Prepared by:

Madam Ruth Mwangi

CONNECTIVE TISSUE

- Connective tissue is the most abundant tissue in the body.
- Cells are widely separated from each other than in the epithelial tissues.
- Fibres are present in matrix semisolid jelly-like consistency.
- Fibres form a supporting network for the cells to attach to .
- They have a good blood supply

Functions of connective tissue

- Binding and structural support
- Transportation
- Protection
- insulation

Cells in connective tissue

- Cells in connective tissue excluding blood are found in all organs supporting the specialized tissue.

These cells are:-

- Fibroblasts
- Fat cells
- Macrophages
- Leukocytes
- Mast cells
- Plasma cells

Fibroblasts

- Large cells with irregular process produce collagen; elastic fibres and matrix of extracellular material.
- Fine collagen fibres called Recticulin fibres are found in very active tissue such as the liver and lymphoid tissue .
- Fibroblast are active in tissue repair (wound healing) .
- They bind together cut surfaces of wounds forming granulation tissue following tissue destruction.

Fat Cells

- Also known as a dipoctyes
- Occur singly or in groups mainly found in a dispose tissue.
- Vary in size and shape depending on the amount of fat they contain.

Macrophages

- They are irregular shaped cells occurring singly or in groups .
- They are active in the defense mechanism of the body.
- They are actively phagocytic engulfing and digesting cells, debris , bacteria and other foreign bodies.
- Their activities is typical of those.

1. Macrophage/monocyte defense system in the blood
2. Phagocytes in the alveoli of the lungs.
3. Kupffer cells in the liver
4. Fibroblasts in lymph nodes & spleen
5. Microglia cells in the brain

Leucocytes

- White blood cells found in small numbers in healthy connective tissue.
- Neutrophils migrate in significant numbers during infection.
- Playing an important part in tissue defence.

Plasma Cells

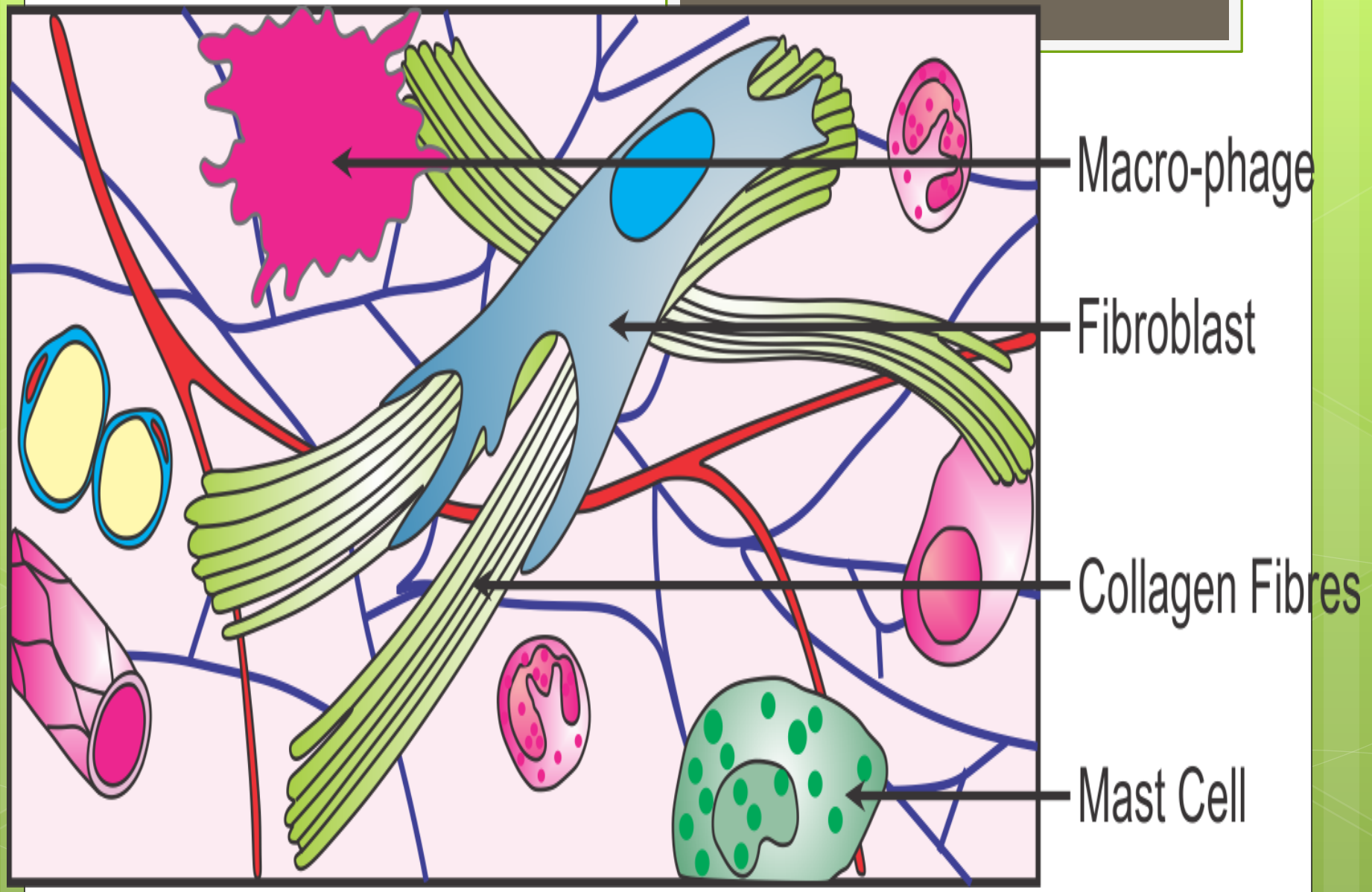
- They are part of B lymphocytes
- A type of a white blood cells
- They synthesis and secrete specific defensive antibodies into the blood and tissues

Mast Cells

- They are similar to Basophil Leukocytes
- They are found in loose connective tissues of some organs e.g.
  - Spleen
  - Liver
  - Round blood vessels
- They produce granules containing heparin and histamine which are released when cells are damaged by disease or injury.
- Histamine is involved in local and general inflammatory reactions.
- It stimulates the secretion of gastric juice.
- It is associated with the development of allergies & hypersentivity states.
- Heparin prevents coagulation of blood.

Loose areolar connective tissue

- The most generalized type of connective tissue.
- Found is almost every part of the body.
- It provides elasticity and tensile strength.
- It connects and supports other tissues e.g
  1. Under the skin
  2. Between muscles
  3. Supporting blood vessels & Nerves
  4. Alimentary canal
  5. Glands of secretary cells


Macro-phage
Fibroblast
Collagen Fibres
Mast Cell

White Adipose tissue are 2 types : 1 Whites 2: Brown

- Makes up to 20-25% of body weight in well nourished adults
- The amount of a dispose tissue in an individual is determined by the balance between energy intake and expenditure
- Found supporting the kidneys eyes, muscle fibres and skin .
- On the muscles and skin it acts as thermal insulator and energy store.

Brown Adipose tissue

- This is present in the newborns
- Has a more extensive capillary network than white adipose tissue.
- When metabolized it produces less energy but more heat to maintain body temperature.

Lymphoid tissue

- It is also known as Reticular tissue.
- It contains reticular cells white blood cells of monocytes and lymphocytes.
- Lymphoid tissue is found in lymphoid tissue (Lymph nodes) and all organs of the Lymphatic system.

Dense Connective Tissue

- Contains more fibres and fewer cells than loose connective tissue.

Fibrous Tissue

- Made up mainly of closely packed bundles of collagen fibres.

Fibroblasts are the cells found in fibrous tissue.

Mainly found in:-

1. Ligaments which bind bones together.
2. Outer protective covering for bone called periosteum .
3. Outer protective covering for some organs e.g. Kidneys, lymph nodes and Brain
4. Forming muscle sheaths called muscle fascia muscle to become the tendon that attaches the muscle to bone.

Elastic Tissue

- Is capable of considerable extension and recoil
- Cells are fibroblast
- Found in organs where stretching or shape alteration is required e.g.
  - ✓ large blood vessel walls
  - ✓ Trachea
  - ✓ Bronchi
  - ✓ lungs

Cartilage

- Firmer than other connective tissues.
- Cells are called chondrocytes and less numerous
- There are three types of cartilage

1. Fibrocartilage
2. Hyaline cartilage
3. Elastic fibrocartilage

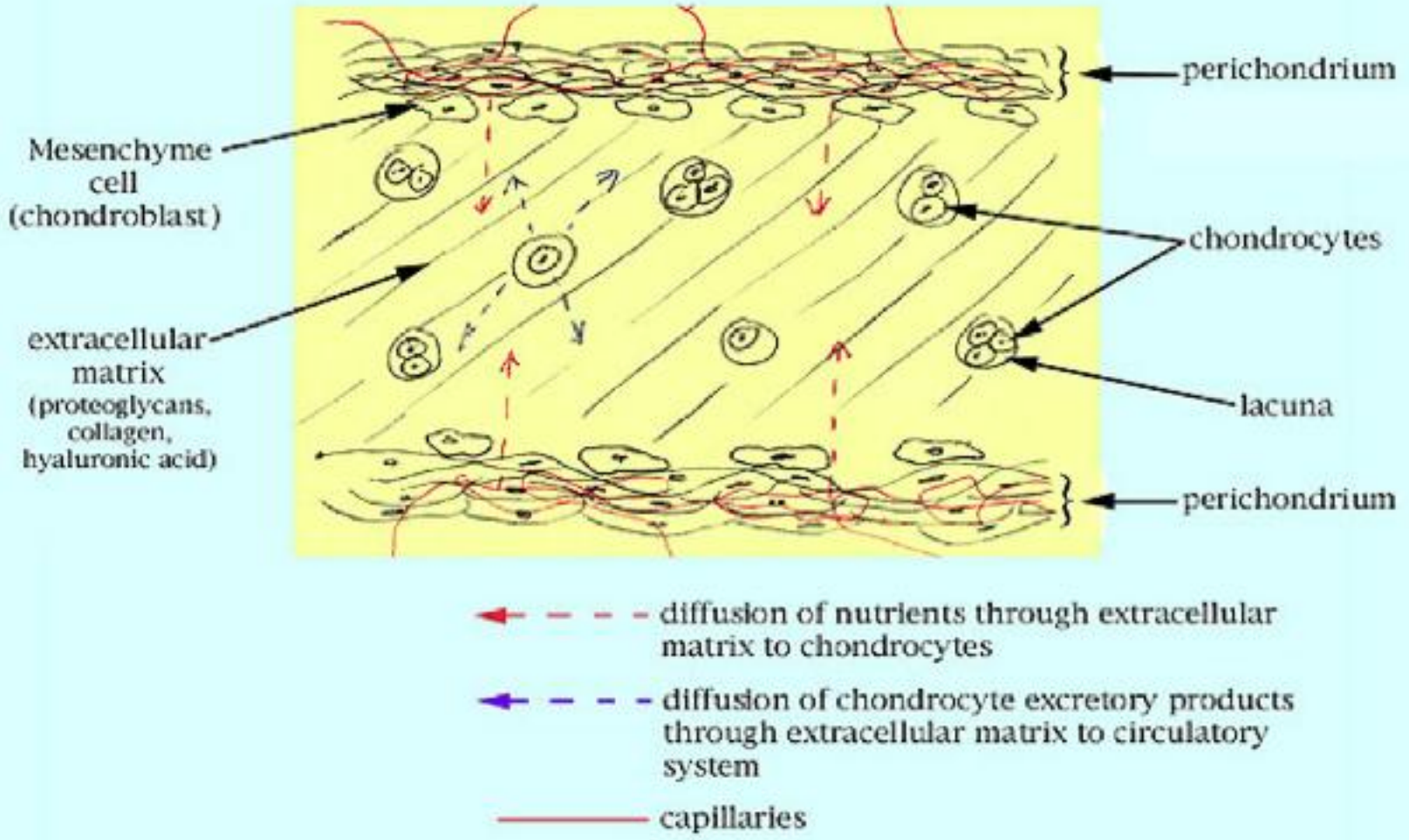
Fibrocatilage

- Consist of dense white collagen fibres
- It is tough slightly flexible supporting tissues found in
- As pads between the bodies of the vertebrae i.e. the intervertebral discs between the articulating surfaces of the bones of the knee joints called Semi-lunar cartilages
- On the rim of bony sockets of the hip and shoulder joints, deepening the cavities without restricting movement
- As ligaments joining bones.

Hylaine Cartilage

- Smooth bluish white tissue
- Chondrocytes are the cells
- They are flexible support surfaces for movement at
- On the end of long bones that form joints
- Forming the costal cartilages which attach the ribs to the system.
- Forms part of the trachea larynx and bronchi.

Components of Cartilage



Elastic Fibrocartilage

- Yellow elastic fibres
- Chondrocytes are the cells in the fibres
- Provide support and maintain shapes of the pinna or lobe of the ear
- Epiglottis
- Blood vessel walls.

Bone

- Collagen formed by inorganic salts of calcium & phosphate
- Bone cells are osteocytes
- Salts provide the bone with strength and rigidity.
- Bone has capacity for growth in the first 2 decades
- It has re-generation capacity throughout life.
- Two types of bone are identified:-

1. Compact bone- solid or dense appearance
2. Spongy or concellous bone- “spongy” or honey comb appearance.

Blood

- Blood is a fluid connective tissue
- It circulates constantly around the body allowing constant communication between tissues distant from each other.

Composition of blood

- Blood makes up approximately 8% of the body weight i.e. 5.6 ltrs in a 70kg weight.
- It is composed of a faintly yellow transparent fluid known as Plasma and different types of cells and corpuscles floating in it.
- Plasma constitutes about 55%
- The cells and corpuscles is about 45% blood volume.

Characteristics of blood

- Oxygenated blood is bright red.
- Deoxygenated blood is dark red or purplish in colour
- Blood is heavier than pure water.
- PH range from7.35-7.45 (alkaline in nature)
- An adult male has 5-6ltrs of volume.
- An adult female has 4-5ltrs in volume.

Functions of blood

- The primary function of blood is to deliver oxygen & nutrients to, and remove wastes from the body cells others include defense distribution of heat & maintenance of homeostasis.

1. Transportation

- Nutrients from the food we eat are absorbed in the digestive tract.
- Most of those travel in the blood stream directly to the liver where they are processed and released back into the blood stream for delivery to body cells.
- Oxygen from the air we breath diffuses into the blood , than transported to the lungs and the heart, then pumped to the rest of the body.
- Endocrine glands scattered all over the body release hormones into the blood stream which carriers them to distant target cells.
- Blood also picks up cellular wastes and byproducts, transports them to various organs for removal e.g. blood takes away carbondioxed from the lungs through exhalation , wastes from the body transported to the kidneys for excretion as urine and from the liver through the bile

2. Defense

- Many types of white blood cells (WBC's) protect the body from external threats , such as disease causing microbes i.e. bacteria , fungi, virus yeast that might have entered the blood stream.
- Some other WBC's destroy internal threats such as cells that have mutated DNA that could multiply to become cancerous.
- When blood vessels get damaged resulting to bleeding blood platelets and other dissolved proteins into the plasma interact to create clots which block the raptured area of blood vessel protecting the body from further blood loss.

3. Maintenance of Homeostasis

1. Oxygen
2. PH
3. Temperature

Oxygen

- Oxygen has 4 (four) binding sites on the blood mainly the haemoglobin molecule .
- When its full with oxygen, its referred as saturated.

i.e. Haemoglobin +Oxygen

(Hb) O_2

Oxyhaemoglobin

(Hbo)

- As the o2 content of blood increase, its colour changes too.
- Blood rich in o_2 is bright red (usually arterial blood) due to high levels of exyhaemglobin.
- Blood with lower o2 levels usually venous blood is dark bluish, normally less saturated.

PH

- During exercise muscles release acid as a waste product , hence local Ph. falls.
- Oxyhaemoglobin breaks down to release more oxygen for tissue use and picks up acid as waste products for elimination.

Temperature

- During exercise body tissues require higher o2 content, this increases o2 transportation to the tissues, heat that is generated is lost hence maintaining a balanced body temperature.
- Blood also maintains the chemicals balance of the body as well as water content into the cells.

Composition of Blood Plasma

- The constituents of Plasma is water which is 90-92%.
- Dissolved and suspended substances include:-

1. Plasma proteins
2. Inorganic salts
3. Nutrients principally from digested foods
4. Waste materials
5. Hormones
6. Gases

Plasma Proteins

- They are large protein particles making up to 7% of plasma.
- Responsible for creating osmotic pressure of blood.
- Keeps plasma fluid within circulation.
- When plasma proteins falls either due to loss of production osmotic pressure falls & fluid moves into the tissues as oedema
- Plasma viscosity (thickness) is due to plasma proteins
- Plasma proteins are formed in the liver except immunoglobulins.
- Plasma proteins are 60-80gm /litrs

1. Albumin 35-50gm/l
2. Globulin 20-37gm/l
3. Firbrinogen 2-4gm/l

4. Prothrombin 100-150gm/l

Minerals:-

- Sodium chloride
- Sodium bicarbonate
- Potassium
- Magnesium
- Phosphorous
- Calcium
- Iron
- Iodine
- Copper
- cobalt

Nutrient Materials

- Amino acids manosaccharides , mainly glucose
- Fatty acids & glycerol
- Vitamins

Organic waste , products

Urea , uric acid, creatinine

Hormones

Enzymes

Antibodies and antitoxins

Gases

- Oxygen
- Carbon dioxide
- Nitrogen

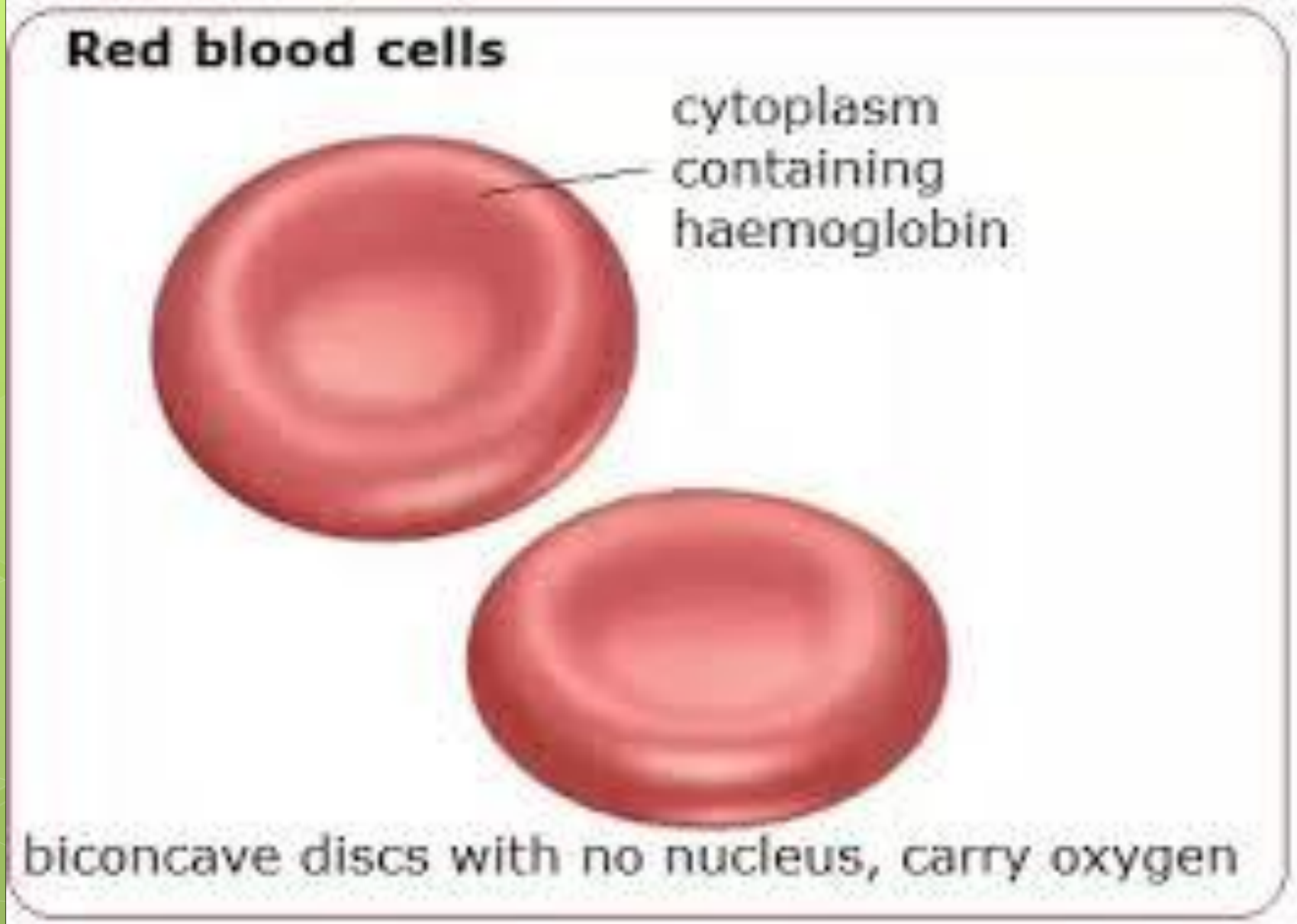
Cellular Component of blood

Blood has three types of cells namely:-

1. Erythrocytes (These are red blood cells
2. Leucocytes (These are white blood cells
3. Thrombocytes (These are platelets)

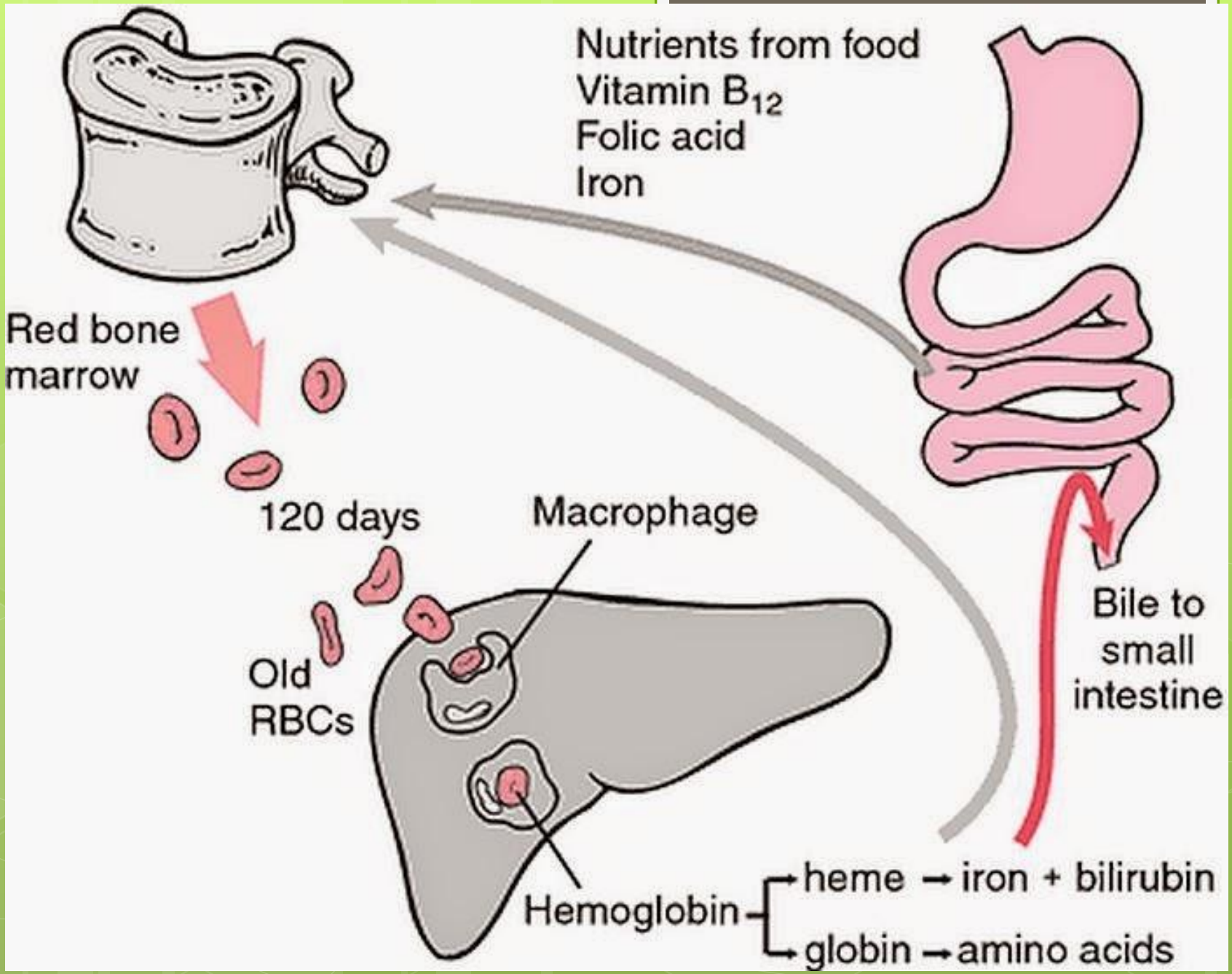
Erthrocytes (red blood cells)

- Red blood cells are by for the most abundant types of blood cells, 99% of all erythrocytes.
- They are biconcave discs with no nucleus.
- Their diameter is 7 micro centimeter (UM) and 2 Um thick
- Have few organelles
- They have no mitochondria
- Their main function is in gas transport mainly oxygen but also carry carbon dioxide.
- They are concave in shape which increases their surface area for gas exchange
- They are red and give blood its colour.


Red blood cells
cytoplasm containing haemoglobin
biconcave discs with no nucleus, carry oxygen

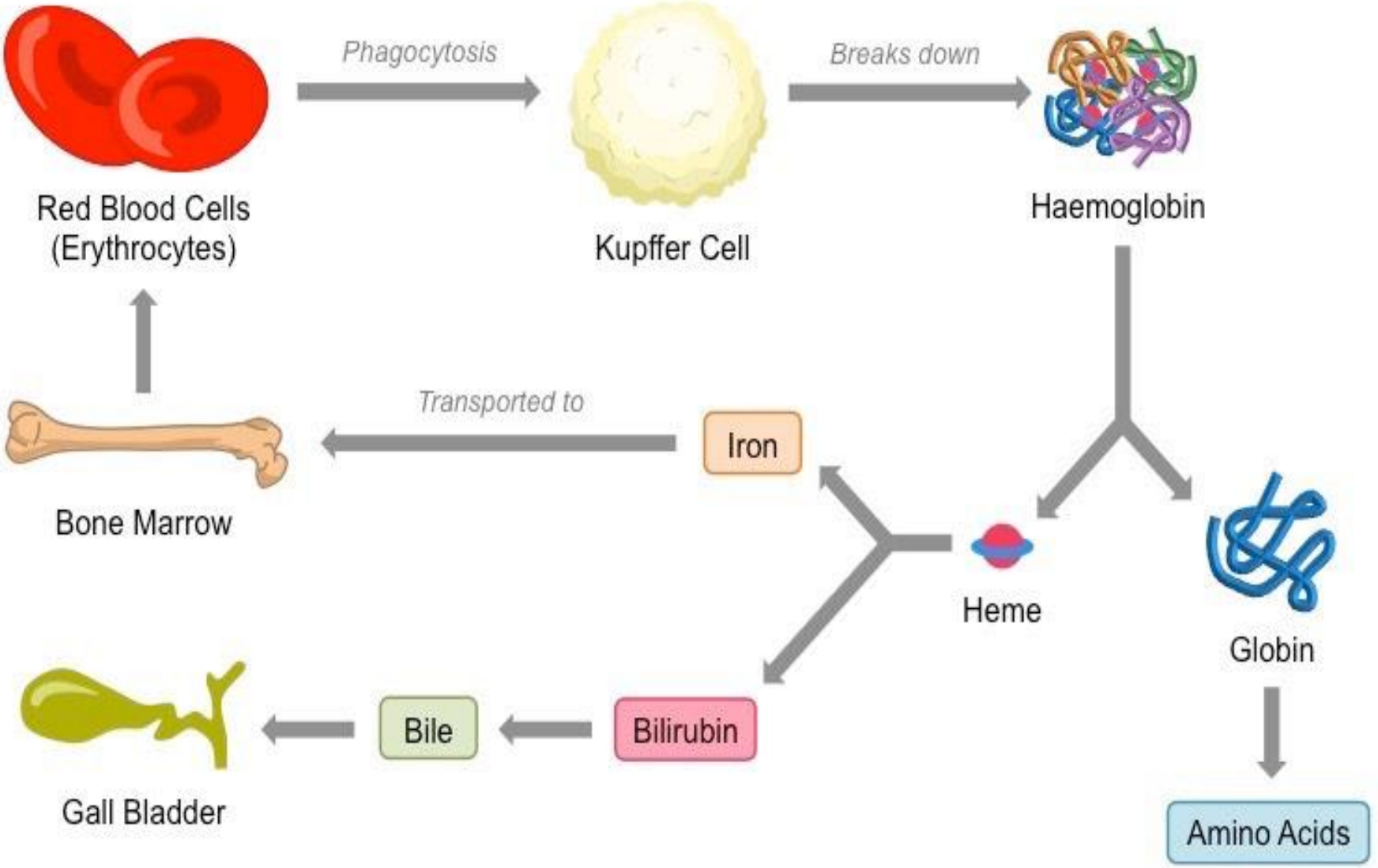
Life span and function Erythrocytes

- Red blood cells are formed from the bone marrow (red bone marrow)
- They pass through several stages of development before entering the blood stream .
- The process takes 7 days and is called Erythropoiesis.
- The immature cells called Reticulocytes are released into the blood stream, during this time they loose their nucleaus and unable to divide.
- They have a lifespan of 120days, after span those elder cells are destroyed or eliminated from the circulation.


Nutrients from food
Vitamin B_{12}
Folic acid
Iron
Red bone marrow
120 days
Macrophage
Old RBCs
Bile to small intestine
Hemoglobin
heme → iron + bilirubin
globin → amino acids

Haemoglobin

- Haemoglobin is a large complex molecule containing a globular protein called globin .
- Contains also a pigmented iron-containing complex called Haem.
- Each haemoglobin molecule contains four globin chains and four haem units each with one (1) atom of iron .
- Each atom of iron can combine with an oxygen molecule hence a single haemoglobin moecule can carry up to four molecules of oxygen .
- A single erythrocytes carries about 280 million haemoglobin molecules hence can bind to and transport up to a billion oxygen molecules.


Red Blood Cells
(Erythrocytes)
Phagocytosis
Kupffer Cell
Breaks down
Haemoglobin
Bone Marrow
Transported to
Iron
Heme
Globin
Gall Bladder
Bile
Bilirubin
Amino Acids

Blood group

- The surface of the Red blood cells carries a range of different proteins called Antigens.
- These antigens which are inherited determine the individuals blood group.
- These antigens happen to be transfused into and individual of different antigens causes anti-body antigen reaction that can be fatal .
- This is called incompatibility reaction.

Common Blood group

A	-	Antigen A
B	-	Antigen B
AB	-	Antigen AB
O	-	Neither A nor B Antigen

Note: Antigens are Molecules

O	-	Blood type is Compatible with AB & O
A	-	is compatible with AB and A
B	-	is compatible with AB and B
AB	-	is compatible with all blood types.

Leukocytes (White Blood cells)

- Leukocytes are the largest blood cells but they account for only 1% of the blood volume.
- The contain nuclei and granules is their cytoplasm .
- They are fewer than RBC'S (6-11x109 /liter of blood.
- Leukocytes are divided into 2 (two) main varieties:-

1. Granular- (polymorphon uclear leucocytes.
2. Non Granular or mononuclear leukocytes.

Granular Leukocytes (Granulocytes)

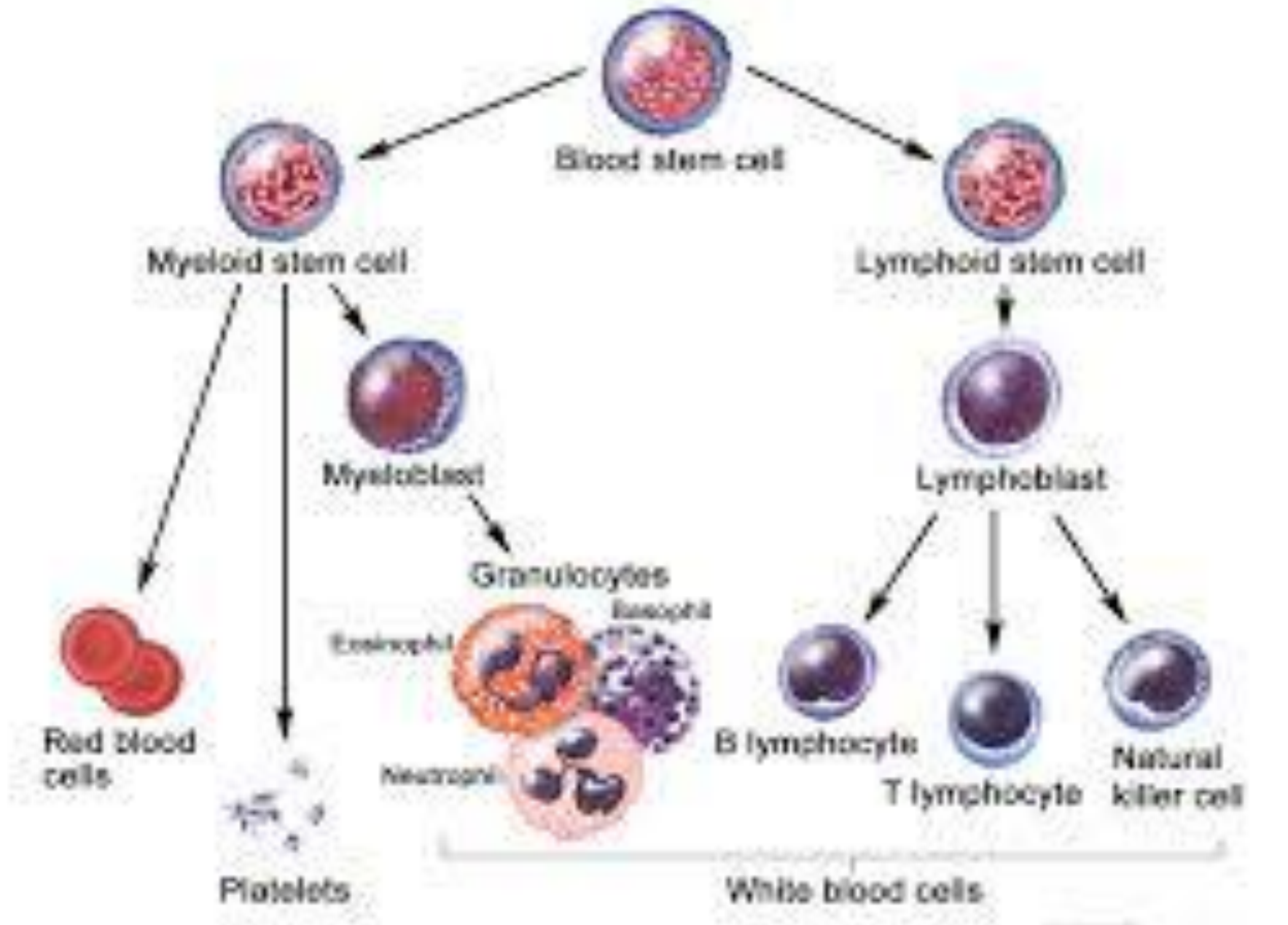
- Constitutes 75% of all WBC'S

There are 3 varieties

- Neutrophils – 70%
- Eosinophil's – 4%
- Basophils – 1%

Granulocytes

- This name is given to those cells because they absorb different dyes when stained .
- Eosinophilis take up red acid dye called Eosin
- Basophils take up methylene blue which is alkaline .
- Neutrophils absorb both dyes so they are purple in colour.


Blood stem cell
Myeloid stem cell
Lymphoid stem cell
Myeloblast
Lymphoblast
Granulocytes
Basophil
Eosinophil
Neutrophil
Red blood cells
Platelets
B lymphocyte
T lymphocyte
Natural killer cell
White blood cells

Neutrophils

- They are granular Leucocytes
- They are the most common leucocytes, making up around 40-70% of those found in pheripheral blood.
- They are primarily involved in immune response against bacterial infection and their presence in tissue is associated with acute inflammation.
- A high Neutrophil count is often seen in bacterial infection.

Eosinophils

- They are also granular leukocytes that histologically stain with eosin.
- They mainly make up 1-3% of circulating leucocytes mainly found within tissues.
- Their granules contain molecules that toxic to parasites.
- They also phagocytose antigen – antibody complexes .
- A high Eosinophil count is typically seen in parasite infection and any other allergic reactions.

Basophils

- They are part of granular leucocytes
- They are found of granular leucocytes.
- They are very similar in function and appearance to most cells which are found within tissues.
- They have granules containing histamine and they cause local inflammation through interaction with IgE
- A high Basophil count is typically seen in patients with allergic reactions.

Non-granular Leucocytes

- They are WBC'S without granules in their cytoplasm .
- They comprise 25% of all Leucocytes
- They exist in 2 varieties.

1. Lymphocytes 23%
2. Monocytes 2%

Lymphocytes

- Lymphocytes are a granular leucocytes
- They are primarily involved in the immune response against Viral Infection
- They are the smallest leucocytes their diameter is 6-15lm
- They have a round densely staining nuclei and sparse cytoplasm
- They circulate between tissues; peripheral blood and the lymphatic system .
- They are present in great numbers in lymphatic tissue such as nodes and the spleen.
- There are three major types of lymphocytes.

1. Natural Killer cells
2. T-Cells (T-Lymphocytes
3. B cells (B lymphocytes

Natural Killer Cells

- Provide non-specific immunity against cells displaying foreign proteins such as cancer cells virally infected cells.
- They make up less than 5% of circulating leucocytes.
- They are able to detect and kill pathogens independently as part of innate immune system.
- Once an abnormal cell id detected NK cells release perforins which embed into the plasma membrane and create channels that allow extra cellular fluid to enter cells causing them to burst(lysis)

T-LYMPHOCYTES

- They are formed in the bone marrow but mature in the thymus.
- They are involved in cell mediated immunity.
- they are involved in cell mediated immunity.
- They respond against virus injected cells and cancer cells
- They recognize and destroy virus infected cells, tumor cells fungi, tissue and organ grafts.

B-lymphocytes

- They are formed and mature in the bone marrow.
- They differentiate into different plasma cells which produce antibodies against foreign substances(humoral immunity).

Monocytes

- Monocytes are the largest of all leucocytes
- They have a large nucleus which is dark purple and kidney shaped.
- They originate in the bone marrow and Reticuloendothelial tissue.
- They phagocytize micro-organisms and other foreign material
- The monocytes that migrate into the tissues become macrophages
- Their main role is phagocytic, their name means big eaters.

MONOCYTE

Monocytes engage in phagocytosis

Thrombocytes (Platelets)

- They are very small discs 2-3μm diameter.
- They do not have a nucleus but have granules in their cytoplasm containing substances that promote blood clotting
- They originate from the bone marrow
- The normal number of blood platelet count is

$200\times10^{9}/_{L}$ $-350\times10^{9}/_{L}$

i.e 150,000-450 Per ml of blood

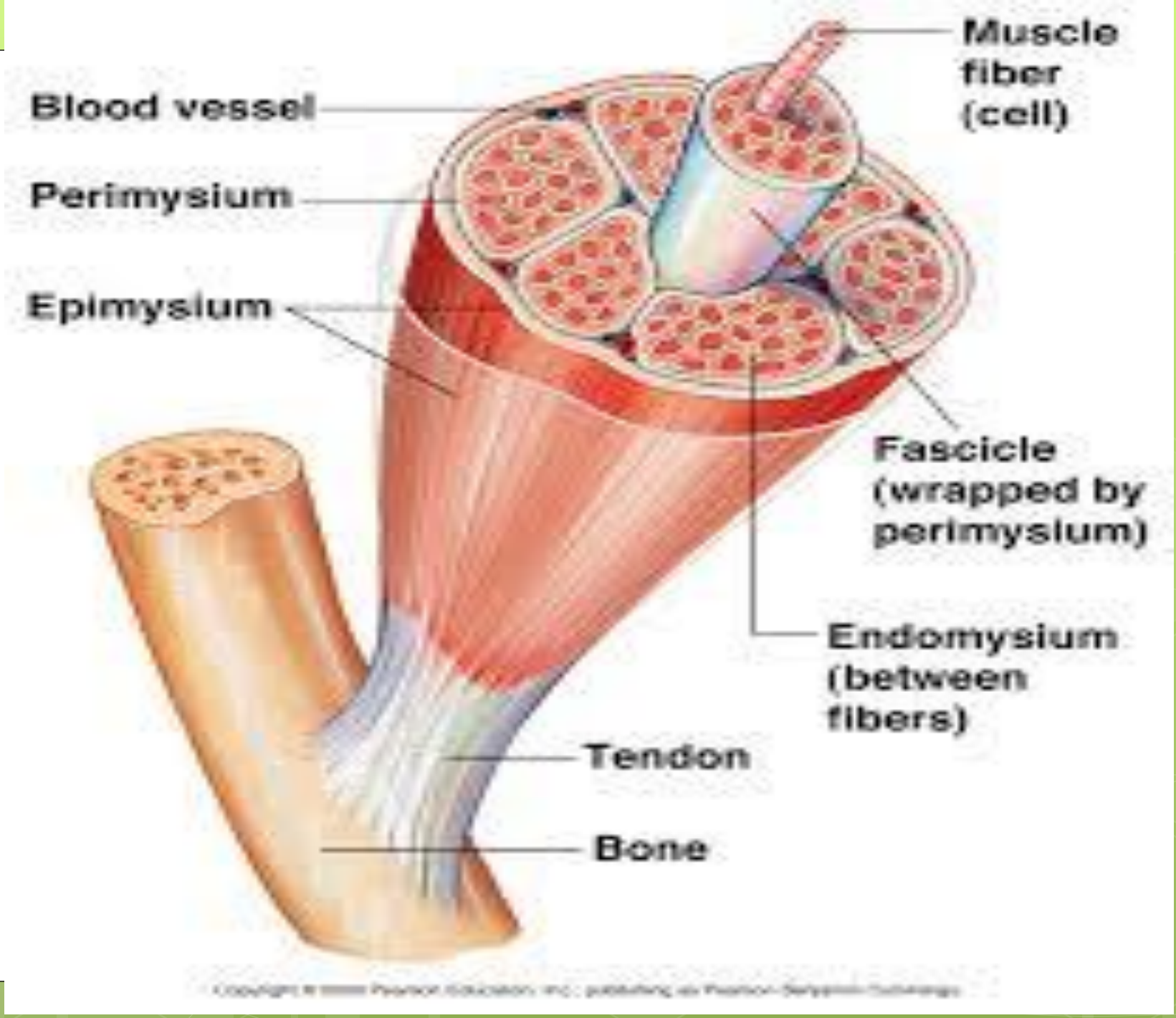
- The hormone Thrombopoetin from the liver stimulates and regulates platelete production.
- Their life span is btw 8-11 days
- Those not used in blood clotting are destroyed by the macrophages.
- Some platelets are stored in the spleen only to be released during haemostasis

Muscle tissue

- This tissue is able to contract and relax providing movement within the body and of the body itself
- Muscle contraction requires an adequate blood supply to provide sufficient oxygen, Calcium and nutrients and well as removing waste products
- There are 3(three)types of specialized contractile cells known as fibres:
  1. Skeletal muscle
  2. Smooth muscle
  3. Cardiac muscle

Skeletal Muscle Tissue

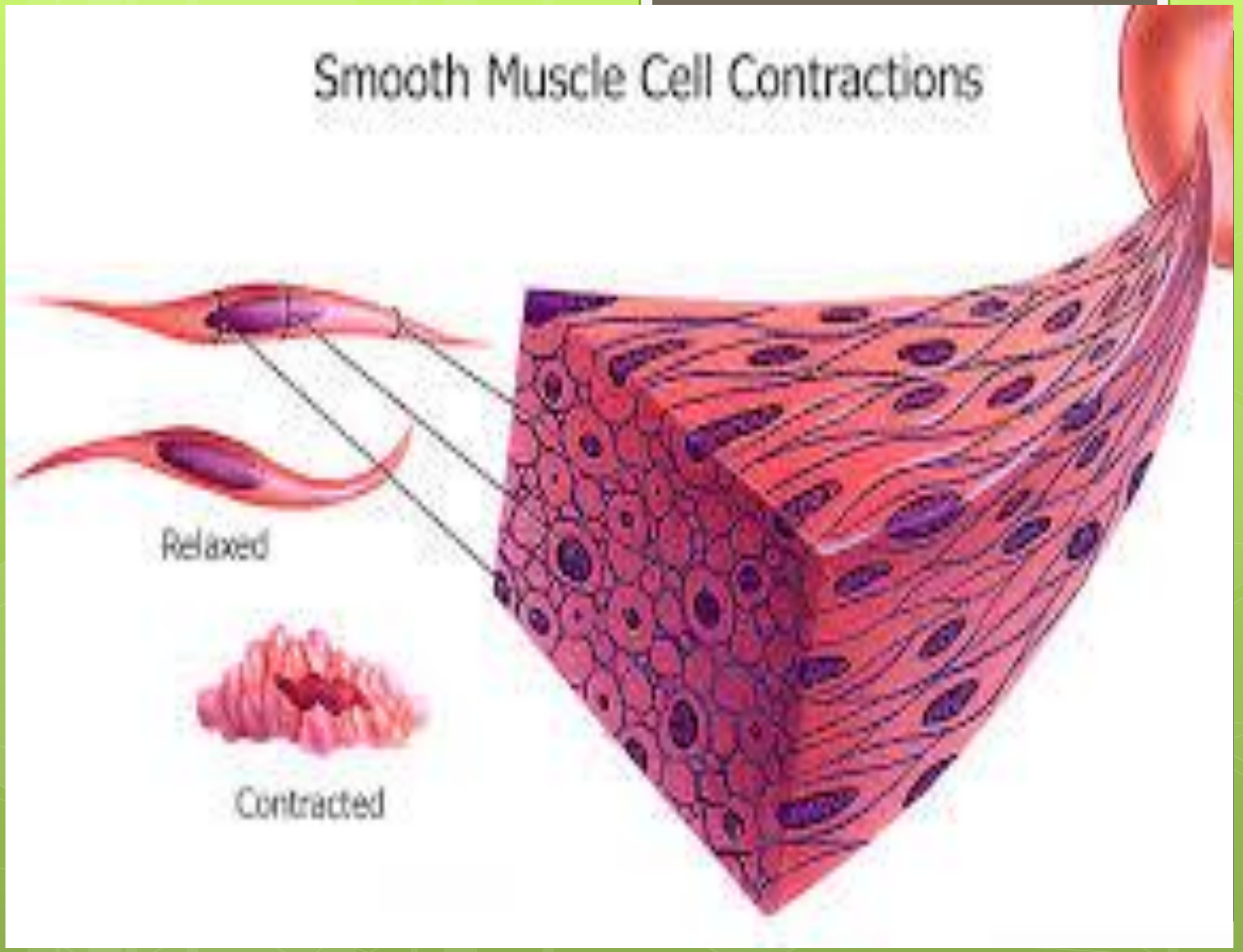
- This form the muscles that move the skeleton
- The tissue is striated or has stripes that are seen microscopically
- The tissue is under voluntary control(i.e under conscious control)
- Skeletal muscle cells are cylindrical; and contain a nuclei very long can be up to 35 cm long
- Skeletal muscle contraction is under stimulation of motor nerve impulses originating from the brain or spinal cord


Muscle fiber (cell)
Blood vessel
Perimysium
Epimysium
Fascicle (wrapped by perimysium)
Endomysium (between fibers)
Tendon
Bone

Smooth Muscle Tissue

- It is referred as non-striated, visceral tissue or Involuntary tissue
- It is not under conscious control autonomic nerve impulses, some hormones or local metabolites to stimulate contraction
- Contraction of smooth muscles is slower than skeletal muscles but it is steady.
- Smooth muscles are found in the walls of hollow organs e.g

1. Walls of blood vessels and respiratory tracts.
2. In the ureters, ducts of glands and alimentary tract
3. Urinary bladder and uterus


Smooth Muscle Cell Contractions
Relaxed
Contracted

Cardiac Muscle Tissue

- This type of muscle tissue is only found in the heart walls.
- It is not under voluntary or conscious control.
- The fibres have cells with a nucleus.
- Microscopically the fibres seem to have joints called intercalated discs.
- The heart muscles contract by intrinsic pacemaker system or the autonomic nervous system.

Nervous Tissue

There are two types of tissue found in the nervous system

Excitable cells – These are called neurons, they initiate, receive, conduct and transmit information.

Non – excitable cells- also known as Glial cells. These support the neurons.

Neurons are the nerve cells.

They generate and transmit electrical impulses called **action potentials**

Some neurons initiate nerve impulses white others act as relay stations

Nerve impulses can be initiated in response to stimuli From:-

outside the body e.g. touch, light waves

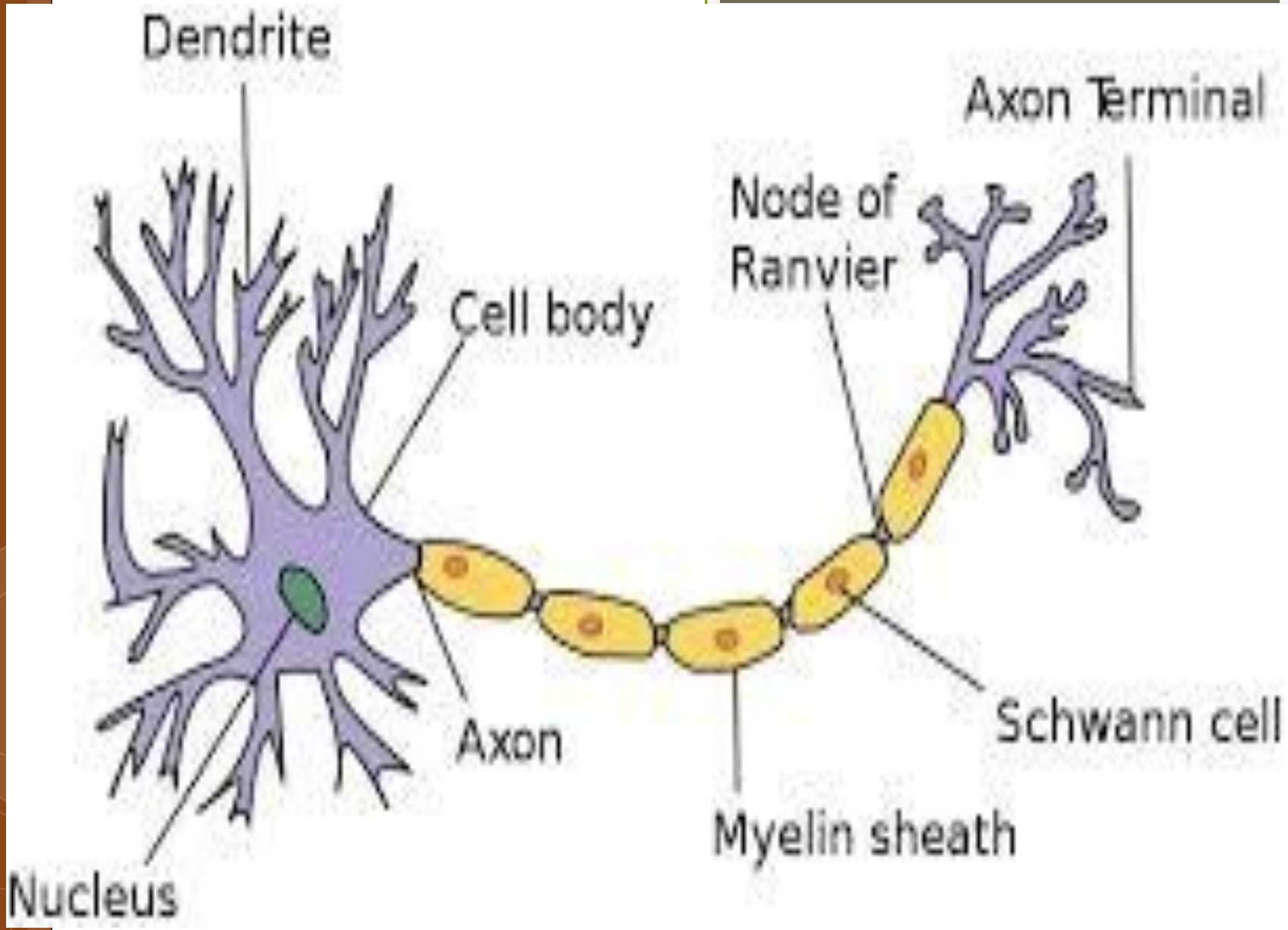
inside the body e.g. change in the concentration of carbon dioxide in the blood

Transmission of nerve signals is both electrical and chemical.

One nerve tissues are injured regeneration happens in three ways

Quick regeneration

Unable to regenerate completely replaced by fibrous tissue and looses its original functions


Dendrite
Axon Terminal
Node of Ranvier
Cell body
Schwann cell
Axon
Myelin sheath
Nucleus