ANATOMY & PHYSIOLOGY CLUSTER B.

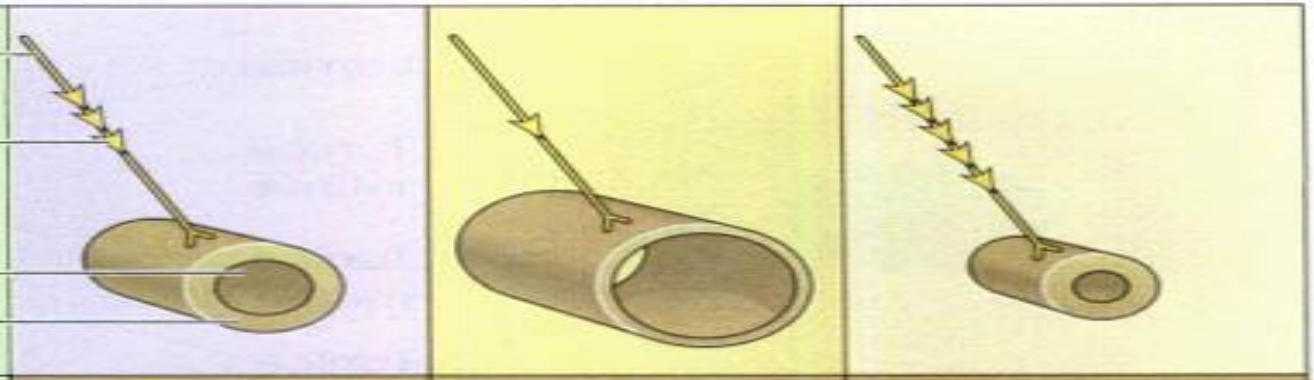
- **Cardiovascular System cont'd**

By: L. Ayora

Control of blood vessel diameter

- Sympathetic nervous system
  - Vasomotor centre
- Autoregulation
  - **Exercise;** e.g. lactic acid accumulation in muscle causes vasodilatation
  - **Hypoxia;** vasodilatation follows an episode of reduced tissue blood flow
  - **Tissue damage;** e.g. in inflammation, mediators such as histamine, prostaglandins and bradykinin lead to vasodilatation

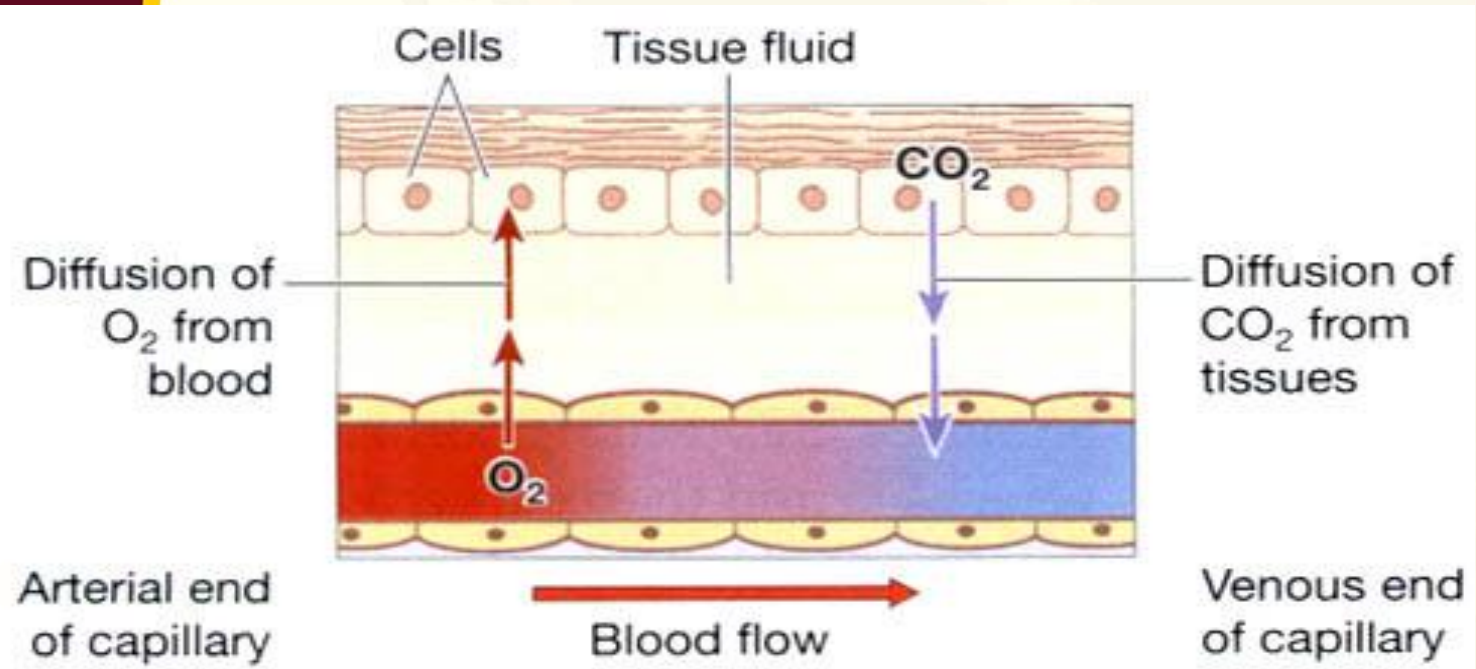
The relationship between sympathetic stimulation and blood vessel diameter.



	Resting situation	Vasodilatation	Vasoconstriction
Sympathetic stimulation	Moderate	Decreased	Increased
Smooth muscle	Moderate tone	Relaxed	Contracted
Thickness of vessel wall	Moderate	Thinner	Thicker
Diameter of lumen	Moderate	Increased	Decreased
Peripheral resistance in arterioles	Moderate	Decreased	Increased

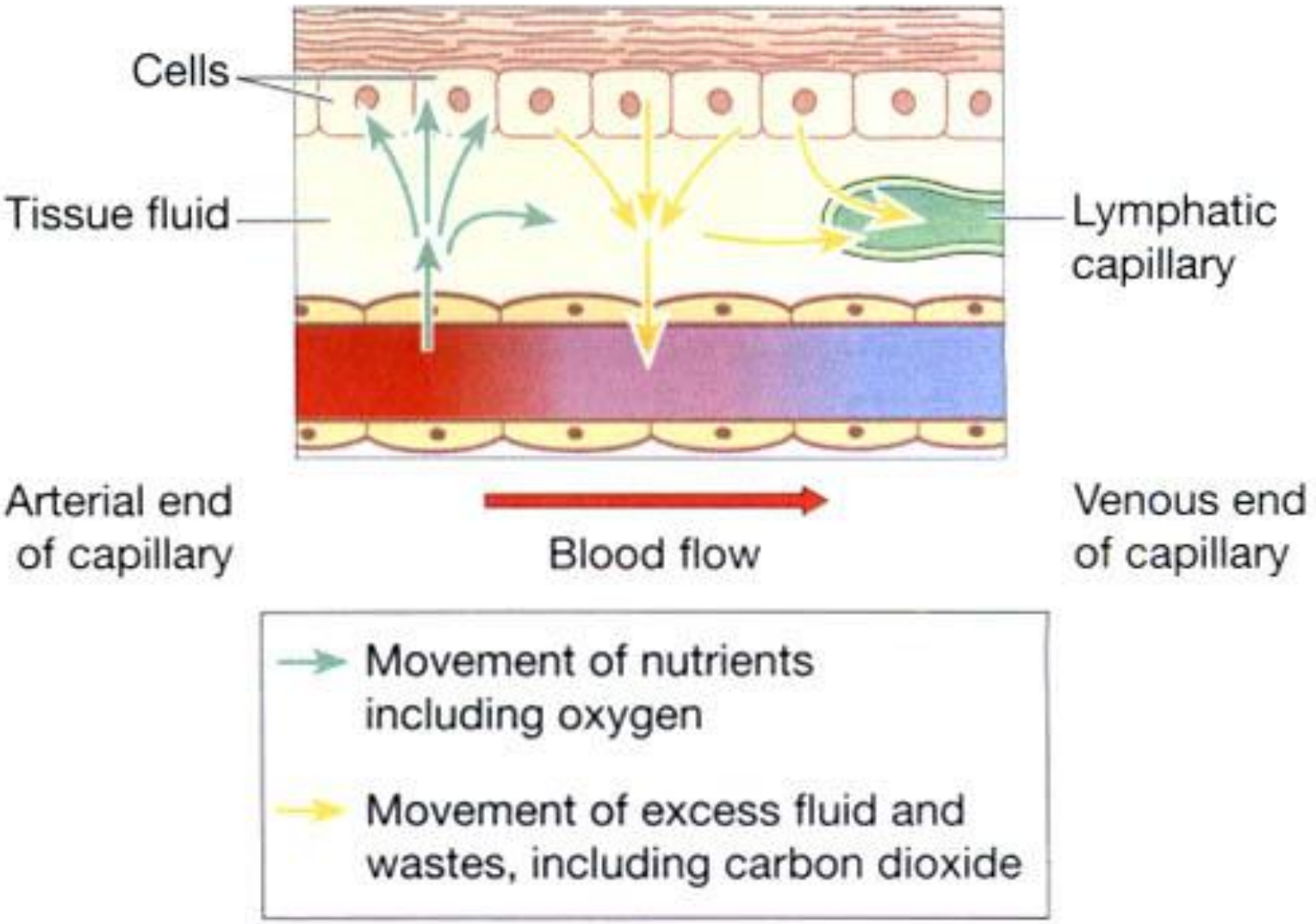
Internal respiration

- Exchange of gases between capillary blood and local body cells



The exchange of gases in internal respiration

Diffusion of nutrients and waste products between Diffusion of nutrients and waste products between



Effect of capillary pressures on water movement between capillaries and cells.

Objectives

By the end of the lesson, the learner should be able to:

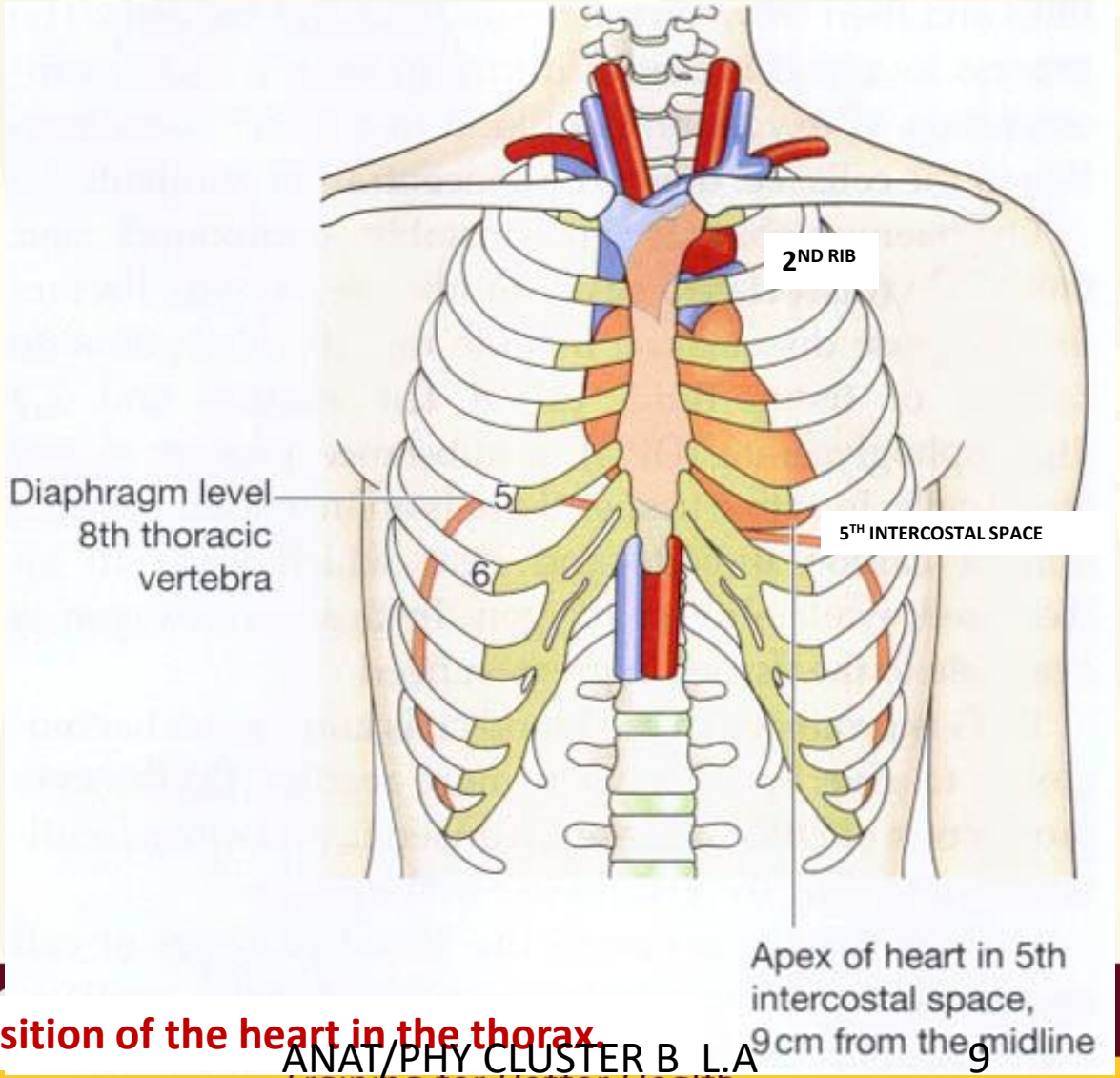
- Describe the structure of the heart and its position within the thorax
- Trace the circulation of the blood through the heart and the blood vessels of the body
- Outline the conducting system of the heart
- Relate the electrical activity of the cardiac conduction system to the cardiac cycle
- Describe the main factors determining heart rate and cardiac output.

Heart.

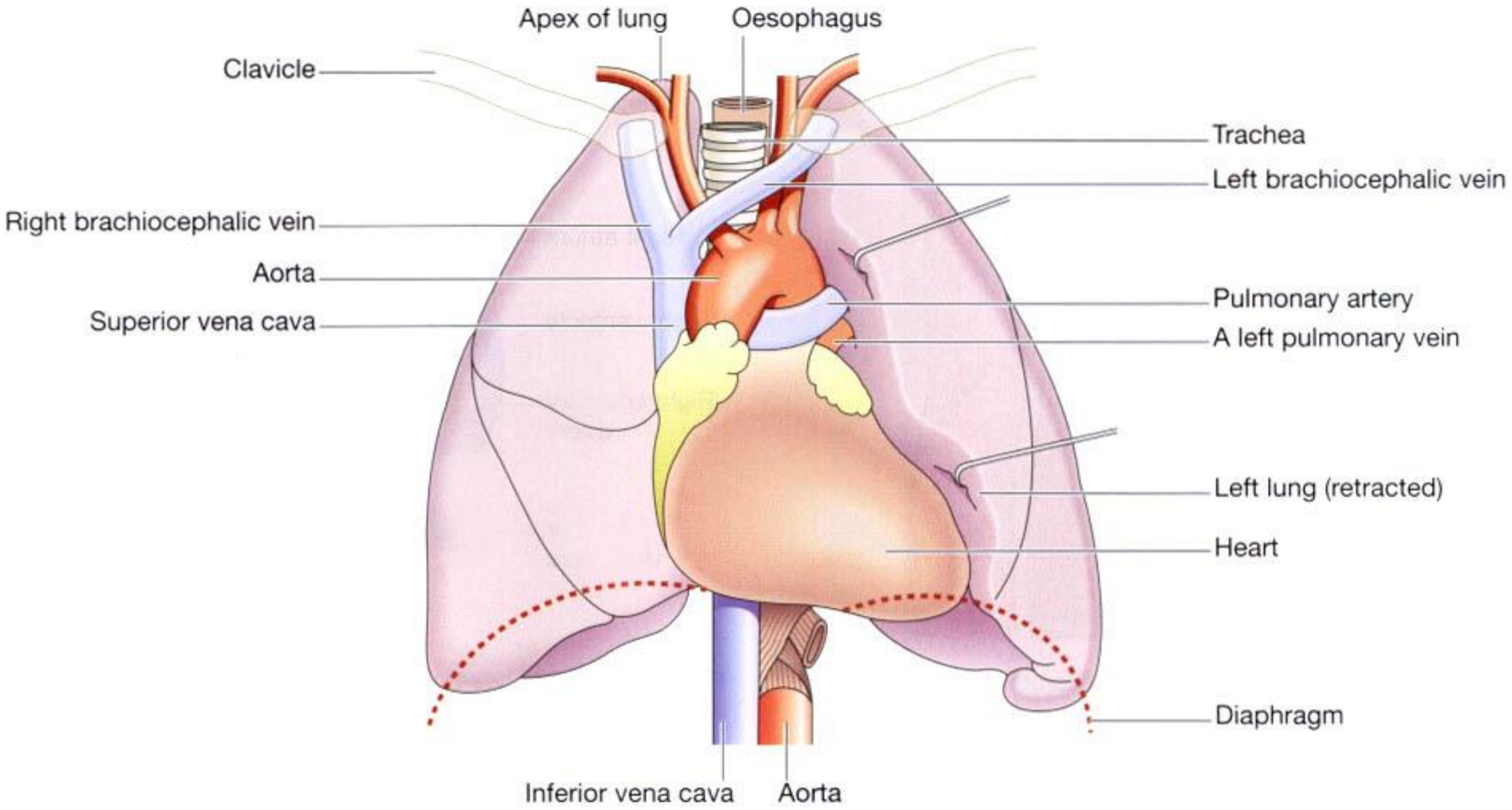
- cone-shaped hollow muscular organ.
- It is about 10 cm long and is about the size of the your fist.
- It weighs about 225 g in women and is heavier in men (about 310 g).

Position

T_8



Position of the heart in the thorax.


Apex of lung
Oesophagus
Clavicle
Trachea
Left brachiocephalic vein
Right brachiocephalic vein
Aorta
Pulmonary artery
Superior vena cava
A left pulmonary vein
Left lung (retracted)
Heart
Diaphragm
Inferior vena cava
Aorta

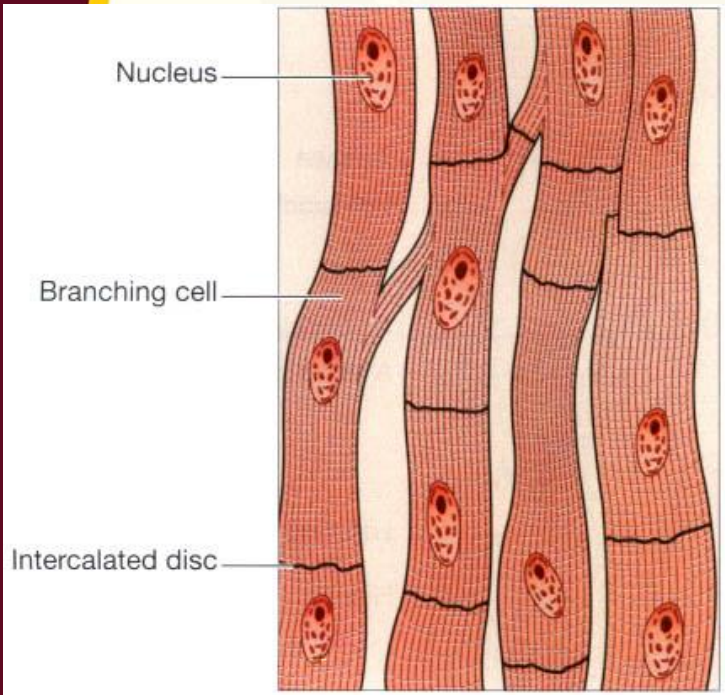
Structure

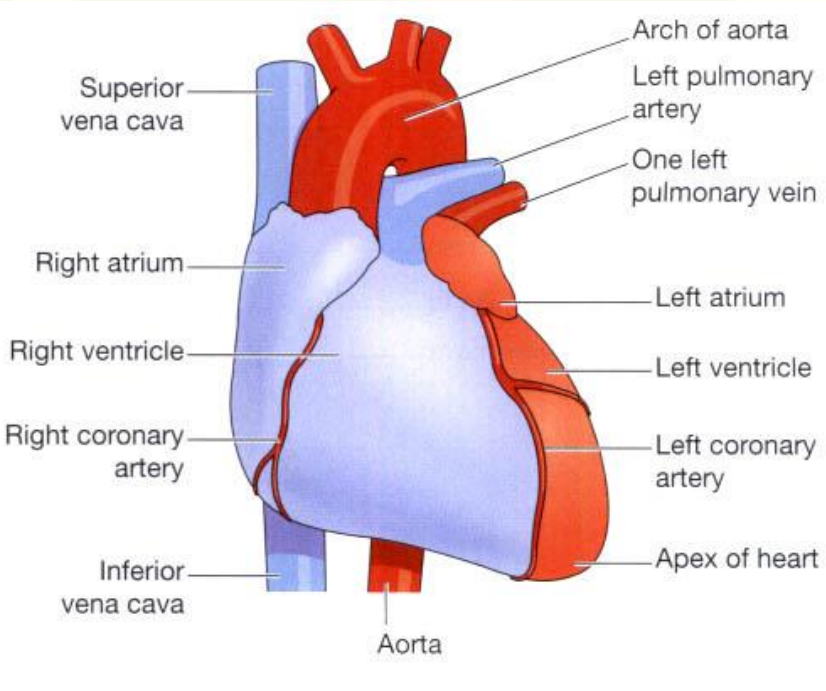
- The heart is composed of three layers of tissue:
  - Pericardium,
  - Myocardium and
  - Endocardium.

Layers of the heart wall.

(Epicardium)

Myocardium





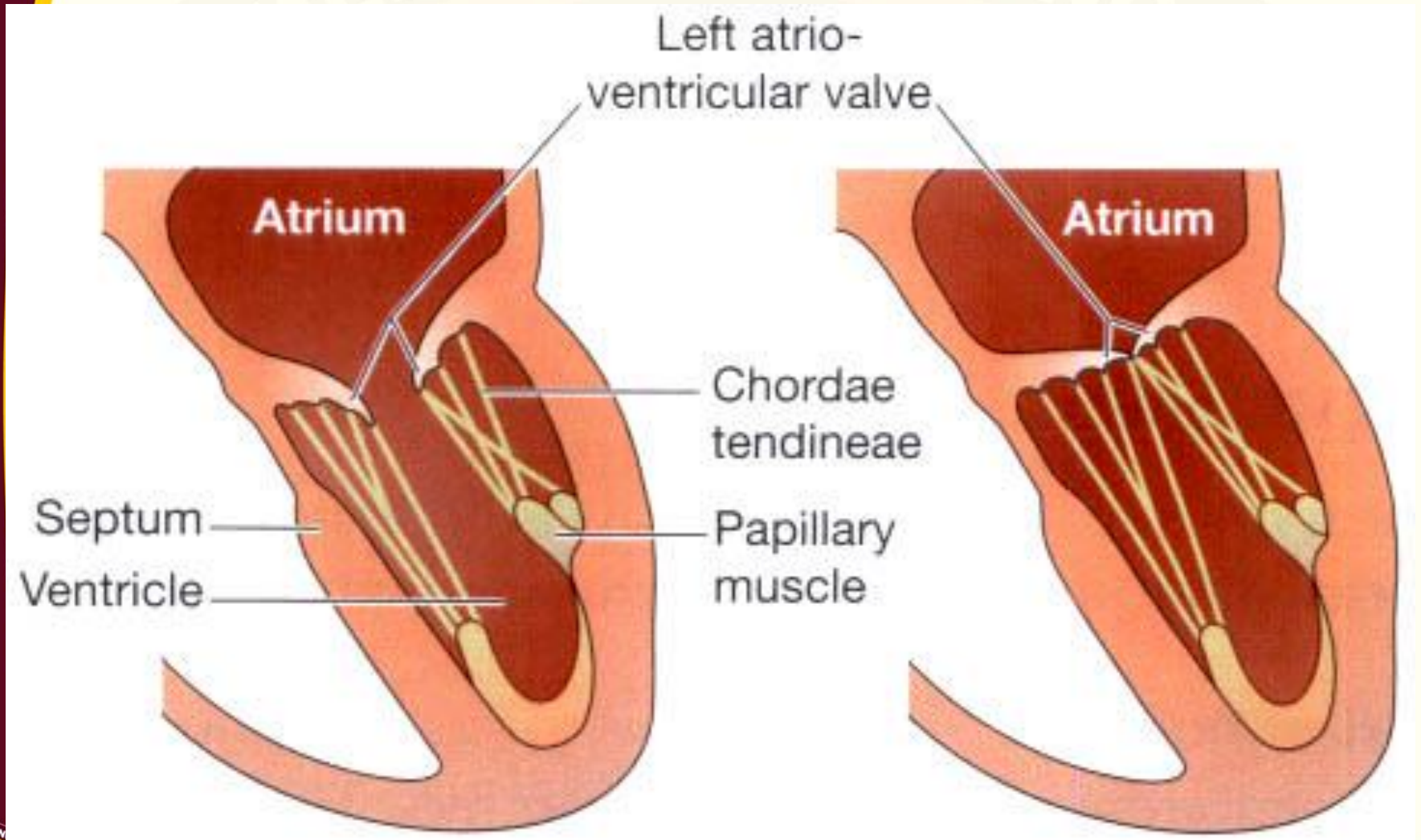
Cardiac muscle showing intercalated discs

The myocardium is thickest at the apex and thins out towards the base

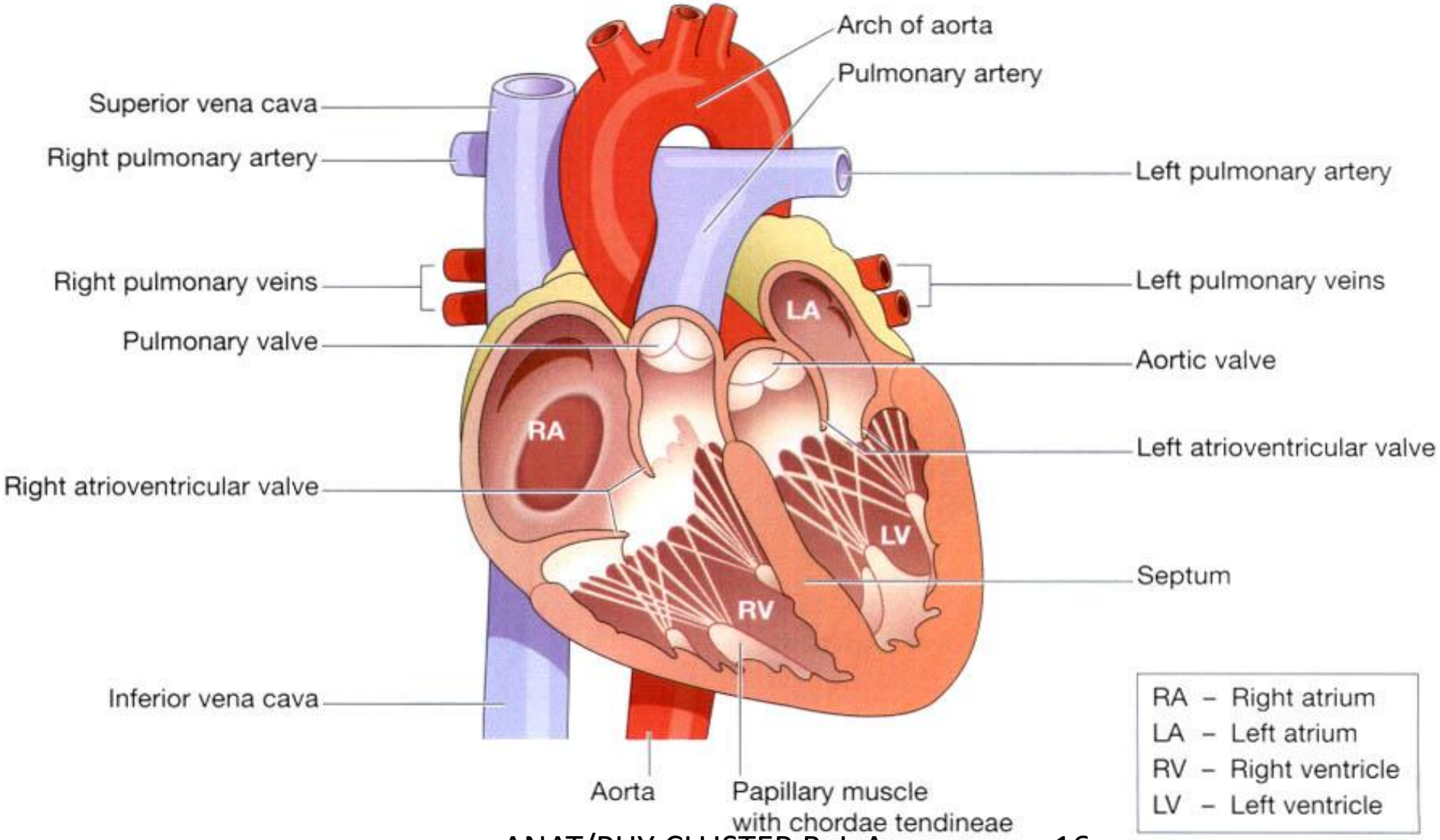
Endocardium

- Forms the lining of the myocardium and the heart valves.
- Flattened epithelial cells

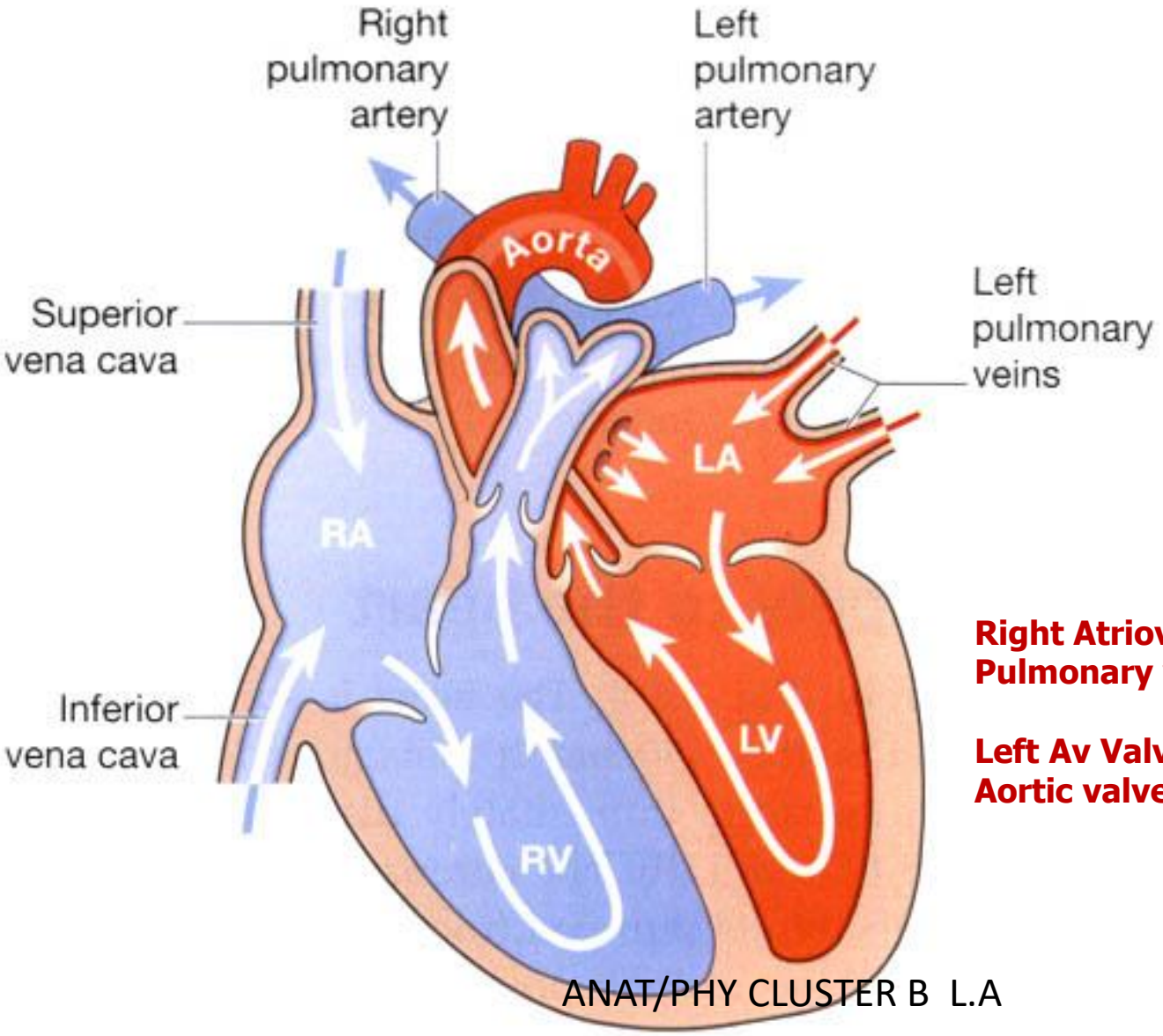
Interior of the heart



Interior of the heart



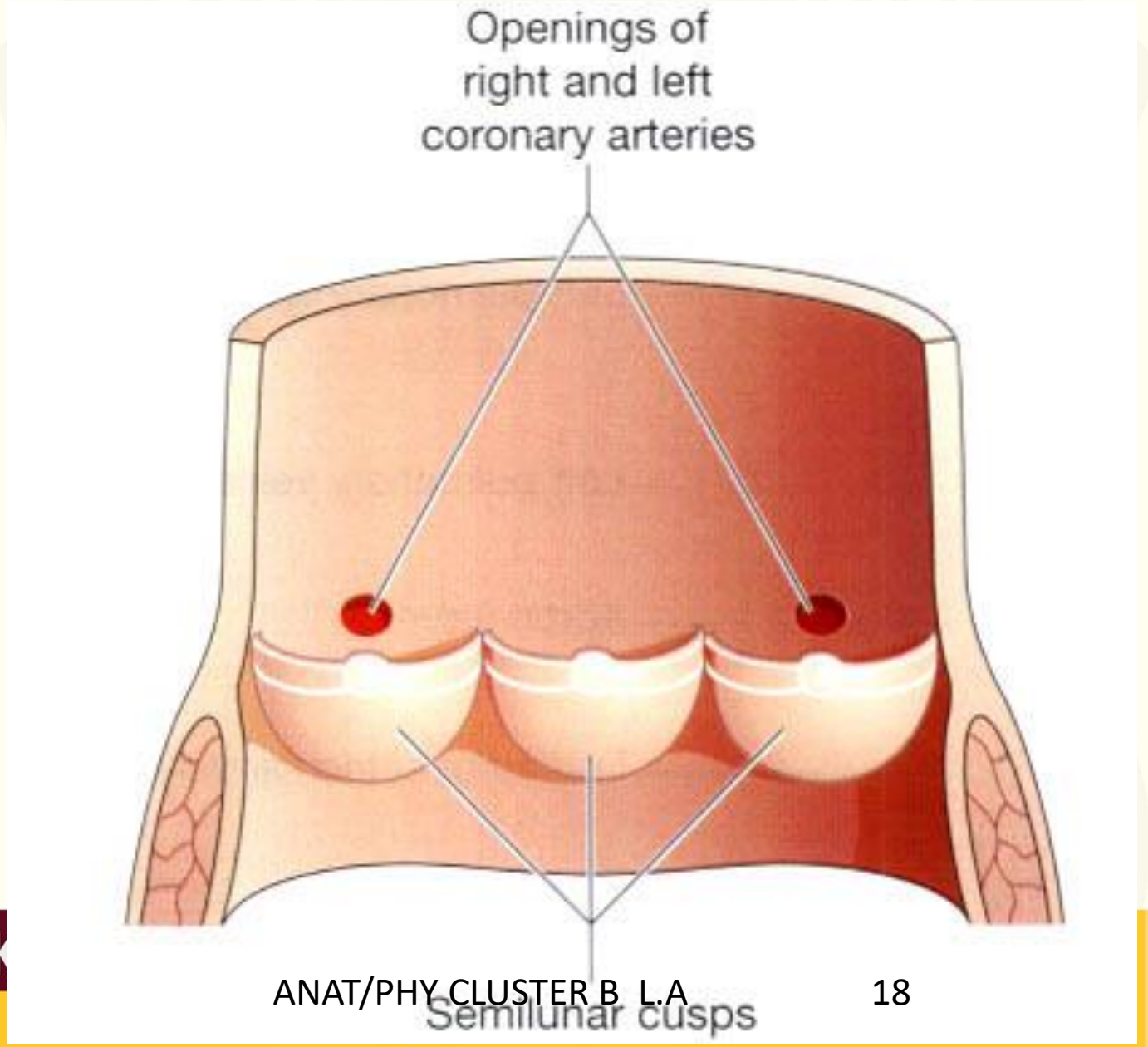
Flow of blood through the heart



Right Atrioventricular = Tricuspid
Pulmonary valves = 3 semilunar cusps

Left Av Valve = Bicuspid / Mitral
Aortic valve: 3 semilunar cusps

Aorta…

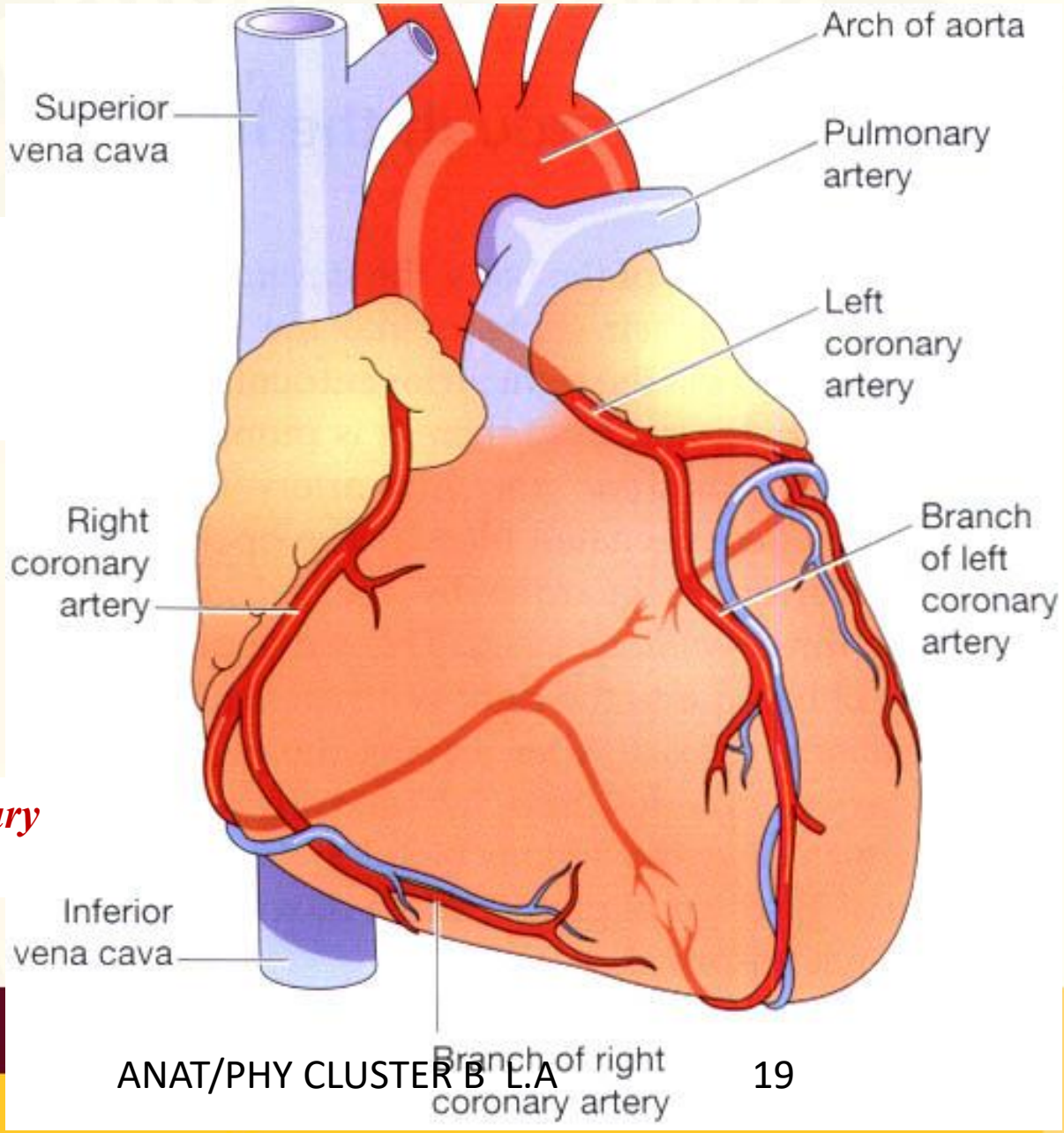

Openings of
right and left
coronary arteries
Semilunar cusps

Blood supply to the heart

The coronary arteries.

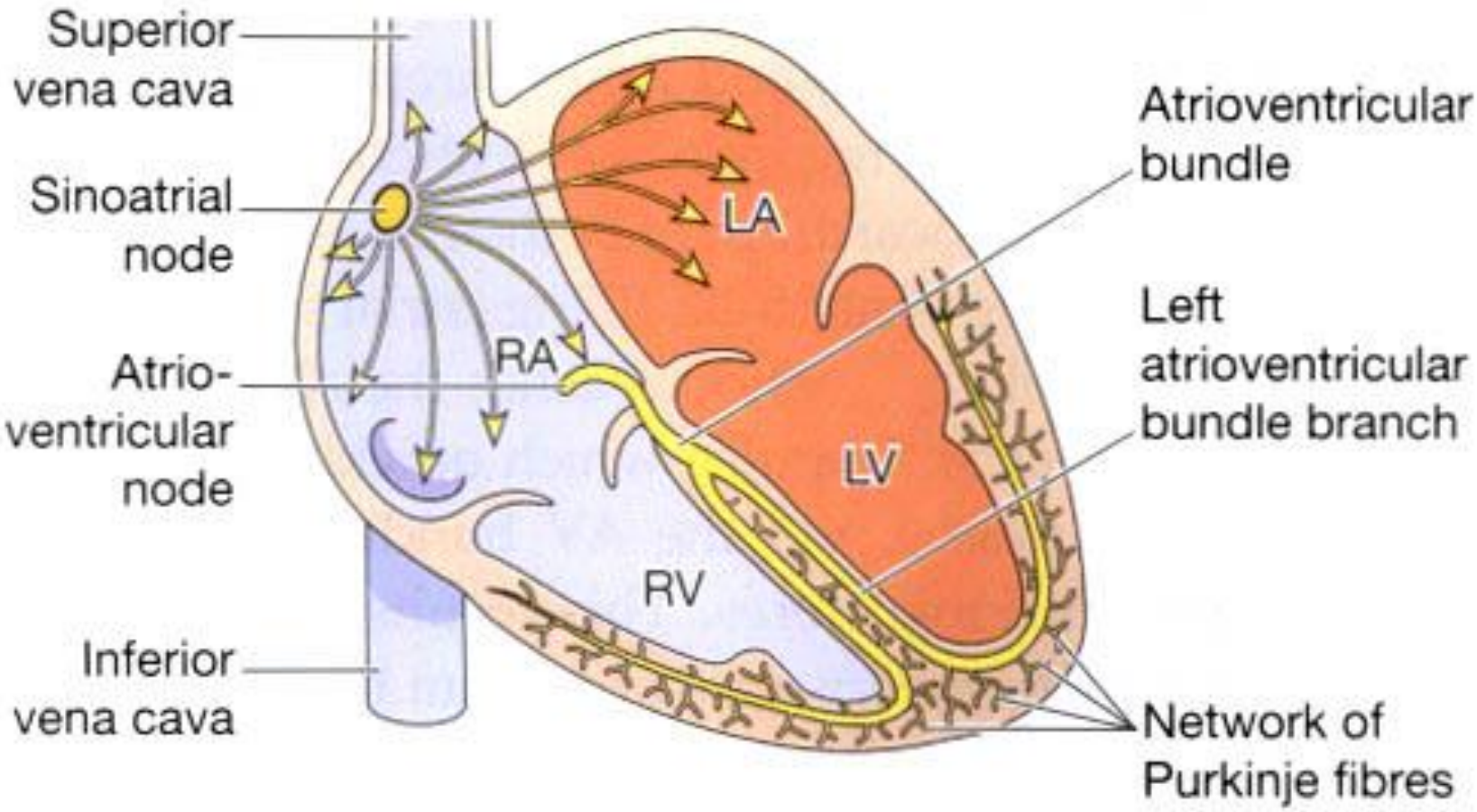
Receives 5% of blood pumped!

Venous Drainage: Coronary sinus



Conducting system of the heart

Neuromuscular Cells In The Myocardium



Nerve supply to the heart

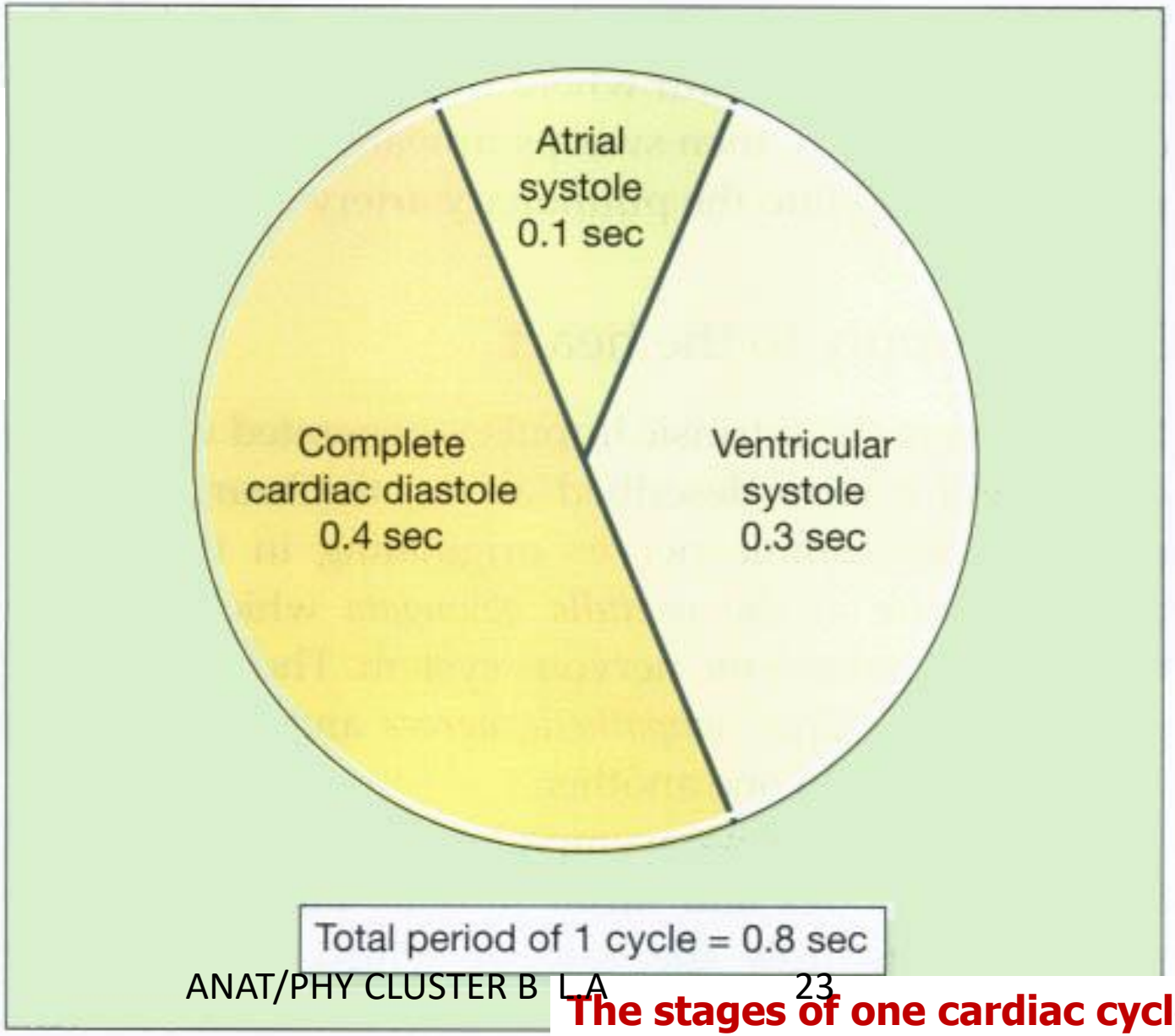
- *ANS [**Cardiovascular centre** in Medulla Oblongata]*
  - *Sympathetic NS*
  - *Parasympathetic NS*
    - *Vagus nerve*
- *Effect of sympathetic and parasympathetic nervous stimulation?*

Factors affecting heart rate

- Autonomic nervous system
- Circulating chemicals
- Position: upright vs lying down
- Exercise
- Emotional state
- Age
- Gender: F>M
- Temperature

The cardiac cycle

Systole Vs Diastole



The stages of one cardiac cycle.

Heart sounds

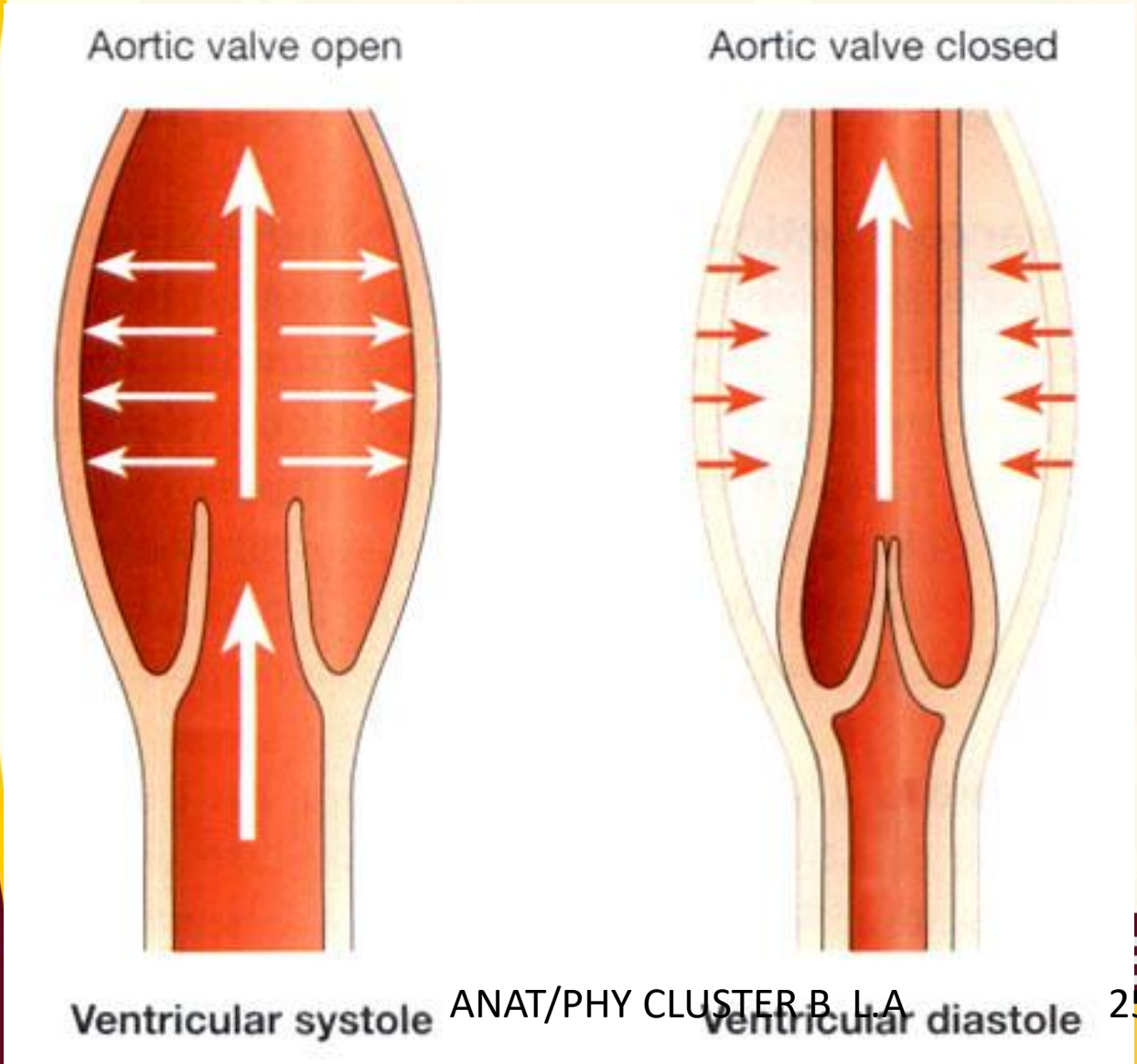
- *'lub dup'.*
  - The first sound, *'lub',* is fairly loud
    - Closure of the atrioventricular valves.

      This corresponds with **ventricular systole.**

- The second sound, *'dup',* is softer
  - due to the closure of the aortic and pulmonary valves.

    Corresponds with **atrial systole.**

Recall that…



Aorta is an elastic blood vessel

Electrical changes in the heart

- **Electrocardiograph** *[Apparatus]*
- **Electrocardiogram** (ECG) [Tracing].

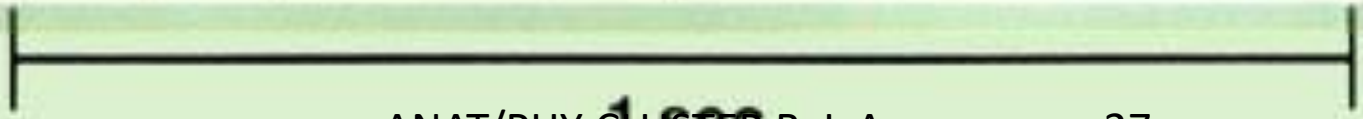
Electrical changes in the heart

QRS Complex: Ventricular systole

Atrial systole .

Ventricular relaxation

Electrocardiogram of one cardiac cycle.



Terminologies…

- Sinus rhythm: 60-100 beats/min
  - Origin: SAN
- Tachycardia: Faster heart rate
- Bradycardia: Slower heart rate

Cardiac Output.

- Amount of blood ejected from the heart.
- Cardiac output = Stroke volume x Heart rate.
  - Stroke volume depends on:
    - Ventricular End-Diastolic Volume [Preload]
      - Preload depends on Venous return
- Increased VEDV leads to stronger myocardial contraction

Note.

- The capacity to increase the stroke volume with increasing VEDV is **finite**

Quiz

- What is the cardiac output for an adult who's stroke volume is 75ml and has a heart rate of 74 beats per minute?

Answer:

- Cardiac output = Stroke volume x Heart rate.

C.O = 75ml X 74 bpm

= 5550 ml/Min

= 5.5L/min

- **What are the factors affecting CO?**

Box 5.1 Summary of factors affecting cardiac output

Cardiac output = Stroke volume × Heart rate

Factors affecting stroke volume:

- VEDV (ventricular end-diastolic volume)
- Venous return
  - position of the body
  - skeletal muscle pump
  - respiratory pump
- Strength of myocardial contraction
- Blood volume.

Factors affecting heart rate:

- Autonomic nerve stimulation
- Circulating chemicals
- Activity and exercise
- Emotional states
- Gender
- Age
- Body temperature
- Baroreceptor reflex.

BLOOD PRESSURE

Objectives

By the end of the lesson, learners should be able to:

i. Define the term blood pressure

ii. Describe the main control mechanisms for regulation of blood pressure

Blood Pressure

- **Definition**
  - **Blood pressure is the force or pressure which the blood exerts on the walls of the blood vessels.**

- **Systolic blood pressure.**
  - **120 mmHg**

Left ventricle contraction

- **Distolic blood pressure.**
  - **80 mmHg**

During complete cardiac diastole

- **Pulse pressure = Systolic P – Diastolic P**

Sphygmomanometer

$$\text{BP} = \frac{120}{80}\ \text{mmHg} \qquad \text{or} \ \frac{16}{11}\ \text{kPa}$$

Blood pressure = Cardiac output x Peripheral resistance

Control of blood pressure (BP)

- **Short-term control**
  - Baroreceptor reflex, chemoreceptors, hormones
- **Long-term control**
  - kidneys and the renin—angiotensin—
  - aldosterone system [R-A-A system]

Blood pressure control

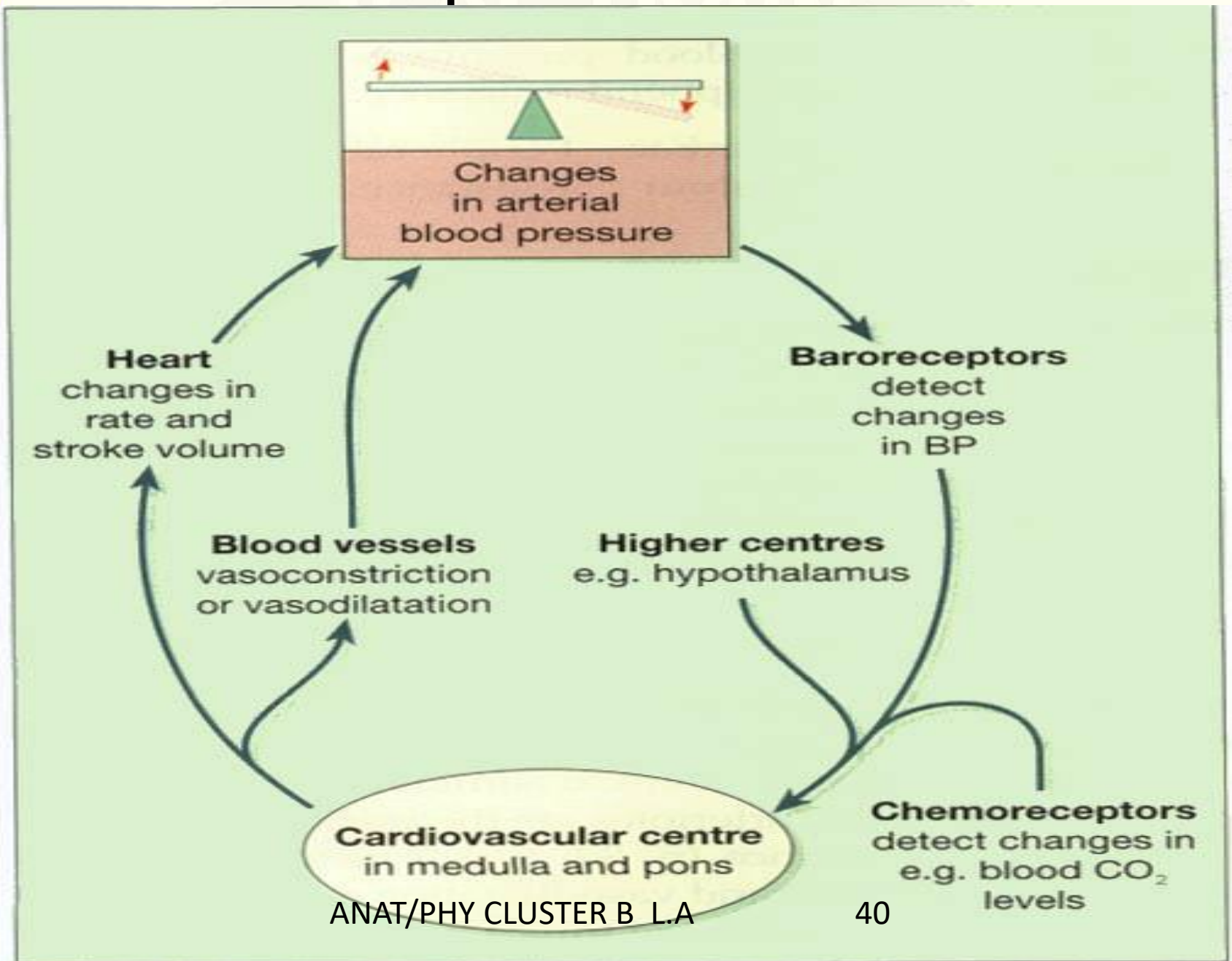
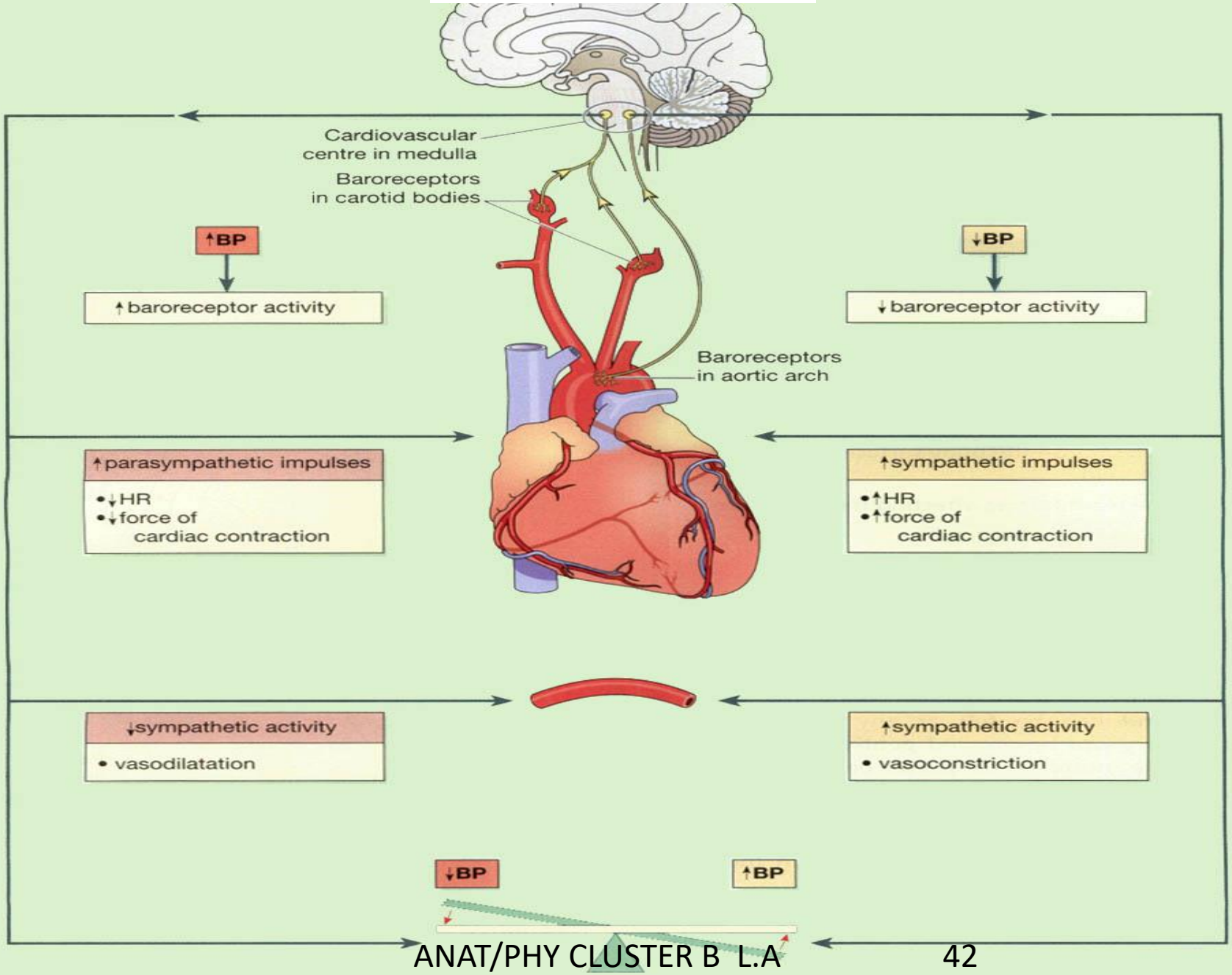


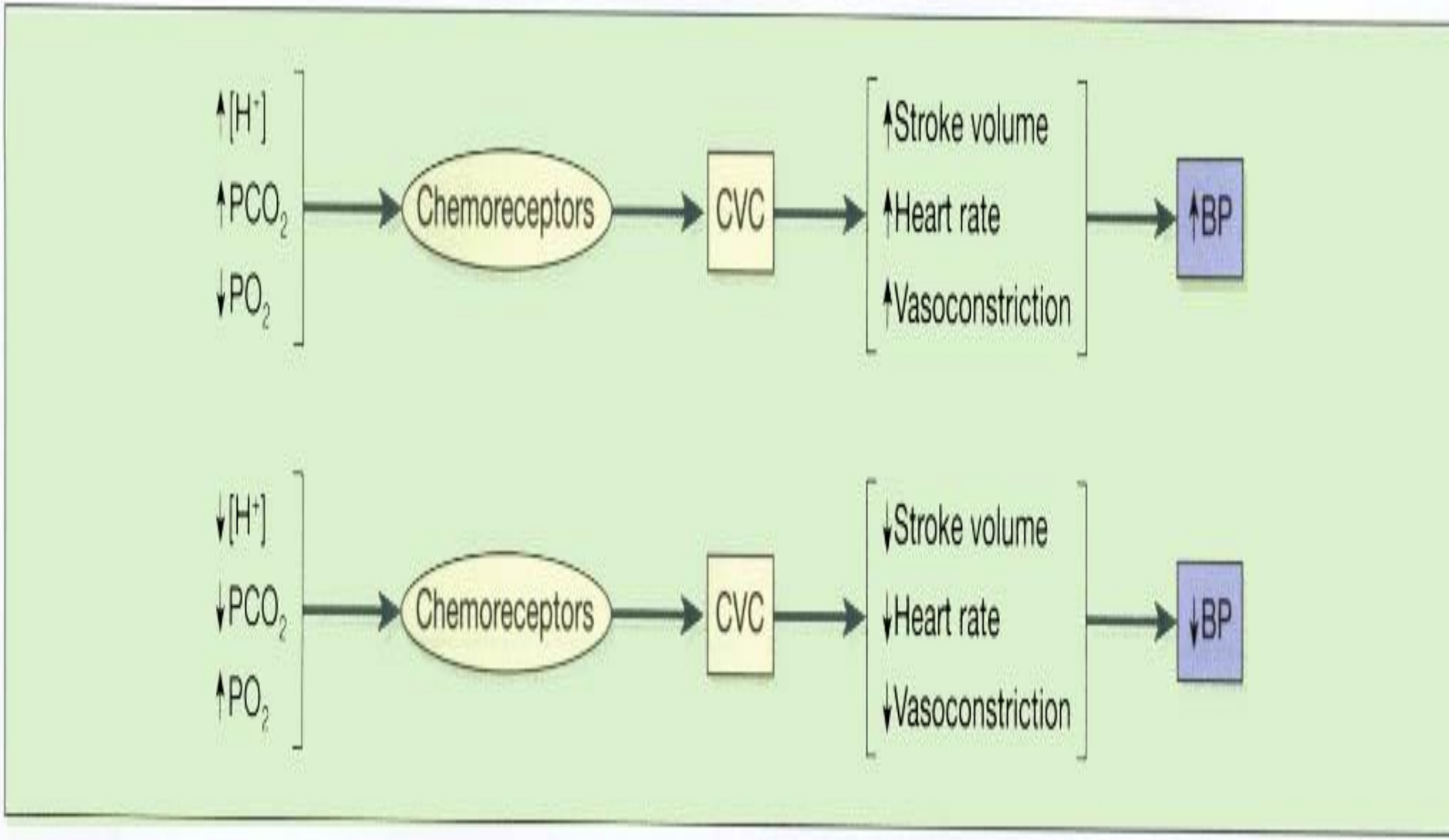
Table 5.1 The sympathetic and parasympathetic nervous systems

	Sympathetic stimulation	Parasympathetic stimulation
Heart	↑Rate ↑Strength of contraction	↓Rate ↓Strength of contraction
Blood vessels	Most constrict	There is little parasympathetic innervation to most blood vessels

The baroreceptor reflex.



The relationship between stimulation of chemoreceptors and arterial blood pressure

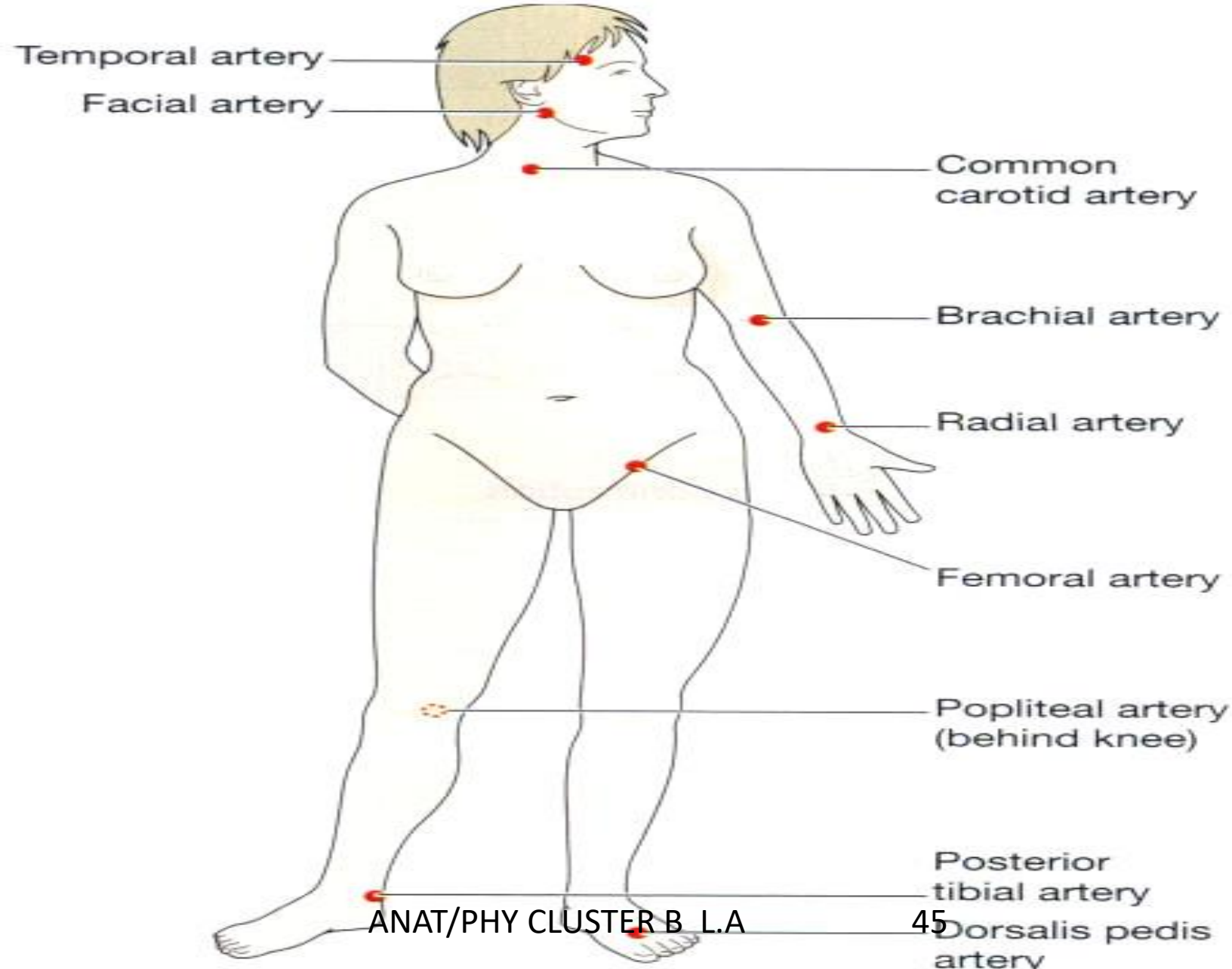


Pulse

- Wave of distension and elongation felt in an artery wall due to the contraction of the left ventricle

- 60-80 beats/min [rate]
- regularity
- Volume or strength

Pulse sites


Temporal artery
Facial artery
Common carotid artery
Brachial artery
Radial artery
Femoral artery
Popliteal artery (behind knee)
Posterior tibial artery
Dorsalis pedis artery

Quiz

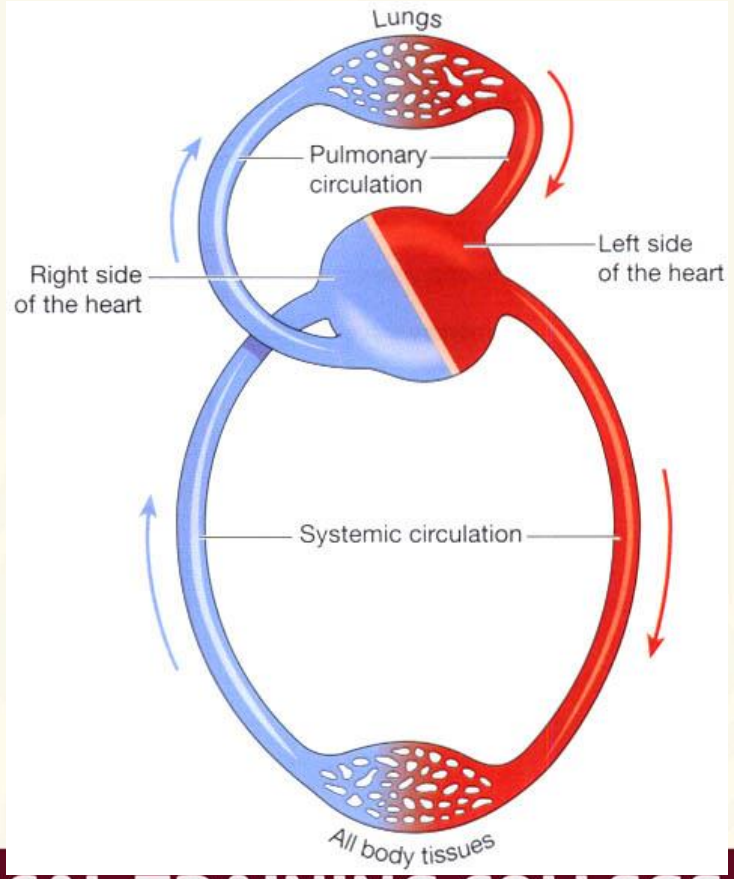
- **State seven factors that affects the pulse rate**

Next lesson:

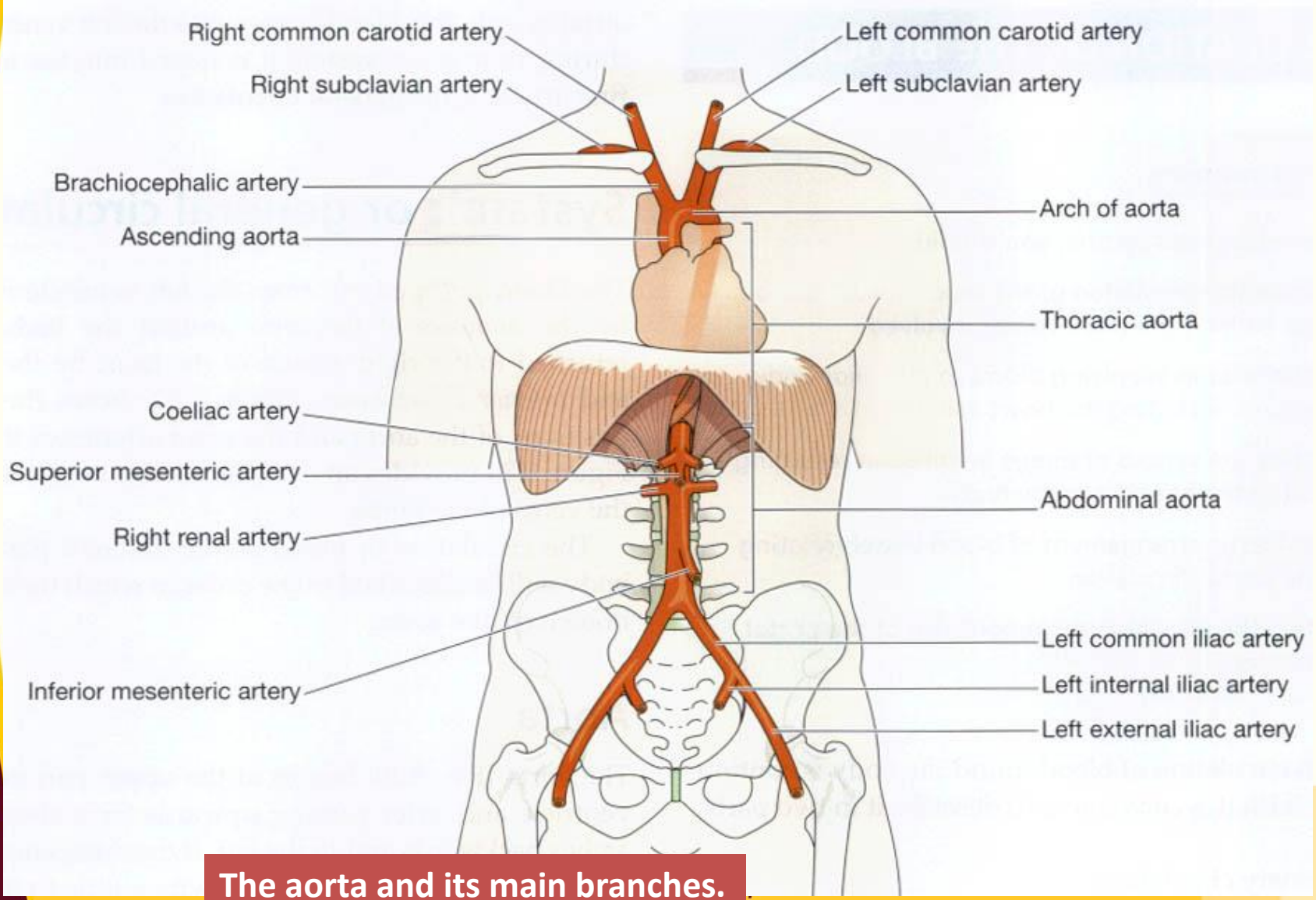
- To review assignment on **CIRCULATION** of blood.
  - –Pulmonary circulation
  - –Systemic circulation

CIRCULATION OF THE BLOOD

- **Pulmonary circulation**

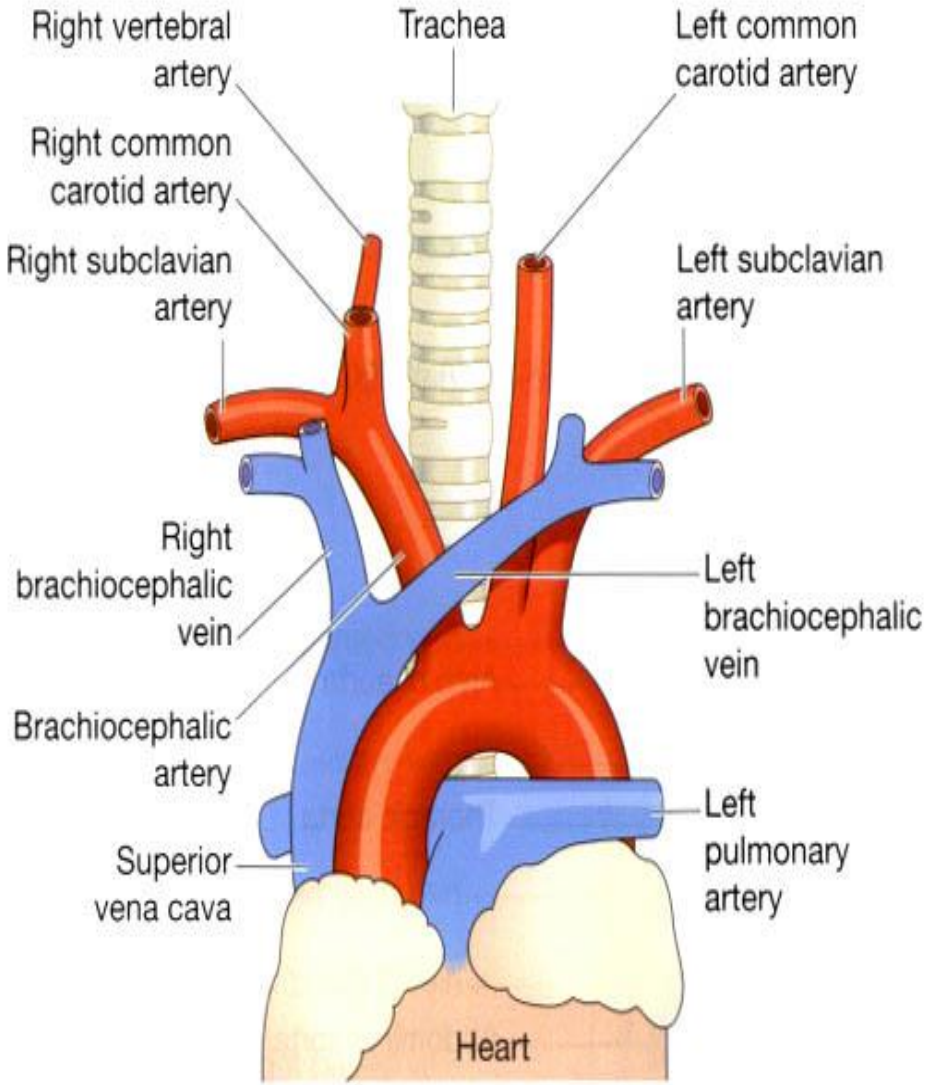


Systemic or general circulation

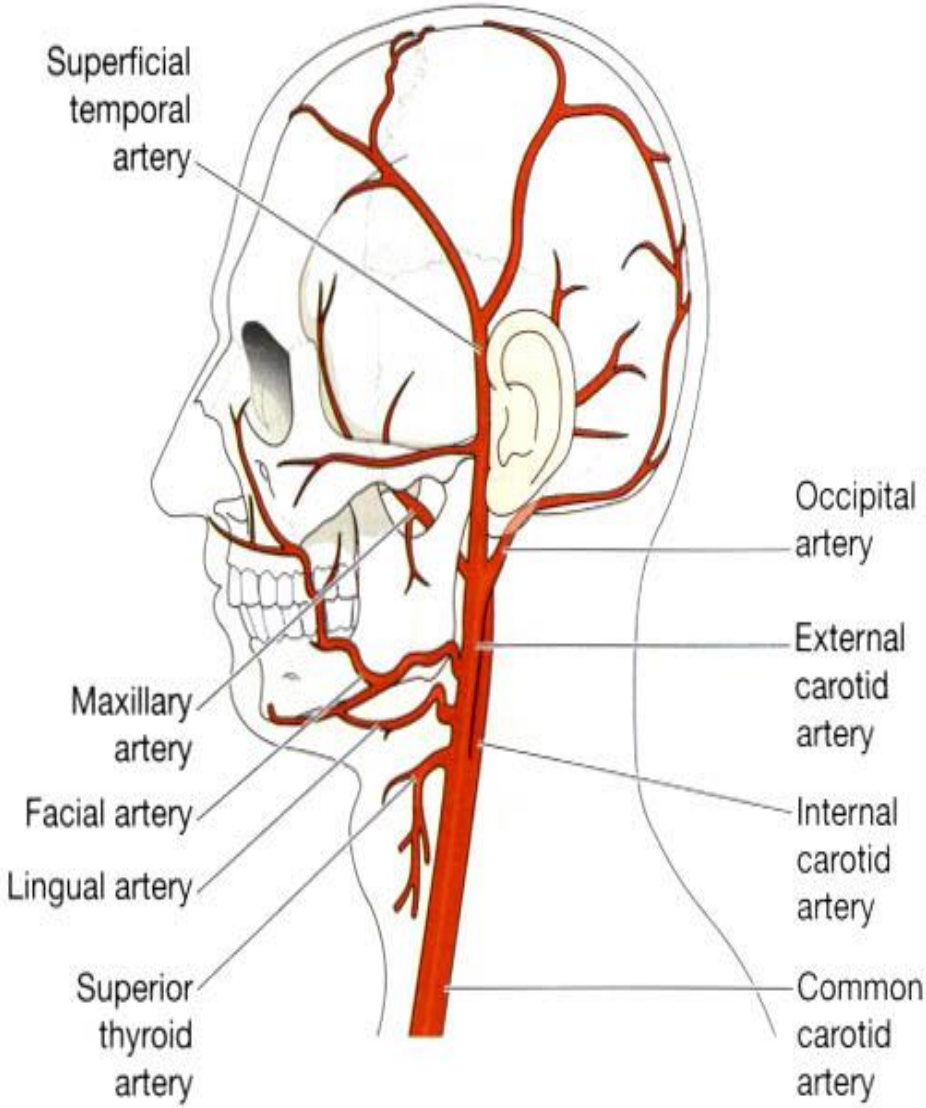


The aorta and its main branches.

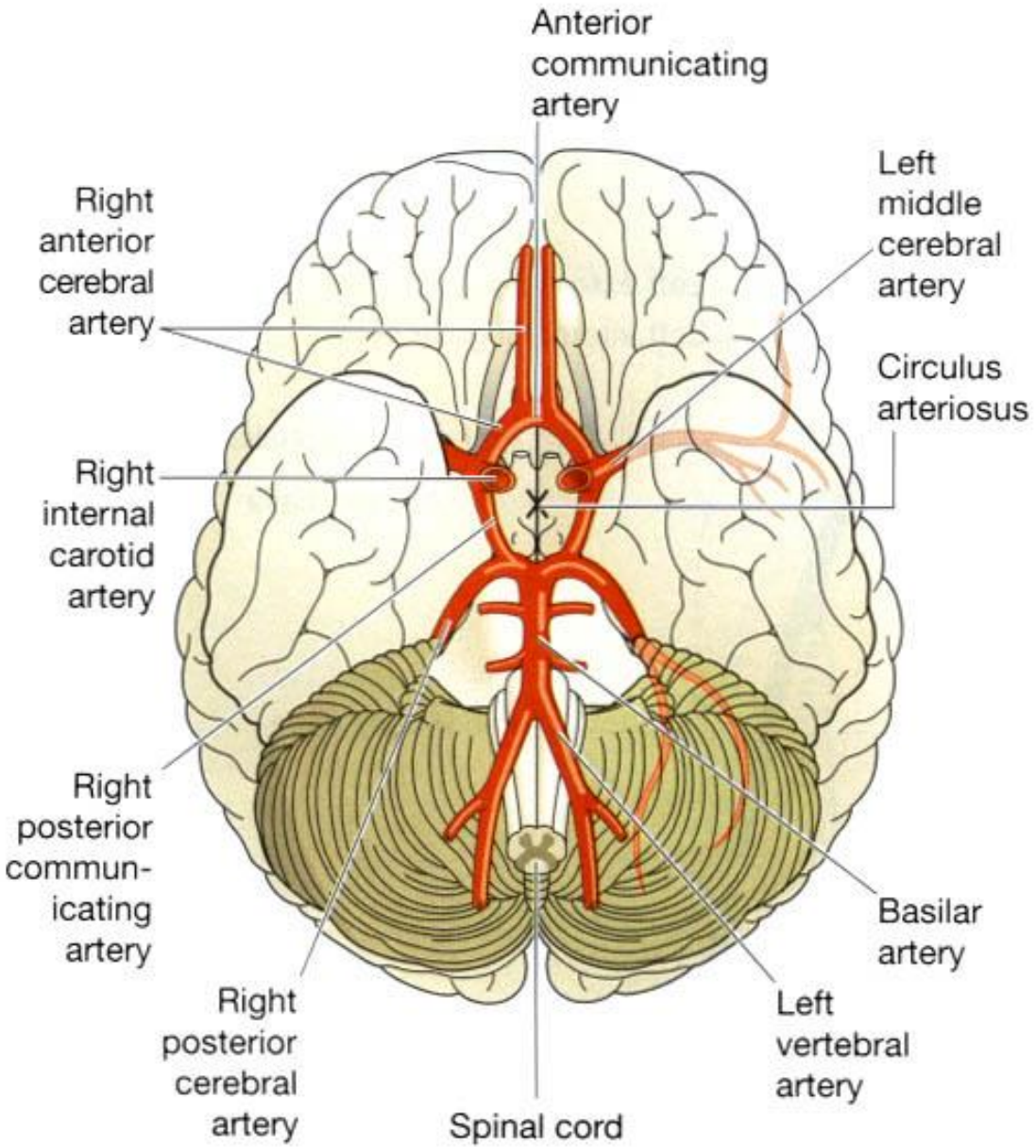
The arch of the aorta and its branches.



Main arteries of the left side of the head and neck.

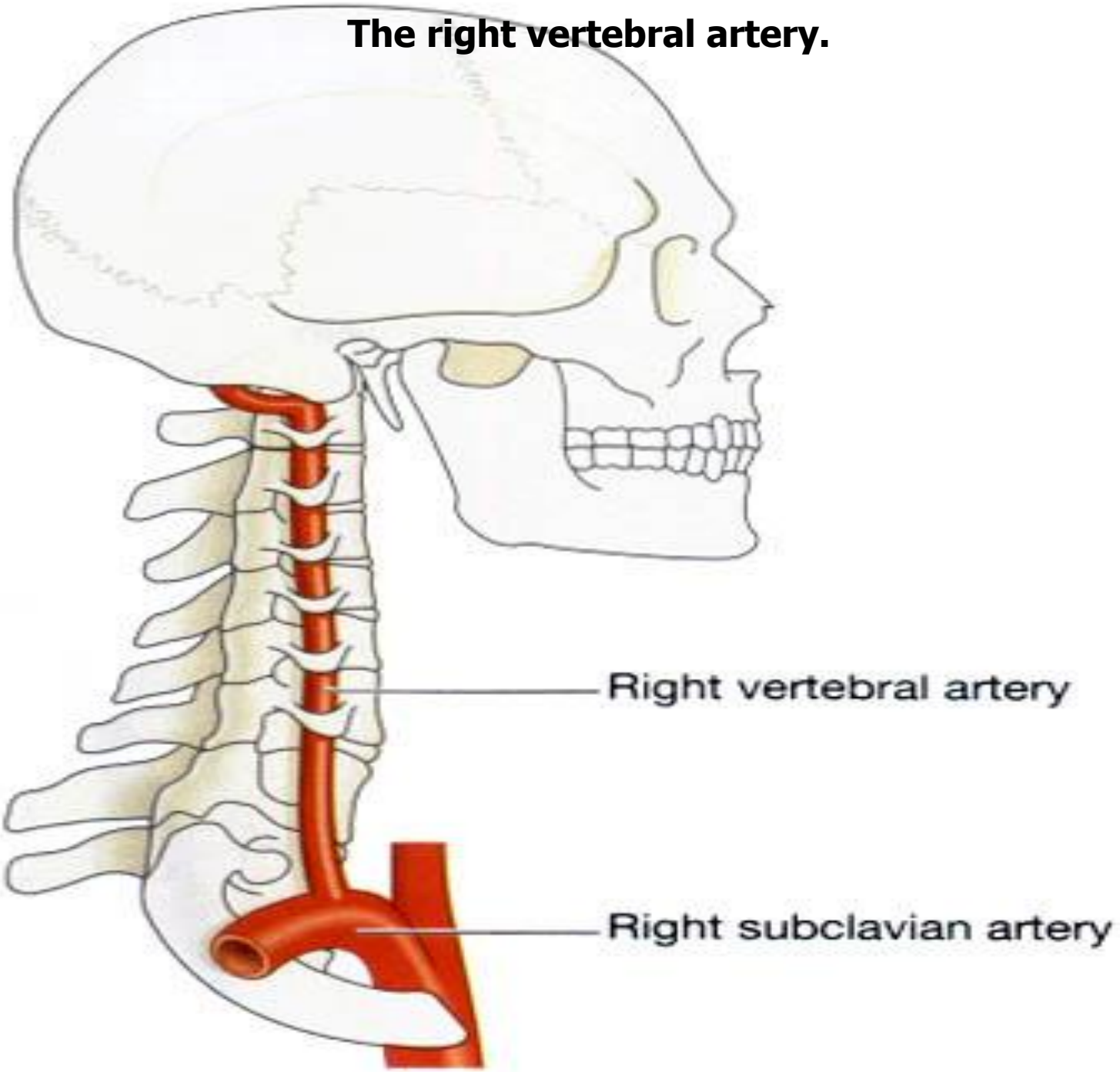


Circulus arteriosus (circle of Willis).



- **2 anterior cerebral arteries**
- **2 internal carotid arteries**
- **1 anterior communicating artery**
- **2 posterior communicating arteries**
- **2 posterior cerebral arteries**
- **1 basilar artery.**

The right vertebral artery.



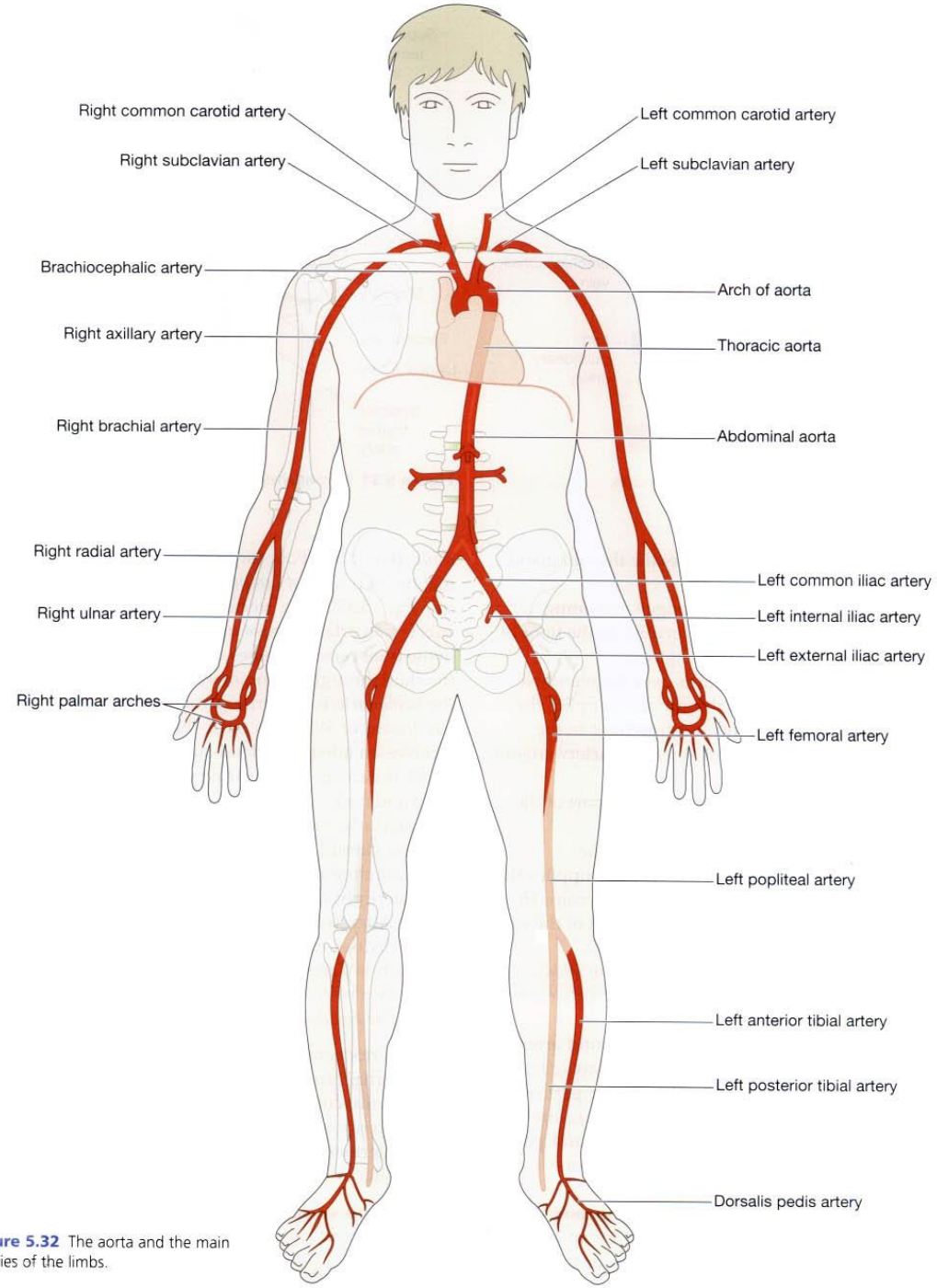
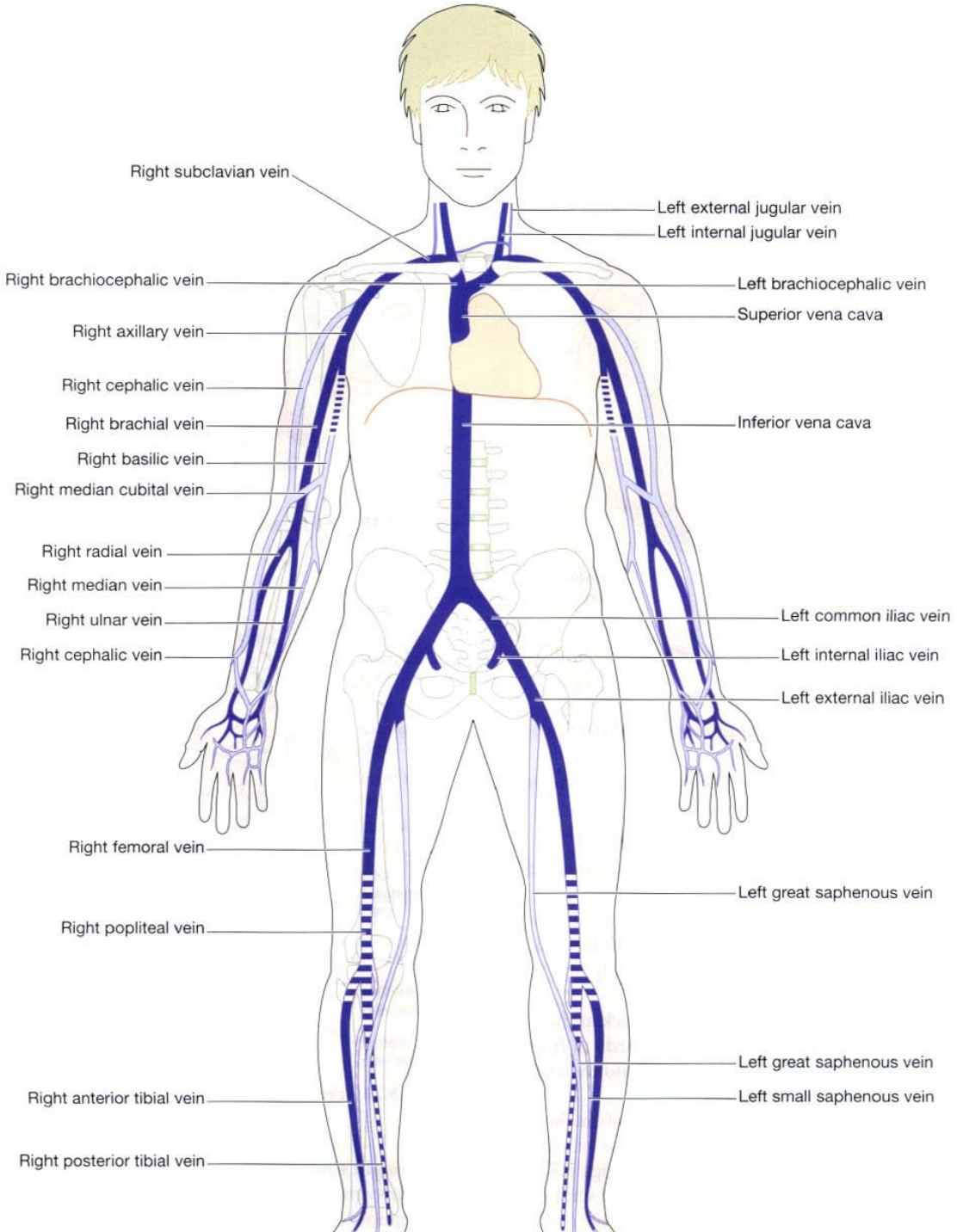
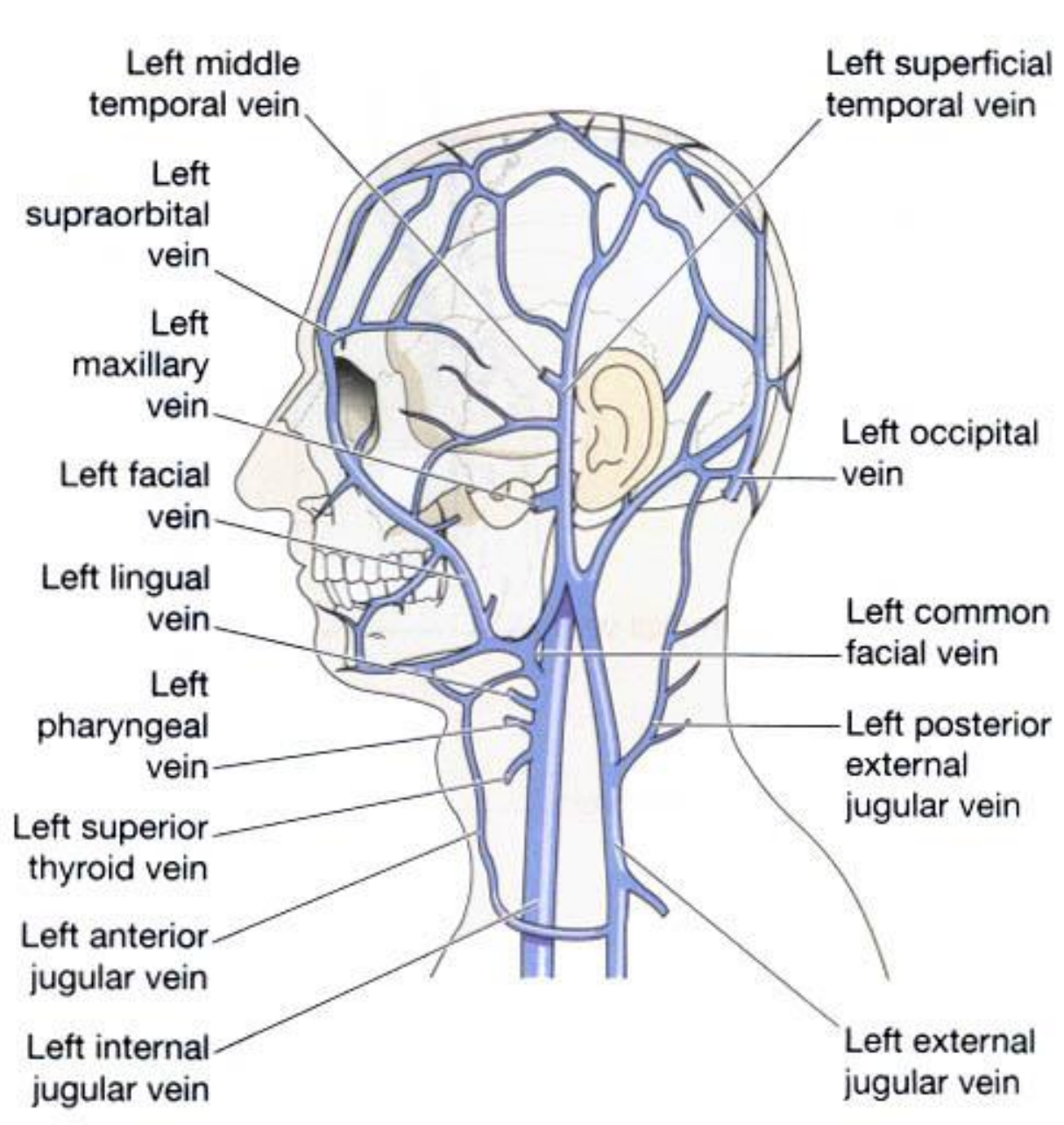


Figure 5.32 The aorta and the main arteries of the limbs.

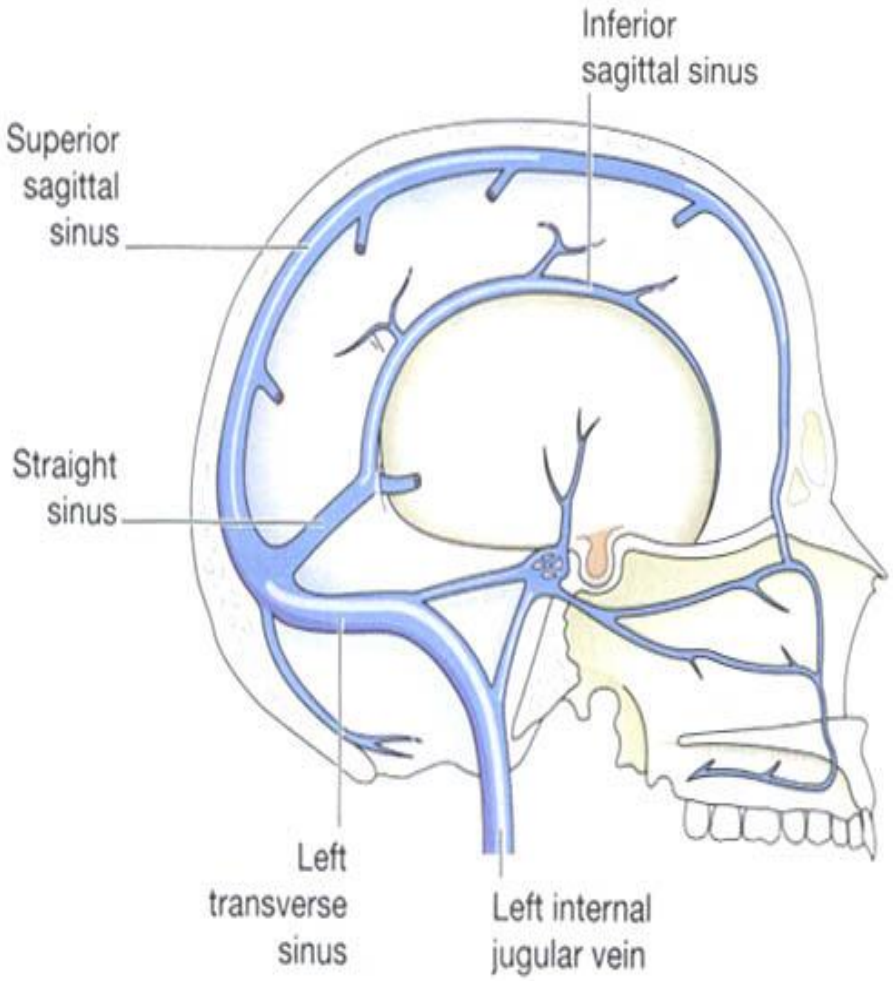
The vena cavae and the main veins of the limbs.



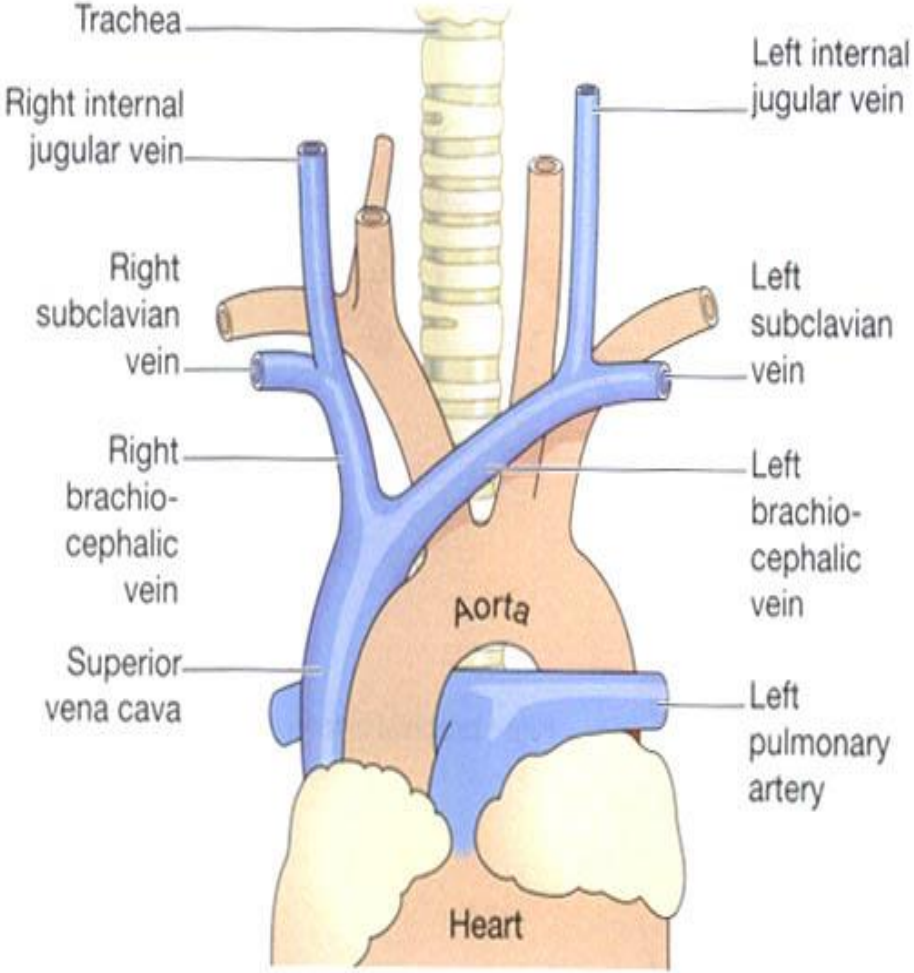
Venous return from the head and neck



Venous sinuses of the brain viewed from the right



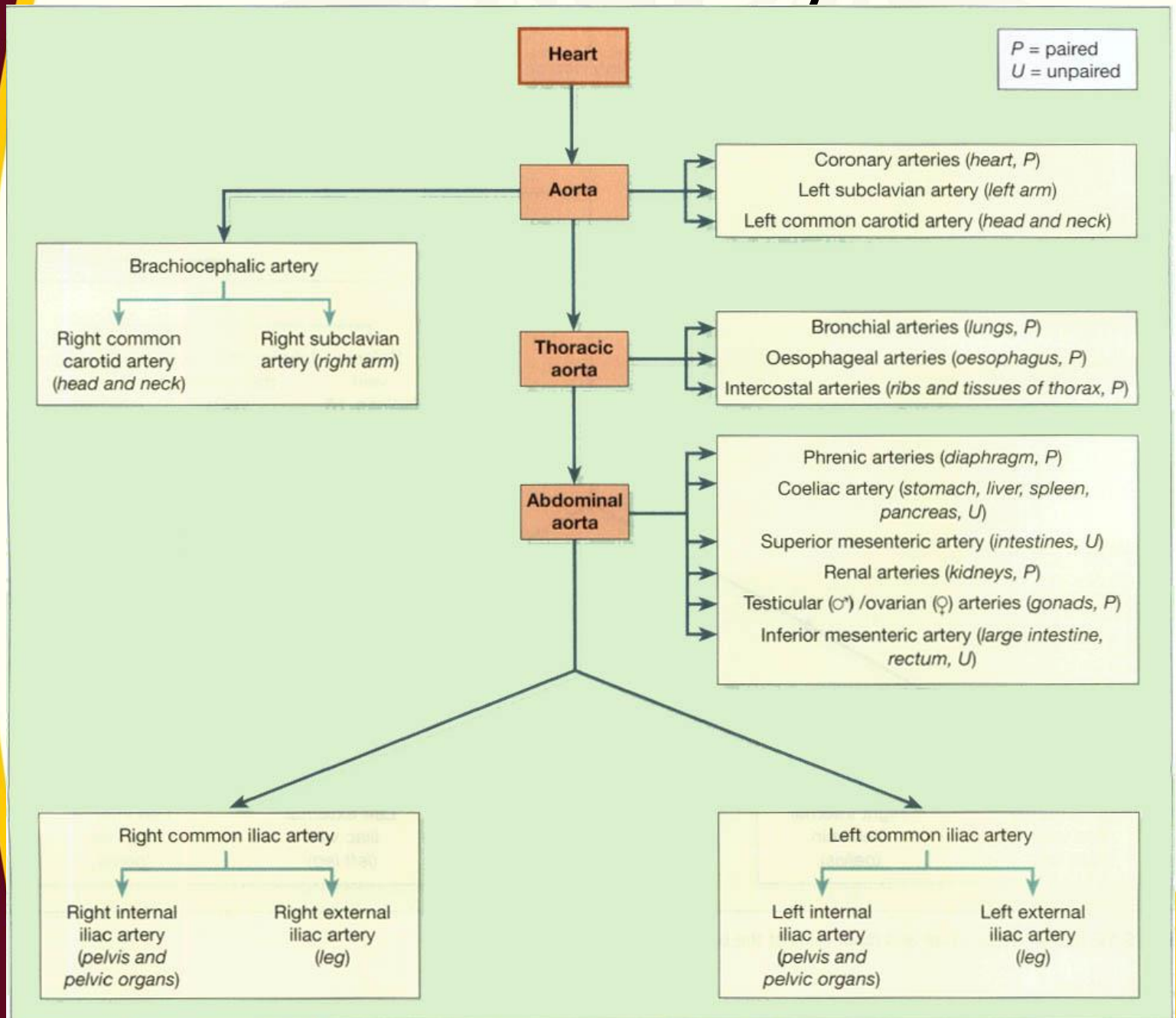
The superior vena cava and the veins which form it.

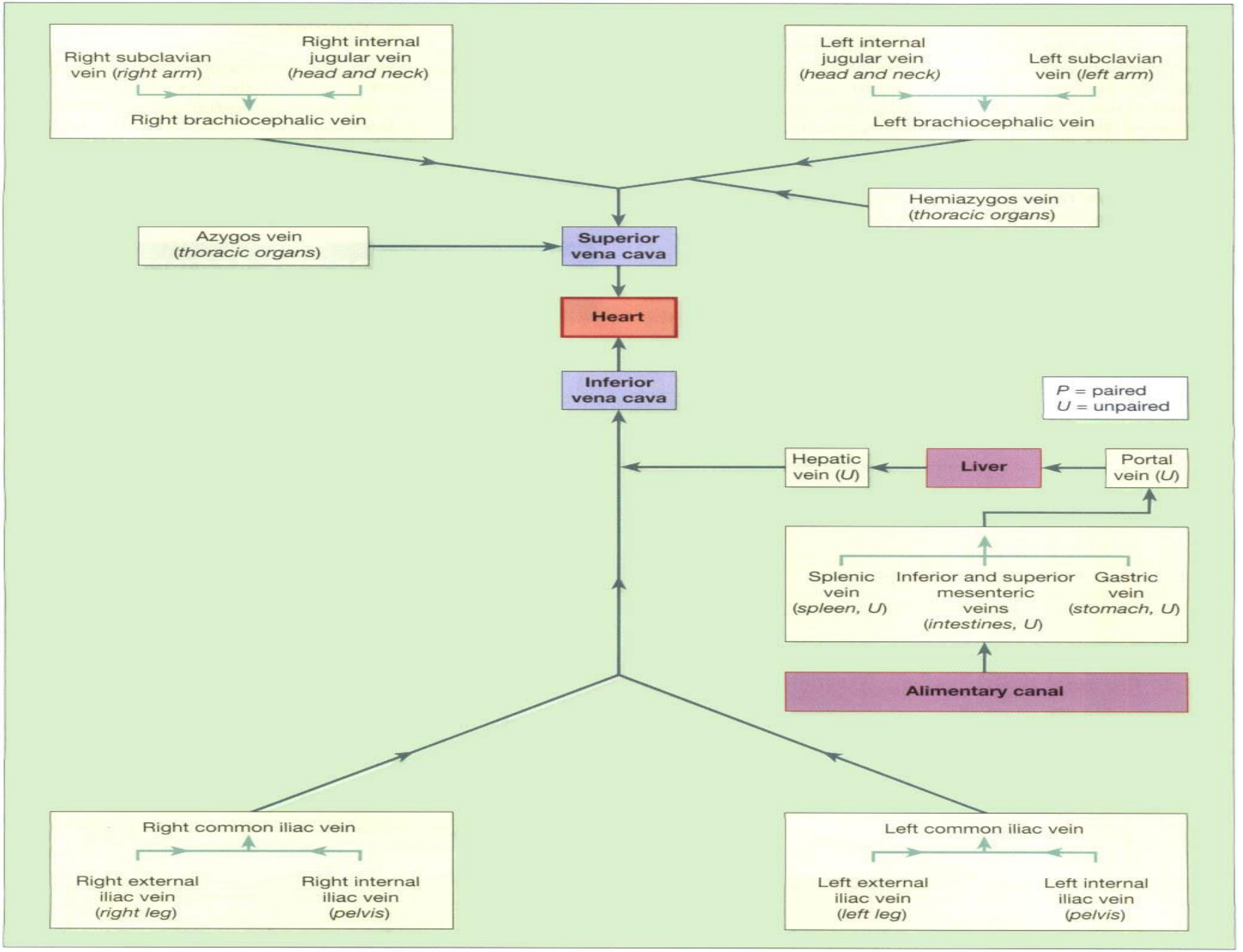


Read on circulation

- Upper limbs
- Portal circulation
- Lower limbs
- Fetal circulation

summary


Heart
P = paired
U = unpaired
Aorta
Coronary arteries (heart, P)
Left subclavian artery (left arm)
Left common carotid artery (head and neck)
Brachiocephalic artery
Right common carotid artery (head and neck)
Right subclavian artery (right arm)
Thoracic aorta
Bronchial arteries (lungs, P)
Oesophageal arteries (oesophagus, P)
Intercostal arteries (ribs and tissues of thorax, P)
Abdominal aorta
Phrenic arteries (diaphragm, P)
Coeliac artery (stomach, liver, spleen, pancreas, U)
Superior mesenteric artery (intestines, U)
Renal arteries (kidneys, P)
Testicular (♂) /ovarian (♀) arteries (gonads, P)
Inferior mesenteric artery (large intestine, rectum, U)
Right common iliac artery
Right internal iliac artery (pelvis and pelvic organs)
Right external iliac artery (leg)
Left common iliac artery
Left internal iliac artery (pelvis and pelvic organs)
Left external iliac artery (leg)


Right subclavian vein (right arm)
Right internal jugular vein (head and neck)
Right brachiocephalic vein
Left internal jugular vein (head and neck)
Left subclavian vein (left arm)
Left brachiocephalic vein
Hemiazygos vein (thoracic organs)
Azygos vein (thoracic organs)
Superior vena cava
Heart
Inferior vena cava
P = paired
U = unpaired
Hepatic vein (U)
Liver
Portal vein (U)
Splenic vein (spleen, U)
Inferior and superior mesenteric veins (intestines, U)
Gastric vein (stomach, U)
Alimentary canal
Right common iliac vein
Right external iliac vein (right leg)
Right internal iliac vein (pelvis)
Left common iliac vein
Left external iliac vein (left leg)
Left internal iliac vein (pelvis)

The end

- Thank you all