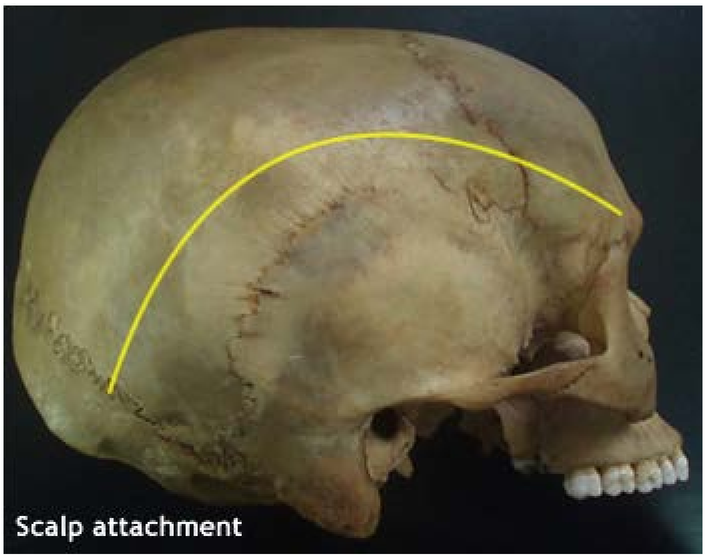
THE SCALP

The scalp is the composite soft tissue structure that covers the [calvaria.](#)

Extents



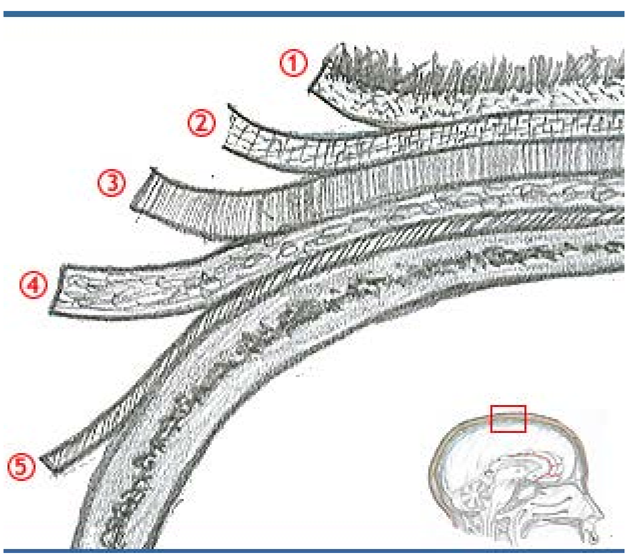
Scalp attachment

Superiorly: Superior nuchal line.

Laterally: Superior temporal line and continous with the fascia over temporalis muscle.

Anteriorly: Attached to the upper part of orbicularis oculi and the overlying skin of the eyebrow.

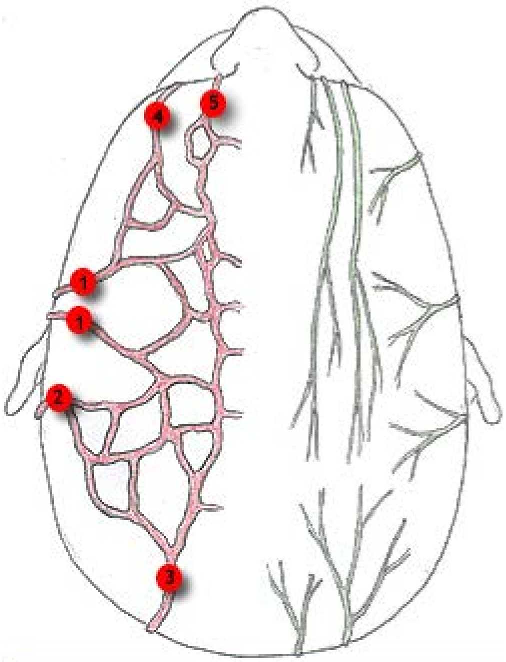
Layers



Skin: Thick, hairy and rich in sweat glands.
Connective tissue: Dense, irregular and highly vascular.
Aponeurosis: Unites frontalis and occipitalis muscles.
Loose areolar tissue:Potential space.
Pericranium:Attaches to suture lines.

Blood supply

Arterial:



External carotid branches:

1. Superficial temporal artery.
2. Posterior auricular artery.
3. Occipital artery.

Internal carotid branches:

1. supraorbital artery
2. Supratrochlear artery, both from the opthalmic artery.

Note:

- *These branches anastomose freely with each other threfore scalp wounds bleed profusely but heal rapidly when cut.*
- *The arterial walls are attached to the dense connective tissue of the second layer of the scalp and tend to be held open and bleed profusely when cut.*

Venous:

The veins run back with the arteries.

- The supraorbital and supratrochlear veins drain into the facial vein
- The superficial temporal vein drains into the retromandibular vein.
- Occipital veins drain into the vertebral veins.
- The posterior auricular vein drains into the external jugular vein.

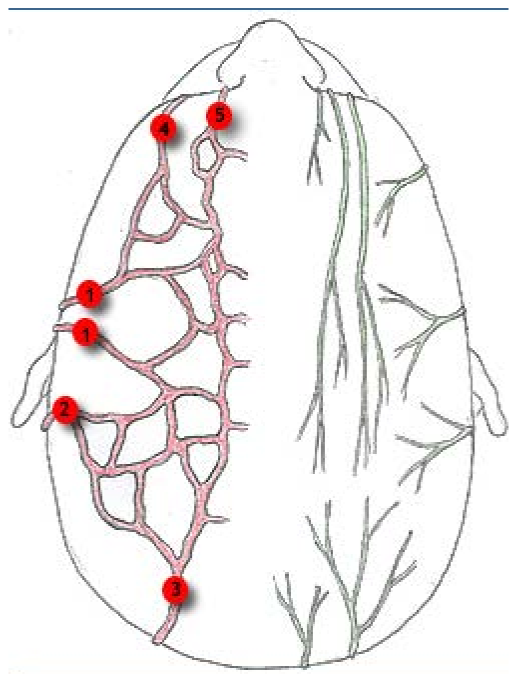
The veins connect with intracranial sinuses through emissary veins

Innervation

The scalp receives sensory innervation from:

- Supratrochlear Nn
- Supraorbital Nn
- Zygomaticotemporal Nn
- Auriculotemporal Nn
- Lesser occipital Nn (C2,C3)
- Greater occipital Nn (C2)
- Third occipital Nn (C3)

Facial nerve supplies occipito-frontalis muscle



Lymph drainage

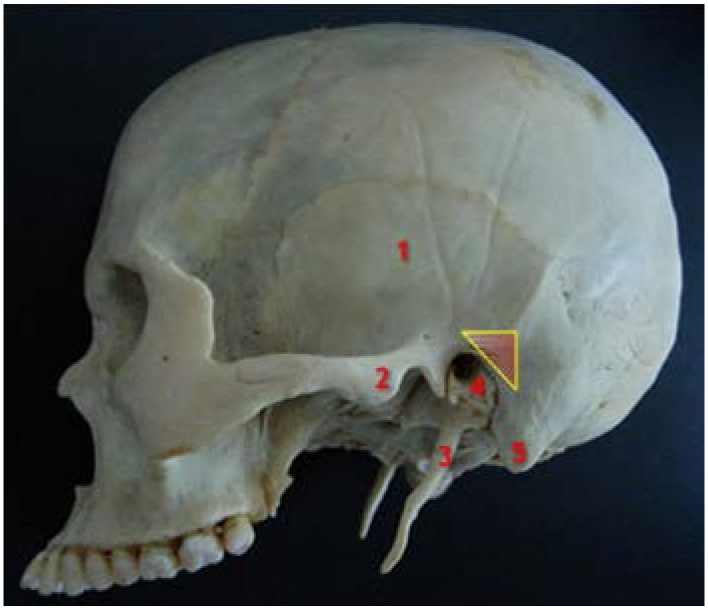
- Lymphatic channels from the posterior half of the scalp drain to occipital and posterior auricular nodes
- Lymphatic channels from anterior half drain to the parotid nodes.
- The lymph eventually reaches the submandibular and deep cervical nodes .

THE SKULL AND SCALP

SKULL BONES

The Neuro Cranium

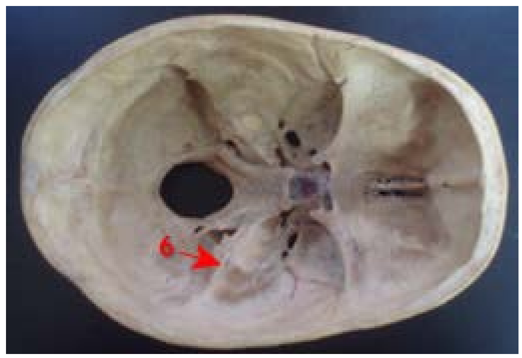
Temporal Bone



Hover over hotspot to show name

Has the following parts:

- Squamous part.
- Styloid process.
- Mastoid process.
- Zygomatic process.
- Tympanic part
- Petrous part



Frontal Bone

Has the following parts:

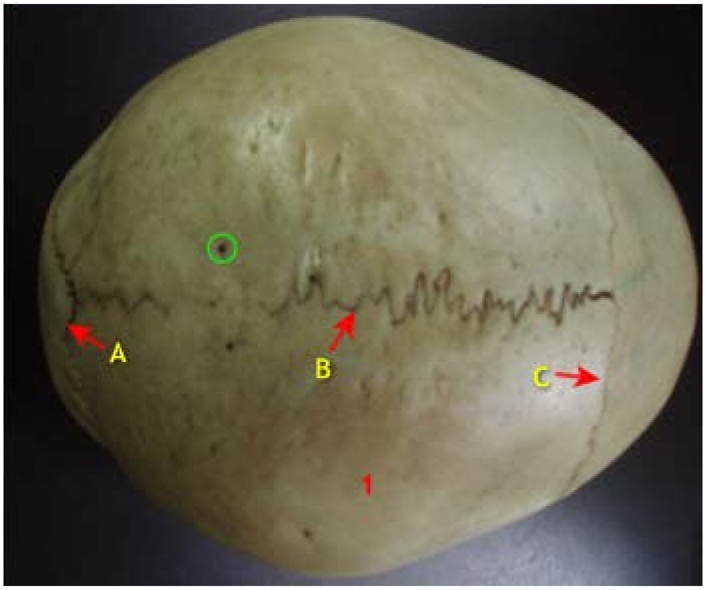
- Squamous **(1)**
- Orbital process **(2)**
- Nasal process **(3)**

Note:

The frontal bone articulates with the paired parietals along the coronal suture and forms the forehead

Above the orbit the frontal bone posseses a supraorbital notch or if completely surrounded by bone, a supraorbital foramen.

Parietal Bone



On the external surface , each possess a Superior, and Inferior Temporal Line, to which the muscle temporalis is attached.

Review Questions

1. Describe the location , relations , blood supply , lymphatic drainage and secretomotor pathway for the parotid , submandibular and sublingual glands
2. Give an account of the branches and distribution of the external carotid artery . Add notes on the sites of anastomosis between external and internal carotid arteries
3. Outline briefly the boundaries and contents of the infratemporal fossa. Do specific notes on a) attachments and actions of the temporalis and pterygoid muscles b) parts and distribution of the maxillary artery and their distribution c) branches and distribution of the Mandibular nerve
4. Describe the origin , course and distribution of the hypoglossal nerve
5. Outline the attachments and relations of the hyoglossus muscle
6. Write briefly about : a) styloid apparatus b) parts , foramina , relations and sites of muscle attachments on the mandible
7. Give a brief account of the classification , stability factors , relations , blood supply , innervation and movements (including relevant muscles) of the temporomandibular joint .

Structures entering in between pharyngeal muscles

Above superior constrictor:	Between superior and middle constrictor	Between middle and inferior constrictor	Below inferior constrictor
• Auditory tube • Levator palati • Ascending palatine artery	• Stylopharyngeus • Glossopharyngeal nerve	• Internal laryngeal nerve • Superior laryngeal artery	• Recurrent laryngeal nerve • Inferior laryngeal nerve

Pharyngeal venous plexus

Location: Posterior wall and borders of pharynx.

Tributaries: Receives blood from pharynx and palate through pharyngeal and nasopalatine veins.

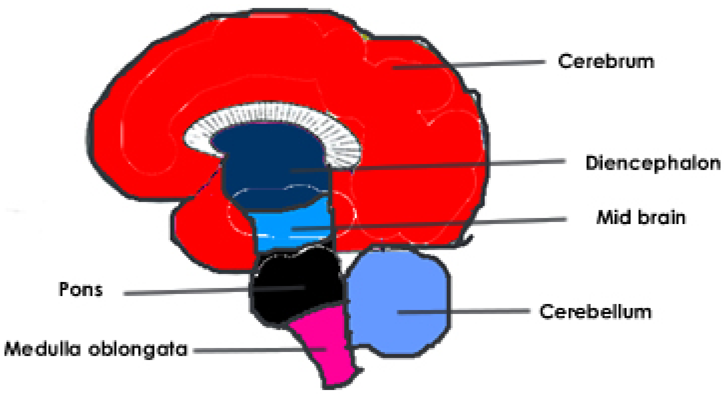
Termination: Efferents join both internal jugular veins

Communications: Pterygoid venous plexus, cavernous venous sinus.

Clinical importance: Spread of malignancy or infection.

INTRODUCTION TO NEUROANATOMY

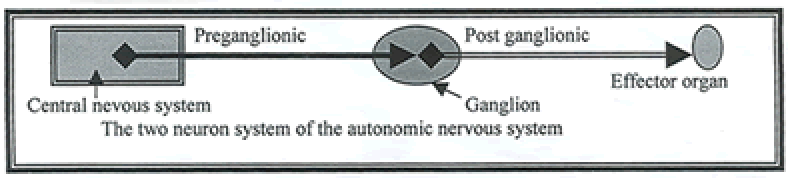
Divisions of the brain



Sub divisions of the brain

- **Cerebrum**
- **Diancephalon**
- **Brainstem**
  - Mid brain
  - Pons
  - Medulla oblongata
- **Cerebellum**

Autonomic nervous system

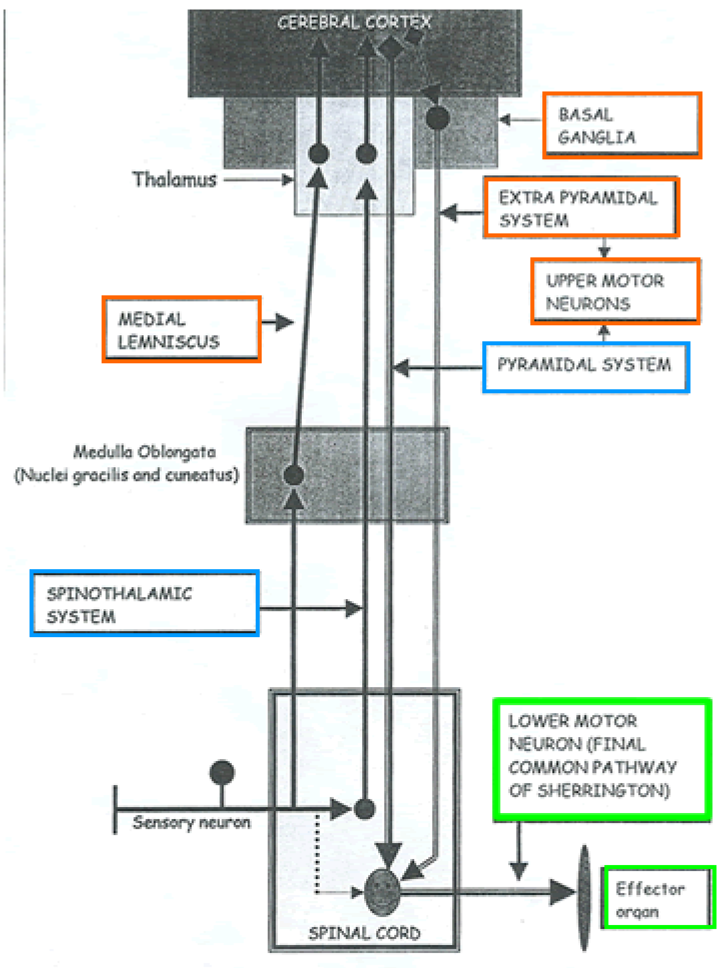


The two neuron system of the autonomic nervous system

- This system controls smooth muscles and glands.
- Two neurons: **pre** and **post ganglionic**.
- It consists of two broad complementary parts i.e. **sympathetic** and **parasympathetic**. A third component, the **enteric nervous system**, for GIT control has recently been recognized as an independent entity.

Motor Effector pathways

Basic reflex pathways



There are two broad divisions of the effector pathways

- Somatic motor system
- Visceral (autonomic) motor system.

The somatic motor system comprises of two main components:

- The **lower motor neurons**, which make direct contact with the muscles. These form the final common pathway. Accordingly therefore, all spinal and motor cranial nerves are lower motor nerves.
- The **upper motor neurons**, which influence the activity of the lower motor neurons. They do not make direct contact with the target muscles.
- The axons that constitute the upper motor systems also occupy specific places in the nervous system, share origins and destinations.
- The bundles are also called **tracts**, and are named for origin to destination e.g.

  corticospinal, vestibulospinal, olivospinal, reticulospinal.

Note: Destruction or atrophy of **lower motor neurons** (in present context those of the ventral horn) results in:

1. **Flaccid paralysis of the affected muscles,**
2. **Diminished or absent tendons reflexes, and**
3. **Progressive atrophy of the muscles deprived of motor fibres.**

The following signs are associated with an "**upper motor neuron lesion**" after the acute effects have worn off:

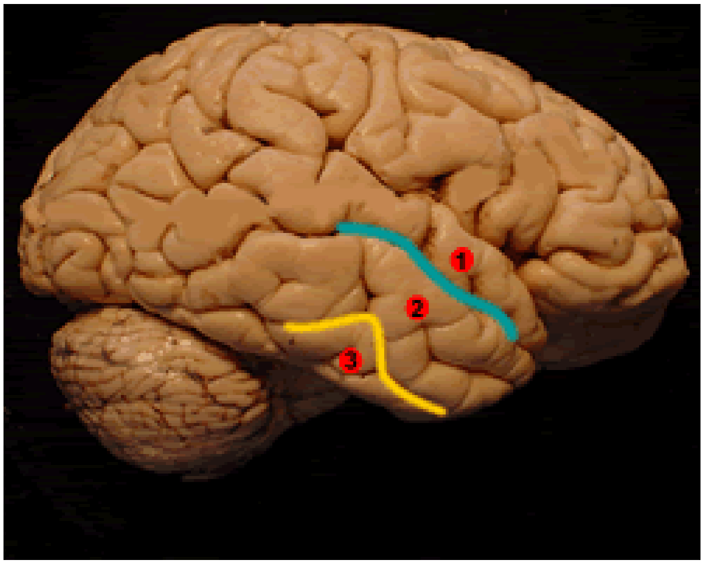
- **Varying degrees of voluntary paralysis, which is most severe in the upper extremity,**
- **The sign of Babinski (up-turning of the great toe and spreading of the toes on stroking the sole),**
- **Spasticity with exaggerated tendon reflexes.**
- **Little or no muslce atrophy**

Sensory Motor integration

- The various types of sensory activities reaching the central nervous system are very distinctly interpreted, coded and classified by the central neurons especially of the cerebral cortex.

- As a result of the comparison, a choice of a particular response is made (out of the many alternatives available) normally the one with the highest probability of effectiveness under the prevailing circumstances.

Temporal Lobe



Lateral surface displays two sulci, the superior and inferior temporal sulci and three gyri:

- ***The superior temporal gyrus (1)*** ,
- ***The middle temporal gyrus(2)***)
- ***The inferior temporal gyrus (3) :***

Inferior surface of the temporal lobe reveals:

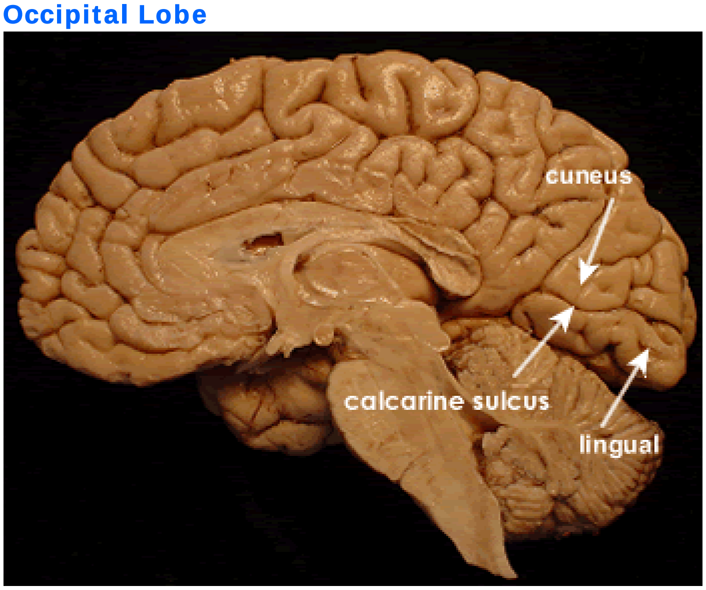
- The inferior temporal gyrus
- The broad occipito-temporal gyrus,
- The parahippocampal gyrus.

Major functions of temporal lobe:

- Primary auditory.
- Association auditory.
- Many of the limbic structures are contained in the temporal lobe.
- Association olfactory.
- Tertiary sensory (especially visual) association.

Temporal lobectomy or damage may disturb these functions, often with dire consequences.

Occipital Lobe



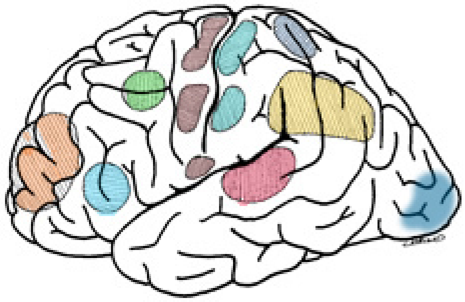
The **calcarine sulcus** divides the occipital lobe into a ***dorsal cuneus*** and ***ventral lingual gyri*****.**

The cortex on both banks of the calcarine represents the primary visual cortex (also called the striate cortex). Central (macular) vision is represented nearest the occipital pole.

As one moves away from the striate cortex, you encounter the secondary visual cortex and psychovisual areas.

Summary of functional localization of cerebral cortex

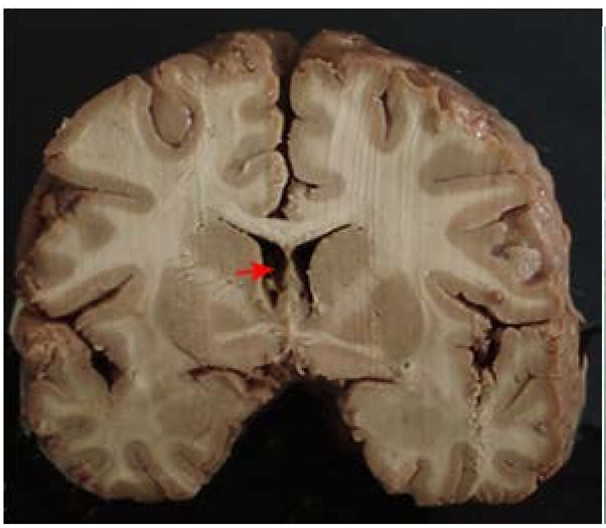
hover on the colored areas to show functional areas

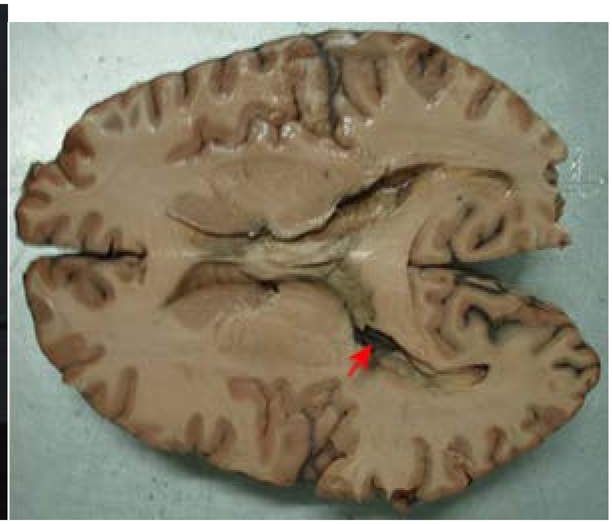


Lateral ventricle

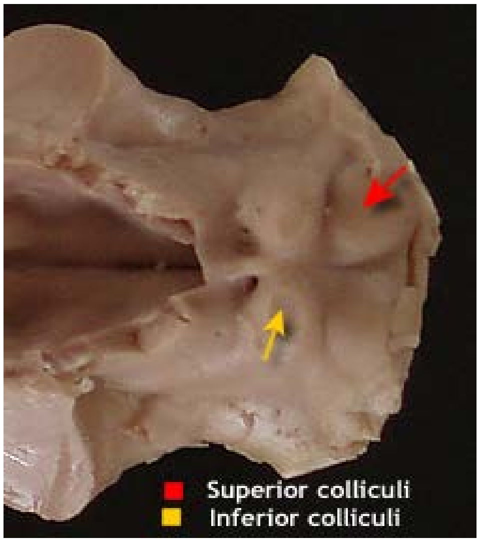
The parts of this ventricle include : anterior horn, body, collateral trigone, posterior horn and inferior horn.

Anterior horn	Body	Posterior horn	Inferior horn
• Lateral: Head of caudate. • Anterior: Corpus callosum. • Roof: Corpus callosum.	• Roof: corpus callosum. • Medially: septum pellucidum. • Floor: thalamus, caudate, thalamostriate vein, fornix.	• Roof: tapetum of corpus callosum • Lateral: tapetum of corpus callosum • Floor: white matter of occipital lobe	• Roof: fibers of corpus callosum • Lateral: wall fibers of corpus callosum • Floor: hippocampus with impression of collateral sulcus





The Midbrain



The central aqueduct is distinctive. Dorsal to this is the tectum with four colliculi.

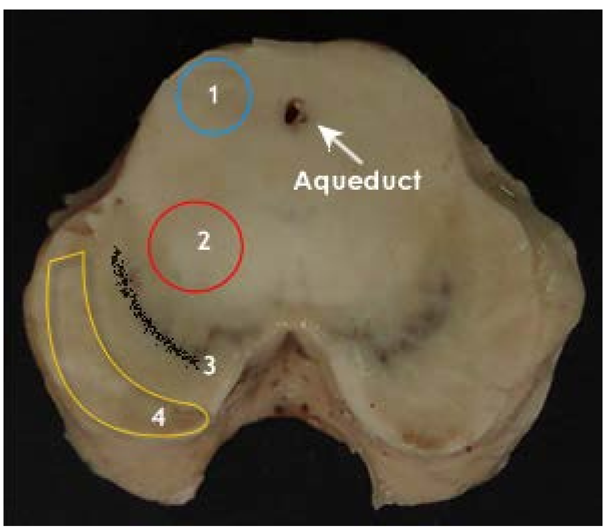
- Superior colliculi process visual sensations.
- Inferior colliculi process auditory sensations.

Red nucleus is most distinctive in the midbrain tegmentum. It integrates information from cerebrum and cerebellum (involuntary motor control)

Its fibers to the spinal cord (rubrospinal) transmit impulses that facilitate flexor muscle tone.

Structures dorsal and lateral to the red nucleus form the midbrain reticular formation.

task ***What do you consider to be the main functions of the reticular formation?***



The mibrain consists of four main parts:

- Tectum(1)
- Red nucleus(2)
- Substantia nigra (3)
- Crus cerebri (4)

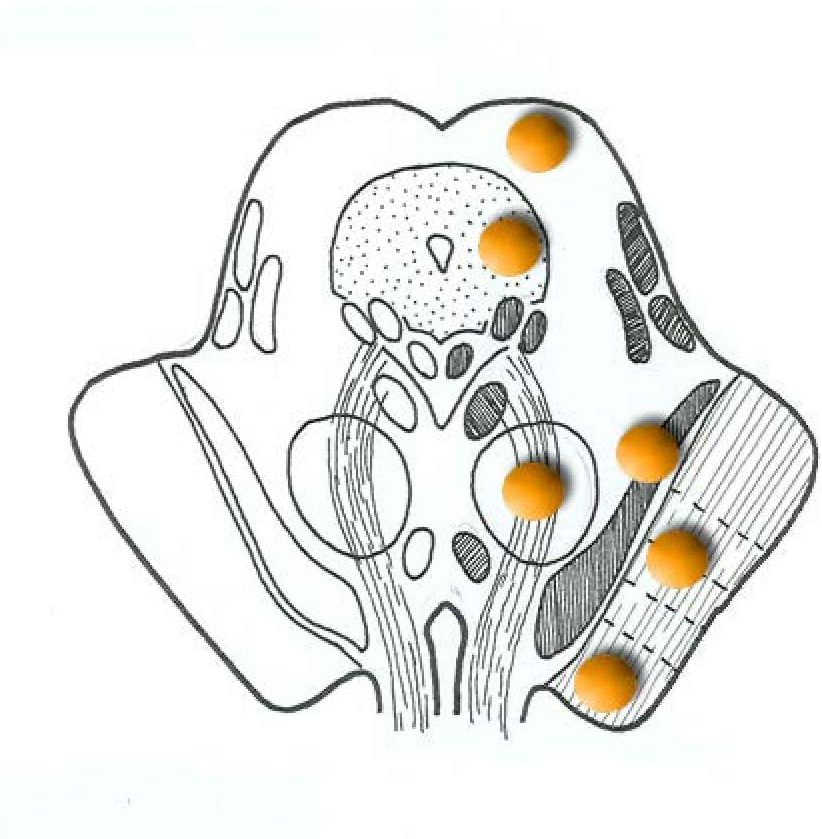
Around the aqueduct is the periaqueductal gray. It contains nuclei of oculomotor and trochlear nerves.

The most prominent structure in the tegmentum is the red nucleus but the tegmentum, also contains ascending tracts.

The substantia nigra consits of melanin containing neurons tha regulate motor output of cerebral cortex

Crus cerebri represents a bundle of projection fibers.

Click on hot spots to show names



The following structures can be identified In a cross section of the midbrain.

- Mesencephalic nucleus.
- Medial lemniscus.
- Decussation of superior cerebellar peduncle.
- **Inferior / superior Colliculi.**
- Descending fibers from motor cortex.
- Nuclei of cranial nerve and gray matter.
- **Periaqueductal gray**
- Oculomotor/trochlear nucleus
- Edinger Westphal
- **Red nucleus**
- **Substantia nigra**
- Mesencephalic reticular formation

Blood supply to the midbrain
Most of the blood supply is derived from branches of the basilar artery.

1. Posterior cerebral
2. Superior cerebellar
3. Posterior communicating
4. Anterior choroidal

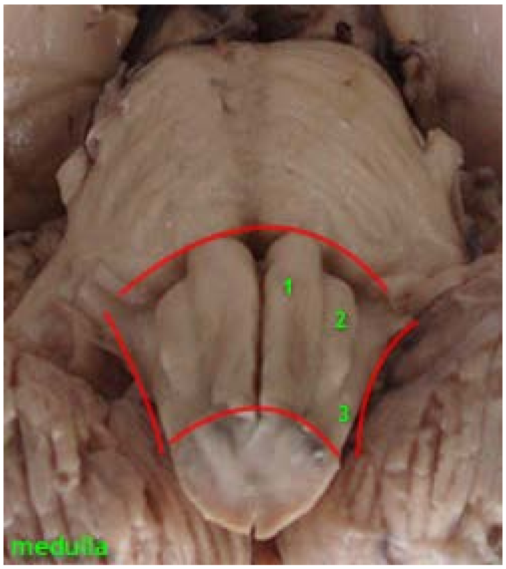
Vascular lesions of the midbrain include:
Weber's syndrome, which involves the basal portion of the midbrain due to occlusion of a **mesencephalic branch of the posterior cerebral artery**.

Area of infarction involves:

1. **Pyramidal fibres**- contralateral hemiparesis.
2. **Oculomotor nerve** - ipslateral paralysis of the ocular muscles except the lateral rectus and superior oblique.

Red area: shows area of vascular lesion involvement

Medulla Oblongata

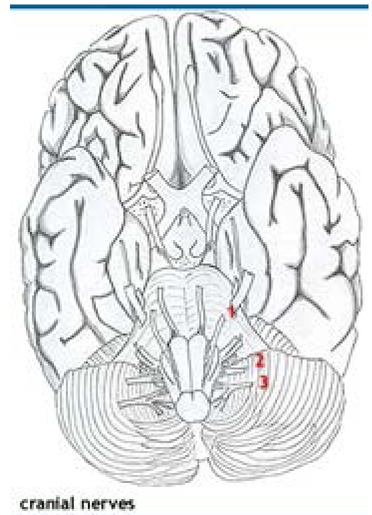


The medulla extends from **foramen magnum** to **pons.**

Transition from spinal cord to medulla is characterized by:

- Obliteration of median fissure by pyramidal decussation
- Appearance of gracile and cuneate tubercles
- Appearance of cranial nerves
- Appearance of fourth ventricle
- Dissapearance of spinal nerves
- Cranial nerves associated with the medulla include:
  - Hypoglossal - between pyramid and olive.
  - Glossopharyngeal post -olivary sulcus.
  - Vagus post - olivary sulcus.
  - Accessory post - olivary sulcus.
  - Vestibulocochlear - cerebellopontine angle.

The caudal medulla is closed but the cranial half is open dorsally (fourth ventricle).



Its external appearance is characterized by the **pyramid** anteriorly, **olive** anterolaterally, **tuberculum cinereum** posterolaterally , **gracile** and **cuneate** tubercles dorsally and the attached nerves

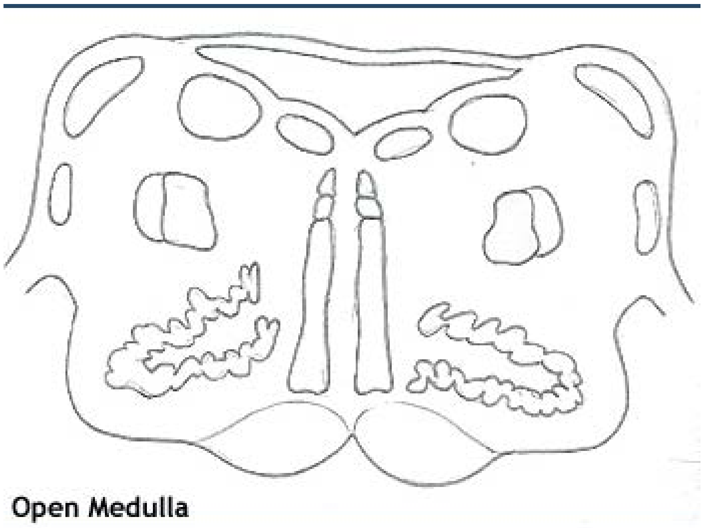
The medulla relays sensory information to thalamus and contains major regulatory centers in its reticular formation

It also a number of nuclei:

- Relay nuclei - gracilis, cuneatus, olivary.
- Sensory and motor nuclei of cranial nerves vestibulocochlear, glossopharyngeal, vagus, accessory and hypoglossal nerves).

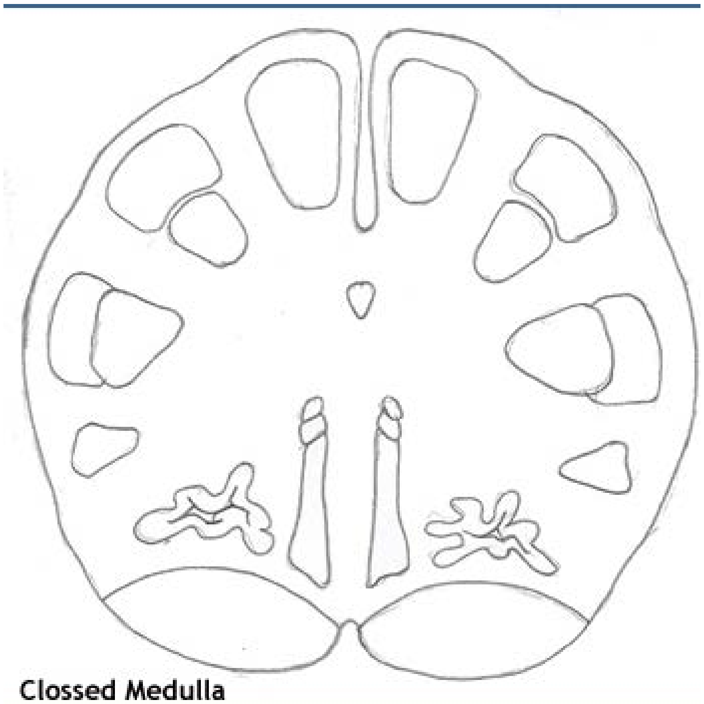
The internal anatomy of the closed and open medulla demonstrates the following structures .

- Fourth ventricle and central canal and central gray



- Nuclei:
  - Hypoglossal
  - Cuneate and accessory cuneate
  - Gracile
  - Trigeminal (spinal)
  - Ambiguus (for IXN, XN, XIN)
  - Dorsal motor nucleus of vagus
  - Vestibular
  - Olivary
  - Reticular

Fiber bundles



- Fasciculus gracilis
- Fasciculus cuneatus
- Pyramidal
- Spinal tract of trigeminal
- Medial lemniscus
- Internal arcuate
- Hypoglossal fibers
- Inferior cerebellar peduncle
- MLF

Blood supply to the medulla oblongata

Four main arteries supply the medulla oblangata

- **Anterior spinal arteries** supplying the antero-medial structures namely

- Pyramids

- Medial lemniscus

- Hypoglossal nucleus

- Medial Longitudinal fasciculus

- Solitary and vagal nuclei

- **Posterior spinal** arteries supplying the fasciculus and nucleus gracilis and cuneatus

- **Posterior inferior cerebellar artery** supplying the retro-olivary region, including

- Spinothalamic tract

- Spinal trigeminal nucleus

- Nucleus ambiguus

Hypothalamo spinal tracts

- **Bulbar branches** of the vertebral artery supplying the pyramids, hypoglossal, nucleus, and inferior olivary nuclear complex.

Applied anatomy

Medial medullary syndrome results occlusion of a anterior spinal artery or bulbar branches of the vertebral artery.

Structures normally included in the area of infarction are:

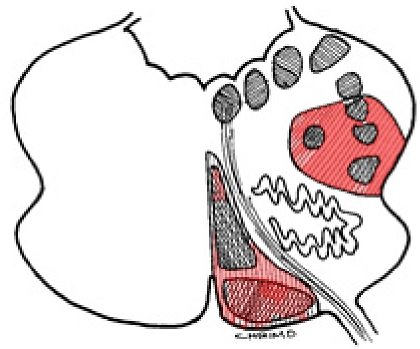
i) Medial lemniscus

ii) Pyramid

iii) Hypoglossal nerve

Sensations of **position, movement, discriminative touch** and **vibrations** on the opposite side of the body (interruption of medial lemniscus) and **ipsilateral paralysis of the tongue** due to the involvement of the hypoglossal nerve.

This disorder forms an example of a crossed or alternating paralysis in which the body is affected on the opposite side, but the muscles supplied by the cranial nerve affected are on the same side. This particular condition is known as " **alternating hypoglossal hemiplegia** " or **inferior alternating hemiplegia** .



Lateral medullary syndrome

Results from occlusion of the posterior inferior cerebellar artery or a medullary branch of it.

Lesions normally includes the following structures with the respective deficits:

i) **Spinal trigeminal tract and nucleus** : Ipsilateral loss of pain and temperature in the areas of distribution of the trigeminal nerve.

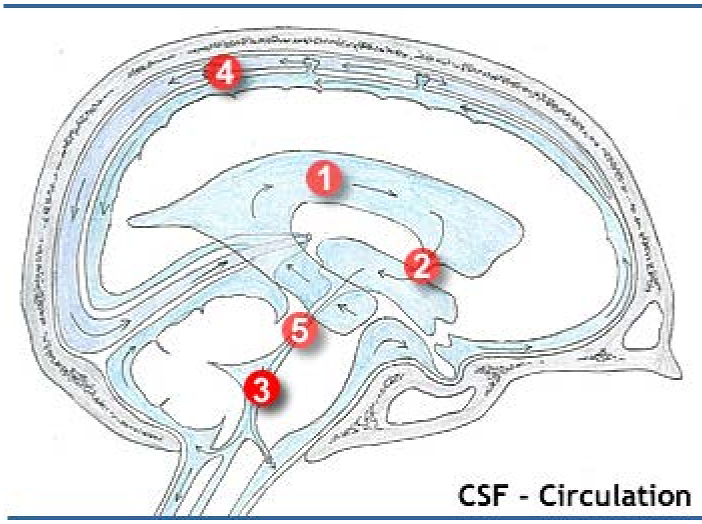
ii) **Spinal lemniscus** : loss of pain and temperature sensibilities on the opposite side of the body. Touch is diminished rather than lost (explain why).

iii) **Nucleus ambiguus:** ipslateral paralysis of the muscle of the palate in swallowing and phonation (explain why).

iv) **Hypothalamospinal tract** : Horner's syndrome characterised by small pupil, ptosis (drooping of eyelids) and anhidrosis (explain why).

Vi) **Inferior cerebellar penduncle and vestibular nuclei** : if included caused dizziness, cerebellar ataxia and nystagmus.

Circulation:



- From lateral ventricle to third via foramina of Monroe.
- From third to fourth via cerebral aqueduct.
- From fourth ventricle to subarachnoid spaces via:

  a) Lateral foramina (Luschka) and
  b) Median foramen (Magendie).
  c) Central canal

Reabsorption

- CSF returns to the blood via **arachnoid granulations** (pasive, one way valves).
- The exit into the venous sinus is pressure dependent.

CSF circulates in widened subarachnoid spaces called **cisterns.**

task **Identify the parts labelled 1-5**

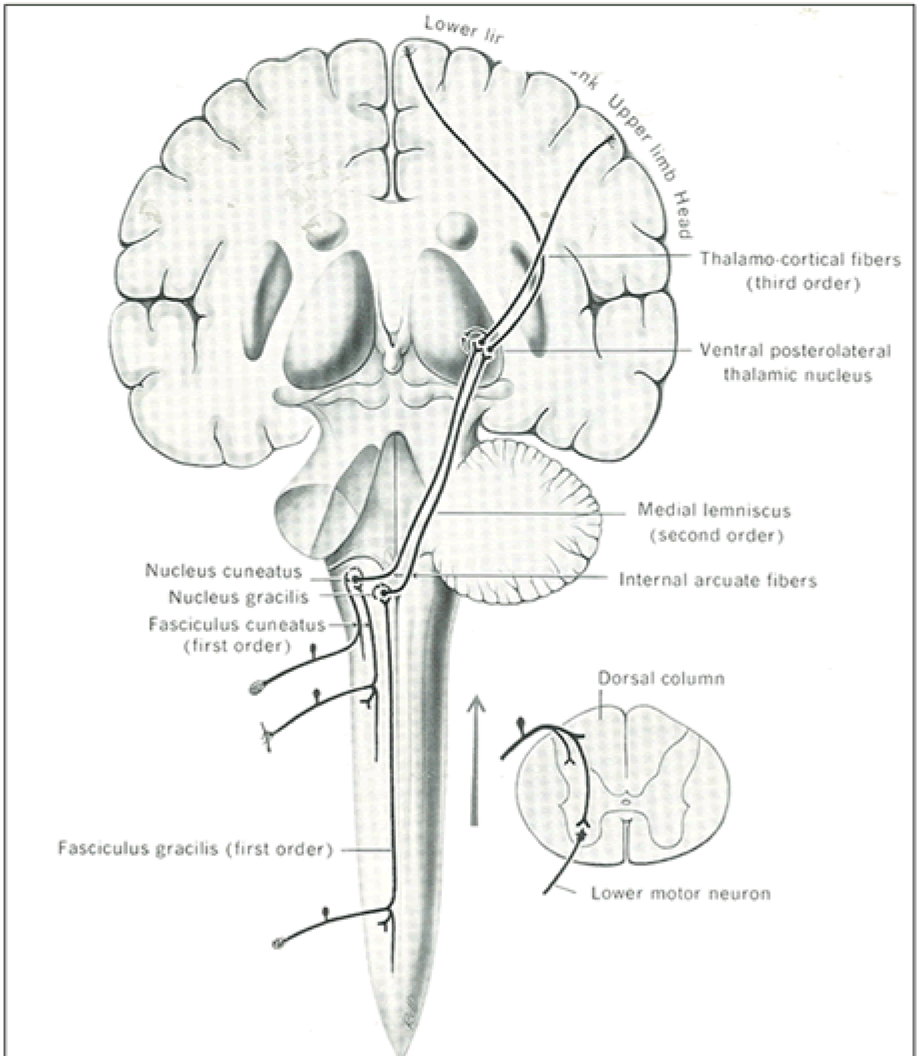
task **Review the anatomy of cisterns**

ASCENDING SENSORY PATHWAYS

Pathways to consider:

- Spinothalamic
- Posterior column pathway
- Spinocerebellar

The posterior column pathway



DORSAL COLUMN-MEDIAL LEMNISCAL PATHWAY

- Also termed the medial lemniscus system.
- A pathway for sensory modalities: fine touch, vibration, proprioception
  Highly specific with respect to modality, place (precise localization, two-point discrimination)

task ***What is synaptic security as relates to the pathway?***

Receptors for the sensory modalities include:

- Paccinian corpuscles
- Muscle spindles
- Golgi tendon organs

Primary afferents (cell bodies in spinal ganglia) enter the spinal cord and ascend in the posterior funiculi as fasciculus gracilis or cuneatus
Fasciculus gracilis is present in all sections carry fibers from the sacrum, lumbar and lower thoracic regions.
Fasciculus cuneatus appears from T6 spinal cord and carry primary afferents from receptors in the upper thorax and cervical levels
The fibers in the dorsal funiculi are somatotopically organized:

Sacral fibers are most medial while cervical fibers are most lateral.

These fibers (first order neurons) terminate in the posterior column nuclei in the medulla (nuclei gracilis and cuneatus).

Second order neurons from these medullary nuclei cross the midline at this level as internal arcuate fibers and ascend as the medial lemniscus fibers.

Medial leminiscal fibers ascend through the pons, midbrain (Fig.) and terminate in the ventral thalamus (ventral posterolateral nucleus- VPN)
The VPN nucleus is a specific thalamic nucleus.

task ***Name one other specific thalamic nucleus associated with posterior column pathway.***

Third order neurons from the VPN then project specifically to the primary somesthetic area in the postcentral gyrus.

For unconscious proprioception from the lower limb, primary afferents enter the spinal cord and synapse at the thoracic nucleus of Clarke. Second order neurons then ascend in the posterior column of the spinal cord and into the medulla oblongata.

They join the inferior cerebellar peduncle to terminate in the ipsilateral cerebellum.

Similar fibers from the upper limb first synapse in the accessory cuneate nucleus in the medulla. They then traverse the inferior cerebellar peduncle to terminate in the ipsilateral cerebellum.

Note:

- There are some accounts that detail a four-neuron system for conscious proprioception from the lower limb. Give details.
- The pathway for touch, vibration and proprioception from the head involves a series of trigeminal nuclei and also decussates at the brainstem. Elaborate.

Spinothalamic system

Also termed the anterolateral ascending system.A pathway for touch, pain and temperature. A less precise and specific system.

Some fibers component traverses the non-specific thalamus and projects diffusely to the cerebral cortex.

Receptors for the sensory modalities include:

- Fine free nerve endings.
- Meissners corpuscle.
- Bulbs of Krause, Ruffini.

Primary afferents (cell bodies in the dorsal root ganglia) present central processes that enter the sensory laminae I-III of the dorsal horn.

Second order neurons forming spinothalamic fibers arise from cells in lamina I,IV,V.

Spinothalamic fibers cross to the opposite side through the anterior white commissure and ascends occupying the anterolateral funiculi of the spinal cord.

Sacral fibers lie most lateral, thoracic/cervical fibers most medial.

The spinothalamic tract is closely associated with the medial lemniscus in the pons and midbrain.

Termination of the fibers:

- Ventral posterolateral nucleus (VPN) of thalamus.
- Periaqueductal gray of midbrain.
- Intralaminar thalamic nuclei bilaterally.

Third order neurons project to the postcental gyrus and other parts of the cortex.

task Describe the pathway for pain and temperature from the head. Add notes on trigeminal neuralgia.

Spinotectal fibers

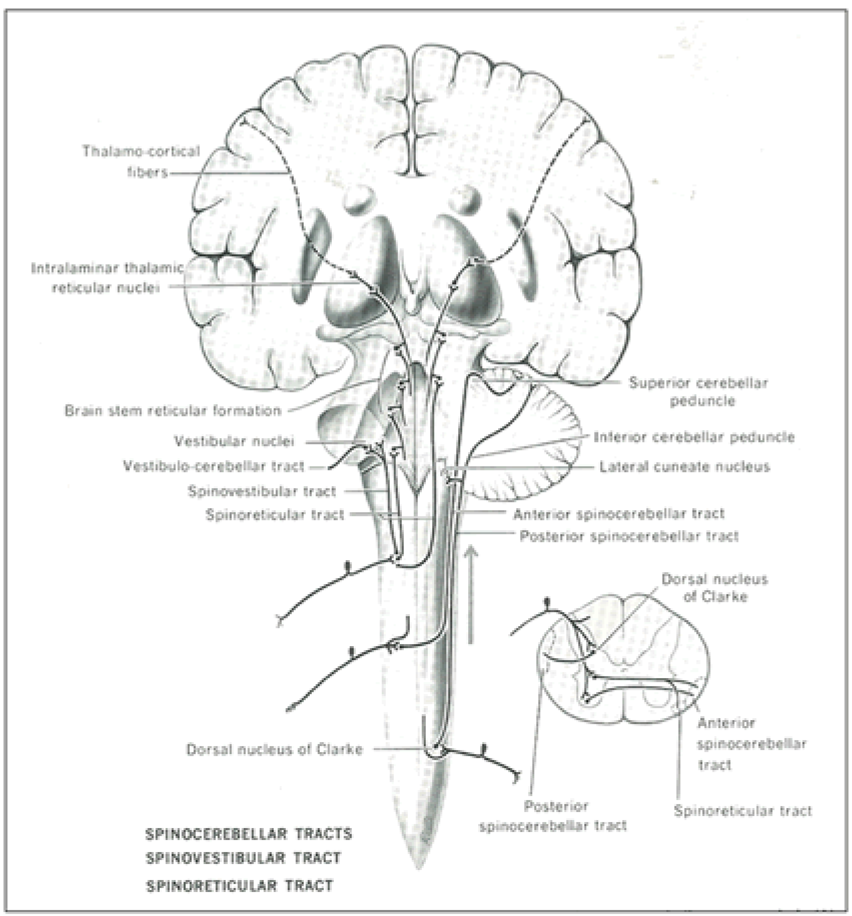
Origin: Laminae I and V of dorsal horn.

Crossed and ascends close to spinothalamic.

At midbrain fibers terminate in the superior colliculus and periaqueductal gray.

? transmission of nociceptive impulses.

Spinocerebellar fibers



Posterior:

- Origin: Dorsal nucleus of Clark
- In the medulla, this uncrossed tract joins the inferior cerebellar peduncle.
- Terminates in ipsilateral cerebellum.
- Impulses used in the fine coordination of posture and movement of individual limb muscles.

Anterior:

- Origin: Cells of laminae V,VI, VII.
- Crossed pathway.
- Terminate contralaterally in the cerebellum.
- Impulses concerned with coordinated movement and posture of entire lower limb.

Clinical anatomy:

- How does you understanding of the ascending pathways explain the clinical features of hemisection of the spinal cord (Brown- Sequard syndrome)?
- What is a sensory level on spinal cord compression syndromes?
- Define spinal shock.
- Define syringomyelia and state the

anatomical basis for attendant "sensory dissociation."

- What is the anatomical basis of the ataxia and difficulty in walking characteristic of "tabes dorsalis"?

Blood supply of the lungs

- The **pulmonary arteries** distribute deoxygenated blood to the lungs for aeration.
- The **pulmonary veins** drain oxygenated blood from the lungs to the left atrium of the heart.
- The **bronchial arteries** supply the substance of the lung with oxygenated blood.

  +) The two left bronchial arteries arise from the *thoracic aorta* .

  +) The single right bronchial artery arises from the first intercostal artery, or from the superior left bronchial artery.
- The **bronchial veins** drain the lung tissue.

  +) The right bronchial vein drains into the azygous vein

  +) The left bronchial vein drains into the accessory hemiazygous vein or into the left superior intercostal vein.

Lymphatics of the lungs

There are two plexuses namely:

- The **superficial plexus,** lying deep to the visceral pleura - bronchopulmonary lymph nodes.
- The **deep plexus**, located in the submucosa of the bronchi, and in the peribronchial connective tissue- **pulmonary** thence to **bronchopulmonary** nodes
- These drain into **bronchomediastinal** lymph trunks
- These lymph trunks usually terminate on each side at the **junction of the subclavian and internal jugular veins**. The left trunk may terminate in the thoracic duct.

The relations of the lung

Mediastinal surface	Diaphragmatic surface	Costosternal surface	Posterior surface	Apex
• Phrenic nerve, • Mediastinum and its	• Liver on the right side, • Stomach and spleen on the		• Upper thoracic vertebrae • Intervertebral discs.	• **Anteriorly** to the 1 st rib and clavicle.

contents	left side. • The thoracic diaphragm intervenes.	• ribs, • intercostal vessels and nerves; • sternum • internal thoracic vessels.		• **Medially** it is related to the: - brachial plexus, - sympathetic chain, - trachea - esophagus - recurrent laryngeal nerve between them. • It is crossed by the subclavian artery and vein.

The bronchopulmonary segements

Definition

- Portion of the lung aerated by a **tertiary bronchus**, together with its blood vessels, lymphatics, connective tissue and nerves.
- The **right lung** bears **10** segments
- The **left** has only **8** segments.

Characteristics of bronchopulmonary segments

- Each segment is **pyramidal in shape** with its apex pointed towards the root of the lung and its base at the pleural surface.
- Each segment is supplied by its **own nerve, artery and vein**.
- Each segment is surrounded by **connective tissue** that is **continous with the visceral pleura**.
- Each segment can be **visualised independently** during **bronchoscopy**

J. Ogengó

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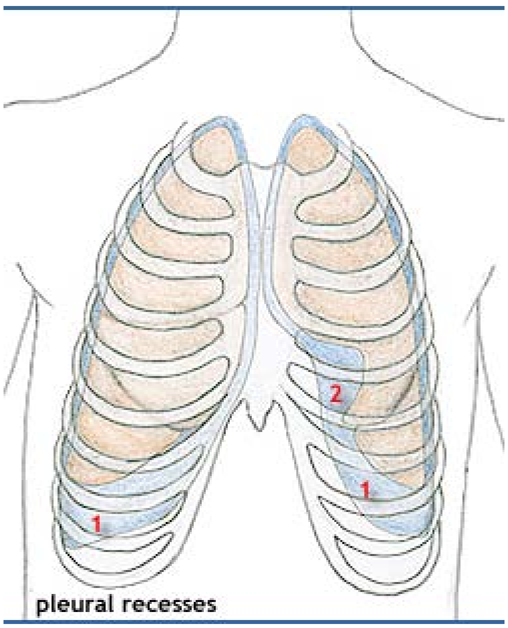
Chapter 28: The Chest Wall and Pleura

Learning points | Core anatomy | Applied anatomy | Review questions

Pleural recesses:

These are parts of the pleural cavity, not occupied by the lung during quiet respiration.



a) The costodiaphragmatic recesses (1)
b) The costomediastinal recess (2):
c) Cupula **(3)** or dome of pleura projects above the first rib.

Innervation of the pleura

Sensory innervation is from two main sources:

- **Intercostal nerves:** costal pleura and the peripheral parts of the diaphragmatic pleura.
- **Phrenic nerves:** mediastinal pleura and the central part of the diaphragmatic pleura.

Blood supply of the parietal pleura

Is derived predominantly from the arteries that supply the thoracic body wall. They include:

- **Intercostal arteries**,: costal part.
- **Pericardiophrenic arteries** : mediastinal parts.
- **Musculophrenic arteries** :diaphragmatic pleura.
- **Transverse cervical**,:apical.

The veins correspond

Lymphatic drainage of the parietal pleura

Generally follows the patterns of the veins.

- **Mediastinal parts** -> parasternal nodes.
- **Costal parts** -> intercostal, and posterior mediastinal lymph nodes.
- **Diaphragmatic part**-> drain into the diaphragmatic nodes

---

The visceral pleura

- This layer of pleura develops from the **splanchnopleura**.
- It **covers** the **lung** closely, and is adherent to all its surfaces, **dipping** into the **fissures**,
- Provides lungs with a smooth , slippery surface, which enables them to move freely on parietal pleura.

Blood supply lymphatic drainage

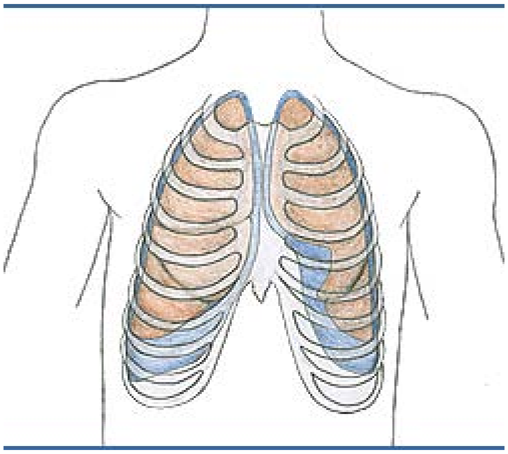
- Arterial supply of the visceral pleura is from the **bronchial arteries**, branches of the thoracic aorta.
- Veins of the visceral pleura drain into the **pulmonary veins**.
- Numerous lymphatics drain into **bronchopulmonary nodes.**

Innervation

- Predominantly general visceral efferent, GVE (autonomic).
- No nerves of general sensitisation are known to enter the visceral pleura.

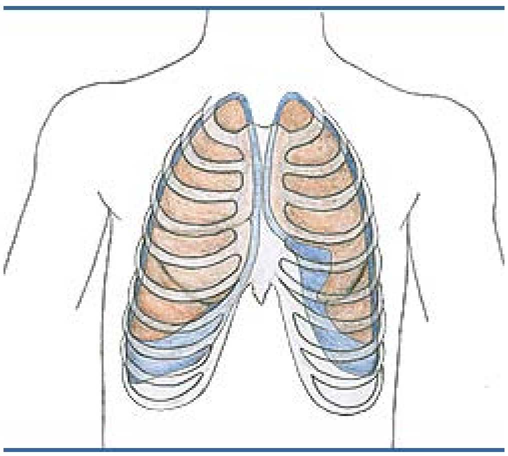
Structural details of the lungs

Surface markings



The apex:

- Sternoclavicular joint
- 2.5cm superior to the middle third of the clavicle
- Junction of the middle and medial thirds of the clavicle.



The anterior border; varies between left and right.

Right side

- Between the levels of the 2 nd and 4 th cartilages anterior margin is near the midline.
- Inferior to the 4 th costal cartilage, the surface of the right lung gradually diverges from the midline, and leaves the sternum posterior to the 6 th costal cartilage.

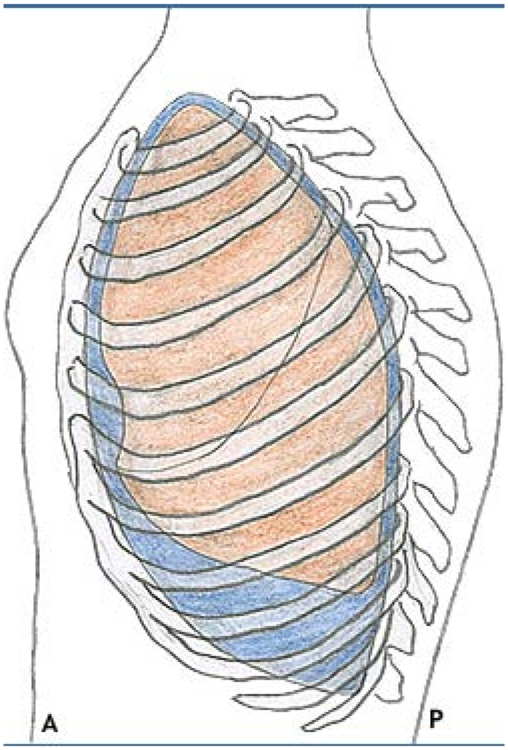
Left side

- Close to the midline fill the level of the 4 th costal cartilage the lung deviates laterally to a pint about 2.5cm lateral to the left border of the sternum to form the cardiac notch.
- It then turns inferiorly and slightly medially to the 6 th cartilage.

The inferior border

- Indicated by a line drawn from the inferior end of the line representing the anterior border that crosses :

  - the 6 th rib in the midclavicular line;
  - the 8 th rib in the mid-axillary line,
  - the 10 th rib in the midscapular line, and ends about 2.5cm lateral to the spinous process of the 10 th thoracic vertebra.



- The projection of the oblique fissure is the same for each lung, and is indicated on the surface of the thorax by a line from the spinous process of T2 around the thorax to the 6 th costochondral junction.

- The horizontal fissure (on the right lung) is indicated by a line on the surface of the thorax that runs from the anterior border of the lung along the fourth cartilage to the oblique fissure.

Right brachiocephalic vein

Formed behind the sterna end of the right clavicle by the union of the right internal jugualar and subclavian veins. Ends at the lower border of the 1st costal cartilage close to the sternum by joining its fellow to form the superior vena cava

Relations

Medial
Brachocephalic artery

Lateral

Right phrenic nerve
Internal thoracic artery
Pleura covers the right aspect

Posterior

Right vagus

Tributaries of right brachiocephalic vein

- Internal jugular vein
- Subclavian vein
- Vertebral vein
- Internal thoracic vein
- Inferior thyroid vein
- Supreme intercostals vein
- Right lymphatic duct

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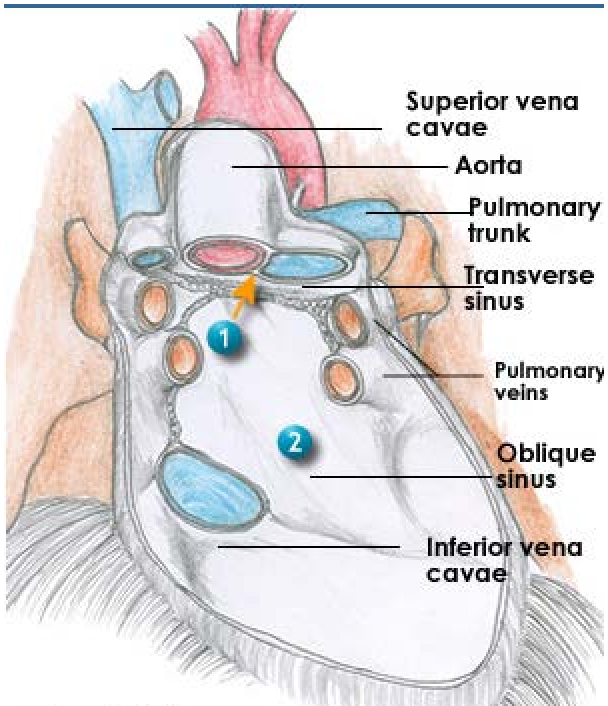
Sinuses of the pericardium



pericardial sinuses

These are created where the parietal pericardium becomes continous with the visceral pericardium.

1.The transverse sinus:

- Located between the aorta and pulmonary trunk anteriorly and the left atrium and superior vena cavae posteriorly.
- It connects the two sides of the pericardial cavity.

2.The oblique sinus:

- Located between the pulmonary veins and inferior vene cavae posterioly and the left atrium anteriorly.
- It is a blind sac (cul de sac).

Attachment of the pericardium:

Inferiorly: Central tendon of the diaphragm and fuses with tunica adventitia of inferior vena cava.

Superiorly: Fuses with tunica adventitia of the great arteries and of superior vena cava

Laterally: Fuses with tunica adventitia of pulmonary veins

Anteriorly: Attached to the sternum by the sternopericardial ligaments (superior and inferior)

Functions of the pericardium

- Encloses and protects the heart
- Limits unnecessary movements of the heart
- Prevents unnecesary distention of the heart

Blood supply of the pericardium

The visceral pericardium is supplied and drained by the coronary system

The parietal and fibrous pericardium receive arterial blood from the following sources:

- **Pericardiophrenic** and **musculophrenic** branches of the internal thoracic artery
- **Pericardial branches** from
  -Bronchial

  -Esophageal

  -Superior phrenic arteries.

The veins drain into the azygous system and internal thoracic veins.

Lymphatics of the pericardium:

These mainly drain into the following groups of lymph nodes:

- Parasternal
- Tracheobronchial
- Supradiaphragmatic
- Posterior mediastinal

Innervation of the pericardium

The **visceral pericardium** receives autonomic innervation from the **cardiac plexus**

The **parietal and fibrous pericardium** are innervated mainly by the **phrenic nerve.**

Veins of the heart

The heart is drained mainly by:

- Veins that empty into the coronary sinus
- Small veins that open directly into the chambers of the heart (i.e. the venae cordis minimae, and anterior cardiac veins).

Hover to show names

Coronary sinus

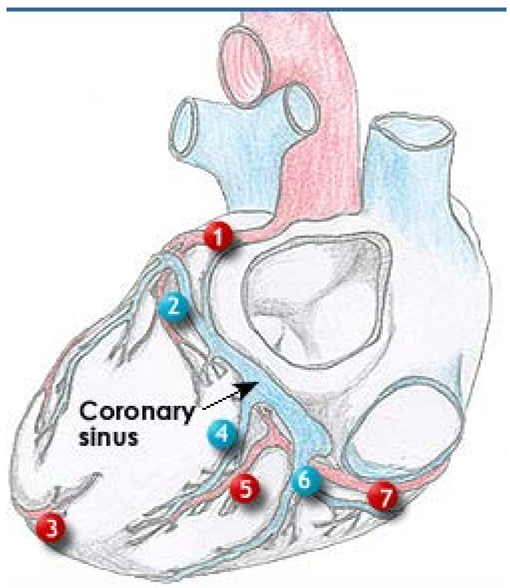
- A short wide venous channel in the coronary groove
- **Tributaries**

  +) Great cardiac vein at its left

  +) Middle and small cardiac veins at its right end.

  +) The oblique vein of Marshal

- Drains all the venous blood from the heart, except that carried by the anterior cardiac veins , and the vena cordis minimae , that open directly into the heart.
- Opens into the right atrium
- Has a one-cusp valve



Lymphatic drainage of the heart

- Lymphatic vessels form plexuses adjacent to the endocardium and epicardium.
- Efferent vessels follow the coronary arteries
- Empty into the mediastinal and tracheobronchial lymph nodes**.**

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Chapter 29: The Middle Mediastinum, Heart and Pericardium and the Superior Mediastinum

Learning points | Core anatomy | Applied anatomy | Review questions

The heart

The outline of the heart of the heart is variable and depends partly on the physique of the individual.

The outline of the heart on the anterior surface of the chest is verified using the following guidelines:

A line connecting the inferior margin of the second left costal cartilage (3cm to the left of the median plane) to the

superior border of the third right costal cartilage (2cm from the median plane). This usually corresponds to the

superior border of the heart.

A line, slightly co nvex to the right, connecting the 3 rd right costal cartilage (2cm from the median plane) to the

6 th right costal cartilage (no 2cm from the median plane) corresponds to the right border of the heart
A line drawn from the inferior end of the right border to a point in the fifth intercostals space close to the fifth

intercostal space close to the midclavicular line corresponds to the inferior border of the heart . The left end of this

line corresponds to the location of the apex beat

A line connecting the left ends of the lines representing the superior and inferior borders corresponds to the left

border of the heart

The internal surface of anterior abdominal wall

In the midline, there are elevations of peritoneum with free edges, called folds.

Superior to the umbilicus:

- A median fold, the **falciform ligament**. This contains the **ligamentum teres**, the obliterated umbilical vein. Note that the umbilical vein is patent for sometime after birth and may be used for exchange transfusion.

Inferior to the umbilicus, there are 5 folds:

- The median umbilical fold is due to **median umbilical ligament**, the remnant of the urachus, which develops from the **allantois**. It attaches to the urinary bladder.

- 2 medial umbilical folds formed by **medial umbilical ligaments** – the obliterated umbilical arteries.
- 2 lateral umbilical folds – formed by the **inferior epigastric vessels**

The inguinal canal

Canal represents path taken by testis out of the abdomen.

Boundaries

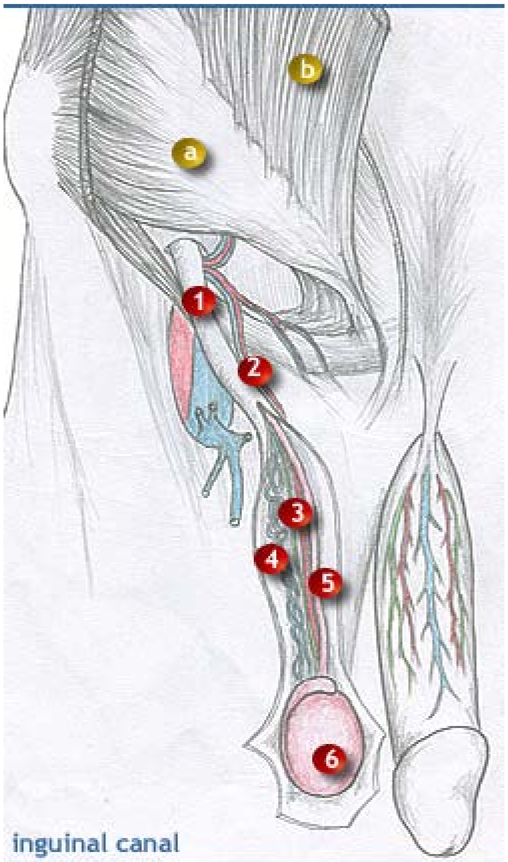
Floor:	Inguinal ligament and lacunar ligament
Roof:	Arching fibres of internal oblique and transversus abdominis.
Antero lateral:	Aponeurosis of external oblique
Posterior:	Fascia transversalis laterally and conjoint tendon medially (of transversus and internal oblique abdominal muscles)

Contents

- Spermatic cord in male
- Round ligament of uterus in female and its artery
- Ilioinguinal nerve

It may contain:

- Iliohypogastric nerve
- Genitofemoral nerve (genital branch)



- Subcostal (in the upper part)

Inguinal Rings

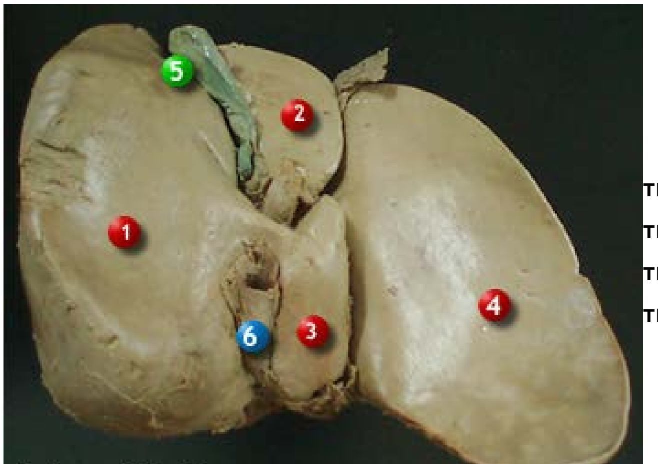
- **Superficial ring** is a triangular aperture in the aponeurosis of the external oblique muscle.

  (+) Base: pubic crest
  (+) Sides: crura of the external oblique aponeurosis.

- The **deep ring** is a deficit in transversalis fascia, lateral to inferior epigastric artery.

Organs of the supra colic compartment

The lobes of the liver



Lobes of the liver

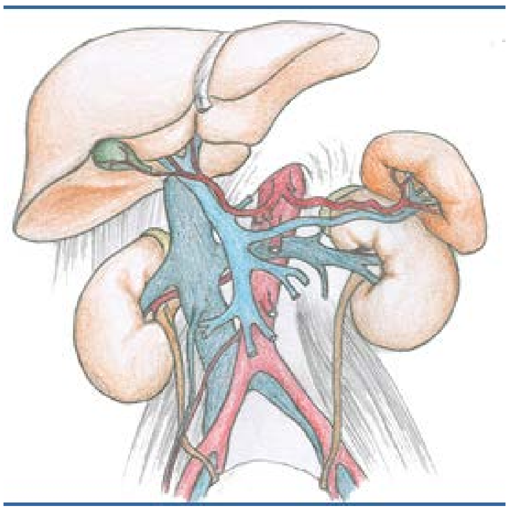
The right lobe (1)

The caudate lobe (3)

The Quadrate lobe (2)

The left lobe (4)

Blood vessels of the liver



- Double blood-supply from:

  hepatic artery
  portal vein.

- The hepatic artery, branch of **coeliac trunk** brings supplies **oxygenated blood.**
- The portal vein carries most of the products of digestion absorbed from the elementary canal.

Vascular segments of the liver

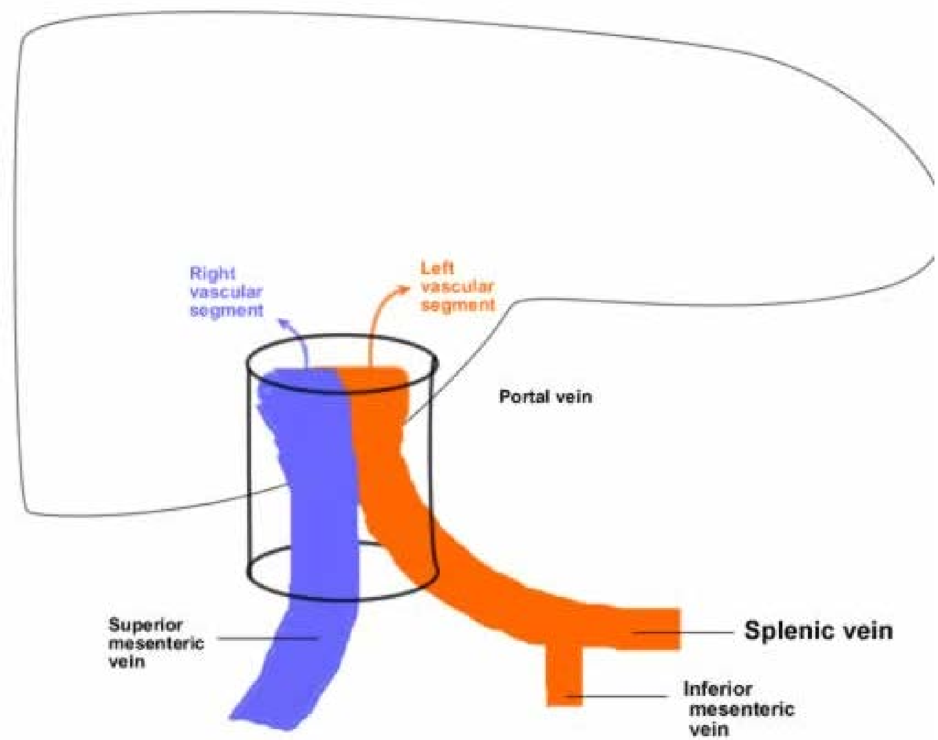
The liver has **two vascular segments**, right and left separated by a plane that passes through the fissure for the inferior vena cava and fossa for gall bladder.

The left segment receives blood from the splenic vein and this blood is mainly from the territory of drainage of splenic vein and inferior mesenteric vein:

- Stomach
- Spleen
- Descending colon
- Sigmoid colon
- Rectum

The right segment receives blood from the superior mesenteric vein:

- Small intestine
- Ascending colon,
- Cecum,
- Appendix
- Right part of transverse colon



Lymphatic drainage of the liver

- The deeper lymphatics from the hepatic parenchyma accompany the main vascular channels to the hilus, ie. Porta hepatis.
- Larger channels run in the lesser omentum, anterior to the portal vein.
- After traversing the hepatic lymph-nodes alongside the hepatic artery in the lesser omentum, the lymph drains into the **superior pancreatic nodes** above the pancreas.
- Most of the more superficial lymphatics from the entire surface of the liver join the deeper vessels in the porta.
- There are two exceptions where bare areas exist.

(+)The first is the **bare area on the diaphragmatic surface**: here, the superficail lymphatics pass to the diaphragm and, through it, to the **phrenic** and **mediastinal nodes** and to both major lymph-trunks (thoracic duct and right lymphatic duct). A few enter the falciform ligament and pass to the umbilicus.

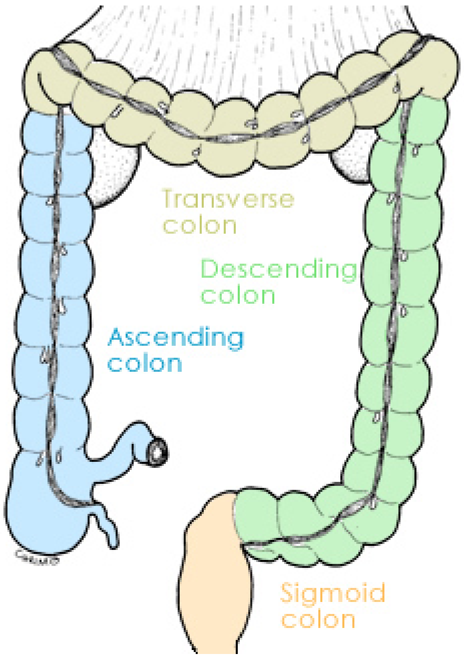
(+) The second area is where the **oesophagus** lies against **hepatic tissue** without any intervening peritoneum: here, a few superficial lymphaticvs join the lymphatic vessels of the oesophagus.

Innervation of the liver : hepatic plexus

- An offshoot of the coeliac plexus

- Accompanies the hepatic artery and its branches
- Conveys both sympathetic and parasympathetic nerve-fibres from **vagus** and **greater splanchnic** nerves.

The large Intestine



It consists of the following parts:

- Caecum and appendix
- Ascending colon
- Transverse colon
- Descending colon
- Sigmoid colon
- Rectum

Note:

- The ascending and descending colon are usually devoid of a mesocolon, or both, may be present.
- A transverse mesocolon and sigmoid mesocolon are always present.

The caecum

Position

- Lies in the **right iliac fossa,** below the ascending colon
- Upper end continues into the ascending colon at the **intertubercular plane**.
- It opens into the upper most part of its medial aspect, the opening being guarded by the **ileocaecal valve**.
- About 2.5 cm below the ilecaecal junction, the vermiform appendix opens into its medial aspect.

Posterior relations

- The **iliacus muscle** and its fascia, **psoas major**.
- The **lateral cutaneous nerve** of the thigh, genitofemoral nerve
.
- The femoral nerve and the gonadal vessels.

The ascending colon

- Continuous below with the upper end of the caecum at the intertubercular plane.
- Ascends on the posterior abdominal wall to reach the right lobe of the liver, where it turns to the left and downwards as the right colic flexure.
- About 12.5 – 15 cm long.
- Posterior surface is usually devoid of a serous coat, but the ascending colon may retain an ascending mesocolon.
- Posteriorly, the ascending colon lies on:

  (+) Iliacus
  (+) Quadratus lumborum
  (+) Ilio-inguinal
  (+) Iliohypogastric nerves
  (+) Lower part of the right kidney.

The right colic flexure

- Lies on the lower part of the **right kidney** and the descending part of the abdomen.
- In front and above it is in contact with the colic impression on the **right lobe of the liver.**
- Slightly below the **transpyloric plane**.

The transverse colon

- Extends across the abdominal cavity from the right colic to the left colic flexure.
- The **greater omentum** is attached to its **anterior taenia** and the **transverse mesocolon** to its **superior taenia**, thus completing the curtain between the supracolic and infracolic compartments of the greater sac.
- The anterior aspect of the transverse colon forms part of the posterior wall of the omental bursa and is a constituent of the stomach bed.

The left colic flexure

- Lies on the lower part of the left kidney and the diaphragm, behind the stomach and below the lower pole of the spleen.
- It is slightly above the **transpyloric plane.**
- The **phrenico- colic ligament** is a horizontal fold of peritoneum attaching the flexure to the diaphragm opposite the 11 th rib in the midaxillary upper limit to the left paracolic gutter.

Retroperitoneal organs

Peritoneal relations of the pancreas

- The pancreas is **retro-peritoneal**
- The **tail** lies in the **spleno-renal ligament**

Pancreatic duct system :

- The **main pancreatic duct** (of Wirsung) runs most of the length, to join the common bile duct to form the ampulla of vater
- It pierces the postero medial wall of the descending part of the duodenum, to open at the summit of the **major duodenal papilla**.
- Each of the ducts has a sphincter, and the **ampulla of vater** is guarded by the **sphincter of Oddi**. Sometimes the pancreatic and bile ducts open into duodenum separately.
- There may be an **accessory duct(s)**.

Support

- Fixed by peritoneal relations
- Duct system

Blood supply

Arterial:

Mainly from

- Superior pancreaticcoduodenal - branch of **gastroduodenal**
- Inferior pancreaticoduodenal - branch of **superior mesenteric.**

These vessels anastomose.

Other sources include:

- **Supraduodenal** artery from hepatic artery.
- **Right gastric artery**
- **Right gastroepiploic**

- **Gastroduodenal**

These vessels also anastomose.

Veins:

In general, these follow the arteries and drain into the **portal venous system**.

Most drain into **superior mesenteric**, but some may enter the **portal vein** directly.

One of the anterior veins – the **prepyloric vein (of Mayo)** ascends anterior to the pylorus and drains into the right gastric vein. This vein consistently runs over the **gastroduodenal junction** and is an important guidepost to surgeons.

Lymphatics

- Posterior and anterior vessels anastome :
- Follow arteries to the following nodes:

  (+) Pancreaticduodenal

  (+) Gastroduodenal

  (+) Coeliac nodes

- The posterior ones go Superior mesenteric nodes.

Innervation

- Parasympathetic and sympathetic from both **coeliac** and **superior mesenteric** plexus.
- Pain fibres run with the sympathetic nerves

Retroperitoneal organs

Applied anatomy

- **Duodenal ulcers** are commonly located in the proximal part of the superior part of the duodenum called the **duodenal cap** . In the ulcer, the duodenal wall is eroded to varying depth. It may perforate the entire wall causing peritonitis.
- Due to its close proximity to the liver and gall bladder, duodenal ulcer can cause ulceration of the two. In inflamation of the gall bladder, the latter may become adherent to the duodenum.
- In extreme cases, ulceration may cause a fistula between the gall bladder and the duodenum, and gall stones may find way into the duodenum, and be passed out with stool.
- Posterior duodenal ulcer may invade the pancreas.
- The artery commonly eroded in posterior duodenal ulcer is the **gastroduodenal** . This may result in severe hemorrhage into the peritoneal cavity. (How will a patient with perforated duodenal ulcer present)?
- During repair of the perforated duodenal ulcer, special care must be taken to avoid damage to;
  - Bile duct
  - Portal vein
  - Inferior vena cava

  Rupture spleen is fairly common injury usually treated by **splenectomy**. In ligating and cutting the splenic vessels (preferably the artery separate from the vein) care must be taken not to damage the tail of the pancreas.

  Sometimes pancreatic tissue may encircle the duodenum, as a congenital malformation. This is called **anular pancreas** . When it causes obstruction, it is usually surgically removes. Again, all these structures must be preserved.

  The portal vein forms behind the neck of the pancreas.

  If advancing **cancer of pancreas** compresses the portal vein, (what are the possible effects)?

Posterior abdominal wall and diaphragm

Diaphragm: Minor orifices

Location	Contents
Between Sternal and Costal Origins	• The superior epigastric vessels
Between Costal Origins	• The musculophrenic vessels • Intercostal nerves 7-11
Between Costal and Lumbar Origins	• The subcostal nerve and vessels
In relation to Lumbar Origins	• The sympathetic trunk • The greater and lesser splanchnic nerves • The lowest splanchnic nerve • Vena azygos on the right and vena hemiazygos on the left
In the Domes	• Branches of the phrenic nerves

Actions of diaphragm

- Flattening increases the vertical diameter of the thorax. This increases intrathoracic volume thus dcreasing pressure.
- Flattening also displaces abdominal viscera.

Neurovascular supply to diaphragm

Blood supply	Lymphatic drainage	Innervation
• Musculophrenic • Superior phrenic • Inferior phrenic	• Parasternal nodes • Posterior mediastinal • Subdiaphragmatic nodes	**Phrenic nerve** • Motor to the ipsilateral half of the diaphragm • Sensory (pain and proprioception) to the greater part of the muscle. **Lower 6 or 7 intercostal and subcostal nerves**

- Sensory to peripheral part

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Last Updated : 14th November 2006 :

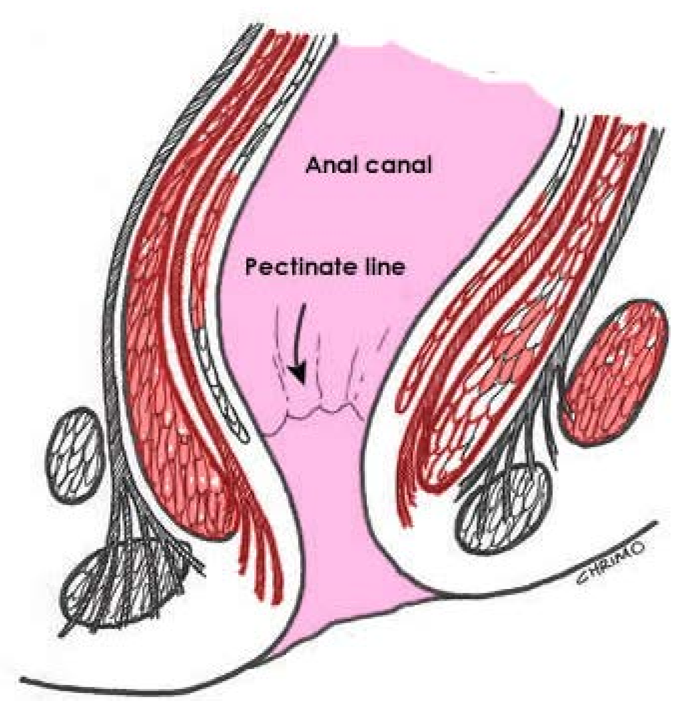
Summary of Pelvic Viscera

The anal canal

Position

- Terminal part of the large intestines
- Extends from the anorectal angle
- Descends postero inferiorly between the anococcygeal ligament and the central perineal tendon
- Sorrounded the levator ani

Interior of the anal canal



Anal colums:

- A series of longitudinal ridges / folds
- in the superior half of the mucous membrane of the anal canal.
- Contain terminal branches of superior rectal artery and vein
- The superior ends of the anal columns indicate the anorectal line where the anus joins the rectum

Anal pectinate line

- The inferior comb shaped limit of the anal valve.
- It indicates the site of junction of the superior part of the anal canal and inferior parts.

Sphincters

The internal sphincter	External sphincter

- Involuntary
- Stimulated by parasympathetic nerves
- Sorrounds the superior 2/3rds of the anal canal

- Involuntary
- Supplied by S4 via the inferior rectal nerve

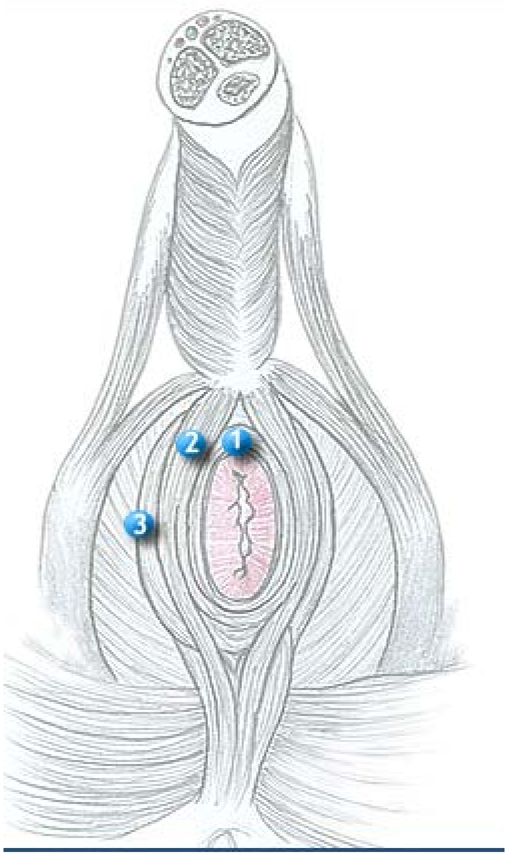
Anorectal ring

Comprises of the following structures:

- Puborectalis muscle
- External anal sphincter
- A few involuntary fibres from the internal anal sphincter

It is responsible for maintaining anal continence

External anal sphincter



- Voluntary and surrounds the inferior end of the anal canal
- Lies in the perineum
- Has three parts
    - Subcutaneous part (1)

      (+) Consists of slender fibres

      (+) Sorrounds the anus (crossing anterior and posterior to it)

      (+) Has no bony attachments.
    - Superficial part

      (+) Fibres extend anteriorly from:
      the tip of the coccyx and the Anococcygeal ligament around the anus
      to the central perineal tendon.
    - Deep part

      (+) Arises from the central perineal tendon

      (+) Fuses with the puborectalis part of the lavetor ani superiorly

      (+) Blends with lavetor ani, and is not sharply distinguished from it.
    - All the components are innervated by perineal branch of S4; and inferior rectal branch of the pudendal nerve.

Functions of the external anal sphincter;

- Closes the anus
- Draws anal canal anteriorly, thereby increasing the anorectal angle.
- Deep fibres are assisted by puborectalis

Blood supply

- Superior rectal – above pectinate line
- Inferior rectal – below pectinate line
- Middle rectal anastomoses the two
- The veins correspond

Lymphatics

- Above the pectinate line – internal iliac- common iliac and aortic lymph nodes
- Below pectinate line – superficial inguinal – deep inguinal and then to iliac nodes

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Innervation

- The part above the pectinate receives autonomic innervation and is sensitive only to stretch
- The part below the pectinate line is innervated by inferior rectal branches of the pudendal nerve. This is somatic innervation and is sensitive to pain, touch and temperature

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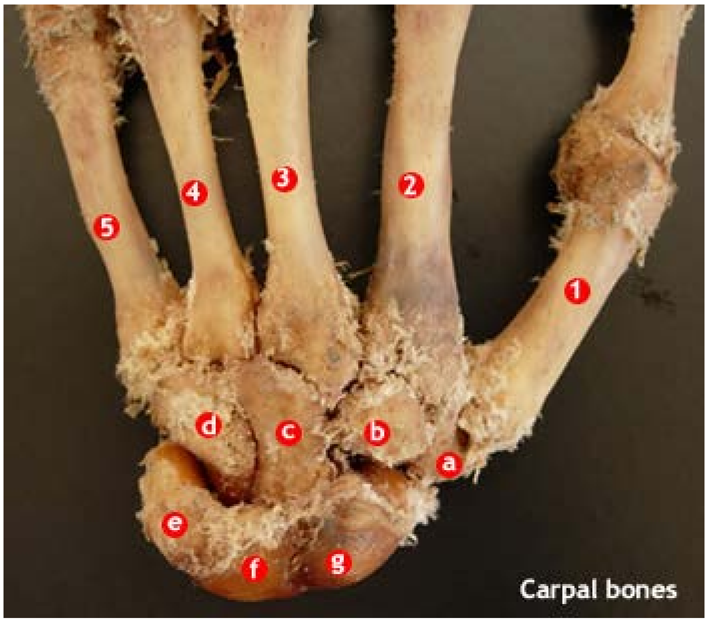
CHAPTER 18 : The Joints of the wrist , hand and fingers

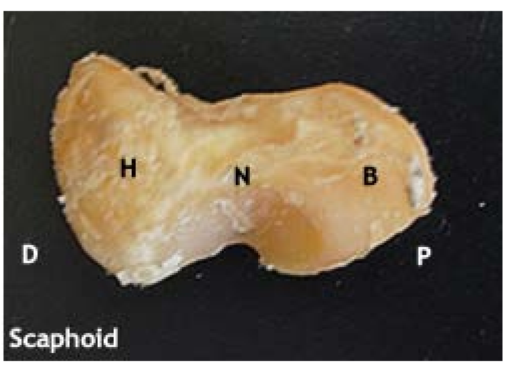
Organization of the Hand

Hand Osteology



- Includes the carpus, metacarpus and phalanges
- Carpal bones are 8 and are arranged in proximal and distal rows.
- ***Can you name them in order?***
- Scaphoid, lunate and triquetral form a convex articulating surface for the radiocarpal joint
- Pisiform articulates with palmar surface of triquetral bone
- Palmar surfaces of the bones form a concavity bridged by flexor retinaculum to form **carpal tunnel**.
- ***Are the carpal bones at the borders of the tunnel projected on the surface?***
- The trapezium and hamate are palpable proximal to the thenar and hypothenar eminence
- The retinaculum strengthens the carpus and enhances flexor efficiency
- Attached to the bones are various ligaments: radiocarpal, intercarpal & carpometacarpal

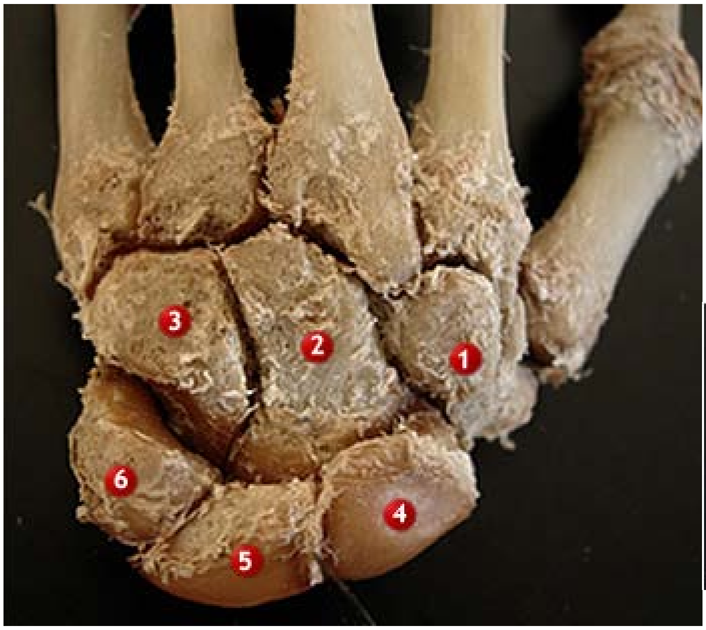
The Scaphoid bone



- To it is attached flexor retinaculum, abductor pollicis brevis, and radial collateral ligament.
- Has a body, neck and head. In a proportion (13%), the blood supply to the body is from the distal end
- Scaphoid fractures are common. *Why?*
- *How can you clinically detect a fracture of the scaphoid?*
- *Why are X-rays initially negative for scaphoid fractures?*

Other carpal bones

- Dislocations are common with the Lunate
- Triquetral makes contact with ulna at adduction
- The tendon of the *flexor carpi ulnaris, pisohamate* and *piso-metacarpal ligament* attach to the pisiform
- Trapezium characterized by grove for tendon of flexor carpi radialis. To it is attached the flexor retinaculum and radial collateral ligament
- Capitate is centrally placed and is the largest carpal bone
- Hamate affords attachment to flexor retinaculum and has rough dorsal and palmar surfaces for ligament.
- Capitate is first to ossify. Pisiform is last (***What is the order for the***



other?)

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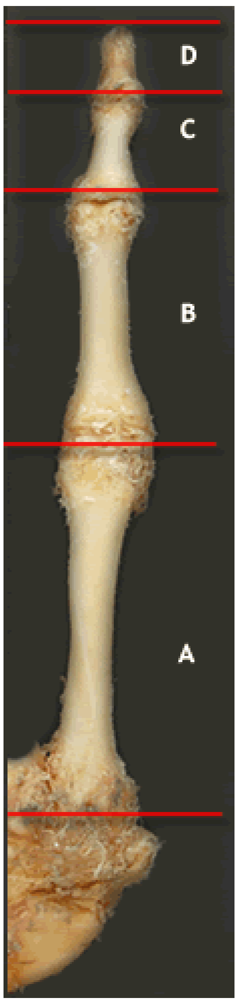
metacapals and phallanges :



- Metacarpals are long bones with head, shaft and base. The second metacarpal has the largest base and shaft
- The 14 phalanges bear heads, shafts and bases
- Note primary ossification centers for the shafts and secondary centers for base of 1 st and heads of other metacarpals

CHAPTER 18 : The Joints of the wrist , hand and fingers

Organs of supra colic compartment

Applied Anatomy-(Gall bladder)

1. Gall stones related to cholesterol tend to parallel coronary heart diseases. The stones may block the cystic or common bile duct – obstructive jaundice.
2. Due to the stones or otherwise, the gall bladder may be inflamed (cholecystits). This can be chronic or acute. Chronic cholecystitis, and especially due to stones is managed by surgical removal of gall bladder (cholecystectomy).
3. A lot of problems can arise during gall bladder surgery due to failure to appreciate the variations in blood supply, and the extrahepatic duct system.
   What are the blood vessel variations?
4. Accessory hepatic ducts are common and must be remembered. In some cases, the cystic duct opens into one of these accessory ducts.
5. It is important that during surgery all the ducts and vessels, including their origins are identified before cutting.
6. Some narrow billiary channels (accessory hepatic ducts) may run from the right lobe of the liver into the anterior surface of the body of the gall bladder These may be a cause of bile leakage following cholesystectmy. Such leakage may be contained by careful coutery of the gall bladder bed. Many surgeons now patch the bed with omental material.A small pouch may exist from the right wall of the neck of the gall bladder. This is called Hartsmann's pouch. And usually projects inferiorly and posteriorly towards the duodenum. Gall stones may easily lodge in this pouch.
7. The technique of visualizing gall bladder by introduction of radioopaque dye is called cholecystography, and the dye could be given intravenously; orally; or into the duct.

Applied anatomy(appendix)

1. Since afferent fibres from the appendix are carried in the lesser splanchnic nerve, and impulses enter T10; pain from the appendix is initially referred to the **periumbilical region** . Later, the pain may localize in the right lower quadrant - due to irritation of perietal perutoneum. If the appendix is long and enters the pelvis, acute appendicitis may resemble raptured ectopic pregnancy.
2. Since the appendix crosses the psoas major, the patient flexes the right thigh to relieve pain. If this thigh is hyperextended (psoas test), there will be pain because it stretches the muscle and its inflamed fascia.
3. MC Burney's point -joint between lateral 1/3; and medial 2/3 of a line between anterior superior iliac spine and umbilicus. This is the point of maximum tenderness in appendicitis. The Gridiron incision is made perpendicular to the line at this point, in appendicectomy.

Applied anatomy(spleen)

1. The spleen is not normally palpable. Where it becomes enlarged, it is its notched superior border which becomes palpable below the left costal margin. The left colic flexure is displaced downwards so that there is no area of colonic reasonance, an expanding retroperitoneal tumor such as carcinoma of the left kidney, does not displace gut; and therefore has a band of colonic reasonance extending across it.
2. Massive splenomegally can occur due to tropical parasitic infestations or malignancy or storage disorders. Such enlarged spleens could rupture spontaneously.
3. Ruptured spleen is a common surgical emergency, treated by surgical removal. During this procedure (splenectomy) the tail of the pancreas must be guarded. If the rupture is massive several pieces of splenic

tissue may be seeded into the peritoneum. This is called splenosis.

4. Following splenectomy, especially in children, a piece of splenic tissue may be buried in the peritoneum, to continue function.
5. Small accessory spleens or spleniculi may be found in the neighborhood of the spleen, being especially common in the Gastrosplenic ligament and greater omentum.

Review Questions

1. Describe the position, relations, peritoneal relations, supporting structures, blood supply, lymphatic drainage and innervation of each of the following

a) Liver

b) Pancreas

- Stomach
- Duodenum
- Colon
- Spleen

(Add notes on the peritoneal recesses and any other aspects of applied anatomy)

2. Subdivide the abdominal cavity into 9 regions, and list the contents of each. Outline the clinical relevance of this information, with special reference to pain and masses in the various regions

3. A 75 year old male presents to the outpatient clinic with deep obstructive jaundice, back pain, distended fluidy abdomen, leg oedema, distended abdominal veins filling from above, caput medussae. Examination and investigations reveal a supracolic mass. Discuss the primary pathology that would cause the features described above.

4. A 50 year old chronic smoker presents to the clinic with a history of constipation and previous bloody stool. Examination reveals a mass in the right loun. Discuss the anatomy of this case.

THE PERITONEUM

- A large serous membrane that lines the interior of the abdominopelvic walls, roof and floor.
- Reflected along certain lines from these parietes to be continuous with a layer of peritoneum over certain viscera.
- In the male the peritoneum surrounds a closed sac, the peritoneum cavity, but in female there are two openings in this sac at the ends of the uterine tubes.
- Consists of: a single layer of flat mesothelial cells, supported by an underlying layer of loose connective tissue.
- A thin layer of fluid covers the peritoneal surfaces, derived from interstitial fluid and from adjacent capillaries.
- The fluid contains water, electrolytes, solutes and protein and a cellular component that consists of desquamated cells wandering macrophages, mast cells, fibroblasts, lymphocytes and leucocytes.

- In places such as the greater omentum there may be gaps in the peritoneum,

peritoneal folds

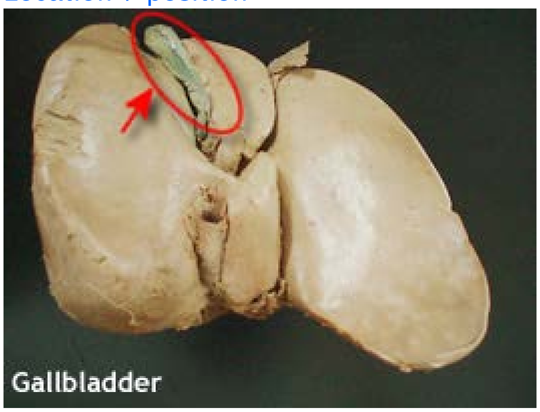
- peritoneal folds are raised between the parietes and the viscera and between the viscera themselves.
- Some of these folds are called 'ligaments', some 'mesenteries', and others 'omenta'.
- A mesentery is a double-layered fold of peritoneum that suspends viscera from the parietes.
- One thick fold of peritoneum hangs from the stomach over the viscera of the mid-abdomen, and is called the greater omentum (Latin for cover or apron).
- The lesser omentum is a double layer of peritoneal pockets in the adultn.

Upper abdominal peritoneal pockets in the adult

Chapter 32: The Peritoneum and the Organs of the Gastrointestinal System

THE GALL BLADDER AND BILE DUCTS

Location / position



- At the tip of the 9 th costal cartilage in the mid-clavicular line, where the linear semilunaris meets the costal margin.
- It lies along the right edge of the quadrate lobe of the liver.

Relations

Its superior surface is in contact with the liver, from which it is separated be loose connective tissue.

Its inferior and fundus is in contact with:

- Right part of the transverse colon
- Superior part of the duodenum

The neck of the gall bladder is narrow and tapers towards the porta hepatis. It is continuous with the cystic duct. The epiploic foramen lies immediately to its left.

Peritoneal relations

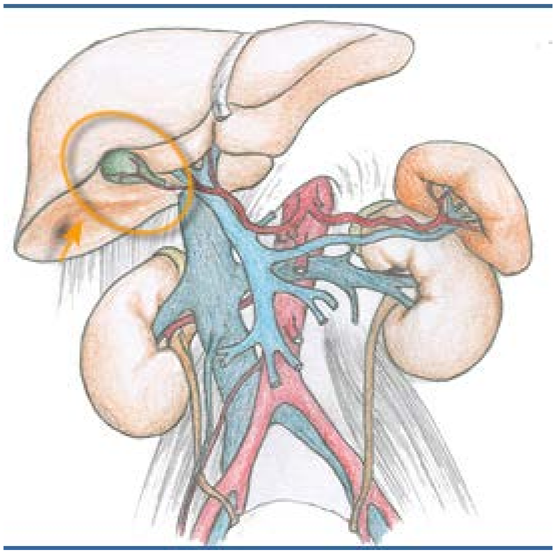
- Covered on the posterior and inferior surfaces by peritoneum.
- Occasionally, the gall bladder is completely invested with peritoneum, and may be connected to the liver by a short mesentry.

Blood supply

Arterial :

Cystic artery – commonly a branch of the right hepatic between hepatic duct and cystic duct. The origin and course of this artery is variable. It may arise from:

- Common hepatic
- Left hepatic



- Superior epigastric
- Left gastric
- Left hepatic
- Gastroduodenal
- Superior mesenteric
- Coeliac trunk

It commonly runs posterior to hepatic duct, but may run anterior .

Veins :

Those from the ducts and neck of gall bladder join veins which connect the

- Gastric
- Duodenal
- Pancreatic
- Portal vein
- Some go to the liver directly.

Lymphatics

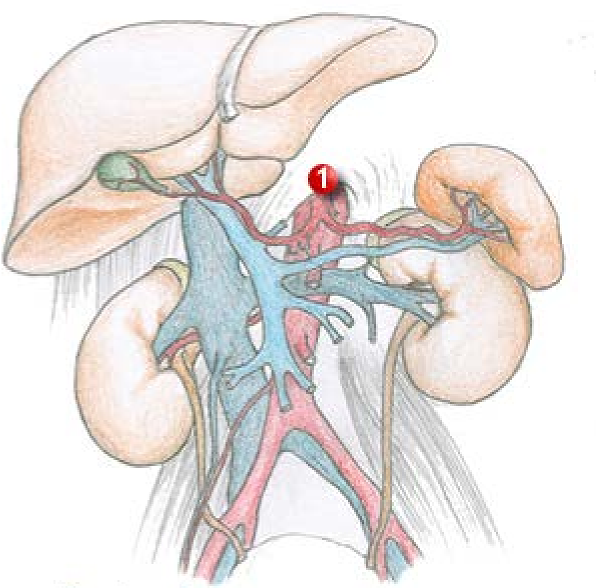
1. Cystic node at the neck of the gall bladder.
2. Node of epiploic foramen – hepatic nodes – coeliac lymph nodes

Innervation

1. Sensory innervation - phrenic nerve
2. Sympathetic - coeliac plexus
3. Parasympathetic - gall bladder

Blood supply to the abdomino-pelvic GIT

The coeliac trunk



coeliac trunk

The coeliac trunk is the first and largest unpaired branch of the abdominal aorta. It arises opposite the body of L1, and just below the aorta hiatus. It is the artery of the foregut and supplies the alimentary canal from the lower third of the oesophagus to the middle of the descending part of the duodenum, as well as related gut derivatives (the liver, gall bladder and pancreas) and the spleen.

Branches of the coeliac trunk

Remember them from the 3 large organs they supply:- stomach, liver and spleen.

1) The **left gastric artery** gives off oesophageal branches, and then turns downwards to follow the lesser curvature where it forms an anastomosis with the right gastric artery.

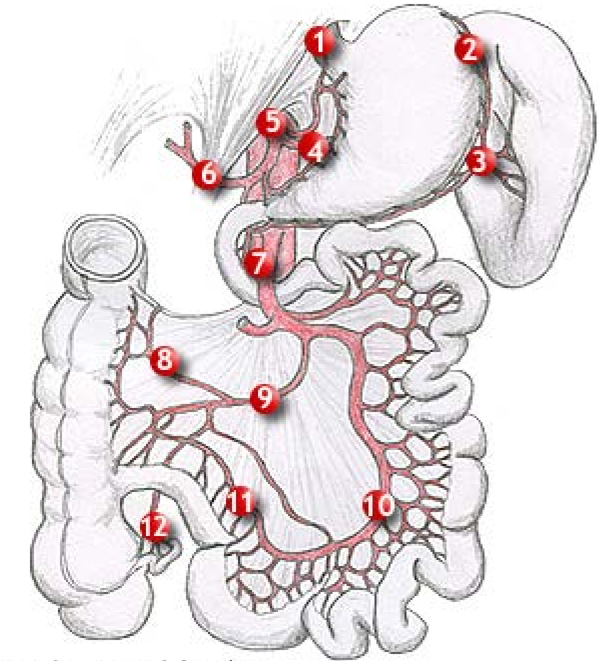
2) The **common hepatic artery** passes below the omental foramen, giving off the right gastric and gastroduodenal arteries, and then ascends in the free edge of the lesser omentum, as the hepatic artery proper . The gastroduodenal artery gives rise to the superior pancreaticoduodenal**,** to supply the respective organs and the right gastroepiploic which runs on the greater curvature of the stomach, anastomosing with the left gastroepiploic artery.

3) The **splenic artery** runs across the left suprarenal and left kidney and enters the splenorenal ligament and reaches the hilus of the spleen. It gives three main branches.

- Pancreatic branches supply the pancreas.
- Short gastric arteries enter the gastrosplenic ligament to reach the fundus of the stomach.
- Left gastro-epiploic artery, anastomoses with the right gastro-epiploic artery and supply both stomach and greater omentum.

Superior mesenteric artery (SMA)

The superior mesenteric artery is found in the root of the mesentery at L2 near the midline, just below coeliac trunk.



superior mesenteric branches

It is the artery of the midgut and supplies the GIT between greater duodenal papilla tto middle 1/3rd of transverse colon. Its branches include:

a) Inferior pancreaticoduodenal artery to supply the corresponding organs.

b) Jejunal and ileal branches

Anastomotic arcades between adjacent branches form secondary, tertiary and in the more distal parts even quaternary arcades. Vasa recta arise from the peripheral row of arcades.

c) The ileocolic artery runs towards the ileocolic angle and divides into ascending and descending branches. It gives the appendidular artery, to the appendix.

d) The right colic artery runs horizontally to the right and gives ascending and descending branches.

e) The middle colic artery arises from the right side and descends in the mesocolon to upper border of the transverse colon, where it divides into right and left branches.

Clinical anatomy

1. The coelic axis syndrome: This occurs when the coeliac trunk is compressed by the diaphragmatic crura leading to reduced blood supply to the foregut structures. It presents with pain in these structures.
2. Intestinal angina: This may follow atherosclerosis or other narrowing of the mesenteric arteries causing ischaemic pain in the intestines. It is worsened by eating and so victims tend to avoid eating. The impaired absorption and food avoidance lead to wasting of the victims.
3. Mesenteric artery thrombosis: This is a rare condition that causes gut gangrene
4. Water shed areas: The areas of the colon where branches of major arteries are vulnerable to ischaemia.
5. Portal hypertension: If portal pressure increases say from compression of portal vein or liver fibrosis, veins at portosystemic anastomosis distend. In the esophagus-esophageal varices in the rectum- haemorrhoids; at the umbilus- caput medussae.

Review Questions

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1. Give an account of the distribution of the following:

- Celiac trunk
- Superior mesenteric artery
- Inferior mesenteric artery

2. Describe the pattern of blood supply to the colon and rectum. Add notes on portosystemic anastomosis
3. Give an account of the circulation through the liver. Add notes on the anatomical basis and clinical relevance of hepatic vascular segements.
4. Give a detailed account of the lymphatic drainage of the organs of the GIT
5. A 60 year male chronic alcoholic is admitted to the ward with ascites, jaundice, malabsorption, lower limb oedema. He has had an episode of hematemesis and shows caput medussae. Discuss briefly the likely disorder that will cause there features. State the useful investigations and most likely findings.

Navigation of the site:
GROSS ANATOMY:
The material on the website has been organised under the following headings:

Objectives:
These contains the learning goals that should be achieved for each topic or region under study. Students are advised to go through them before covering the learning material. They will provide a useful guideline on the important areas of note and enable students focus on those important aspects of the region under study as well as reduce time that may otherwise be spent studying less relevant aspects.

Osteology:
Osteology refers to the study of bones. This section is meant to provide a simple study of the bones of the human body under the region of study. The start page (image) consists of list of bones in the region of study from which the student will select the desired one. Clicking the link of the selected bone brings up a page with an image of the bone listing important landmarks on the bone that are necessary for identification. The images are interactive to encourage the learning process. The landmarks are marked with hotspots, which together with the accompanying list of landmarks, can aid the student in familiarising themselves with those landmarks.
(Image with one landmark highlighted)

Summary:
This section contains brief notes on important aspects in the region under study. The notes are accompanied by photographic images from a dissected specimen to highlight the important points. Also included in the images is an artist's impression of the dissection. In a similar manner to osteology, the images are interactive with an accompanying list of features to identify from the images. (Image)
The summary section should be perused with the objectives, ealier defined, in mind.

Review questions:
As a means of ensuring that the learning objectives are met, several review questions are provided to test the student's understanding of the material. The questions will be based on the learning objectives with short sample answers supplied to the questions. It is obviously advised that students attempt the review questions on their own and only use the sample answers as a means of assessing and counterchecking their replies to the questions.

Image gallery:
This section is an image database of extra photographs taken during actual dissection. The gallery provides a wealth of images that students may utilise to better create a more rounded understanding of the region under study. The image gallery may be browsed online in which students may attempt to identify the structures in the view area, even with the aid of an atlas. The images may also be saved for offline viewing.

The Pancreas

This organ bears important relations which have clinical relevance. Its functions in digestion are extremely vital. Its anatomy must be well understood.

Location:

It extends across the posterior abdominal wall from the epigastric region to the left hypochondrium, lying across the bodies of the superior lumbar vertebrae. It lies behind the stomach, and runs from the concavity of the duodenum to the hilum of the spleen.

Parts

- Head
- Neck
- Body
- Tail

These parts have different relations all important, and are best studied separately.

The head

Lies in curve of the duodenum and anteriorly, is separated from the stomach by the lesser sac.

Posteriorly, it is related to:

- Inferior vena cava
- Right renal vessels
- Left renal vessels
- Common bile duct (sometimes embedded)

The head has a prolongation called the uncinate process which lies between the superior mesenteric vessels and the aorta.

Notice, that by virtue of this relationship(s) cancer of head of the pancreas causes

- Obstruction to the bile duct – obstructive jaudice
- Obstruction of the IVC – oedema of the lower extremity.

The neck

Anteriorly covered by peritoneum and related also to the pylorus of the stomach.

Posteriorly grooved by superior mesenteric vessels. The superior mesenteric vein is joined by the splenic vein posterior to the neck of the pancreas to form the portal vein.

The posterior surface is in contact with:

- Aorta
- Superior mesenteric artery
- Let supra renal gland
- Left kidney and its vessels
- Intimately related to the splenic vein

The body may have a small projection from the superior surface, called tuber omentale (the omental tuberosity) which contacts the lesser omentum, immediately inferior to the coeliac trunk.

The tail

Passes between the two layers of the lienorenal ligament, together with the splenic vessels. Its tip contacts the hilum of the spleen.

What is the importance of these relationships?

We have already noted some of the pressure effects of cancer of the pancreas.

The operation done for cancer of the pancreas is extensive, involving removal of the following:

- Pancreas
- Duodenum
- Common bile duct (and gall bladder)
- Connective tissue and lymph vessels and nodes in this area.

Would you wish to remove or injure any of the relations, if so; which?

Rupture spleen is fairly common injury usually treated by splenectomy. In ligating and cutting the splenic vessels (preferably the artery separate from the vein) care must be taken not to damage the tail of the pancreas.
What would happen if you did?

Sometimes pancreatic tissue may encircle the duodenum, as a congenital malformation. This is called anular pancreas . When it causes obstruction, it is usually surgically removes. Again, all these structures must be preserved.

The portal vein forms behind the neck of the pancreas.

If advancing cancer of pancreas compresses the portal vein, what are the possible effects?

Clinical anatomy

Review Questions

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1. Describe the location, relations, and pattern of blood supply and lymphatic drainage of the left kidney. Add notes on the right kidney.
2. Outline the course, landmarks, relations, constrictions, blood supply and innervation of the ureters. Add notes on the clinical applications of this information.
3. Describe the location, relations, blood supply and lymphatic drainage of the suprarenal gland. Add brief notes on the embryonic origins and microscopic structure of this gland.
4. Give an account of the attachments, relations, openings, blood supply, lymphatic drainage and innervation of the thoracic diaphragm. Add notes on the development and malformations of the thoracic diaphragm.
5. Give an account of the distribution and branches of the aorta from the lateral aspect. Add notes on the anastomotic sites between the aortic arch, and other parts of the aorta.
6. Give an account of the structures drained by the various tributaries of the inferior vena cava. Add brief notes on the sites of communication between the superior and inferior vena cava; and porto-systemic anastomosis.

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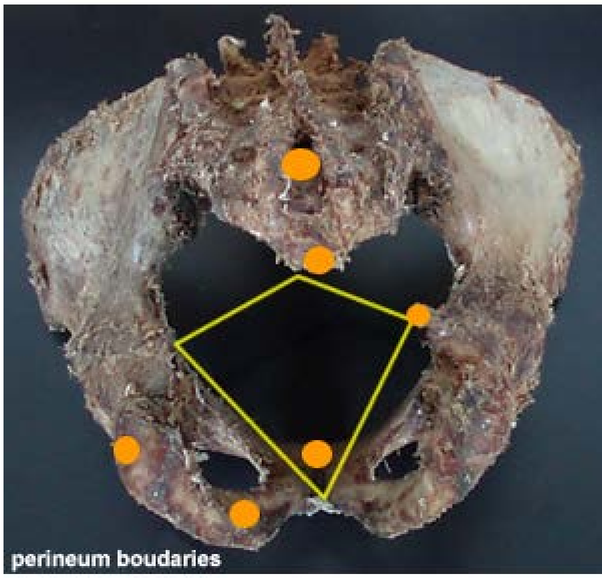
Image gallery

PERINEUM

Definition and Boundaries



The perineum is the diamond shaped region demarcated by 4 angles

- anteriorly – symphysis pubis
- posteriorly – tip of the coccyx
- laterally – 2 ischial tuberosities

The pubic arch and the sacrotuberous ligaments form its sides
Note: The sacrotuberous ligament is overlapped by the lower border of the gluteus maximus.

The perineum is divided into 2 triangles by a line joining the 2 ischial tuberosities.

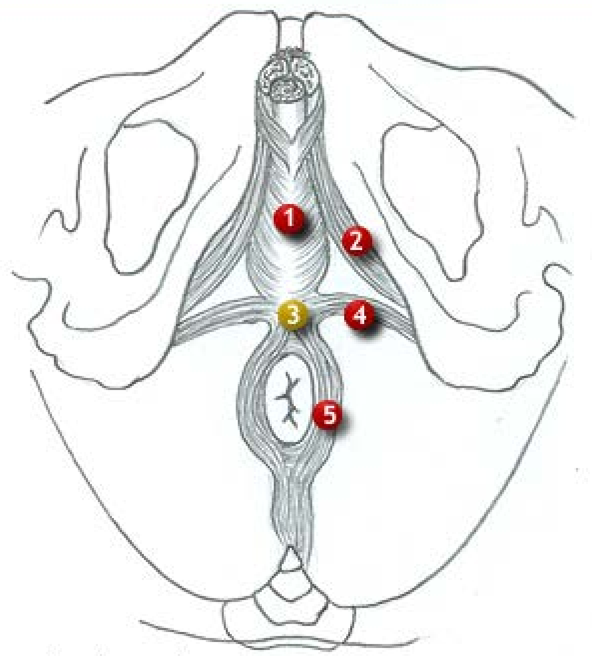
These are:

- Urogenital triangle – anteriorly
- Anorectal triangle – posteriorly

In the centre of the perineum is a small fibrous mass the perineal body. Attached here is the base of the perineal membrane. 5 muscles insert in this body from 5 directions.

These are:

- External anal sphincter – posterior
- Transverse perinei superficialis- from right and left
- Bulbospongiosus – anterior
- part of levator ani (from lateral and superior)



perineal muscles

Urogenital triangle

Boundaries

- anteriorly – symphysis pubis
- posteriorly – line joining the 2 ischial tuberosities and perineal body
- laterally – pubic arch

Urogenital diaphragm

This is a thin sheet of striated muscle which stretches between the 2 sides of the pubic arch. It occupies the urogenital triangle.

Has 3 parts

- anterior fibres – run transversely
- posterior fibres – are the muscle Transverse perinei profundus
- Middle fibres – circular and encircle the urethra and form the sphincter urethrae

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The urogenital diaphragm has 2 fascial coverings – superior and inferior urogenital fascia. The inferior urogenital diaphragm fascia is called the Perineal membrane. The narrow space enclosed by fascia of the urogenital diaphragm is the Deep perineal pouch.

Applied anatomy

Applied Anatomy(Ureters)

The ureters have normal constrictions at the following points

- Ureteropelvic junction
- Where it crosses the iliac vessels, and the pelvic brim
- Where it passes through the bladder wall.
- These must be born in mind when interpreting urograms.
- They are points of relative stasis of urine and potential sites for start of infection.
- Renal stones commonly lodge there.

When stones lodge in the ureters, the forceful contraction cause a sharp stabbing pain which follows along the course of the ureters. Because the ureters are innervated by T12, L1, (L2), pain of ureteric colic may be referred to the scrotum, or labia majora.

Urography can map out most abnormalities of the ureters and/ kidneys.

- Obstruction of the ureters cause backflow of urine leading to hydronephrosis (dilation of the renal calyces) with possible subsequent destruction of renal tissue.
- When the fatty renal capsule is absent, the kidney descends to an abnormally low level, where it is supported mainly by the renal vessels. This is called **nephroptosis** (renal ptosis) when the kidney goes low, the ureters may be kinked causing some obstruction.
- Because the renal fascia is attached in the midline, blood from kidney damage or pus from perinephric abscess CANNOT cross to the opposite side but can force its way into the pelvis.
- Because of its close relationship to the psoas major, inflamation relate to the kidneys/ureters makes thigh extension very painful.

The common surgical approach to the kidney is from the back - retroperitoneal. During this approach the nerves posterior to the kidney must be safeguarded. However, if peritoneal contamination and/or injury to other abdominal organs is suspected, the transabdominal approach is used.

Kidney transplants are common now – so the anatomy of the kidney and ureters is a must

Congenital malformations of the kidneys and ureters may be important clinically e.g

Pelvic kidneys and other ectopic kidneys may cause pressure symptoms wherever they are.

Horseshoe kidneys could occur, and be normally functioning. Normal ascent is usually prevented by the inferior mesenteric artery. They must be remembered when no kidneys are found in the normal position etc.

1. Membranous Urethra – prone to injure in the male as a result of falling astride on objects or a kick in the perineum.
2. Extravasation of urine from urethral injury in the perineum will be to the
    - scrotum
    - penis
    - anterior abdominal wall

   (see attachment of superficial perineal fascia)
3. Infections of the urethra especially gonnorcoccal – lodge in the Bulbourethral glands of Cowper.Therefore post-gonnorcoccal urethral stricture common in bulba-urethra

4. Pelvic fractures – especially pubic ramus often result in injury to membranous urethra and hence urine extravasation (see 4 ii above).
5. Lymphatics from the perineum drain into the deep inguinal nodes. Tumours and infections in this area present with swollen inguinal lymph nodes
6. Episiotomy – lateral surgical incision of the vulva and vaginal wall to allow for passage of baby during delivery. This also prevents tears of perineal body.
7. Anal fistulae
8. Ischiorectal abscess

Surgical Approaches to Prostate

Total prostatectomy is the surgical removal of the entire prostate. This operation is performed in cases of early malignant growths. Subtotal prostactomy is the surgical removal of less than the entire organ, and is carried out in cases of nonmalignant growths that interfere with normal urination. Any one of four approaches to the prostate may be used. In supra-pubic prostatectomy the anterior abdominal wall and the wall of the urinary bladder are incised. In retropubic prostatectomy, the anterior abdominal wall is incised, and the approach is made through the retropubic space and the fascia covering the anterior aspect of the prostate. In perineal prostatectomy (not common), access to the prostate is gained through the tendinous centre of the perineum and the rectouretralis muscle. Transurethral opening and then through the spongy and membranous parts of the urethra.

Clinical coorelates of the Pelvic Diaphragm

1. The pubococcygeus muscle may be damaged during parturition, or during episiotomy, or may be paralysed by a neurological disorder. When this happens, the support for pelvic viscera is weakened markedly. These viscera may herniate out e.g.

a) cystocele = herniation of urinary bladder

b) cystourethrocele = herniation of the urinary bladder and urethra

c) rectocele = herniation of the rectum.

d) uterine prolapse = herniation of the uterus.

2. When the pelvic diaphragm is damaged mildly the support of the urethra and ano-rectum is impaired even though the organs may not herniate. This results in strees incontinence of both urine and stool, more for the urine. In this condition, there is dribbling of urine, whenever the intraabdominal pressure is raised e.g. during coughing or sneezing.

Clinical coorelates of the scrotum:

1. Hydrocele

• This is presence of excess fluid in the processus vaginalis after birth.

• Infants may accumulate fluid in the cavity of their tunuca vaginalis testis. This is called non-communicating hydrocele. This fluid usually absorbs during the first year.

• If the processus vaginalis remains patent, peritoneal fluid may be forced into it, forming a communicating hydrocele. This is often associated with indirect inguinal hernia.

• The proximal and distal ends of the stalk of the processus vaginalis may obliterate, leaving an intermediate cystic area called a hydrocele of the cord.

• There are several other conditions that can cause hydrocele e.g. trauma, filarial worm infestations stds etc.

Some Clinical Coorelates on the Testis

a) Varicocele, is vericostity of the pampini - form plexus. Varicocele, is more common on the left side, and often results from defective valves in the testicular vein. They may temporarily disappear when the person lies down and the scrotum is elevated.

- Rarely, a varicocele may result from blockage of the renal vein owing to a tumor of the left kidney.

b) Hematocele, of the testis, is a collection of blood in the cavity of the tunica vaginalis, often due to trauma.

c) The difference in lymphatic drainage of the testis and the scrotum is important:

- Cells from a testicular tumor, may spread through lymphatics to lumbar lymph nodes; those from the scrotum to the superficial inguinal nodes.

d) Vasectomy, is a contraceptive procedure in which the vas deferens is ligated and cut, so that sperms can no longer pass to the urethra.

Clinical Coorelates

a. Ischio rectal abscess; A collection of pus in the fossa due to infection therein. Infection may reach the ischiorectal fossa;

- following infection in the anus
- from extension of a pelvirectal abscess.
- following a tear in the anal mucosal membrane.
- from a penetrating wound in anal region etc.
- Ischio rectal abscesses are best managed by surgical incision and drainage. If this is not done, the absecess may spontaneously open into; the anal canal; the rectum, the skin in the perineum or all these spaces.
- The two ischiorectal fossae communicate. Therefore, an abscess in one ischiorectal fossa, may spread to the other one.

b. Pudendal block anaestheia. In this procedure, a local anesthetic agent is injected into the tissues surrounding the pudendal nerve in the pudendal nerve in the pudendal canal. The injection is usually make where the pudendal nerve crosses the lateral aspect of the sacrospinous ligament near its attachment to the ischial spine, which is a good landmark. Pudendal blocks are done to relieve pain in the perineum, e.g. during labour and especially when an episiotomy is required.

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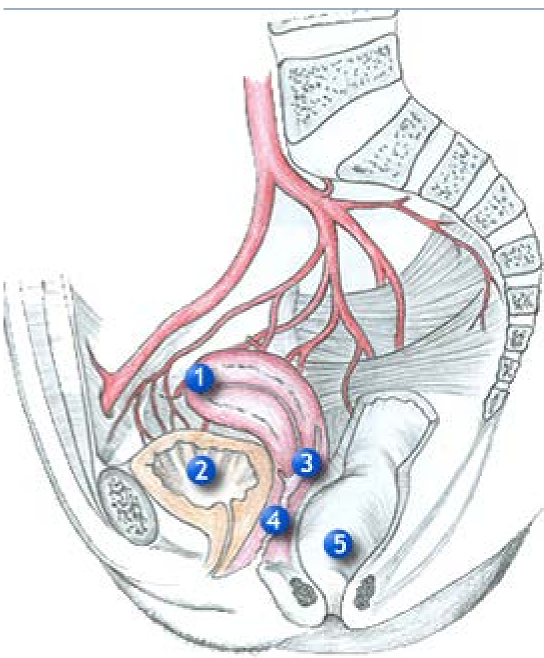
Chapter 35: The Male Reproductive System and The Perineum

objectives | osteology | summary | clinical anatomy | reviewquestions | image gallery | help

Review Questions

1. Give an account of the blood supply, innervation and lymphatic drainage of the testis. Add brief notes on microscopic organization of the testis with reference to blood testis barrier
2. Give an account of the parts, structure, blood supply, innervation and lymphatic drainage of the penis. Add notes on the mechanism of penile erection and detumescence.
3. Describe briefly the formation and contents of the perineal recess pouches. Add clinical notes
4. Outline the boundaries and contents of the ischiorectal fossa. Add clinical notes
5. Give an account of the blood supply, innervation and lymphatic drainage of the perineum

FEMALE GENITAL ORGANS



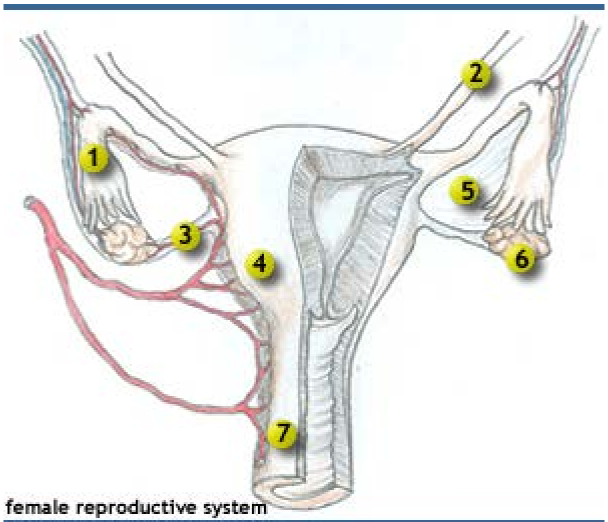
female crossection

The female genital organs consist of:

- the ovaries
- uterine tubes
- uterus
- vagina and,
- external genital organs.

The paired ovaries and uterine tubes and the single uterus are situated in the pelvic cavity. The single vagina is located partly within the pelvic cavity and partly in the perineum. The external genital organs lie in front of and below the pubis.

Ovary



functions

1. Oogenesis - produce ova after puberty.
2. Parts of the m function as endocrine glands , and are responsible for the production of two main hormones:

- estrogen, or follicular hormone, secreted by the ovarian follicle. It controls the development of the secondary sexual characteristics, such as the enlargement of the breasts, the deposition of fat over the hips and buttocks, and the growth of pubic and axillary hair.

  It also initiates the growth of the lining of the uterus during the menstrual cycle.

- progesterone, or corpus luteum hormone, secreted by the corpus luteum. It is indispensable for the implantation of the fertilized ovum and for the early development of the embryo. The secretion of both ovarian hormones is controlled by the gonadotrophic hormone from the pars distalis of the hypophysis. The ovaries are homologous with the testes of the male.
- A third hormone, called relaxin, is secreted by the ovary during pregnancy. It is said to inhibit premature contraction of the uterus during pregnancy, and , in certain mammals, is responsible for the relaxation of the sacroiliac joint and the pubic symphysis. The ovary also produces several paracine factors.

Location

In a woman who has not borne children (nullipara), The ovary is situated on the lateral wall of the pelvis, at the level of the anterior superior spine, and just medial to the lateral plane, where it can be palpated bimanually. Its position may be altered by other pelvic organs, especially the uterus, to which the ovary is attached by ligaments. When the uterus ascends into the abdomen during pregnancy, the ovary is pulled away from its original position, which is usually regained after parturition.

It resembles a large almond in shape. Its size varies with age and with the stage of the ovarian cycle. It is somewhat larger before than after pregnancy. After pregnancy, it is about two and a half to four centimeters long, and its average weight is seven grams. In old age it becomes further reduced in size.

When the ovary is in its usual position, its long axis is nearly vertical. It has medial and lateral surfaces, tubal and uterine ends, and mesovarian and free borders. It lies in a depression, the ovarian fossa, which is bounded in front by the obliterated umbilical artery and behind by the ureter and internal iliac artery.

The lateral surface is in contact with the parietal peritoneum lining the ovarian fossa and is separated by this peritoneum from the extraperitoneal tissue that covers the obturator vessels and nerve. Most of the medial surface is covered by the uterine tube; elsewhere this surface is related to the coils of the ileum.

The mesovarian or anterior border is attached to the mesovarium and faces the obliterated umbilical artery. The hilus of the ovary, through which blood vessels, lymphatic vessels, and nerve pass, is located on this border. The free or posterior border is related to the uterine tube and, behind this, to the ureter.

The tubal or upper end is closely connected to the uterine tube; the suspensory ligament of the ovary is attached to this end. The uterine or lower end gives attachment to the ovarian ligament.

Chapter 36: Female Reproductive System and the Contents of the Female Pelvis

CLINICAL ANATOMY

Review Questions

1. Describe the location, position, and relations, supporting structures, blood supply, lymphatic drainage and innervation of the uterus. Pay special attention to the cervix
2. Give a brief account of the location, supporting structures, blood supply, lymphatic drainage and innervation of the urinary bladder
3. Outline the relationships, orientation, blood supply, lymphatic drainage and innervation of a) urethra b) Vagina
4. Give an account of the formation and contents of the perineal pouches in the female
5. Give an account of the blood supply, lymphatic drainage and innervation of the vulva.

SUMMARY OF THE ORGANIZATION OF THE PERINEUM

Boundaries

1.1 The pubic symphysis

1.2 The inferior pubic rami

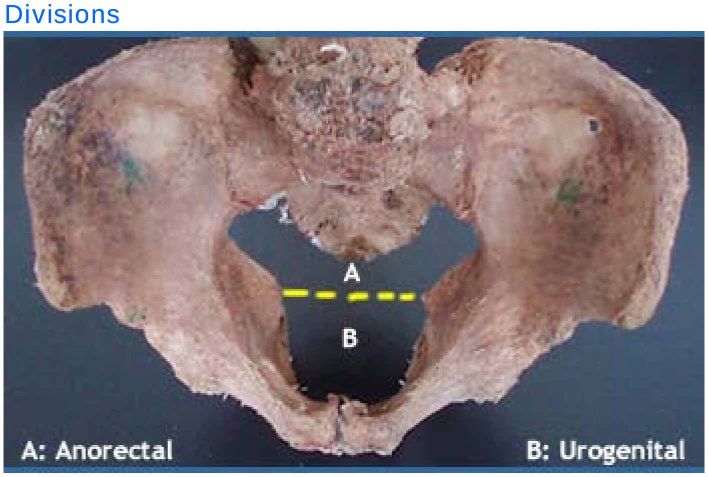
1.3 The ischial rami

1.4 The ischial tuberosities

1.5 Sacrotuberous ligaments

1.6 The coccyx.

Divisions



The line joining the two ischial tuberosites divides the perineum into two triangular parts.

2.1 The anal triangle, posterior to this line, containing the anus.

2.2 The urogenital region, anterior to this line, and containing scrotum, and the root of the penis (or the vulva in the female).

The Pelvic Diaphragm

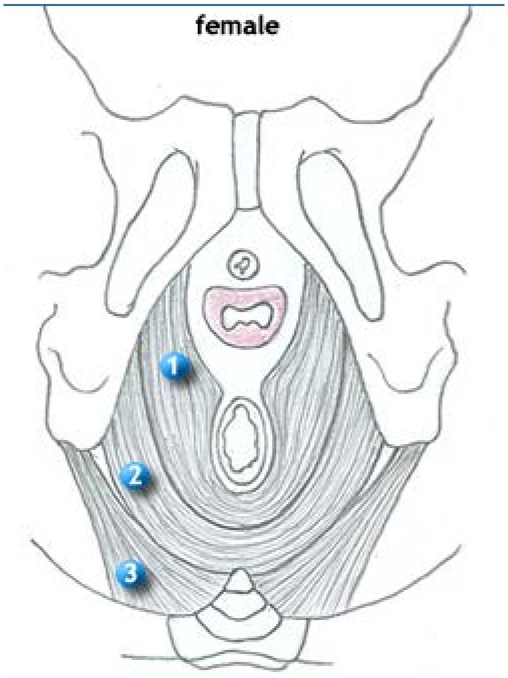
Components

- Laveta ani
- Coccygeus muscles, together with their investing fasciae; both superiorly and inferiorly.

The lavetor ari muscles and their fascia form the larger and more important part of the pelvic diaphragm.

These muscles originate from;

- The pelvic surface of the body of the pubis



• Tendinous arch, formed by a thickening of the parietal pelvic fascia over the obturator internus muscle.

• Ischial spine.

They insert onto;

- Central perineal tendon
- The wall of the anal canal
- Anococcygeal ligament
- Coccyx.

Parts of Lavetor Ani

• Pubococcygeus, is the main par. It arises from the pubis, and inserts into the coccyx, and the anococcygeal ligament. The anococcygeal ligament, is the median fibrous intersection of the pubococcygeus muscles from the two sides. It is located between the anal canal and the tip of the coccyx. The pubococcygens encircles the urethra, vagina, and anus and merges into the central perineal tendon.

• The puborectalis, is the part that loops around the anorectal junction, and arises from the pubis.

• Lavetor prostatae, are the anterior fibres that run inferior to the prostate. In the females, these fibres constitute the pubo vaginali muscle.

Functions of Lavetor Ani

1. Constitute the pelvic floor for the containment/support of pelvic viscera - resisting inferior thrust during e.g. coughing, deep expiration etc.

2. They raise the pelvic floor, assisting the anterior abdominal wall muscles in compressing the viscera, e.g. in coughing, deep expiration, vomiting, urinating.

3. Support of the prostate and the vagina providing sphincteric action of the latter, and urethra.

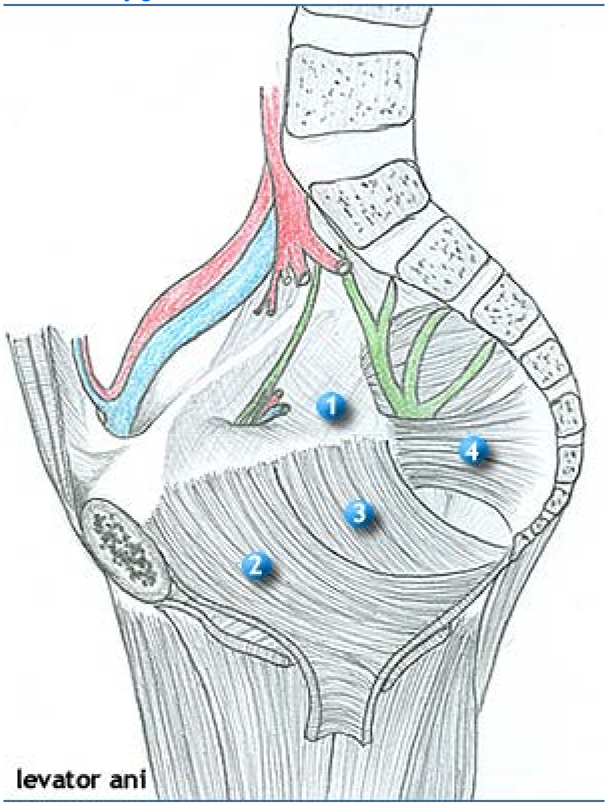
4. The puborectalis holds the anorectal junction anteriorly, increasing the angle between the rectum, and anal canal. This prevents passage of feces from the rectum, into the anal canal when defecation is not desired, or is inconvenient.

5. The gutter arrangement, facilitates the rotation of the baby's head during parturition, in accordance with the

pelvic diameters.

6. Supports the fetal head while cervix is dilating during parturition.

The Coccygeus



- The coccygeus muscle, is continuous with the iliococcygeus muscle; and forms the posterior and smaller part of the pelvic diaphragm.
- It rises from the pelvic surface of the ischial spine.
- It inserts on the lateral margins of the 5 th sacral vertebra and coccyx.
- The fibres support the coccyx, and pull it anteriorly, after it has been pressed posteriorly during child-birth.

Structures piercing pelvic diaphragm

- The anus
- The urethra
- The vagina (in females)

Chapter 37:The Structures of the male pelvis and pelvic diaphragm

clinical anatomy

Review Questions

1. Describe the location, supporting structures, relations, blood supply, lymphatic drainage and innervation of the rectum and anal canal in a) males b) females
2. Outline the location, relations, blood supply, lymphatic drainage and innervation of the prostrate gland. Add notes on prostatic hypertrophy and its effects
3. Describe the formation, components, innervation and functions of the pelvic diaphragm
4. Give an account of the location, stability factors, relations, blood supply, lymphatic drainage of the male urinary bladder and urethra.

Movements at the Sub Talar Joint

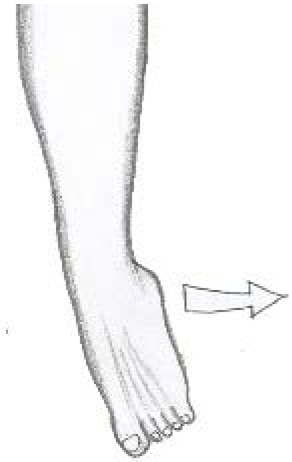
Inversion and eversion:

- These important movements adjust the position of the foot when walking on uneven ground and / or uphill.
- Inversion raises the medial border of the foot, turning the sole inwards. Eversion raises the lateral border of the foot turning the sole outwards.

They occur at two joints:

- The subtalar joint
- Midtarsal joint

Movement	Muscles
Inversion 	• Tibialis anterior and posterior • Extensor hallucis longus • Medial tendons of extensor digitorum longus
Eversion	• Peroneus longus and brevis • Peroneus tertius • Lateral tendons of extensor digitorum longus



The axis of the movement is along an oblique line passing from the lateral tubercle of the Calcaneous upwards, forwards and medially through the neck of the talus and the medial part of the tarsal sinus.

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Lymph nodes of arm

Node	Location	Area drained
Infraclavicular	Deltopectoral groove	Superficial tissues of thumb Lateral side of arm and forearm
Supratrochlear	Just above medial epicondyle	Superficial tissues of medial part of forearm and hand

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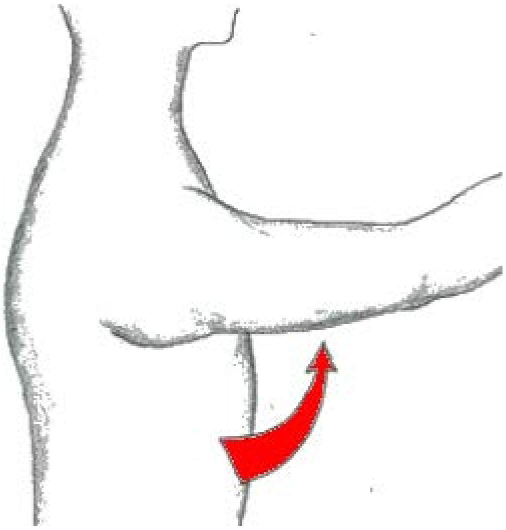
4.8) Movements at the shoulder joint

This consists of movements of the pectoral girdle and thos of the limb

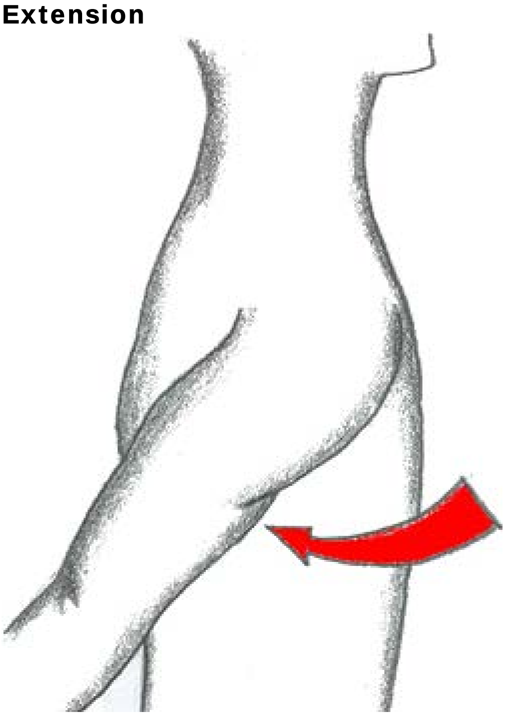
Flexion



Forward and slightly medial movement of the arm – is produced by :

- Pectoralis major
- Deltoid (the anterior fibres),
- Biceps brachii

Extension

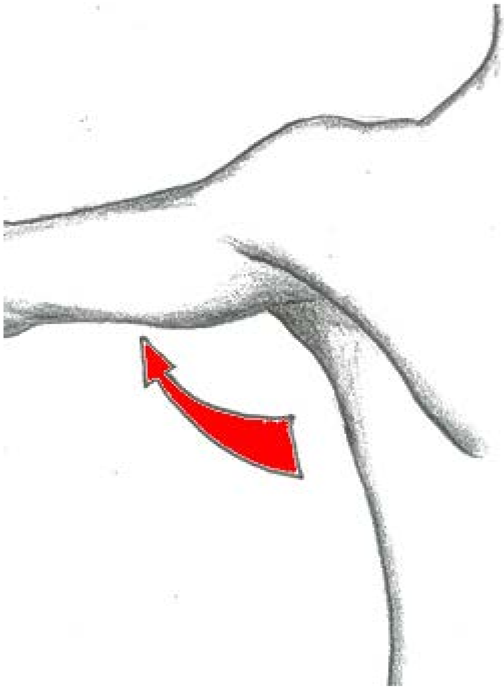


The opposite movement – is produced by:

- Latissimus dorsi,
- Teres major and minor,
- Deltoid (the posterior fibres),
- Infraspinatus
- Long head of triceps brachii

Abduction

Elevation away from the side of the body in the plane of the scapula



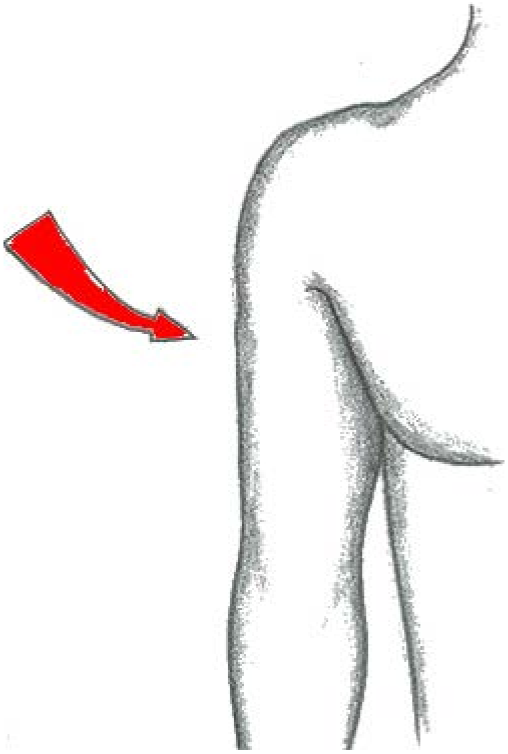
– produced by:

- Deltoid
- Supraspinatus.

The initial 15° is caused by supraspinatus, 15-90° by deltoid , 90-180° requires lateral rotation of scapula to point glenoid cavity upwards therefore

- Serratus anterior
- Trapezius contributes.

Adduction



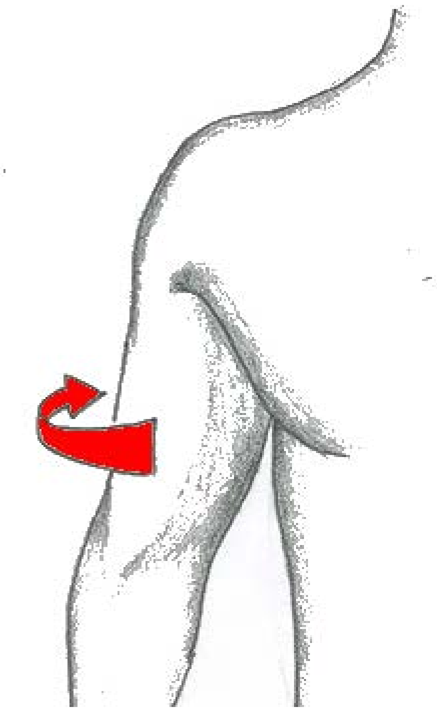
Produced mainly by gravity, while the adductor muscles are relaxed. Adduction against resistance is produced by

- Subscapularis
- Pectoralis major
- Teres major and minor
- Latissimus dorsi
- Coracobrachialis
- Long head of triceps

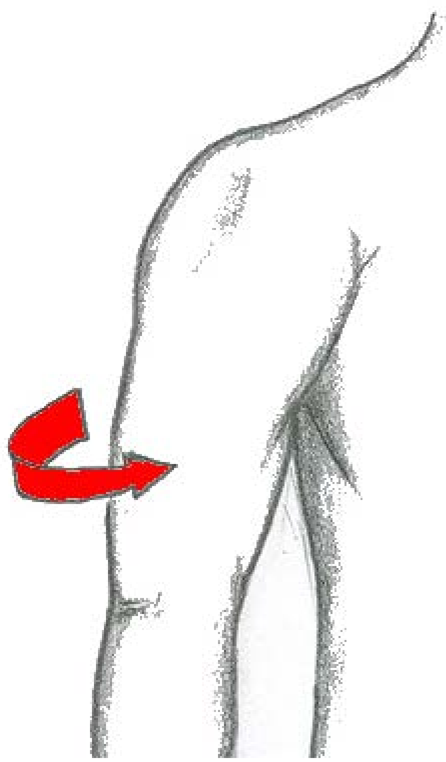
Lateral rotation

The front of the arm turning laterally – is produced by:

- Infraspinatus,
- Teres minor
- Posterior fibres of deltoid



Medial rotation



Produced by:

- Pectoralis major,
- Anterior fibres of deltoid
- Subscapularis
- Latissimus dorsi
- Teres major

Peculiarities

Most striking peculiarities in this joint are:

1. The **large size** of the **head of the humerus** in comparison with the **depth of the glenoid cavity**, even when this latter is supplemented by the glenoidal labrum.

2. The **looseness of the capsule** of the joint.

3. **The intimate connection of the capsule with the** muscles attached to the head of the humerus.

4. The peculiar relation of the **tendon of the long head** of the **Biceps brachii** to the joint.

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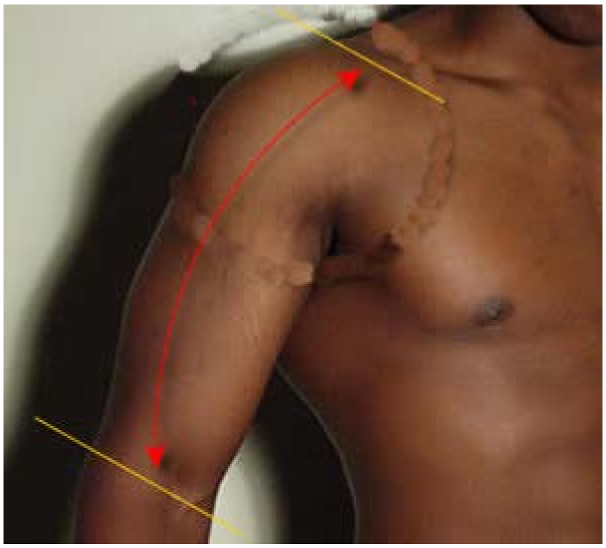
Organization of the arm



Region extending from the shoulder to the elbow

Superficial fascia

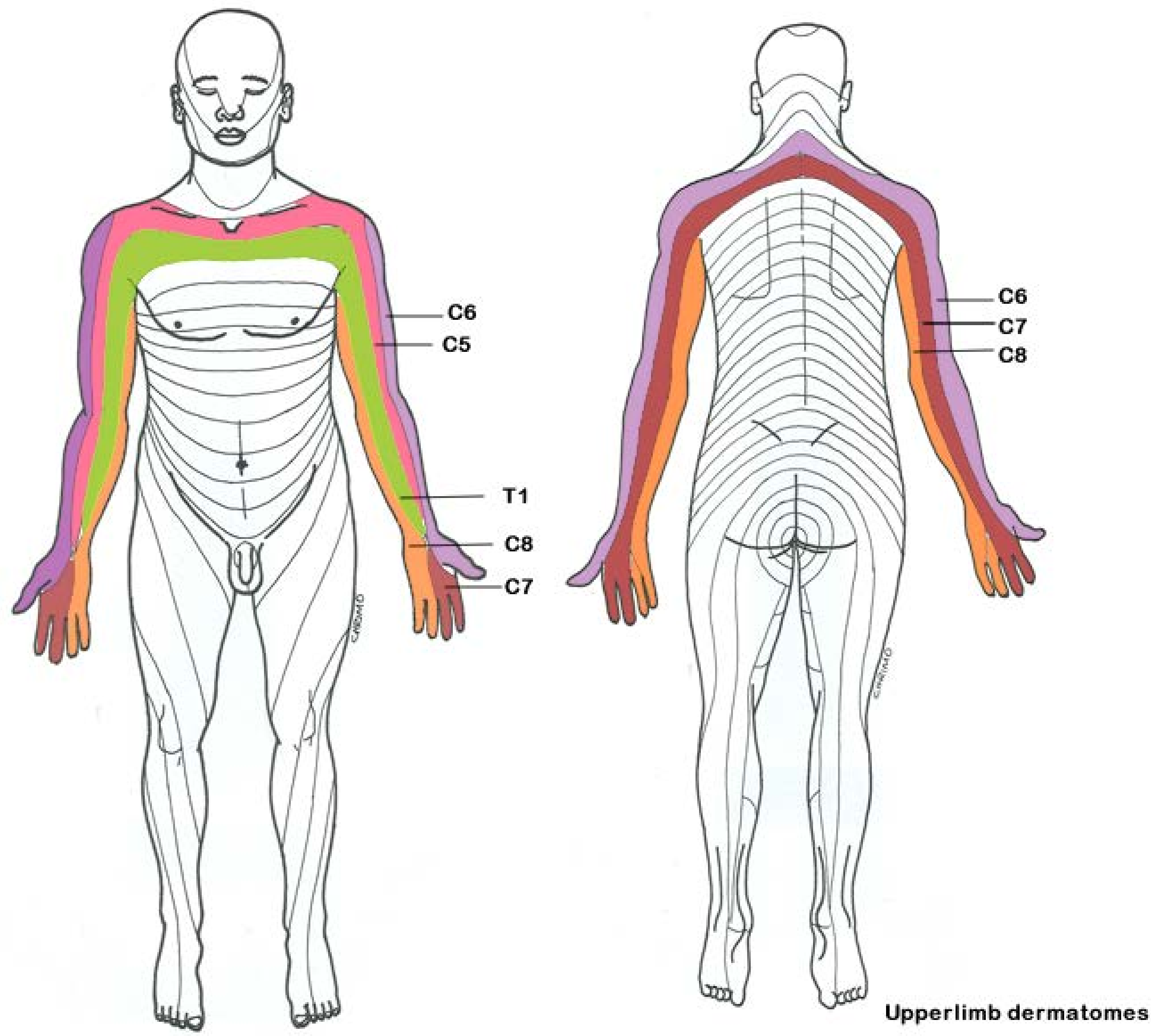
Contains nerves and veins

Two veins

- Basilic veins joins brachial vein to form axillary vein
- Cephalic vein courses upwards laterally through deltopectoral groove to join axillary vein

Cutaneous nerves

- Medial cutaneous nerve of the arm usually joined by inter costo brachial nerve
- Upper lateral cutaneous nerve of arm
- Lower lateral cutaneous nerve of arm
- Posterior cutaneous nerve of arm



Deep fascia (Brachial fascia)

- Binds and holds arm muscles in place
- Sends in two septa medial and lateral to form anterior and posterior compartments.

palsoftweblink

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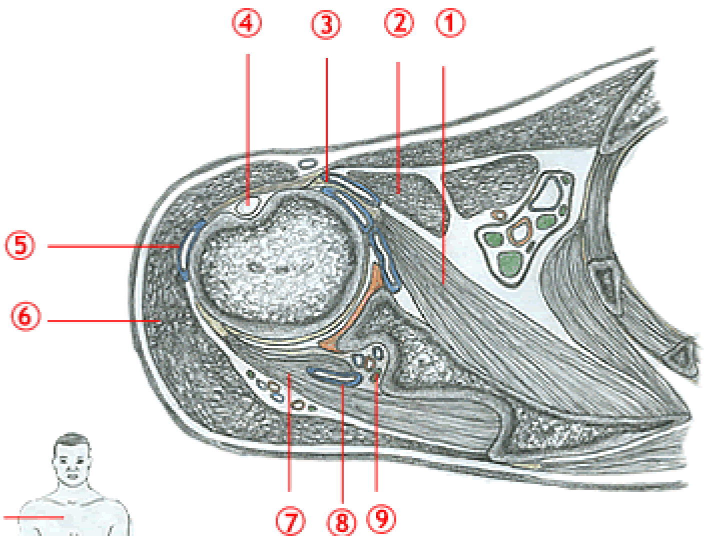
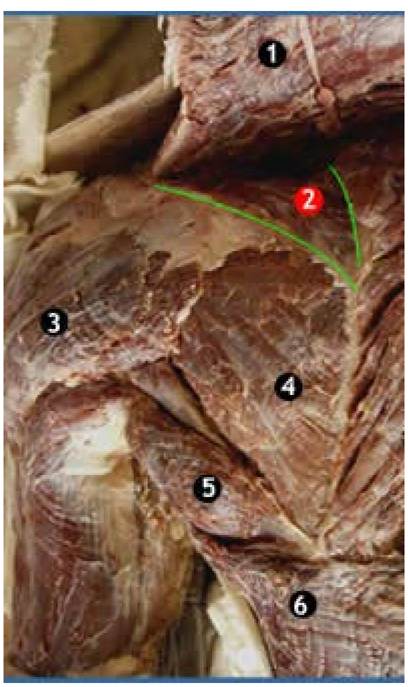
4.5) Relations of the shoulder joint

Crossectional view of Shoulder Joint



Hover over hot points to show structure name.

Superior

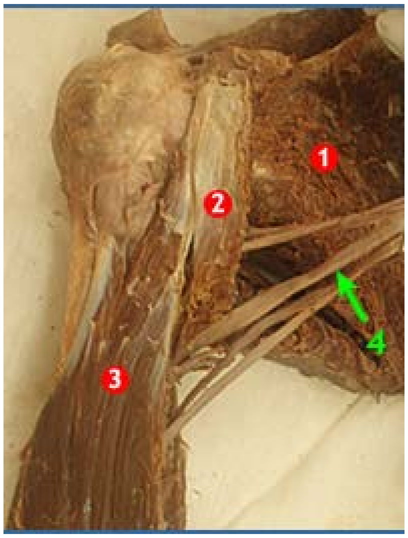


The tendon of ***supraspinatus*** ***(2)*** fuses with the capsule, and is separated from the secondary socket above by the *subacromial bursa*.

task ***Identify the stractures 1,3,4 and 5***

Anterior .

The *subtendinous bursa of subscapularis* partly intervenes between the capsule and the tendon of *subscapularis*. More



distant are the *axillary structures* which lie on the tendon of *coracobrachialis*, the *short head of biceps brachii*, the axillary vessels and the brachial plexus.

Posterior

The tendon of ***infraspinatus*** and its bursa ***(1)***
The tendon of ***teres minor*** posterosuperior ***(2)*** .All the above relations are covered by deltoid

---

Inferior

The *axillary nerve* and the *posterior circumflex humeral vessels*

4.6) Blood Supply and Innervation

---

a) Blood Supply

The ***anterior*** and ***posterior circumflex humeral*** arteries and the suprascapular artery.

b) Innervation

The nerves supplying the muscles whose tendons fuse with the capsule, viz. the suprascapular, ***axillary*** and ***subscapular nerves***

CHAPTER 18 : The Joints of the wrist , hand and fingers

Organization of the Hand

Hand Osteology

- Includes the carpus, metacarpus and phalanges
- Carpal bones are 8 and arranged in proximal and distal rows.
- *Can you name them in order?*
- Scaphoid, lunate and triquetral form a convex articulating surface for the radiocarpal joint
- Pisiform articulates with palmar surface of triquetral
- Palmar surfaces of the bones form a concavity bridged by flexor retinaculum to form **carpal tunnel**.
- *Are the carpal bones at the borders of the tunnel projected on the surface?*
- The trapezium and hamate are palpable proximal to the thenar and hypothenar eminence
- The retinaculum strengthens the carpus and enhances flexor efficiency
- Attached to the bones are various ligaments: radiocarpal, intercarpal & carpometacarpal

The Scaphoid bone

- To it is attached flexor retinaculum, abductor pollicis brevis, and radial collateral ligament.
- Has a body, neck and head. In a proportion (13%), the blood supply to the body is from the distal end
- Scaphoid fractures are common. *Why?*
- *How can you clinically detect a fracture of the scaphoid?*
- *Why are X-rays initially negative for scaphoid fractures?*

Other carpal bones

- Dislocations are common with the Lunate
- Triquetral makes contact with ulna at adduction
- The tendon of the flexor carpi ulnaris, pisohamate and piso-metacarpal ligament attach to the pisiform
- Trapezium characterized by grove for tendon of flexor carpi radialis. To it is attached the flexor retinaculum and radial collateral ligament
- Capitate is centrally placed and is the largest carpal bone
- Hamate affords attachment to flexor retinaculum and has rough dorsal and palmar surfaces for ligament.
- Capitate is first to ossify. Pisiform is last (*What is the order for the other*)?

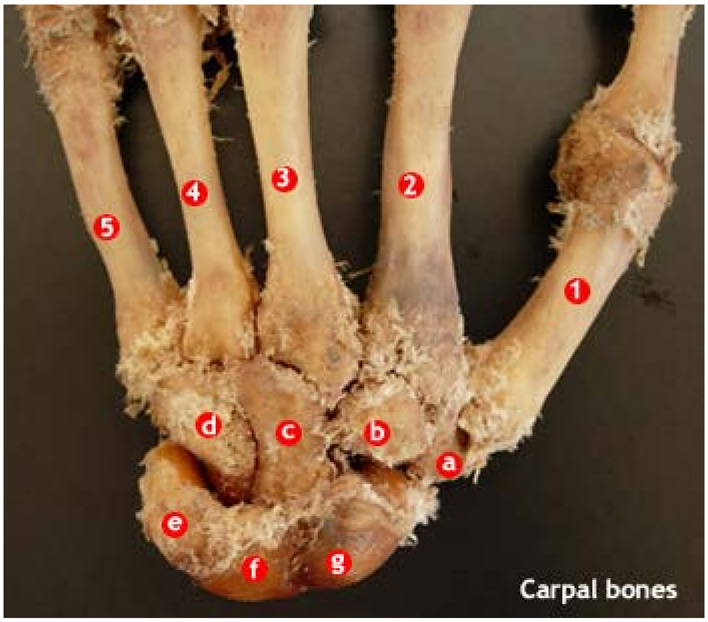
metacapals and phallanges :

- Metacarpals are long bones with head, shaft and base. The second metacarpal has the largest base and shaft
- The 14 phalanges bear heads, shafts and bases
- Note primary ossification centers for the shafts and secondary centers for base of 1 st and heads of other metacarpals

CHAPTER 18 : The Joints of the wrist , hand and fingers

Organization of the Hand

Hand Osteology



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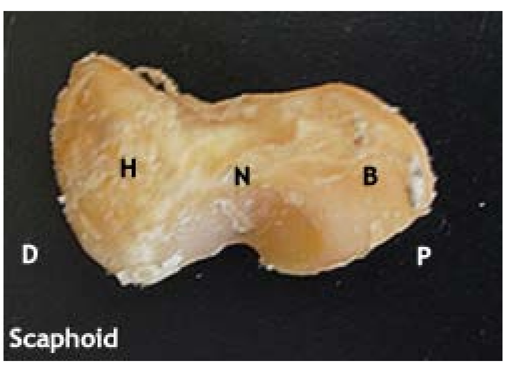

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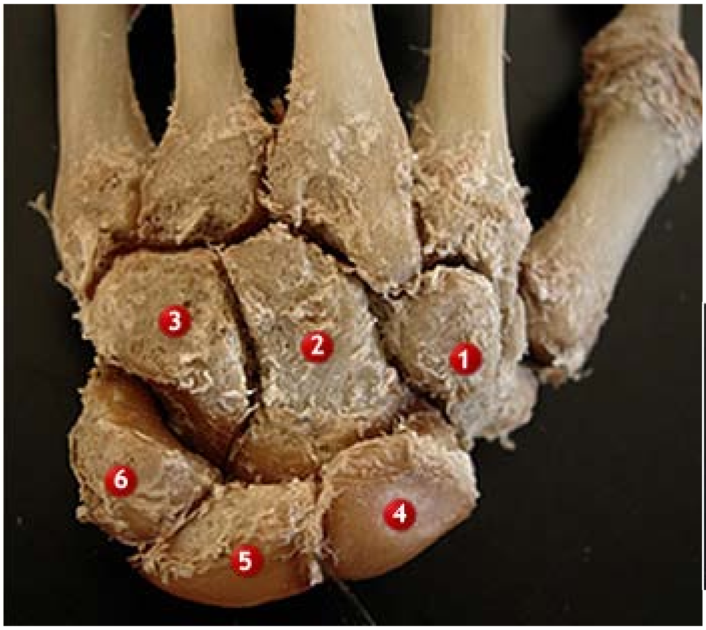

other?)

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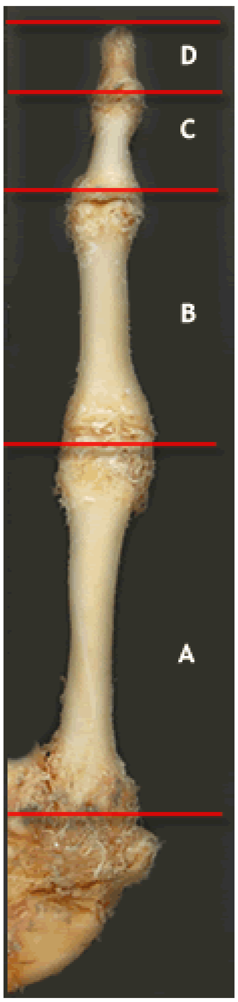
metacapals and phallanges :



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THE SKULL AND SCALP

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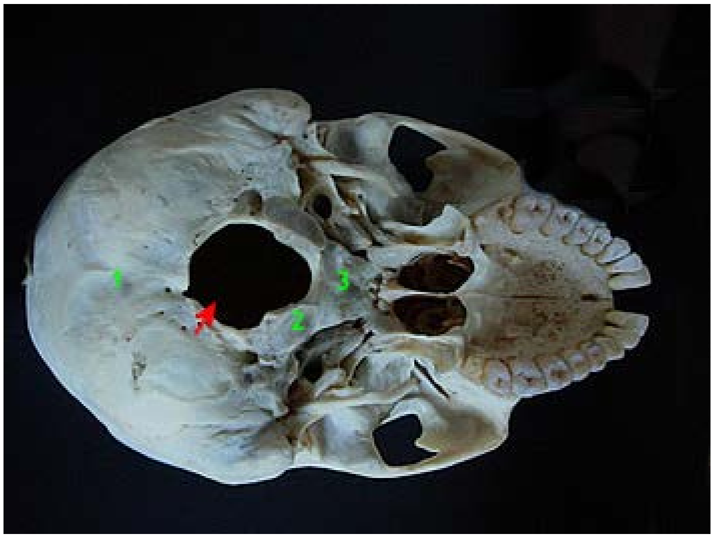
Chondrocranium

Occipital Bone



Has three parts which sorround foramen magnum:

- The **squamous** part(posteriorly) - 1
- The **occipital condyles**(lateral) - 2
- The **basilar** part(anteriorly) - 3

Externally, the squamous portion of the bone possesses supreme, superior and inferior nuchal lines to which the muscles at the back of the neck are attached.

The occipital condyles articulate with the first cervical vertebrae (the atlas).

Lateral to each occipital condyle are the condylar fossae and foramen while the hypoglossal canal is medial to them.

The Sphenoid Bone

Hover over hotspot to show name

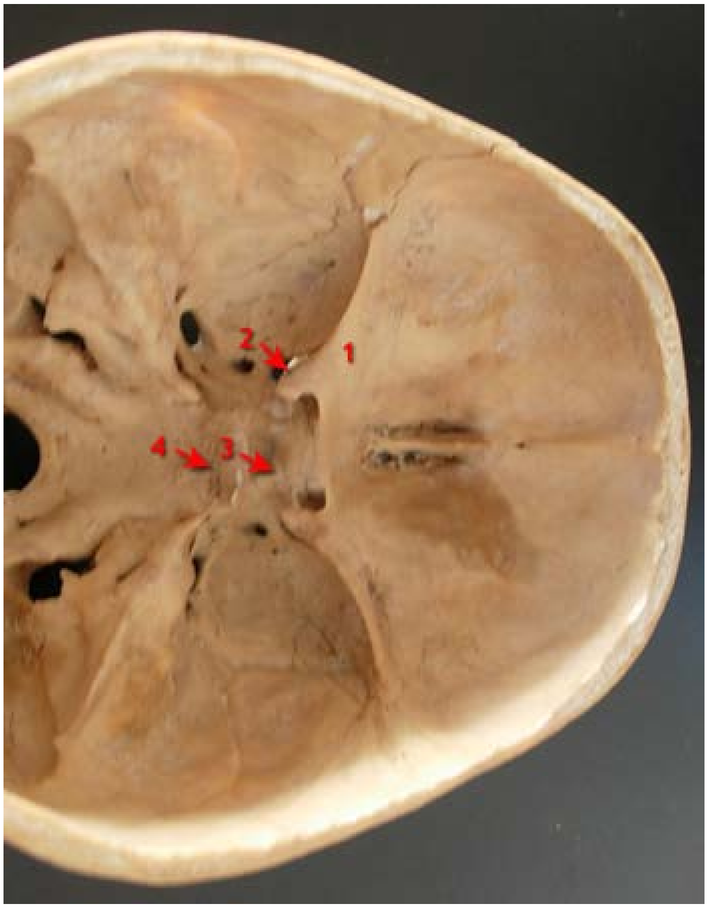
Parts

- Body
- Greater wing
- Lesser wing
- Pterygoid plates(Medial and Lateral)

Body lodges pitituary fossa (sella turcica)

Fissures and foramina

- superior-orbital fissure
- Rotundum
- Ovale
- Spinosum



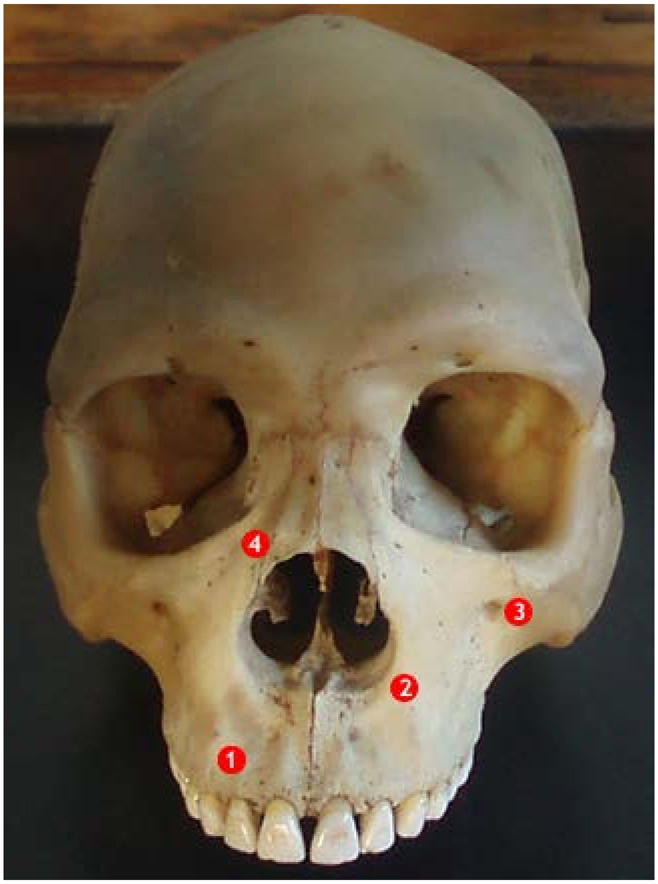
Viscerocranium

Maxillary bone

Parts

1. Alveolar process.
2. The body.
3. Zygomatic process.
4. The frontal process - joins the frontal bone.

Contains maxillary air sinus



The Zygomatic (Malar) Bones

Hover over hotspot to show name

Parts:

- A temporal process.
- An orbital part bounding the lateral and inferior margins of the orbit.
- A maxillary part joining the maxilla.
- The body from which the three parts orbital, temporal and maxillary extend.

What forms the zygomatic arch?

Processes:

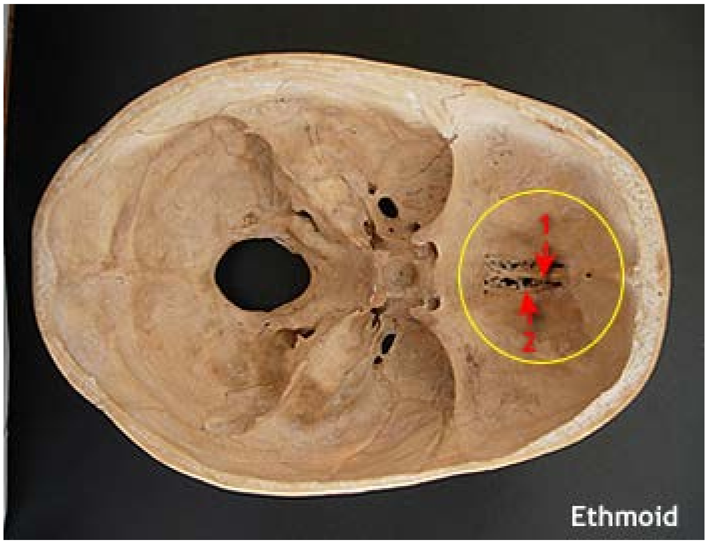
- Marginal process
- Temporal process
- The maxillary process

Ethmoid Bone

Connects the facial and cranial skeletons

Plates

- Crista galli **(1)**
- Cribriform **(2)**



Perpendicular
- Orbital plate

Projections

- Superior and inferior nasal conchae

The Vomer

Is a single flat bone located in the mid-sagittal plane. It articulates with the perpendicular plate of the ethmoid superiorly and together aid in forming the nasal septum, aligned perpendicularly and divides the the nasal aperture into the the left and right nasal passages.

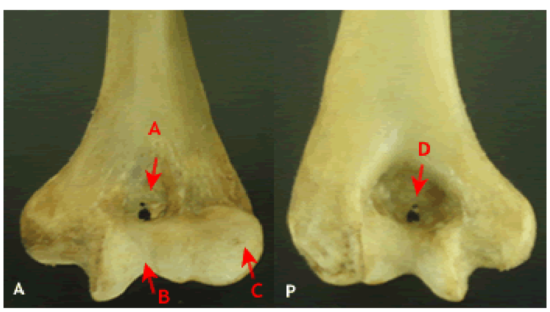
In addition to the Perpendicular portion, superiorly the Vomer mushrooms out into a pair of Alae which terminate and articulate with the sphenoid in a heart shaped process.
Inferiorly the Vomer rests on both the maxillae and the palatines.

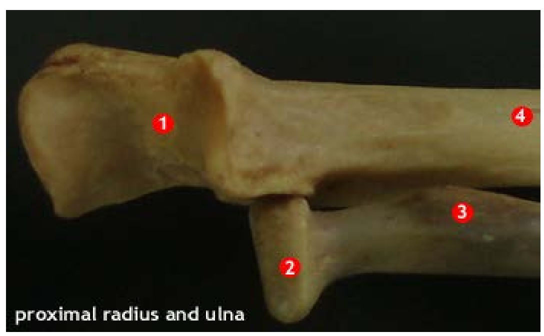
Organization of the elbow joint

Synovial joint of hinge variety. Its cavity communicates with that of the proximal radio-ulna joint, a reason that the two are at times referred to as the ‘elbow joint complex'.

Articular surfaces

- Capitulum and trochlea of distal humerus
- Radial head and trochlea fossa of ulna





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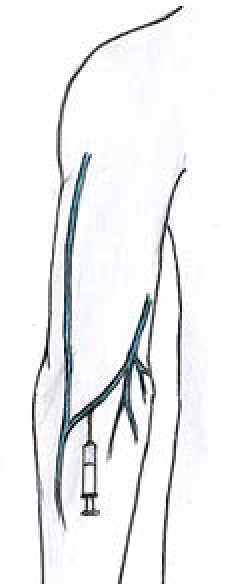
Applied Anatomy

Cubital Fossa



The Cubital Fossa is important clinically because of

1. Removal of blood from median cubital vein
2. Palpation of the brachial artery in blood pressure measurement
3. Supracondylar fractures of humerus and danger of injury to contents

task ***with the use of an illustration show the contents of the cubital fossa in relation to each other***

Forearm

- Posterior border of ulna is subcutaneous. The bone can be exposed surgically from end to end without danger
- When forerarm is flexed against resistance, brachioradialis is prominent along the radial border. The radial pulse is medial to this.
- The median nerve is deep to palmaris longus tendon therefore cuts anterior to the wrist region may damage any number of these structures
- The scaphoid bone is papbable in the depth of the anatomical snuff box. Scaphoid fractures present with tenderness in the box
- Note the tremendous importance of antecubital veins in venesections
- Radial fractures proximal to the pronator teres may be splinted with the forearm in supination.
- Radial fractures distal to the pronator teres may be splinted with forarm in neutral position.
- Stethoscopes are placed on the brachial artery, medial to the tendon of biceps for blood pressure measurements
- Hand infections may spread proximally into the space of Parona

Review Questions

Outline the origin , course , relations , branches and distribution of the following nerves

- Radial
- Ulnar
- Median

(add notes on the sites of injury to these nerves)

Give a brief account of the organization of the muscles of the forearm , with details of their attachments , actions and innervation

With the help of diagrams indicate the sites of muscle attachments on the humerus , radius and ulna

State the location , boundaries , contents and clinical importance of the anatomical snuff box

Describe the configuration of the articular surfaces , classification , capsule , stability factors , innervation , blood supply , relations and movements of the elbow joint

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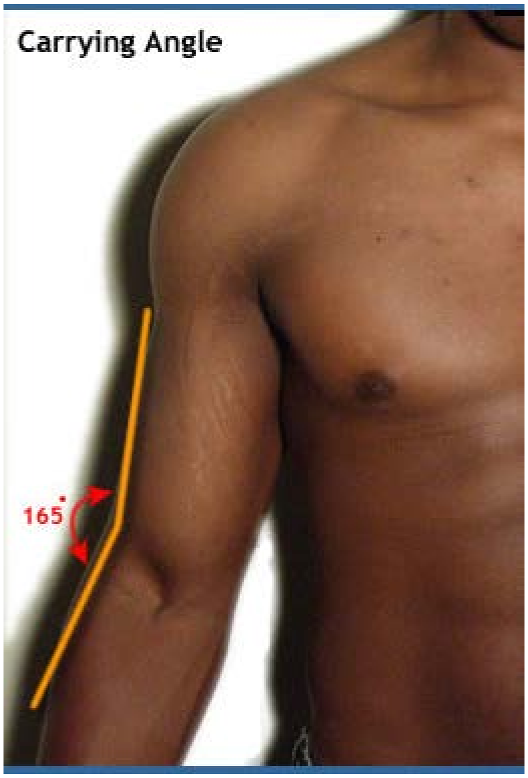
The Carying Angle and Cubital Fossa



The articular surfaces of the lower end of the humerus are not set at a right angle to the shaft, but incline upwards about 15º laterally.

The angle between the arm and forearm is thus about 165º and allows the hand to swing freely past the hip.

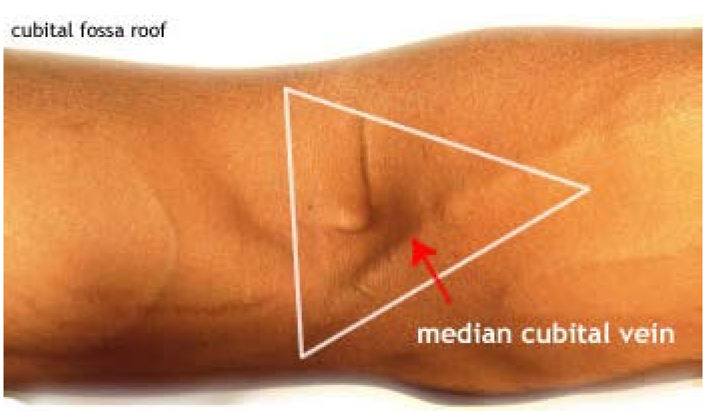
It is therefore known as the carrying angle.

It is made obvious when the limb is extended at the elbow, with the forearm in supination.

The carrying angle has often been said to be more acute in females, on account of the greater width of the female pelvis, but this claim has been disproved.

If the forearm is pronated or flexed, the carrying angle disappears.

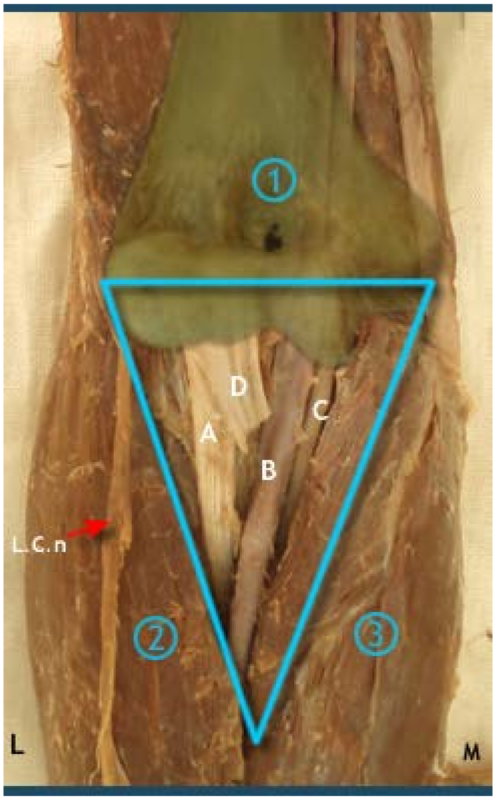
The Cubital Fossa



The cubital fossa is a triangular fossa in front of the elbow joint.

BOUNDARIES:

1. Imaginary line joining the humeral epicondyles superiorly **(1)**
2. Brachioradialis laterally **(2)**
3. Pronator teres medially **(3)**

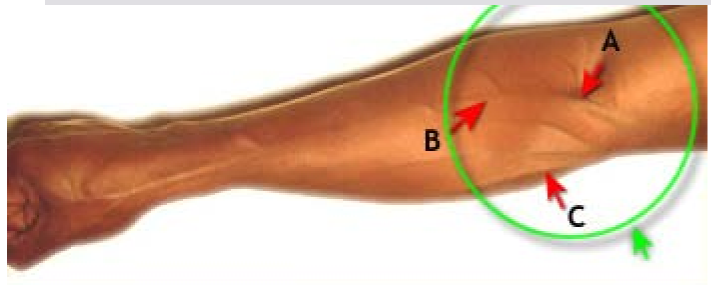


Supinator and brachialis constitute the floor of the cubital fossa.

The roof is formed by the deep fascia and includes the bicipital aponeurosis **(D)**.

On the roof lie three named veins (*cephalic, basilic and median cubital*) and two cutaneous nerves (*the lateral cutaneous of the forearm* and the *anterior branch of the medial cutaneous of the forearm*.

Hover over the veins to show names



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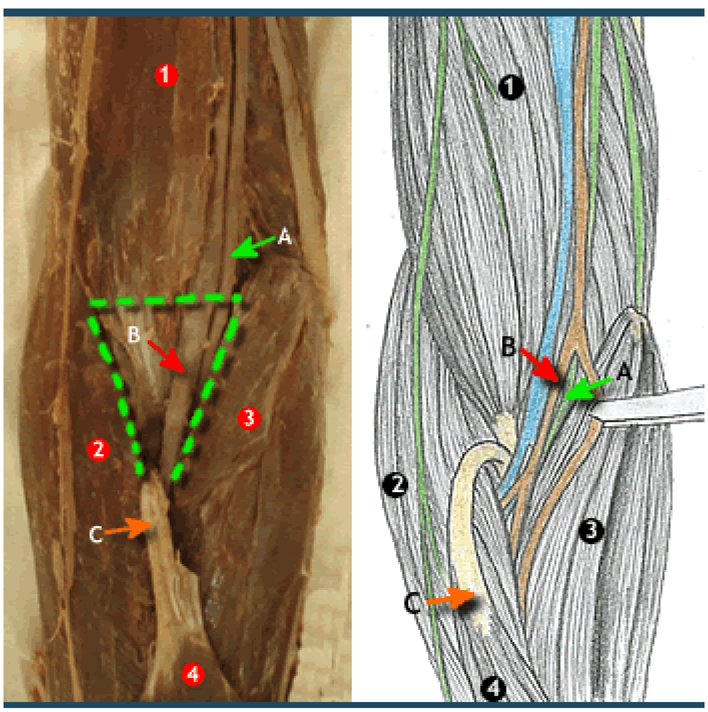


Biceps brachii tendon.

Brachial artery and **veins**

Median nerve

Radial nerve

Radial recurrent artery

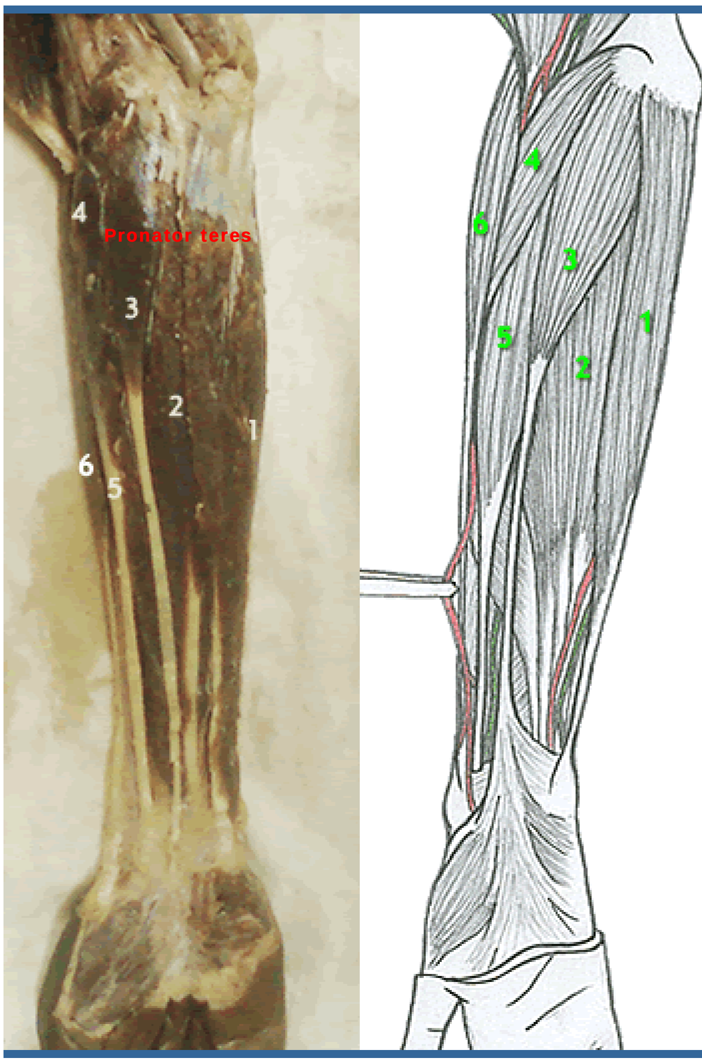
d structures (1-4)

Anterior Compartment

2.2 The contents include:

- Superficial muscles: pronator teres, flexor carpi radialis, palmaris longus, flexor carpi ulnaris
- Intermediate muscle: flexor digitorum superficialis
- Deep muscles: flexor pollicis longus, flexor digitorum profundus, pronator quadratus
- Ulnar and radial arteries
- Median
- Ulnar nerve

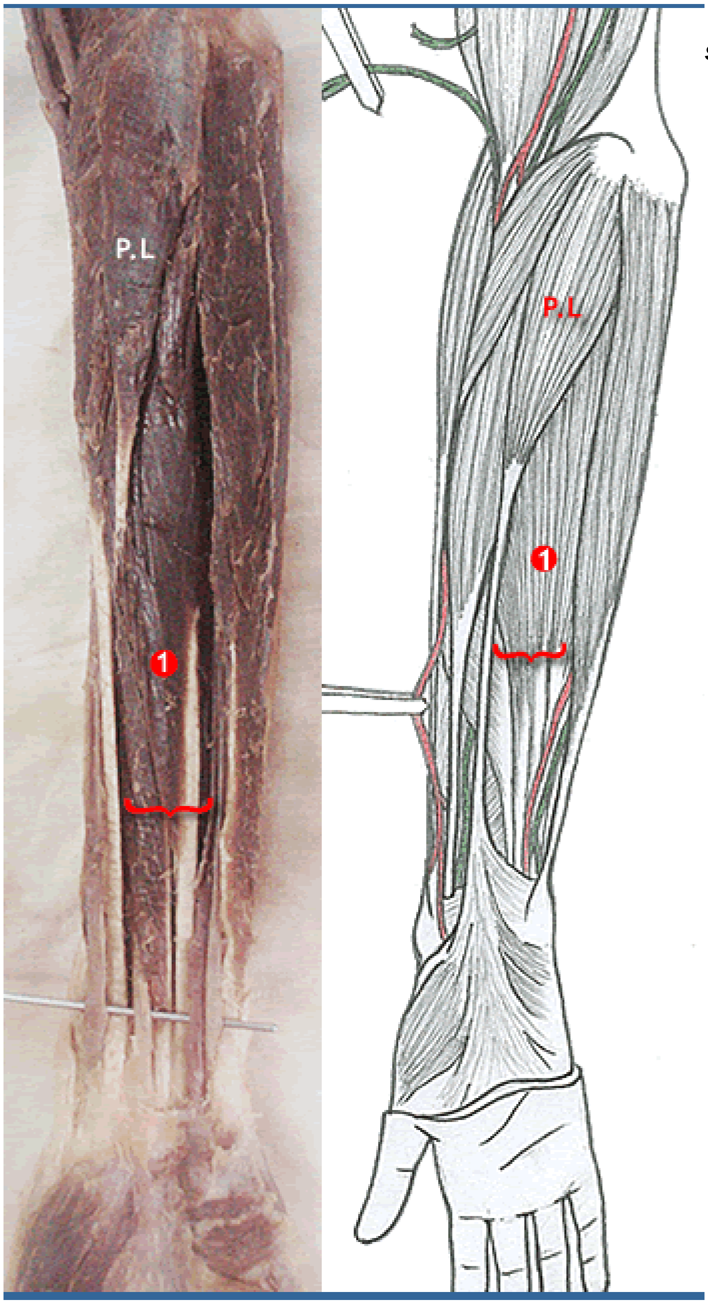
Superficial muscles



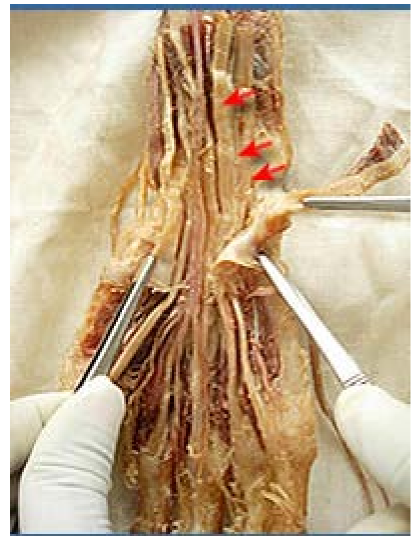
Pronator teres, Flexor carpi radialis, Palmaris longus, Flexor carpi ulnaris

Intermediate muscles

flexor digitorum



superficialis(1)

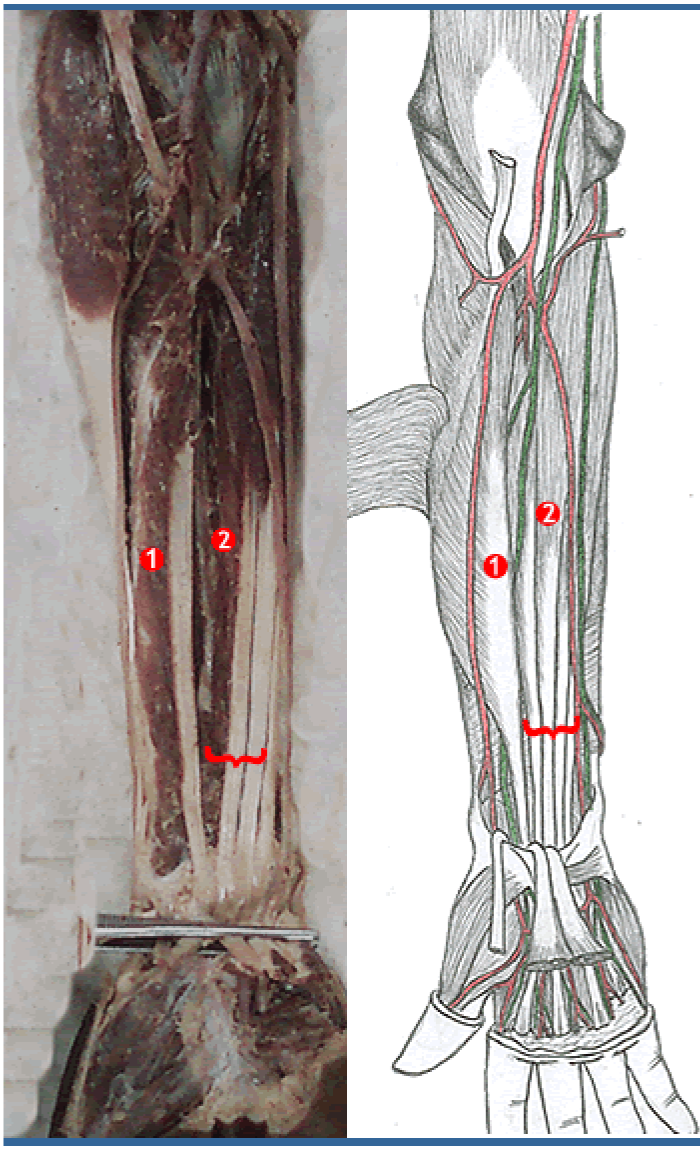


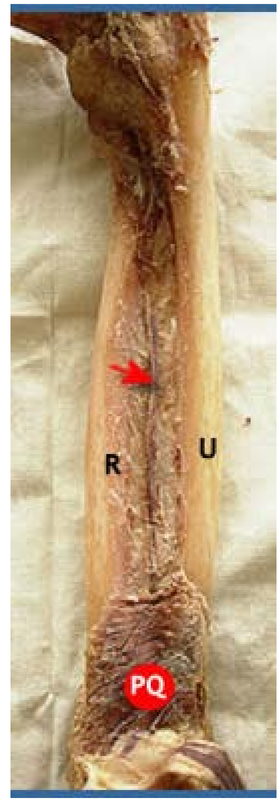
Deep muscles

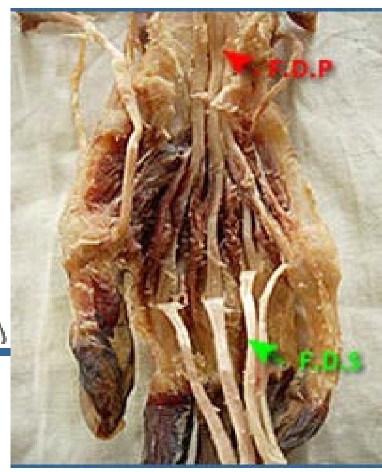
flexor pollicis longus*, *flexor digitorum profundus*, *pronator quadratus

The deep muscles have varied attachments.

Flexor digitorum profundus from medial side of olecranon, upper ulna and the interrosseous membrane to distal phalanx.
Flexor pollicis from anterior surface of radius below oblique line to base of distal phalanx of pollex
Pronator quadratus **[PQ]** from the distal ulnar to lower quarter of radius







note the ***flexor digitorum superficials tendons [F.D.S]*** reflected and the ***flexor digitorum profundus tendons [F.D.P]***

Note:

For power grip, flexors are more powerful than extensors

The superficial and intermediate muscles have a common origin with three muscles having additional points of origin

task ***Which are these additional points of origin?***
Which of the muscles have these additional origins?

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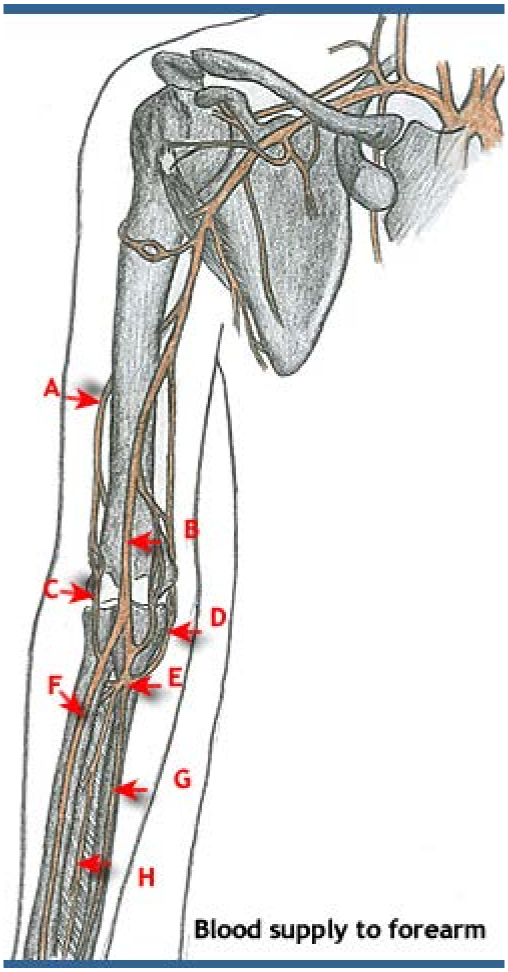
4. Vascular supply of the forearm



Blood supply to forearm

Schematic illustration of the blood supply to the upper limb.

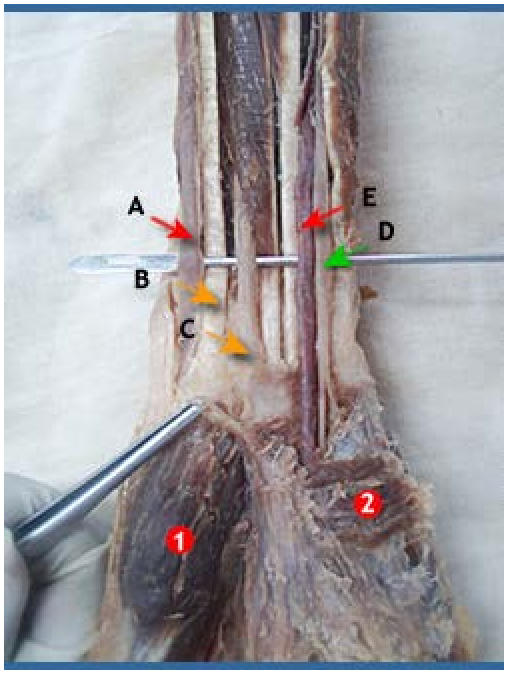
task ***Identify the arteries illustrated (8 mks)***

task ***Name the arteries that take part in the cubital anastomosis***

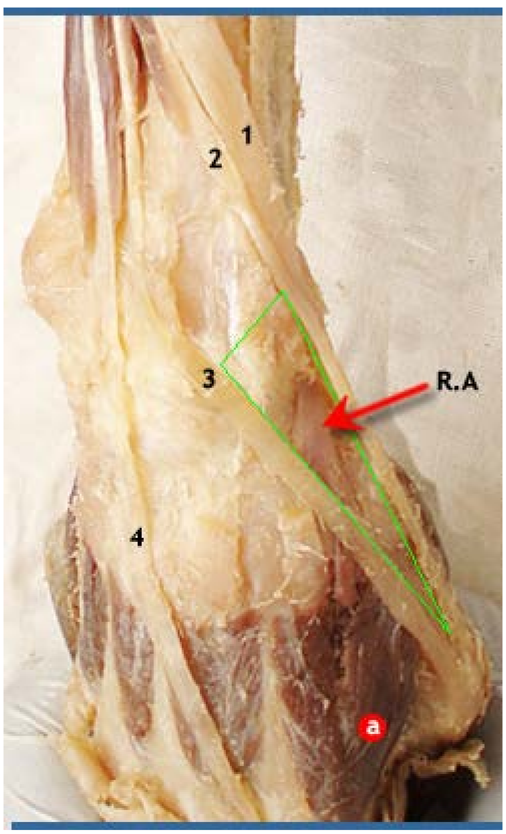
4.1 Ulnar artery [E]

- Passes deep to pronator teres and beneath fibrous arch
- Lies on flexor digitorum profundus
- Ulnar nerve on its ulnar side
- Crosses the hand and forms the superficial arch
- Pulsation can be felt radial side of tendon of flexor carpi ulnaris
- Surface landmark line convex medially from medial to tendon of biceps to the radial side of pisiform.

*(note the **ulnar artery [E]** lying lateral to the **ulnar nerve [D]**)*



4.2 Radial Artery [A]



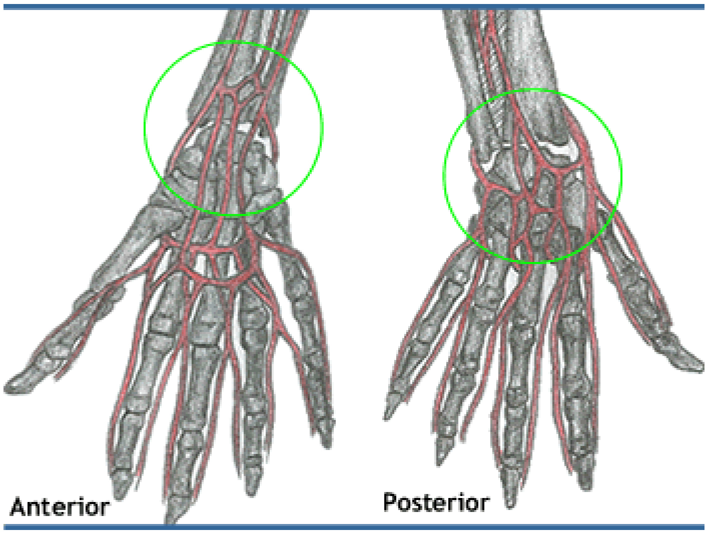
- Arises at level of neck of radius
- Passes deep to brachioradialis proximally but skin and fascia distally
- In lower forearm, emerges on medial side of tendon of brachioradialis and lateral to tendon of flexor carpi radialis.
- It lies in the plane between the extensor and flexor muscles
- Along its course it lies on; tendon of biceps, supinator, pronator teres, radial head of flexor digitorum superficialis, flexor pollicis longus, pronator quadratus
- Passes beneath the tendons of extensor and abductors of the pollex to cross the snuff box
- The superficial branch of radial nerve is lateral to it lower in the forearm
- Its branches in the forearm include: muscular, recurrent branch to the elbow anastomosis,
- Surface landmark: a line convex laterally from point medial to biceps tendon to point medial to styloid process of the radius.

(note the ***radial artery [R.A]*** in the anatomical snuff box)

task ***identify the tendons labelled that form bounadries of the anatomical snuff box***

4.4 Wrist anastomosis/rete

Dorsal and carpal branches of radial and ulnar arteries form the carpal arches. From these arise branches to the



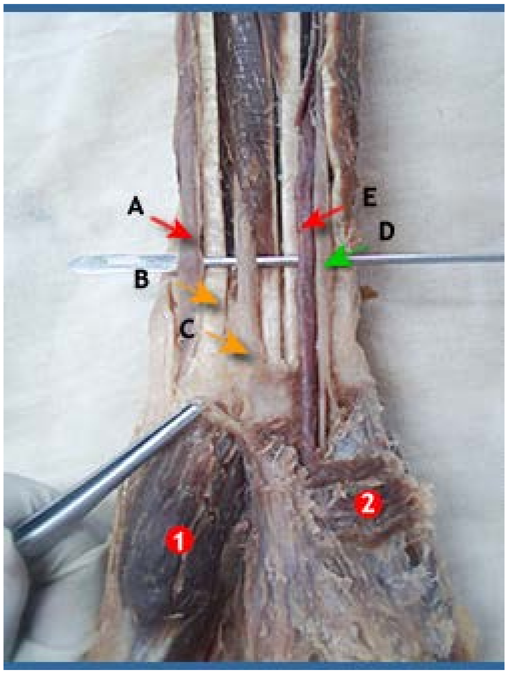
deep arterial arch which establishe free anastomosis

4.5 Venous drainage

Understand the origin, course and termination of the ***cephalic*** *and* ***brachial*** *veins. Understand also the variable venous patterns around the cubital fossa .*

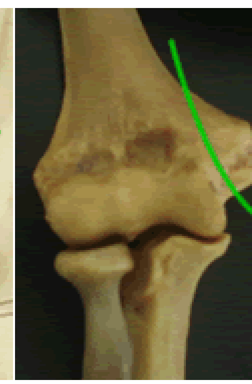
5. Nerve supply of the forearm

5.1 Ulnar nerve



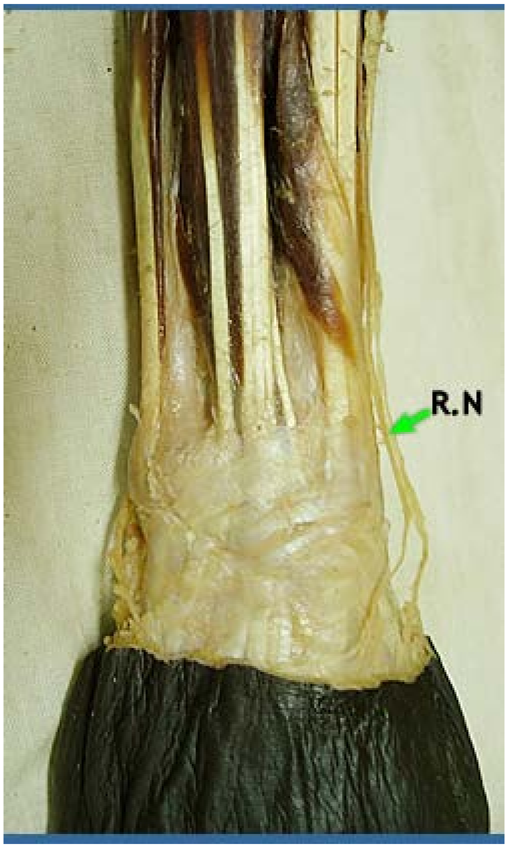
- Enters the forearm between the heads of flexor carpi ulnaris.
- Runs on flexor digitorum profundus.
- In the lower forearm the artery is lateral to it.
- At wrist it lies between the tendons of flexor carpi ulnaris and flexor digirotum superficialis
- Branches include: muscular to one and half muscles (*which ones?*), articular to elbow, palmar cutenous and digital branches (*How does it supply the skin of hand?)*
- Surface landmark: line from medial epicondyle to radial side of pisiform bone

(note the ***ulnar nerve [D]*** ; ***ulnar artery [E]*** lies lateral to it)



5.2 Radial nerve:

- Lies between brachioradialis/extensor carpi radialis longus on the lateral side and the brachialis while at elbow.
- It divided into superficial and deep at the level of the lateral epicondyle..
- The superficial branch runs under brachioradialis and lies on supinator and pronator teres.
- The artery is medial to it but distally proceeds dorsally under the tendon of brachioradialis.
- Branches include: muscular (*to which muscles?*), articular to elbow, deep branch , superficial branch
- Will supply radial 2/3 dorsum of hand, thumb and lateral two and halffingers.



5.3 Median nerve

- Leaves cubital fossa between the heads of pronator teres
- Runs behind humeral head of pronator teres, then flexor dig. Superficialis.
- It lies on flexor digitorum profundus.
- At wrist it is lateral to flexor digitorum superficialis and posterior to palmaris longus
- Branches: muscular (*state the muscles*), articular to elbow, anterior interrosseous, palmar cutenous nerve
- Carpal branch given off before entry into carpal tunnel (*any significance clinically?)*
- Surface landmark: middle of cubital fossa to ulnar side of tendon of flexor carpi radialis

note :

Ulnar and radial nerves run in company of similarly named arteries
Medial nerve and radial nerve are main nerves for the forearm
Radial artery lies medial to the nerve
Ulnar artery lies lateral to ulnar nerve
The median nerve crosses ulnar artery to lie between the two vessels
The radial and ulnar artery proper supply the hand through the superficial and deep arterial arches

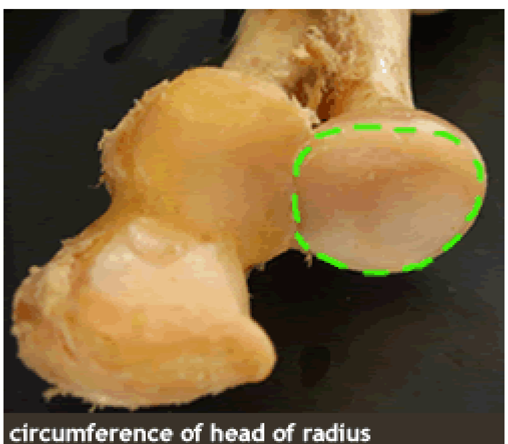
The forearm supply is the common interrrosseous artey
The interrrosseous nerves supply deeper muscles with no contribution to the innervation of the skin
The three nerves (ulna , radial and median) supply the muscles of the forearm with each passing between two heads of a muscle (*name them*)

PROXIMAL RADIO-ULNAR JOINT

Classification

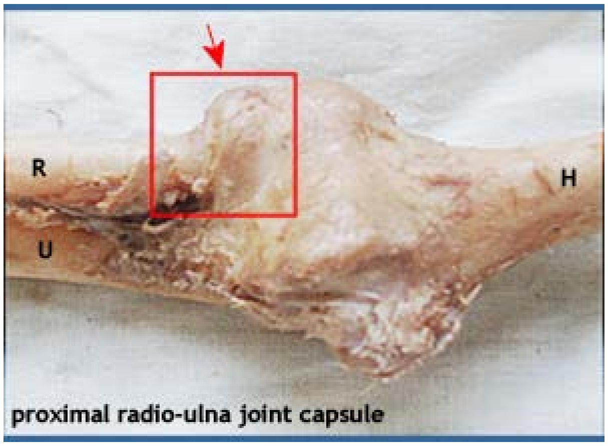
Synovial joint of the ***trochloid or pivot-joint*** variety between

Articular surfaces



The **articular surfaces** involved are
(i) the ***circumference of the head of the radius***,
(ii) the osseofibrous collar formed by the radial notch of the ulna and the anular ligament.
The internal surface of the ligament is coated with cartilage

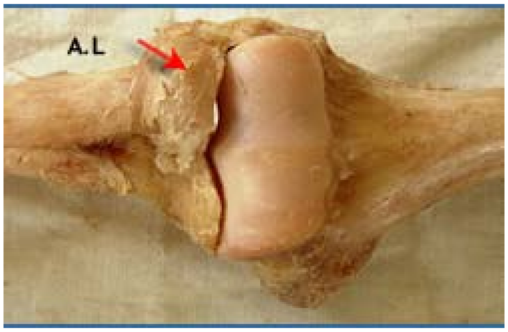
Capsule



Replaced in this joint by the anular ligament. This is a strong band, forming an incomplete ring, attached by its ends to the anterior and posterior edges of the radial notch.

The diameter of the ring is smaller below, around the neck of the radius.

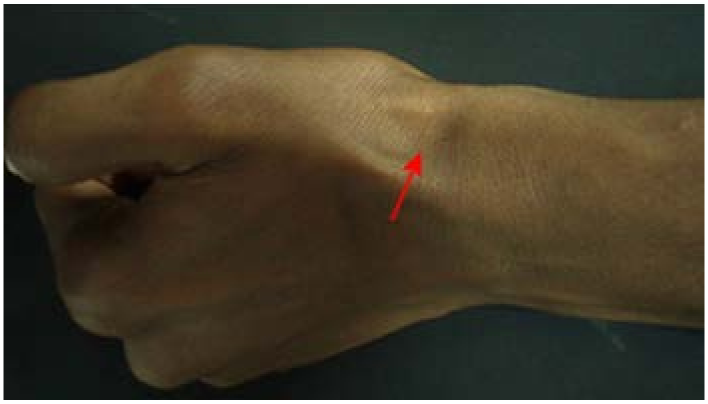
Ligaments



All the ligaments connecting the radius and ulna play a part in the movement at both radio-ulnar joints:

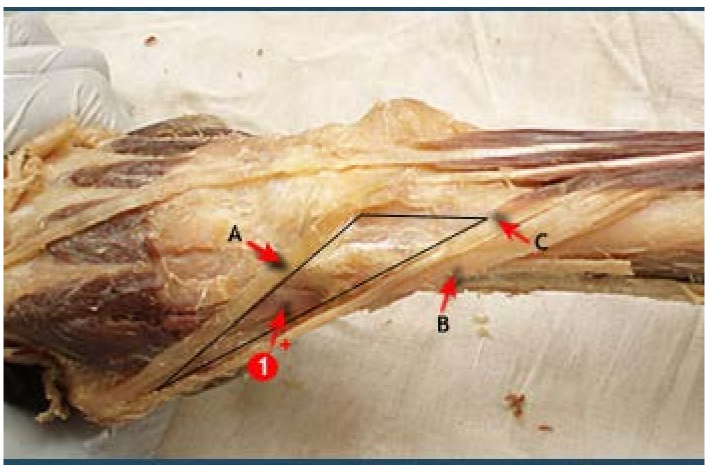
1. The ***anular ligament (A.L)***
2. The ***quadrate ligament***
3. The ***oblique cord***, a slender band passing distally and laterally from the ulnar tuberosity to the radius just distal to its tuberosity.
4. The ***interosseous membrane (I.M)*** of the forearm connects the interosseous margins of the two forearm bones.

3.3. The anatomical snuff box



This is a concavity visible with the thumb is fully extended

Boundaries



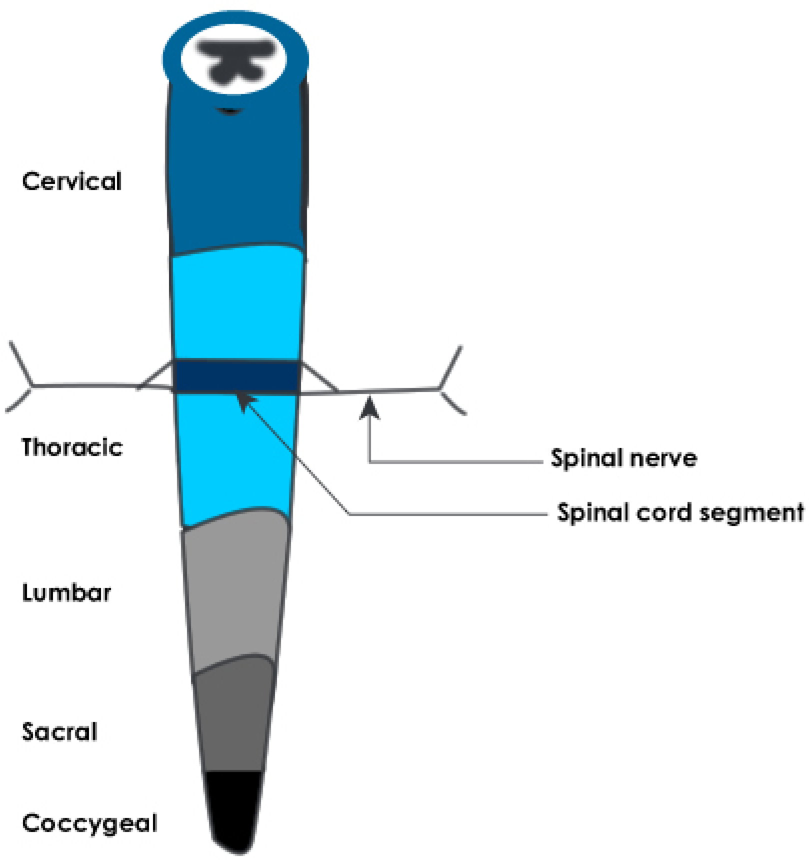
- Bounded by **extensor pollicis longus** posteriorly and the tendons of **extensor pollicis brevis**/**abductor pollicis longus** anteriorly
- Crossed by the cutaneous branch of **radial nerve** and the **cephalic vein** on its roof
- Floor is made of **radial styloid**, **scaphoid**, **trapezium** and **base of first metacarpal**

Content

- Radial artery
- Vennae committante
-

INTRODUCTION TO NEUROANATOMY

spinal cord



- Caudal continuation of the brain stem
- Extends from the foramen magnum to L1/L2 junction.
- Functionally segmented :each segment gives rise to one pair of spinal nerves.
- Has five parts:
  cervical
  thoracic
  Lumbar
  Sacral
  coccygeal

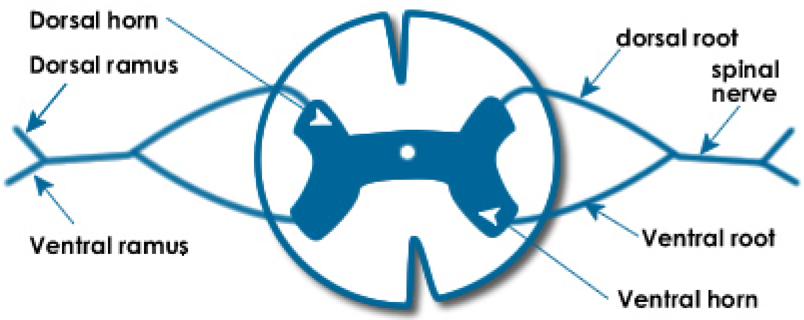
Peripheral nervous system:

1. Cranial nerves

No	Name		Main supply area	Function
1	Olfactory		Nasal Mucosa	Smell
2	Optic		Retina	Vision
3	Oculomotor		Eye muscles	Eye movements
4.	Trochlea		Eye muscles	Eye movements

5.	Trigeminal	Ophthalmic	Eye and forehead	Sensory
		Maxillary	Face over maxilla	Sensory
		Mandibular	Face over mandible Muscles of mastication	Sensory,Jaw movements
6	Abducens		Eye muscles	Eye Movements
7	Facial		Face muscles	Facial expression
8.	Vestibulocochlea		Inner ear	Hearing & balance
9	Glossopharyngeal		Tongue, pharynx	Sensory
10	Vagus		Larynx, Pharynx Thoracic and abdominal viscera	Motor, sensory and parasympathetic
11	Accessory		Trapezius and Sternocleidomastoid	Neck movements
12	Hypoglossal		Tongue Muscles	Tongue Movements

Spinal nerves

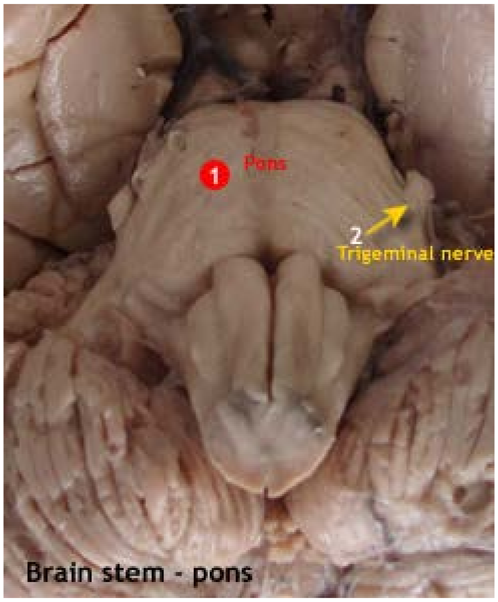


- **Dorsal (Sensory) root** “arises” from dorsal horn joins **ventral (motor) root** from ventral horn, to form a **mixed spinal nerve**.
- Spinal nerve divides into **dorsal** and **ventral rami** to supply respective muscles and skin
- **Specific region** of skin innervated by **one cord segment** is called a **dermatome**.

OGanatomy J. Ogengó palsoftweblink

Learning points | Core anatomy | Applied anatomy | Review questions

The Pons



Brain stem - pons

The pons consists of two parts i.e

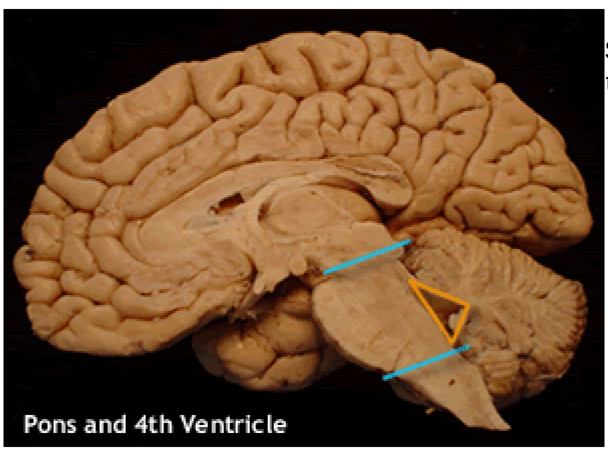
- Ventral basal pons
- Dorsal pontine tegmentum

The basal pons makes a ventral bulge with a median basilar sulcus which lodges the basilar artery.

The pons contains cranial nerve nuclei, ascending and descending tacts, many pontine nuclei including an extensive reticular formation.

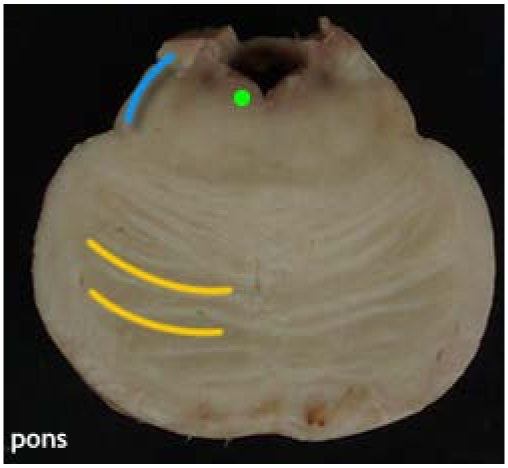
Cranial nerves attached close to the pons include:

- Trigeminal: Junction of pons and middle cerebellar peduncle.
- Abducent: Junction of pons and pyramid.
- Facial: Junction of pons with olive.
- Vestibulocochlear: Crebellopontine angle.


Pons and 4th Ventricle

Sections through the pons and pontine tegmentum characterized by the presence of the following:

- Dorsal fourth ventricle - dorsal.
- Longitudinal descending fibers - ventral.
- Transverse fibers to the cerebellum - ventral.
- Pontine nuclei - ventral.
- Reticular formation - dorsal.
- Medial lemniscus fibers - dorsal.
- Vestibular nuclei - dorsolateral.
- Spinothalamic fibers.
- Nuclei of trigeminal, abducent, facial nerve.
- Trapezoid body and nucleus.
- Locus ceruleus.



The cranial nerve nuclei include

- abducens
- Facial
- Motor part of trigeminal
- Chief sensory nucleus of trigeminal
- Vestibular nerve

Other nuclei include the following

- **Pontine nuclei**. These relay information from the neocortex to the cerebellum. **Corticopontine fibres** terminate in the pontine nuclei, and **pontocerebellar fibres** arise from these nuclei and enter the cerebellum as the middle cerebellar peduncle.
- **Dorsal nucleus of trapezoid body** (superior olivary). This acts as a relay station for some fibres of the cochlea projection. Some of the axons eventually synapse in trochlear an oculomotor nuclei.
- **Pontine reticular formation nuclei**. These control lacriminal glands (lacriminal nucleus) or salivary glands (superior salivatory) or control cardiorespiratory function.

Fibre tracts include the following

- **Corticospinal** continuing into the pyramid
- **Corticonuclear** terminating on CN, V, VI and VII.
- Corticopontine
- **Trapezoid** body which eventually forms lateral lemniscus
- **Ascending tracts** – spinothalamic, medial lemniscus
- Interconnecting fibres such as medial longitudinal fasciculus (MLF)

Blood supply to pons

This is mainly from pontine branches of the basilar artery.

These are grouped into 3:

i) **Paramedian branches** which supply the medial pontine region encompassing:

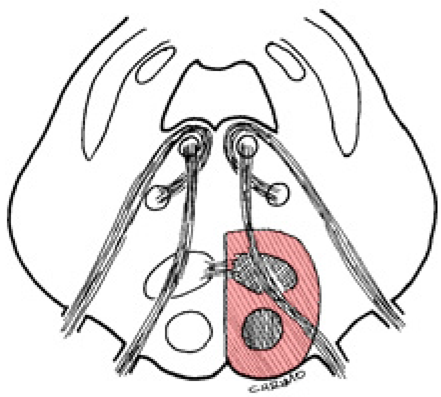
(+) Pontine nuclei
(+) Corticopontine
(+) Corticospinal
(+) Corticobulbar tracts

ii) **Short circumferential arteries** supplying adjacent anterolateral part of the pons and variable parts of the overlying tegmentum.

iii) **Long circumferential arteries**, which supply lateral parts of middle cerebellar peduncle, and most of the pontine tegmentum.

iv) **Anterior inferior cerebellar artery** supplying caudal pontine tegmentum.

Vascular lesion



Vascular lesions of the pons may result from occlusion of a pontine branch of the basialr artery.

The area of infarction may involve the following structures and hence the respective disorders:

a) **Corticospinal fibres**: contralateral hemiparesis.
b) **Abducens nerve**: Paralysis of ipsilateral rectus muscle with medial strabismus or squint.

Cerebello Pontine Angle

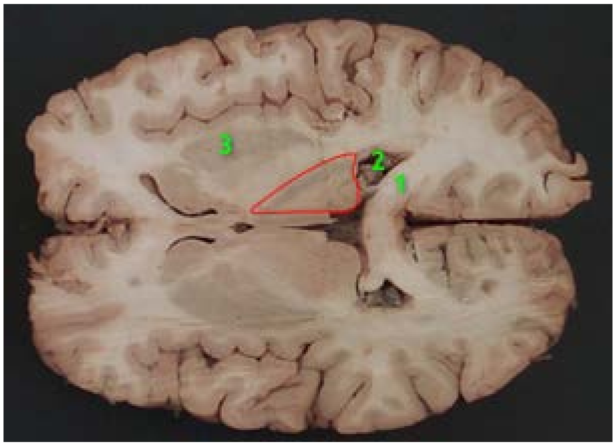
- Angle between the pons and the cerebellum.
- Bounded by:

  (+) Pons - rostrally
  (+) Medulla - caudally
  (+) Cerebellum -laterally

- Two nerves found in that interval i.e. the **facial** and **vestibulocochlear**.

Tumors at the CP angle compress CN VII and VIII, together with the pyramid and cerebellum. They present with CN VII/VIII defects together with motor deficits

The Diencephalon



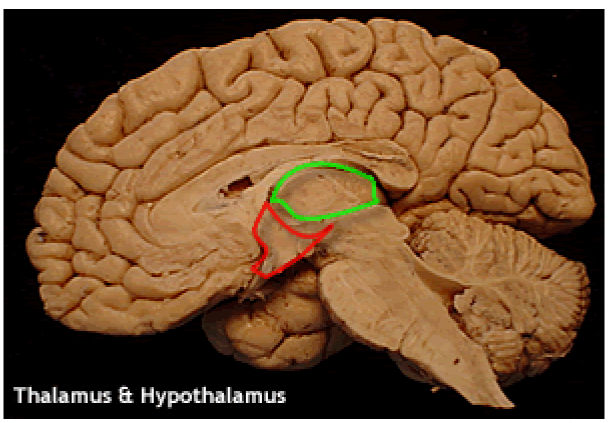
This part of the brainstem has the following relations:

- Medially, third ventricle.
- Laterally, internal capsule and caudate nucleus.
- Superiorly, lateral ventricle, corpus callosum, fornix.
- Rostrally, interventricular foramen and lamina terminalis.

Subdivisions of the diencephalon:

- Epithalamus (pineal gland, habenular nuclei, striae medullaris)
- Thalamus
- Hypothalamus
- Subthalamus

The Thalamus



An egg shaped mass whose extent is:

- **Foramina of Monroe** to the **posterior commissures**.
- The third ventricle to the posterior limb of internal capsule.

The posterior enlarged part (pulvinar) overlies the midbrain.

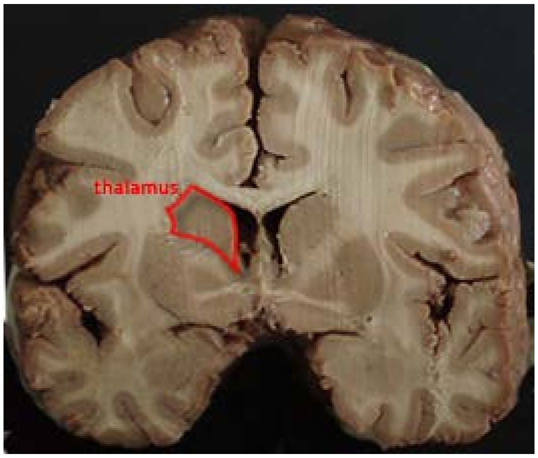
Structures related to its dorsal surface include:

- Striae terminalis
- Terminal vein
- Striae medullaris

It is joined with the opposite medially by interthalamic adhesion.

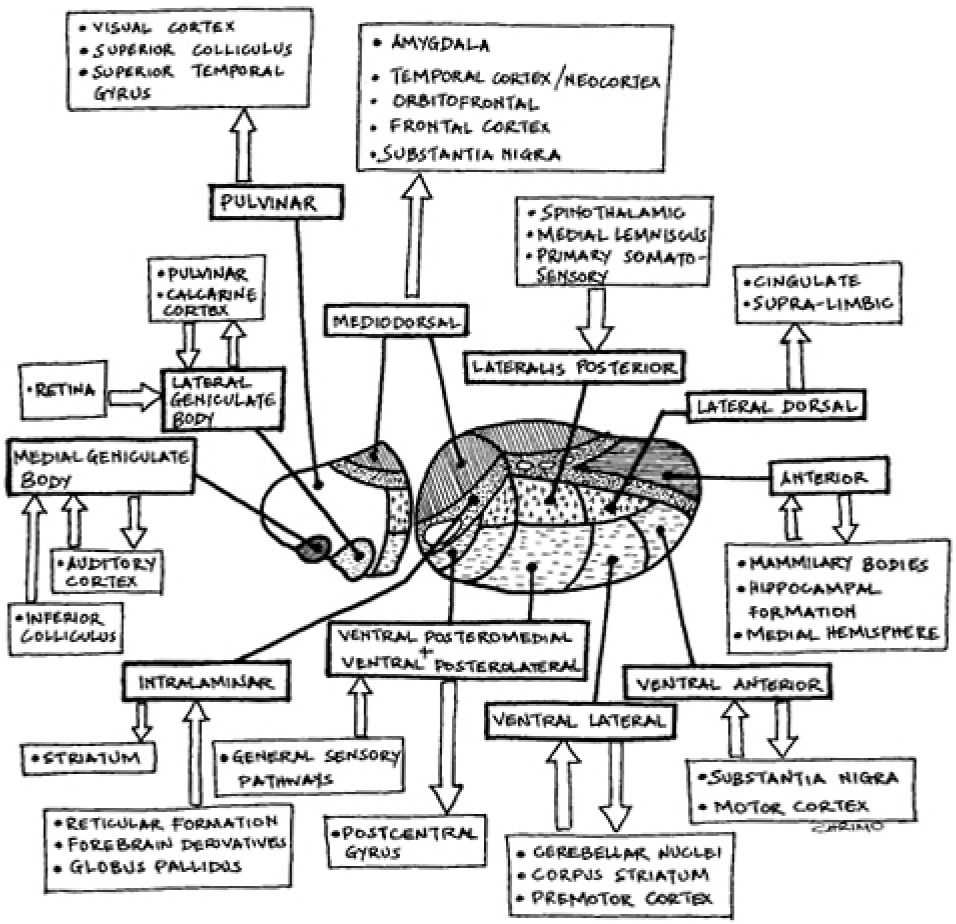
The internal medullary lamina divides the thalamus into nuclear groups:

- Anterior
- Medial
- Lateral
- Ventral



- Nuclei within the he lamina are termed intralaminar.

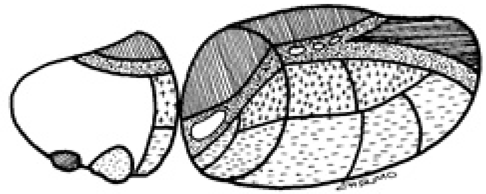
Connections



Functions:

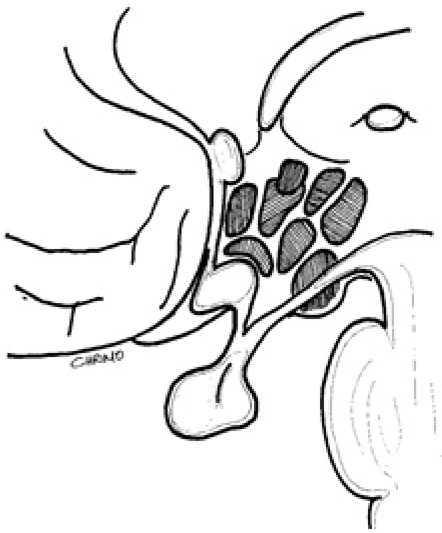
- Relay/processing/filtering center for sensory information
- Distribution of most afferent input to cortex.
- Control of electrocortical activity of the cortex (attention, alertness, consciousness).
- Integration of motor functions (relays inputs to cerebellum, striatum etc).

Functions of specific nuclei:



- **Anterior group:** part of limbic system (mamillothalamo-cortical sytem).
- **Medial group:** integrate sensory data for projection to frontal lobe.
- **Ventral group:** integrate sensory data for projection to primary sensory cortex (VPL, VPM).
- **Posterior LGB** project visual information to occipital cortex.
- **Posterior MGB** project auditory information to auditory cortex.
- **Intralaminar / midline** receive from brainstem reticular formation and project diffusely to cortex.

The Hypothalamus



- It forms the lateral wall and floor of third ventricle.
- Parts of the hypothalamus visible on the base of the brain include the infundibulum, tuber cinerium and mamillary bodies.
- Tuber cinerium is the floor between the the infundibulum and mamillary.
- The hypothalamus is divided by fibers of the fornix into medial and lateral nuclear groups.
- Three rostrocaudal regions: Supraoptic, Tuberal and Mamillary are described.
- The zone forming the floor of the third ventricle is the median eminence.

Connections of hypothalamus

- Medial forebrain bundle
- Hippocampal-hypothalamic fibres.
- Commissural fibers of fornix.
- Amygdalo-hypothalmic fibers (striae terminalis)
- Brainstem recicular afferents.
- Retinohypothalamic fibers.
- Mamillary efferents.
- Descending hypothamic fibres.
- Efferents to suprachiasmatic.
- Supraoptic-hypophysial.

Functions of hypothalamus:

- Control of involuntary actions, expressions, behaviour associated with emotions, rage, pain, sexual arousal, feeding.
- Coordination of parasympathetic autonomic function.
- Coordination of sympathetic autonomic function.
- Control of temperature (mechanisms for this include dissipation and production of heat, in anterior and posterior regions).
- Body water balance.

- Coordination of activities of anterior pituitary gland.
- Secrete hormones e.g. ADH, oxytocin, releasing hormones.
- Regulation of satiety – destruction may be associated with hyperphagia and obesity.

Functions of specific nuclei:

Nucleus	Function
Supraoptic	Production of ADH
Paraventricular	Production of Oxytocin
Medial/anterior	Coordination of parasympathetic activity.
Lateral/posterior	Body temperature regulation.
Preoptic	Production of releasing hormones to pituitary
Tuberal	Control of heart rate and blood pressure.
Autonomic center	Control of feeding, continues with grey regions of basal olfactory.
Mamillary	Region, septal region and substantia innominata.
Suprachiasmatic	Receives inputs from retina

The Epithalamus

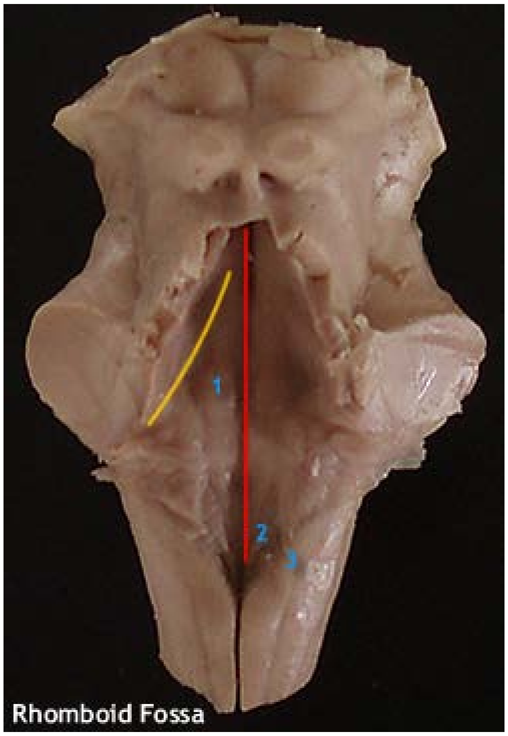
- Forms part of the roof of third ventricle.
- The pineal gland is posterior and secretes melatonin.
- The gland regulates day-night cycles with secondary effect in reproductive function.
- It also produces serotonin, norepinephrine.
- Flactuations of melanin are related related to daily cycle of photic(light) input.
- It is connected to the suprachiasmatic nucleus of hypothalamus.
- The habenular nuclei are sites of convergence of limbic pathways that carry impulses to midbrain.
- They receive striae medullaris and give rise to the fasciculus retroflexus.

The subthalamus

- The subthalamus is bounded above by thalmus, medially by hypothalamus, and laterally by the internal capsule.
- Its main nuclear group is the subthalamic nucleus
- Rostral and dorsal to the subthalamic nucleus is the zona incerta (Fig)
- Its main concern is somatic control of some somatic motor function
- Fiber systems pass though this area

- Main concern: somatic motor function.

The Rhomboid Fossa

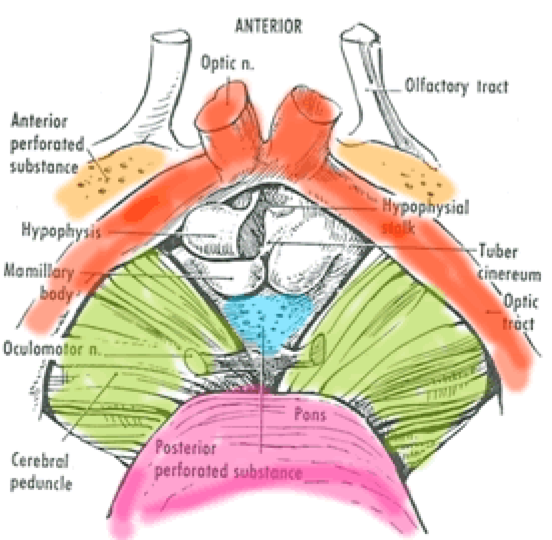


This forms the floor of the fourth ventricle (roof is inferior and superior medullary vella).

Anatomical features characteristic of this fossa include (Fig):

- Median sulcus dividing it into right and left.
- Sulcus limitans divides each half into into:
  - Median eminence medially.
  - Vestibular area laterally.
- Striae medullaris fibers cross the fossa.
- The facial colliculus**(1)** and the the hypoglossal trigone lie within the median eminence.
- The vagal trigone lies lateral to hypoglossal trigone**(2).**
- The point of caudal junction of the walls of the fossa is termed the obex.
- Area postrema refers to an area rostral to obex.

- **The interpeduncular fossa**



The crus cerebri embraces a midline depression called the **interpeduncular fossa** .

Boundaries include:

Its boundaries are caudally the

Laterally : crus cerebri

Caudally: basal pons laterally theand

Rostrally: Optic chiasma and optic tracts.

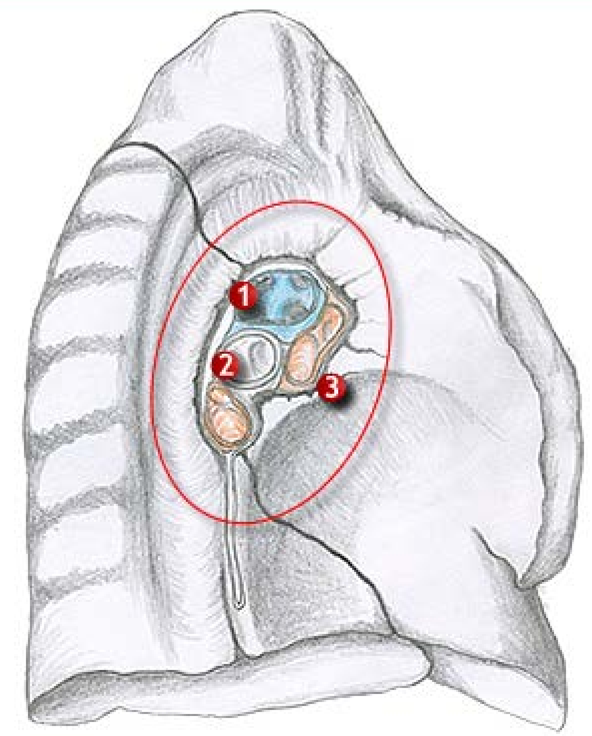
Contents

- the mammillary bodies
- the oculomotor nerve
- the tuber cinereum
- the infundibular stalk

The Roots of the lungs

These consist of the structures entering and leaving the hilum. Each root is surrounded by pleura, which is prolonged inferiorly as the pulmonary ligament. The roots descend during deep inspiration.

Contents of the right lung root:



Root of the lung

- Two pulmonary arteries
- Two pulmonary veins
- A principal bronchus
- One bronchial artery
- Bronchial veins
- A pulmonary plexus of nerves
- Lymph vessels
- Bronchopulmonary lymph nodes

Contents of the left lung root:

These are similar to those of the right, except:

- There is only one pulmonary atery.
- There are two bronchial arteries.

Clinical Anatomy of pleura

---

1)

Left brachiocephalic vein

- Formed behind the sterna end of the left clavicle by the union of the left internal jugular and subclavian veins
- Passes downwards to the right across the midline behind the upper half of manubrium sterni
  Ends at the lower border of the 1st costal cartilage clse to sternum by joining its fellow to form the superior vena cava

Note: The left brachiocephalic vein shunts blood from the left side of the head and neck and from the left upper limb, across the right: the blood is flowing towards the right atrium. The left vein is therefore longer than the right.

Relations

While in the midline it crosses infront of:

- Internal thoracic artery
- Phrenic nerve
- Vagus nerves
- Left subclavian arteries
- Common carotid arteries
- Brachiocephalic trunk

The left pleura overlaps it from the left.

Tributaries

Correspond to those of the right brachiocephalic vein.
The following additional are received.

- Left superior intercostals vein
- Small pericardial
- Thymic veins

Note: Occasionaly both inferior thyroid veins end in the left brachiocephalic veins, more rarely, both end in the right.

Incisions in the anterior abdominal wall

Midline

Because the vessels mainly approach the linear alba from the sides, the linear alba is a “water shed” area. Besides the composition of connective tissue (fibro elastic) with a low metabolic turn-over, does not necessitate very profuse vascularization. Consequently, incisions here do not cause troublesome bleeding. However, union is slow, and therefore either non-absorbable or long staying suture material is required when closing up. Otherwise deficits will remain, and be potential sites for hernia (incisional hernia.

Paramedian

Usually, the rectus abdominis is retracted laterally, to avoid detaching its nerve and vessels. It is unwise to cut the muscle longitudinally.

These incisions, do not meet many blood vessels. The epigastric vessels (inferior and superior) are usually easy to identify.

Horizontal incision

Especially in the lower abdomen (Pfanesteil) may encounter the inferior and superficial epigastric vessels. If these can be guarded, handled, the incision heals rapidly, leaving thin scars.

Gridiron incision

It is mentioned under appendix, which see etc.

Venous enlargement

Venous enlargement in the anterior abdominal wall may signify important underlying pathology.

For example:

- Caput medusae may suggest portal hypertension with obstruction
- Enlargement of the veins on the sides may suggest obstruction of one of the vena cavae.

Under Construction

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Department Of Human Anatomy - Background Information

Started in July 1967 with the inception of Kenya 's first Medical School, it is physically located in the College of Biological and Physical Sciences on Chiromo Campus along Riverside Drive, off Chiromo Road. It is approximately 3 km from the city center. Functionally, like the other pre-clinical Departments namely Medical Biochemistry and Physiology. It is a constituent department of the school of Medicine in the College of Health Sciences whose headquarters, laboratory and clinical departments, are at the Kenyatta Hospital Campus along Ngong Road.

University Of Nairobi

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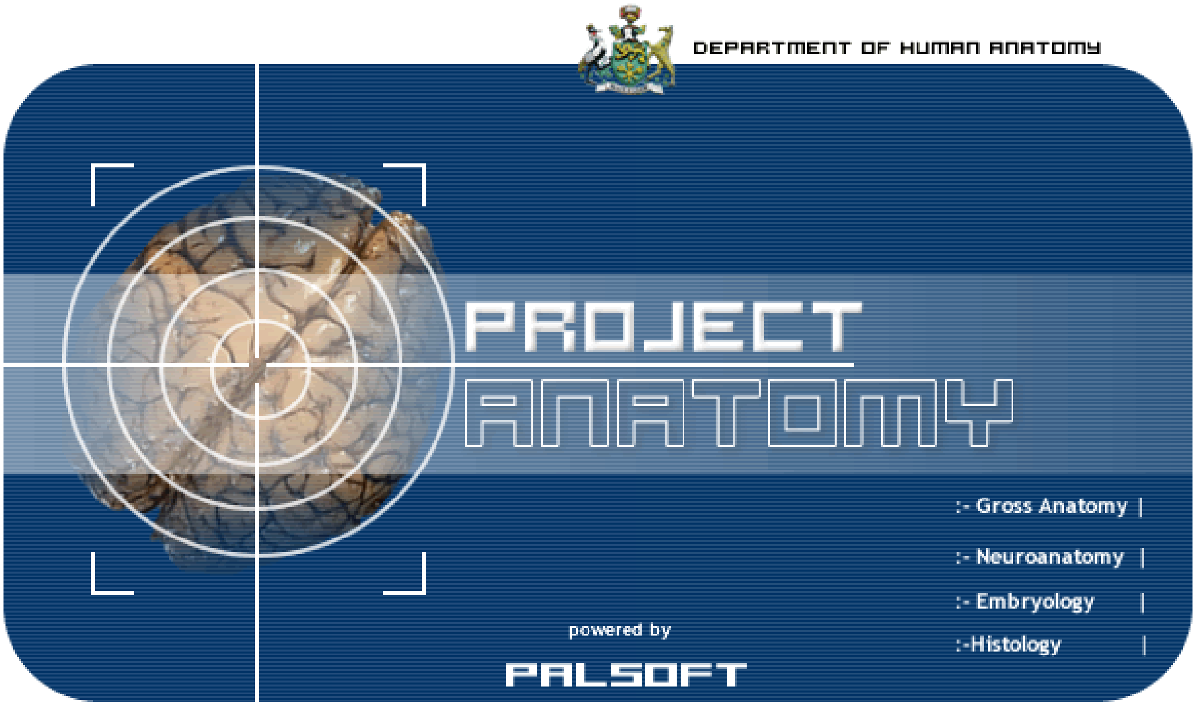

Welcome

ProjectAnatomy is an online learning project by the Department of Human Anatomy, University Of Nairobi tailored for students taking a course in anatomy.

Course Work

The course work on this site is organised as per the teaching schedule followed at the University of Nairobi College of Health Sciences with the material subdivided into Neuroanatomy, Gross Anatomy, Embryology and Histology. Gross anatomy is taught on a topographic basis while Histology and Embryology are taught on a sytemic basis. To jump to a specific location select the subject from the links below.

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Department Of Human Anatomy - Functions

The department adopted and practices the integrated approach of teaching Topographic, Microscopic, Developmental, Radiological and Clinical anatomy.

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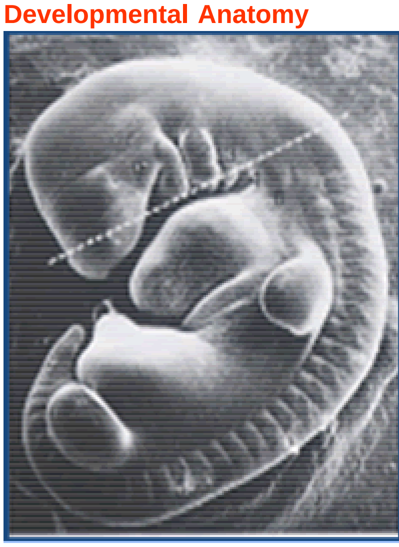
Topographic Anatomy

- Didactic lecturers
- Small group, supervised, regional dissection of cadavers tutorial system.

Microscopic Anatomy

- Cytology
- Histology
- Organology systemic approach
- Permanent slides from primates (vervet monkeys) tissues and student microscopes. Augumented by a closed circuit television network.

Developmental Anatomy

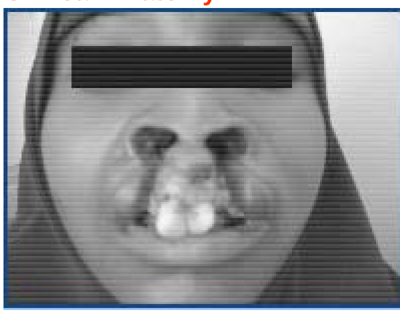


- Didactic lectures on normal and abnormal development.
- Small group tutorials
- Basic embryology.
- Emphasis on the developmental basis of common malformations.
- Systemic development.

Radiological Anatomy

- Principals of imaging.
- Studying of images of normal and abnormal anatomy.

Clinical Anatomy



- The anatomical basis of management of clinical conditions.

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Faculty Profile

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Adel Malek

Egyptian, born 1949. PhD (Anatomy) 1982 Assut .Paediatrician turned Anatomist. Widely published in anthropometric and growth studies with special interest in Growth and growth retardation in children , body composition and ageing changes . Renown scientist and teacher of International standing.

Full cv

Benard Ndung'u

Kenyan born 1967.BSc(Anat.), MBChB, Mmed Surgery (UoN) 2002. Experienced teacher and consultant surgeon, with interest in cardiovascular anatomy with special reference in artiodactyls limb arteries and breast, endocrine and colorectal surgery.

Full cv

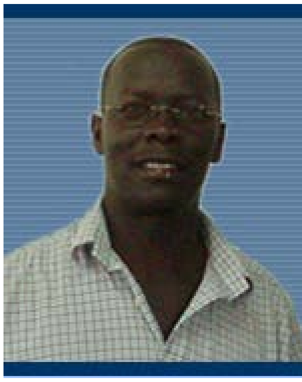
Gichambira Gikenye

Kenyan, born 1953. Mmed Surg Uon 1985. Experienced teacher and surgeon with special interest in orthopaedics and trauma.

Full cv

Hassan Saidi

Holds MBChB and BSc.(Anatomy) degrees of the University of Nairobi Received residency training in Surgery at the same University graduating in 2000. Certified as specialist in general surgery by the Kenya Medical & Dentists Board and holds consulting appointments in major hospitals in Nairobi . Teaching experience spans 12 years. He has served as both external faculty and



examiner in other Universities. He has authored several scientific papers in the twin disciplines of Anatomy and Surgery.

Full cv

Jameela Hassanali

Tanzanian of Indian origin, born 1945. DDS ( ) Widely published in mesencephalic nucleus connections in primates and patterns of dentition among Kenyans with special reference to deciduous canine extraction among the Maasai.

Full cv

James Kimani

Kenyan, born 1950. PHd (UoN) 1979. Widely published in cardiovascular anatomy, with special interest in mammalian carotid arterial system with reference to baroreceptor mechanisms. Currently managing Director University of Nairobi Enterprises and Services. Renown Scientist and teacher of International reputation. Founder secretary general of SONA.

Full cv

Joseph Githaiga

Kenyan, born 1962. Mmed Surg UoN (1996) Expereienced teacher and surgeon with special interest in breast and thyroid disorders.

Full cv

Julius Ogeng'o

Kenyan born 1961. BSc Hons Anat MBChB (UoN). Long experience in teaching all areas of anatomy, with international exposure. Published in cardiovascular anatomy and neuro degeneration. A prolific writer of general medical articles in the Health Digest. Special interest in cardiovasucalr anatomy with reference to artiodactyls aorta, and elastic fibres.

Full cv

Kirsten Awori

Kenyan, born 1971. Mmed Surgeon UoN) 2003. Expereinced hands-on anatomy teacher and upcoming surgeon, with special interest in orthopaedics. Research interst in bone morphogenic proteins.

Full cv

Peter Gichangi

Kenyan, born 1964 1st degree in Human Anatomy PhD UoN 2004. Widely published in gynaecology, with special emphasis on HIV and cervical neoplasia.

Full cv

Paul Odula

Kenyan, born 1967.BSc (Anat); MBChB, MMed (Surg) (MUK)FCS (ECSA). Experienced teacher. General surgeon with a special interest in Trauma, Breast and Hernia surgery.

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Wycliff Kaisha

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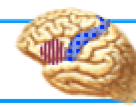
- Neuroscience 
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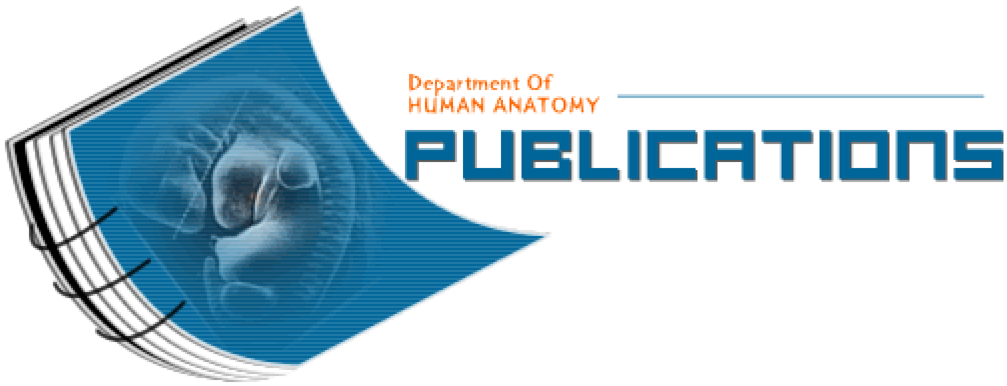

CHAPTER 18 : The Joints of the wrist , hand and fingers

Organization of the Hand

Hand Osteology

- Includes the carpus, metacarpus and phalanges
- Carpal bones are 8 and arranged in proximal and distal rows.
- *Can you name them in order?*
- Scaphoid, lunate and triquetral form a convex articulating surface for the radiocarpal joint
- Pisiform articulates with palmar surface of triquetral
- Palmar surfaces of the bones form a concavity bridged by flexor retinaculum to form **carpal tunnel**.
- *Are the carpal bones at the borders of the tunnel projected on the surface?*
- The trapezium and hamate are palpable proximal to the thenar and hypothenar eminence
- The retinaculum strengthens the carpus and enhances flexor efficiency
- Attached to the bones are various ligaments: radiocarpal, intercarpal & carpometacarpal

The Scaphoid bone

- To it is attached flexor retinaculum, abductor pollicis brevis, and radial collateral ligament.
- Has a body, neck and head. In a proportion (13%), the blood supply to the body is from the distal end
- Scaphoid fractures are common. *Why?*
- *How can you clinically detect a fracture of the scaphoid?*
- *Why are X-rays initially negative for scaphoid fractures?*

Other carpal bones

- Dislocations are common with the Lunate
- Triquetral makes contact with ulna at adduction
- The tendon of the flexor carpi ulnaris, pisohamate and piso-metacarpal ligament attach to the pisiform
- Trapezium characterized by grove for tendon of flexor carpi radialis. To it is attached the flexor retinaculum and radial collateral ligament
- Capitate is centrally placed and is the largest carpal bone
- Hamate affords attachment to flexor retinaculum and has rough dorsal and palmar surfaces for ligament.
- Capitate is first to ossify. Pisiform is last (*What is the order for the other*)?

metacapals and phallanges :

- Metacarpals are long bones with head, shaft and base. The second metacarpal has the largest base and shaft
- The 14 phalanges bear heads, shafts and bases
- Note primary ossification centers for the shafts and secondary centers for base of 1 st and heads of other metacarpals

palsoftweblink

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CHAPTER 18 : The Joints of the wrist , hand and fingers

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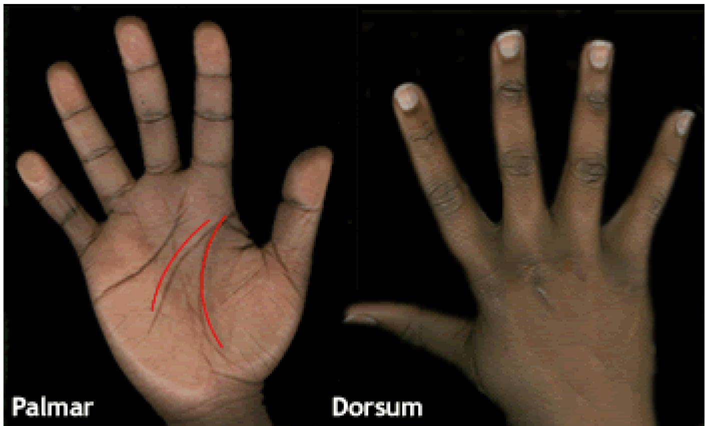
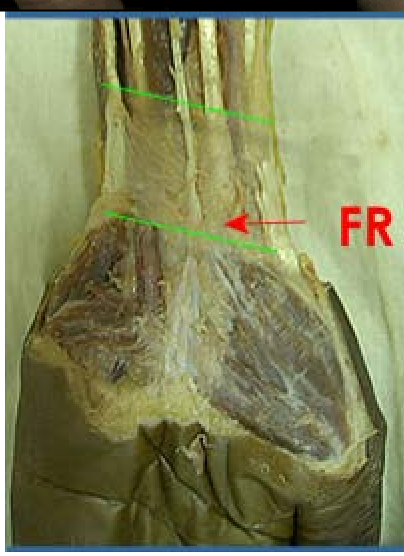
Skin and fascia



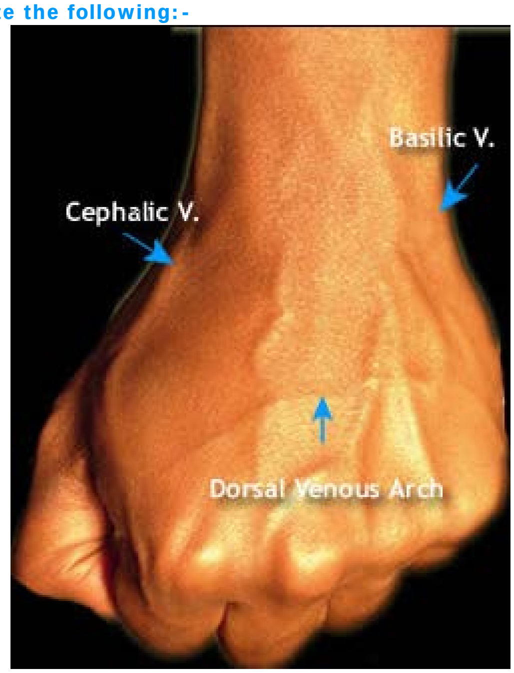


- Thick on the palmar side and loose dorsal side
- A fibrous subcutaneous tissue overlies the thick aponeurosis
- The Palm has flexor lines (creases) and papillary ridges to improve grip
- The flexor aponeurosis is reinforced by fibers from palmaris longus tendon
- It is a continuation of the flexor retinaculum. Distally divided into longitudinal slips which diverge to the fingers
- Its modifications include:
    - Thickened central part
    - Medial septum to 5 th metacarpal
    - Lateral septum to 1 st metacarpal
    - Thickened to form superficial transverse metacarpal ligaments at level of metatarsal heads
    - Inserts onto the fibrous flexor sheaths
    - Distal attachment to the dermis via creases

the palmar aponeurosis

- Digital nerves and vessels, lumbrical tendons pass between distal slips
- Palmaris brevis attaches to it
- Thinned over the thenar and hypothenar eminences
- Contracted in Dupuytrens contracture resulting in flexed ring and little fingers

Also note the following:-



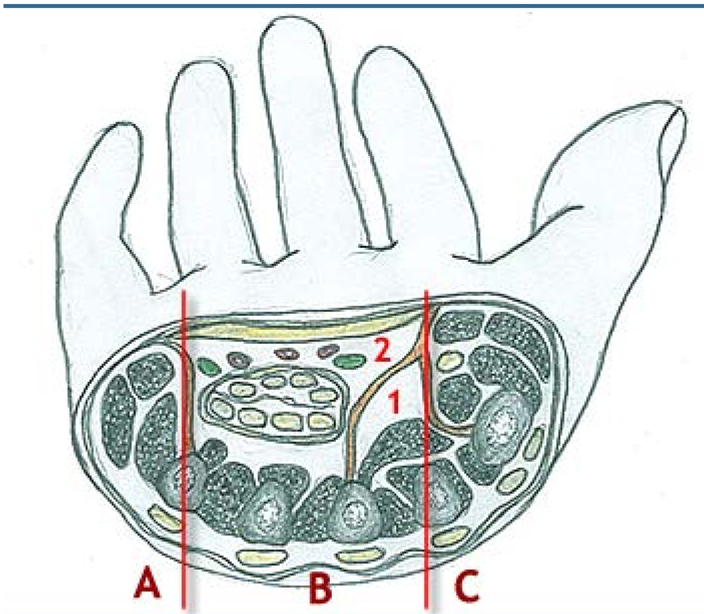
The dorsal venous network lies beneath skin of the back of hand, superficial to extensor tendons
The Network drains into cephalic (radial side) and basilic (ulnar side) veins
Beyond the extensor retinaculum, extensor tendons spread out over the hand
Tendons are connected by oblique fibers (intertendinous connections)

Compartments and fascial spaces of the hand

These allow mobility but offer little resistance to infection.
They are bounded by connective tissue.
The spaces include

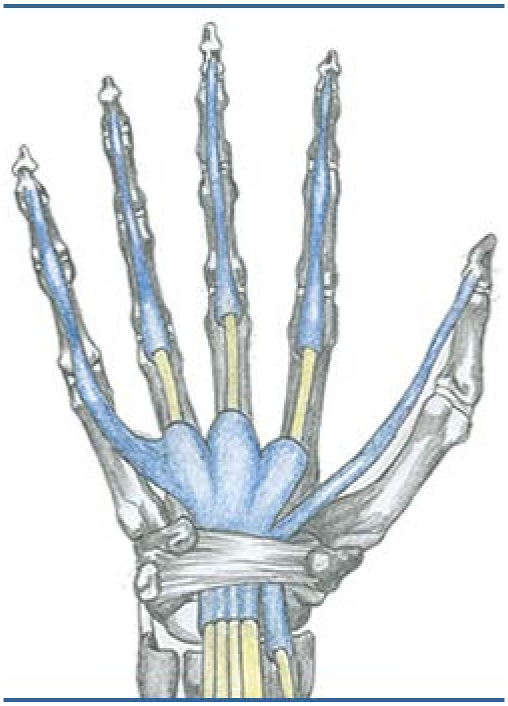
- Dorsal spaces
- Hypothenar space
- Midpalmar space
- Thenar space
- Web spaces
- Pulp spaces

The mid palmar space lies between the palmar aponeurosis anteriorly and pronator quadratus posteriorly.
It contains the flexor tendons, lumbricals, superficial arterial arch, nerves and



vessels
The thenar space contains flexor pollicis longus, flexor indicis, 1st lumbrical and digital nerves to pollex and index.
What are the boundaries of the thenar space?

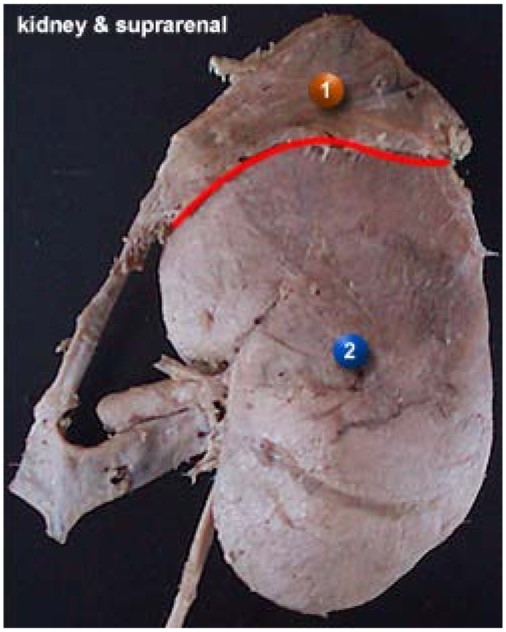
Fibrous flexor and Synovial Flexor sheaths



Fibrous flexor sheaths form tunnels for digital tendons. Each tunnel holds the deep and superficial flexor tendons except the pollex where the tunnel contains only the flexor pollicis longus.
The sheaths are alternately dense (annular pulleys) and lax (cruxiform pulleys) along the fingers.
Tendons within the carpal tunnel are invested with synovial sheath that extend proximally about 3cm in lower part of the forearm.
Tendon of superficialis and profundus are enclosed together in a sheath incomplete on the radial side
This common sheath is only extended to the terminal phalanx of the small digit.
What is the clinical relevance of this piece of information?
The sheath ends beyond the flexor retinaculum for the index, ring and middle finger. However a separate synovial sheath lines the fibrous flexor tunnels.
The tendon of flexor pollicis longus has its own sheath that continues from the carpal tunnel to the distal phalanc of the pollex. These sheaths communicate with the common sheath for the profundus and superficialis in about 50% of individuals.

What do you understand by the terms radial bursa , ulnar bursa, compound palmar ganglion, vinvula?

The Suprarenal Glands



- These are important structures, with important metabolic functions.
- They are frequently involved in endocrine disorders.
- They lie on each side of the vertebral column, against the superomedial surface of the corresponding kidney.
- They are enclosed with the kidney, within the renal fascia. A little fat separates it from the superior pole of the kidney.

Structures:

1. Left suprarenal gland
2. Left kidney

Relations of the right suprarenal gland

Inferiorly: the right kidney

Superiorly: the liver

Postero medially: the thoracic diaphragm

Anteromedially: the IVC

Relations of the left suprarenal

This gland extends further inferiorly on the medial margin of the kidney than the right gland.

Anteriorly : the stomach and the pancreas

Posteriorly : the diaphragm

Inferiorly : the left kidney.

Blood supply

3 arteries

- Superior suprarenal from the inferior phrenic
- Middle suprarenal from the aorta
- Inferior suprarenal from the renal artery

1 large central vein

- the right - inferior vena cava
- the left - left renal vein

Innervation

Autonomic from the coeliac plexus – medulla

Cortex has (?) no nerve supply.

Lymphatics

Aortic lymph nodes

A tumor of the suprarenal medulla called **pheochromocytoma** is usually associated with a very rich blood supply. Abdominal aortography is frequently employed as a diagnostic procedure.

---

1. Work out the extents and relations of the aorta. Classify and name the branches of the aorta.
2. Work out the extents and relations of the IVC. Name the main tributaries of the IVC.

Development of the lower peritoneal cavity

Whereas the geography of the upper abdominal cavity is determined by the growth and extension of the liver and rotation of the stomach, that of the lower peritoneal cavity is to a large extent governed by the development and rotation of the midgut.

The mesentery of the midgut loop thus rotates during herniation and reduction, twisting around the origin of the superior mesenteric artery. The mesentery of the ascending colon is pressed against the posterior abdominal wall and its peritoneum fuses with the parietal peritoneum. As a result the ascending colon becomes retroperitoneal in position. Occasionally the mesentery persists and gives rise to a caecum which is completely surrounded by peritoneum. Such a caucum is mobile, and volvulus may occur if the caecum twists around this long mesentery. The mesentery of the jejunum and ileum, at first attached to the midline of the dorsal abdominal wall acquires a new line of attachment passing from the duodenojejunol junction below. The mesentery of the descending colon becomes fused to the peritoneum of the posterior abdominal wall. This leaves transverse colon with its mesocolon between the hepatic and splenic flexures. The mesocolon fuses with the peritoneum of the posterior wall of the omental bursa, the greater omentum.

Peritoneal pockets and folds related to the midgut and hindgut

The complicated foldings produced by midgut herniation and return create the adult pattern of folds and pockets around the lower gut. A number of small peritoneal pockets or recesses are produced at the duodenojejunal flexure. A crescentic superior duodenal fold of peritoneum stretches from the duodenojejunal flexure to the posterior abdominal wall, and is continuous with a paraduodenal fold which may be traced downwards. This latter fold is produced by the underlying inferior mesenteric vein and the ascending branch of the left colic artery. The superior duodenal pocket or recess lies behind its peritoneal floor. The paraduodenal recess is rarely found, but when present lies behind the paraduodenal fold. An inferior nonvascular duodenal fold is found fairly frequently, with an inferior duodenal recess extending behind it. The recess may be fairly extensive, passing behind the ascending branch of the left colic artery and inferior mesenteric vein on the left. A loop of gut occasionally becomes trapped in such an inferior duodenal pocket, as an 'internal' hernia. When the fourth part of the duodenal and the flexure are lifted, two folds are raised between the duodenum and the peritoneum on the front of the abdominal aorta. These are the duodenoparietal folds and occasionally enclose a pocket which extends behind the duodenum, the retroduodenal recess. It will be noted that the orifices of these four duodenal recesses face each other. A loop of gut which becomes trapped in one or more of the pocket may therefore be difficult to remove without cutting one of the peritoneal folds. The surgeon must remember that the paraduodenal fold is vascular and cannot be cut. A mesocolic recess is sometimes found between the duodenojejunal juction and the root of the transverse mesocolon. The pocket is found at the side of the aorta in the interval between the left renal vein and the kidney. Very rarely a pocket is found invaginating the peritoneum behind the superior mesenteric artery as this crosses the duodenum, the so-called meseterico-parietal recess of Waldeyer.

The mesetery of the small intestine is a fan-shaped double layer of peritoneum whose root lies obliquely across the posterior abdominal wall and whose other border is attached to the gut from the duodenajejunal flexure to the terminal ileum. The root of the mesetery is only 15cm long, and extends to the obliquely downwards from the level of the 2 nd lumbar vertebra to the upper part of the right sacaroiliac joint. Traced downwards it crosses the third part of the duodenum, the abdorminal aorta, the inferior vena cava, the right ureter and the psoas. The intestinal border of the mesentery is 6m long. Jejunal and ileal branches of the superior mesenteric artery and vein, together with lymphatics and autonomic nerve plexuses,are found between the two layers of the mesetery.

Fat is abundant in the lower part of the mesentery, and may be traced as far as the intestinal border. In the upper part of the mesentery, however, there is less fat, and the mesetery is relatively fat-free near the jejunal border.

Once the caecum has descended to its adult position a number of peritoneal pockets may be identified around it. In the infant the caecum is coniucal in shape, with the appendix arising from its tip, in the adult the shape of the caecum is irregular, with the appendix arising from its posteromedial surface. The appendix is suspended from the back of the mesentery by a mesoappendix. It usually extends to the tip of the appendix, and appendicular blood vessels, lymphatics and autonomic nerves are contained within it. A fold of peritoneum is frequently found in front of the mesoappendix, appendix or caecum. This is known as the bloodless fold of Treves, although it must be admitted that it sometimes contains blood vessel. When present, therefore, there is a peritoneal pocket between the mesoappendix and the bloodless fold, the inferior ileocaecal recess. The anterior caecal artery, a branch of the ileocolic artery, raises the ‘vascular fold of the caecum' just in front of the mesetery at the ielocaecal junction. The superior ileocaecal recess lies behind it. If the caecum is elevated, folds of peritoneum are frequently found connecting it to the posterior abdominal wall. These caecal folds, together with the caecum, bound the retrocaecal recess.

The peritoneal covering of the colon presents certain characteristics. Appendices epiploicae, small tufts of peritoneum containing a little fat, are found on its surface. They are especially numerous on the transverse and sigmoud parts of the colon, along the line of the taenia libra; they are absent from the rectum. The ascending and descending parts of the colon do not have complete coats of peritoneum, being covered on their anterior and side walls only. Right and left paracolic gutters are found on the lateral sides of the ascending and descending sections of the colon respectively. The transverse mesocolon is a double fold of peritoneum which attaches the transverse colon to the posterior abdominal wall along the second part of the duodenum, the front of the head of the pancreas, and the anterior border of the body of the pancreas. It contains between itd layer the middle colic artery and its branches, together with lymphatics and autonomic nerves. A fold of peritoneum is often found passing from the left colic flexure to the diaphragm opposite the 10 th and 11 th ribs, the phrenicocolic ligament. The sigmoid colon has a mesentery, the sigmoid mesocolon, which attaches it to the pelvic wall. This attachment takes the form of an inverted 'V', the apex of which lies at the division of the left common iliac artery. The intestigmoid recess of peritoneum is found at the apex of the V-shaped attachment, and the left ureter lies behind the peritoneum of this recess. The mesetery contains the sigmoid and superior rectal vessels, lymphatics and nerves.

The lowest part of the peritoneal cavity is found within the pelvis. Within this basin, peritoneal folds occur in association with the rectum and bladder, and in the female with the uterus. In the male, peritoneum covers the front and sides of the upper third of the rectum but the anterior surface only on its middle third. From here, the peritoneum is reflected forwards over the upper parts of the seminal vesicles to the upper surface of the bladder. A pocket therefore is formed between the two viscera called the rectovesical pouch. The pouch is limited, on each side, by a sacrogenital fold of peritoneum which can be traced from the bladder, past the side of the rectum, to the sacrum. The lower one-third of the rectum is devoid of peritoneum in the adult, but in the fetus the peritoneal cavity extends further down. During development the two layers of peritoneum fuse and are represented in the adult by a fascial layer between the rectum behind and the bladder and seminal vesicles in front, the rectovesical fascia of Denonvilliers. Further laterally on each side of the bladder is a paravesical fossa.

In female, the pararectal and paravesical fossae are similar to those found in the male. The uterus, however, is located between the rectum and the bladder and therefore divides the two associated pouches:

1. Rectouterine
2. Vescouterine

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Chapter 32: The Peritoneum and the Organs of the Gastrointestinal System

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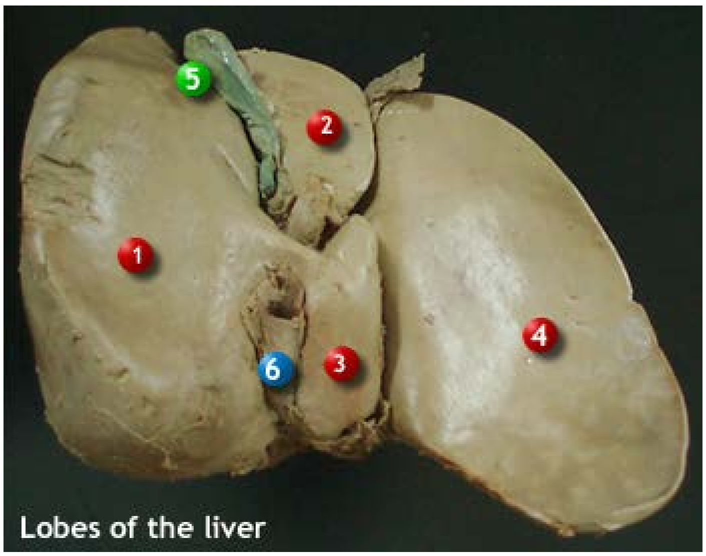
The lobes of the liver



The right lobe

- This is the largest of the four lobes.
- It is demarcated from the rest of the liver by:
  (+) The gallbladder fossa on the inferior border and visceral surface
  (+) by the sulcus for the inferior vena cava on the posterior part of the diaphragmatic and visceral surfaces;
  (+) An imaginary sagittal line over the diaphragmatic surface from the fundus of the gall bladder to the inferior vena cava.

The caudate lobe

- On the posterior part of the diaphragmatic surface, the caudate lobe lies between the fissure for ligamentum venosum and the sulcus for the inferior vena cava.
- B ounded above by the transverse part of the fissure for ligamentum venosum, and below by porta hepatis.
- The lobe bears a small papillary process on the left, and on the right, a taillike caudate process.
- The caudate process separates the portal vein in front from the inferior vena cava behind, and forms a narrow bridge on the surface between the caudate lobe and the right lobe.

The superior recess of the omental bursa extends up behind the caudate lobe. From the surface the caudate lobe appears to have only two surfaces – the rectangular posterior surface and the inferior surface. But the fissure for ligamentum venosum passes dely forwards into the liver, creating a left surface for the caudate lobe, and then to the right, creating an anterior surface. The buried surfaces may be seen in a horizontal section of the liver.

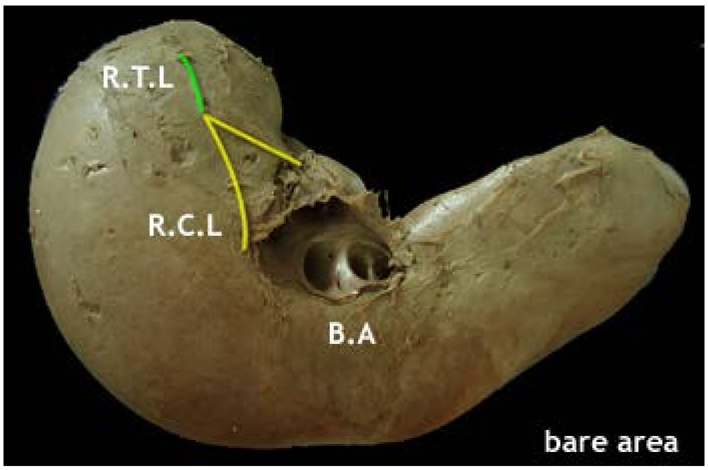
The Quadrate lobe

On the visceral surface, the rectangular quadrate lobe lies between the fissure for ligamentum teres, and the gall bladder. The latter is a wide depression, usually shallow but occasionally deep. If deep, the gallbladder is embedded in the liver to a variable extent. The fossa is parallel to the fissure for ligamentum teres, and ends posteriorly near the right end of the porta. Anteriorly is usually reaches the margin of the liver, so that the fundus of the gall bladder generally protrudes beyond that margin. The quadrate lobe is bounded in front by the inferior margin and posteriorly by the porta.

The left lobe

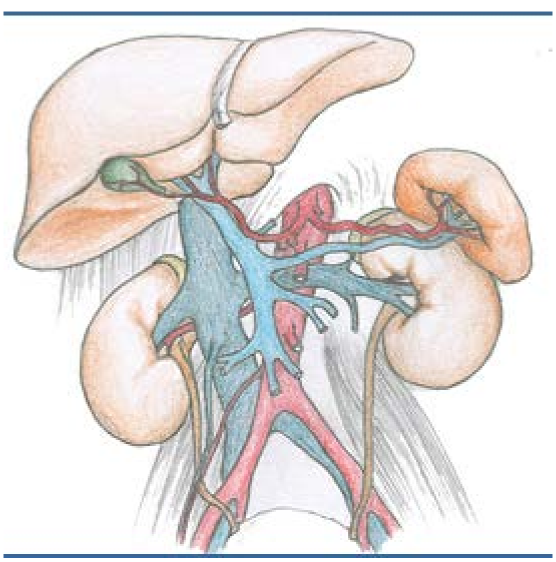
This is the second largest of the four hepatic lobes. It is demarcated from the quadrate and caudate lobes by the fissure for ligamentum teres; the fissure for ligamentum venosum; and the attachment of the falciform ligament on the diaphragmatic surface.

The bare area of the liver



On the posterior part of the diaphragmatic surface, note the bare area on the right lobe, to the right of the sulcus for the inferior vena cava. It is a peritoneum-free triangular area, between the two layers of the coronary ligament, and is loosely attached to the diaphragm.

Blood vessels of the liver



The liver has a double blood-supply, from the **hepatic artery** and from the **portal vein**.

The hepatic artery brings most of the oxygen required by the liver. The portal vein carries most of the products of digestion absorbed from the elimentary canal. The hepatic artery is usually a branch of coeliac trunk. As the liver arises from the junction between foregut and midgut, it is not surprising that occasionally, the liver gets some or all of its blood-supply from the midgut artery(superior mesenteric). Most commonly, however, its supply comes from the foregut artery (coeliac trunk).

The portal vein carries blood from the entire alimentary canal between the lower third of the oesophagus and the upper part of the anal wall.

Two fairly distinct streams of blood flow in the portal vein; the left stream carries blood mainly from the stomach, spleen and large intestine, through the left branch of the portal vein, to the left half of the liver; the right stream carries blood mainly from the stomach and small intestine, through the right branch of the portal vein, to the right half of the liver.

Thus, there are two vascular setments – left and right. The plane of division passes through the fossa of the gall bladder and fissure for IVC.

NB: The stomach drains into both left and right streams. Most of the quadrate and caudate lobes of the liver receive their blood-supply, along with the left lobe, from the left branches of the portal vein and hepatic artery. Likewise the left and right halves of the liver give rise to the left and right hepatic ducts. Pathology may be limited to one segment, and malignacies or ifection first affect respective segments.

Lymphatic drainage of the liver

General principles: The internal organs are drained by lymphatics in two main ways:

• Along the blood-vessels which supply them, and

• Independently, through areas of contact with the walls of the body cavities. Thus an organ invested with visceral peritoneum drains along its vascular pedicle, and where they exist, through 'bare areas', where it is in contact with the body wall.

As is the rule for abdominal organs in general, the deeper lymphatics from the hepatic parenchyma accompany the main vascular channels to the hilus, ie. Porta hepatis. Larger channels run in the lesser omentum, anterior to the portal vein. After traversing the hepatic lymph-nodes alongside the hepatic artery in the lesser omentum, the lymph drains into the superior pancreatic nodes above the pancreas.

Likewise, most of the more superficial lymphatics from the entire surface of the liver join the deeper vessels in the porta. There are two exceptions where bare areas exist.

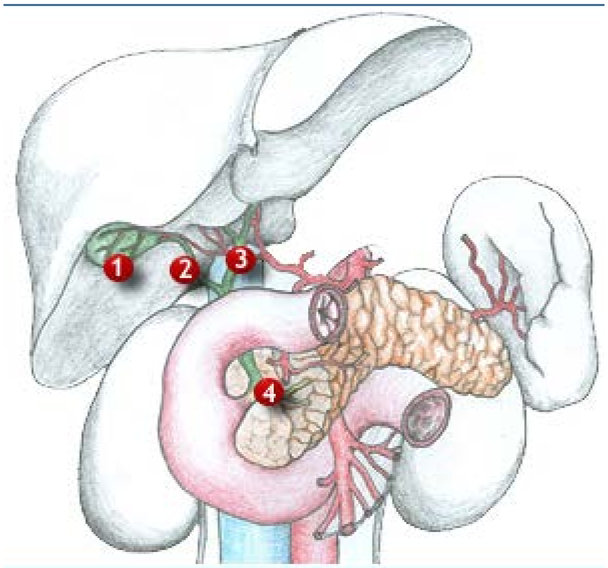
The first is the bare area on the diaphragmatic surface: here, the superficail lymphatics pass to the diaphragm and, through it, to the phrenic and mediastinal nodes and to both major lymph-trunks (thoracic duct and right lymphatic duct). A few enter the falciform ligament and pass to the umbilicus.

The second area is where the oesophagus lies against hepatic tissue without any interviewing peritoneum: here, a few superficial lymphaticvs join the lymphatic vessels of the oesophagus.

Innervation of the liver

The hepatic plexus, an offshoot of the coeliac plexus accompanies the hepatic artery and its branches, conveying both sympathetic and parasympathetic nerve-fibres to the liver.

The Duct system



- The right and left hepatic ducts emerge from the ends of the porta and descend in front of the branches of the hepatic artery for about 2.5 cm.
- They join to form the common hepatic duct (CHD)
- The CHD descends in the right free edge of the lesser omentum, to be joined from above by the cystic duct, forming the common bile duct (CBD).
- The CBD is about 9 cm long. It descends in the right free edge of the lesser omentum. It passes behind the superior part of the duodenum, and enters a groove on the back of the pancraeatic head.
- The CBD ends just below the middle of the descending part of the duodenum, between the anterior and posterior pancraeaticoduodenal arterial arches.

Note that throughout its course, the bile duct is accompanied on its left side by a blood vessel.

- above the duodenum - the hepatic artery
- behind the duodenum - gastroduodenal artery
- below the pancreatic head - pancreatic duodenal vein

Variations of the biliary ducts and hepatic and cystic arteries are common. For instance, though the right branch of the hepatic artery usually passes behind the common hepatic duct, it may pass in front, and be endangered in operations on the duct.

The artery divides into superficial and deep branches - the superficial branch ramifies on the lower surface of the gall bladder; while the branch supplies the upper surface of the organ.

Note: An accessory cystic artery may arise from the common hepatic artery or from other arteries in the neighbourhood.

The veins from the gall bladder usually drain through the areolar tissue in the gall bladder bed into the liver substance.

Other veins from one or two cystic veins near the neck of the gall bladder, enter the liver, or end by joining the veins around the bile duct.

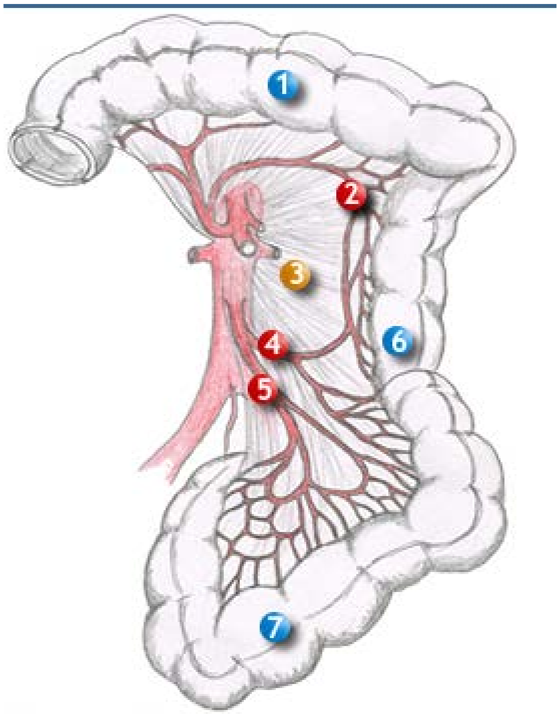
The common bile duct gets blood from

- Cystic artery
- Posterior superior pancreatico duodenal artery
- A few branches from right hepatic artery

Imaging of hepato billiary apparatus

- Plain abdominal X-ray
- Abdominal ultrasound
- Oral cholecystography
- Intravenous cholangiography
- Percutaneous transhepatic cholngiography
- Endosopic retrograde cholangiography and pancreatography
- Hepatic venography
- CT scan

Inferior mesenteric artery



inferior mesenteric artery

The inferior mesenteric artery arises from the front of the aorta at the level of the body of L3 (the subcostal plane). It is the artery of the hindgut, supplying the bowel from the left third of the transverse colon to the upper part of the anal canal.

Branches of inferior mesenteric artery

- The left colic artery divides into ascending and descending branches, which take part in the formation of the marginal artery. The ascending branch ascends to anastomose with the left branch of the middle colic artery. The descending branch anastomoses with the ascending branch of the highest sigmoid artery.
- Two or three sigmoid arteries each divides into ascending and descending branches which contribute to the marginal artery. The descending branch anastomoses with the superior rectal artery.
- The superior rectal artery is the pelvic continuation of the inferior mesenteric artery. It curves medially in the sigmoid mesocolon and, reaching the upper end of the rectum, divides into right and left branches.

Note: The marginal artery (of Drummond) is formed by anastomosis between branches of iliocolic, right colic, middle colic, left colic and sigmoidal. It supplies the large colon.

Note: The superior rectal arteries anastomose with the middle rectal artery, a branch of the internal iliac artery on each side, and with the inferior rectal artery, a branch of the internal pudendal artery given off in the ischio-anal fossa on each side.

The main distribution of the superior rectal artery is to the mucosa of the rectum and anal canal, whereas the middle rectal artery supplies mainly the muscle coat of the rectum.

The anastomosis between the superior rectal artery (from the inferior mesenteric) and the other rectal arteries (from the internal iliac) may be of importance, because of the sometimes poor anastomosis between the superior rectal and the lowest sigmoid. If, for example, the surgeon has to ligate and remove the trunk of the inferior mesenteric artery, the only way to ensure blood-flow in the lowest sigmoid artery is to ligate the trunk above the origin of the latter branch. In this way, there remains a communi9cation between the lowest sigmoid artery and the superior rectal artery: blood reaching the superior rectal artery from its anastomosis below can thus pass in reverse direction up the superior rectal artery and, so, into the lowest sigmoid artery.

Venous drainage of the abdominal GIT

The veins correspond with the arteries. The inferior mesenteric vein draining the hind gut joins the splenic vein, which drains the foregut structures, the superior mesenteric vein drains the midgut and joins the splenic to form the portal vein.

The portal vein

The portal vein collects blood from the abdominal part of the alimentary tract, from the gall bladder, pancreas and spleen, and conveys it to the liver. There the portal vein branches to end in expanded capillaries known as sinusoids. From the sinusoids, the blood is collected into hepatic veins which drain into the inferior vena cava.

It is a large vein, about 7.5 cm long formed behind the neck of the pancreas. It ascends in front of the inferior vena cava and behind the superior part of the duodenum to enter the right lesser omentum. Here it lies behind the hepatic artery and the bile duct, while posterior to it is the omental foramen at the porta hepatis, it divides into right and left branches.

Tributaries of the portal vein

These are a set of veins broadly corresponding to the three unpaired arteries of the gut. The two forming tributaries are the splenic and superior mesenteric veins. Once formed, the portal vein receives the left and right gastric veins, the cystis veins and the para-umbilical veins.

Splenic vein:

This vessel receives the inferior mesentric vein (usually) the short gastric veins; the left gastro-omental vein, and the pancreatic veins. The inferior mesentric vein is the continuation of the superior rectal vein; it receives the sigmoid vein; and the left colic vein; and it uses the splenic vein to drain its blood across over to the right.

Superior mesenteric vein:

This large vein drains all the parts supplied by the superior mesenteric artery and in addition it receives the right gastro-omental vein, pancreatic veins and the pancreaticoduodenal vein.

Left and right gastric veins:

These drain the lesser curvature of the stomach. In addition, the right gastric vein receives the clinically important prepyloric vein which runs upwards over the pylorus.

Cystic veins:

These drain from the gall bladder either into the right branch of the portal vein, or directly into the liver.

Para-umbilical veins:

These small veins run along ligamentum teres between the layers of the falciform ligament. They connect the superficial veins of the anterior abdominal wall around the umbilicus with the left branch of the portal vein. Thus they effect an anastomosis between the portal and systemic veins (i.e a portacaaval anastomosis).

Sites of portacaval anastomosis

When the portal vein is obstructed or the blood-flow through the liver impeded, the anastomoses between the portal and systemic veins provide alternative routes known as a collateral circulation. The following are the most important sites of portacaval anastomosis:

- Lower oesophagus: between the oesophageal tributaries of the left gastric vein and oesophageal veins joining the azygos system.
- Anal canal: between the rectal venous plexus (portal drainage and the middle and inferior rectal veins (systemic drainage)
- Pelvis: between the rectal venous plexus (portal and systemic drainage) and the other pelvic venous plexuses, such as the vesical and prostatic, the uterine and vaginal (systemic)
- Umbilicus: between epigastric veins (systemic) and the left branch of the portal vein, along ligamentum teres.
- Bare area of liver: between hepatic venules and veins of diaphragm and thorax.
- Intestine and spleen: between colic and splenic venous twigs (portal) and renal or lumbar veins (systemic).

Lymphatic drainage of abdomino-pelvic GIT

Lymphatics run with the main arteries and veins. Nodes are distributed along the course of these vessels and in the corresponding para-aortic nodes and eventually in the thoracic duct.

The Duct System:

The main pancreatic duct (of Wirsung) runs most of the length, to join the common bile duct to form the ampulla of vater, and then pierce the postero medial wall of the descending part of the duodenum, to open at the summit of the major duodenal papilla. Each of the ducts has a sphincter, and the ampulla of vater is guarded by the sphincter of Oddi. Sometimes the pancreatic and bile ducts open into duodenum separately.

There may be an accessory duct(s). Note that a bile stone or spasm of sphincter of Oddi may block the Ampulla of Vater. Bile may then reflex into the pancreatic duct causing pancreatitis. In this case, the accessory pancreatic duct may be safe guard.

Innervation

Derived from:

- Vagus
- Greater (and lesser) splanchnic nerves.

Reach the gland via coeliac and superior mesenteric plexuses. Pain from the pancreas may be referred to middle and lower thoracic dermatomes.

Rapture of the pancreas may tear the duct system, allowing pancreatic juice to enter the substance of the gland, and invade adjacent tissues. Haemorrhagic pancreatitis that may follow is serious and very painful. Its management is difficult.

Peritoneal relations of the pancreas:

The initial and terminal parts of the duodenum are covered by peritoneum, and the superior part of the duodenum is ataached to the liver by the hepatoduodenal ligament.

The rest of the duodenum is retroperitoneal.

The recesses associated with the duodenojejunal junction include;

- Superior duodenal recess
- Inferior duodenal recess
- Retroduodenal recess
- Paradeudenal recess. This recess is guarded by the paraduodenal fold, which contains the inferior mesenteric vein and the superior left colic artery.

These recesses are potential sites of internal hernia.

Blood supply

Arterial:

Mainly from:

- Superior pancreaticcoduodenal - branch of gastroduodenal.
- Inferior pancreaticoduodenal - branch of superior mesenteric.

These vessels anastomose.

Other sources include:

- Supraduodenal artery from hepatic artery.
- Right gastric artery
- Right gastroepiploic
- Gastroduodenal

These vessels also anastomose.

Veins:

In general, these follow the arteries and drain into the portal venous system.

Most drain into superior mesenteric, but some may enter the portal vein directly.

One of the anterior veins – the prepyloric vein (of Mayo) ascends anterior to the pylorus and drains into the right gastric vein. This vein consistently runs over the gastroduodenal junction and is an important guidepost to surgeons.

Lymphatics

Posterior and anterior vessels anastomes:

Follow arteries:

- Pancreaticoduodenal
- Gastroduodenal
- Coeliac nodes. (anterior ones)
- The posterior ones
- Superior mesenteric nodes.

Contents

1. Urogenital diaphragm
   - transversus perineal profundus
   - sphincter urethrae
2. membranus urethra – 1 cm long
3. bulbo-urethral glands (Cowpers glands) only in male
4. Internal pudendal artery and vein
5. Dorsal nerve of the penis/clitoris
6. Perineal nerve

Superficial perineal fascia

This is the continuation of scarpas fascia from the abdomen into the perineum.

Attachments

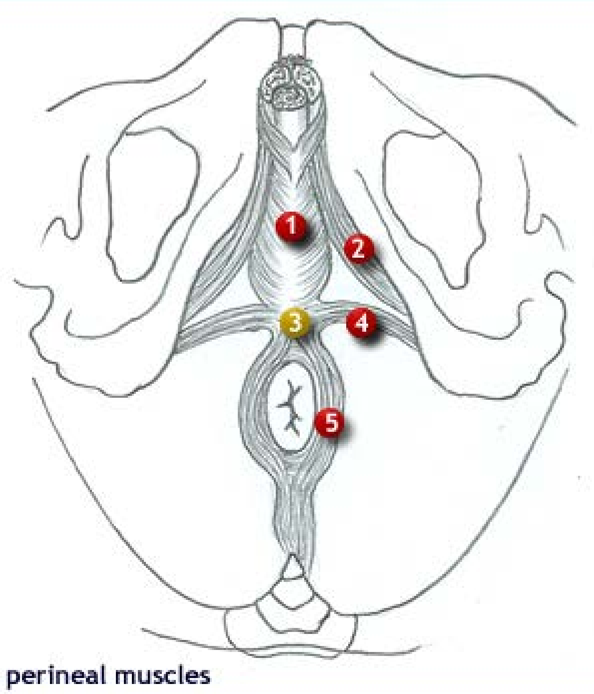
- Fascia lata
- Pubic arch
- Perineal body and perineal membrane – posteriorl
- Anteriorly the fascia is prolonged over the penis and scrotum in the male.
- Superiorly continues with the scarpas fascia

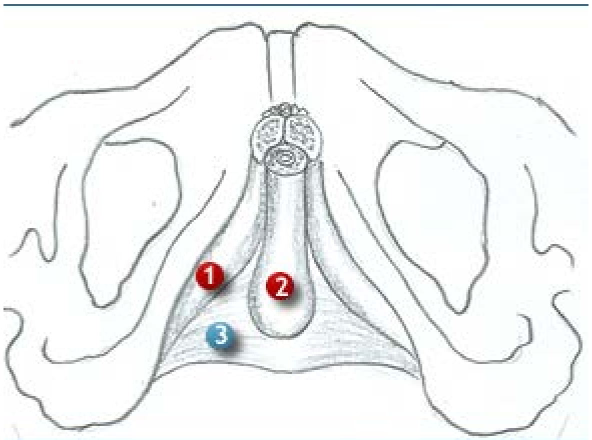
Superficial perineal pouch

This is a fascial space deep to the superficial perineal membrane.Its boundaries are:

- Superiorly – perineal membrane
- Inferiorly (superficial) perineal membrane
- Posteriorly - perineal body
- Anteriorly continues into the penis, scrotum (in the male) and anterior abdominal wall

Contents of superficial perineal pouch





- bulbar urethra
- root of the penis i.e.
    - Crura of corpus cavernosum penis (CCP)
    - Bulb of corpus spongiosum penis (CSP)

NB: The crura of the corpus carvenosum and bulb of corpus spongiosm are attached to the perineal membrane and form the root of the penis.

- pierced by the vagina in the female.
- Three superficial muscles
    - ischiocarvenosus
    - bulbospongiosus
    - transversus perinei superficialis
- Superficial arteries – 3 paired arteries all branches of the internal pudendal artery
    - Perineal artery – arises behind base of the urogenital diaphragm. branches -
    - posterior labial artery (female)
    - posterior scrotial artery (male)
    - transverse perineal artery
    - Artery to the bulb of the penis or vestibule (female)
    - Deep artery of the penis or clitoris

- Superficial Nerves
    - Posterior scrotal/labial nerves (branches of the perineal nerve)
    - Posterior cutaneous nerve of the thigh
    - Dorsal nerve of the penis/clitoris
    - Nerve to the bulb of the urethra and the vestibule (female)

Pelvic Part of Autonomic Nervous System

The sympathetic part of the autonomic nervous system reaches the pelvis by two different routes.

a) the downward continuation of the sympathetic trunk, and

b) the downward continuation of the aortic plexus.

Sympathetic trunk

The sacral part of the sympathetic trunk lies on the pelvic surface of the sacrum, medial to the upper three pelvic sacral foramina and usually in front of the fourth. It consists largely of preganglionic fibres. It often ends by forming an enlargement, the ganglion impar, with the contralateral trunk in front of the coccyx. The number of ganglia interspersed along the sacral part of the trunk is variable, but there are usually three of four. Each ganglion tends to be connected by rami communicates with only one spinal nerve. The fibres in these rami are postganglionic, and most of them are distributed to the lower limb and perineum with branches of the sacral plexus. A variable number of fine fibres (sacral splanchnic nerves) passes forward from the trunk to join the inferior hypogastric plexus.

Autonomic Plexuses

After the aortic plexus continues downward in front of the fifth lumbar vertebra, it receives some fibres from the lower lumbar splanchnic nerves and is called the superior hypogastric plexus (or presacral nerve). The latter plexus divides in front of the sacrum into two elongated, narrow networks, which are sometimes collected into trunks, and which are termed the right and left hypogastric nerves. Each hypogastric nerve or plexus passes downward on the side of the rectum (or rectum and vagina in the female). At the level of the lower part of the front of the sacrum, each hypogastric nerve is joined by the pelvic splanchnic nerves of the corresponding side to form the right and left inferior hypogastric (or pelvic) plexuses, which consist of dense networks of interlacing nerves embedded in tough connective tissue. Small pelvic ganglia are scattered throughout these networks.

Subdivisions of the inferior hypogastric plexuses and supply the pelvic organs. Although these subdivisions are named either according to the organs that they supply or the vessels that they accompany, they intercommunicate freely and their names are arbitrary.

A number of branches leave the inferior hypogastric plexus on each side and supply the rectum. One or two of these branches accompany the middle rectal artery and constitute the middle rectal plexus, which helps supply the rectum. A large part of the inferior hypogastric plexus forms the prostatic plexus, which supplies the prostate and parts of adjacent organs. It is continued forward as the cavernous nerves of the penis. The vesical plexus supplies the bladder and parts of the ureter, ductus deferens, and seminal vesicle. The uterovaginal plexus passes with the uterine artery between the layers of the broad ligament. It supplies the uterus, ovary, vagina, urethra, and the erectile tissue of the vestibule. Fibres from the lower most part of this plexus continue as the cavernous nerves of the clitoris.

Functional components

The inferior hypogastric plexus contains three types of fibres:

1) postganglionic sympathetic fibres, some of which arise from the lumbar part of the sympathetic trunk and descend by way of the superior hypogastric plexus, and others of which arise from the sacral part of the trunk;

2) preganglionic parasympathetic fibres, which arise from the sacral part of the spinal and reach the inferior hypogastric plexus by way of pelvic splanchnic nerves. They supply the descending colon, the sigmoid colon, and the pelvic viscera. The fibres that supply the descending and sigmoid colon may ascend directly to these organs, but usually ascend in the plexus and then leave in a branch of the hypogastric nerve. This branch gives a branch to the sigmoid colon and then ascends along the descending colon, sometimes as far as the left colic flexure; and

3) sensory fibres of various types

Some of these carry pain impulses, and they enter the spinal cord in lumbar splanchnic nerves. They often ascend in the superior hypogastric plexus, but they also run by way of the pelvic splanchnic nerves. Other sensory fibres, which are concerned in various reflexes and with sensations from the urinary bladder, reach the sacral part of the cord in the pelvic splanchnic nerves.

Much more information in regard to the innervation of pelvic organs in man is needed. The types of fibres reaching a particular organ and the functions of these are uncertain in many instances.

Lymphatic Drainage

The lymphatic nodes of the pelvis are available in size, number, and location. Four main groups are located in or closely adjacent to the pelvis, and they receive most of the lymphatic vessels from the pelvis. They are named according to the arteries with which are associated, but the division into definite groups is somewhat arbitrary. In addition to the nodes in the named groups, small nodes lie in the connective tissue along the pathways of various branches of the internal iliac artery.

1) The sacral lymphatic nodes lie in the hollow of the sacrum. They receive vessels from some of the pelvic

organs and from parietal and gluteal regions. They are frequently regarded as a part of the internal iliac group, and they drain either into this group or into the common iliac nodes.

2) The internal iliac lymphatic nodes are arranged around the internal iliac artery and near the origins of the branches of this artery. They receive vessels from the pelvic viscera, the perineum, and the buttock. Their efferent vessels drain into the common iliac nodes.

3) The external iliac lymphatic nodes are arranged around the external iliac artery. They receive vessels from the superficial and deep inguinal nodes, from the deep part of the abdominal wall below the umbilicus, and from the some of the pelvic viscera. Their efferent vessels drain into the common iliac nodes.

4) The common iliac lymphatic nodes receive the drainage from the external and internal iliac and the sacral nodes. They drain into the lumbar group of nodes.

There are many connections between the lymphatic vessels that drain the various pelvic organs. Because of these connections, no disturbance in drainage results from the removal of large numbers of nodes. Furthermore, cancer within the pelvis can spread to any pelvic or abdominal organ. Most of the lymphatic vessels follow the course of the arteries, but some do not.

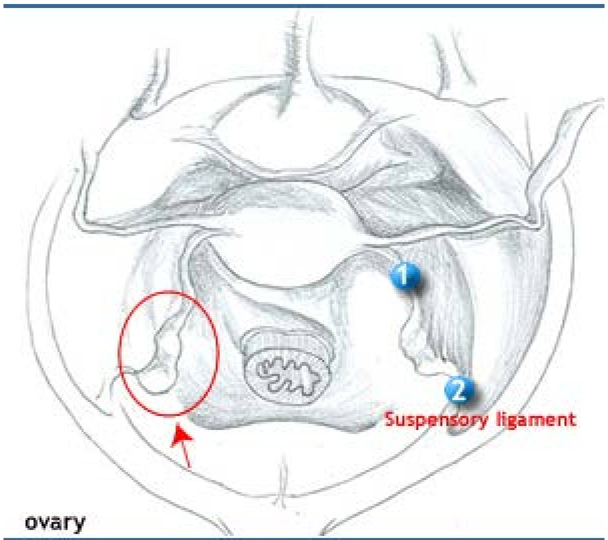
The pelvic organs and the groups of lymphatic nodes into which their afferent lymphatic vessels drain are listed in the table.

FEMALE GENITAL ORGANS

The female genital organs consist of the ovaries, uterine tubes, uterus, vagina, and external genital organs. The paired ovaries and uterine tubes and the single uterus are situated in the pelvic cavity. The single vagina is located partly within the pelvic cavity and partly in the perineum. The external genital organs lie in front of and below the pubis.

Ovary

Functions



a) Oogenesis - produce ova after puberty.

b) Parts of the m function as endocrine glands , and are responsible for the production of two main hormones:

i) estrogen, or follicular hormone, secreted by the ovarian follicle. It controls the development of the secondary sexual characteristics, such as the enlargement of the breasts, the deposition of fat over the hips and buttocks, and the growth of pubic and axillary hair.

It also initiates the growth of the lining of the uterus during the menstrual cycle.

ii) progesterone, or corpus luteum hormone, secreted by the corpus luteum. It is indispensable for the implantation of the fertilized ovum and for the early development of the embryo. The secretion of both ovarian hormones is controlled by the gonadotrophic hormone from the pars distalis of the hypophysis. The ovaries are homologous with the testes of the male.

A third hormone, called relaxin, is secreted by the ovary during pregnancy. It is said to inhibit premature contraction of the uterus during pregnancy, and , in certain mammals, is responsible for the relaxation of the sacroiliac joint and the pubic symphysis. The ovary also produces several paracine factors.

Location

In a woman who has not borne children (nullipara), The ovary is situated on the lateral wall of the pelvis, at the level of the anterior superior spine, and just medial to the lateral plane, where it can be palpated bimanually. Its position may be altered by other pelvic organs, especially the uterus, to which the ovary is attached by ligaments. When the uterus ascends into the abdomen during pregnancy, the ovary is pulled away from its original position, which is usually regained after parturition.

It resembles a large almond in shape. Its size varies with age and with the stage of the ovarian cycle. It is somewhat larger before than after pregnancy. After pregnancy, it is about two and a half to four centimeters long, and its average weight is seven grams. In old age it becomes further reduced in size.

When the ovary is in its usual position, its long axis is nearly vertical. It has medial and lateral surfaces, tubal and uterine ends, and mesovarian and free borders. It lies in a depression, the ovarian fossa, which is bounded in front by the obliterated umbilical artery and behind by the ureter and internal iliac artery.

The lateral surface is in contact with the parietal peritoneum lining the ovarian fossa and is separated by this peritoneum from the extraperitoneal tissue that covers the obturator vessels and nerve. Most of the medial surface is covered by the uterine tube; elsewhere this surface is related to the coils of the ileum.

The mesovarian or anterior border is attached to the mesovarium and faces the obliterated umbilical artery. The hilus of the ovary, through which blood vessels, lymphatic vessels, and nerve pass, is located on this border. The free or posterior border is related to the uterine tube and, behind this, to the ureter.

The tubal or upper end is closely connected to the uterine tube; the suspensory ligament of the ovary is attached to this end. The uterine or lower end gives attachment to the ovarian ligament.

Attachments

The mesovarium is a short, double-layered mesentery which extends backward from the posterior layer of the broad ligament to the mesovarian border of the ovary. Its two layers are attached one on each side of this border. The suspensory ligament of ovary, or infundibulopelvic ligament, extends upward over the external iliac vessels and becomes lost in the connective tissue covering the psoas major. It contains the ovarian vessels and the ovarian plexus of nerves. The ovarian ligament passes from the uterine end of the ovary to the body of the uterus, just below and behind the entrance of the muscle fibres.

Structure

The structure of the ovary varies with age and with the stage of the ovarian cycle. It is covered by a layer of cuboidal cells (germinal epithelium), which joins the mesothelium of the mesovarium at the hilus. The part of the ovary beneath the germinal epithelium is customarily divided into a cortex and a medulla. Details of structure are covered in histology.

Blood supply

The ovary is supplied by the ovarian artery and by the ovarian branch of the uterine artery. After descending to the brim of the pelvis, the ovarian artery passes in the suspensory ligament and then between the two layers of the broad ligament until it reaches the mesovarium, in which it passes to reach the hilus of the ovary. The ovarian branch of the uterine artery passes laterally in the broad ligament to the mesovarium, where it ends by anastomosing with the ovarian artery.

The veins from the ovary begin as a plexus which communicates with the uterine plexus. Two veins arise from this plexus and they become a single vein by the time they reach the abdomen.

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lymphatic drainage

The lymphatic drainage vessels from the ovary pass upward with the ovarian vessels and drain into the lumbar (or aortic) nodes.

Nerve supply

The ovary is supplied by the ovarian plexus. Most of the fibres in this plexus are vasomotor.

Vagina

The vagina is the female organ of copulation. It is also the lower end of the "birth canal", and it serves as the excretory duct for products of menstruation. The cavity of the vagina communicates with that of the uterus above, and it opens into the vestibule of the vagina below. The vagina extends downward and forward in a plane parallel to that of the pelvic inlet. This plane is approximately 60 degrees from the horizontal. In the adult, when the urinary bladder is empty, the axis of the vagina forms an angle of a little more than 90 degrees with the axis of the uterus. However, this angle increases as the urinary bladder fills and pushes the fundus of the uterus upward and backward.

The vagina is highly dilatable, especially in the part above the pelvic diaphragm. When the cavity is empty, it is H-shaped in transverse section in most of its extent. Its anterior and posterior walls are in contact with each other below the entrance of the cervix. The anterior wall, which is pierced by the cervix, is about seven and a half centimeters long; the posterior wall is about 9 cm long. These walls are especially distensible. The lateral walls are attached above to the lateral cervical ligament and , below this, to the pelvic diaphragm. They are, therefore, more rigid.

The recess between the vaginal part of the cervix and the walls of the vagina is termed the fornix of the vagina. Although it is continuous around the cervix, it is often subdivided into anterior, posterior, and lateral fornices. The posterior fornix is the deepest, and its wall is related to the peritoneum of the rectouterine pouch.

In most virgins, the opening of the vagina into the vestibule is partially closed by a fold, called the hymen. This fold is variable in size and shape, but is often annular or crescentic. It usually has one opening, but it may be cribriform. When an opening is lacking, the fold is called an imperforate hymen. After the hymen has been torn or ruptured, small rounded fragments remain at the site of its attached margin. These are termed the carunculae hymen.

Relations

Anteriorly, the upper part of the vagina is related to the cervix. Just below this, it is separated from the urinary bladder and ureters by loose connective tissue. Because the uterus is usually twisted and the upper part of the vagina is correspondingly deviated (usually to the left), much more of one ureter than the other situated in front of the vagina. The urethra is fused with the lower two-thirds of the anterior wall of the vagina.

Posteriorly, the upper part of the vagina is related to the rectouterine pouch, and below this, it is separated from the rectum by relatively avascular connective tissue. The lower part of the vagina is fused with the tendinous center of the perineum.

Laterally, the upper part of the vagina is attached to the parametrium forming the lateral cervical ligament and the two layers of the broad ligament on either side of this. The ureter and uterine artery are also related to this part of the vagina. The pubococcygeal portions of the levatores ani embrace the vagina about 3 cm above its opening and act as a sphincter.

Below the pelvic diaphragm, the vagina is related laterally to the greater vestibular gland, the bulb of the vestibule, and the bulbospongiosus muscle.

Structure

The vagina has three layers, a mucosa, a muscular coat, and a fibrous coat, details of which are covered in histology.

Blood supply

The upper of the vagina is supplied by branches of the uterine artery. The vaginal artery, sometimes arising as two or three branches from the internal iliac, divides into numerous branches, which are distributed to the front and back of the vagina. These branches may anastomose in the median plane to form two longitudinal trunks, called the anterior and posterior azygos arteries of the vagina. A few branches from the artery of the bulb of the vestibule reach the lower part of the vagina.

The blood from the vagina drains into the vaginal venous plexus, which communicates with the uterine and vesicle plexuses.

Blood supply

The labia majora and minora are supplied by the anterior labial branches of the external pudendal arteries and by the posterior labial branches of the internal pudendal arteries. The crura and corpora cavernosa of the clitoris are supplied by the deep arteries of the clitoris. The glans is supplied by the dorsal arteries of the clitoris. The bulb of the vestibule and the greater vestubular gland receive their blood supply from the artery of the bulb of the vestibule and form the anterior vaginal artery.

Lymphatic drainage

The lymphatic vessels from the external genital organs drain into the superficial inguinal nodes.
The lymphatic vessels from the upper part of the vagina pass along the uterine artery and drainage into the external and internal iliac nodes. Those from the middle part pass with the vaginal artery and drain into the internal iliac nodes, whereas from the lower part pass to the sacral and common iliac nodes. Lymphatic vessels from the part of the vagina adjacent to the hymen pass to the superficial inguinal nodes.

Nerve Supply

The labia majora and minora are supplied by the anterior labial nerve (from the ilio-inguinal nerve) and the posterior labial nerves (from the pudendal nerve). The bulb of the vestibule is supplied by hte uterovaginal plexus, which is continued as the cavernous nerves of the clitoris. The clitoris is also supplied by the dorsal nerves of the clitoris.

These various nerve include

1) sensory fibres, some of which conduct pain and others of which arise from a variety of special receptors,

2) autonomic fibres, which supply the numerous blood vessels, and

3) autonomic fobres, which supply the various glands.

[Except for its lowermost part, which is supplied by the pudendal nerve, the vagina is supplied by the uterovaginal plexus. The plexus contains autonomic fibres for the supply of smooth muscle as well as vasomotor fibres. There is little sensation in the vagina, except in its lowermost part.]

Examination of pelvic organs

Digital examinations per vaginam are made by placing one or two fingers in the vagina. In bimanual examinations, pelvic structures are palpated between these fingers in the vagina and the other hand placed on the anterior abdominal wall.

The following structures are palpable:

In front, the urethra and the vaginal part of the cervix, the urinary bladder when distended, and the body of the uterus (bimanually).

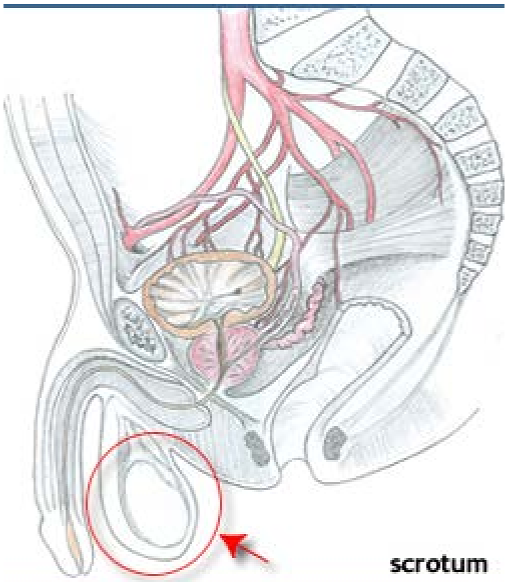
Behind, the rectum and any masses present in the rectouterine pouch, which is readily accessible. An abscess in this pouch may be drained by an incision in the wall of the vagina behind the posterior fornix. When the sacral promontory is felt, the diagonal conjugate can be measured.

Laterally, the ureters, displaced or enlarged broad ligaments and lymphatic nodes, and displaced or enlarged ovaries and uterine tubes (bimanually).

A speculum introduced into the vagina permits visualization of the vagina and cervix, performance of certain minor operations on the cervix, and under anesthesia, removal of the uterus.

The urogenital triangle

The scrotum



Recall that this is a cutaneous outpouching of the skin of the abdomen, that contains the testis.

1. The skin remains the skin, and is thin, dark colored, and rugose. The scrotal raphe is a ridge that indicates the bilateral origin of the scrotum (from the labioscrotal swellings).

The superficial fascia, devoid of fat, contains smooth muscle called **dartos muscle**, which helps regulate temparature. This superficial fascia is continuous anteriorly with the membranous layer of superficial fascia of the anterior abdominal wall, and posteriorly with superficial fascia of the perineum.

2. The main content of the scrotum is the testis. The coverings of the testis are continuous with the coverings of the spermatic cord.

- The external spermatic fascia - external oblique aponeurosis.
- Cremaster muscle and cremasteric fascia - internal oblique aponeurosis.
- Internal spermatic fascia - transversalis fascia.
- Tunica vaginalis - peritoneum (processus vaginalis) - vesceral and parietal.

Blood supply of the scrotum

- Perineal branch of internal pudendal artery .
- External pudendal branches of femoral artery.
- Cremasteric branch of inferior epigastric artery.

The veins correspond. The external pudendal veins enter the great saphenous veins.

Nerve supply of the scrotum

- Genital branch of genitofemoral - sensory to the anterior and lateral surfaces of the scrotum.
- Ilioinguinal nerve - sensory to anterior surface.
- Perineal branch of the pudendal nerve - posterior surface.
- Perineal branch of posterior femoral cutaneous - inferior surface.

Lymphatics of the scrotum

- Superficial inguinal lymph nodes.
- A very small proportion - deep external iliac or the lumbar nodes.

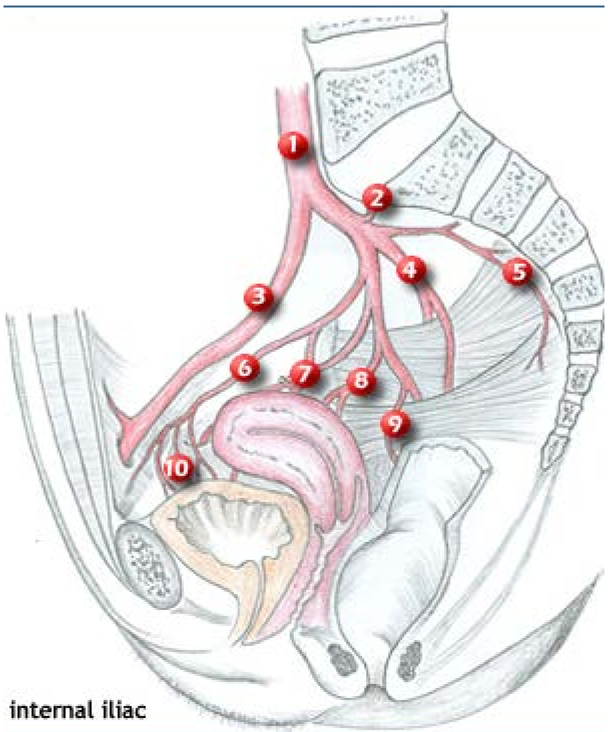
BLOOD VESSELS AND NERVES OF THE PELVIS

Internal iliac artery

The internal iliac (hypogastric) artery furnishes most of the blood supply to the pelvis. It arises from the common iliac in front of the sacro-iliac joint, at the level of the intervertebral disc between the fifth lumbar vertebra and the sacrum. Its origin can be marked on the surface of the body by the upper point of trisection of a line extending between the anterior superior iliac spine and the pubic symphysis. It is usually about 4 cm long.

The internal iliac artery is crossed in front by the ureter. It is separated from the sacro-iliac joint behind by the internal iliac vein and the lumbosacral trunk. In its upper part, the external iliac vein and psoas major are lateral to it; in its lower part the obturator nerve is lateral.

Parietal Branches



a) **The iliolumbar artery.** The iliac branch sends branches to the iliacus muscle and a large nutrient branch to the ilium. The lumbar branch ascends to supply the psoas major and the quadratus lumborum. It sends a spinal branch through the intervertebral foramen between the fifth lumbar vertebra and the sacrum.

b) T**he lateral sacral arteries**, usually an upper and a lower, may arise from a common trunk Both lateral sacral arteries give off spinal branches, which after passing through pelvic sacral foramina and supplying the contents of the sacral canal, may emerge through dorsal sacral foramina.

c) The **obturator artery**, the origin of which is variable, passes forward and downward on the obturator fascia to the obturator foramen. The posterior gives off an **acetabular branch**, which supplies the fat in the acetabular fossa and the ligament of the head of the femur (medial epiphysial branches).

d) The **superior gluteal artery** passes backward, usually between the lumbosacral trunk and the first sacral nerve, and leaves the pelvis through the greater sciatic foramen, above the piriformis.

e) The **inferior gluteal artery** passes backward, between the first and second, or second and third sacral nerves, and leaves the pelvis through the greater sciatic foramen, below the piriformis.

f) The **internal pudendal artery** is larger in the male than in the female.

The internal pudendal artery gives off the following branches:

i) the inferior rectal artery

ii) the posterior scrotal (or labial) branches,

iii) the perineal artery

iv) the artery of the bulb of the penis (or vestibule)

v) the urethral artery and

vi) the deep and dorsal arteries of the penis (or clitoris)

---

collateral circulation

The collateral circulation that develops after obstruction of an internal iliac artery results from anastomoses

1) with branches of the opposite internal iliac,

2) between parietal branches and branches of the femoral artery in the thigh, and

3) between the superior and middle rectal arteries.

The collateral circulation may be demonstrated by arteriography. The collateral channels also supply the lower part of the abdomen if the abdominal aorta is obstructed, and the lower limb if the femoral artery is obstructed.

Three other arteries enter the pelvis

a) Median sacral

b) Inferior mesentric

c) Ovarian artery

Internal Iliac Vein

The internal iliac (hypogastric) vein is a short trunk, which unites with the external iliac to form the common iliac vein. Its tributaries correspond in general to the branches of the internal iliac artery, with the exception of the umbilical and the iliolumbar arteries.

Each of the viscera within the pelvis is surrounded by a network of relatively large, thin-walled veins, which have few valves. These **plexuses communicate freely** with each other and give rise to the visceral tributaries of the internal iliac vein. They also communicate with the parietal tributaries, and thereby provide easy pathways for the spread of infections. The plexuses are named as follows:

1) the rectal venous plexus

2) the vesical venous plexus

3) the prostatic venous plexus

4) the uterine venous plexus

5) the vaginal venous plexus

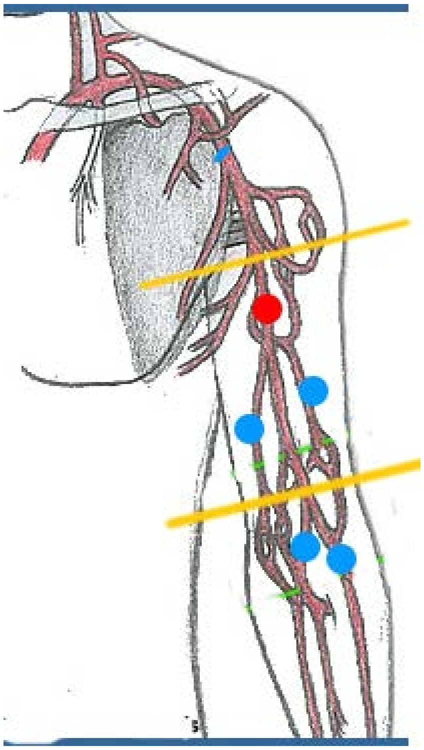
6) The sacral venous plexus, located on the pelvic surface of the sacrum, is not associated with an organ, but it provides a pathway for blood to pass from the pelvic viscera to the azygos and vertebral venous systems. Material injected into the deep dorsal vein of the penis has been found in the veins of the head, thorax, abdomen, pelvis, and thighs, and in the vertebral venous system. During hysterosalpingography, radiopaque material reached the veins of the uterus and was detected in the ascending lumbar veins.

Nerves

The nerve supply to the pelvis is derived mainly from the sacral and coccygeal spinal nerves, and from the pelvic part of the autonomic system.

Brachial Artery

Hover over hot spots to show names



Origin

Continuation of axillary artery

Extent

Lower border of teres major to radial neck

Surface marking

With arm abducted at right angles:
A line from middle of clavicle to mid point between humeral epicondyles

Course and relations

- Superficial in the course of the arm
- Lies immediately deep to the deep fascia of the antero medial aspect of the arm
- In the cubital fossa covered, covered by bicipital aponeurosis
- Median nerve initially lateral, then crosses it anteriorly to the medial nerve
- Ulna nerve initially posterior to it

Branches	Distribution	Anastomosis
• Profunda brachii • Superior ulna collateral • Inferior ulna collateral • Muscular branches • Nutrient artery • Ulnar • Radial	• Muscles of arm • Elbow joint • Humerus	• Cubital anastomosis

Palpation

In the cubital fossa with finger pressure directed laterally

Surgical approach

Exposed in the groove between biceps and triceps brachii at medial border of biceps brachii

Anterior compartment muscles

Muscle	Origin	Insertion	Innervation	Action
Coracobrachialis	• Coracoid process	• Mid medial border of humerus	Musculocutaneous	• Weak flexor and adductor of shoulder
Biceps brachii (1) 	• Long head- supra glenoid tubercle • Labrum glenoidiae	• Radial tuberosity • Bicipital aponeurosis • Upper humerus	Musculocutaneous	• Elbow flexion • Supinator • Weak shoulder flexor
Brachialis (2)	• Front lower Humerus • Medial	• Coronoid process • Tuberosity	Musculocutaneous	• Elbow flexion

	intermuscular septum • Radial groove	of ulna		

Posterior Compartment muscles

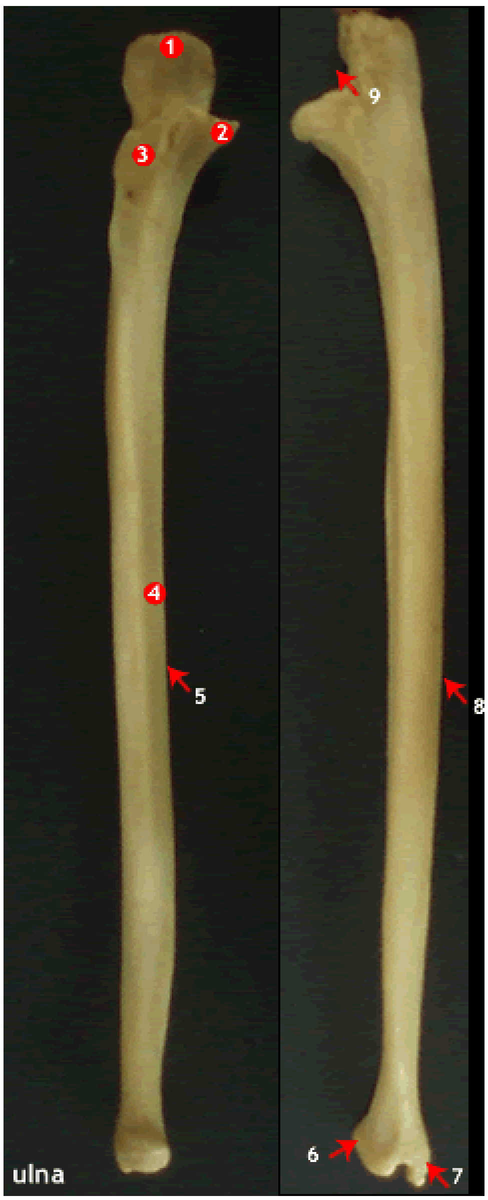
Triceps brachii  	• **Long head** **(1)** - supraglenoid tubercle • **Lateral head** – Humerus above radial groove • **Medial head** **(2)** - Humerus below radial groove	• Olecranon **(3)** • Capsule of elbow joint	Radial	• Elbow extension • Shoulder extension • Support shoulder joint capsule

Osteology of the forearm

Bones in this region consist of the

1. **Radius** (lateral side)
2. **Ulna** (medial side)

Ulna



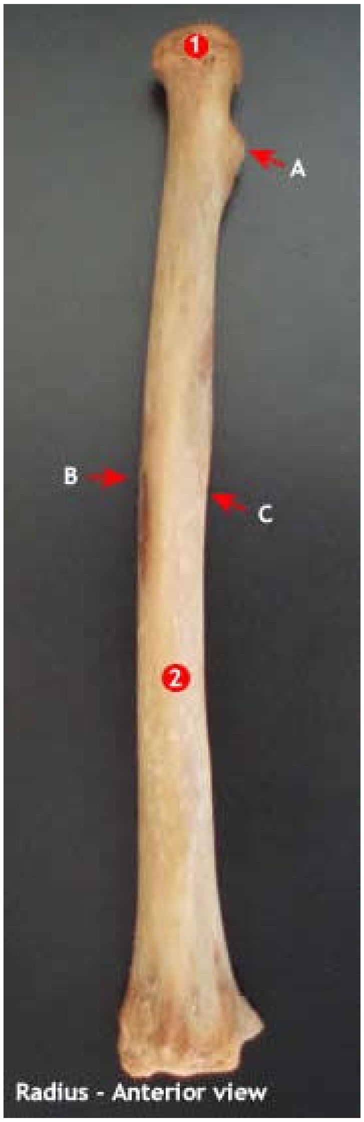
Note the following about the medial bone ulna

- Anatomical parts of proximal end include:

  olecranon process, **trochlear fossa**, **coronoid process**

- The shaft has three surfaces and three borders
- The **interrosseous border** to which a membrane attaches, is lateral
- Posterior border is subcutaneous and limits the flexor and extensor compartments
- Distal end bears the head from which projects the **styloid process**.
- Articulates with trochlear of humerus at elbow and radius at the radioulnar joints

Radius

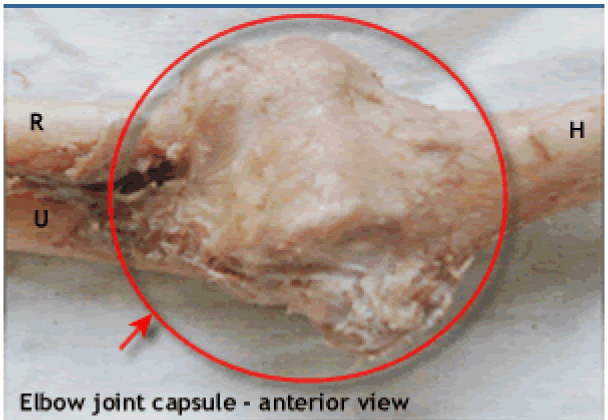


Proximal end bears the **head**, **neck**, **radial tuberosity**:

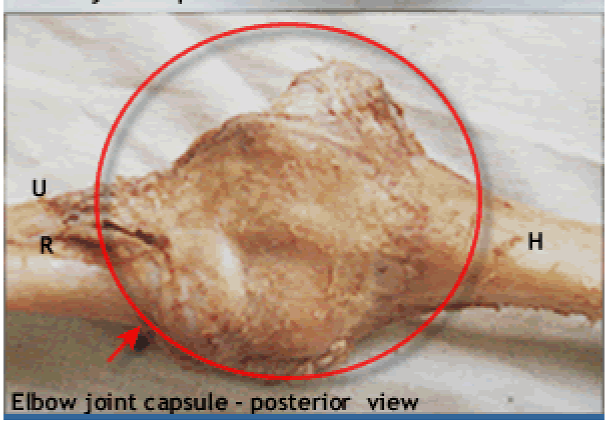
- The shaft is wider inferiorly and bears a sharp **interosseuos border**
- Shaft also bears the **anterior oblique line**
- Lower end possesses the **radial styloid process**, **ulnar notch**, **dorsal tubercle**
- The superiorly concave head articulates with **capitulum of humerus** and and **radial notch of ulna**
- The strong interosseous membrane joins it to ulna
- Also articulates with **ulna** at **distal radioulnar joints** and **scaphoid** & **lunate** at the **wrist**.

Capsule and ligaments

Capsule



Elbow joint capsule - anterior view

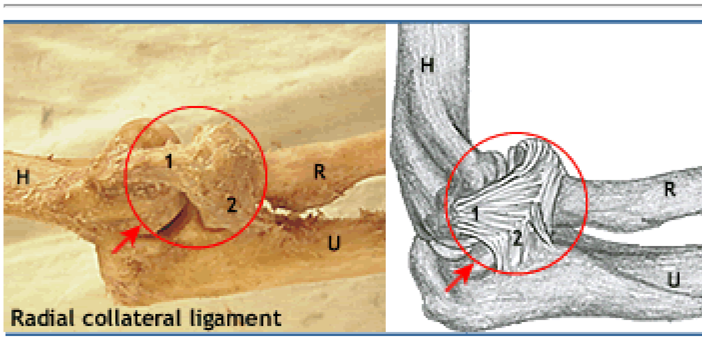


Elbow joint capsule - posterior view

- Capsule encloses the radial and coronoid fossae in front and most of the olecranon fossa behind
- Distally, it is attached in front to the anterior edge of the coronoid process, anular ligament and olecranon process

Ligaments

Radial collateral ligament

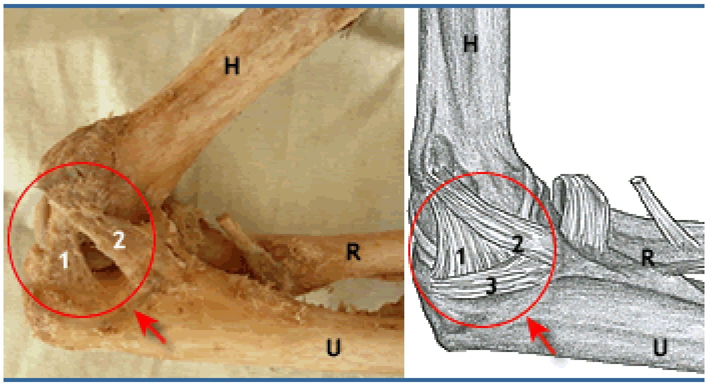


Radial collateral ligament

- This strong and fan shaped ligament ***(1)*** arises from the lateral epicondyle
- Blends with the annular ligament distally***(2)***.
- It is reinforced by origins of the superficial extensors of the forearm and supinator.

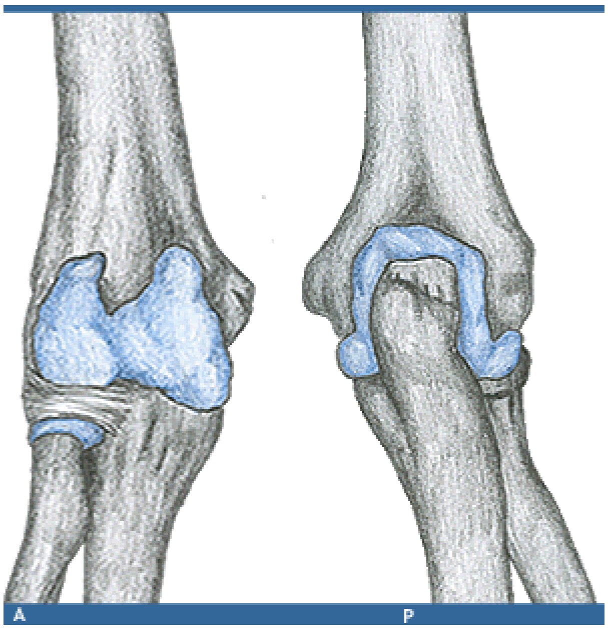
Ulna collateral ligament

- Originates from the medial epicondyle
- Anterior fibres ***(2)*** extend to the coronoid process



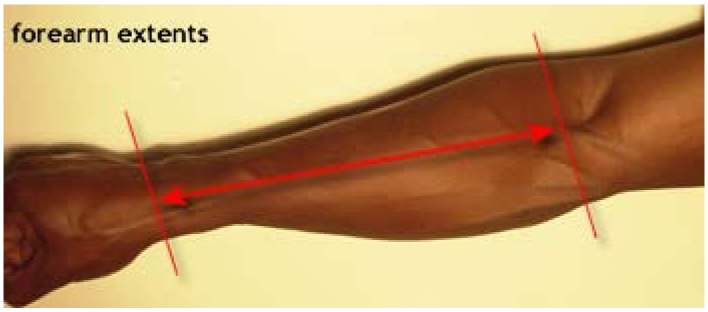
- Posterior fibres ***(1)*** extend to the olecranon process.

Synovial membrane



- Lines the elbow joint capsule, the lower part of the annular ligament and the fossae of the distal humerus.
- It is attached to the articular margins of the three bones.
- Fatty pads occupy the fossae, between the fibrous and synovial membranes of the capsule.
- The synovial membrane extends distally as a pouch within the anular ligament on to the neck of the radius below the ligament.
- Continuous with that of proximal radio-ulna

6 Surface anatomy and skin



- Cutenous nerves lateral cutenous (continuation of musculocutenous), medial cutenous nerve of forearm, posterior cutenous nerve of forearm
- Dermatome of lateral skin is C7 while that of forearm medial skin is C8
- Superficial fascia is not special. *Name the contents of this space*
- The deep fasciae send septae dividing the forearm into compartrments.
- It is also modified to form extensor retinaculum.
- At the lower back, osteofascial compartments lodge extensor tendons at the back of the wrist

Blood-Supply

Cubital anastomosis

Nerve-Supply

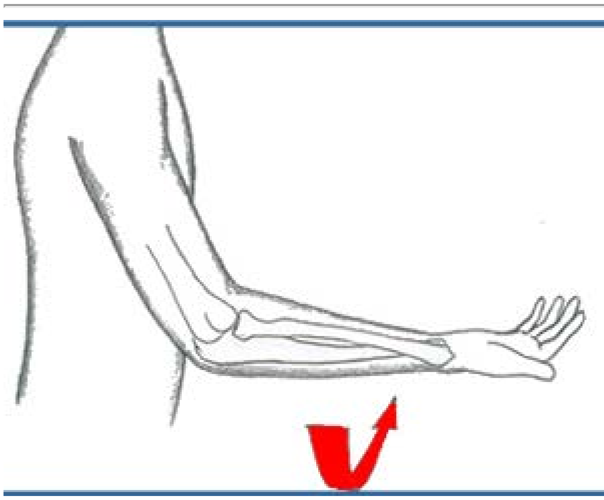
The musculocutaneous and radial nerves (i.e. the nerves which supply the related muscles).

Movements

- Supination
- Pronation

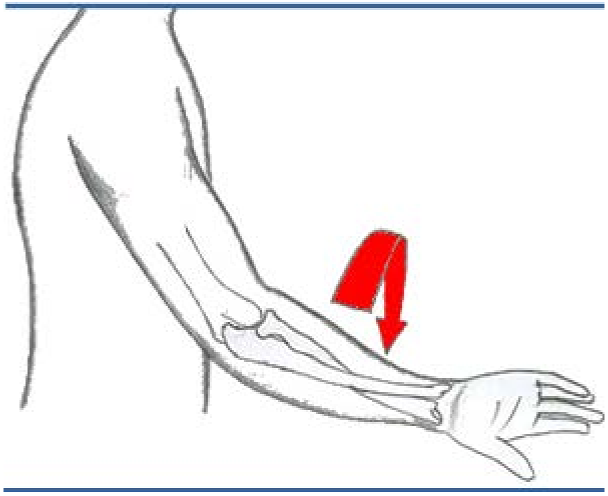
Axis passes through centre of radial head and centre of triangular ligament at the wrist.

Supination



Performed by the *Biceps brachii* ***(1)*** and *Supinator* ***(2)*** .
Biceps brachii is the more powerful muscle especially where force is required
Supination is assisted to a slight extent by the *Extensor muscles* of the thumb

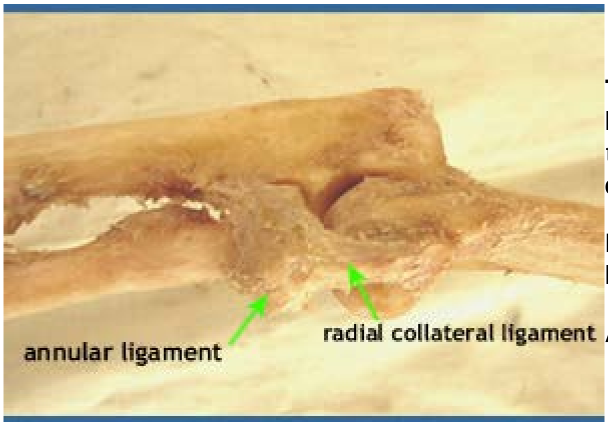
pronation



Pronator quadratus is the prime mover in pronation pronation is performed by the ***Pronator teres(1)***, ***Pronator quadratus (2)*** and ***Flexor carpi radialis***.

The former two are the principal pronator muscles P. quadratus is reinforced by the P. teres during rapid and forceful pronation . During pronation the anconeus abducts the ulna so that the latter takes the place of the distal end of the

Relations



The annular ligament gives attachment to the radial collateral ligament and to supinator. It is almost subcutaneous and the head of the radius can easily be felt rotating within it just distal to the capitulum of the humerus.

Posteriorly, the interosseous recurrent artery ascends on the ligament.

Anteriorly, the ligament is crossed by the lateral edge of brachialis

Anterior Compartment

The muscles of the flexor compartment perform the following actions/functions :

1. *Wrist flexion*
2. *Radial abduction of wrist*
3. *Stabilization of wrist in finger movements*
4. *Flexion at Metacarpophalngeal and interphalangeal joints*
5. *Anchorage of skin/fascia against shear forces*
6. *Tendon grafts*
7. *Writs adduction*
8. *Pronation of forearm*
9. *Elbow flexion*

task ***Work out the muscle or muscle groups that subserve the functions listed***

2.4. Muscle origins, insertions, innervation and actions: Flexor forearm compartment

Muscle	Origin	Insertion	Innervation	Action
Pronator teres	Medial epicondyle; medial border of coronoid process	Pronator tuberosity on lateral radial shaft	median	Pronation and flexion of forearm
Flexor carpi radialis	Medial epicondyle of humerus	Trapezium, Base of 2 nd and 3rrd metacarpal	median	Flexion and abduction of hand
Palmaris longus	Medial epicondyle of humerus	Flexor retinaculum and palmar aponeurosis	median	Flexes hand
Flexor carpi ulnaris	Medial epicondyle & medial aspect of olecranon process	Pisiform, hook of hamate, base of 5 th metacarpal	ulna	Flexion pf hand, adduction of hand
Flexor digitorum superficialis	Medial epicondyle, & medial asoect coronoid process & oblique line of radius	Sides of middle phalanx	median	Flexion of middle finger, assists hand flexion and that of proximal phalanx
Flexor pollicis longus	Shaft of radius and interosseous	Base of distal phalanx of thumb	Anterior interosseous branch of median	Flexes distal phalanx

	membrane			
Flexor digitorum profundus	Upper ulnar shaft and interosseous membrane	Base of distal phalanx	Ulnar and Anterior interosseous branch of median	Flexes distal phalanx, assists flexion of middle and proximal phalanges
Pronator quadratus	Lower shaft of ulna	Lower shaft of radius	Anterior interosseous branch of median	Pronation of forearm

Cutaneous Veins of Forearm

Cephalic Vein

Origin:

Lateral continuation of dorsal venous arch

Course

- Begins in the roof of anatomical snuff box in close proximity with cutaneous branch of radial nerve
- Runs up along the lateral border of forearm accompanied by lateral cutaneous vein of forearm
- Anterolateral over roof of cubital fossa
- Lateral to biceps brachii muscle (Lateral bicipital sulcus)
- In the deltopectoral groove
- Pierces clavicopectoral fascia

Termination

Axillary vein

Communications

- Connected to basilic vein at cubital fossa by median cubital vein
- Un-named communications with:

1. Basilic vein
2. Deep veins (Vennae commitante)

Utilization

- Drawing of blood
- Intravenous injection
- Venous cutdown

3. Posterior compartment of the forearm

The muscles of the posterior compartment perform the following actions/functions

1. Wrist extension
2. Wrist abduction
3. Extension at the metaphalangeal and Interphalangeal joints
4. Writ adduction
5. Synergistic in making a fist
6. Little extension and abduction during pronation
7. Supination of elbow
8. Thumb extension
9. Flexion of the elbow when the forearm is semipronated

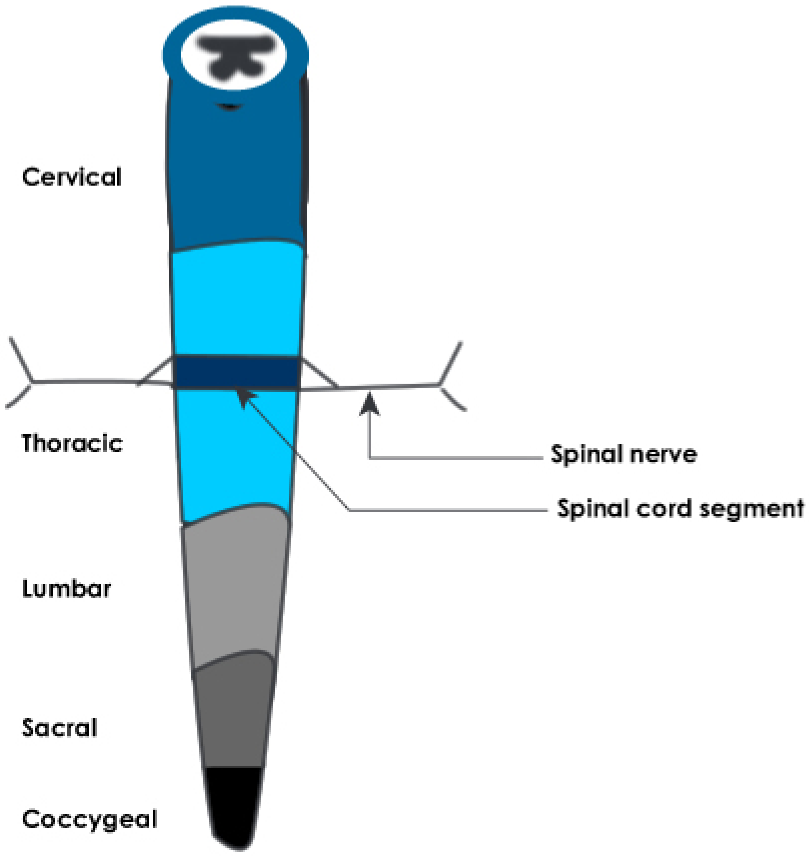
task *Work out the muscle or muscle groups that subserve the functions listed*

3.4 Muscle origins, insertions, innervation and actions: Extensor forearm compartment

Muscle	Origin	Insertion	Innervation	Action
Brachioradialis	Lateral supracondylar ridge of humerus	Styloid process of radius	Radial nerve	Forearm flexion, rotation to mid-prone
Extensor carpi radialis longus	Lateral supracondylar ridge of humerus	Bas of 2 nd metacarpal	radial	Hand extension & abduction at wrist
Extensor carpi radialis brevis	Lateral humeral epicondyle	Base of 3 rd metacarpal	Deep branch radial	Extends and abducts the hand
Extensor digitorum	Lateral humeral epicondyle	Extensoer expansion, base of middle phalanx, base of distal phalanx	Lateral humeral epicondyle	Extends MP, DIP, PIP joints
Extensor digiti minimi	Lateral humeral epicondyle	Extensor expansion of little finger	Lateral humeral epicondyle	Extends the MP joint of little finger
Extensor carpi ulnaris	Lateral humeral epicondyle			
anconeus	Lateral epicondyle	Lateral face of olecranon and shaft of ulna		

supinator	Lateral epicondyle, lateral ligament, annular ligament, supinator crest/fossa of ulna	Between anterior and posterior oblique lines of radius		
abductor pollicis longus	Foream			
extensor pollicis brevis	Forearm			
extensor pollicis longus	Forearm			
extensor indicis	Forearm			

The spinal cord



- This is the caudal continuation of the brain stem into the vertebral canal.
- It extends from the foramen magnum to the L1/L2 junction.
- The spinal cord is functionally segmented.
- Each segment gives rise to one pair of spinal nerves.
- The segments are cervical; thoracic; Lumbar; Sacral and coccygeal.


DEPARTMENT OF HUMAN ANATOMY
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Prof. Jameela Hassanali

• Trigeminal ganglion and brainstem nuclei of trigeminal nerve, especially the mesencephalic nucleus in the monkey, baboon and other animals.

• Morphometric study of brains of some animals related to development, function and evolution.

Department Of
HUMAN ANATOMY

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Prof.James K. Kimani, PhD

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Prof. Adel Malek, PhD

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CHAPTER 18 : The Joints of the wrist , hand and fingers

Muscles of the hand

Muscle	origin	insertion	Nerve supply	Action(s)
Abductor pollicis brevis	Flexor retinaculum, tubercle of scaphoid	Radial side base of proximal phalanx , FPL	Recurrent branch of Median	Abduction of thumb ***(Can you demonstrate this movement?)*** , Assist thumb extension
Flexor pollicis brevis	Flexor retinaculum, trapezium, trapezoid, capitate	Radial Sesamoid of thumb/proximal phalanx	Recurrent branch of Median/variable	Thumb flexion (thumb drawn across palm)
Opponens pollicis	Flexor retinaculum, trapezium	Radial border of metacarpal thumb	Recurrent branch of Median	Opposes metacarpal of thumb. ***Can you demonstrate this movement?***
Abductor digiti minimi	Pisiform, tendon of FCU	Ulnar side of base proximal phalanx	Deep branch of ulnar nerve (T1)	Cupping of the palm/ assist in hand grip
Flexor digiti minimi brevis	Flexor retinaculum, hook of hamate	Ulnar side of base proximal phalanx	Deep branch of ulnar nerve (T1	Cupping of the palm/ assist in hand grip
Opponens digiti minimi	Flexor retinaculum, hook of hamate	Ulnar border of 5 th metacarpal	Deep branch of ulnar nerve (T1	Cupping of the palm/ assist in hand grip
Palmar interrossei (3)	Middle finger side of index, ring and ring finger metacarpals	Extensor expansion and proximal phalanx of respective finger	Deep branch of ulnar nerve (T1	Finger adduction
Dorsal interrossei (4)	Arise by two heads from adjacent metacarpal bones	Extensor expansion and proximal phalanx of respective finger	Deep branch of ulnar nerve (T1	Finger abduction
Lumbricals	Tendons of flexor digitorum profundus	Extensor expansion	Median Ulnar	Flexes MP joint, extend IP joint
Palmaris brevis				

Functional adaptations of the human hand

consider the following:-

- Presence of Thenar and hypothenar muscles
- Mobility of the thumb
- Opposability of pollex
- Elongated digits
- Palmar creases and grip
- Palmar aponeurosis and protective role
- Precision and small motor units
- Cerebral representation of hand in cortex

Note:

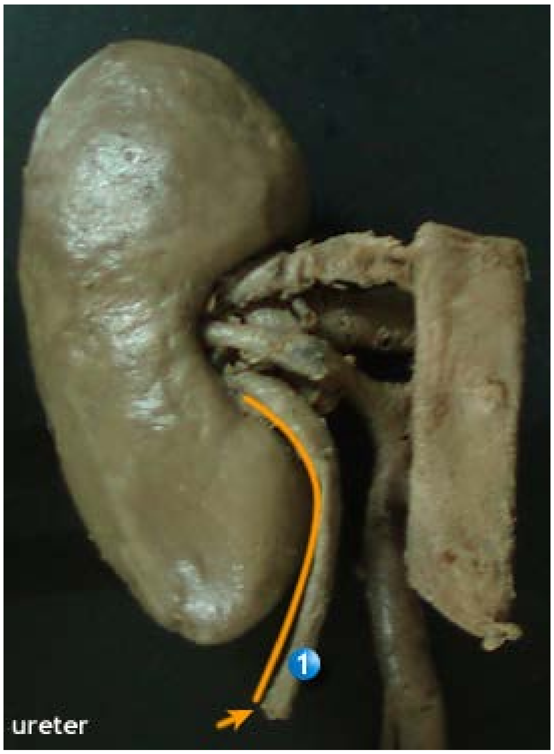
Be sure you can demonstrate the following thumb movements;

- Palmar abduction,
- Radial abduction
- Ulnar adduction,
- Flexion adduction and
- Opposition (see Last)

Also note the hand grips firm, hook and pinch grips.

The Ureters

Position and Relations



- Run from the pelvis, posterior to the vessels at the level of the transverse process of L2 –L5.
- It is retroperitoneal throughout and has important relations.
- It runs anterior to psoas major muscles and the common iliac vessels.
- Runs posterior to the colic vessels and the mesenteric vessels in the mesentery.
- It is first lateral, then medial to the gonadal vessels, all the time posteriorly (the gonadal vessels cross it from medial to lateral, anteriorly)
- The right ureter is in close relationship to the IVC (on the right, the lumbar lymph nodes and the sympathetic trunk.

Blood supply

A longitudinal anastomosis contributed to by branches of

- renal
- aorta
- Common iliac
- Vescical
- Uterine

Others may be

- Gonadal
- Internal iliac
- Mesenteric vessels

The veins correspond.

Lymphatics

Superior part :lateral aortic

Middle part : common iliac nodes

Inferior part : common, external or internal iliac nodes.

Innervation Same as the kidneys

The Appendix

This is a small organ, with no well defined function, but is a surgical nuisance – inflammation of the appendix (appendicitis) is a common surgical emergency.

Position/location

Usually in the right iliac fossa. Its position varies. Could be on the left side in situs inversus.

- Retrocecal
- Retrocolic
- Subhepatic
- Pelvic

Relations

Posteriorly : psoas major

Medial (post): ureters and iliac vessels

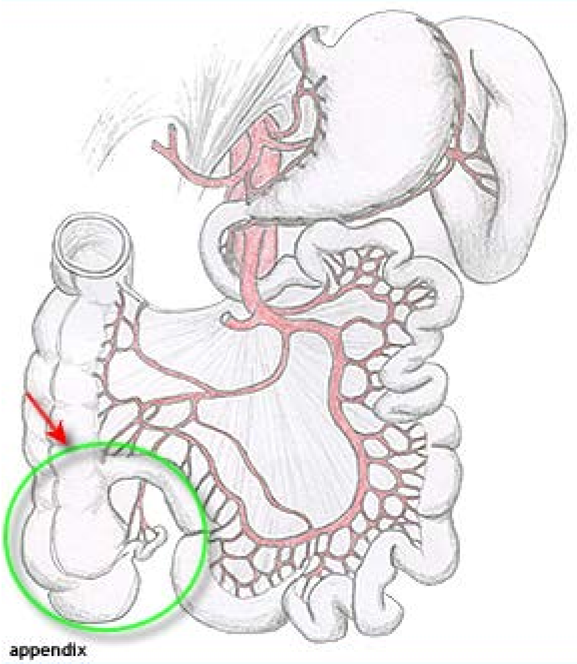
Anteriorly : caecum

Superiorly : coils of ileum (and ascending colon).

Anteriorly : may be separated from the anterior abdominal wall by intestines.

Peritoneal relations	Surrounded by peritoneum, and has mesoappendix.

blood supply aa	Appendicular branch of ileocolic artery – a branch of the superior mesenteric artery. The appendicular tributary of ileocolic vein takes the blood to the superior mesenteric vein.



Lymphatics

Nodes in the mesoappendix – ileocolic artery.

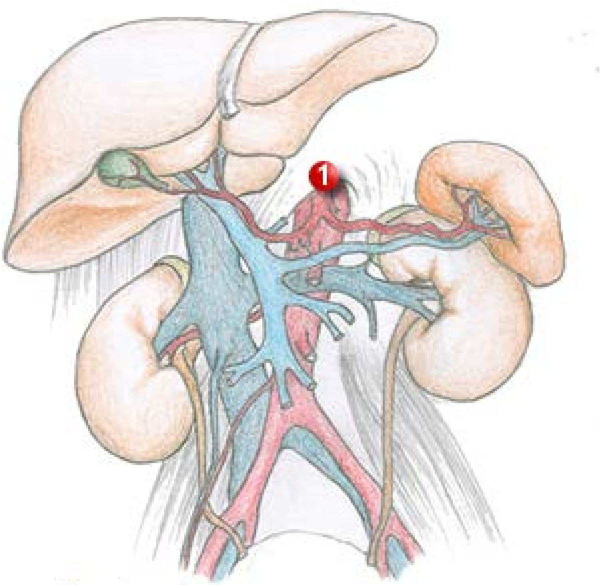
Nerves

Parasympathetic : vagus

Sympathetic : superior mesenteric plexus

BLOOD SUPPLY TO THE ABDOMINO - PELVIC GIT

The coeliac trunk



coeliac trunk

- It is the artery of the foregut
- It supplies the alimentary canal from the lower third of the oesophagus to the middle of the descending part of the duodenum, as well as related gut derivatives (the liver, gall bladder and pancreas) and the spleen.
- It arises opposite the body of L1, and just below the aorta hiatus.
- It runs forwards for about 1cm and divides into three arteries to supply the three large organs of the upper abdomen - the liver, stomach and spleen.

Branches of the coeliac trunk

The **left gastric artery** runs upwards and slightly to the left towards the caradiac orifice of the stomach, in the left gastropancreatic fold. It gives off oesophageal branches, and then turns downwards to follow the lesser curvature where it forms an anastomosis with the right gastric artery.

The **common hepatic artery** runs to the right, along the upper border of the head of the pancreas, behind the lesser sac, crossing in front of the inferior vena cava in the right gastropancreatic fold. It passes below the omental foramen, giving off the right gastric and gastroduodenal arteries, and then ascends in the free edge of the lesser omentum, as the hepatic artery proper . The bile duct lies on its right side and portal vein behind it.

The **gastoduodenal artery** gives rise to the superior pancreaticoduodenal**,** to supply the respective organs and the right gastroepiploic which runs on the greater curvature of the stomach, anastomosing with the left gastroepiploic artery.

The **splenic artery** is the third branch of the coeliac trunk. It runs to the left along the upper border of the pancreas, behind the omental bursa. It often passes under conver of the upper border of the pancreas at certain points in its course. It is tortuous. Traced to the left, it runs across the left suprarenal and left kidney. It enters the splenorenal ligament and so reaches the hilus of the spleen.

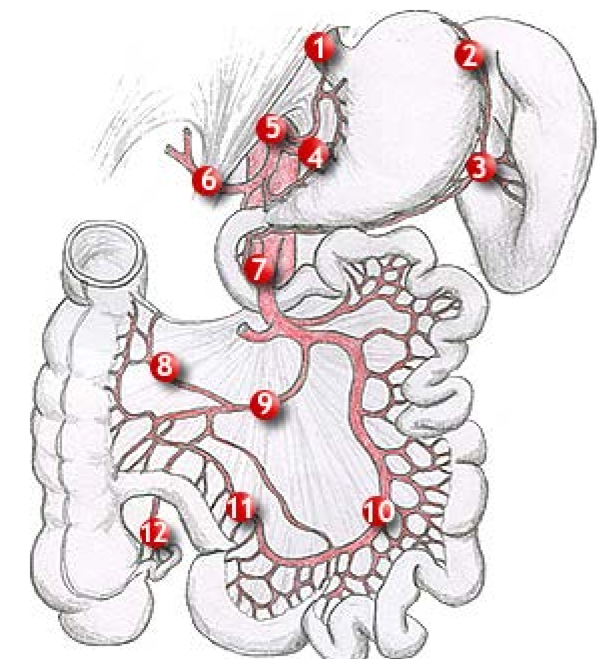
Branches of the splenic artery

- Pancreatic branches supply the pancreas.

- Short gastric arteries enter the gastrosplenic ligament to reach the fundus of the stomach.

- The left gastro-epiploic artery, the original continuation of the splenic artery in the dorsal mesogastrium, reaches the stomach via the gastrosplenic ligament. It runs to the right along the greater curvature. It anastomoses with the right gastro-epiploic artery. The gastro-epiploic arteries supply both stomach and greater omentum.

Superior mesenteric artery (SMA)



superior mesenteric branches

- Found in the root of the mesentery near the midline, just below coeliac trunk.
- Most of its branches arise from its left side.
- The branches to the small intestines are called jejunal and ileal branches respectively.
- There are anastomotic arcades between adjacent branches and these form secondary, tertiary and in the more distal parts even quaternary arcades.
- Vasa recta which arise from the peripheral row of arcades and pass alternatively to either side of the bowel.
- Traced to the terminal ileum, the SMA anastomoses with its ileocoloc branch on its right.
- The ileocolic artery runs towards the ileocolic angle and divides into ascending and descending branches. It gives the appendidular artery, to the appendix.

Other branches of the SMA

- The right colic artery runs horizontally to the right and divides ascending and descending

Branches.

- Higher up, the middle colic artery arises from the right side of the superior mesenteric, and near it, the most proximal branch, the inferior pancreatic coduodenal artery .

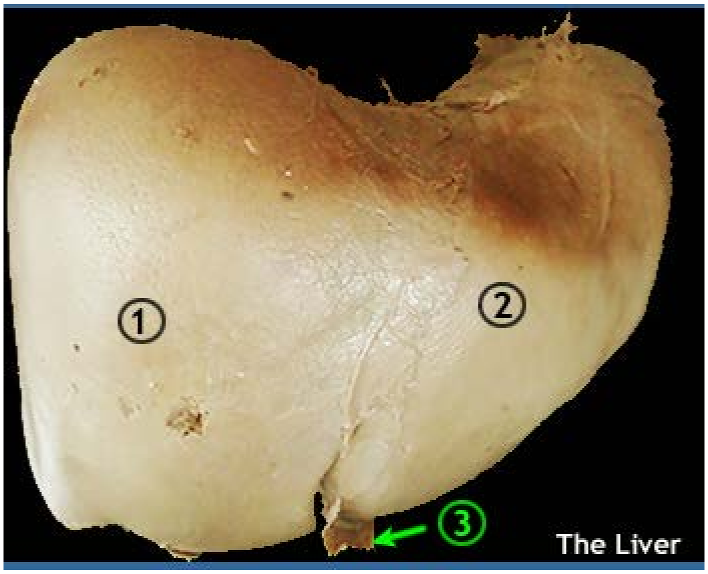
- The middle colic artery enters the root of the transverse mesocolon. It descends in the mesocolon to the upper border of the transverse colon, where it divides into right and left branches.

The superior mesenteric vein and its tributaries, accompany the artery and its branches. The vein lies on the right side of the artery. Both vessels cross the horizontal part of the duodenum and pass between the head of the pancreas and its uncinate process.

Note that the superior mesenteric artery is the artery of the midgut, that portion of the alimentary tract which is extruded into the umbilical stalk between the 5 th and 10 th week of embryonic life. The midgut extends from the greater duodenal papilla (where the bile duct enters) to the transverse colon near the left colic flexure.

THE LIVER AND BILLARY APPARATUS

Position



The liver is the largest organ in the supracolic cmpartment of the abdominal cavity extending between the right hypochondrium and epigastric regions.

The liver is pyramidal in shape, with its base on the right side. For descriptive purpose, it has only two surfaces, diaphragmatic and visceral.

Visceral relations of the liver

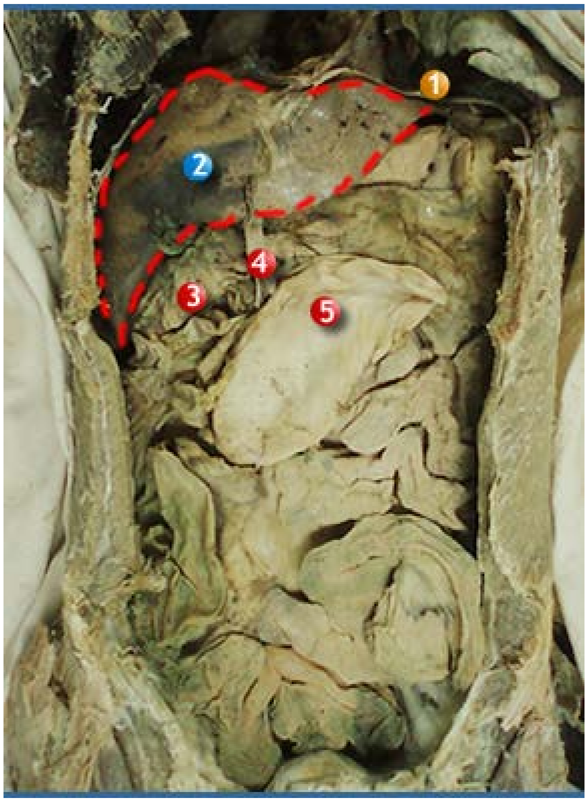
The visceral surface faces downwards, posteriorly and to the left. This surface is related to the anterior wall of the stomach and to the pyloric part; the superior part of the duodenum; the right colic flexure, the upper pole of the right kidney and the right suprarenal. The oesophagus grooves it above. The gall bladder interverse colon below. The impressions left by the viscera can be seen on the isolated liver.

The most obvious structure on the visceral surface of the liver is the portal hepatis .

This contains/transmits;

- Hepatic artery
- Portal veins
- Common hepatic duct
- Lymphatics, lymph nodes
- Autonomic nerve plexus

At the porta, the hepatic ducts are situated anteriorly . Behind them are right and left branches of the hepatic



artery proper. The most posterior structures are the left and right branches of the portal vein.

The diaphragmatic relations

The diaphragmatic relations surface is moulded to the undersurface of the diaphragm separating it from pericardium, lungs pleura and the right costodiaphragmatic recess.

Peritoneal relations

The liver develops in the ventural mesogastrium and is thus covered by peritoneum.

Two layers of the falciform ligament connect the diaphragm and upper anterior abdominal wall to the diaphragmatic surface, just to the right of the median plane. The fulciform ligament contains ligamentum teres and the paraumbilical veins**.**

At the reflection onto the liver, the layers of the falciform ligament separate. To the right it forms the upper leaf of the right triangular ligament (coronary ligament) on the left, it continues as the left triangular ligament.

The liver is in direct contact wit the diaphragm between the leaves of the right triangular ligament. This part of the liver is called the **bare area of the liver**.

THE PANCREAS

- This organ bears important relations which have clinical relevance.
- Its functions in digestion are extremely vital. Its anatomy must be well understood.

Location/position :

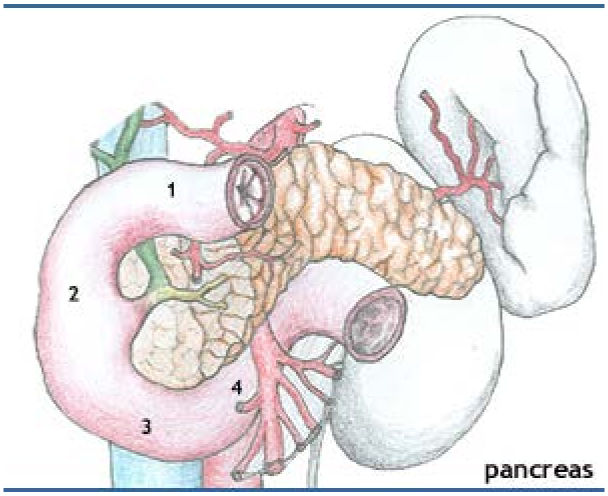
- It extends across the posterior abdominal wall from the epigastric region to the left hypochondrium, lying across the bodies of the superior lumbar vertebrae.
- It lies behind the stomach, and runs from the concavity of the duodenum to the hilum of the spleen.

Parts

- Head
- Neck
- Body
- Tail

These parts have different relations all important, and are best studied separately.

task ***Name parts 1-4 of the duodenum***



The head :

Lies in curve of the duodenum and anteriorly, is separated from the stomach by the lesser sac.

Posteriorly: it is related to

- Inferior vena cava
- Right renal vessels
- Left renal vessels
- Common bile duct (sometimes embedded)

The head has a prolongation called the uncinate process which lies between the superior mesenteric vessels and the aorta.

Notice, that by virtue of this relationship(s) cancer of head of the pancreas causes

1. Obstruction to the bile duct – obstructive jaudice
2. Obstruction of the IVC – oedema of the lower extremity.

The neck :

Anteriorly covered by peritoneum and related also to the pylorus of the stomach.

Posteriorly grooved by superior mesenteric vessels. The superior mesenteric vein is joined by the splenic vein posterior to the neck of the pancreas to form the portal vein.

The posterior surface is in contact with

- Aorta
- Superior mesenteric artery
- Let supra renal gland
- Left kidney and its vessels
- Intimately related to the splenic vein

The body may have a small projection from the superior surface, called tuber omentale (the omental tuberosity) which contacts the lesser omentum, immediately inferior to the coeliac trunk.

The tail :

Passes between the two layers of the lienorenal ligament, together with the splenic vessels. Its tip contacts the hilum of the spleen.

What is the importance of these relationships?

We have already noted some of the pressure effects of cancer of the pancreas.

The operation done for cancer of the pancreas is extensive, involving removal of

- pancreas
- duodenum
- CBD and (gall bladder)
- Connective tissue and lymph vessels and nodes in this area.

Would you wish to remove or injure any of the relations, if so; which?

Rupture spleen is fairly common injury usually treated by splenectomy. In ligating and cutting the splenic vessels (preferably the artery separate from the vein) care must be taken not to damage the tail of the pancreas.

What would happen if you did?

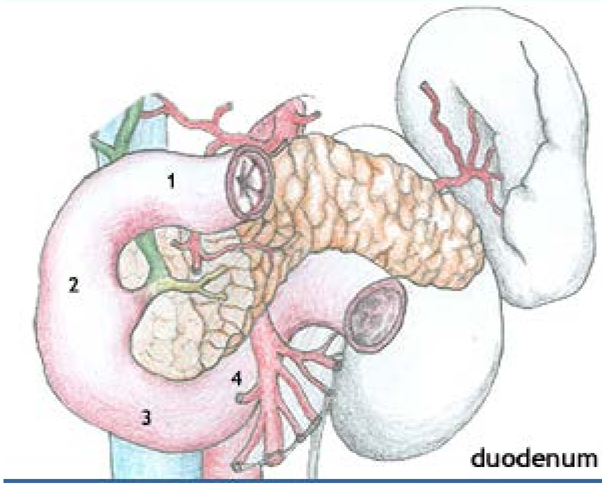
Sometimes pancreatic tissue may encircle the duodenum, as a congenital malformation. This is called anular pancreas . When it causes obstruction, it is usually surgically removes. Again, all these structures must be preserved.

The portal vein forms behind the neck of the pancreas.

If advancing cancer of pancreas compresses the portal vein, (what are the possible effects)?

The Duodenum

Location and position



- Epigastric region: Extending a little into the right hypochondrium and right lumbar.
- Joins the pylorus of the stomach to the jejunum, and is moulded around the head of the pancreas.
- Mostly retroperitoneal, from L1 –L3.

The pancreas has the following parts:

- Superior (first part), anteriolateral to the body of L1.
- Descending (second part) to the right of L1, L2 and L3.
- Horizontal (third part) anterior to L3.
- Ascending (fourth part) to the left of the body of L3.

Superior part:

Its proximal part has a mesentery. The greater omentum and hepatoduodenal ligament are attached to it - It is free to move.

Relations:

Anteriorly:

- Peritoneum
- Gall bladder
- Quadrate lobe of the liver

Posteriorly:

- Bile duct
- Portal vein
- Inferior vena cava
- Gastroduodenal artery. This artery is commonly eroded in duodenal ulcer to cause massive bleeding.

Superiorly:

- Neck of gall bladder

Inferiorly:

- Pancreas

Descending part:

- Retroperitoneal
- Parallel and to the right of inferior vena cava.

Relations:
Anteriorly:

- Transverse colon
- Transverse mesocolon
- Some coils of jejunum

Posteriorly:

- Hilum of right kidney
- Renal vessels
- Ureter
- Psoas major muscle

Medially:

- Head of pancreas
- Pancreatic duct
- Bile duct

Horizontal part:
Retroperitoneal and adherent to the posterior abdominal wall.

Relations:
Posteriorly:

- Right psoas major muscle
- Inferior vena cava
- Aorta
- Right ureter

Superior relations:

- Pancreas
- Supero mesenteric vessels

Ascending part:

- Its distal end is covered by peritoneum, and is movable.
- Most of it is retroperitoneal and adherent to the posterior abdominal wall.
- Ascends to the left of the aorta to L2.

Relations:
Anteriorly:

- Root of mesentery and coils of jejunum.

Posteriorly:

- Left psoas major muscle
- Left margin of aorta.

Medially:

- Head of pancreas

At its termination, the ascending part of the duodenum becomes continuous with the jejunum at the duodenojejunal junction. The duodenojejunal flexure is supported by a fibromuscular band called the suspensory ligament(muscle) of the duodenum (ligament of Treitz). The superior part of this slender band contains striated muscle; its intermediate part consists of elastic tissue, and its inferior part contains smooth muscle. This ligament connects the duodenum, and the duodenojejunal flexure to the right crus of the diaphragm close to the esophagus opening.

This structure serves two functions:

- Wupports the duodenojejunal flexure.
- Widens the angle of the flexure, thereby facilitating movement of its contents.

Peptic ulcer disease is very common, previously considered a “disease of affluence”, now better described as “a disease of your own making” and is also now quite common in the third world due to a stress factor. The duodenal type is commonly located in the proximal part of the superior part of the duodenum called the duodenal cap. In the ulcer, the duodenal wall is eroded to varying depth. It may perforate the entire wall causing peritonitis.

Due to its close proximity to the liver and gall bladder, duodenal ulcer can cause ulceration of the two. In inflamation of the gall bladder, the latter may become adherent to the duodenum. In extreme cases, ulceration may cause a fistula between the gall bladder and the duodenum, and gall stones may find way into the duodenum, and be passed out with stool.

Posterior duodenal ulcer may invade the pancreas.

The artery commonly eroded in posterior duodenal ulcer is the gastroduodenal. This may result in severe hemorrhage into the peritoneal cavity. (How will a patient with perforated duodenal ulcer present)?

During repair of the perforated duodenal ulcer, special care must be taken to avoid damage to:

- Bile duct
- Portal vein
- Inferior vena cava

The eroded gastroduodenal artery is ligated. How do the structures it supplies get their blood?

When removing the duodenum e.g with the pancreas the structures must be preserved. Separation from these structures is usually not difficult, because their attachment is secondary and weak.

Anorectal region(Triangle)

Boundaries

- Anteriorly – a line joining the ischial tuberosities. This line passes through the perineal body.
- Posteriorly – tip of the coccyx
- Laterally – sacrotuberous ligament

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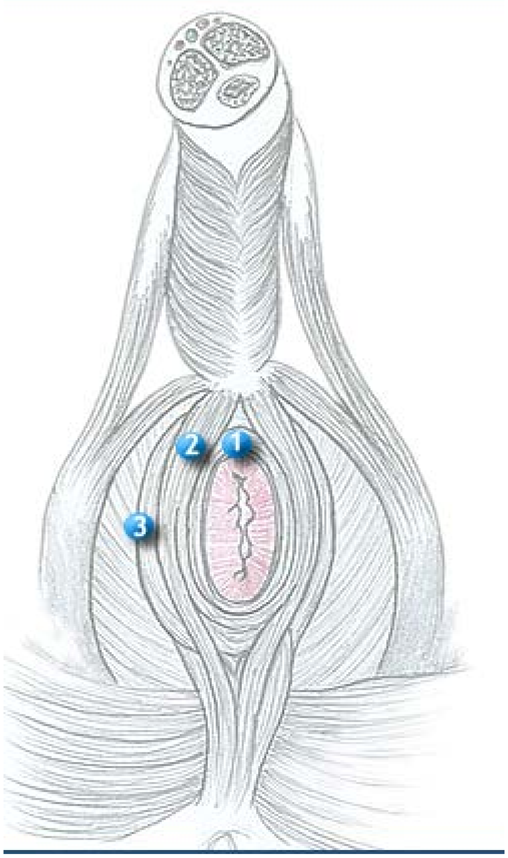


- Anal orifice and the external anal sphincters

external anal sphincter has 3 parts:

- Deep part **(1)** – encircles and canal above and blends with levator ani
- Superficial part **(2)** – elliptical and extends from tip of coccyx and anoccocygeal raphe to the perineal body
- Subcutaneous part **(3)** – slender and encircles the anal orifice

- Ischiorectal fossa – on either side of anal orifice

Annococcgeal raphe is a fibrous band stretching between the anus and the coccyx

.

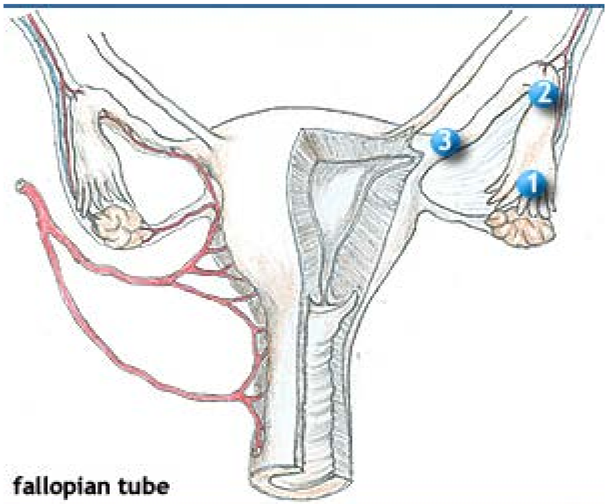
Bulbourethral Gland

The bulbourethral glands are two rounded structures, one half to one and a half centimeters in diameter,situated on each side of the median plane. They are embedded in the substance of the sphincter urethrae, just behind the mebranous part of the urethra. They secrete a mucus-like substance, the function of which is to lubricate and cleanse the urethra during sexual arousal.

The ducts of the bulbo-urethral glands pass through the inferior fascia of the urogenital diaphragm, enter the bulb of the penis, and transverse its substance. After a course of two and a half to four centimeters they end by opening into the lower aspect of the spongy part of the urethra.

Blood Supply	The bulbourethral glands are supplied by the arteries of the bulb of the penis.
Lymphatic Drainage	The lymphatic vessels drain into the internal iliac group of nodes. The scrotum and the penis are covered with the perineum.

Uterine Tube



fallopian tube

The uterine tubes, two in number, convey the ova from the ovaries to the cavity of the uterus. They transmit spermatozoa in the opposite direction, and fertilization of an ovum occurs usually within the tube.

The Greek word salpinx, which means a trumpet or tube, is also used in referring to the uterine tube. Such words as salpingitis, salpingography, and mesosalpinx are derived from it.

Each uterine tube is about 10 cm long and is located in the upper margin, and between the two layers, of the broad ligament. It runs laterally from the uterus to the uterine end of the ovary. It then passes upward on the mesovarian border, arches over the tubal end, and terminates on the free border and medial surface. It is subdivided into four parts, which, in passing from the uterus to the ovary, are: a uterine interstitial part, an isthmus, an ampulla, and a infundibulum.

The **infundibulum** is somewhat funnel-shaped. The abdominal or pelvic opening of the uterine tube is located at the bottom of the funnel, and the ovum enters the tube through it. This opening permits a communication of the peritoneal cavity with exterior of the body. (In the male, no such communication exists, and the peritoneal cavity is closed). The abdominal opening of the tube is about 2 mm in diameter when the muscles around it are relaxed. The fimbriae are a number of thin, irregular processes, which project from the margins of the infundibulum. One of these, the ovarian fimbria, is longer than the rest, and is usually attached to the tubal end of the ovary.

The **ampulla** is the longest and widest part of the tube. It is slightly tortuous, and its walls are relatively thin. The isthmus is narrower and has thicker walls than the ampulla. The uterine part lies in the wall of the uterus; it ends in the cavity of the uterus as the uterine opening.

In passing medially, the lumen of the tube decreases in size. Its diameter is about 1 mm at the uterine opening.

When an ovum is discharged from the ovary, it is caught by the fimbriae and passes through the abdominal opening of the tube. Spermatozoa reach the infundibulum within hours after entering the cervix, and fertilization usually occurs here. Whether or not an ovum is fertilized, its movement through the tube to the uterus requires three to four days, and is influenced by both the ciliary action of the epithelial cells and the peristaltic action of the muscular coat. A fertilized ovum occasionally becomes embedded in the tube (usually the ampulla). The uterine tube is the commonest site of ectopic pregnancy.

The movement of spermatozoa and of ova through the tube is obviously dependent upon its patency, which can be determined radiographically after the injection of a radiopaque material into it by way of the vagina and uterus. It can also be tested by blowing air through the same route. If the tubes are patent, the air escapes through them into the peritoneal cavity. When the patient stands, the air ascends to the lower aspect of the diaphragm (usually the right dome), where it can be demonstrated radiographically. The air in this location may serve as a painful stimulus to the diaphragm, and the patient may experience pain in the regi

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structure

The uterine tube has three layers, a mucosa, a muscular coat, and a serosa. The serosa is the peritoneum of the broad ligament.

Blood supply

The tubal branch of the uterine artery and small branches of the ovarian artery supply the uterine tube. The veins from the tube have courses similar to those of the arteries.

Lymphatic drainage

The lymphatic drainage vessels from the uterine tube follow the blood vessels and drain into the lumbar (or aortic) nodes.

Nerve supply

The uterine tube is supplied by the ovarian plexus and by fibres from the inferior hypogastric plexus. Some of the nerve fibres are sensory, others are autonomic for the supply of the muscular coat, and still are vasomotor for the supply of blood vessels.

Uterus

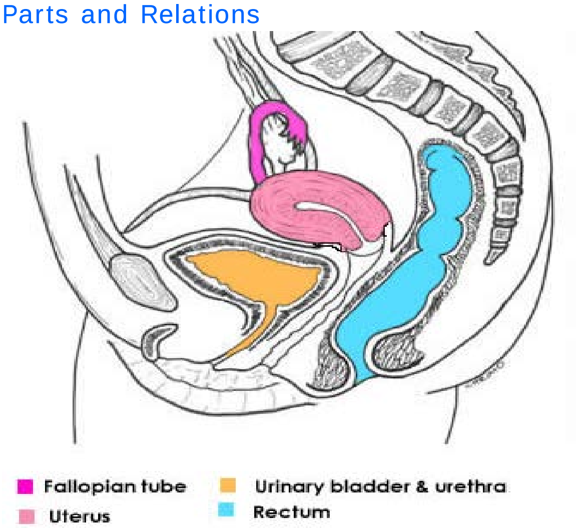
The uterus is the organ in which the fertilized ovum normally becomes embedded and in which the developing organism grows and is nourished until its birth. The cavity of the uterus and that of the vagina below it together form the “birth canal”, through which the fetus passes at the end of its period of gestation. The uterine tubes open into the upper part of the uterine tubes of the uterine cavity.

The Greek word for uterus is hystera. Its combining form, hyster-, is used in words such as hysterogram and hysterectomy.

The uterus varies in shape, size, location, and structure. These variations are dependent upon age and upon other circumstances, such as pregnancy.

In the nulliparous woman, the walls of the uterus are thick and muscular. The entire organ is shaped like an inverted pear, and its narrow end, which is directed downward and backward, forms an angle of slightly more than 90 degrees with the vagina (angle of anteversion). The uterus lies within the pelvis, and its long axis is approximately in the axis of the upper pelvic aperture. It does not usually lie exactly in the median plane, but is inclined to one side or the other, usually to the right. Commonly it is also slightly twisted. Its position is not fixed, however, and readily changes with the degree of fullness of the bladder, which is below and in front, and with the degree of fullness of the bladder, which is below and in front, and with the degree of fullness of the rectum, which is above and behind. The uterus is about seven and a half centimeters long, five centimeters wide in its upper part, and two and a half centimeters thick. It is subdivided into a fundus, a body, an isthmus, and a cervix.

Parts and Relations



The fundus is the rounded part of the uterus that lies above and in front of the plane of the openings of the uterine tubes. The body is the main part of the uterus, and it extends downward and backward to a constriction, the isthmus. It can be palpated bimanually. It has two surfaces, and two borders, or margins. The vesical surface is separated from the urinary bladder in front and below by the uterovesical pouch. The intestinal surface is separated from the sigmoid colon above and behind by the rectouterine pouch, which usually contains some coils of the ileum. The left and right margins are related to the respective broad ligaments, and to the structures contained between the two layers of each ligament.

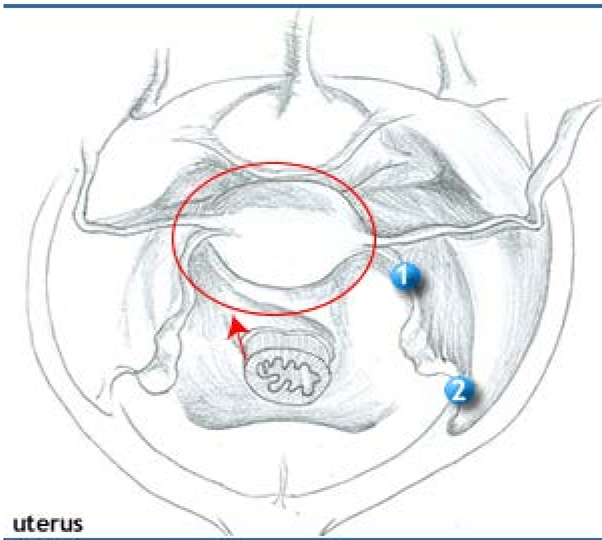
The isthmus is the constricted part of the uterus and is about 1 cm or less in length. During pregnancy, it becomes taken up by the body and is therefore often referred to by obstetricians as the “lower uterine segment”. The fetal membranes, however, do not usually become firmly attached to it. It resembles the body histologically but shows some differences in its musculature, epithelium, and number of glands. The changes that it undergoes during menstruation are not as marked as those in the body.

The cervix extends downward and backward from the isthmus to the opening within the vagina. It is the least freely movable part of the uterus and is divided into two parts by the anterior wall of the vagina, through which it passes. The supravaginal part is separated from the urinary bladder in front by loose connective tissue, and from the rectum behind by the recto-uterine pouch. It is related laterally to the ureter and uterine artery. The vaginal part extends into the vagina. Its cavity communicates with that of the vagina by means of the ostium of the uterus (formerly called external os or orifice). This opening is a short depressed slit in the nillipara, but in women who have borne children it is larger and more irregular in outline. The ostium has anterior and posterior lips, which usually reach the posterior wall of the vagina.

The cavity of the uterus is wide above at the entrance of the uterine tubes, but it gradually decreases in width as it extends downward to the isthmus. It is very narrow in sagittal section, because the anterior and posterior walls are almost in contact.

The canal of the cervix is narrower at its ends than in its middle. A vertical fold located on its anterior wall and another on its posterior wall. Palmate folds radiate obliquely from these in such a way that those on the anterior wall do not oppose those on the posterior wall. Instead, they fit each other so as to close the canal. They tend to disappear after pregnancy. The cavity of the uterus and the canal of the cervix can be viewed radiographically after the introduction through the vagina of a suitable radiopaque material (hysterosalpingography).

Position



In the adult, the entire uterus is usually anteverted. In this position, it extends forward and upward from the upper end of the vagina at an angle of about 90 degrees. The uterus is generally anteflexed also, that is, the body is bent downward at its junction with the isthmus. These positions are readily altered, especially during distention of the urinary bladder or the intestine. When the bladder is full, the uterus extends upward and backward (retroversion).

Attachments and Peritoneal Relations

The uterus gains much of its support by its direct attachment to the vagina. Indirect attachment to nearby structures, such as the rectum, urinary bladder, pelvic diaphragm, and bony pelvis, also help to support it.

The peritoneum is reflected from the posterior aspect of the bladder to the isthmus of the uterus and the passes upward on the vesical surface of the body. This reflection forms the uterovesical pouch. After passing around the fundus of the uterus, the peritoneum passes downward on the intestinal surface of the body, and on the back of the cervix and the upper part of the vagina, from which it is reflected onto the front of the rectum. The recess formed by this reflection is the rectouterine pouch.

The broad ligament is formed at the lateral margin of the uterus by the two layers of peritoneum that cover the vesical and intestinal surfaces. It extends to the lateral wall of the pelvis. The two layers are continuous with each other above, where they enclose they the uterine tube. They are close to each other near the uterus, but they diverge laterally and below. The anterior layer passes forward to become continuous with the peritoneum covering the floor and lateral wall of the pelvis. The posterior layer extends backward from the cervix of the uterus as the rectouterine fold. This fold forms the lateral boundary of the rectouterine pouch, and , after passing along the side of the rectum, reaches the posterior wall of the pelvis. The plane of the broad ligament varies with the position of the uterus.

The mesosalpinx is the part of the broad ligament between the uterine tube and the line along which the broad ligament is drawn out to form the mesovarium. In addition to branches of the ovarian and uterine vessels, it contains two structures, called the epoophoron and the paraoophoron. The mesometrium is the part of the broad ligament below the mesosalpinx and mesovarium.

The epoophoron consists of a duct, which runs parallel to and below the tube, and tubules, which run upward from the region of the ovary to join the duct at a right angle. It is the remains of a part of the mesonephric duct and some of its tubules. The paraoophoron lies medial to the epoophoron and is a group of very small tubules. It usually cannot be recognized grossly in the adult. Both structures are important only in that cysts sometimes arise in them.

The broad ligament encloses between its two layers some loose connective tissue and smooth muscle, collectively called the parametrium. Where the two layers are close together (near the uterus and near the uterine tube), the parametrium is not abundant, but laterally and below, where the layers diverge, it increases in amount. The broad ligament also encloses the uterine tube, the ovarian ligament, part of the round ligament, the uterine artery and vein, the uterovaginal plexus of nerves, and a part of the ureter.

The round ligament is a narrow, flat band of fibrous tissue that is attached to the uterus just below and in front of the entrance of the uterine tube. It contains some smooth muscle near this attachment. After passing laterally and forward across the umbilical artery and external iliac vessels, it hooks around the inferior epigastric artery. It then traverses the inguinal canal and becomes lost in the subcutaneous tissue of the labium majus. In the fetus, a tubular process of peritoneum, the processus vaginalis peritonei, accompanies the round ligament into the inguinal canal. This prolongation occasionally remains in the adult.

The visceral pelvic fascia at the side of the cervix and vagina is considerably thickened and contains numerous smooth muscle fibres. Part of this thickening passes laterally to merge with the upper fascia of the pelvic diaphragm and is called the lateral (or transverse) cervical cardinal ligament. The uterine artery runs on its upper aspect. The rest of this thickening passes backward in the recto-uterine fold and is attached to the front of the sacrum. This is the uterosacral ligament, and it can be palpated per rectum.

Changes with age

At birth, the uterus reaches above the level of the pelvic inlet. The cervix is larger than the body, and the palmate folds extend into the upper part of the uterine cavity. The difference between the axis of the uterus and that of the vagina is relatively small. The growth of the uterus is slow until puberty, when it grows rapidly until its adult size and shape are reached. After the menopause, the uterus becomes smaller, more fibrous, and paler in colour.

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changes during pregnancy and post-parturition

The size of the uterus increases tremendously during pregnancy. The fundus rises above the level of the pubic symphysis in the third month. It reaches the supracristal plane in the sixth month and the level of the xiphisternal joint in the eighth month. It descends slightly in the ninth month, when the maximal circumference of the fetal head becomes engaged below the pelvic inlet. During this increase in size of the uterus, there is also a large increase in its weight, and the walls of the uterus become thinner.

After parturition, the uterus undergoes a process called involution. It gradually becomes reduced in size and weight until, after six to eight weeks, it reaches its resting state, in which it is about 1 cm larger in all dimensions than it was before pregnancy. It is also slightly heavier, its cavity is somewhat larger, and the lips of the opening into the vagina are irregular in outline.

Structure

The uterus has three layers, a mucosa, a muscular coat, and a serosa, details of which are covered in histology.

Blood supply

The uterine arteries provide the main blood supply to the uterus. Each artery passes medially on the upper aspect of the lateral cervical ligament. As it approaches the cervix, it gives off a branch the supplies the cervix and the upper part of the vagina and it then turn upward to run between the layers of the broad ligament, near the lateral margins of the body. As it ascends, it sends branches to both surfaces of the body. The uterine arteries become greatly enlarged during pregnancy and are tortuous after parturition.

The blood is returned from the uterus by way of a venous plexus that follows the uterine artery. An important anastomisis between the portal and systemic venous systems is formed by veins that run below the rectouterine pouch and connect the uterine venous plexus with the superior rectal vein.

Lymphatic drainage

The lymphatic vessels from the fundus and upper part of the body drain into lumbar (or aortic) nodes, those from the lower part of the body into the external iliac nodes, and those from the cervix into the external iliac, internal iliac, and sacral nodes. Some vessels from the region of the uterus near the entrance of the uterine tube pas with the round ligament and drain into the superficial inguinal nodes.

Nerve supply

The uterus receives autonomic and sensory fibres by way of the uterovaginal plexuses, which run along the uterine arteries. The uterus is painless to most stimuli, but pain may be felt when the cervix is grasped with a forceps or is dilated. Some uterine disorders are painful, however, and pelvic pain may be felt in some phases of the menstrual cycle. There is some evidence that fibres concerned ascend and enter the spinal cord by way of the lumbar splanchnic nerves. Resection of the superior hypogastric plexus has been performed to alleviate severe pain of this kind.

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Chapter 35: The Male Reproductive System and The Perineum

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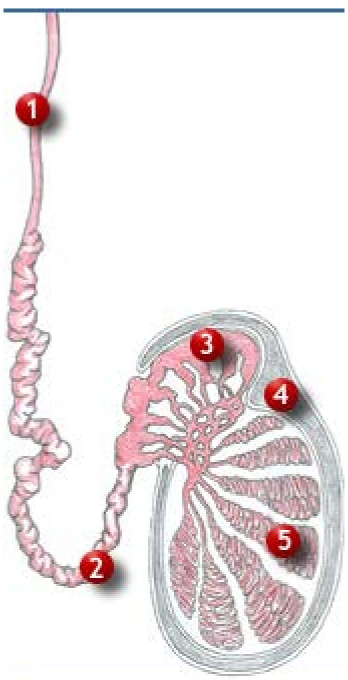
The Testis

- Male reproductive organs, producing spermatozoa, suspended in the scrotum by the spermatic cords.
- By and large, covered by tunica vaginalis except where it is attached to the epididymis.
- The epididymis, is a coma - shaped structure, applied to the superior and posterolateral surfaces of the testis. It consists of a head, a body, and a tail. The tail is continuous with the ductus deferens.

[Stop question; what are the functions of the epididymis?]



BLOOD SUPPLY OF THE TESTIS

- Testicular artery, a branch of the aorta at about L2
- Other sources are minor and include the scrotal vessels, contributions from the artery to the vas deferens, and cremasteric artery.

The veins correspond. The testicular vein is formed from the pampini form plexus.

Innervation of the Testis

- Autonomic innervation from the hypogastric plexus.
- With the sympathetic fibres, run the pain fibres.

Lymphatics of the Testis

- These mainly go to the lumbar lymph nodes.
- A very small percentage may go to injuinal and iliac nodes.

4.3 The Spermatic cord:

- The spermatic cord passes through the injuinal canal, and emerges at the superficial injuinal ring to descend into the scrotum.
- Review again the coverings of the spermatic cord.

Constituents of the spermatic cord

1. Ductus deferens, lying in the posterior part of the spermatic cord. It is easily palpable because of its thick wall of smooth muscle.

Tail of epididymis

2. Arteries

- testicular artery, from aorta.
- artery to the vas deferens, from inferior vescical artery.
- cremasteric artery, from the inferior epigastric artery.

These freely anastomose with each other.

3. The pampiniform plexus, is formed of 10 -12 veins from the posterior surface of the testis, which anastomose with each other. They end in the testicular vein.

4. Nerves, are mainly autonomic nerves around the arteries and vas deferens. The genital branch of the geinito femoral nerve passes into the spermatic cord, supplies cremaster muscle, and is responsible for the cremasteric reflex.

5. Lymph vessels, from the testis and closely associated structures, and draining into lateral aortic, and preaortic nodes.

6. Remnants of the processus vaginalis, when they persist, are usually in direct communication with the peritoneal cavity.

External anal sphincter

• Voluntary, surrounds the inferior end of the anal canal, lies in the perineum, and has three parts;

• Subcutaneous part, consists of slender fibres, surrounds the anus (crossing anterior and posterior to it), and has no bony attachments.

• Superficial part, whose fibres extend anteriorly from the tip of the coccyx and the anococcygeal ligament around the anus, to the central perineal tendon.

• Deep part, arises from the central perineal tendon, and fuses with the puborectalis part of lavetor ani superiorly, it bends with lavetor ani, and is not sharply distinguishable from it.

• All the components are innervated by perineal branch of S4; and inferior rectal branch of pudendal nerve.

Functions of External anal sphincter

Closes the anus, and draws anal canal anteriorly, thereby increasing the anorectal angle. The deep fibres are assisted by the puborectalis.

Central tendon of the perineum

• This is a fibrous septum extending from the posterior labial commisure/scrotal raphe to the anal region. To it are attached;

a) Lavetor ani

b) External anal sphincter

c) Deep and superficial transverse perinei muscles

d) Bulbospongiosus.

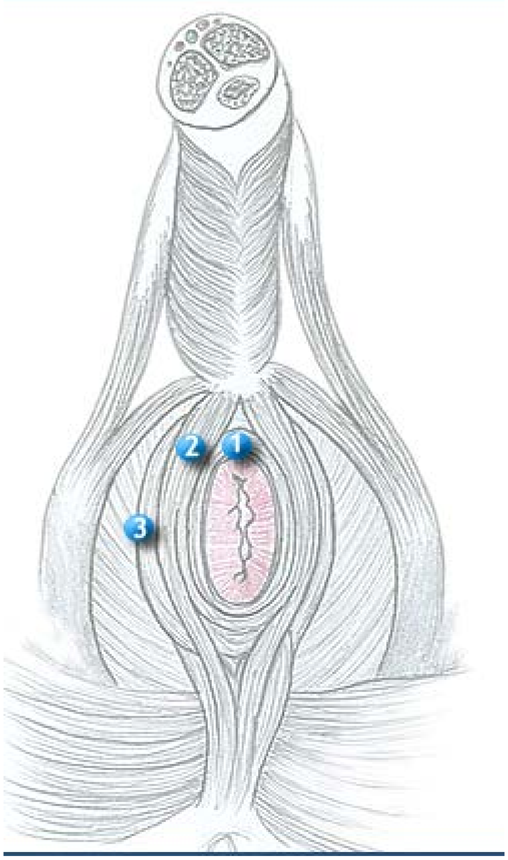
• This structure is crucial to the integrity of the perineum - both pelvic and urogenital diaphragms.

• Its damage impairs this integrity with the effects similar to those following damage to pelvic diaphragm.

• It can be badly torn during unaided parturition.

• Care must be taken not to cut it, or else, it must be repaired securely.

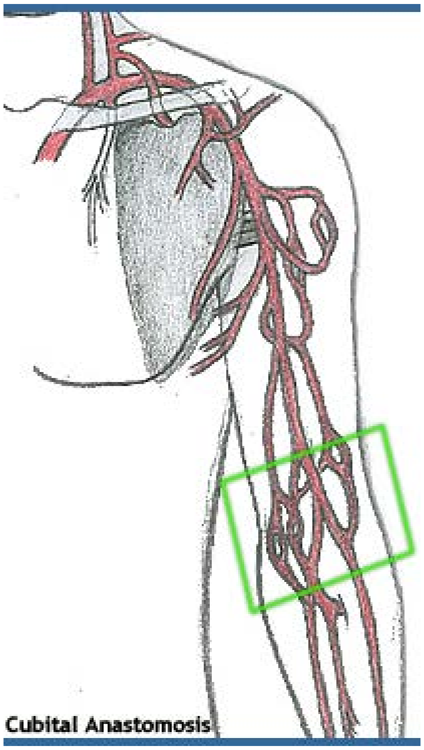
task ***Name muscles 1,2 and 3***



2
1
3

Innervation and Blood Supply

Blood supply

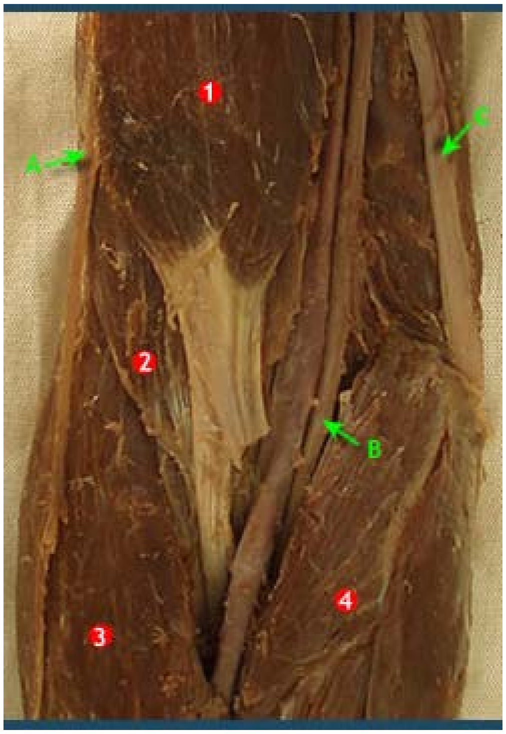


Cubital anastomosis made by

- Superior and inferior ulna *collateral branches* of the brachial artery
- *Lateral radial collateral continuing from Profunda brachii* artery
- Radial recurrent arteries of the radial artery
- ulna recurrent from ulna artery
- interosseous recurrent from common interosseous artery

Innervation

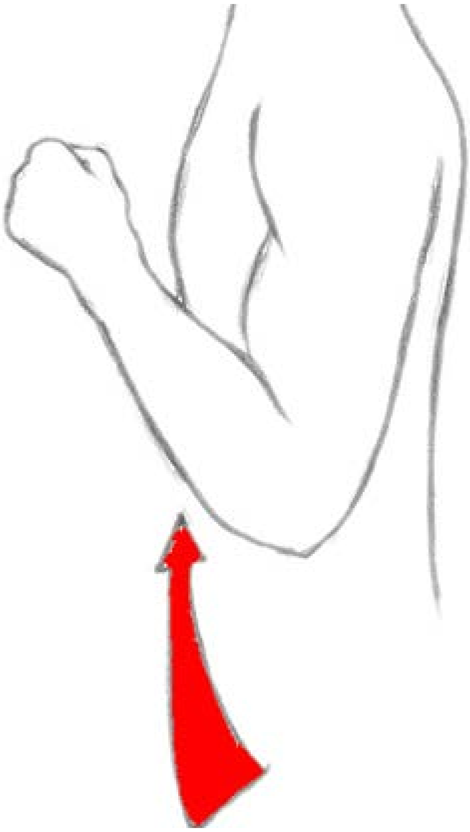
–*ulnar*, *musculocutaneous*, *median* and *radial*.



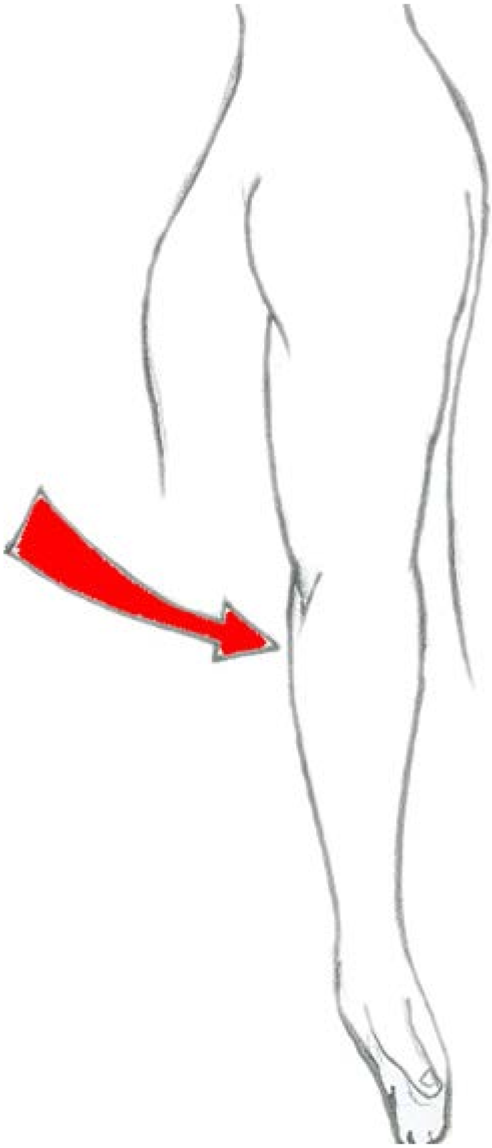
Movements

The only movements possible are flexion and extension

Movement	Muscles
Flexion	**Main flexors** *Brachialis, biceps brachii,* **Accessory flexors** *Pronator teres , brachioradialis*



Extension



Main Extensors

Triceps brachii and anconeus,

Accessory

Superficial extensors of the forearm

Cutaneous Veins of Forearm

Basilic Vein

Origin

Medial continuation of dorsal venous arch

Course

- Runs up medial border of forearm
- Inclines forward to anterior aspect of forearm
- Runs anteromedial over roof of cubital fossa accompanied by medial cutaneous nerve of forearm
- In proximal forearm and cubital region
- Ascends medial to biceps brachii (Medial bicipital sulcus)
- Pierces deep fascia halfway between elbow and axilla
- Accompanies brachial vessels towards axilla

Termination

- Becomes axillary vein at lower border of teres major

Communications

- With cephalic vein
- With deep veins (vena committante)

palsoftweblink

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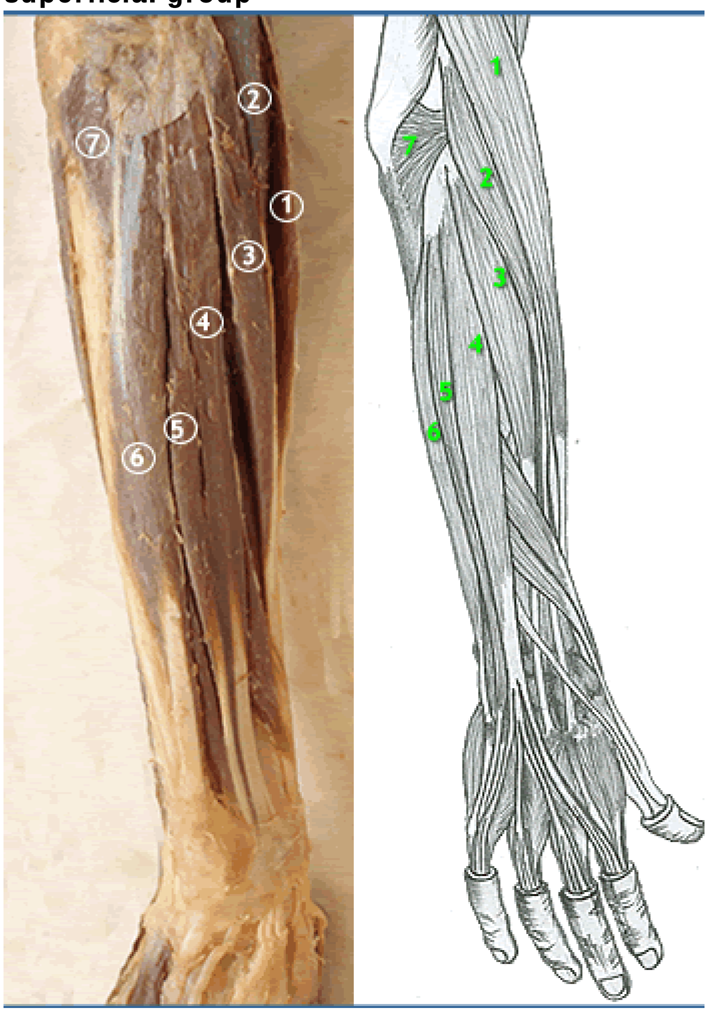
3. Posterior compartment of the forearm

Contents

- Twelve muscles
- At the upper end are two muscles (*which ones?)*
- Six muscles arise from the lateral part of the humerus (*which ones?)*
- At the lower end, three muscles of the pollex emerge from beneath the tendons of the six muscles above (*can you name them?)*
- The last muscle is a deep muscle for the forefinger (*surely, you know this* !)
- A superficial group is defined to include: brachioradialis, extensor carpi radialis longus. Extensor carpi radialis brevis, extensor digitorum, extensor digiti minimi, extensor carpi ulnaris, anconeus
- The deep group includes: supinator, abductor pollicis longus, extensor pollicis brevis, extensor pollicis longus, extensor indicis

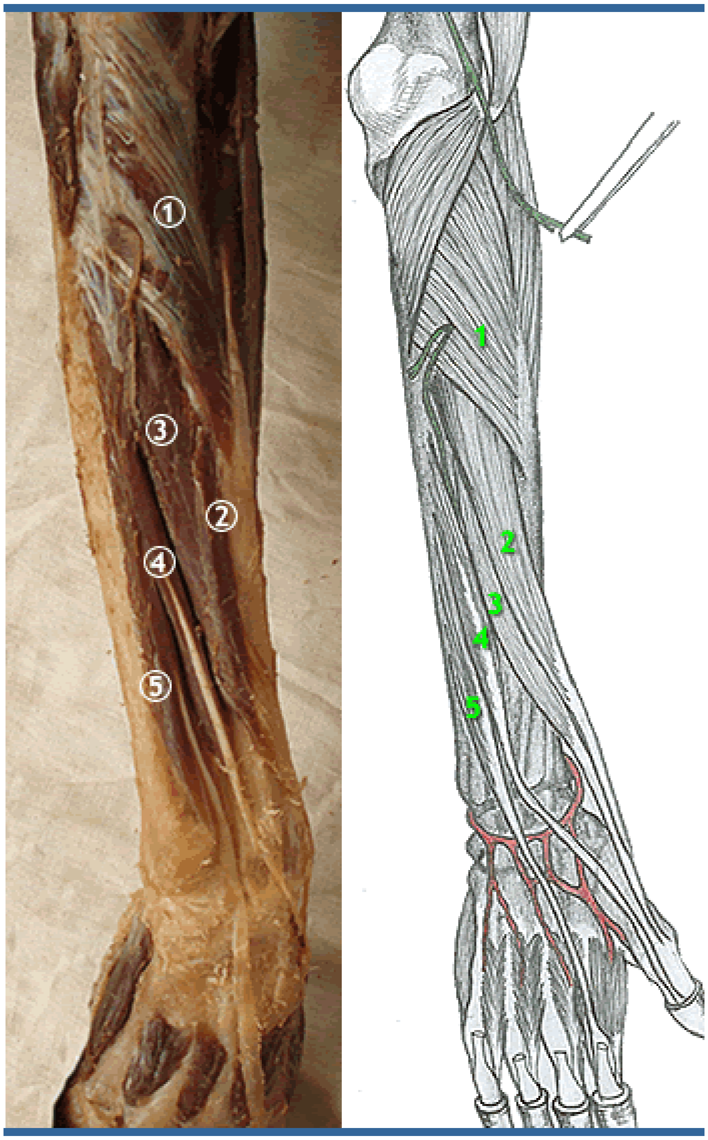
The other contents of this compartment include Radial nerve, Radial artery

superficial group

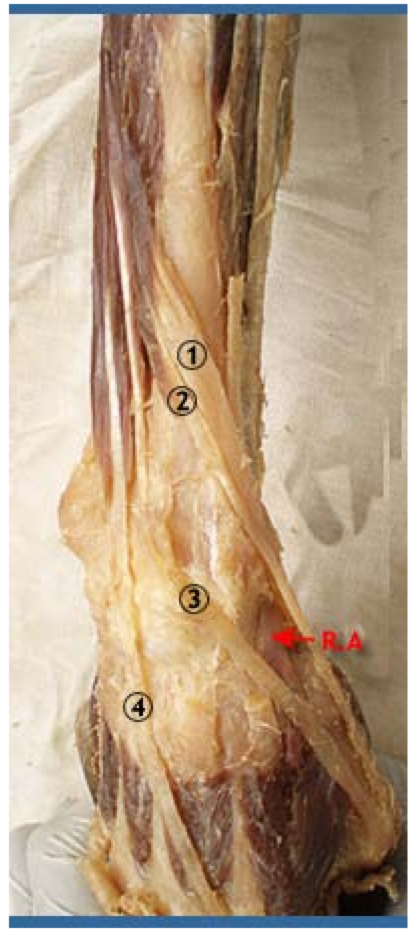


brachioradialis, extensor carpi radialis longus. Extensor carpi radialis brevis, extensor digitorum, extensor digiti minimi, extensor carpi ulnaris, anconeus

Deep group



supinator, abductor pollicis longus, extensor pollicis brevis, extensor pollicis longus, extensor indicis

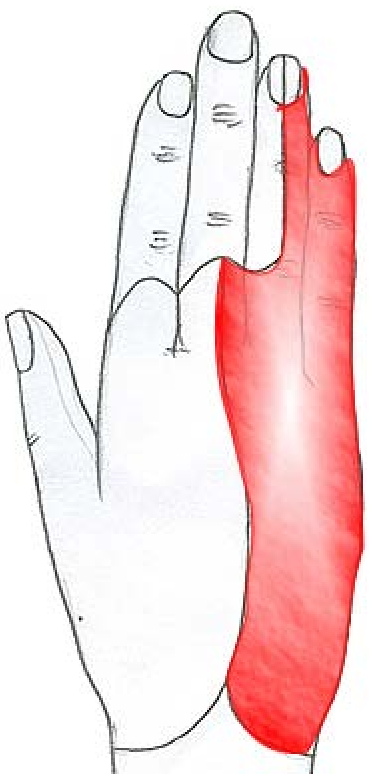


CHAPTER 18 : The Joints of the wrist , hand and fingers

Hand innervation

Main nerves; ulnar, radial, median, cutaneous nerves

Ulnar nerve



Passes anterior to flexor retinaculum and divides into *superficial* and *deep* branches
Superficial: supplies palmaris brevis and medial one and half fingers
Deep branch- this arches deep in the concavity of the deep palmar arch and gives motor braches to

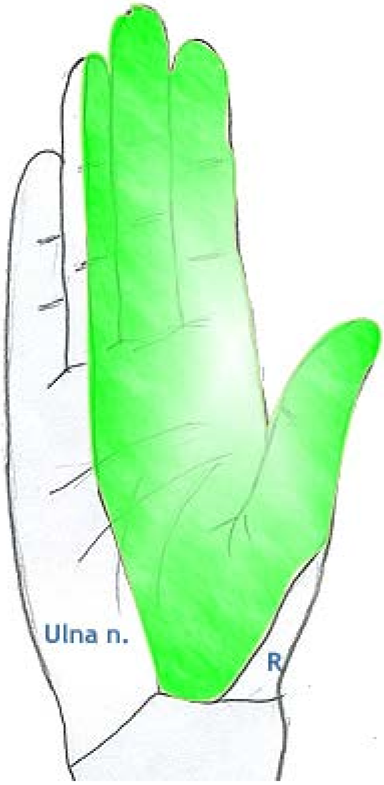
- hypothenar muscles
- medial two lumbricals
- 8 interrossei
- deep head of flexor pollicis brevis
- heads of adductor hallucis

Ulnar nerve injury presents with

- Claw hand (***can you explain why the medial fingers are more clawed?*** *)*
- Loss of sensation medial one and half fingers
- Loss of finger abduction *(**How would you clinically test for this?**)*
- Loss of finger adduction (***How would you clinically test for this?*** *)*
- Atrophy of hypothenar eminence and inter-metatarsal spaces

Median nerve

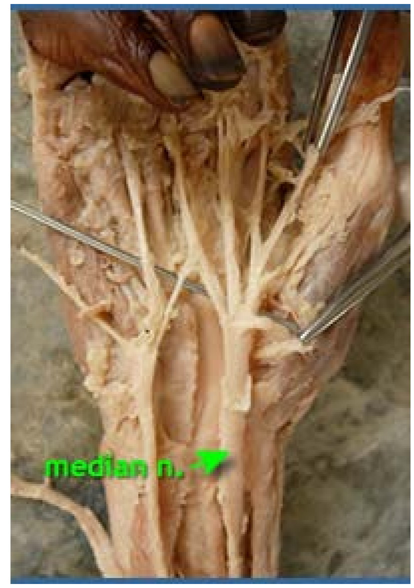
Deep to flexor retinaculum distal to which it gives a recurrent branch to thenar muscles
The nerve then gives a medial and a lateral branches
The medial branch gives 2 common digital for 2nd and 3rd clefts and sides of ring middle and index fingers.
The lateral supplies palmar skin, radial side



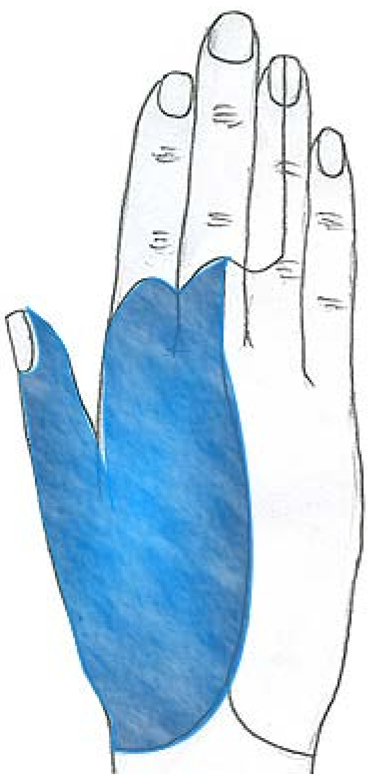
of index and whole of the thumb on the palmar surface and distal dorsal surface. The branch to the index finger supplies the 1 st lumbrical

Medial nerve injury

- The hand position is described “papal hand” **Can you explain how?**
- There is loss of sensation on the palmar medial three and half fingers to include their nail beds



Radial nerve



It is a continuation of superficial terminal branch
At dorsum of hand it divides into 4-5 dorsal digital branches
Supplies lateral three and half fingers on the dorsal side except the nail beds

Arterial blood supply

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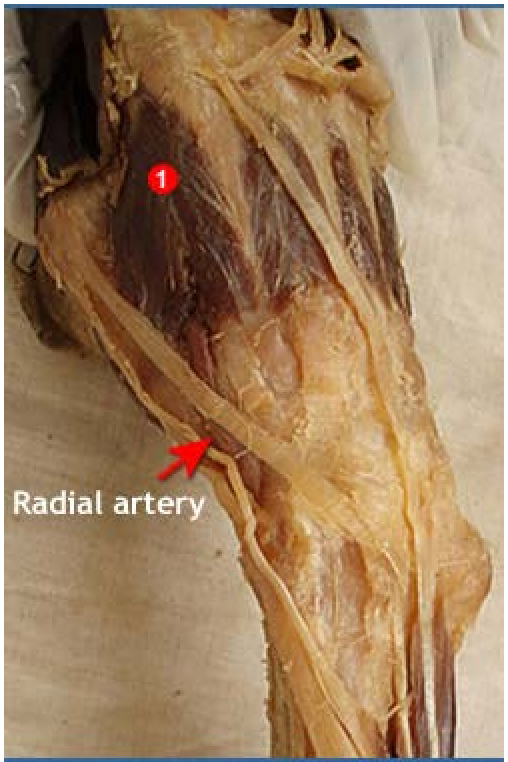
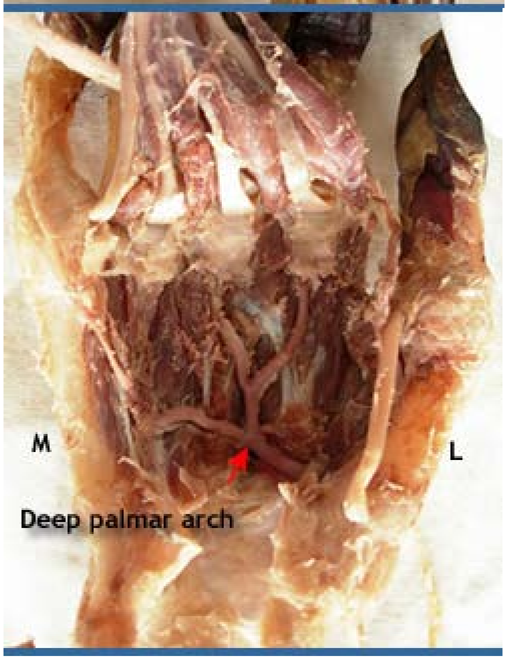
radial artery

This vessels crosses the ***anatomical snuff box,*** enters the hand and runs deep to the two heads of dorsal interosseous muscle



It Gives off:

- Radialis indicis
- Princeps pollicis

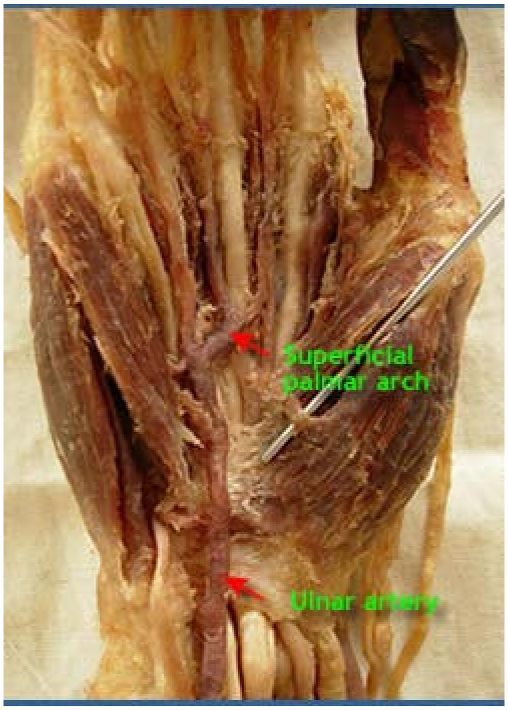


Then continues to form the deep palmar arterial arch.
The deep arch anastomoses with the deep branch of ulnar artery
What is the surface landmark of this arterial arch?
The arch gives off three metacarpal arteries which anastomose with common digital branches of the superficial arterial arch (see below)
Other branches anastomose with dorsal metacarpal arteries (see below)

Ulnar artery

The ulnar artery continues beyond the flexor retinaculum as the superficial arterial arch
This is often an incomplete arch
What is the surface projection of this arch?
Its braches include:

- palmar digital artery to ulnar side of little finger



- common digital arteries that supply adjacent fingers

Palmar digital vessels anastomose with dorsal digital arteries

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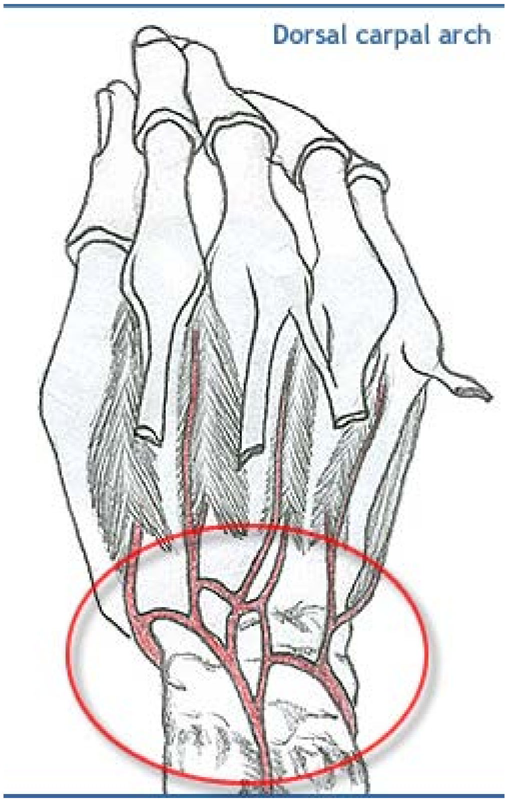
Dorsal carpal arterial arch



This is a network formed by branches of radial, ulnar and anterior interosseous arteries.
It gives off dorsal metacarpal arteries which then split to supply adjacent fingers
They arteries anastomose with palmar metacarpal branches from the deep palmar arch

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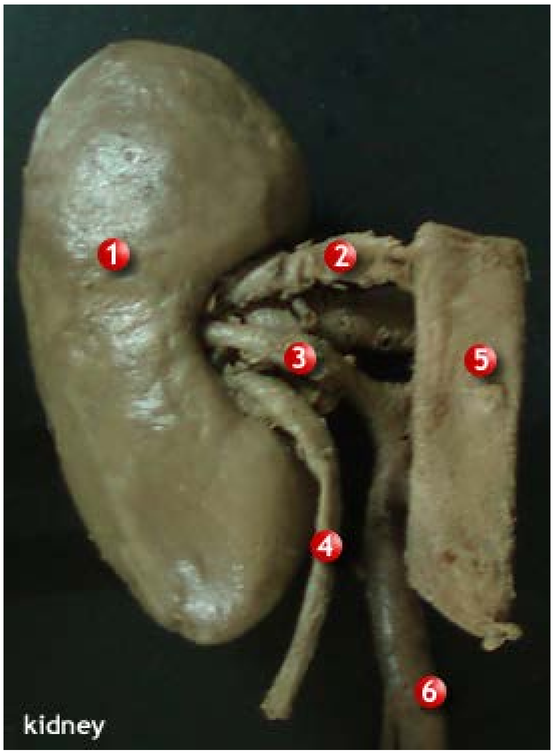
Chapter 32: The Peritoneum and the Organs of the Gastrointestinal System

The Kidneys

Position



- Lumbar regions, in the superior of paravertebral gutters.
- From T12 – L3. The right kidney being a little lower (due to liver)
- Lie against psoas major muscle.
- Superior poles are protected by 11 th and 12 th ribs.
- The hila lie along the transpyloric plans.

Peritoneal relations

The posterior relations are common

Muscles:

- psoas major
- quadratus lumborum
- diaphragm

Nerves

- subcostal nerve
- iliohypogastric nerve
- ilioinguinal nerve

Vessels:

- subcostal

Anterior relations vary from left to right

On the left

- left suprarenal
- stomach
- spleen
- pancreas
- jejunum
- descenbding colon

On the right

- liver (from which it is separated by the hepatorenal recess).
- right supra renal
- duodenum
- right colic flexure
- small intestine

Coverings (from inside)

Fibrous renal capsule

Perirenal fat (fatty renal capsule) – relatively less anteriorly.

Fibro areolar tissue called renal fascia. This also encloses the suprarenal.

When the fat wastes away, the kidney may drop (renal ptosis) leaving the suprarenal.

Pararenal fat – outside the renal fascia.

The fat supports the kidney, but allows considerable mobility

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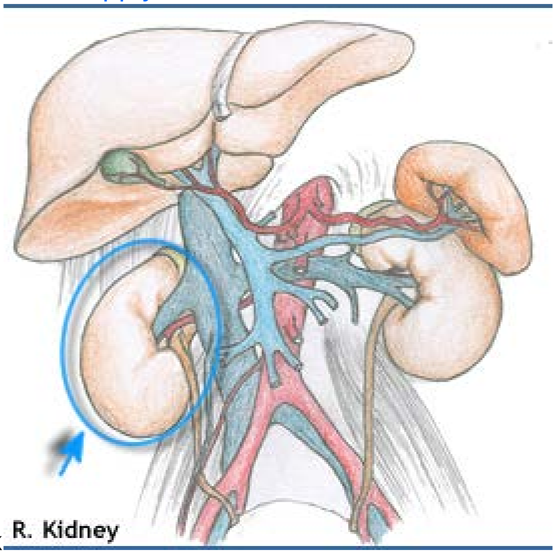
Blood supply



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- The renal arteries, branches of the aorta. Note that the kidney develops in the pelvis, and “ascends” to lumbar region.
- The original blood supply is in the pelvis, the caudal vessels degenerates as it acquires vessels from the higher regions. This is the basis for some “polar” vessels which may originate from the ;
- Internal iliac:
- Common iliac end encircle the ureters.
- These polar vessels are important as they must be ligated and cut during nephrectomy, and if they are damaged, may cause infarction of the area they supply.

Note: the artery may divide before the hilum and there may be multiple renal arteries.

- The renal veins carry the venous blood.
- The left renal vein is longer since the IVC is more to the right.
- It frequently receives the left gonadal vein.
- The left renal vein may also anastomose with the splenic vein (porto-systemic anastomosis).

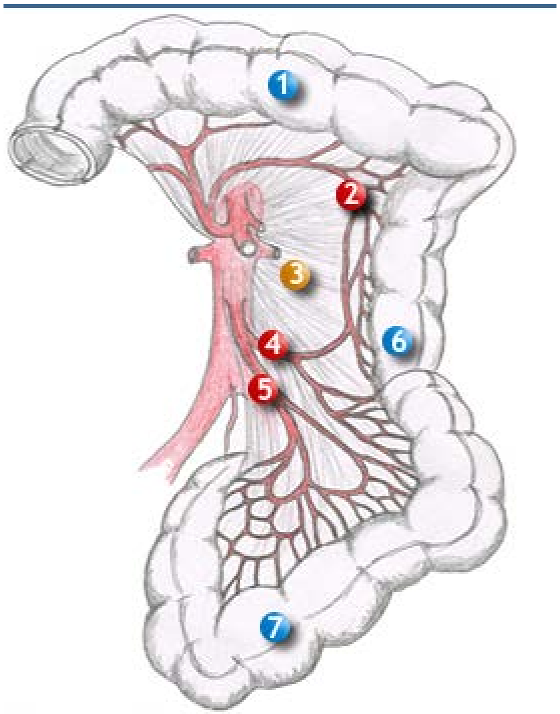
Lymphatics

Lateral aortic nodes.

Innervation

From the renal plexus – lesser and lowest splanchnic and the vagus.

Inferior mesenteric artery



Inferior mesenteric artery

- The inferior mesenteric artery is the artery of the hindgut,
- Supplies the bowel from the left third of the transverse colon to the upper part of the anal canal.

Course and Relations

- It arises from the front of the aorta at the level of the body of L3 (the subcostal plane).
- It appears from under the horizontal part of the duodenum and descends obliquely to the left, towards the middle of the left common iliac artery.
- From the middle of the left common iliac artery, the inferior mesenteric artery descends in front of the left sympathetic trunk and psoas major
- It enters the apex of the sigmoid mesocolon as the superior rectal artery.
- The inferior mesenteric vein lies on its left side, the two vessels diverge as they are traced upwards – the artery inclining towards the aorta medially, and the vein ascending more vertically towards the duodenojumal flexure.
- A fine inferior mesenteric nerve plexus surrounds the main artery and gives offshoots to its branches.
- Inferior mesenteric lymphnodes are associated with the artery.

Branches and Distribution

- The branches of the inferior mesenteric artery come off its left side.
- They form an anastomotic trunk alongside the colon- marginal artery (of Drummond) that extends from the ileocaecal junction to the distal end of the sigmoid colon. s
- The anastomosis between the left colic (of the inferior mesenteric) is usually a good one.

Branches of inferior mesenteric artery

Left colic artery arises 2.5-5 cm below the upper end of the trunk and runs upwards end to the left, over the psoas, the left ureter and left gonadal vessels. It may lie superficial or deep to the inferior mesenteric vein. Near the descending colon, it divides into ascending and descending branches, which take part in the formation of the marginal artery.

The ascending branch ascends to anastomose with the left branch of the middle colic artery. The descending branch anastomoses with the ascending branch of the highest sigmoid artery.

Two or **three sigmoid arteries** descend obliquely to the left. Each divides into ascending and descending branches which contribute to the marginal artery, though the highest sigmoid artery anastomoses with the descending branch of the left colic artery. The descending branch anastomoses with the superior rectal artery.

The extramural anastomosis between the lowest sigmoid and the superior rectal arteries is often poor, though there may be a reasonable intramural anastomosis between them, i.e in the wall of the gut.

3.3 The **superior rectal artery** is the pelvic continuation of the inferior mesenteric artery below the middle of the left common iliac artery. It curves medially in the sigmoid mesocolon and, reaching the upper end of the rectum, divides into right and left branches. The right branch divides into anterior and posterior branches.

The three branches anastomose with the middle rectal artery , a branch of the internal iliac artery on each side, and with the inferior rectal artery , a branch of the internal pudendal artery given off in the ischio-anal fossa on each side

The main distribution of the superior rectal artery is to the mucosa of the rectum and anal canal, whereas the middle rectal artery supplies mainly the muscle coat of the rectum.

The duct system :

- The main pancreatic duct (of Wirsung) runs most of the length, to join the common bile duct to form the ampulla of vater, and then pierce the postero medial wall of the descending part of the duodenum, to open at the summit of the major duodenal papilla.
- Each of the ducts has a sphincter, and the ampulla of vater is guarded by the sphincter of Oddi. Sometimes the pancreatic and bile ducts open into duodenum separately.
- There may be an accessory duct(s). Note that a bile stone or spasm of sphincter of Oddi may block the Ampulla of Vater. Bile may then reflex into the pancreatic duct causing pancreatitis. In this case, the accessory pancreatic duct may be safe guard.

Peritoneal relations

- Pancreas is retroperitoneal, anterior surface covered.
- Tail is between layers of lieno renal ligament.

Support

- Fixed by peritoneal relations
- Duct system

Blood supply

Arteries

1. Pancreaticoduodenal arteries

- superior from gastroduodenal
- inferior from superior mesenteric

2. Splenic artery

veins

- most open into splenic vein
- Others:
  - portal and;
  - superior mesenteric

Lymphatics

- Follow blood vessels
- Most - pancreaticosplenis nodes along the superior border of the pancreas.
- Others - pyloric nodes
  - - lumbar (around superior mesenteric)
  - - Coeliac (around coeliac trunk)

Innervation

Derived from

- vagus
- greater (and lesser) splanchnic nerves

Reach the gland via coeliac and superior mesenteric plexuses. Pain from the pancreas may be referred to middle and lower thoracic dermatomes.

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Chapter 35: The Male Reproductive System and The Perineum

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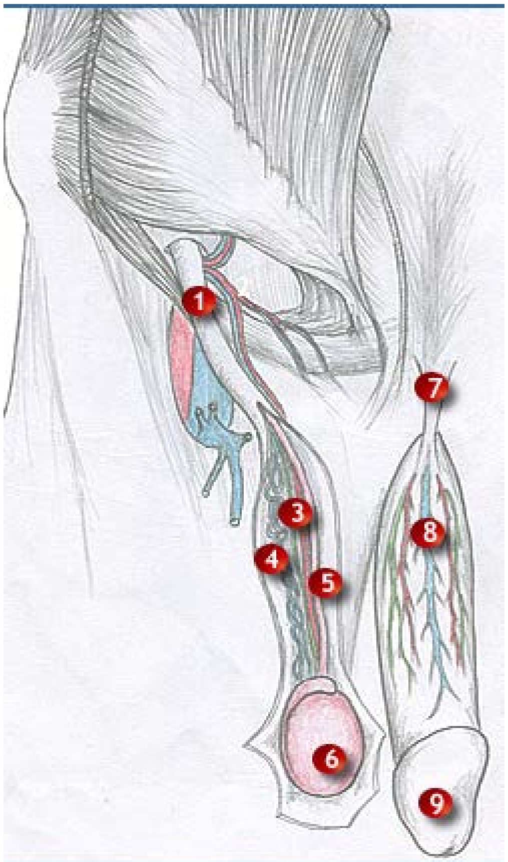
MALE GENITAL ORGANS



The male genital organs consist of :

1. the testes and epididymides, which are situated in the scrotum,
2. the ductus deferentes (vasa deferentia), which are contained in the spermatic cords in a part of their course,
3. the seminal vesicles,
4. the ejaculatory ducts,
5. the prostate,
6. the bulbo-urethral glands, and
7. the penis.

All of these organs are paired, except the prostate and the penis, which are single. The scrotum and the penis, are classified as external genital organs.

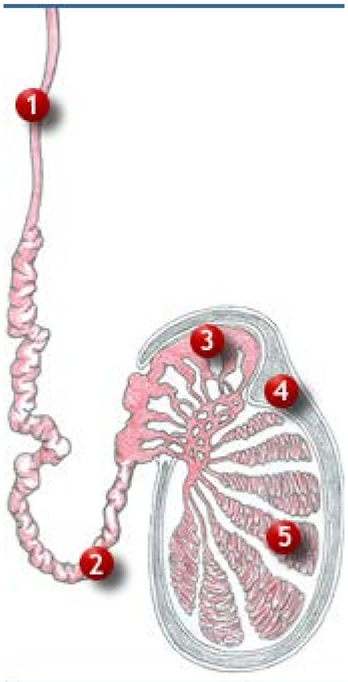
The spermatozoa, which are formed in the testis, are the essential constituents of the seminal fluid. They pass from the testis to the epididymis, where they are stored. A mucoid secretion from the epididymis forms one of the constiuents of the seminal fluid. After their emission from the epididymis, the spermatozoa pass through the urethra to reach the exterior.

The remaining constituents of the seminal fluid are produced in the seminal vesicles, the prostate, the bulbourethral glands, and urethral glands. The secretions of these structures, which are sometimes called the accessory genital organs, empty into the urethra.

Testis and epididymis

Testis

The testes are paired, ovoid organs. After puberty they produce spermatozoa, and, in as much as they are in part endocrine glands, they secrete a hormone testosterone, which is responsible for the secondary sexual characteristics of the male. They are situated in the scrotum, where the left is usually at a lower level than the right. The right is usually lower than the left in cases of situs inversus totalis, and is usually lower than the left in lefthanded men. In the adult, each testis weighs, on the average, 25 gm; in the majority of cases the right is heavier than the left. The testis may weigh much less in old age.



Each testis has superior and inferior ends, medial and lateral surfaces, and anterior and posterior margins. Both surfaces are somewhat flattened. The posterior margin is covered by the epididymis and the lower part of the spermatic cord.

Structure

The tunical albuginea is the outer covering of the testis. It lies beneath the visceral layer of the tunica vaginalis and consists mainly of dense, inelastic connective tissue. Delicate fibrous septa pass from its deep aspect into the interior and incompletely divide the testis into wedge-shaped lobules, between 250 and 400 in number, each with one to four tubules. The bases of the wedges are at the deep aspect of the tunical albuginea; the apices converge near the posterior margin of the testis, where the septa also converge and form the mediastinum testis, which is a mass of fibrous tissue continuous with the tunica albinea.

The parenchyma of he testis is located within the lobules and consists of the convoluted seminiferous tubules, which resemble delicate, tortous threads. It is estimated that more than 800 tubules are present in each testis. These tubules become less twisted and convoluted in their course backward. As they approach the mediastinum they unite to form between 20 and 30 straight seminiferous tubules. These in turn pass in the rete testis, an elaborate network of canals, which traverses the mediastinum. From this network are formed 15 to 20 channels, the efferent ductules, which enter the head of the epididymis.

The interstitial cells are located in the loose tissue under the tunical albuginea, in the septa, and in the stroma that surrounds the individual convoluted seminiferous tubules. They secrete testosterone, the male sex hormone. Details of the testis are covered in histology section.

Epididymis

The epididymis is a C-shaped structure, which is applied to the posterior margin of the testis and overlaps the adjacent part of the lateral surface. The spermatozoa are stored in it until they are emitted. It is subdivided into three parts, a head, a body, and a tail.

The efferent ductules of the testis, which are at first straight, become tortuous after they enter the head of he epididymis. Here they form wedge-shaped masses, the lobules (or cones)of the epididymis, the apices of which are directed toward the testis. After a twisted course, each ductule opens opposite the base of a lobule into a single tube, the duct of the epididymis. This duct is very greatly convoluted, and it makes up the main mas of the remainder of the epididymis. It is about 6 meters long.

The head of the epididymis is the upper, larger part, which lies on the superior end of the testis and overhangs it. The body of the epididymis is attached to the posterior margin of the testis. It is separated from the adjacent part of the lateral surface by the sinus of the epididymis, a space formed by an invagination of this region. The tail of the epididymis is the lower, smaller part. In it the duct of the epididymis increases in thickness and diameter, and becomes the ductus deferens.

The appendix testis is a small body on the upper end of the testis. It is usually sessile, but may be pedunculated. It is a remnant of the upper of the peramesonephric duct, and is homologous with the fimbriated end of the uterine tube of the female.

The appendix of the epididymis is a small appendage, usually pedunculated, on the head of the epididymis. It is regarded as a remnant of the mesonephros.

Blood Supply

- Testicular artery
- Artery of the vas deferens
- External spermatic artery

Lymphatic Drainage

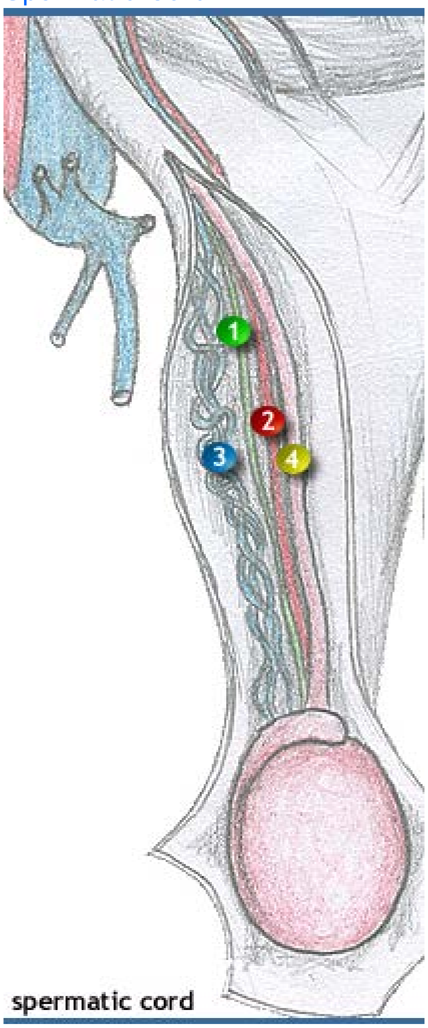
The lymphatic vessels from the testis and epididymis pass upward with the testicular vessels. They drain into the lumbar (aortic) nodes.

Nerve SupplyThe testis is supplied by the testicular plexus, which receives additional fibres from the genitofemoral nerve and also from the posterior scrotal nerves. The sympathetic fibres reaching the testis are probably mainly vascomotor. Testicular pain resulting from squeezing or swelling is severe, and often sickening or shocking, especially when it is acute. Under certain conditions it may be referred to the groin or to the lower part of the abdominal wall.

The epididymis is supplied by fibres of the ductus deferens. The importance of the autonomic supply to the smooth muscle of the ductus is uncertain.

SPERMATIC CORD; COVERINGS OF SPERMATIC CORD, TESTIS AND EPIDIDYMIS .

Spermatic Cord



The spermatic cord is formed at the deep inguinal ring by the structures that accompany the testis and epididymis during their descent. It extends through the inguinal canal and into the scrotum, when it ends along the posterior margin of the testis. The left spermatic cord is the longer in men in whom the left testis is lower than the right.

Below the superficial inguinal ring, the spermatic cord lies in front of the adductor longus. Here the superficial external pudendal artery crosses it anteriorly, and the deep external pudendal artery crosses it posteriorly.

The spermatic cord contains the following structures, all of which are embedded in a downward continuation of extraperitoneal tissue:

1. The ductus deferens, together with the closely associated artery and vein of the ductus deferens, and the nerves that pass to the posterior part of the cord below the superficial inguinal ring, and inthe lower part of the cord within the inguinal canal.
2. The testicular artery, which lies in front of the ductus deferens and is accompanied by the testicular plexus of nerves.
3. The pampiniform plexus of veins, which forms much of the bulk of the spermatic cord. This plexus is formed by the veins that drain the testis and epididymis and ascend as a number of anastomosing longitudinal vessels to the deep inguinal ring, where their number is reduced to two or three. These veins often become varicose, more frequently on the left side, and the resulting condition is called varicocele.
4. Lymphatic vessels
5. The cremasteric artery v
6. The genital branch of the genitofemoral nerve
7. Remnants of the processus vaginalis peritonei.

Covering of Spermatic Cord, Testis, and Epididymis

The coverings of the spermatic cord, testis and epididymis are derived from several layers of the abdominal wall. They are not easily separable from one another, either in the cadaver or the living individual. Occassionally, one of the coverings can be separated into two or more layers.

The internal spermatic fascia, derived from the transversalis fascia, derived from the transversalis fascia, is the thin innermost covering. It forms a loose investment for the spermatic cord and the associated extraperitoneal tissue.

The cremasteric fascia is closely applied to the external aspect of the internal spermatic fascia. It can be recognized by the presence of many bundles of skeletal muscle fibres, collectively termed cremaster muscle, which are continuous above with the internal oblique abdominis. The cremaster muscle receives its blood supply from the cremasteric artery, and its nerve supply from the genital branch of the genitofemoral nerve. Contraction of its fibres can often be produced by a gentle stroking the skin of the medial aspect of the thigh (cremasteric reflex). Its contraction results in a raising of the testis and epididymis to a higher position within the scrotum.

The external spermatic fascia is the thin, outer covering. It is attached above to the crura of the superficial inguinal ring, and is continuous with the fascia covering the external oblique.

The tunica vaginalis testis is a double-layered serous membrane which covers the front and sides of the testis and epididymis. Covered by the internal spermatic fascia, it extends for a variable distance above the testis. During prenatal development, the tunica vaginalis is continuous with the peritoneum. This connection is usually lost, however, and most of the part above the testis disappears or becomes reduced to a strand of connective tissue lying in the anterior part of the spermatic cord. The layers of the tuinica vaginalis are separated from each other by a small space, which contains serous fluid. The accumulation of an abnormally large amount of fluid in this space results in a condition called hydrocele. The inner or viceral layer of the tunica vaginalis is firmly attached to the front and sides of the testis and epididymis. Laterally it passes into the narrow interval between these organs to form the sinus of the epididymis. Posteriorly it is reflected from the testis and epididymis as the outer parietal layer.

PROSTATE AND BULBOURETHRAL GLAND

Prostate

The prostate consists chiefly of smooth muscle and fibrous tissue. It also contains glands, the secretion of which accounts for the characteristic odour of semen, and together with the secretion of tthe seminal vesicles, forms the bulk of the seminal fluid. It is situated in the pelvis, behind the pubic symphysis, and on the medial margins of the pubococcygei. It is structurally continuous with the urinary bladder, which lies above it, but laterally a superficial groove marks a separation between the two organs. This groove is evident after the removal from it of a venous plexus embedded in fat and loose connective tissue. The size of the prostate is variable; the greatest diameters of a prostate considered to be free from disease are approximately as follows: transverrsely, 4 cm; vertical, 3 cm; anteroposterior, 2 cm.

Parts:

The apex is the lowermost part of the prostate, and it is located about one and a half cm behind the lower margin of the pubic symphysis. The base is in a horizontal plane that passes through the middle of the symphysis. It is structurally continuous with the wall of the urinary bladder except at its periphery,where a narrow rim forms the floor of a groove that separates it from the bladder. The internal urethral orifice is located approxiamtely in the middle of the base. The inferolateral surfaces are convex, and are separated from the superior fascia of the pelvic diaphragm by a plexus of veins. The anterior surface is narrow. It is separated from the pubis by the retropubic pad of fat. The (medial) puboprostatic ligaments attach to its lower part. The urethra leaves the anterior surface of the prostate just above and in front of the apex. The posterior surface is flattened and triangular, and it presents a more or less prominent median groove. Its upper part is related to the seminal vesicles and the lower ends of the ductus deferentes, and near, the base, it presents small depressions for the entrace of the ejaculatory ducts. It can be palpated per rectum in the living individual.

The prostate has left and right lateral lobes and a middle or median lobe. Superficially the lateral lobes are not demarcated from each other. They are connected with each other in front of the urethra by the by the isthmus of the prostate, which consists mainly of smooth muscle tissue and is devoid o glands. The isthmus is not apparent from the exterior. The median lobe, variable in size, is the part of the prostate projecting inward from the upper part of the posterior surface between the ejaculatory ducts and urethra. The enlargement of this lobe is at least partially responsible for the formation of the uvula, which, projecting into the wall of the bladder, may block the passage of urine. In structure, the median lobe is normally inseparable from the lateral lobes or from the wall of the bladder.

Fascia or Sheath of the Prostate

The superior fascia of the pelvic diaphragm is reflected upward as the visceral fascia of the pelvis to ensheathe

the prostate and then to continue upward over the urinary bladder. The part of this fascia that covers the prostate is dense and fibrous, and is termed the fascia (sheath) of the prostate. It is situated outside of the capsule of the prostate, and is separated from the capsule in front and the side by loose connective tissue containing the prostatic plexus of veins. It is fused anteriorly with the tendinous arch of the pelvic fascia, which passes forward to the pubis as the medial puboprostatic ligament. Smooth muscle fibres are contained in this ligament, and they are collectively termed the puboststic muscle. The lateral puboprostatic ligament, extends from the fascia of the prostate laterally to the tendinous arch of the pelvic fascia. Immediately below the puboprostatic ligaments, the prostate is closely associated with the medial margins of the pubococcygei. Here muscle fibres extend upward from the pubococcygei and fuse with the fascia of the prostate (levator prostate muscle). Posteriorly the fascia of the prostate is separated from that covering the rectum by the retovesical septum, which extends upward on the posterior aspects of the seminal vesicles and ductus deferentes and fuses with the peritoneum of the rectovesical pouch.

Structure

The capsule of the prostate lies inside the fascia of this organ. Numerous strnads pass inward from the capsule, and incompletely divide this organ into about 50 poorly defined lobules. Skeletal muscle fibres from the sphincter uretrae pass upward into the prostate. They are located in front of the lower portion of the prostatic part of the urethra.

The musculofibrous tissue of the prostate, especially that lateral and posterior to the urethra, is broken up by as many as 50 branched tubulo-alveolar glands. These drain into 20 to 30 minute prostatic ductules, which open into or near the prostatic sinuses in the posterior wall of the urethra.

Changes in the level of androgens affect the size and structure of the prostate. It is small at birth, but at puberty is rapidly increase in size,and after one-half to one year of rapid growth, it is tranformed into an organ resembling that of the adult. During the fifth decade, it commonly decreases in size, and the decrease is accompanied by an atrophy of the glandular tissue. In some men, however, the glandular tissue undergoes hyperplasia, and the size of the prostate increases with age. This is the Benign Prostaic Hypertrophy (BPH).

Blood Supply

The main artery to the prostate usually aries in commo with the inferior vesical from one of the branches of the internal iliac artery. Some of its branches ramify in the protatic fascia, and resulting subdivisions give off branches that penetrate the capsule and supply the outer portion of the prostate. The prostate often receives a branch from the superior rectal artery, and when the middle rectal is present, it usually sends brances forward to reach this organ. Branches of the inferior vesical enter the prostate at its junction with the urinary bladder. These accompany the prostatic part of the urethra, and supply adjacent portions of the prostate.

The veins from the prostate drain mainly into the prostatic plexus, an extensive network of thin-walled vessels lying in the fascia of the prostate. This network joins the vesical plexus in the groove that superfiacially separates the urinary bladder from the prostate, and the combined plexuses drain into the internal iliac vein. The prostatic venous plexus communicates with the vertebral venous plexus, a means by which cancer often spreads.

Lymphatic Drainage

Most of the lymphatic vessels from the prostate pass to the internal iliac nodes, but some of them enter the external iliac group, and some others the sacral group.

Nerve Supply

The prostate is supplied by the prostatic plexus, which consists mainly of sympathetic nerves. The se fibres presumably innervate the smooth muscle and blood vessels within this organ. A parasympathetic supply to the prostate has not been coclusively demonstrated. Some pain fibres may be present in the plexus, but in general the sensory innervation of the prostate is still unknown.

The Penis

Male organ of copulation, which serves as the common outlet for urine and semen.

Organization

Consists of 3 cylindrical bodies of cavernous tissue.

1. Corpus spongiosum penis or corpus cavernosum urethrae, ventrally and containing the urethra. The distal end dilates into the glans of the penis, which has the urethral opening.

2. Two bodies, arranged side by side, in the dorsal part of the organ. These are called corpus cavernosa penis.

- These bodies are enclosed in a dense white fibrous tissue called the tunica albuginea.
- Superficial to the tunica albuginea is the deep fascia of the penis, which forms a common covering for all the three bodies.
- The skin is thin, dark and loose. The prepuce covers the glans .

Parts and surfaces

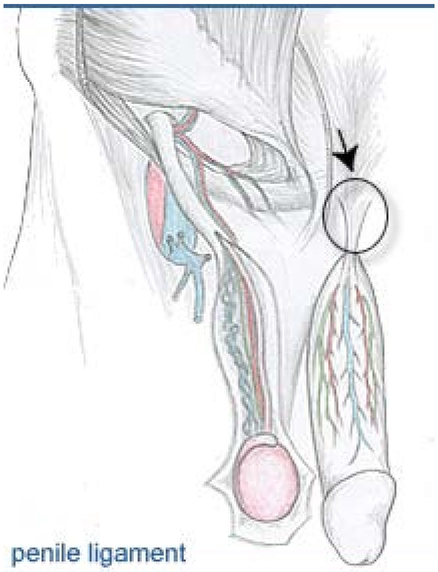
- There are two surfaces - the dorsal surface which faces posterosuperiorly when the penis is erect, and anteriorly when the penis is flaccid. This surface is continuous with the anterior abdominal wall. The opposite surface, continuous with the scrotum is the ventral or urethral surface.

1. The root of the penis, is the attached part. It consists of the two crura of the penis; the bulb and the muscles associated with them. The bulb, located between the crura, is penetrated by the urethra, posteriorly.

2. The body of the penis, is the free part of the penis, consisting of the corpora cavernosa and corpus spongiosum. The prominent margin of the glans penis is called the corona of the glans. The corona of the glans overhangs the Neck of the penis.

Penile Support

1. Fundiform ligament, arises from the inferior part of the linear alba, and splits into two parts which pass on each side of the penis.



2. The suspensory ligament, is a condensation of superficial fascia, arising from the anterior surface of the symphisis pubis, and passes inferiorly splitting to attach to deep fascia of the penis.

Arteries to the Penis

1. Dorsal arteries, running in the interval between the corpora cavernosa penis, on each side of the deep dorsal vein.

2. Deep arteries, run within each of the corpora cavernosa penis. Both of these are branches of the internal pudendal arteries.

[Stop question. Discuss the mechanism of penile erection and detumescence]

Nerves of the penis

1. Autonomic nerves, on vessel plexuses from hypogastric plexus.

2. Dorsal nerve of the penis from the pudendal nerve.

Perineal spaces (pouches):

1. Superficial perineal space;

Boundaries: Superficial perineal fascia inferiorly, and inferior fascia of urogenital diaphragm superiorly.

Contents:

a) Root of the penis

b) Muscles of the penis - bulbospongiosus, and ischicavernosus

c) Spongy urethra

d) Branches of internal pudendal vessels, and pudendal nerve.

e) Superficial transverse perinei muscles.

2. Deep perineal space.

Boundaries: Enclosed by superior and inferior fasciae of the urogenital diaphragm.

Contents:

a) Shincter urethrae

b) Deep trasverse perinei muscle

c) Bulbo urethral glands

d) Membranous urethra

e) Internal pudendal vessel and branches of the pudendal nerve.

Anal triangle
The Ischio Rectal fossae
Boundaries

- Laterally - The ischium, and part of the obturator internus.
- Medially - Rectum, and the anal canal, with their associated lavetor ani and sphincter ani muscles.
- Posteriorly - Sacrotuberous ligament, and the overlying Gluteus maximus muscle.
- Anteriorly - Base of urogenital diaphragm.
- Inferiorly - Skin and deep fascia of the perineum.
- Apex - Between obt. fascia and lavetor ani.

Contents

a) Ischiorectal pad of fat, traversed by many tough, fibrous bands and septa. This pad of fat supports the anal canal, but it is readily displaced to allow feces to pass.

b) Internal pudendal vessels, and pudendal nerve, found in the fibrous canal on the lateral wall called the pudendal canal (Alcock's canal).

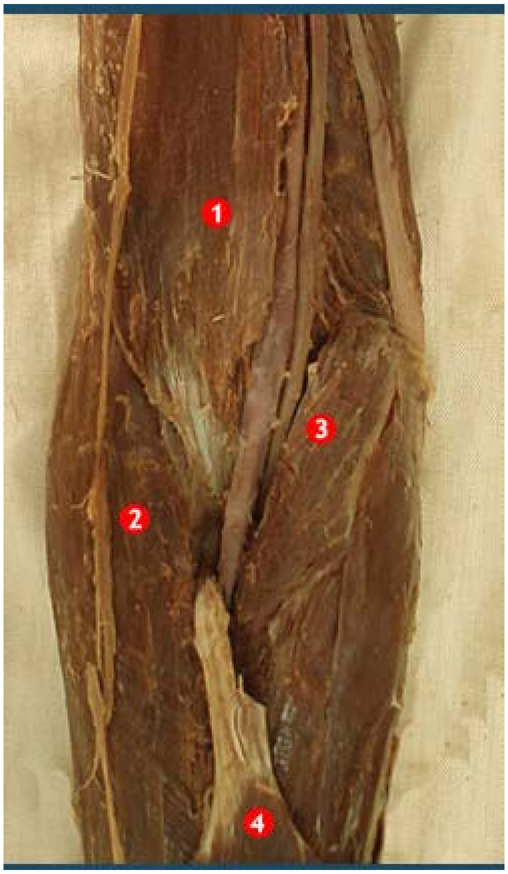
c) Inferior rectal vessels and nerves

d) Perforating branch of S2, S3

e) Perineal branch of S4.

Relations

Anterior



The capsule is covered by

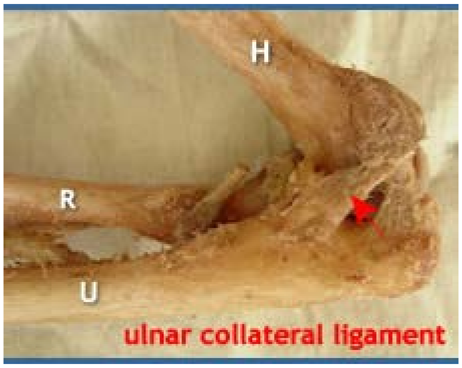
- Brachioradialis (2),
- Radial nerve
- Brachialis(1)
- Brachial artery
- Median nerve
- Pronator teres (3)

Posterior

- Triceps brachii and its subtendinous bursa
- Anconeus
- Flexor carpi ulnaris
- Ulna nerve sule

Medial

- Flexor digitorum superficialis***(1)***
- Common flexor tendon
- Flexor carpi ulnaris
- Ulna nerve



Lateral

- Supinator [2]
- Extensor carpi radialis brevis
- Common flexor tendon

Home | OG anatomy | Gross Anatomy | Topic index | Chapter 18

CHAPTER 18 : The Joints of the wrist , hand and fingers

Learning points | Core anatomy | Applied anatomy | Review questions

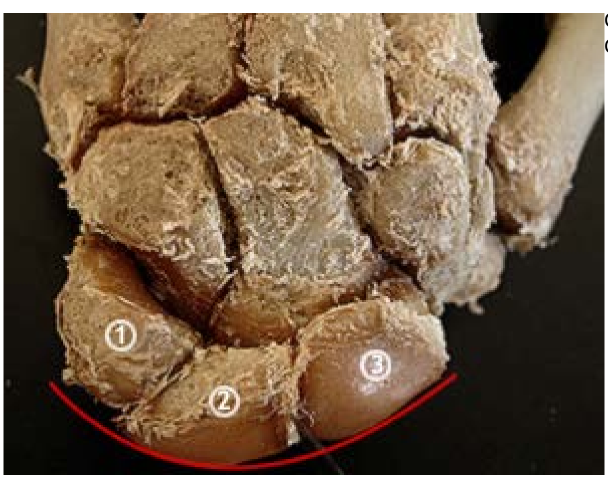
Hand Joints

Wrist joint (radiocarpal articulation)

Classification:

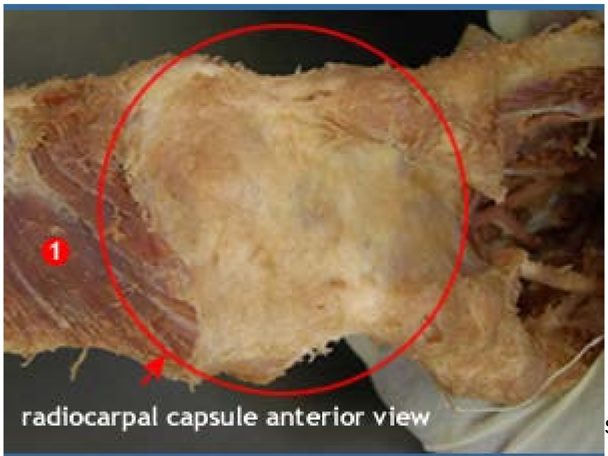
Biaxial synovial joint

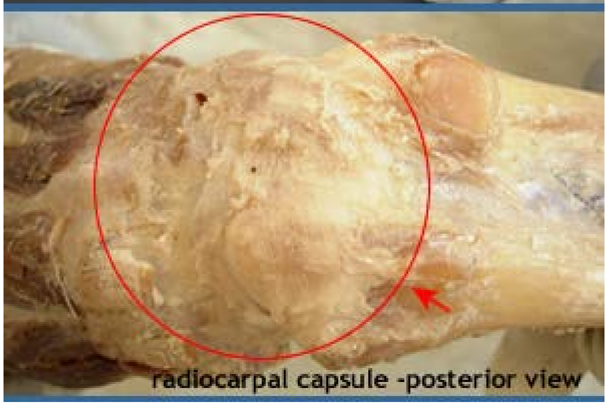
Articular surfaces:



Concave ellipsoid distal surface of radius and articular disc
Convex proximal surfaces of triquetral ***(1)***, lunate ***(2)*** and scaphoid ***(3)*** bones

Capsule:





Surrounds the joint and is thickened to form palmar, dorsal and collateralligaments

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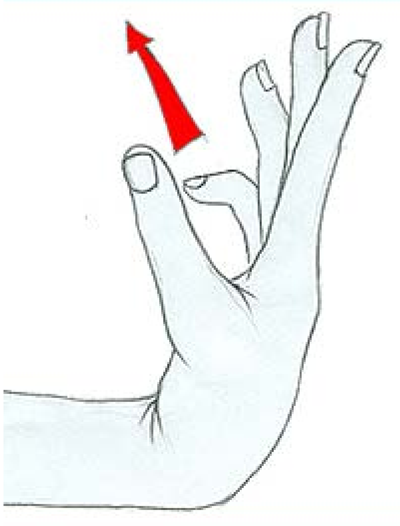
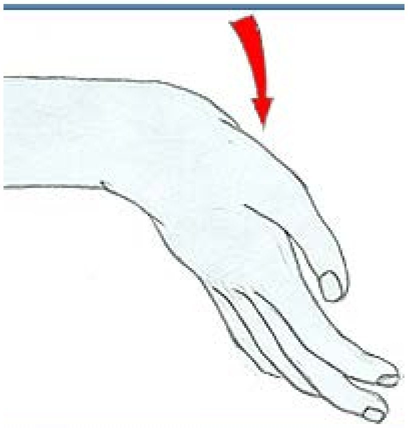
Innervation:

Posterior and anterior interosseous nerves

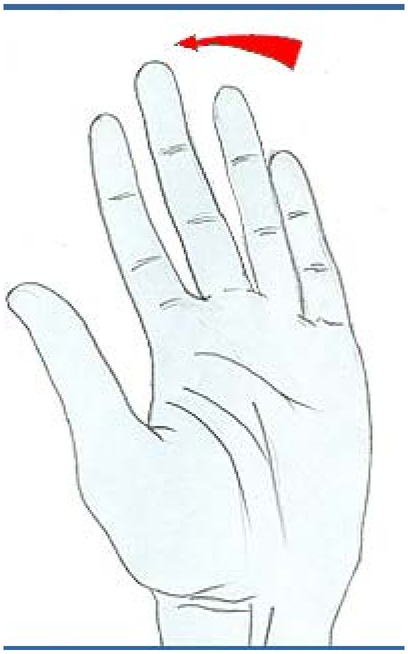
Movements:



Flexion

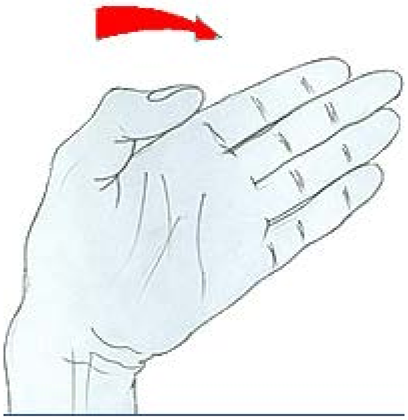


Extension



radial abduction

ulnar adduction

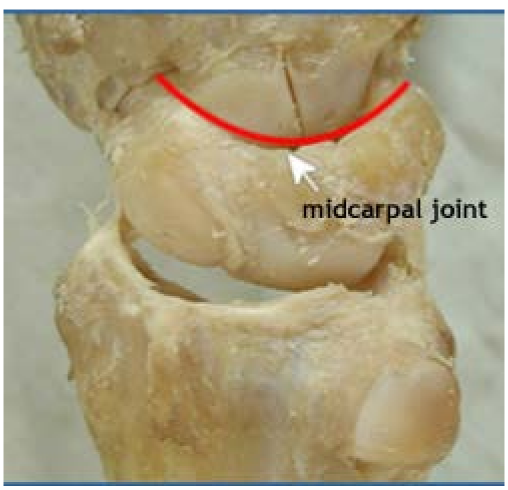


Movements accompanied by those at midcarpal joint
Total range of flexion 80 o , of extension 60 o
More flexion at midcarpal joint while more extension at wrist joint
Range of abduction 15 o , range of adduction 45 o . ***Why the difference?***

Movements produced by:

Movement	**Muscle**
Flexion	flexor carpi radialis, flexor carpi ulnaris, palmaris, flexors of Fingers and thumb
Extension	Radial extensors, ulnar extensor, extensors of fingers and thumb
Abduction	Flexor carpi radialis, two radial extensors, abductor pollicis longus
Adduction	flexor carpi ulnaris, extensor carpi ulnaris

Intercarpal joints



- Synovial
- Intercarpal ligaments connect the bones. Flexor retinaculum is an accessory intercarpal ligament
- Thin capsule
- Synovial cavity may communicate with radiocarpal joint
- **Midcarpal joint** is a compound sellar joint between the proximal and distal row of carpal bones
- Carpometacarpal joints often communicate with intercarpal joints

- The 1 st carpometacarpal joint of the thumb is a saddle joint between **trapezium** and **1 st metacarpal.** Opposition occurs here. It has a loose and lax capsule

allowing ranges of movement

Metacarpophalangeal joints

- Synovial joints allowing flexion, extension, abduction and adduction
- **Palmar ligaments** limit extension
- **Transverse metacarpal ligaments** are additional stability
- **Collateral ligaments** flank the joints

Interphalangeal joints

- Uniaxial
- Capsule
- Extension is limited by palmar and collateral ligaments

The Appendix

This is a small organ, with no well defined function, but is a surgical nuisance – inflammation of the appendix (appendicitis) is a common surgical emergency, and all medical students must know the anatomy of the appendix.

Position/location

Usually in the right iliac fossa. Its position varies. Could be on the left side in situs inversus.

- Retrocecal
- Retrocolic
- Subhepatic
- Pelvic

Relations

Posteriorly : psoas major

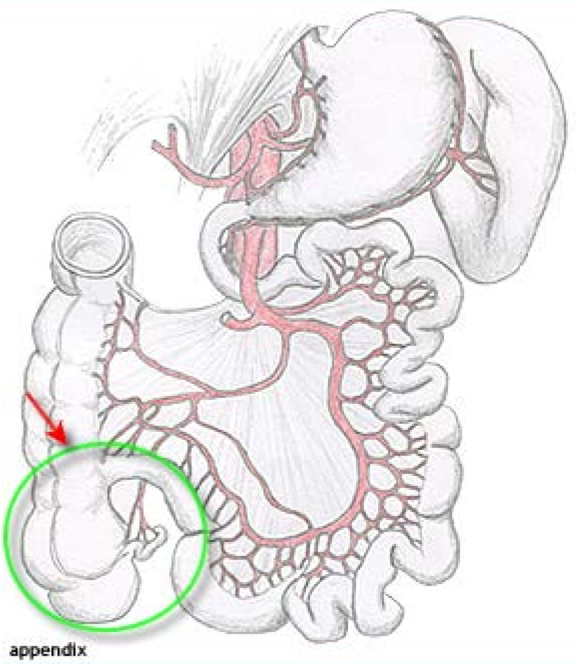
Medial (post): ureters and iliac vessels

Anteriorly : caecum

Superiorly : coils of ileum (and ascending colon).

Anteriorly : may be separated from the anterior abdominal wall by intestines.

Peritoneal relations	Surrounded by peritoneum, and has mesoappendix.
blood supply aa	Appendicular branch of ileocolic artery – a branch of the superior mesenteric artery. The appendicular tributary of ileocolic vein takes the blood to the superior mesenteric vein.



Lymphatics	Nodes in the mesoappendix – ileocolic artery.

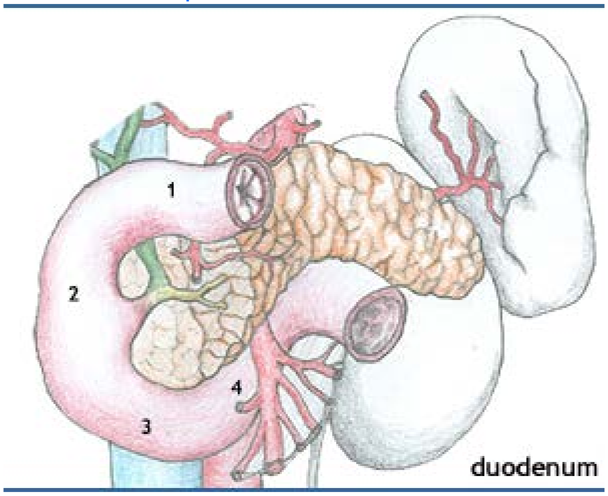
Nerves

Parasympathetic : vagus

Sympathetic : superior mesenteric plexus

THE DUODENUM

Location and position



1. Epigastric region: Extending a little into the right hypochondrium and right lumbar.
2. Joins the pylorus of the stomach to the jejunum, and is moulded around the head of the pancreas.
3. Mostly retroperitoneal, from L1 –l3.

Parts

- Superior (first part), anteriolateral to the body of L1.
- Descending (second part) to the right of L1, L2 and L3.
- Horizontal (third part) anterior to L3.
- Ascending (fourth part) to the left of the body of L3.

These parts have different relations, mentioned below:

Superior part

Its proximal part has a mesentery. The greater omentum and hepatoduodenal ligament are attached to it - It is free to move.

Relations

Anterior relations

- Peritoneum
- Gall bladder
- Quadrate lobe of the liver

Posterior relations:

- Bile duct
- Portal vein
- Inferior vena cava

- Gastroduodenal artery. This artery is commonly eroded in duodenal ulcer - massive bleeding.

Superiorly

- neck of gall bladder

Inferiorly

- pancreas

Descending part :

1. Retroperitoneal
2. Parallel and to the right of inferior vena cava.

Anterior relations:

- Transverse colon
- Transverse mesocolon
- Some coils of jejunum

Posterior relations:

- Hilum of right kidney
- Renal vessels
- Ureter
- Psoas major muscle

Medially:

- Head of pancreas
- Pancreatic duct
- Bile duct

Horizontal part : Retroperitoneal and adherent to the posterior abdominal wall.

Posterior relations:

- Right psoas major muscle
- Inferior vena cava
- Aorta
- Right ureter

Superior relations:

- Pancreas
- Superior mesenteric vessels.

Ascending part :

- Its distal end is covered by peritoneum, and is movable.
- Most of it is retroperitoneal and adherent to the posterior abdominal wall.
- Ascends to the left of the aorta to L2.

Anterior relations:

- Root of mesentery and coils of jejunum.

Posteriorly:

- Left psoas major muscle
- Left margin of aorta.

Medially:

- Head of pancreas

At its termination, the ascending part of the duodenum becomes continuous with the jejunum at the duodenojejunal junction. The duodenojejunal flexure is supported by a fibro muscular band called the **suspensory ligament** (muscle) of the duodenum (ligament of Treitz) {The superior part of this slender band contains striated muscle; its intermediate part consists of elastic tissue, and its inferior part contains smooth muscle}. This ligament connects the duodenum, and the duodenojejunal flexure to the right crus of the diaphragm close to the esophagus opening.

This structure serves two functions

- supports the duodenojejunal flexure
- widens the angle of the flexure, thereby facilitating movement of its contents.

Peptic ulcer disease is very common, previously considered a “disease of affluence”, now better described as “a disease of your own making” and is also now quite common in the third world due to a stress factor. The duodenal type is commonly located in the proximal part of the superior part of the duodenum called the **duodenal cap** . In the ulcer, the duodenal wall is eroded to varying depth. It may perforate the entire wall causing peritonitis.

Due to its close proximity to the liver and gall bladder, duodenal ulcer can cause ulceration of the two. In inflamation of the gall bladder, the latter may become adherent to the duodenum. In extreme cases, ulceration may cause a fistula between the gall bladder and the duodenum, and gall stones may find way into the duodenum, and be passed out with stool.

Posterior duodenal ulcer may invade the pancreas.

The artery commonly eroded in posterior duodenal ulcer is the **gastroduodenal** . This may result in severe hemorrhage into the peritoneal cavity. (How will a patient with perforated duodenal ulcer present)?

During repair of the perforated duodenal ulcer, special care must be taken to avoid damage to;

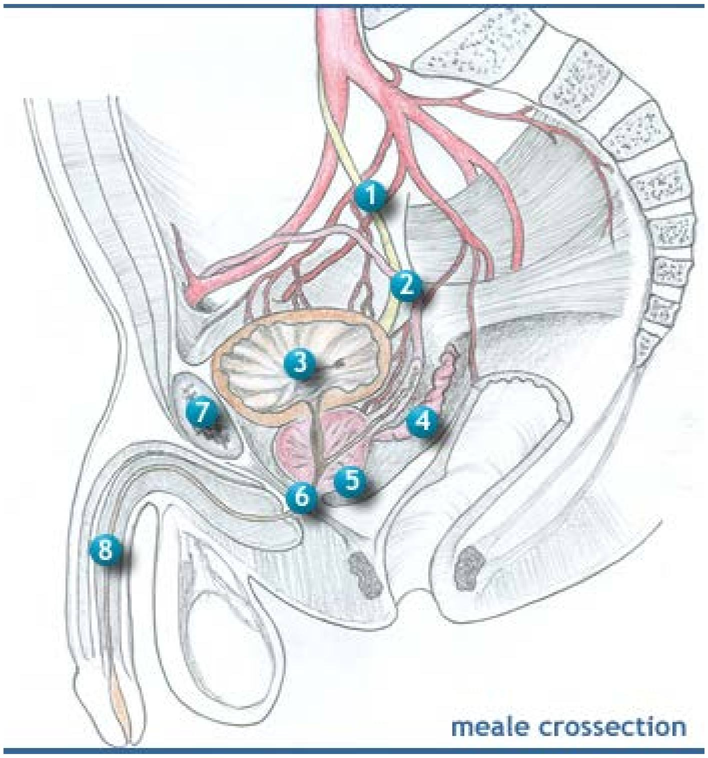
- Bile duct
- Portal vein
- Inferior vena cava

The eroded gastroduodenal artery is ligated. How do the structures it supplies get their blood?

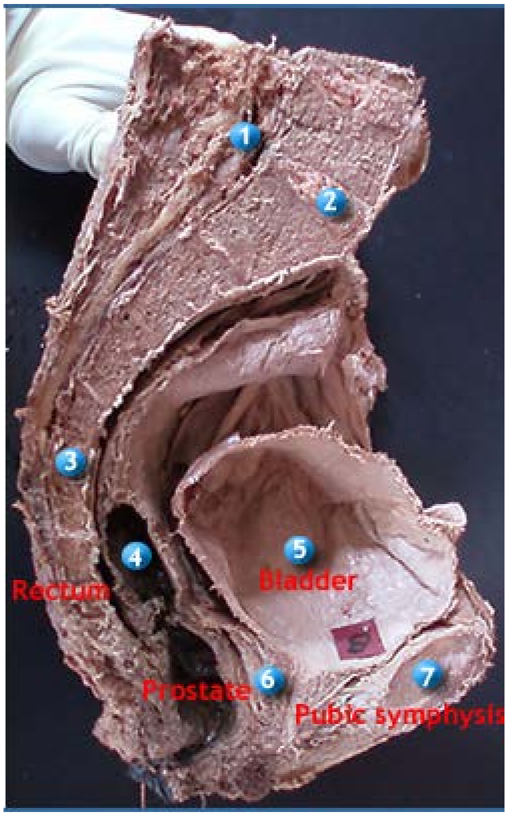
When removing the duodenum e.g with the pancreas the structures must be preserved. Separation from these structures is usually not difficult, because their attachment is secondary and weak.

DUCTUS DEFERENS SEMINAL VESICLE, AND EJACULATORY DUCT

Ductus Deferens



The ductus deferens (vas deferens) is the continuation of the duct of the epididymis, and carries the spermatozoa from the epididymis to the ejaculatory duct. It begins at the tail of the epididymis, where it is very tortous. It becomes straighter as it ascends on the medial side of the epididymis near the posterior border of the testis. Here it is surrounded by the pampiniform plexus of veins and is incorporated into the spermatic cord. It continues upward from the superior end of the testis to the superficial inguinal ring, and in this part of its course it can be felt as a firm cord when held between the thumb and the index finger. After passing through the inguinal canal, it leaves the outer structures in the spermatic cord by turning around the lateral side of the inferior epigastric artery and ascending in front of the external iliac artery for a short distance. It then turns backward and slightly downward, crosses the external iliac vessels, and enters the pelvis. As it continues backward, it is covered medially by peritoneum, and is related laterally to the umbilical artery, the obturator vessels and nerve, and the superior vesical vessels. After crossing the medial side of the ureter, it turns medially and downward to run in the sacrogenital fold. It reaches the posterior aspect of the bladder, and then runs downward and medially on the medial side of the seminal vesicle. In this location, the canal of the ductus is enlarged and tortuous, and this portion of the ductus is termed the ampulla. The canal is again small in calliber near the base of the prostrate, where the ductus deferens joins the duct of the seminal vesicle to form the ejaculatory duct.



Structure

The ductus deferens consists of three layers, a mucous membrane, a muscular coat, and an adventitia.

Seminal Vesicle

The seminal vesicles are two sacculated pouches, which produce a large part of the seminal fluid. Each vesicle is usually about 5 cm long but it may be much shorter. The broad end is directed laterally, upward, and backward. Its narrow end closely approaches that of the contralateral vesicle. When the urinary bladder is distended, the seminal vesicles are most nearly vertical, but when the bladder is empty, they are more nearly horizontal.

The seminal vesicles are embedded in a dense sheath, consisting of smooth muscle and fibrous tissue and attached to the posterior aspect of the urinary bladder. The upper parts, which are separated from the rectum by the rectovesical pouch, are covered by peritoneum. Their lower parts are separated from the rectum by the rectovesical septum. The terminal parts of the ureters and the ampullae of the ductus deferens are medial to the vesicles, and the prostatic and vesicle venous plexuses are lateral.

Each seminal vesicle consists of a coiled tube, which gives off several diverticula and which ends blindly above. Its lower end becomes narrow and straight to form a duct. This joins the corresponding ductus deferens, and the tube resulting from this union is the ejaculatory duct.

The seminal vesicles can be palpated per rectum when the urinary bladder is full. When the seminal vesicles are full, they are very sensitive to pressure. Each has a capacity of one and a half to three millilitres of fluid.

Ejaculatory Duct

The ejaculatory duct is formed by the union of the ductus deferens and the duct of the seminal vesicle. After penetrating the base of the prostate, it passes downward and forward to enter the prostatic part of the urethra on the colliculus seminalis, just lateral to the prostatic utricle. (Openings of the ejaculatory ducts sometimes appear in the utricle, but they are alleged to be secondary). In its course through the prostate, each ejaculatory duct approaches its fellow of the opposite side. Also, its walls become thinner and it diminishes in size.

Blood Supply

The artery of the ductus deferens supplies branches to the seminal vesicle and ejaculatory duct, and accomplishes the ductus deferens as far as the testis, where is anastomoses with the testicular artery. It gives branches to the ductus throughout its course. Branches from the inferior vesical and form the middle rectal artery (when present) also help to supply the seminal vesical and the adjacent part of the ductus deferns.

The veins from the ductus deferens, seminal vesical and ejaculatory duct join the prostatic and vesical venous plexuses.

Lymphatic Drainage

The lymphatic vessels from the ductus deferens drain into the external iliac nodes. Those from the seminal vesicles drain into the external and internal iliac nodes.

NerveSupply

The ductus deferens is supplied by autonomic fibres from the superior and inferior hypogastric plexuses. The function of these fibres is not certain, andit is not definitely known whether sensory fibres are distributed with them. The seminal vesicles are supplied by nerves from the inferior hypogastric and prostatic plexuses. The functional significance of these nerves is also uncertain.

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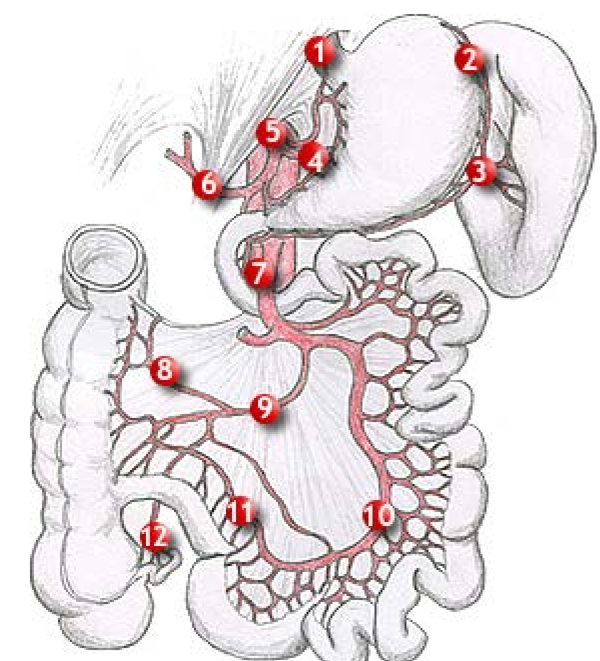
The Descending Colon

- The descending colon connects the left colic flexure to the sigmoid colon.
- It is about 25 cm long, and is narrower than the ascending colon.
- It ascends on the posterior abdominal wall to the iliac crest and then inclines medially on iliacus and psoas major to the pelvic brim.
- There it becomes continuous with the sigmoid colon.
- Its posterior surface is usually devoid of a serous coat, but it may retain a descending mesecolon.
- It is related posteriorly to the diaphragm and quadratus lumborum, but the subcostal vessels and nerve and the iliohypogastric and ilio-inguinal nerves intervene between it and quadratus.
- Beyond the femoral and genitotemoral nerves, gonadal vessels and external iliac vessels are between it and psoas major.

The sigmoid colon

- The sigmoid colon forms a sinous loop about 40 cm long, extending from the pelvic brim to the middle piece of the sacrum where it becomes the rectum.
- Since it is slung on the sigmoid mesocolon, it usually occupies the rectovesical fossa in the male and the recto-uterine fossa in the female, but it may encroach on the abdominal cavity proper.

Rectum



superior mesenteric branches

- The rectum is about 12.5 – 15 cm long.
- It commences in front of the middle piece of the sacrum, at the rectosigmoid junction, and is distinguished from the sigmoid colon by its lack of mobility – it lacks a mesentery.
- It upper third is invested with peritoneum anteriorly and laterally, its middle third anteriorly only; and is lower third lies below the forward reflection of peritoneum (on to uterus or bladder as the case may be.
- The lower third follows the line of curvature of the sacrum and ends below the level of the coccyx by becoming continuous with the anal canal.

The transverse mesocolon

- The transverse mesocolon is a two-layered fold of peritoneum which suspends the transverse colon from the front of the pancreas.
- It does not suspend the right end of the transverse colon which is fixed to the front of the right kidney and to the middle third of the descending part of the duodenum.
- The mesocolon varies in length and may extend down into the pelvis. Its relationships to the peritoneal cavity are noteworthy.
- Like the lesser omentum, it faces both the greater and lesser sacs, but with this difference – its anterior or upper layer faces the lesser sac, and its posterior or lower layer greater sac. The anterior layer forms the stomach bed.
- The transverse mesocolon, together with the transverse colon and the greater omentum, forms a movable partition, separating the supracolic from the infracolic comparatments of the greater sac.

Contents:

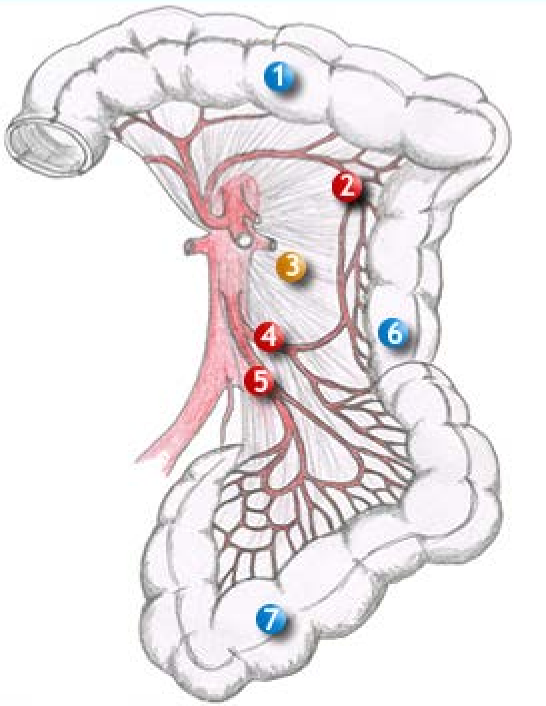
- The contents of the mesocolon are the middle colic vessels and associated nerve plexuses; their anastomoses with the upper branches of the right and left colic vessels; lymphatics and lymp-nodes; and fat.
- Between its root and the duodenojejunal flexure is the occasional mesocolic recess.
- Developmentally, recall that the lower or posterior layer of the transverse mesocolon of the adult is derived from the lower or posterior layer of the transverse mesocolon of the foetus.
- On the other hand, the upper or anterior layer in the adult is derived from the posterior sheet of the greater omentum,ie the dorsal mesogastrium.

The sigmoid mesocolon

- The sigmoid mesocolon is folded on itself and has an inverted V-shaped attachment to the pelvic walls .
- The upper or lateral limb of the inverted V extends along the left edge of the pelvic brim, from the middle of the left external iliac artery to the bifurcation of the left common iliac artery, where the apex of the inverted V is situated.
- The lower or medial limb is attached from the apex of the 3 rd sacral vertebra. The intersigmoid recess is often present at the apex and looks downwards. The left ureter descends in its posterior wall.

Blood-supply of the large intestine

- The proximal part of the large bowel – caecum, appendix, ascending and two-thirds of the transverse colon – is supplied by the superior mesenteric artery, the artery of the midgut.
- The distal part – left third of transverse colon, descending colon, sigmoid colon and rectum – is supplied by the **inferior mesenteric artery**, the artery of the hindgut.



Inferior mesenteric artery

It should be recalled that the whole gut is originally an unpaired structures, and that it is supplied by unpaired, median arteried – coeliac, superior mesenteric and inferior mesenteric arteries.

Branches of these arteries anastomose to form the **marginal artery of Drummond.**

Lymphatic drainage of the large intestine

Lymph drains successively to the :

- Colic nodes (on the colonic wall)
- Paracolic nodes along the inner margin of the colon)
- Mesocolic nodes (in the mesenteries).

The lymphatics run alongside the arteries and finally join the intestinal lymph trunks which empty into cisterna chyli.

The nerve supply of the large intestine

Parasympathetic: The proximal half of the large intestine, as far as the middle third of the transverse colon, receives its parasympathetic fibres from the **posterior vagal trunk** (it nerve-supply being similar to that of the small intestine.

The distal half receives fibres from the **inferior hypogastric plexus**, derived from the pelvic splanchnic nerves from S2,3 and 4. Some of these fibres ascend in the hypogastric nerves to reach the inferior mesenteric plexus, while others ascend the parietal peritoneum to reach the colon independently.

Sympathetic: The larger bowel receives fibres from the plexus on its arteries, derived from the aortic plexus the superior and inferior hypogastric plexuses and also from medial branches of the sacral part of the sympathetic trunks. The preganglionic fibres originate in segments L1 and L2.

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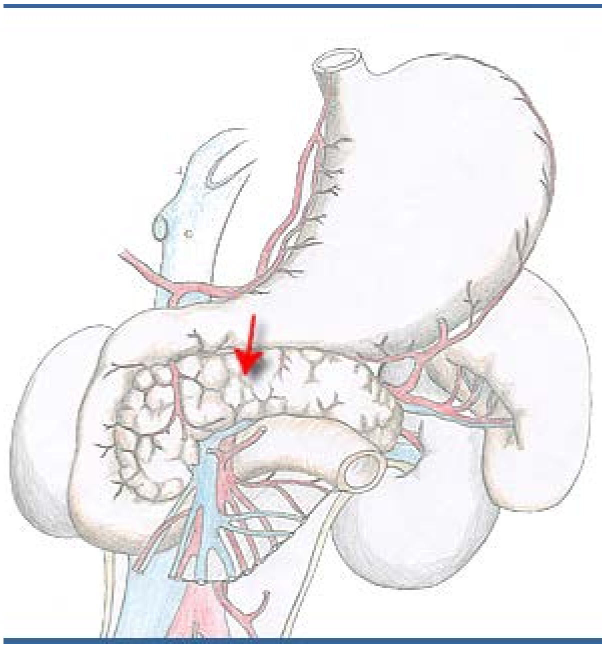
Peritoneal relations of the pancreas



The initial and terminal parts of the duodenum are covered by peritoneum, and the superior part of the duodenum is attached to the liver by the hepatoduodenal ligament.

The rest of the duodenum is retroperitoneal.

The recesses associated with the duodenojejunal junction include;

- Superior duodenal recess
- Inferior duodenal recess
- Retroduodenal recess
- Paradeudenal recess. This recess is guarded by the paraduodenal fold, which contains the inferior mesenteric vein and the superior left colic artery.

These recesses are potential sites of internal hernia.

Blood supply

Arterial:

Mainly from

- Superior pancreaticcoduodenal - branch of gastroduodenal
- Inferior pancreaticoduodenal - branch of superior mesenteric.

These vessels anastomose.

Other sources include:

- Supraduodenal artery from hepatic artery.
- Right gastric artery
- Right gastroepiploic
- Gastroduodenal

These vessels also anastomose.

Veins:

In general, these follow the arteries and drain into the portal venous system.

Most drain into superior mesenteric, but some may enter the portal vein directly.

One of the anterior veins – the prepyloric vein (of Mayo) ascends anterior to the pylorus and drains into the right gastric vein. This vein consistently runs over the gastroduodenal junction and is an important guidepost to surgeons.

Lymphatics

Posterior and anterior vessels anastomes :

Follow arteries pancreatico duodenal gastroduodenal coeliac nodes. (anterior ones)

The posterior ones Superior mesenteric nodes.

Innervation

Parasympathetic and sympathetic from both coeliac and superior mesenteric plexus. Pain fibres run with the sympathetic.

The mesentery

- This is a pleated, fan-shaped stalk.
- It consists of two layers of peritoneum, a right upper layer and a left lower layer.
- It contains the blood-vessels, lymphatics and nerves of the small intestine.
- The attached border is the root of the mesentery. It is about 15 cm long, and runs from left side of the body of L2 to the right iliac fossa.
- The free border contains the intestine, and is equal in length to the related intestine, ie about 6 cm.
- The distance from root to free border varies from 2.5 – 5 cm at the proximal and distal ends to 15-25 cm in between.
- The coils suspended from the middle part of the mesentery are most liable to form the contents of a hernia.

Contents of the mesentery:

These are mainly:

- Blood vessels to the intestines.
- Lymphatics and lymph nodes
- Fibrofatty connective tissue.
- Nervous plexuses

The structures crossed by the root of the mesentery include:

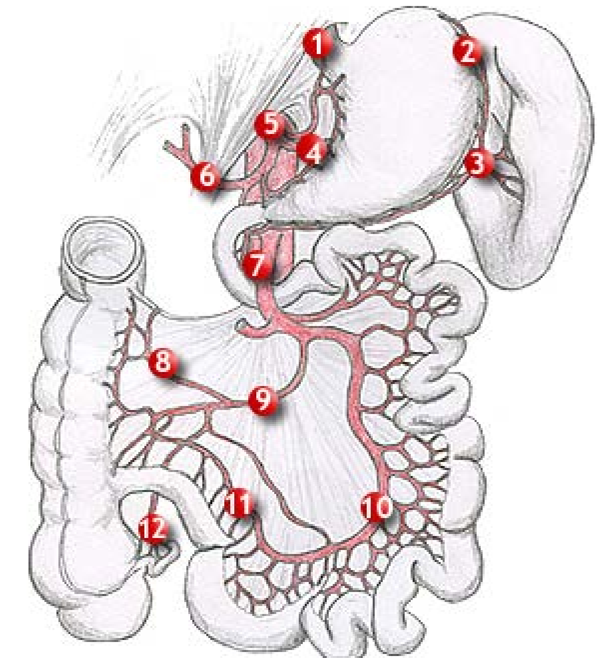
Near the upper left end of the root:

- a small portion of the horizontal part of the duodenum.

Below the duodenum,

- the aorta
- the inferior vena cava
- the right psoas major muscle
- the gonadal vessels
- the ureter and
- the genitofemoral nerve.

Blood-vessels of the jejunum and ileum



superior mesenteric branches

- The superior mesenteric artery runs in the root of the mesentery near the midline, and gives branches to the jejunum and ileum.
- They arise from its left side.
- There are anastomotic arcades between adjacent branches and present are secondary, tertiary and in the more distal parts even quaternary arcades.
- The vasa recta arise from the peripheral row of arcades and pass alternatively to either side of the bowel.
- The superior mesenteric artery anastomoses with its ileocolic branch on its right.
- The ileocolic artery runs towards the ileocolic angle and divides into ascending and descending branches. The right colic artery, arises just above the ileocolic.
- The right colic artery runs horizontally to the right and divides into ascending and descending branches.
- Higher up, the middle colic artery arises from the right side of the superior mesenteric, and near it, the most proximal branch, the inferior pancreaticoduodenal artery .
- The middle colic artery enters the root of the transverse mesocolon. It descends in the mesocolon to the upper border of the transverse colon, where it divides into right and left branches.
- The superior mesenteric vein and its tributaries, accompany the arteries. The vein lies on the right side of the artery.
- Both vessels cross the horizontal part of the duodenum and pass between the head of the pancreas and its uncinate process.

Note:The superior mesenteric artery is the artery of the midgut, that portion of the alimentary tract which is extruded into the umbilical stalk between the 5 th and 10 th weeks of embryonic life. The midgut extends from the greater duodenal papilla (where the bile duct enters) to transverse colon near the left colic flexure.

Mesenteric lymph-nodes

- Numerous lymph nodes lie alongside the mesenteric vessels and their subsidiaries.
- They filter the lymph from the central intestinal lymphatics and convey it by one or more intestinal lymph trunks to cisterna chyli, on the right side of the aorta in front of the bodies of L1 and L2.

Innervation of the stomach and the small intestine

- The stomach and duodenum receive part of their parasympathetic nerve supply from the anterior vagal trunk, which ramifies on their anterior surfaces.
- The posterior surface of the stomach receives branches from the posterior vagal trunk.
- In addition to this supply, the stomach and the entire small intestine receive both parasympathetic and sympathetic nerves from the peri-arterial plexuses on the branches of the coeliac trunk and the superior mesenteric artery.

Coeliac plexus :

- It contains of two large ganglia, one on each side of the coeliac trunk, united by communications above and below that artery. It is mixed parasympathetic and sympathetic plexus.

- Its parasympathetic root is branch of the posterior vagal trunk, containing fibres from both the left and right vagal nerve.

- The sympathetic roots sre the greater and lesser aplanchnic nerves.
- The offshoots of the plexus are therefore mixed sympathetic and parasympathetic nerves, and are distributed as peri-arterial plexus with the branches of the coeliac trunk.

Superior mesenteric plexus :

- The superior mesenteric ganglion or ganglia lies close to the origin of the superior mesenteric artery. The plexus has three roots, one median and two lateral.
- The median root comes from the coeliac plexus just above the artery, the lateral roots come from the lumbar ganglion of the left and right sympathetic trunks.
- It is a mixed parasympathetic and sympathetic plexus, and its offshoots are distributed with the branches of the superior mesenteric artery.

The mesentery

The root of the mesentery is directed obliquely and inferiorly and to the right – from the left side of L2 to the right sacroiliac joint. Between these two points, the mesentery crosses;

- Horizontal part of the duodenum
- Aorta
- Inferior vena cava psoas major muscle
- Right ureter
- Right testicular or ovarian vessels
- Genitofemoral nerve

The mesentery consists of two layers of peritoneum. Between these layers, one finds the following:

- Jejunal and ileal blood vessels
- Lymph nodes, and lymph vessels
- Nerves
- Extraperitoneal fatty tissue.
- Superior mesenteric artery L1

The Jejunum and Ileum

General arrangement:

- The jejunum and ileum together measure about 6m in length in adult.
- The upper two-fifths comprise the jejunum;
- the lower three-fifths the ileum.
- The jejunum and ileum are massed into numerous coils which occupy the major part of the infracolic compartment of the greater sac.
- They are covered to a varying extent by the greater omentum.
- They extend into the pelvic cavity and rest on the pelvic viscera, occupying the various recesses between them.
- The coils have a varying degree of mobility, depending on the length of their mesentery. The first part of the jejunum and the last part of the ileum are shorter stalks and are therefore less mobile than the intervening coils.

External differences between jejunum and ileum

It is sometimes necessary to distinguish between jejunum and ileum by external features, as follows:

1. Position: The jejunum is usually more to the left and above; the ileum to the right and below.
2. Appearance: In the fresh state, the jejunum is redder and wider.
3. Feel: The jejunum is thicker, because it contains numerous plicae circulares, which can be felt through the bowel wall. The plicae decrease in number from above downwards, so that the terminal ileum has few
4. Aggrated lymphatic follicles: May, when enlarged in certain diseases, be visible through the wall of the ileum, especially its lower part, as large oval opacities, 1.0 – 7.5 cm long. They lie along the antimesenteric border of the ileum. They are fewer and smaller in the jejunum.
5. Messenteric fat : There is less fat in the mesentery of the jejunum near the gut, so that translucent ‘windows' are visible when the mesentery is held against the light. Such areas are absent from the mesentery of the terminal ileum.
6. Arterial fat : The arteries supplying the ileum form a greater number of arcades than do the jejunal arteries. Thus the jejunum receives longer terminal branches (vasa recta) from primary or secondary arcades; the ileum receives shorter terminal branches from tertiary or quaternary arcades.
7. Ileocecal fold: This elongated peritoneal fold is found along the lower 5-7 cm of the antimesenteric border of the ileum. .

Diverticulum ilei (Meckel”s diverticulum)

This is an occasional diverticulum which arise from the antimesenteric border of the ileum at the variable distance from the ileocaecal junction. This is the diverticulum ilei. It may be about 5cm long and as wide as the ileum. It occurs in fewer than 1% of subjects.

The structure of the small intestine

The internal structure of the small intestine is characterized by:

Plicae circulares: These are transverse, circular or spiral folds of mucosa, containing a core of the submucous layer. They are more numerous and longer (up to 1 cm) in the jejunum, but are scanty or even absent in the terminal ileum.

intestinal villi: The mucosa has a velvety appearance due to minute tubular projections known as **villi** . Each villus contains a core derived from the lamina propia of the mucosa. Within the mucosal core are a vascular loop and a central lymphatic vessel. The villi are more numerous, longer and thinner in the jejunum than in the ileum.

Lymphatic Follicles : These occur either separately or in aggregations. The solitary follicles occur throughout the small and large bowel. They are visible as tiny opacities (1mm by ½ mm). Villi are absent from their surface. The aggregated follicles are present in the distal ileum. They appear as large oval opacities with their longitudinal axes along the antimesenteric border, from 1 cm to several cm in length.

Submucous Layer : The mucosal coat, is bound to the muscular coat by the submucous layer, consisting of loose but strong areolar tissue. The submucosa contains a vascular plexus and an autonomic nervous plexus, the submucous plexus.

Radiological appearance

The jejunal coils are distinguished by their typical ‘cross-hatching' (owing the plicae circulares) and a feathery appearance when the main mass of barium has passed on; the ileum fills more uniformly with little ‘cross-hatching'.

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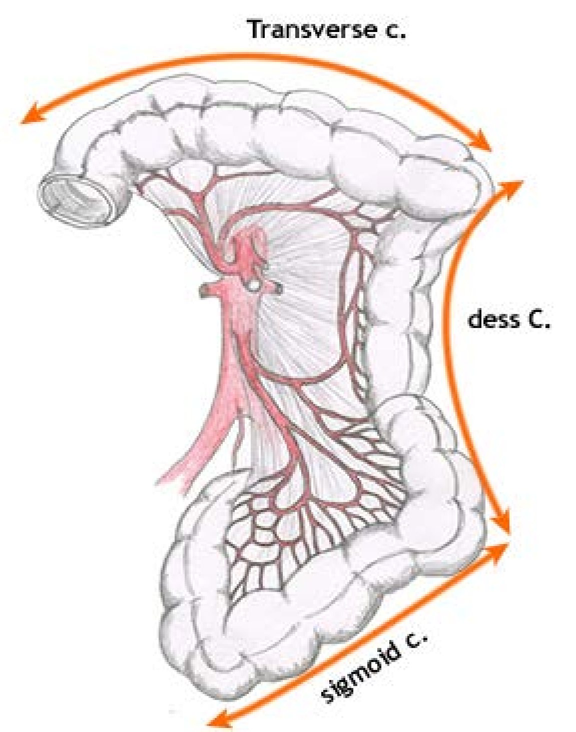
The large Intestine



It consists of the following parts:

- Caecum and appendix
- Ascending colon
- Transverse colon
- Descending colon
- Sigmoid colon
- Rectum

Note:

- The ascending and descending colon are usually devoid of a mesocolon, or both, may be present.
- A transverse mesocolon and sigmoid mesocolon are always present.

The caecum

- A wide, short pouch which lies in the right iliac fossa, below the ascending colon
- Its upper end continues into the ascending colon at the intertubercular plane.
- It opens into the upper most part of its medial aspect, the opening being guarded by the ileocaecal valve.
- About 2.5 cm below the ilecaecal junction, the vermiform appendix opens into its medial aspect.
- The serous coat of the caecum is usually complete, so that the pouch can be lifted freely.

The **structures underlying the caecum** are:

- The ileacus muscle and its fascia, psoas major.
- The lateral cutaneous nerve of the thigh, genitofemoral nerve.
- The femoral nerve and the gonadal vessels.

The three taeniae of the ascending colon continue on the caecum.

The ascending colon

- The ascending colon is continuous below with the upper end of the caecum at the intertubercular plane.
- It ascends on the posterior abdominal wall to reach the right lobe of the liver, where it turns to the left and downwards as the right colic flexure. It is about 12.5 – 15 cm long.
- Its posterior surface is usually devoid of a serous coat, but the ascending colon may retain an ascending mesocolon.
- Posteriorly, the ascending colon lies on ileacus and quadratus lumborum, the ilio-inguinal and iliohypogastric nerves intervening, and higher up in front of the lower part of the right kidney.

The right colic flexure

- The right colic flexure lies on the lower part of the right kidney and the descending part of the abdomen.
- In front and above it is in contact with the colic impression on the right lobe of the liver.
- It is slightly below the transpyloric plane.

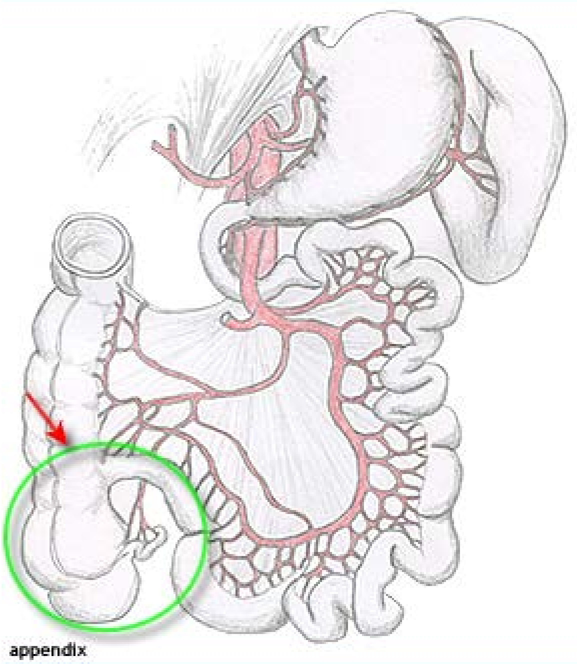
The transverse colon

- The transverse colon extends across the abdominal cavity from the right colic to the left colic flexure. It is not strictly transverse but hangs down as a loop to a variable extent.
- It may attain a length of 40 – 50 cm. Sometimes, it reaches the pelvis, in which case the limbs of the loop of transverse colon are more or less parallel to the ascending and descending colon.
- The greater omentum is attached to its anterior taenia and the transverse mesocolon to its superior taenia, thus completing the curtain between the supracolic and infracolic compartments of the greater sac.
- The anterior aspect of the transverse colon forms part of the posterior wall of the omental bursa and is a constituent of the stomach bed.
- Towards the left end of the transverse colon, the midgut is succeeded by the beginning of the hindgut. This area is thus an important neurovascular junction.

The left colic flexure

- The left colic flexure lies on the lower part of the left kidney and the diaphragm, behind the stomach and below the lower pole of the spleen.
- It is slightly above the transpyloric plane. It is accurately angled, its two limbs being almost parallel and conta1gious.
- The phrenicocolic ligament is a horizontal fold of peritoneum attaching the flexure to the diaphragm opposite the 11 th rib in the midaxillary upper limit to the left paracolic gutter.

THE APPENDIX



- This is a small organ,

Location/position

Usually in the right iliac fossa. Its position varies. Could be on the left side in situs inversus .

- Retrocecal
- Retrocolic
- Subhepatic
- Pelvic

Relations

Posteriorly : psoas major, iliacus.

Medial (post): ureters and iliac vessels

Anteriorly : caecum

Superiorly :coils of ileum (and ascending colon).

Anteriorly : may be separated from the anterior abdominal wall by intestines.

Small and Large Intestines

The small gut can be distinguished from large by the following features.

Position

The small bowel tends to be central, the large bowel peripheral.

Mobility

- The small bowel moves freely on its stalk, the mesentery;
- Portions of the larger bowel also possess mobility, being provided with a mesocolon constantly or only occasionally, but the stalk is usually shorter and mobility less.

Contour

- The small bowel has an even cylindrical contour;
- The large bowel is pinched up by a series of constrictions into **haustrations or sacculations.**

External muscle coat

- The small bowel has a uniform outer coat of longitudinal muscle
- The longitudinal coat of of the large bowel is grouped into three broad thickened bands, the **taeniae coli**,

disposed equidistantly about its circumference.

Appendices epiploicae

- These are presently exclusively in the colon.
- Each is a small rounded evagination of the serous coat, containing a little extraperitoneal fat.
- Appendices epiploicae are absent from the caecum, appendix and rectum.

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THE STOMACH

This is the widest part of the GIT, connecting esophagus and the duodenum.

Position :

Variable from one individual to another; and within some individual, from one position to another.

Most commonly J-shaped, and occupies the epigastric, and left hypochondrial regions .

Parts :

- Cardiac part , which receives the opening of the abdominal esophagus.
- Body.
- Fundus.
- Pyloric part. This has two parts, divided by sulcus intermedius,
- Pyloric antrum, which is the lowest part of the stomach
- The pyloric canal.

Pylorus, by which the stomach communicates with the duodenum.

The junction between the body and pyloric part is marked on the lesser curvature by an angular notch (incisura angularis)

The opening of the pylorus into the duodenum is marked by the prepyloric vein (vein of Mayo).

Surface

Anterior and posterior surfaces, which meet along the lesser curvature, and along the greater curvature.

Relations :

Anteriorly:

It is related to the following structures from which it is separated by the cavity of the greater sac of peritoneum.

- The thoracic diaphragm, which separates it from 6 th to 9 th ribs; and the pericardium.
- The spleen
- Left and quadrate lobes of the liver.
- The anterior abdominal wall.

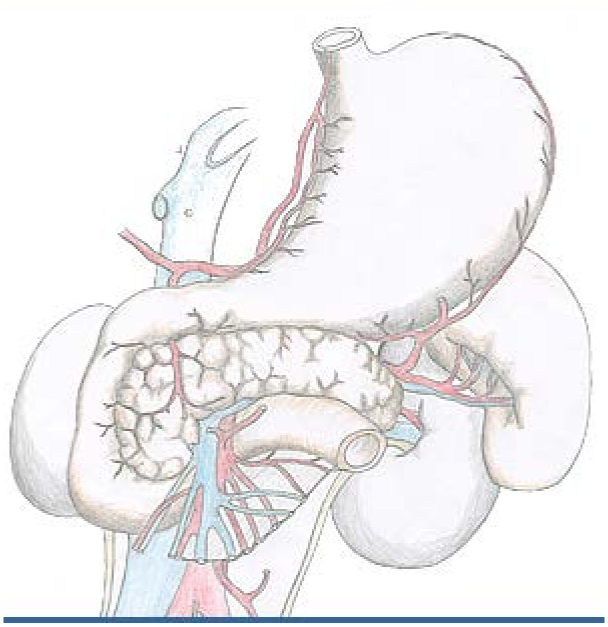
Posteriorly:

These structures are grouped together as the ‘stomach bed', separated from the stomach by the lesser sac of peritoneum except for a small triangular area of the posterior surface of the stomach near its cardiac oriface,, which is in direct contact with the left crus of the diaphragm, and left suprarenal gland.

The stomach bed consists of the diaphragm above. In the midline the bed consists of left and right crura; the aorta, and the coeliac trunk with its three branches.Further to the left, the bed consists of the following from above downwards.

- Left dome of the diaphragm.
- Spleen.
- Left kidney and suprarenal.
- Splenic artery.
- Pancreas.
- Transverse mesocolon.
- Transverse colon and left colic flexure.

Blood supply



Arteries:

On the lesser curvature:-

- Right gastric, from hepatic artery
- Left gastric, from coeliac trunk.

On the greater curvature:-

- Right gastroepiploic, from the gastroduodenal artery.
- Left gastroepiploic, from the splenic artery.

At the fundus:-

- Short gastric arteries from the splenic artery.

These arteries anastomose extensively.

- Posterior gastric artery – frequently from the splenic artery.

venous drainage

The veins of the stomach accompany the arteries for some distance.

- The right gastroepiploic vein joins the superior mesenteric vein.
- The right gastro epiploic vein joins the superior mesenteric vein.
- The left gastro epiploic vein joins the splenic vein.

Note: Coeliac axis compression syndrome:This arises when the coeliac artery is compressed by the mediun arcuate ligament. The subject complains of the upper abdominal pain for which no cause can be found. Angiography or subtraction intravenous angiography is required before the diagnosis can be confirmed.In some cases, relief has been achieved by dividing the median arcuate ligament.

Lymphatic drainage

The lymphatics of the stomach tend to follow blood vessels and drain four main areas, with overlap:

- Both surfaces of the upper body drain to left gastric nodes.
- Fundus and lower left part of the body reach pancreatico splenic nodes close to the hilum of the spleen.
- Lower right part of the greater curvature pass to the right gastro epiploic nodes.
- Pylorus drains into pyloric, left gastric and hepatic nodes.

The valves of the lymphatics are arranged so that lymph tend to pass from the right part of the stomach towards the lesser curvature; and from the left part of the stomach towards the greater curvature.

Innervation :

The stomach receives both sympathetic and parasympathetic innervation.

- Sympathetic fibres are derived mainly from the coeliac plexus and travel along the branches of the coeliac artery. Occasional branches also reach the stomach from the left phrenic plexus, and sympathetic trunks. These fibres are probably vasomotor. Sensory fibres carrying pain follow these sympathetic pathways to the spinal cord.
- Parasympathetic supply is from the vagus.

The anterior trunk (mainly of left vagal fibres) breaks up into anterior vagul nerves to supply the cardiac part, the body and fundus. The branch which lies along the lesser curvature between the layers of the lesser omentum is larger then others and is called greater anterior gastric nerve . A pyloric branch arises from this nerve and passes obliquely to the pyloric antrum.

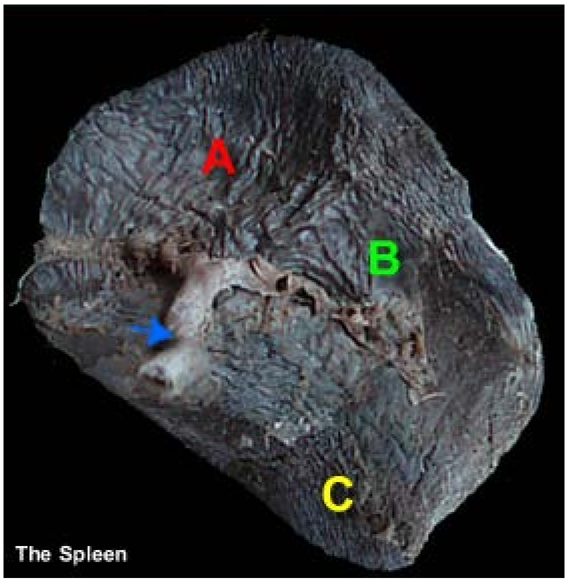
The antrum also receives a direct supply from the anterior vagal trunk by a branch which runs horizontally in the lesser omentum. Before reaching the free edge of the omentum, it runs downwards on the left of the hepatic artery to reach the pylorus. This is the nerve of Laterjet .

The posterior vagal trunk (mainly from right vagal fibres) gives branches which descend on the posterior surface of the fundus and body to the pyloric antrum.

The gastric branch which lies close to the lesser curvature is larger than others and is called the greater posterior gastric nerve , and enters the coeliac plexus. Most of the posterior vagal trunk passes to the coeliac plexus.

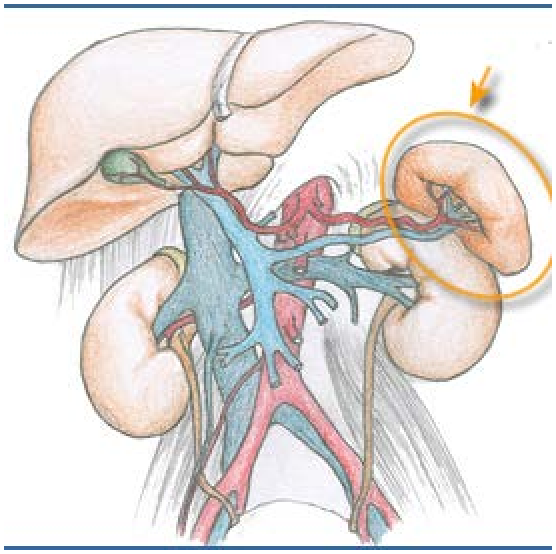
The Spleen

Position



- In the supracolic compartment of the abdominal cavity:
- left hypochondrium,
- mid-axillary line,
- related to ribs 9, 10, 11.
- Its long axis corresponds to that of the 10 th rib.

Relations



There are two surfaces;

Diaphragmatic surface:

- fits into the concavity of the diaphragm opposite ribs 9, 10, and 11.
- The costo diaphragmatic recess intervenes between.
- The lungs and pleura are important relations.

The visceral surface is related to the following organs, which make definite impressions:

  - Left kidney posteriorly
  - The colon inferiorly. Below it is the phrenicocolic ligament and the left colic flexure.
  - Stomach anteriorly. Part of the greater sac may intervene.

- The hilus of the spleen is a fissure on the inferomedial part of the gastric surface and lies in the long axis of the spleen. It transmits the splenic vessels and nerves.
- The tail of the pancreas is in contact with the visceral surface between the hilus and the colic impresssion.

Peritoneal relations

- The spleen develops as mesenchymal masses between the laters of the dorsal mesogastrium, and with growth, it expands into the greater sac of the peritoneum.
- Apart from its hilum therefore, it is covered by peritoneum.

Ligaments of the spleen (peritoneal folds)

- Gastrosplenic ligament
- Splenorenal ligament
- Sleno-phrenic ligament

What is contained in these folds?

Surface/borders

1. Visceral and diaphragmatic surfaces
2. Superior and inferior borders
3. Anterior and posterior extremities.

The superior border characteristically has one or two deep notches. This notching reflects early foetal life, and sometimes the spleen may retain fetal lobulation into adult life.

Blood supply

- The splenic artery divides into five or more segmental branches which enter the hilum.
- The splenic vein starts as 5-6 tributaries in the hilum of the spleen.
- It receives short gastric; gastroepiploic and pancreatic tributaries; finally receiving the inferior mesenteric vein.
- It unites with superior mesenteric vein to form the portal vein.

Lymphatic drainage

Lymphatics end in the pancreatico-splenic lymph nodes.

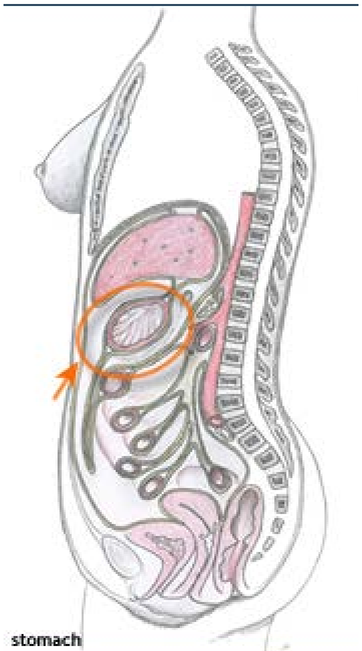
Imaging of spleen

- CT scan
- MRI
- Ultrasound
- Splenic venography

Functions

- Phagocytosis of ‘old' red blood cells and their destruction.
- Haemopoiesis in fetal life.
- Lymphocyte activities.
- Immune response.
- Erythrocyte storage.

Peritoneal relations



The stomach is completely covered by the peritoneum except for two narrow strips along the lesser and greater curvatures (where the omenta attach) and a small area behind the cardia where the stomach lies against the diaphragm.

The peritoneum covering the anterior surface faces the greater sac; the peritoneum covering the posterior surface faces the lesser sac, and forms part of the anterior wall.

These two sheets of peritoneum come together at the lesser curvature to form the hepatogastric ligament (part of lesser omentum) and at the greater curvature to form the anterior sheet of the greater omentum.

Both peritoneal ligaments extend up to the abdominal esophagus. The right edge of the abdominal esophagus is thus enclosed within the layers of the lesser omentum, whilst from the left edge, the peritoneum reflects onto the diaphragm as gastrophrenic ligament.

The stomach is virtually suspended on its omenta, and is thus a very mobile viscus.

Lesser omentum:

This is a two layered peritoneal ligament connecting the lesser curvature of the stomach and the adjoining upper edge of the duodenum to the margins of the porta hepatis and the fissure for ligamentum venosum of the liver.

It consists of two ligaments:

- Hepatogastric
- Hepatoduodenal

The two layers of the lesser omentum are continuous with the serous coats of the liver, stomach and duodenum.

The right edge of the lesser omentum is free and contains:

- Common bile duct on the right.
- The hepatic artery on the left.
- The portal vein behind and between the two.

To the left of this trio, the right and left gastric arteries run between the two layers. The lesser omentum, in addition contains:

Nerve plexuses which accompany the arteries
- Lymphatics
- Lymph nodes and fat.

The greater omentum:

This is an apron-like fold of peritoneum which hangs from the greater curvature of the stomach and the lower part of the first part of the duodenum.

It consists of two layers of peritoneum, continuous at the greater curvature with the anterior and posterior serous coats of the stomach. These two layers are fused and folded back on themselves, below the transverse colon, forming a free lower edge.

It contains:

- Extraperitoneal fat
- Gastroepiploic vessels and their nerve plexuses
- Lymphatics
- Lymph nodes
- Fat

It consists of 3 parts:

- Gastrosplenic ligament containing:
    - Short gastric vessels and their nerve plexus
    - Lymphatics
    - Lymph nodes and fat.
- Gastrophrenis ligament
- Gastrocolic ligament containing mainly fat, lymphatics and lymph nodes

Functions:

- Fat depot
- Mechanical cushion
- Protective “policeman” of the abdominal cavity – tends to adhere to any areas of inflamed peritoneum, with which it may come into contact, and thus often prevents the escape of the contents of a hollow viscus which may have perforated.
