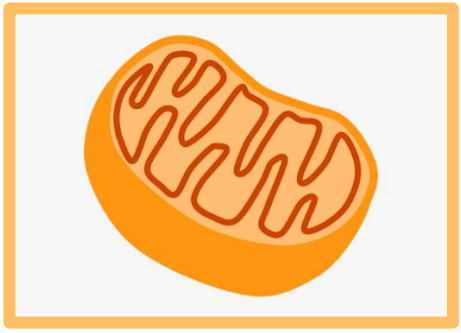
CHAPTER 2.1 – CELL STRUCTURE AND FUNCTION

Components of animal and plant cells and their functions

Animal Cells

MITOCHONDRION

- Plural → mitochondria
- Characteristics
  - Rod-shaped or spherical
  - Consists of two layers of membranes
    - Smooth outer membrane
    - Folded inner membrane
  - Contains enzymes that play a role in a cellular respiration
- Functions
  - As a site that generates energy through the glucose oxidation process during cellular respiration
  - Energy released in the form of ATP (adenosine triphosphate) molecules

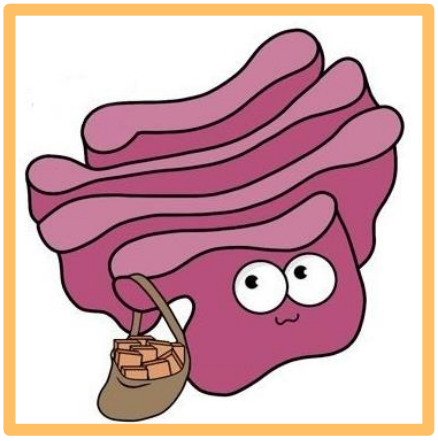


CENTRIOLE

- Characteristics
  - Small cylindrical components that exist in pairs
  - Made up of complex arrangement of microtubules
  - Does not exist in plant cells
- Functions
  - Forms spindle fibre during cell division

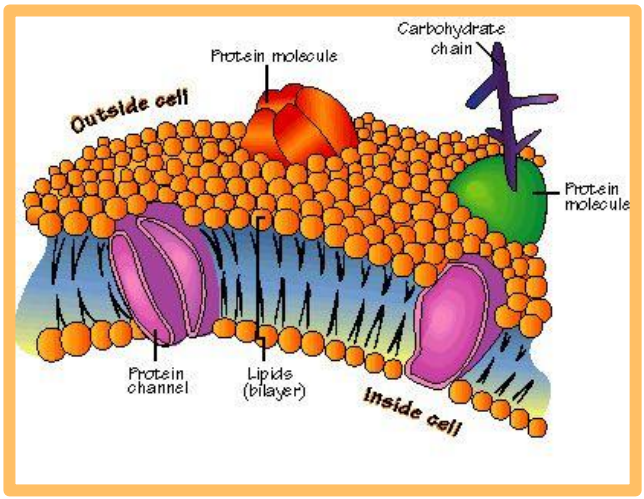
GOLGI APPARATUS

- Characteristics
  - Consists of a stack of parallel flattened sacs that are coated by a single cell membrane
  - New membrane is added at one end of the Golgi apparatus and vesicles bud off from the other end
- Functions
  - Processes, modifies, packs and transports chemicals such as
    - Protein
    - Carbohydrate
    - Glycoprotein (carbohydrate and protein)



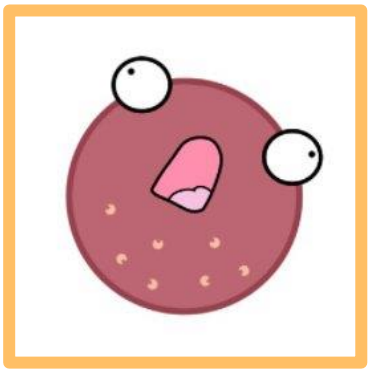
PLASMA MEMBRANE

- ⌂ Characteristics
  - ✓ Outer membrane that surrounds the entire content of cell
  - ✓ Made of proteins and phospholipids
  - ✓ Thin and elastic film
  - ✓ Partially permeable
- ⌂ Functions
  - ↘ Separates content of cell from the external environment or extracellular
  - ↘ Controls movement of substances into and out of the cell
  - ↘ Allows exchange of nutrients, respiratory gases and waste materials



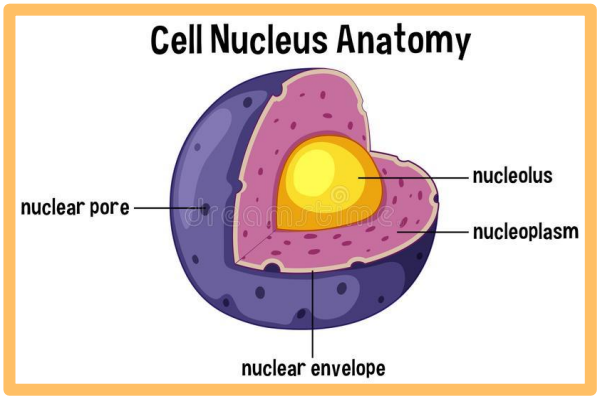
LYSOSOME

- ◊ Characteristics
  - ⊕ Small spherical sac enclosed in a single membrane
  - ⊕ Contains hydrolytic enzymes
- ◊ Functions
  - → Hydrolyses complex organic molecules such as
    - ✓ Protein
    - ✓ Nucleic acid
    - ✓ Lipid
  - → Breaks down bacteria and components of damaged cells



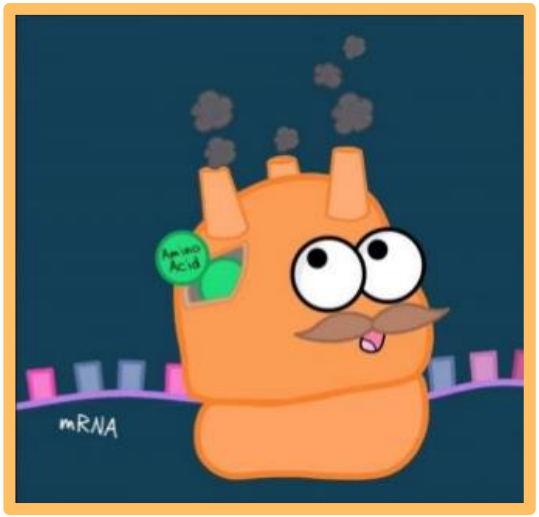
NUCLEUS

- ❑ Plural → nuclei
- ❑ Characteristics
  - ❖ Largest component
  - ❖ Spherical, compressed and enclosed in a nuclear membrane with many pores
  - ❖ The nucleus contains nucleolus, nucleoplasm and chromatin that consist of chromosomes
- ❑ Functions
  - ⌂ Controls all cell activities
  - ⌂ Has chromosomes that contain DNA (deoxyribonucleic acid)
  - ⌂ DNA determines the cell characteristics and metabolic function



RIBOSOME

- Characteristics
  - Small, compact and spherical granules
  - Consists of protein and RNA (ribonucleic acid)
  - Ribosomes are present on the surface of the rough endoplasmic reticulum or freely in the cytoplasm
- Functions
  - As a site for protein synthesis



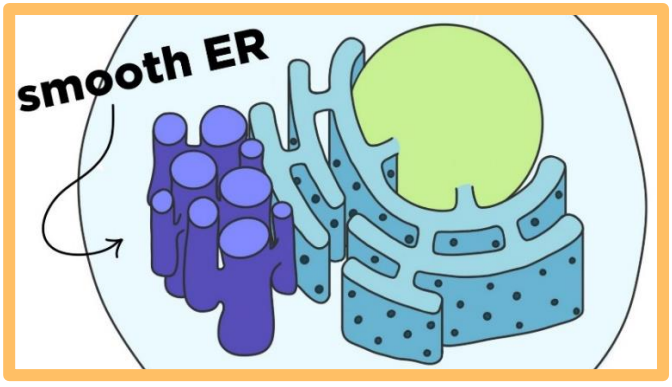
ENDOPLASMIC RETICULUM (ER)

✓ Characteristics

1. Consists of a system of interconnected folded flattened sacs
2. Endoplasmic reticulum membrane is continuous with nuclear membrane
3. Two types of endoplasmic reticulum
   - ❑ Rough endoplasmic reticulum that has ribosomes attached on it
   - ❑ Smooth endoplasmic reticulum (no ribosomes)

✓ Functions

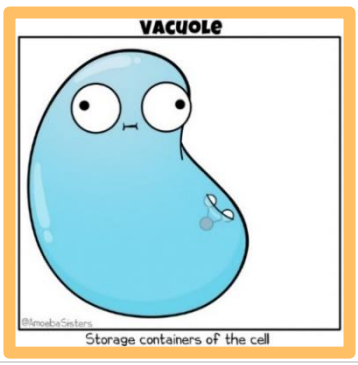
- ♥ As the transport system within the cell
- ♥ Provides a wide surface for enzyme attachment and biochemical reactions
- ♥ The rough endoplasmic reticulum transports proteins synthesised by ribosomes
- ♥ The smooth endoplasmic reticulum
  - ⊕ Synthesises and transports glycerol and lipids
  - ⊕ Carries out detoxification of drugs and metabolic by-products



Plant Cells

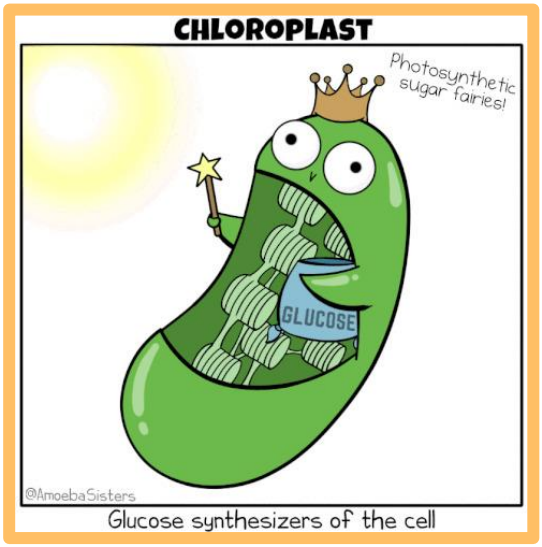
VACOULE

- Characteristics
  - Liquid-filled sac, which is the cell sap
  - Surrounded by tonoplast membrane
  - Young plants have many small vacuoles
  - Mature plants have a large vacuole
  - If vacuole present in animal cells, it is small
  - Cell sap contains
    1. Water
    2. Organic acids
    3. Sugars
    4. Amino acids
    5. Enzymes
    6. Mineral salts
    7. Oxygen
    8. Carbon dioxide
    9. Metabolic by-products
- Functions
  - Water is absorbed into the vacuole and becomes turgid
  - In unicellular animals, the vacuole contracts during
    1. Osmoregulation
    2. Osmosis
    3. Excretion



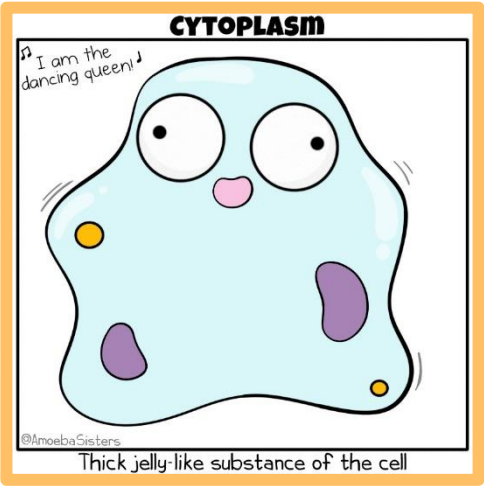
CHLOROPLAST

1) Characteristics
   - Oval shaped
   - Consists of two layers of membrane
   - Contains chlorophyll in the grana that give plants a green colour
   - Does not exist in animal cells
2) Functions
   - Chlorophyll absorbs sunlight and converts it to chemical energy during photosynthesis



CYTOPLASM

- Characteristics
  - Consists of jelly-like medium that contains components of the suspended cells
  - Contains
    1. Organic compounds (protein, lipid and carbohydrate)
    2. Inorganic compounds (potassium ions)
- Functions
  - Acts as a medium for biochemical reactions in cells



CELL WALL

↘ Characteristics
- Δ A strong and rigid outer layer
- Δ Made from cellulose fibre
- Δ Fully permeable

↘ Functions
- I. Maintains the shape
- II. Provides mechanical support

Compare and contrast the components of animal cells and plant cells

SIMILARITIES

❑ Both cells are made of
- A Nucleus
- B Cytoplasm
- C Plasma membrane
- D Golgi apparatus
- E Mitochondrion
- F Endoplasmic reticulum
- G Ribosomes

DIFFERENCES

♥ Plant Cells
- 1 Fixed shape
- 2 Has a cell wall
- 3 Has a large vacuole
- 4 Stores carbohydrate in the form of starch
- 5 Does not have a centriole

♥ Animal Cells
- a Not a fixed shape
- b Does not have a cell wall
- c Does not have chloroplasts
- d No vacuole or if present, it is small
- e Stores carbohydrate in the form of glycogen
- f Has centrioles

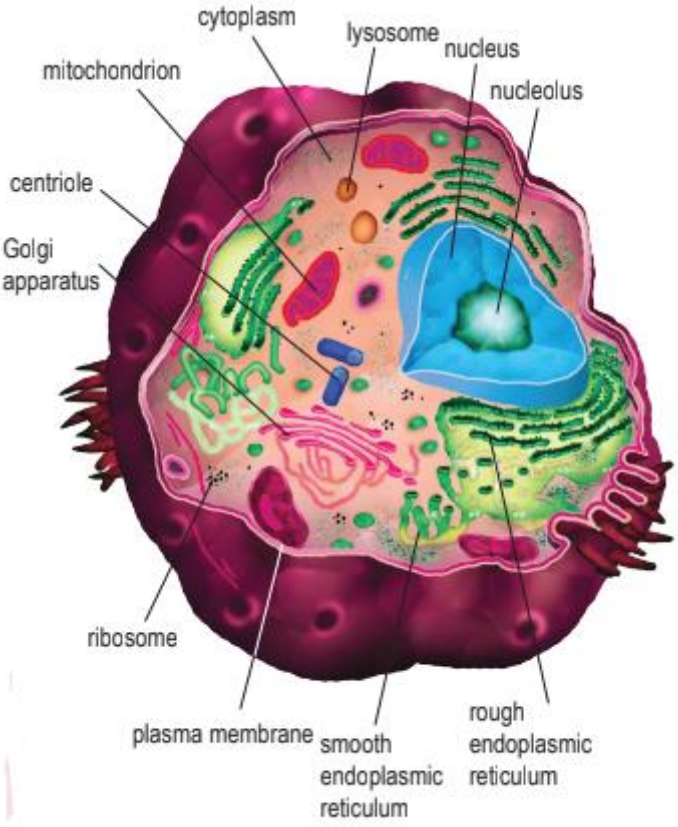


FIGURE 2.1 Animal cells

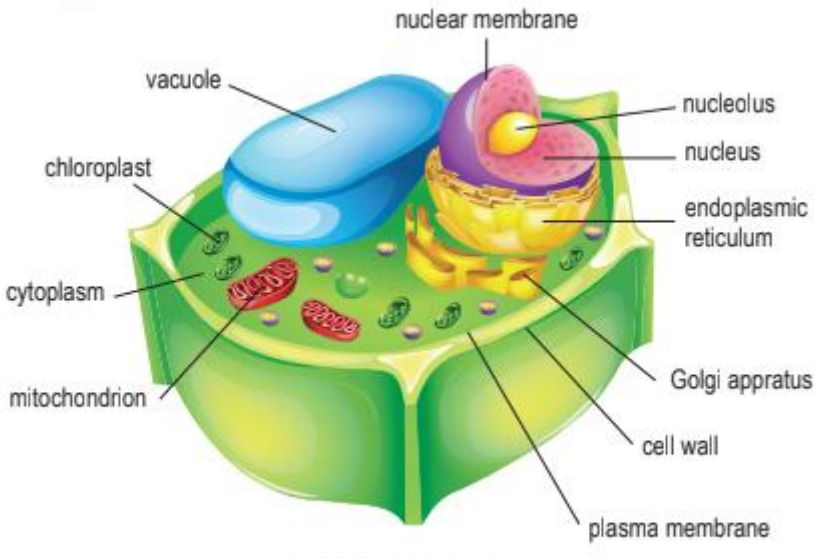


FIGURE 2.2 Plant cell

CHAPTER 2.2 – LIVING PROCESSES IN UNICELLULAR ORGANISMS

Living processes in unicellular organisms

- Δ Unicellular organisms are made of only one cell
  - → Amoeba sp.
  - → Paramecium sp.
- Δ Unicellular organisms carry out
  - I Movement
  - II Nutrition
  - III Growth
  - IV Responding to stimuli
  - V Respiration
  - VI Excretion
  - VII Reproduction

Amoeba sp.

MOVEMENT

- Amoeba sp. constantly changes its shape when it encounters obstacles
- Moves by extending out its pseudopodium (false feet)
- This is followed by the flow of cytoplasm into the extended pseudopodium

NUTRITION

① Amoeba sp. moves towards food by extending its pseudopodium to trap food particles by phagocytosis

② The food vacuole is combined with lysosome and hydrolysed the food particles by the enzyme lysozyme in the lysosome

③ The nutrients are absorbed into the cytoplasm

④ Undigested food is discharged when the Amoeba sp. moves

GROWTH

- Amoeba sp. grow by synthesising new cytoplasm

RESPONDING TO STIMULI

⊕ Amoeba sp. respond to stimuli such as chemicals, touch or bright light by moving away from the stimuli

RESPIRATION

Δ Exchange of oxygen and carbon dioxide gases occur through the plasma membrane by simple diffusion on the surface of the cell

EXCRETION

❑ Waste is removed by diffusion such as
  - ◊ Carbon dioxide
  - ◊ Ammonia

❑ As Amoeba sp. live in freshwater environments, water will diffuse by osmosis and fill the contractile vacuole

❑ When the vacuole expands to the maximum size, contraction occurs and water is excreted from time to time

❑ This process is called osmoregulation

REPRODUCTION

- When there is a food, Amoeba sp. will reproduce via asexual reproduction that is binary fission through mitosis
- Amoeba sp. forms spores that will only germinate when the environment improves if the conditions are not suitable such as
  - I Dry conditions
  - II Low temperature
  - III Food shortage

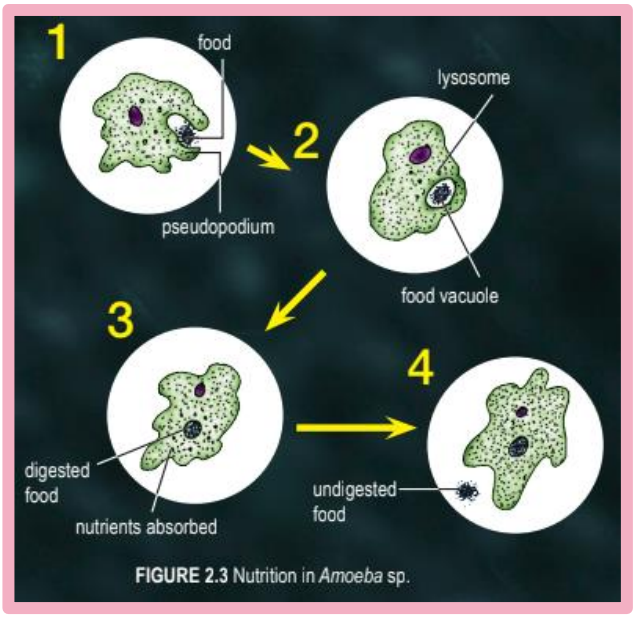
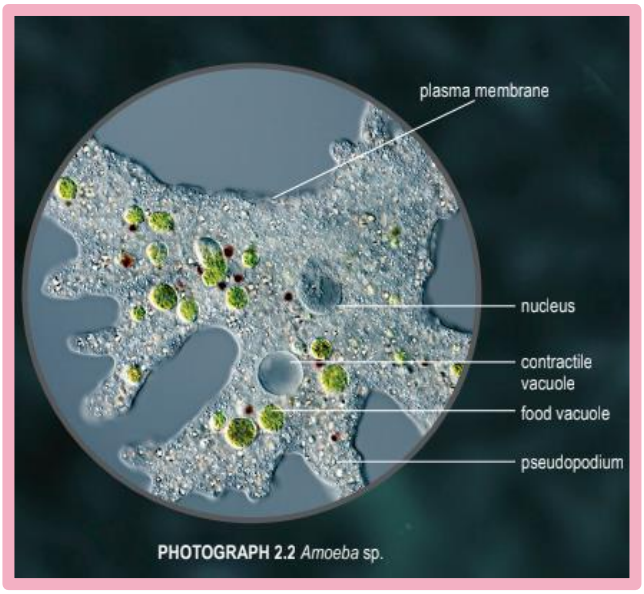


FIGURE 2.3 Nutrition in *Amoeba* sp.



PHOTOGRAPH 2.2 *Amoeba* sp.

Paramecium sp.

MOVEMENT

- Moves using rhythmic cilia beats

NUTRITION

1. The presence of cilium (plural: cilia) beat helps transfer food particles into the oral groove
2. The food vacuole is combined with lysosome and hydrolysed the food particles by the enzyme lysozyme in the lysosome
3. The nutrients are absorbed into the cytoplasm
4. Undigested food in the Paramecium sp. is discharged through the anus

GROWTH

- Paramecium sp. grow by synthesising new cytoplasm

RESPONDING TO STIMULI

- Paramecium sp. respond to stimuli such as chemicals, touch or bright light by moving away from the stimuli

RESPIRATION

- Exchange of oxygen and carbon dioxide gases occur through the plasma membrane by simple diffusion on the surface of the cell

EXCRETION

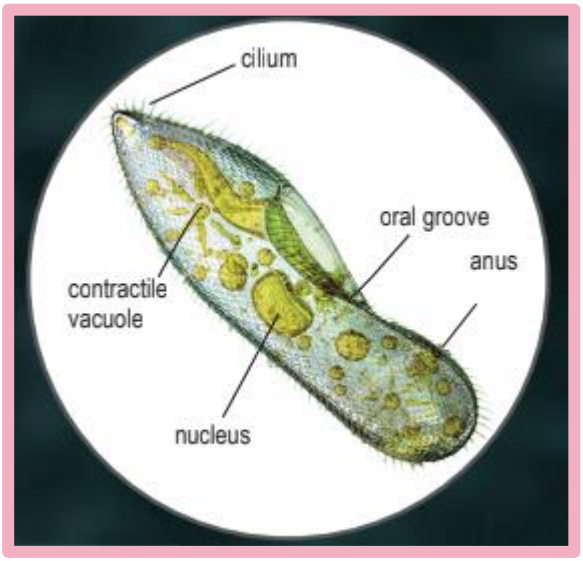
a. Waste is removed by diffusion such ac
   - → Carbon dioxide
   - → Ammonia

b. As Paramecium sp. live in freshwater environments, water will diffuse by

osmosis and fill the contractile vacuole

c When the vacuole expands to the maximum size, contraction occurs and water is excreted from time to time

d This process is called osmoregulation



REPRODUCTION

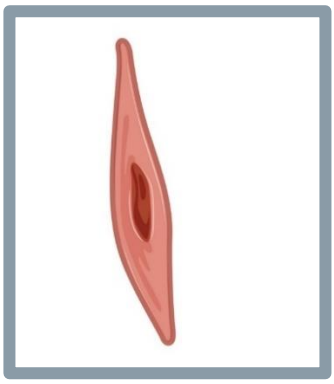
1) When there is a food, Paramecium sp. will reproduce via asexual reproduction that is binary fission through mitosis
2) When the condition is not suitable, sexual reproduction that is conjugation occurs

CHAPTER 2.3 – LIVING PROCESSES IN MULTICELLULAR ORGANISMS

Living processes in multicellular organisms

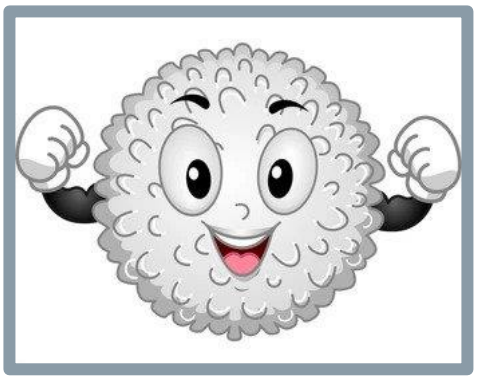
MUSCLE CELL

- ◊ Arranged as multinuclear striated fibres
- ◊ Contract and relax to generate movement



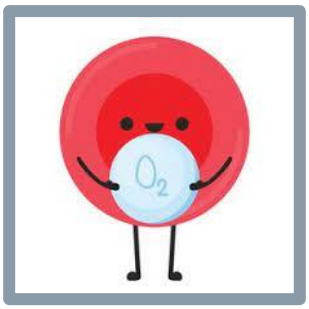
WHITE BLOOD CELL

- ✓ Can change shape
- ✓ Functions in destroying pathogens



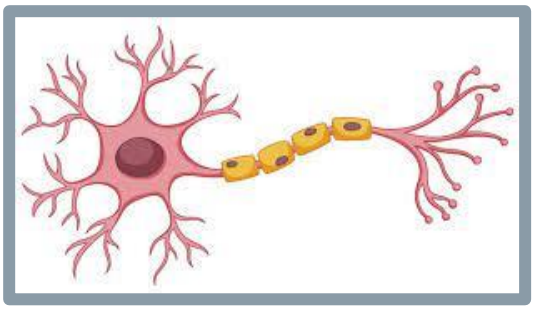
RED BLOOD CELL

- ❑ Does not contain a nucleus
- ❑ Shaped as a biconcave disc
- ❑ Functions to optimise transportation of oxygen



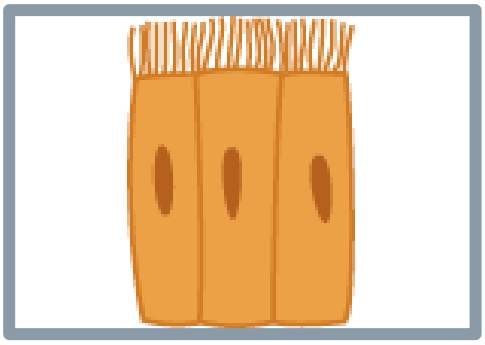
NERVE CELL

- ⌂ Long and thin in shape
- ⌂ Functions in sending nerve impulses



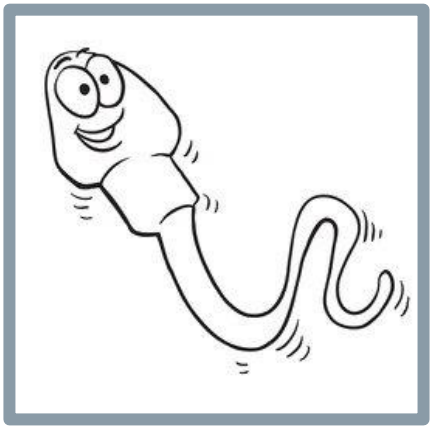
EPITHELIAL CELL

- ❖ Thin and flat cells
- ❖ Coats the surface of organs



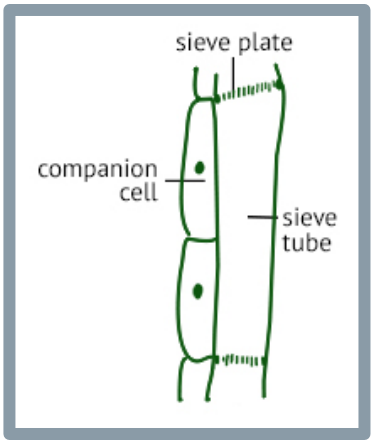
SPERM CELL

- Has long tail to enable it to swim towards the ovum in the Fallopian tube
- The head carries a set of chromosomes from the male



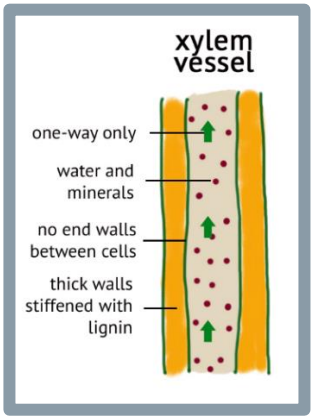
SIEVE TUBE ELEMENT

1. Long cylindrical arranged from end to end
2. Transports organic materials from leaves to storage organs such as fruits



XYLEM VESSEL

- Δ Long, continuous hollow tube
- Δ Functions in transporting water and mineral salts from the root to the other parts of the plant

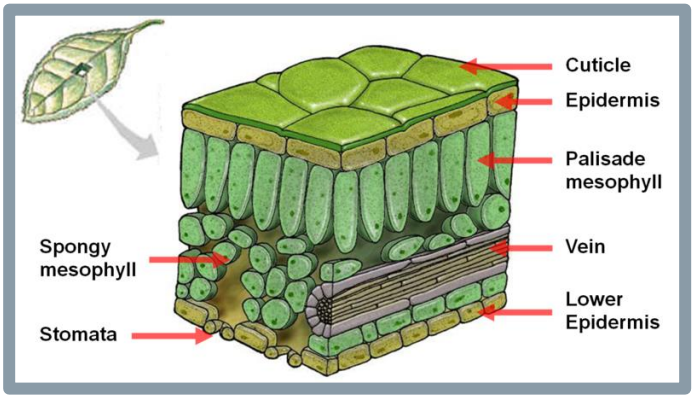


PALISADE MESOPYHLL CELL

- ♥ Consists of long cylindrical cells, arranged vertically and close to each other
- ♥ Contains high chlorophyll density
- ♥ This arrangement allows maximum absorption of sunlight for photosynthesis

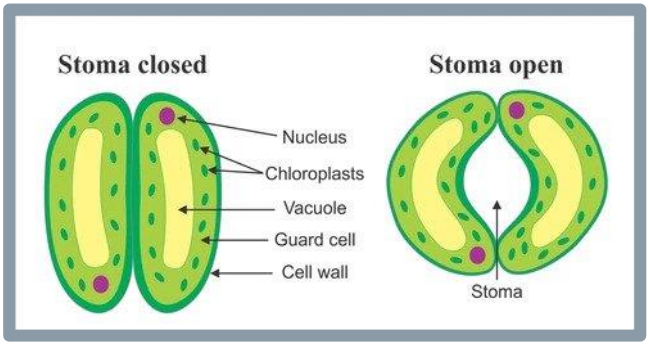
SPONGY MESOPHYLL CELL

- ⊕ Cells are loosely arranged with lots of air space in between
- ⊕ Large air space allows exchange of gas from the inside of the leaves to the palisade mesophyll cells



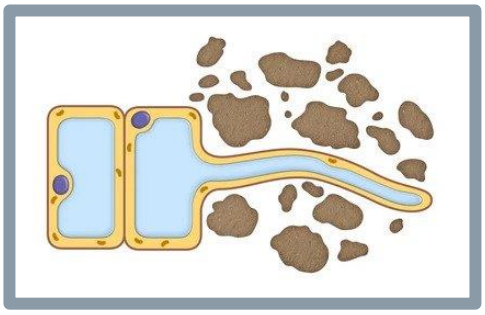
GUARD CELL

- » Modified lower epidermal cells with the thicker cell wall on the inner side
- » Controls the opening and closing of the stoma
- » Stoma is the opening that allows the exchange of oxygen and carbon dioxide



ROOT HAIR CELL

- Has a long projection which adds surface area for the absorption of water and mineral salts



Cell organisation in humans

→ Tissues are a group of cells that have the same structure and function and are arranged together to carry out a specific function

→ Four different types of tissue

A) Epithelial tissue
B) Muscle tissue
C) Nerve tissue
D) Connective tissue

Epithelial Tissue

a) Epithelial tissue covers the outer surface (skin) and hollow surfaces in the body

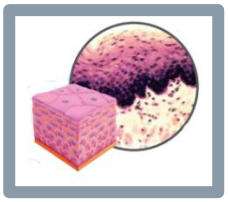
b) For example
- Digestive tract
- Respiratory tract

c) The epithelial tissue on the skin protects against
- Infections
- Injuries
- Chemicals
- Dehydration

d) Epithelial tissues that coat the trachea have projections like hair known as cilia

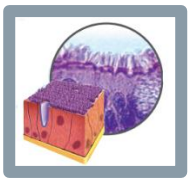
e) Types of epithelial tissues

① Epithelial tissue that covers the surface of the mouth and oesophagus

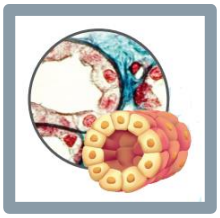


② Epithelial tissue that covers the surface of lungs, body

③ Epithelial tissue that covers the surface of the trachea an bronchus



④ Epithelial tissue that lines tubules, glands and kidney ducts



⑤ Epithelial tissue that covers the small intestine

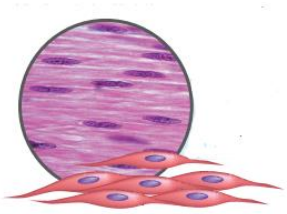
Muscle Tissue

There are three types of muscle tissue

1. Smooth muscle
2. Skeletal muscle
3. Cardiac muscle

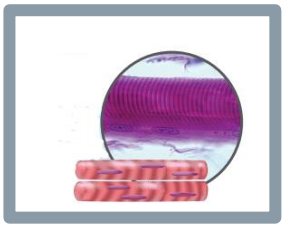
SMOOTH MUSCLE

- ◊ Contraction and relaxation of smooth muscle enable involuntary activities
- ◊ For example: peristalsis along the digestive tract



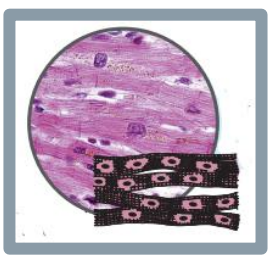
SKELETAL MUSCLE

- ↘ Involved in controlled movement
- ↘ Contract and relax to generate movement in bones and limbs



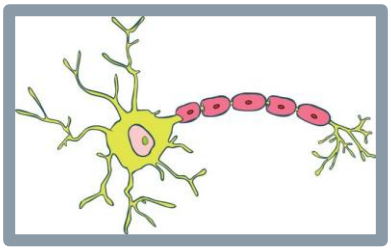
CARDIAC MUSCLE

- ▪ Builds walls of the heart that contract to pump blood to the whole body
- ▪ The contraction is involuntary



Nerve Tissue

- ❑ Made of neuron or nerve cells
- ❑ Each neuron consists of a cell body and nerve fibre
- ❑ Nerve fibre are called dendrite and axon
- ❑ Can detect stimuli and then send information in the form of an electrical signal (nerve impulses) to the muscles and glands
- ❑ Regulates and controls body activity

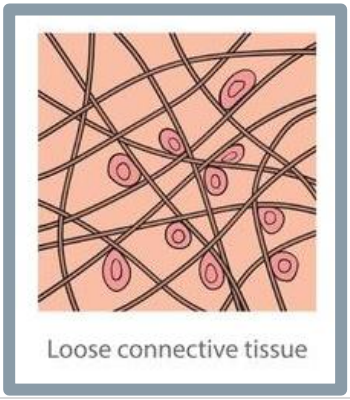


Connective Tissue

1) Loose connective tissue
2) Fibrous connective tissue
3) Blood tissue
4) Bone
5) Adipose tissue
6) Cartilage

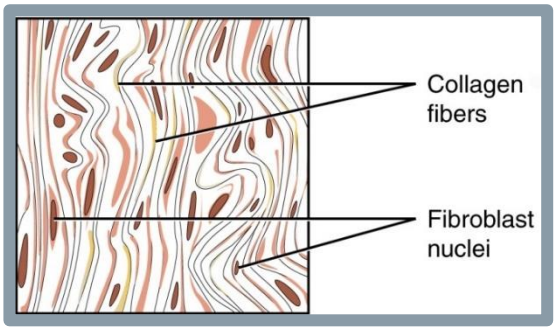
LOOSE CONNECTIVE TISSUE

- ⊕ Links the epithelial tissue to the tissue below it
- ⊕ Fixes the organs in their positions



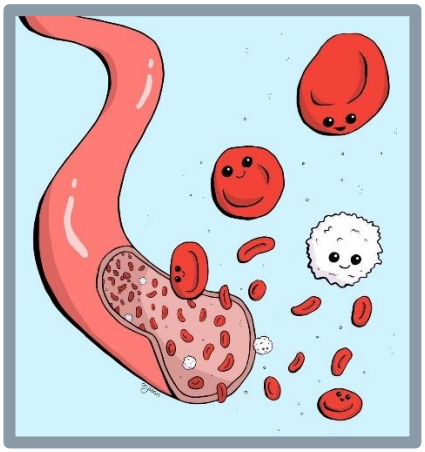
FIBROUS CONNECTIVE TISSUE

- ⌂ Form tendons and ligaments
- ⌂ The tendon connects bones and muscles
- ⌂ The ligaments connect bones to bones



BLOOD TISSUE

- » Plays a functional role in regulation, transportation and protection

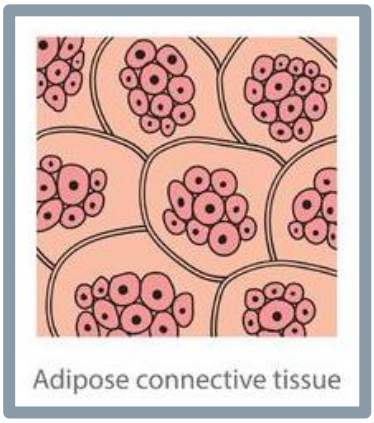


BONE

- Δ Bone forms the body frame
- Δ Protects the internal organs

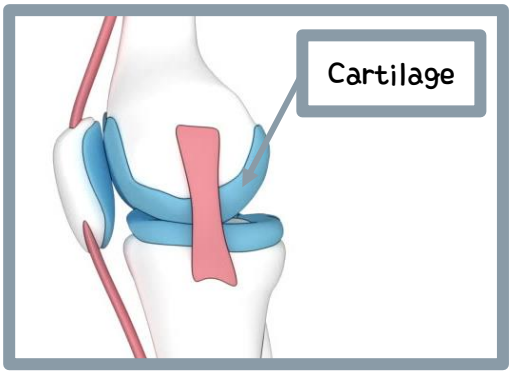
ADIPOSE TISSUE

- ♥ Connective tissues keep fat under the skin dermis and the surface of all main organs

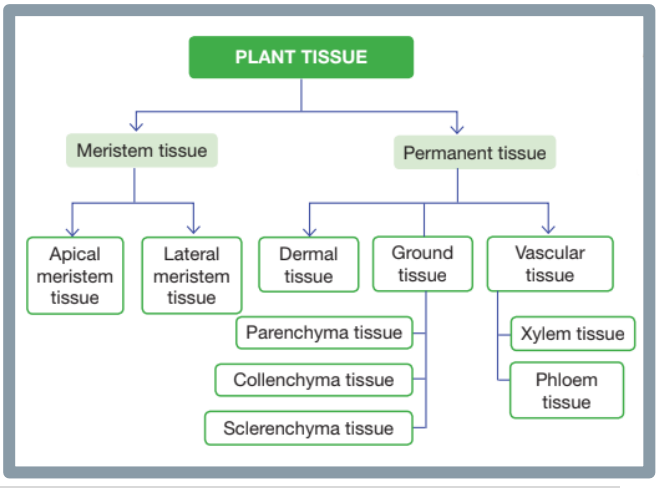


CARTILAGE

- Encloses bone tips to prevent the bone from wearing out



Tissue organisation in plants



Ground Tissue

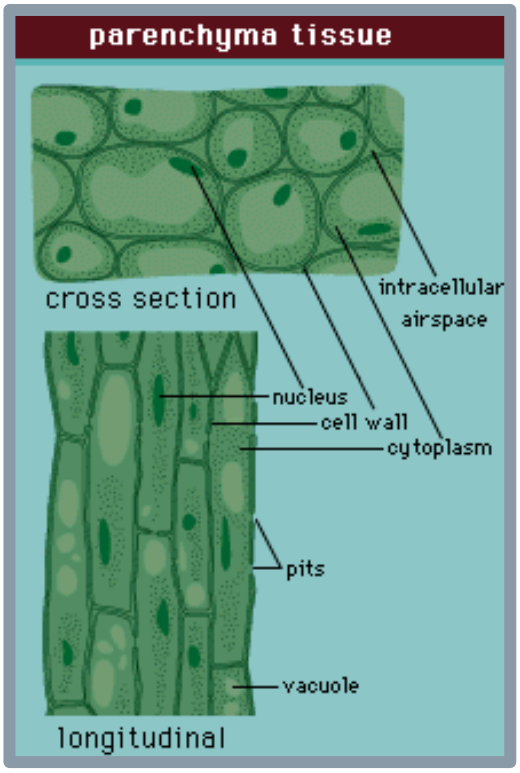
Three types of ground tissue

1. Parenchyma tissue
2. Collenchyma tissue
3. Sclerenchyma tissue

PARENCHYMA TISSUE

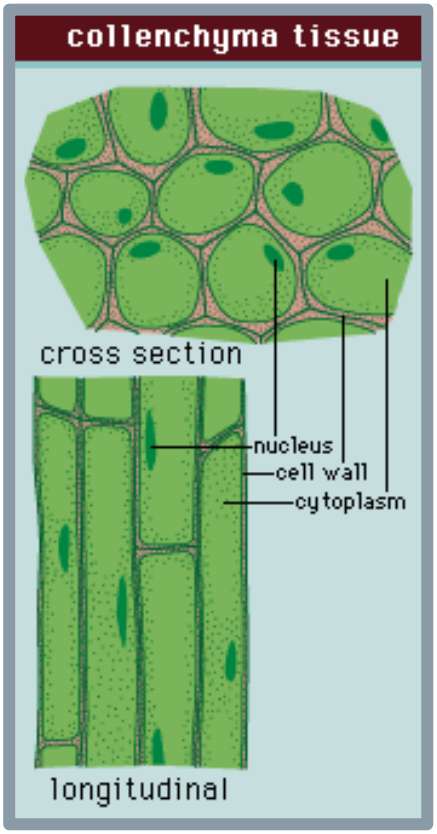
→ Functions to store
- I Starch
- II Protein
- III Water

→ Can also carry out photosynthesis



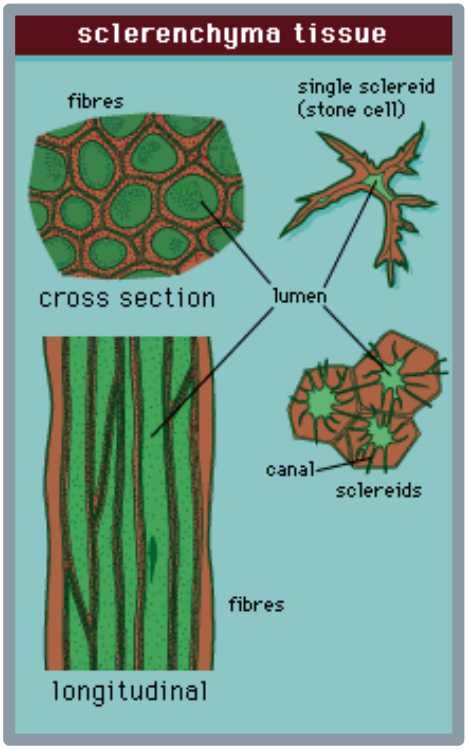
COLLENCHYMA TISSUE

- Functions in giving support to
  - A) Young plants
  - B) Non-woody plants (herbaceous plants)



SCLERENCHYMA TISSUE

» Functions in providing support and mechanical strength to all mature parts of the plant

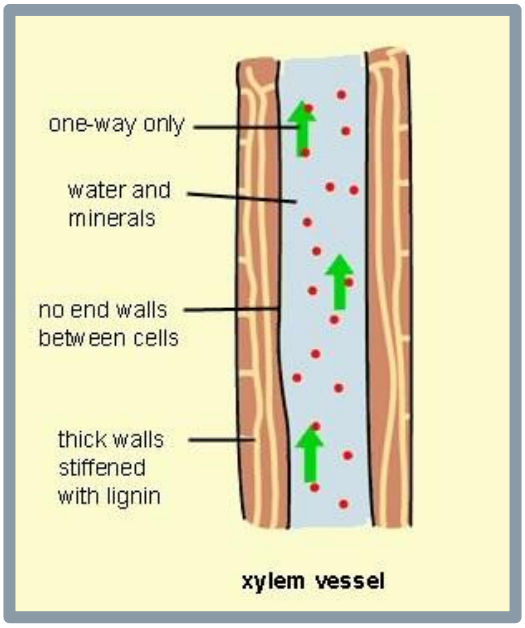


Vascular Tissue

- Made up of
  a Xylem tissue
  b Phloem tissue

XYLEM TISSUE

- Functions in transporting water and mineral salts from the roots to the other parts of the plant
- Ligneous xylem tissue wall provides support and mechanical strength to the plants

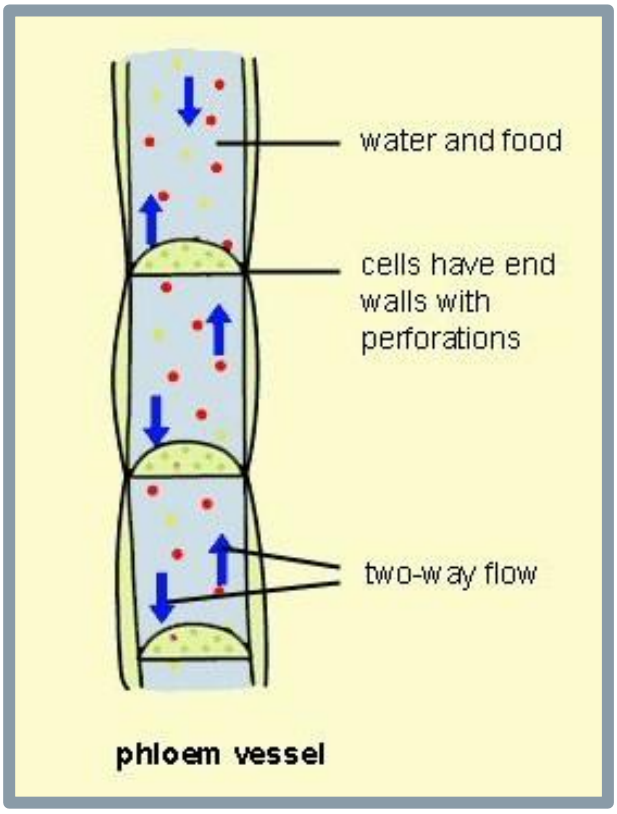


FAILURE OF LYSOSOME COMPONENTS

- Tay-Sachs is a hereditary disease caused by the failure of enzymes to produce in the lysosome
- Tay-Sachs patient will experience stunted growth and mental retardation

PHLOEM TISSUE

- Functions in transporting organic matters such as sucrose from the leaves to all parts of the plant



FAILURE OF MITOCHONDRION COMPONENTS

- Failure of mitochondrion or mitochondrion disjunction can cause stunted growth, weak muscles, hearing and vision problems

Density of certain cell components and specialised cell functions

Types of cells	Cell component found in abundance	Function
Sperm cell	mitochondrion	Requires energy to swim to fertilise the secondary oocytes
Muscle cell (flight muscle cells in insects and birds)		Requires energy to contract and relax to enable flight
Plant meristem cell		Requires a lot of energy to carry out active cell division
Palisade mesophyll cell	chloroplast	Absorbs more sunlight to carry out the process of photosynthesis
Spongy mesophyll cell		
Pancreatic cell	Rough endoplasmic reticulum Golgi apparatus	Increases synthesis and secretion of digestive enzymes
Goblet cell in intestinal epithelium and respiratory tract		Produces mucus
Liver cell	Smooth endoplasmic reticulum	Metabolises carbohydrate and detoxification of drugs and poisons

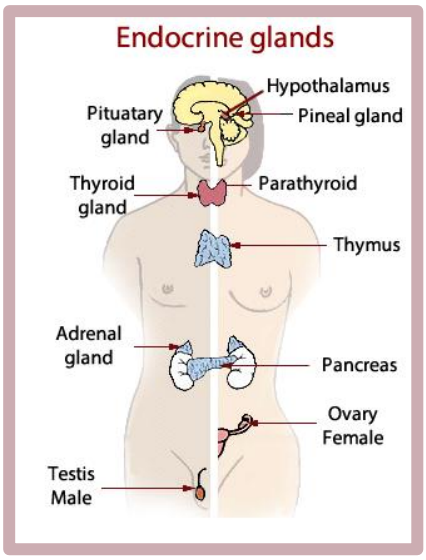
CHAPTER 2.4 – LEVELS OF ORGANISATION IN MULTICELLULAR ORGANISMS

Main organ systems in the human body

- ✓ A group of different tissues combine to form organs
- ✓ Organs perform special functions as a result of the combination of tissues that form the organ
- ✓ For example, the heart organ is composed of
  - ⊕ Epithelial tissue fills up the space in the heart
  - ⊕ Cardiac muscle tissue functions in pumping blood to the rest of the body
  - ⊕ Connective tissues connect the systems in the organ
  - ⊕ Nerve tissue regulates the rhythm of the heartbeat

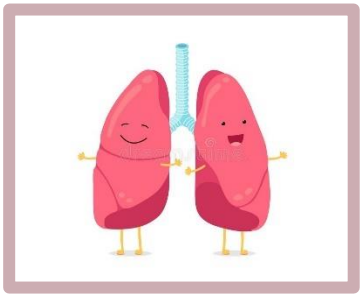
ENDOCRINE SYSTEM

- Δ Characteristic
  - ❑ The endocrine gland that secretes hormones
- Δ Function
  - ❑ Coordinates body activities with the nervous system



RESPIRATORY SYSTEM

- Characteristics
  - Trachea
  - Nose
  - Lungs
  - Diaphragm
- Function
  - Exchange of oxygen and carbon dioxide gases between the body and external environment



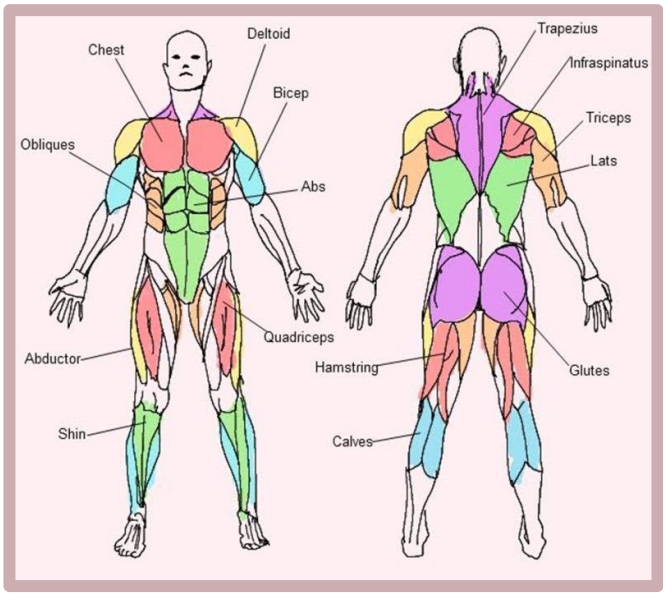
MUSCULAR SYSTEM

- ↘ Characteristics
  - ◊ Skeletal muscles
  - ◊ Smooth muscles

- ◊ Cardiac muscles

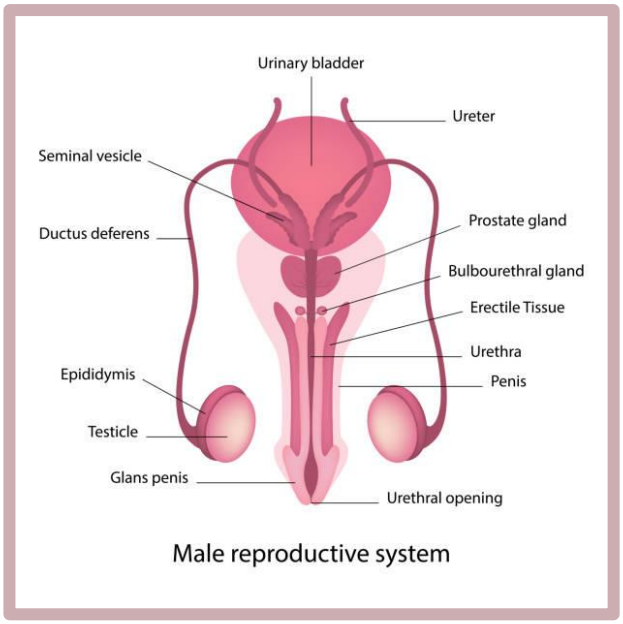
↘ Function

- ◊ Contracts and relaxes to produce movements in different parts of the body



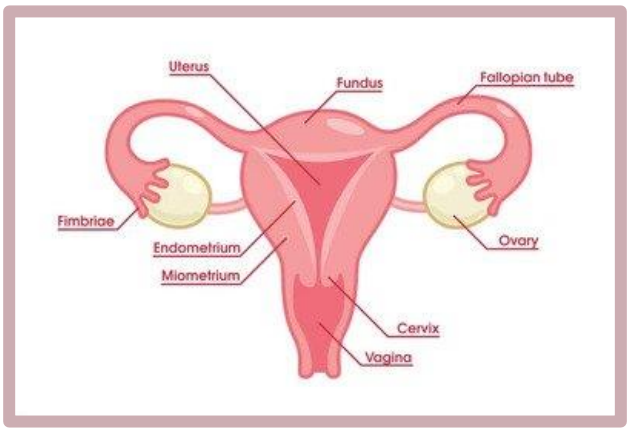
MALE REPRODUCTIVE SYSTEM

- Characteristics
  - » Testes
  - » Prostate gland
  - » Penis
- Function
  - » Produce sperm and male sex hormone



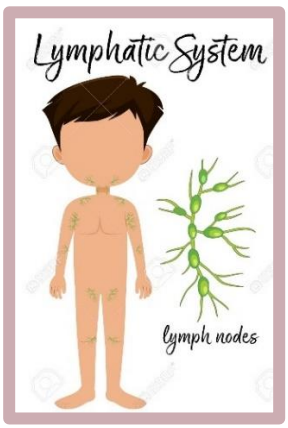
FEMALE REPRODUCTIVE SYSTEM

- ⌂ Characteristics
  - ❖ Ovary
  - ❖ Uterus
  - ❖ Fallopian tube
  - ❖ Vagina
  - ❖ Cervix
- ⌂ Function
  - ❖ Produces ovum and female sex hormones



LYMPATHIC SYSTEM

- » Characteristics
  - ♥ Spleen
  - ♥ Lymph nodes
  - ♥ Lymph vessels
- » Functions
  - ♥ Maintains balance of bodily fluids
  - ♥ Prevents infection diseases

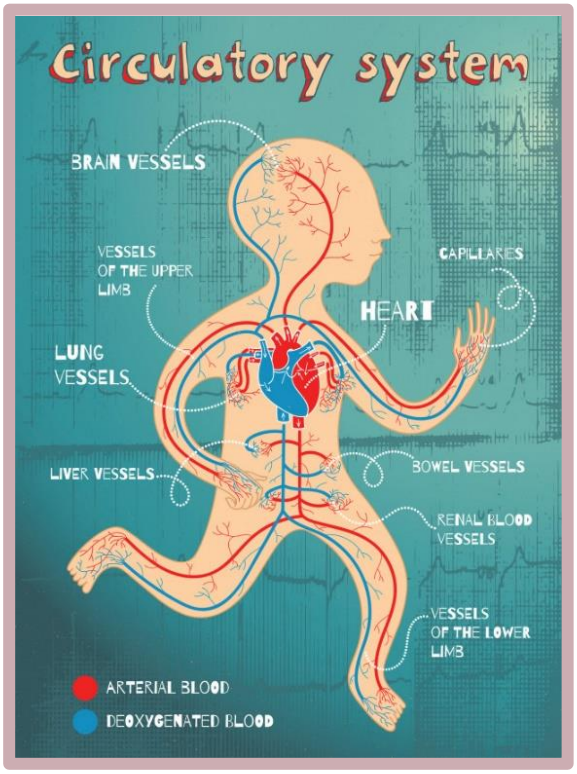


NERVOUS SYSTEM

- Characteristics
  - Brain
  - Spinal cord
  - Peripheral nerves
- Functions
  - Detects and sends information
  - Coordinate body activities

BLOOD CIRCULATORY SYSTEM

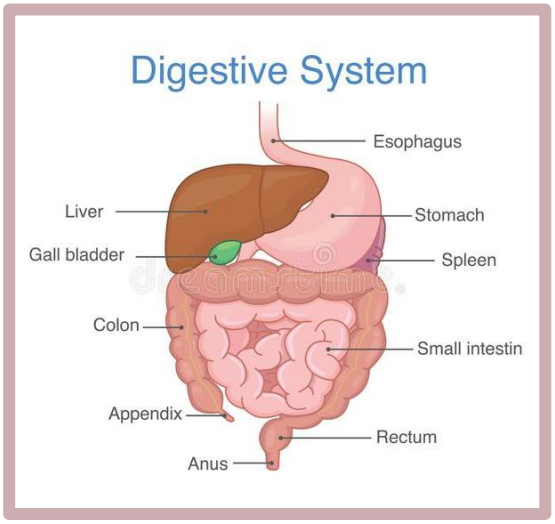
- Characteristics
  - A) Heart
  - B) Artery
  - C) Vein
  - D) Blood capillary
- Function
  - A) Transports nutrients, respiratory gases and waste products



DIGESTIVE SYSTEM

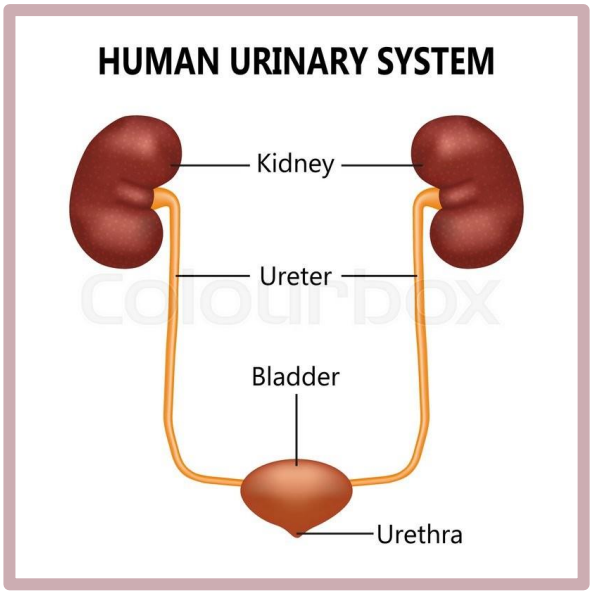
→ Characteristics
- a) Mouth
- b) Oesophagus
- c) Stomach
- d) Liver
- e) Pancreas
- f) Small intestine
- g) Large intestine

→ Function
- a) Digests food into a simpler form for easy absorption



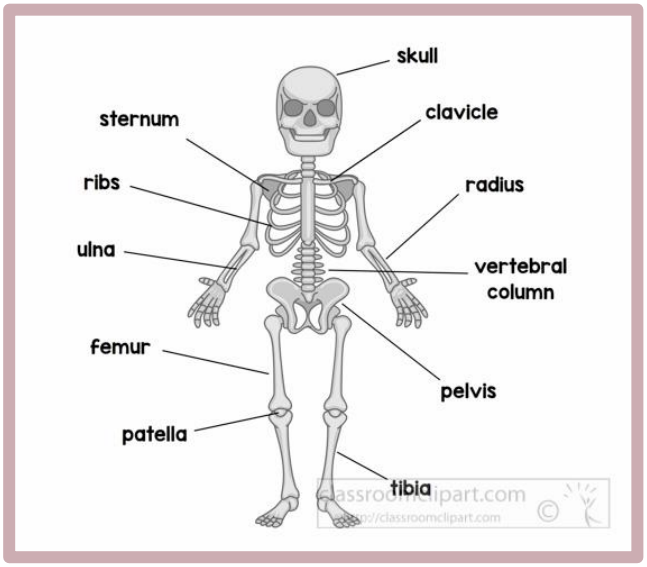
URINARY SYSTEM

- ♥ Characteristics
  - Kidney
  - Ureter
  - Urethra
  - Bladder
- ♥ Function
  - Eliminates waste products such as urea and uric acid from the body



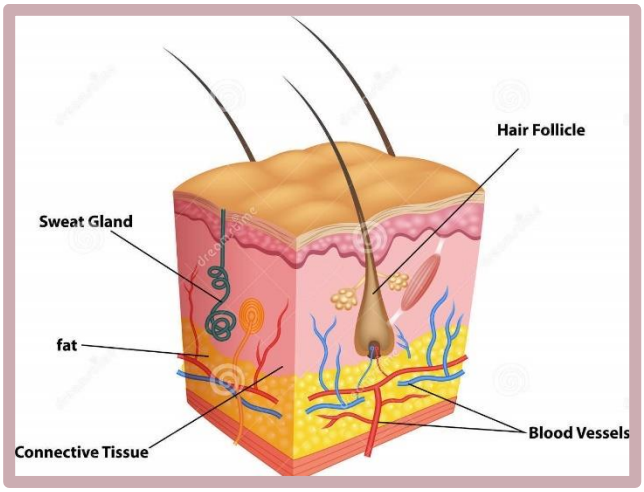
SKELETAL SYSTEM

- ⊕ Characteristics
  - ⌂ Bone
  - ⌂ Cartilage
  - ⌂ Ligament
  - ⌂ Tendon
- ⊕ Functions
  - ⌂ Supports the body
  - ⌂ Protects the internal organs
  - ⌂ Provides a base for muscle adhesion



INTEGUMENTARY SYSTEM

- ❖ Characteristic
  - Skin
- ❖ Function
  - Protects the body from physical injury, infection and dehydration



Main systems in plants

SHOOT SYSTEM

- » Consists of stems, leaves, shoots, flowers and fruits
- » Stems and twigs are support system that support the leaves at a vertical position to allow maximum

absorption of sunlight during photosynthesis

» Flowers are involved in the pollination process

ROOT SYSTEM

↘ Consists of all roots in a plant

↘ Function in absorbing water and mineral salts

↘ Function in providing support for plants

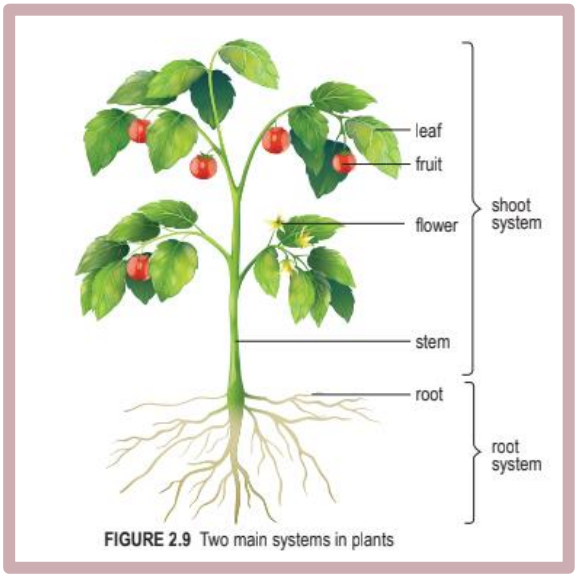


FIGURE 2.9 Two main systems in plants