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CHAPTER 2 : CELL STRUCTURE AND FUNCTIONS

1. PROKARYOTIC AND EUKARYOTIC CELLS
2. STRUCTURE & FUNCTION : CELL MEMBRANE & ORGANELLES
3. CELLS ARE GROUPED INTO TISSUES

CHAPTER 3: CELL TRANSPORT

1. PASSIVE TRANSPORT & ACTIVE TRANSPORT

Learning Objectives : 2.1

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At the end of the lesson, students should be able to :

1. State the three principles of cell theory. (CLO1)
2. Explain the structures of prokaryotic and eukaryotic cells.(CLO2)
3. Illustrate and compare the structures of prokaryotic and eukaryotic cells (plant and animal cells).(CLO3)

CELL BIOLOGY

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Principles of cell theory

1. The cell is the basic structural and functional unit of every organism.
2. The cells derived from other cells by division.
3. The Cell contain hereditary information (DNA) which controls their activities (example for growth, development & cell functioning).

Cells : The size of cells

- Most cells are between **1 to 100 µm** in diameter and their components are even smaller, as are viruses.
- Most cells are **visible under light microscopy.**
- **Electron microscopy** is used to see and study **proteins, lipids,** and etc.

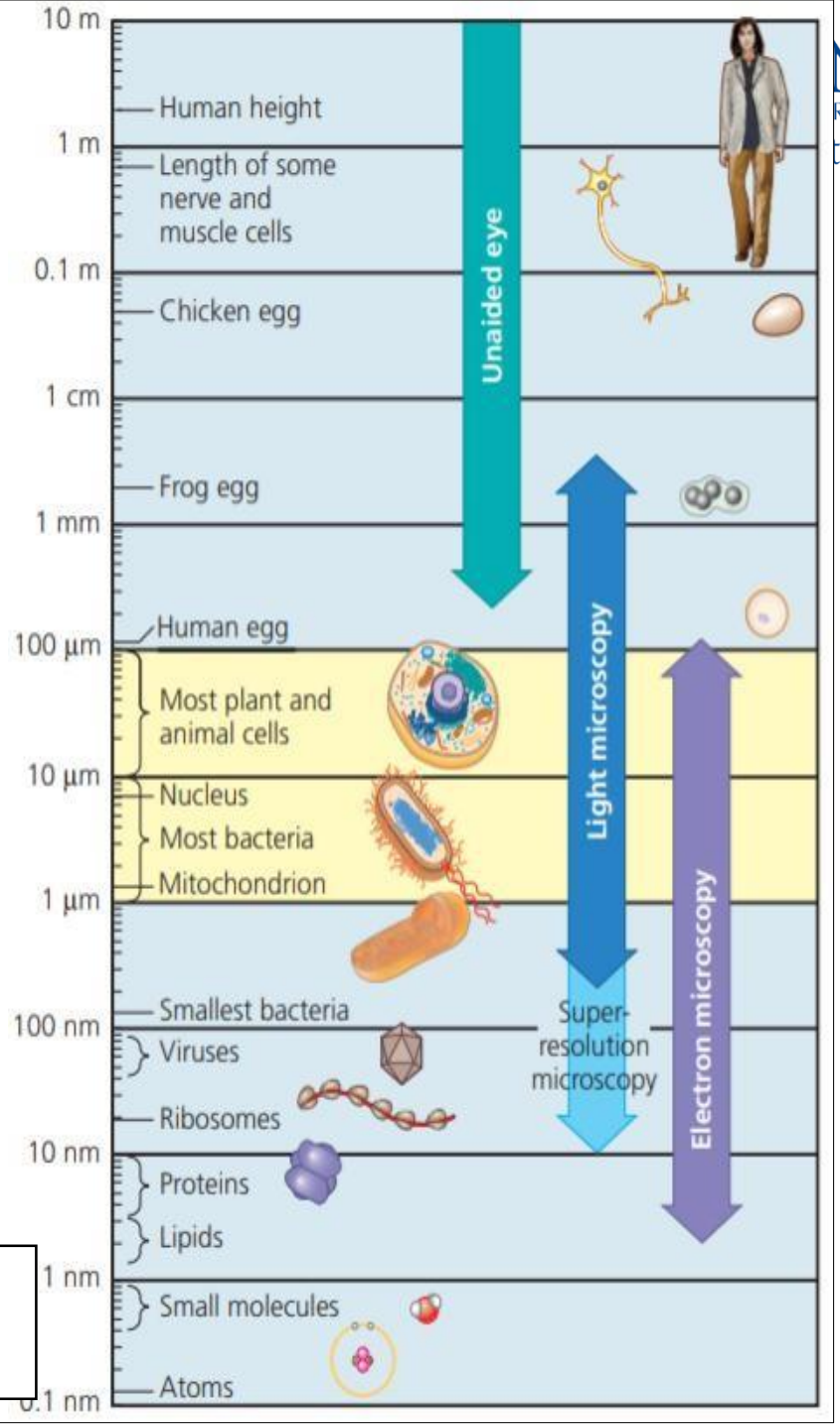
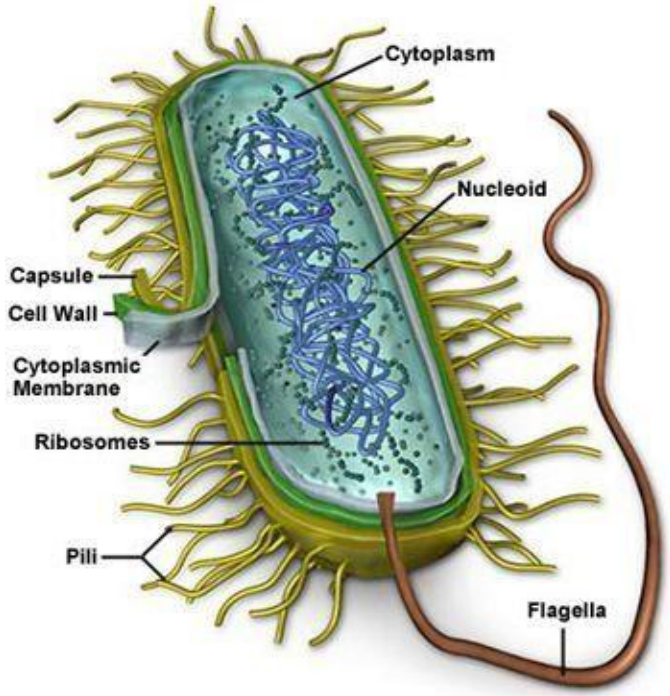


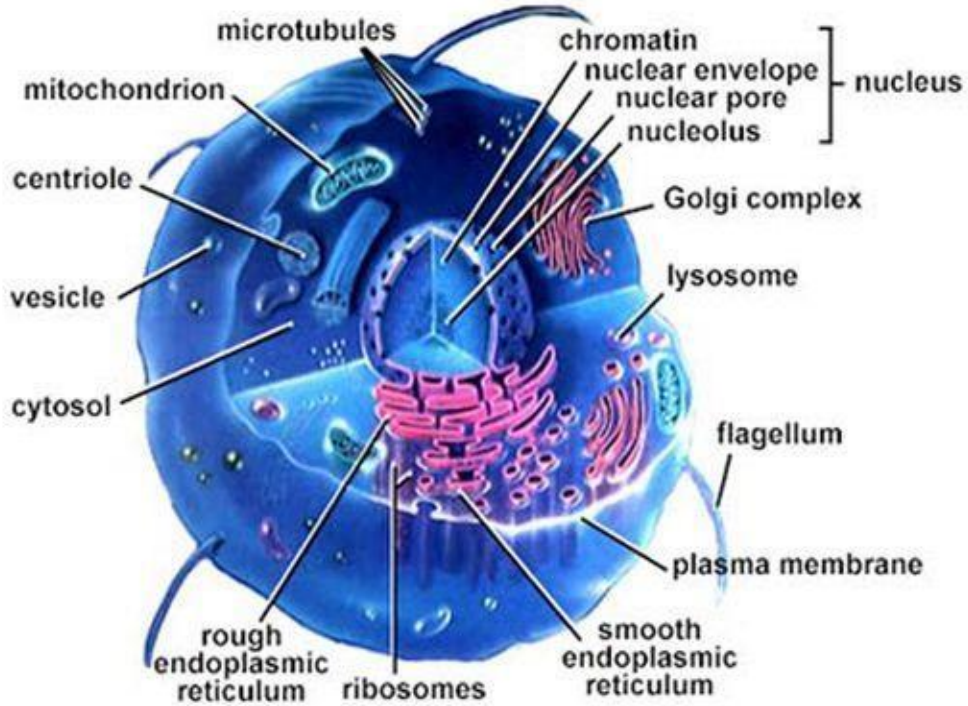
Figure 2.1.1: Size of cells

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TWO TYPES OF CELL



prokaryotic cell
(bacteria)



eukaryotic cell
(protists, fungi, animals, plants)

Figure 2.1.2: Types of cells

CELL TYPE : Prokaryotic cell

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- Prokaryotic origin from (Greek words;pro = **before)**
- **More primitive than eukaryotic cells.**
- Small & structurally simple 0.5-5 µm in diameter.
- Prokaryotic cells lacking true nucleus (they do not have membrane bounded nucleus)
- Prokaryotic DNA is circular. DNA is located in an unbound region called the nucleoid.
- They lack true nucleus (they don't have membrane enclosed organelles such as mitochondria, ER, Golgi body, vacuoles & lysosomes).
- Organism made of prokaryotic cells are called prokaryotes.
- Prokaryotes reproduce asexually generally by binary fission, a process in which one cells divides by two similar cells.
- The ribosomes are composed of 50S large subunit & 30S small subunit forming a 80S ribosome.
- Example : bacterium

CELL TYPE : Prokaryotic cell

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- Some prokaryotes are photoautotroph even though do not have chloroplast. Photosynthesis usually takes place in infolding or extensions derived from the plasma membrane.
- The mesosomes is inward fold (finger like projections) of the plasma membrane for cellular respiration.
- Some bacteria have flagellum for locomotion that made up of flagellin.
- Most bacteria have a rigid cell wall outside the plasma membrane which is made of peptidoglycan. It provide and support and maintain the cell wall, protects the cell wall it from bursting in a hypotonic environment.

CELL TYPE : Prokaryotic cell

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- The mesosomes is inward fold (finger like projections) of the plasma membrane for cellular respiration
- Prokaryotic cell has **mesosome** : carry out similar function to mitochondria in eukaryotic cells.

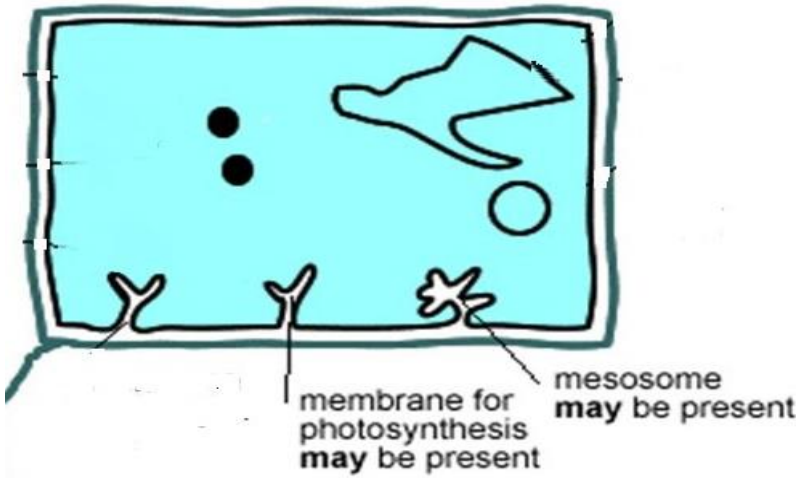


Figure 2.1.3: Mesosomes, infolding of plasma membrane where cellular respiration take place and infolding of plasma membrane for photosynthesis.

CELL TYPE : Prokaryotic cell

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- Some prokaryotes stick to their substrate or to another by hair like appendages called fimbriae (singular, fimbria)
- Sex pili are longer than fimbriae and allow prokaryotes to exchange DNA during conjugation.

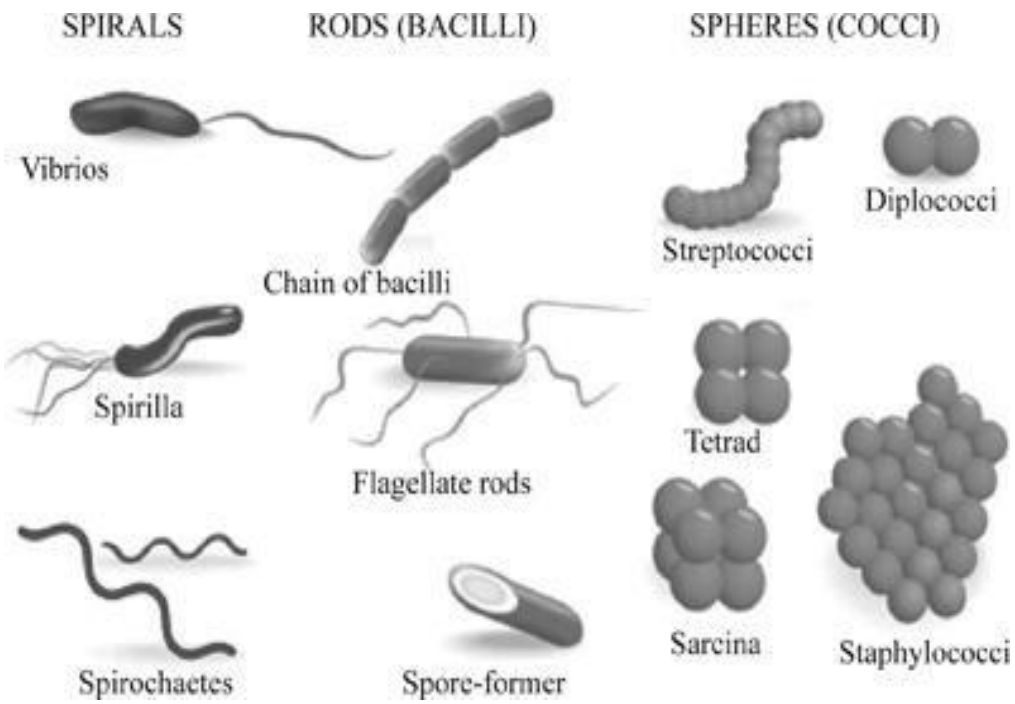
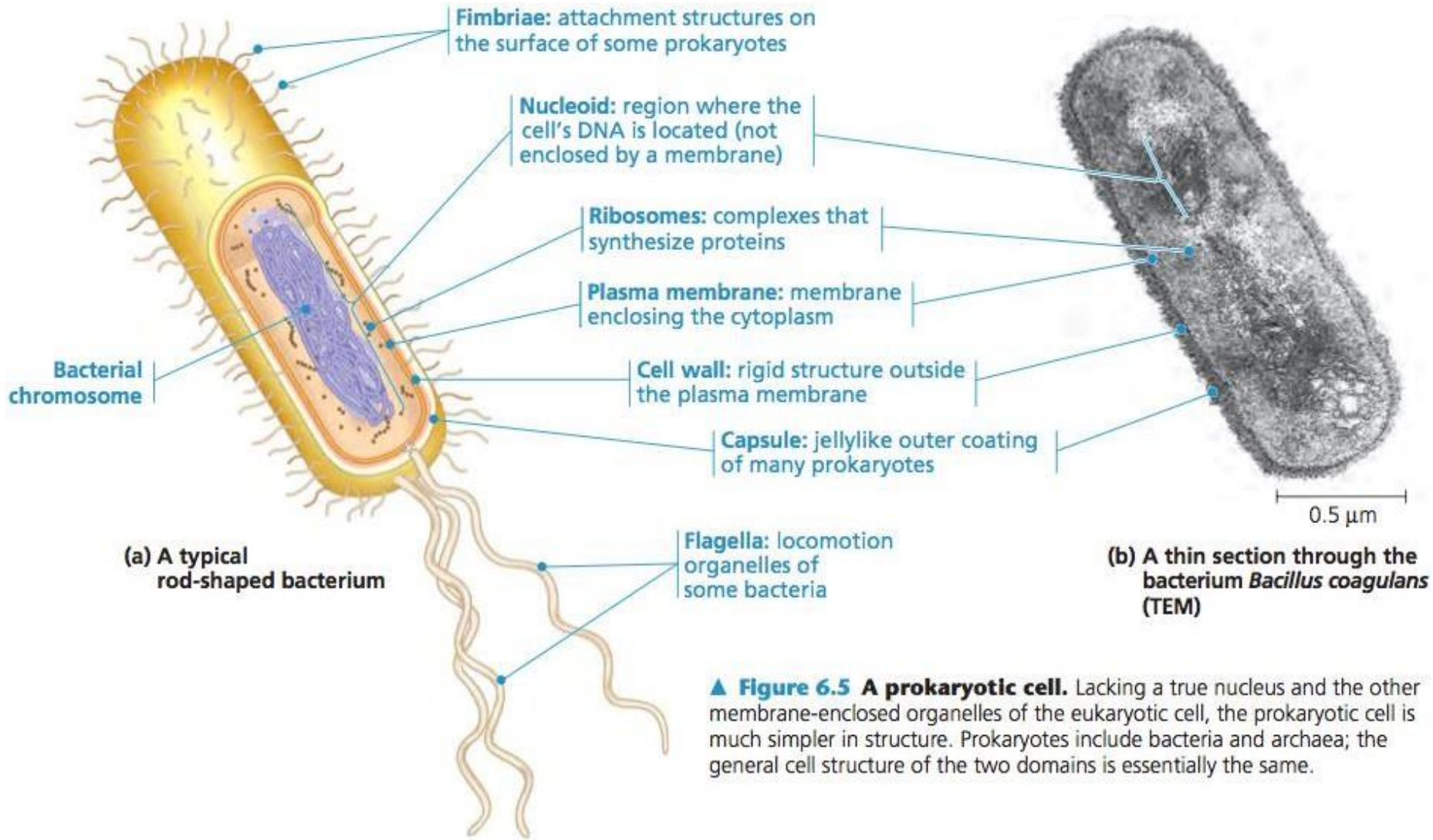


Figure 2.1.4 basic shapes : (i) rod (bacillus) (ii) spherical (coccus) (iii) twisted spirals (spirilla)

CELL TYPE : Prokaryotic cell

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▲ **Figure 6.5 A prokaryotic cell.** Lacking a true nucleus and the other membrane-enclosed organelles of the eukaryotic cell, the prokaryotic cell is much simpler in structure. Prokaryotes include bacteria and archaea; the general cell structure of the two domains is essentially the same.

CELL TYPE : Prokaryotic cell

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- Some bacteria has ability to produce a **capsule** which can contribute to a microbe's pathogenicity (property of causing disease).

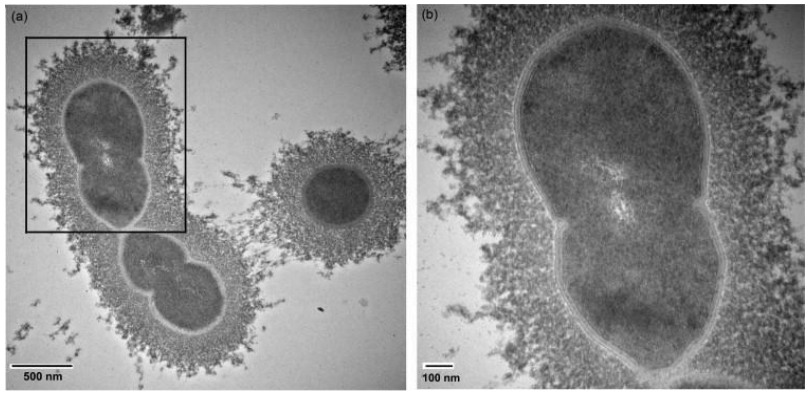


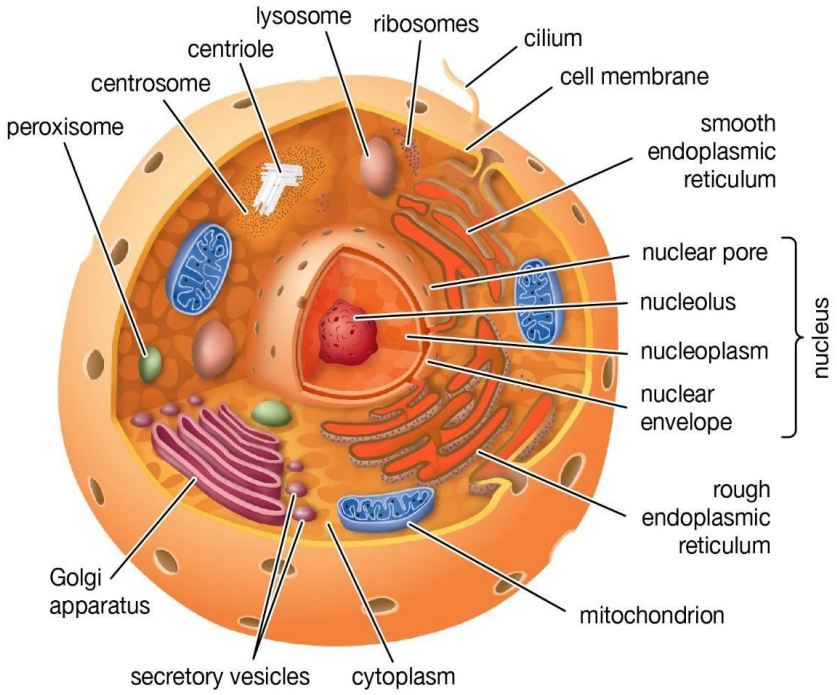
Figure 2.1.5 : Cells producing Capsule.

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CELL TYPE : Eukaryotic cell

- Unicellular, filamentous or multicellular organism with large (10 – 100 um in diameter) cell compare to prokaryote).
- EU – true, Karyo – nucleus… **SO….** The cell has **TRUE nucleus.**
- Based on structure 2 types : **animal cell and plant cell.**
- DNA of the cell surrounded by **nuclear membrane.**
- All living organisms made of eukaryotic cells except bacteria and archaebacteria.



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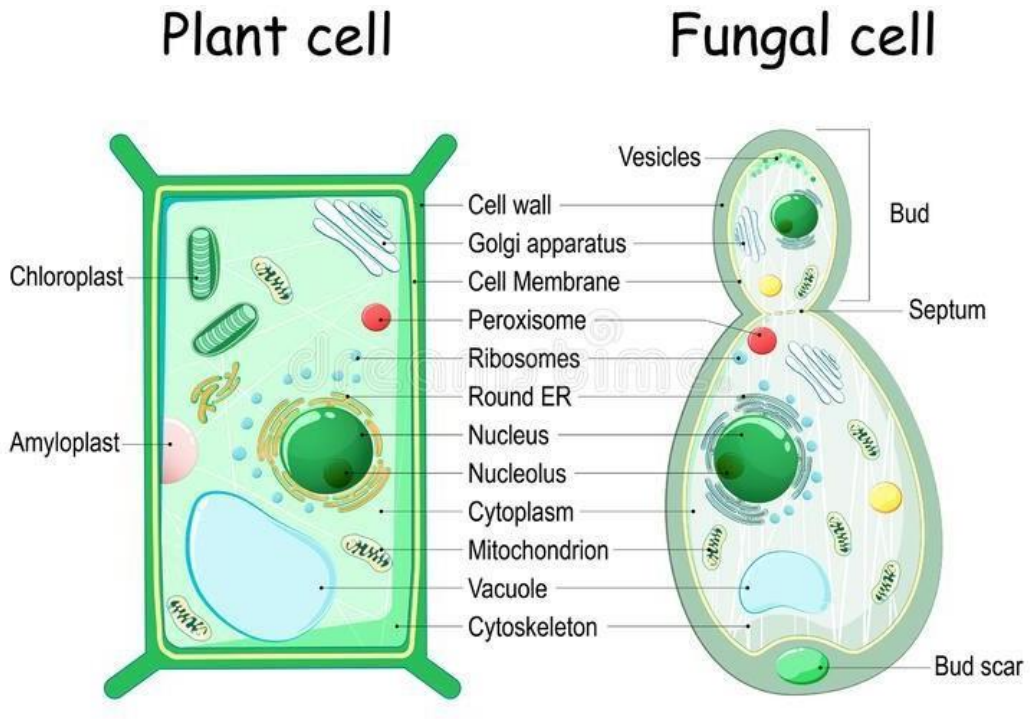
- The cell usually **larger in size compared to bacteria cells.**
- Plant cells and algae have cell walls . Plant cell wall composed of cellulose while for fungi cell wall composed of chitin.

CHARACTERISTICS OF EUKARYOTIC CELL

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- CELL WALL:
  - Cell wall absent in animal cells.
  - Some eukaryotic cells consist of cell wall.
    - **Cellulose cell wall** found in **plant cells and algae**
    - **Chitinous cell wall** found in **fungi.**



2.1.7 Plant cell and Fungal cell

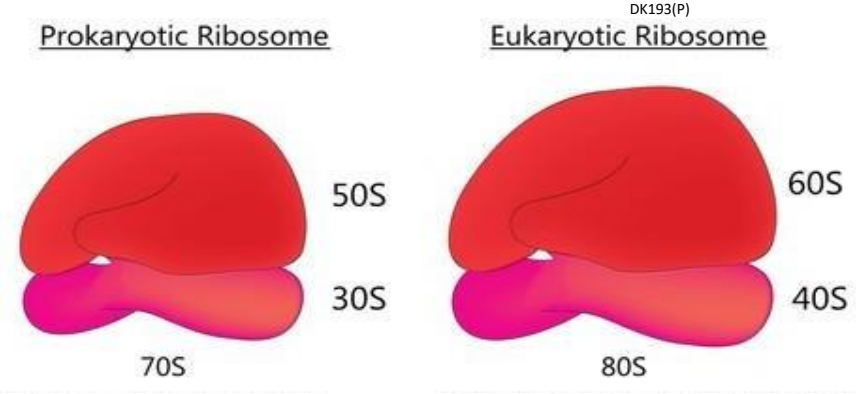
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- Has a complex ribosome: ribosome 80s

- Animal cell consists of a **pair of centrioles**

- Various types of membrane-bound organelles also found in eukaryotic cells including :



2.1.8 Ribosome

- **Nucleus**
- **Mitochondria**
- **Chloroplast (in plant cells)**
- **Golgi body**
- **Endoplasmic reticulum**
- **Lysosome (in animal cells)**

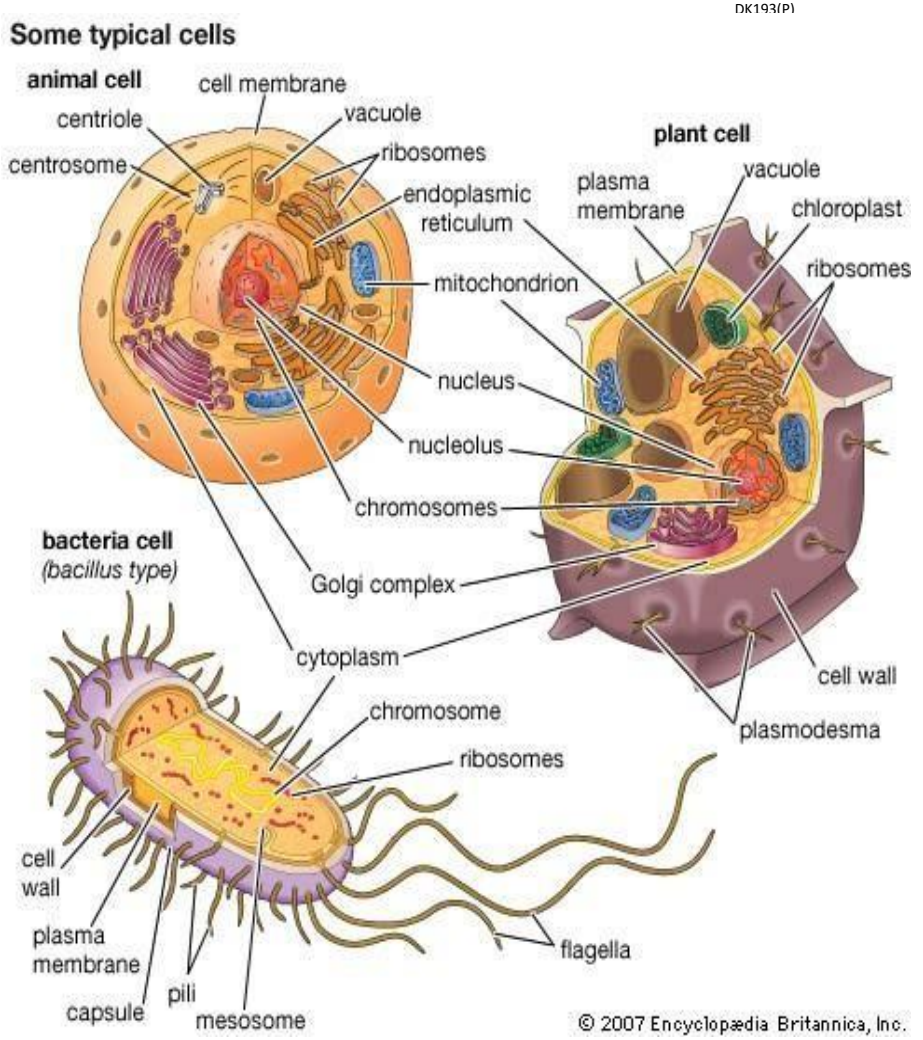
COMPARISON BETWEEN PROKARYOTES AND EUKARYOTES

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Similarities

- Both prokaryotic and eukaryotic cells have :
  1. Plasma membrane
  2. DNA
  3. Ribosome
  4. Cytoplasm
  5. Flagella (for sperms in eukaryotic cell)



2.1.9 Animal cell, Plant cell and Bacteria cell.

COMPARISON BETWEEN PROKARYOTES AND EUKARYOTES

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Features	Prokaryotic Cell	Eukaryotic Cell
Size	Small (0.5 µm to 5.0 µm)	Large (10-100 µm)
DNA	Not associated with histone. Proteins and usually circular and free floating in the cytoplasm.	Associated with histone proteins linear and enclosed by nuclear envelop.
Nucleus	Absent	Present
Organelles	No membrane bounded organelles	Has membrane- bounded organelles. (Mitochondria, Chloroplasts, endoplasmic Reticulum)
Ribosomes	Small ribosomes (70 S)*	Large ribosomes (80 S)*
Cell Well	Cell wall is present but chemically different from eukaryotes. Cell wall consist of peptidoglycan.	Cell wall are absent except in plants (made from cellulose) and fungal cells
Flagella	Simple bacterial flagella	Complex has 9+2 arrangement of microtubules

COMPARISON BETWEEN PROKARYOTES AND EUKARYOTES

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Features	Prokaryotic Cell	Eukaryotic Cell
Cell division	Mostly by binary fission	Mitosis or Meiosis or both
Reproduction	Without sexual system, genetic material are direct passes from donor to recipient	Mitosis or Meiosis and fertilization
Organelles	Few organelles; not surrounded by membrane envelope	Many membrane bounded organelles
Cell wall composition	Peptidoglycan (murein)	Cellulose (plants) & chitin (fungi)
Nucleus	No true nucleus	Has true nucleus, bounded by distinct double membrane and perforated by nuclear pores
Genetic material	Circular DNA lay free in cytoplasm; not supported with histone proteins	Linear DNA and combined with histone proteins; contained within the nucleus

COMPARISON BETWEEN PROKARYOTES AND EUKARYOTES

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FEATURES	PROKARYOTIC CELLS	EUKARYOTIC CELLS
Flagella and cilia	Some have simple flagella (single protein fibre/ flagellin); 9+0 arrangement of microtubules	Some have complex cilia and flagella (tubulin); 9+2 arrangement of microtubules.
Genetic recombination	Sexual reproduction involves transfer of some DNA from one cell to another	Sexual system involves complete nuclear fusion between gametes with equal contribution from both nuclei.
Protein synthesis	Synthesised in small ribosomes (70s)	Synthesised in large ribosomes (80s)
Nitrogen fixation ability	Some can fix nitrogen for consumption in the amino acid synthesis	None has this ability
Capsule	Capsule is present	Capsule is absent
Examples of organisms	Bacteria and cyanobacteria	Plants, animals and fungi

COMPARISON BETWEEN PLANT AND ANIMAL CELL

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Structure	Functions	Plant Cell	Animal Cell
Nucleus	Site for storing DNA & Synthesizing RNA	√	√
Nucleolus	Inside the nucleus and functions as site for Manufacturer of ribosomes.	√	√
Plasma Membrane	Site for Aerobic Respiration	√	√
Mitochondria	Site for aerobic respiration	√	√
Rough ER	• Attached ribosomes synthesizing polypeptide into lumen of rough ER. • The polypeptide is folded into 3D structure and packed into transport vesicle.	√	√
Smooth ER	Synthesis of lipids and steroids	√	√

COMPARISON BETWEEN PLANT AND ANIMAL CELL

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Structure	Functions	Plant Cell	Animal Cell
Golgi apparatus	Receives products from rough ER and smooth ER for further modification and processing. The final products is packed into secretory vesicles.	√	√
Lysosomes	Digest food pathogens, worn out organelle or cell lysis for development.	x	√
Cell wall	Provides strength and maintain shape of plant cells	√	x
Chloroplast	Site of photosynthesis	√	x
Vacuoles	Store food and waste materials Maintain the solute potentials of the cells	√	x
Tonoplast	Membrane that surround vacuoles	√	x
Centrioles	Form spindle fibres during cell division in animal cells	x	√

Learning Outcome: 2.2

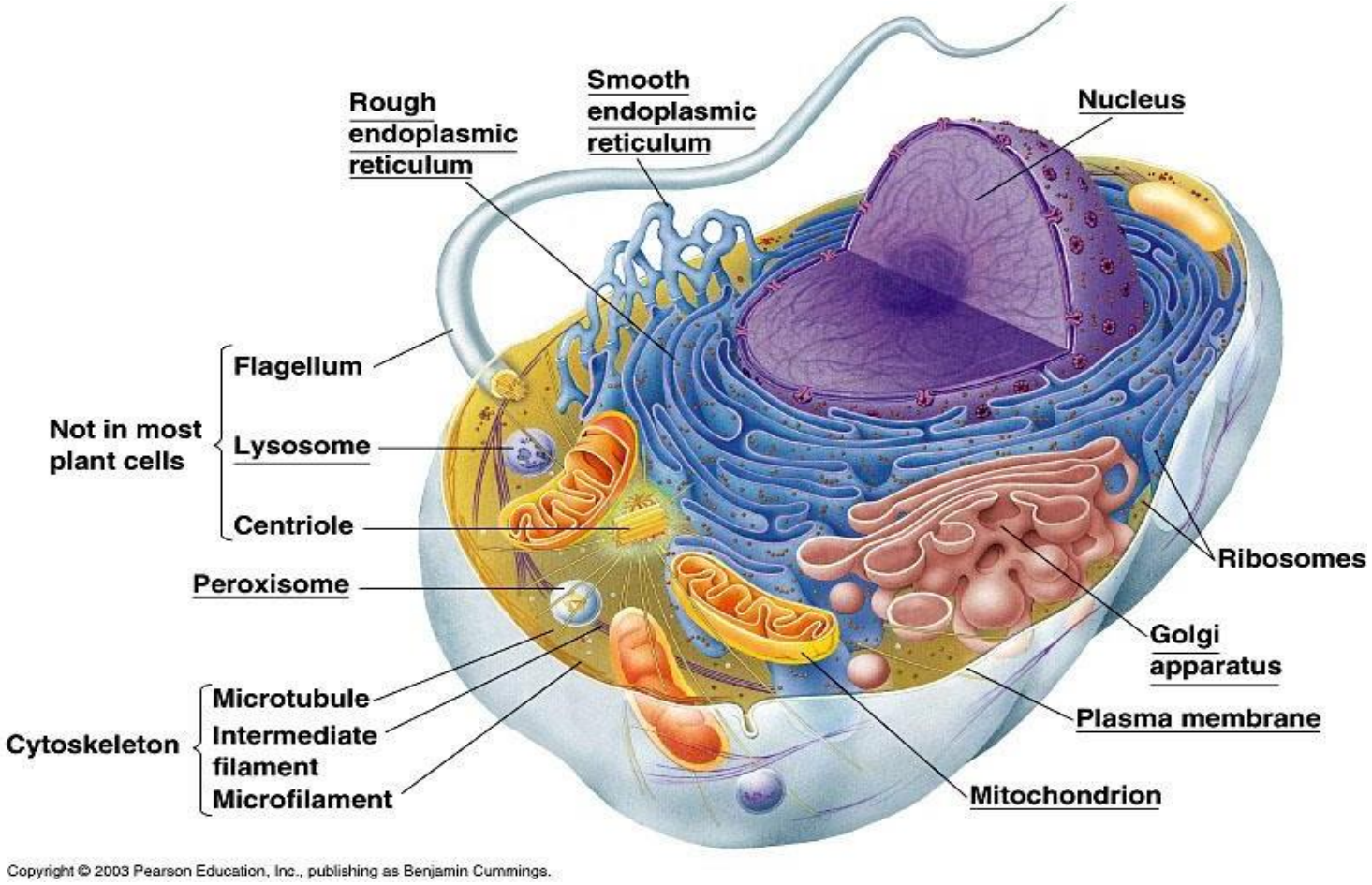
At the end of the lesson, students should be able to :

1. State the structures and functions of the following organelles:
   nucleus, rough endoplasmic reticulum, smooth endoplasmic reticulum, Golgi body, lysosome, ribosome, mitochondria, chloroplast and centriole. (CLO1)
2. Illustrate the detailed structure of animal & plant cell.(CLO3)

Ilustrate the detailed structure of animal cells

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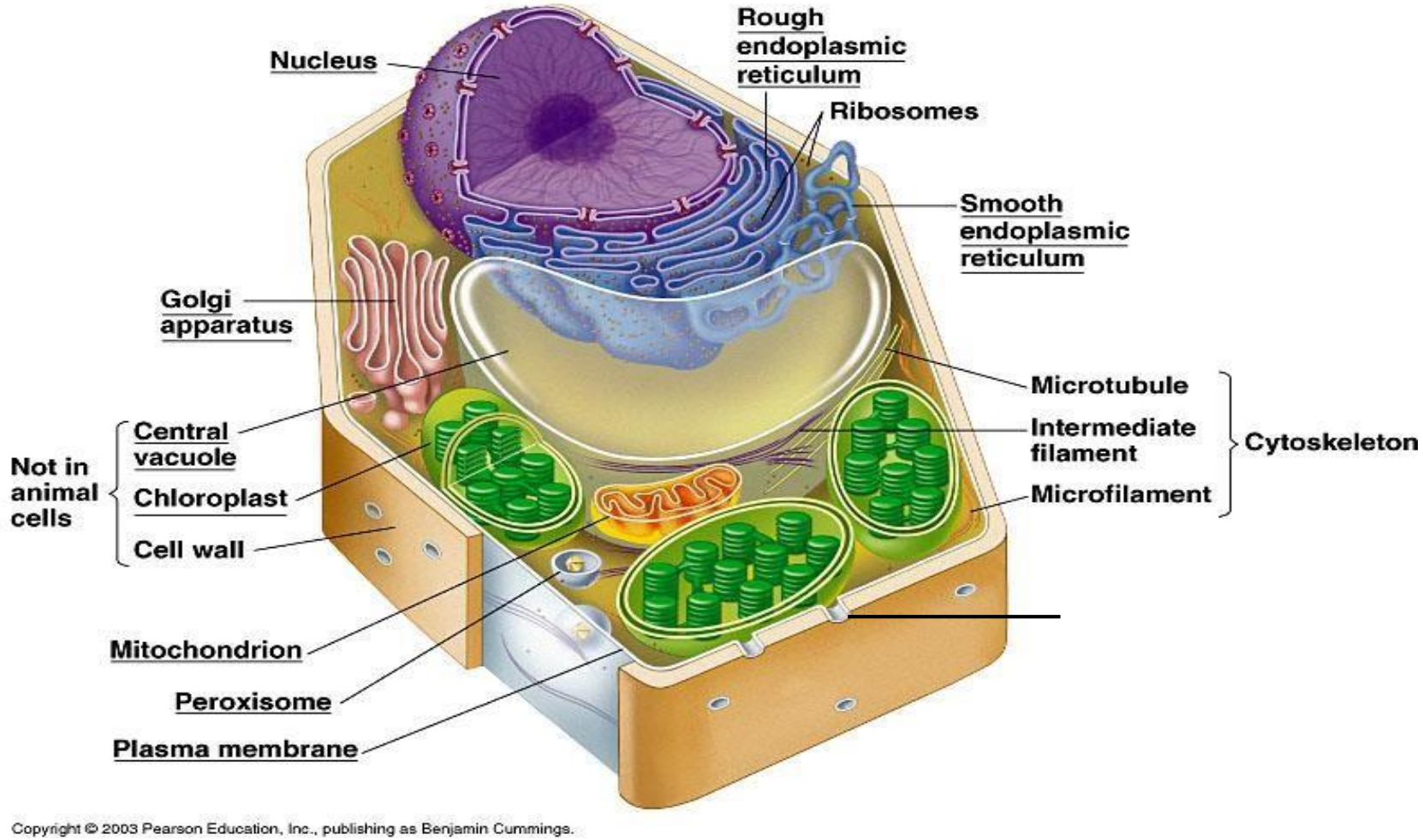
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2.2.1 Animal cell

Ilustrate the detailed structure of typical plant cells

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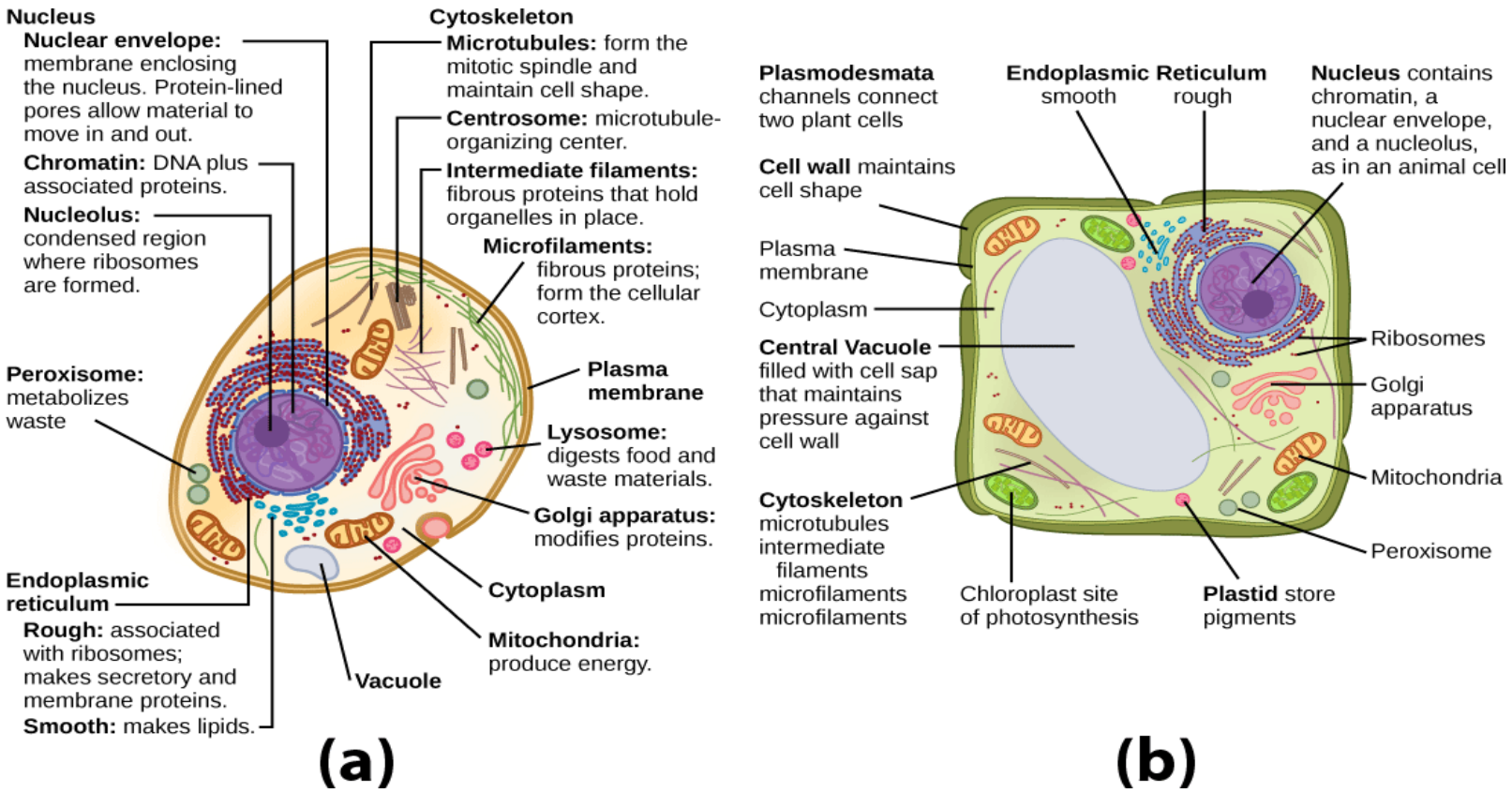
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2.2.2 Plant cell

Animal Cell (a) VS Plant cell (b)

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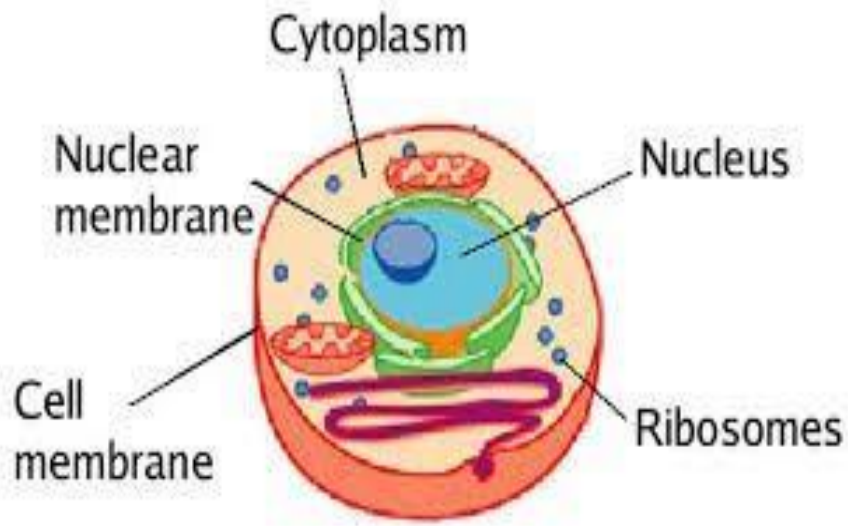
2.2.4 Animal cell Vs Plant cell

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Cytoplasm

- Region between nucleus & plasma membrane
- Consists of **cytosol and organelles suspended i**n it
- **Cytosol**
  - **90% water and solutes** (sugar, amino acids, enzymes, ATP, nucleotide, dissolved gasses, fatty acids
  - **Large molecules** [proteins, colloids (particles ranging between 1 & 1000 nm evenly distributed through out the solution]
  - Microfillaments & microtubules
  - Serve as **site for biochemistry reactions** (glycolysis)



2.2.5 Animal cell showing organelles

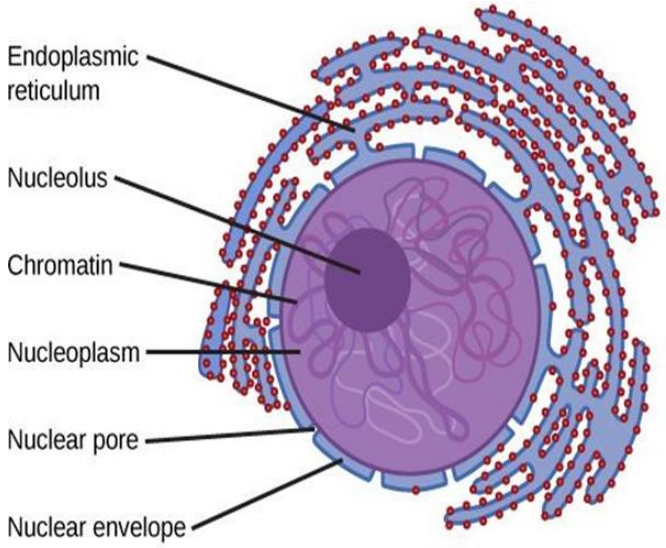
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Nucleus

Structure

- Largest organelle. Consist of :
- Nuclear membrane : Nucleus is separated from cytoplasm
  - **Nuclear envelope :** a double membrane (Outer & Inner Membrane)
  - Nuclear envelop is covered with numerous pores.
  - **Nuclear pores :** control the exit of substances such as RNA and ribosomes from the nucleus.
  - **Nucleoplasm :** interior part full of chromatin
  - **Nucleolus :** dark region of chromatin, involved in making ribosomes.



2.2.6 Animal cell showing organelles

Function

- Contains DNA carrying the genetic information that can be passed from one generation to another
- Center to **control cell activities & division**
- Production of **ribosomes & RNAs for protein & enzyme synthesis**

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Nucleolus

Nucleolus:

- Prominent structure within non dividing nucleus.
- Sometimes there are two or more nucleoli depends on species and stage in the cell reproductive cycle.
- Dense mass of granules/ fibres, non membranous structure.

Functions:

- Acts as the center to control the activities of the cell and cell division.
- Nucleolus play a role in controlling the cell division and life span of the cell.
- Nucleolus involved in the production of ribosomes (rRNA).
- DNA is organized into genes, which are template used in protein synthesis.
- The pores control the exchange of a material between the nucleus & the cytoplasm.

Ribosomes

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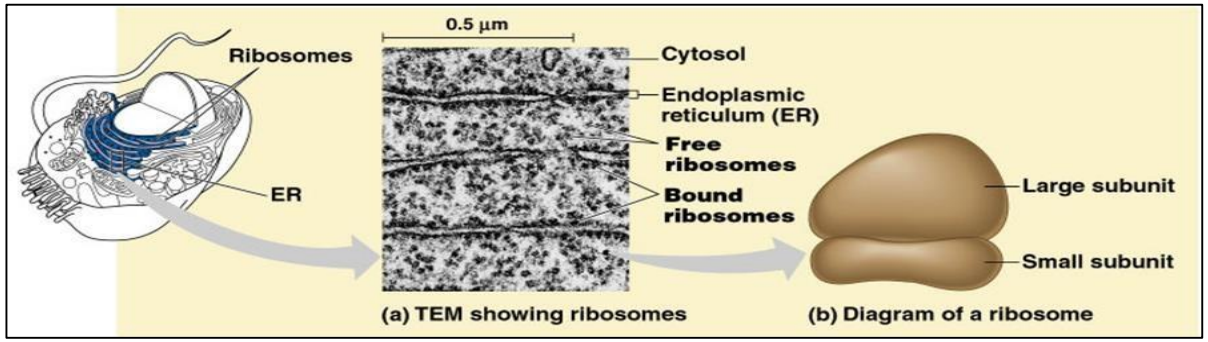
Structure

- **Smallest and most numerous organelle**
- Composed of **protein and rRNA (70%)**
- Manufactured in the nucleolus of the nucleus.
- Some found freely and some attached to the surface of endoplasmic reticulum
- Often found in groups called **polysomes** or **polyribosomes**.

Function

- Synthesis proteins (polypeptide)

in translation process.



2.2.7 Animal cell showing ribosomes

ENDOPLASMIC RETICULUM

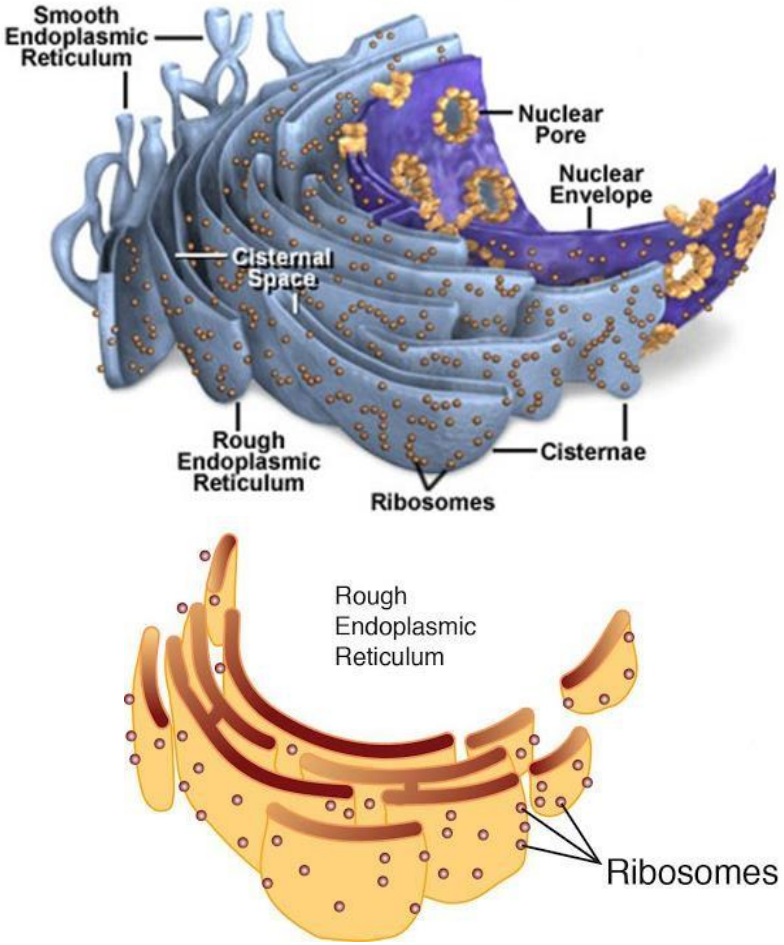
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Endoplasmic Reticulum:

- Endoplasmic reticulum consist of network of membranous tubules and sacs called cisternae.
- It originates from the outer membrane of the nuclear envelop.
- Because of endoplasmic reticulum membrane is continuous with the nuclear envelop, the space between the two membrane of the nuclear envelop is continues with the lumen of the endoplasmic reticulum.
- Studded with ribosome on the outer surface of the membrane and does appear rough through the electron microscope.
- The rough endoplasmic reticulum consists of an interconnected system of membrane- bound flattened sacs called cisternae.

Functions:
To package & transport proteins made by ribosomes.



2.2.8 Animal cell showing endoplasmic reticulum

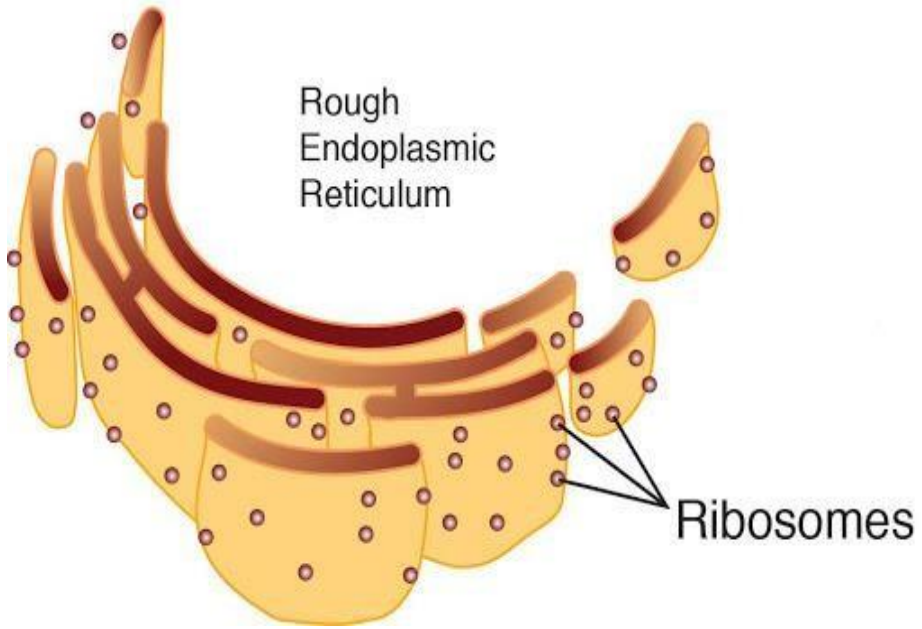
Rough **endoplasmic** reticulum

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Structure

- A membranous system of interconnected flattened sacs,
- Continuous with the nuclear envelope
- The flat sacs called cisternae
- Studded with **numerous ribosome**, which give it rough appearance



Function

- Site for protein synthesis.
- Transport protein synthesized by ribosomes

Smooth **endoplasmic** reticulum

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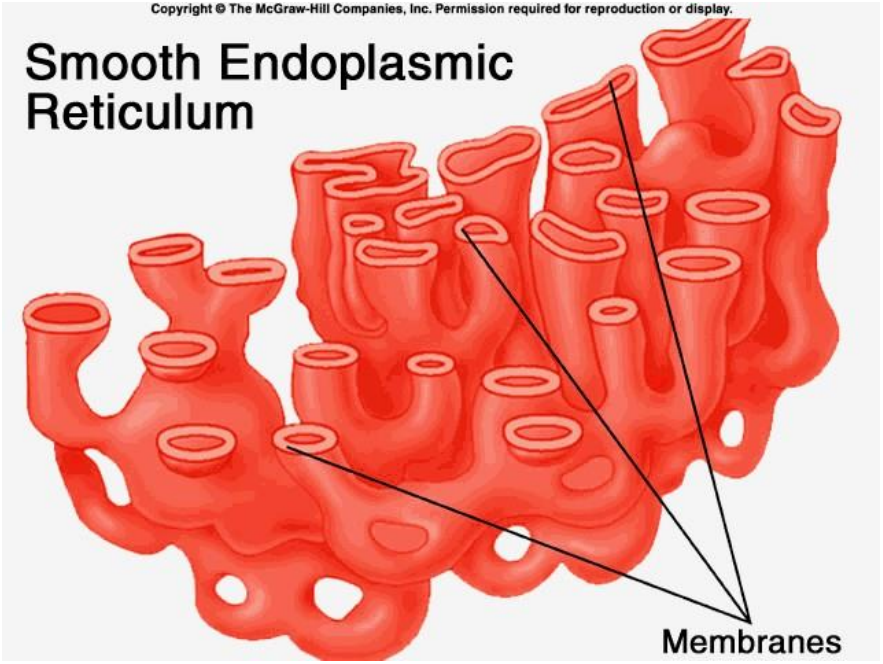
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Structure

- A smooth endoplasmic reticulum lack of ribosomes at the outer surface the membrane
- Consist of interconnected system of membrane bound tubules called cisternae.
- Outer surface lacks ribosomes

Function:

- Synthesis of lipid
- Metabolism of Carbohydrate
- Detoxifies drug and poisons
- Stores calcium ions which are necessary for muscle contraction



2.2.9 Animal cell showing soomth endoplasmic reticulum

Golgi apparatus

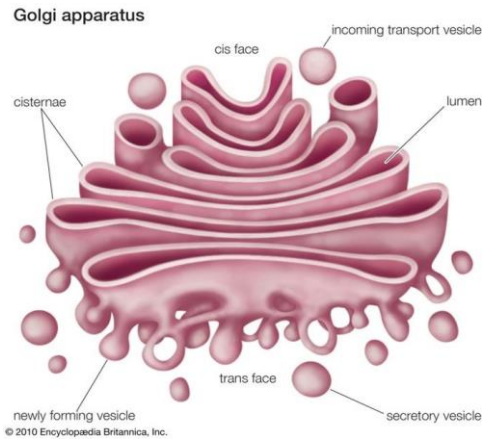
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Structure

- Also called **Golgi complex** or G**olgi body**
- **Consist of a stack of associated flattened membrane bound sacs called cisternae.**
- Golgi body has two faces , the cis face & the trans face.
- The cis face is located near the endoplasmic reticulum & is the receiving side of the golgi body.
- The trans face is located near the cell surface membrane. Located in the cytoplasm next to the endoplasmic reticulum and near the cell nucleus.

❖ While many type of cells contain only one or several Golgi apparatus, plant cells can contain hundreds.



2.2.10 Golgi apparatus

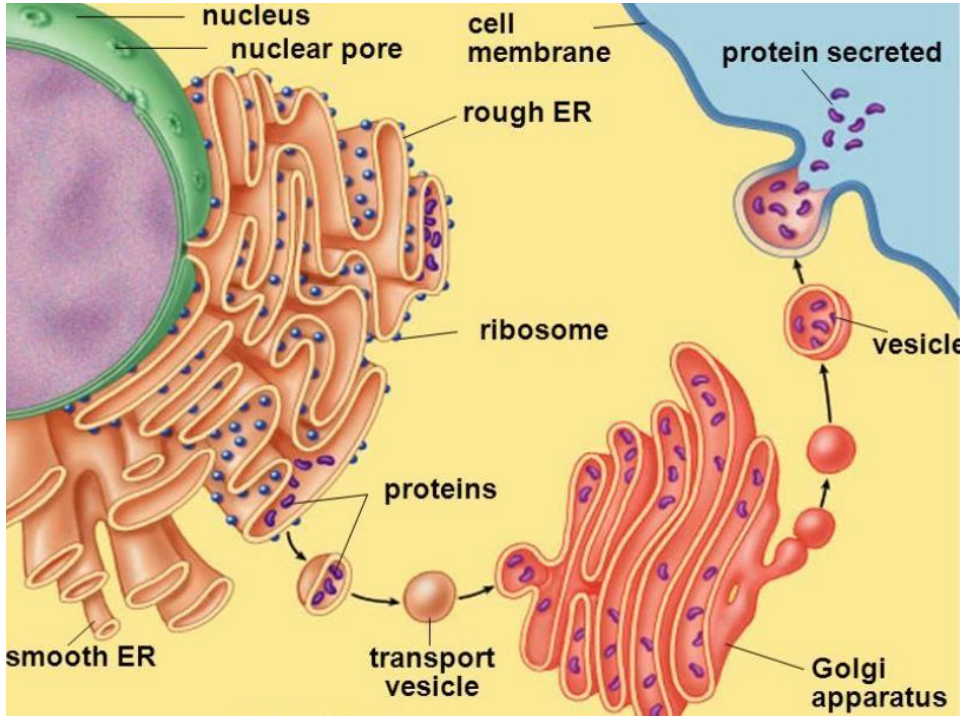
Golgi apparatus

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- Has ***cis face*** and ***trans face.***

- ***Cis face***:
  - found near the endoplasmic reticulum
  - receives vesicles containing unprocessed ER products



2.2.11 Golgi apparatus acts as transport medium

- ***Trans face***:
  - positioned near the plasma membrane of the cell
  - The modified and processed products (such as proteins) exit in the form of smaller detached vesicles

Golgi apparatus

Function:

- The main function of the golgi body are modify, sort, stores & ship (transport) cell products.
- Responsible for Modifying, Packaging, Sorting proteins and lipids into vesicles then transporting the vesicle to target destinations.
- Transporting and storing lipids
- Forming lysosomes containing hydrolytic enzymes.
- Production of digestive enzymes.
- Secretion of carbohydrates for the formation of plant cell wall & insect cuticles.

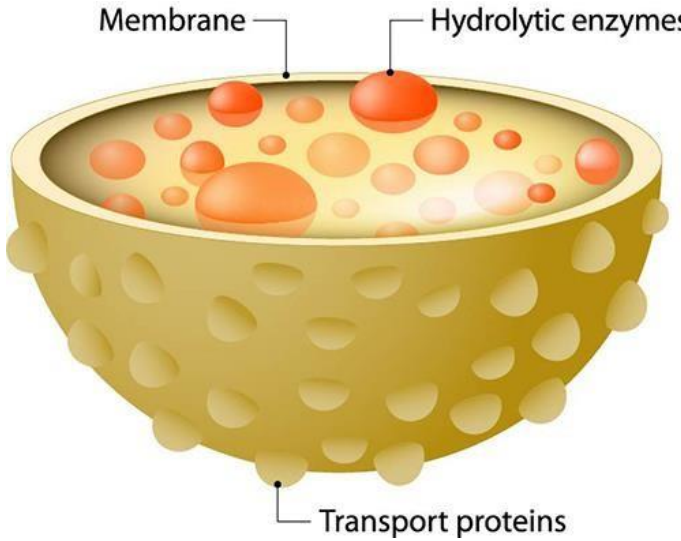
Lysosome

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Structure

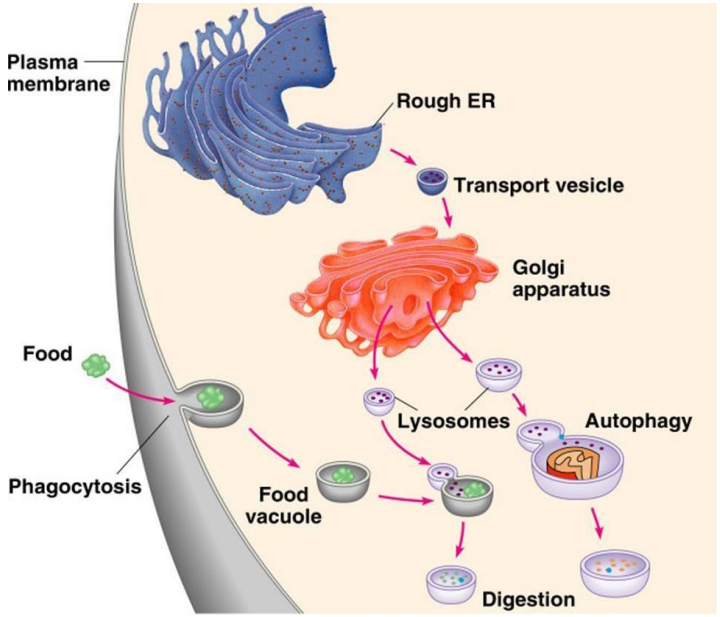
- Small membrane-bound vesicles containing hydrolytic enzymes.
- Secretory vesicle produced by Golgi body.



2.2.12 Lysosome

Function

- Carry out intracellular digestion in a variety of circumstances by phagocytosis
- Undergo autophagy : recycle the cell's own organic material.
- Self digestion may occur if excessive leakage from a large number of lysosome

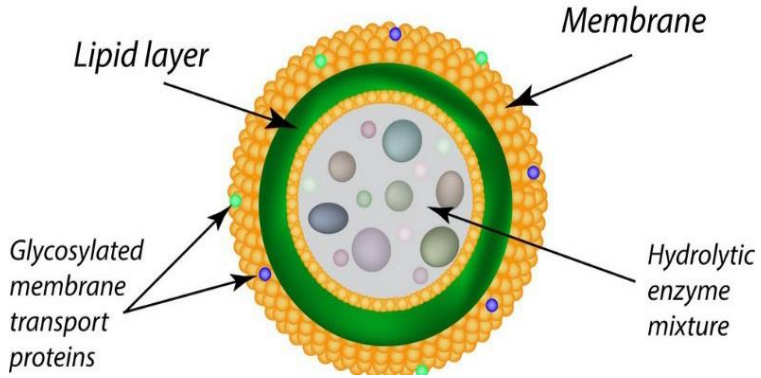


Lysosome

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Structure:
Small vesicle arise from budding of trans face of Golgi apparatus.
Single membrane bounded organelle which contains a variety of active hydrolytic enzymes that can digest macromolecules with in the cell.

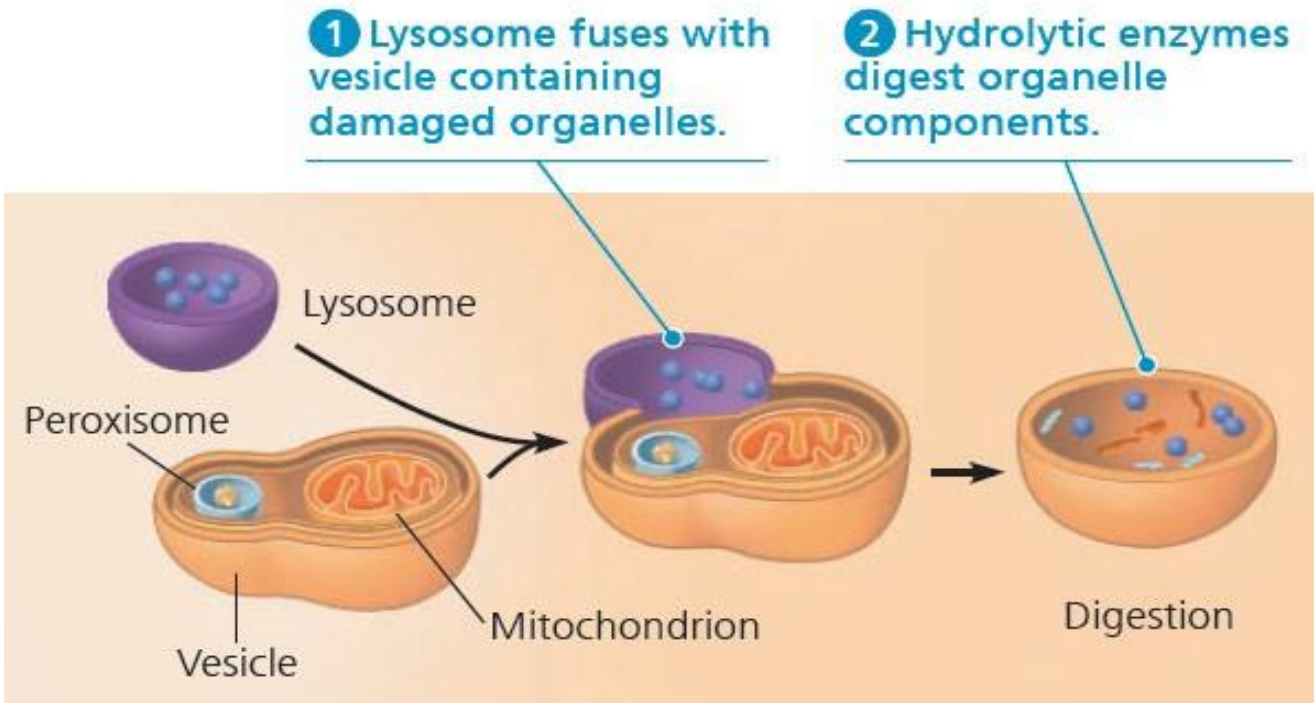


2.2.13 Lysosome

Autophagy

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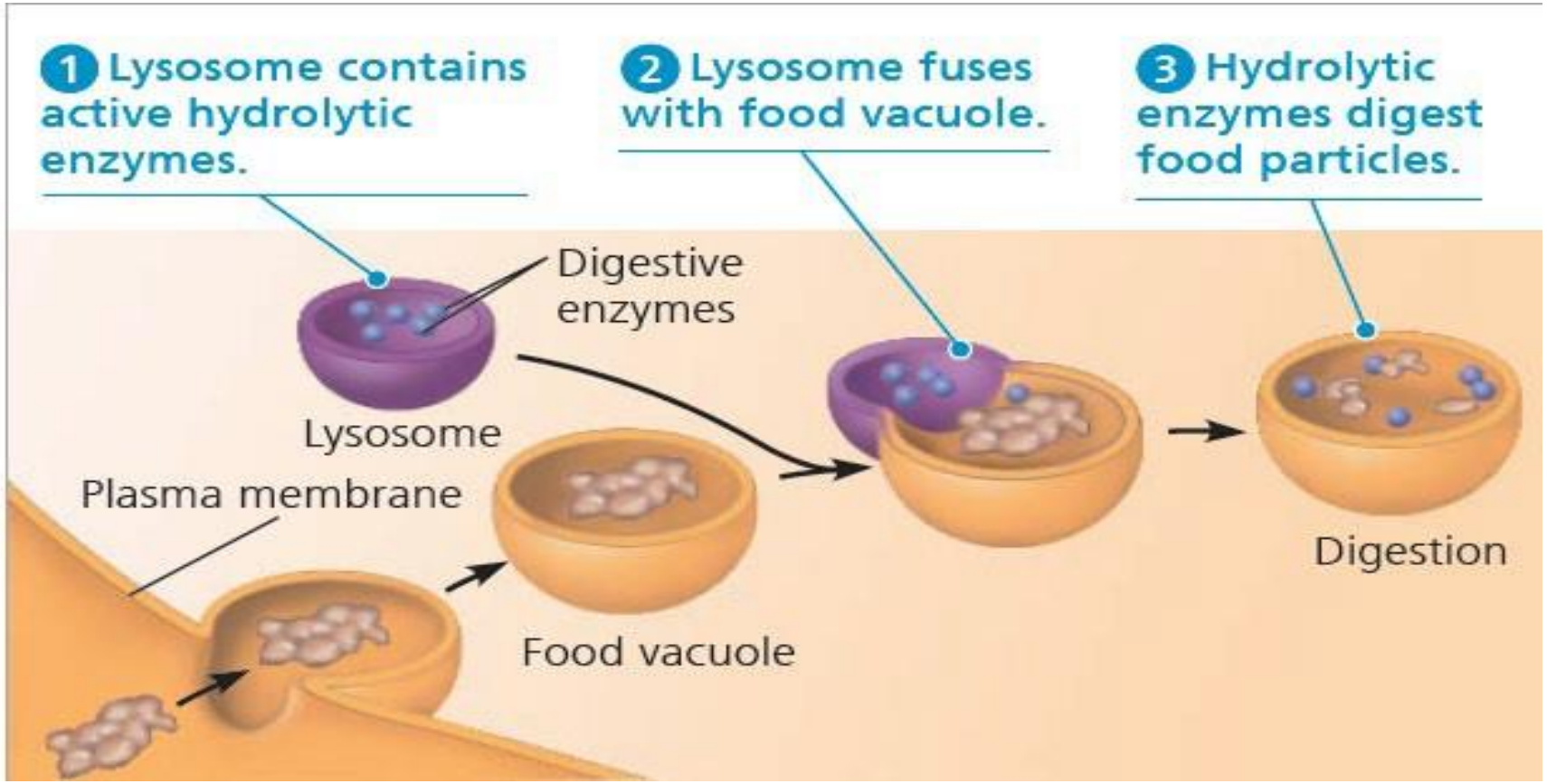
2.2.14 Lysosome process for digestion of organelle components

- **Autolysis**- The lysosome `s membrane breakdown, releasing its enzymes & digesting the entire cell.
- Digest material that has been taken into the cell **via phagocytosis**.
- Release enzymes to the outside of the cell by exocytosis to digest other cells.

Phagocytosis

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2.2.15 Lysosome process for digestion of food particles

Mitochondria

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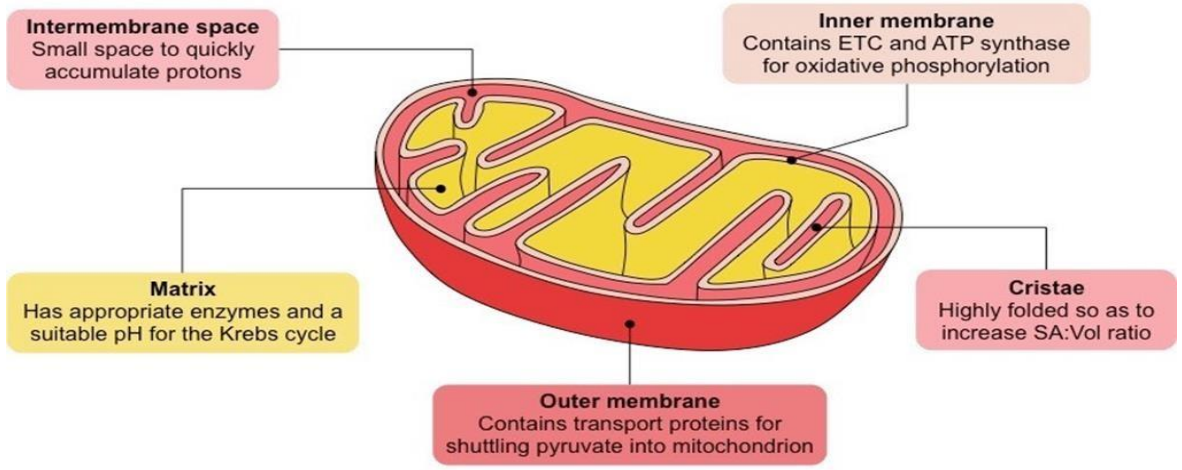
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Structure

- Surrounded by a **double membrane**:
  - **outer membrane** is simple and quite permeable
  - **inner membrane** is highly folded into **cristae** gives a large surface area
- Inner membrane surrounding a fluid region called **matrix**
- Lots of enzymes found on the surface of inner membrane
- Has circular DNA and simple ribosomes

Function

- Site of aerobic respiration / site of ATP synthesis



2.2.16 Mitochondria

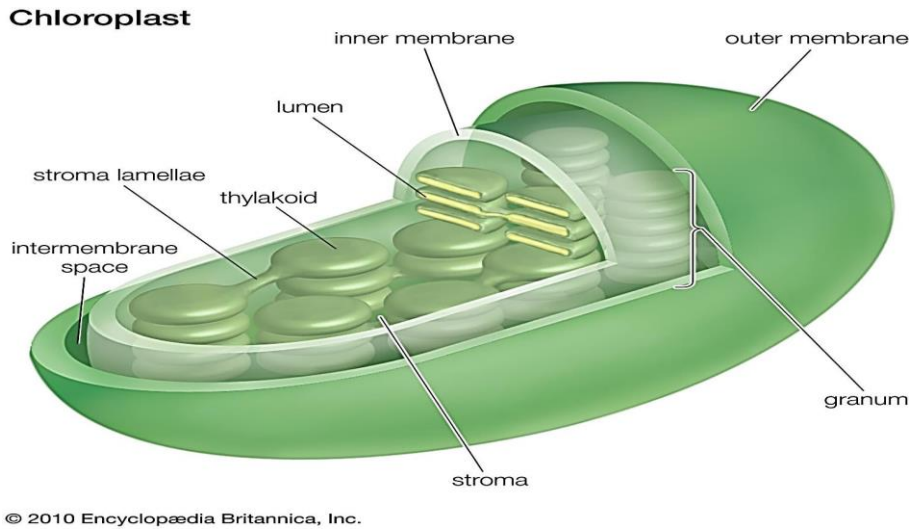
Chloroplast

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Function:

Site of photosynthesis



2.2.17 Chloroplast

Structure

- Enclosed by a double membrane.
- Contains chlorophyll and other photosynthetic pigments.
- **Thylakoid**: membranous system in the form of flattened, interconnected sacs inside the chloroplasts.
- **Granum** : Stacked of thylakoid
- **Grana** : A group of granum
- **Stroma** : fluid region contains of chloroplast DNA, ribosomes and enzymes

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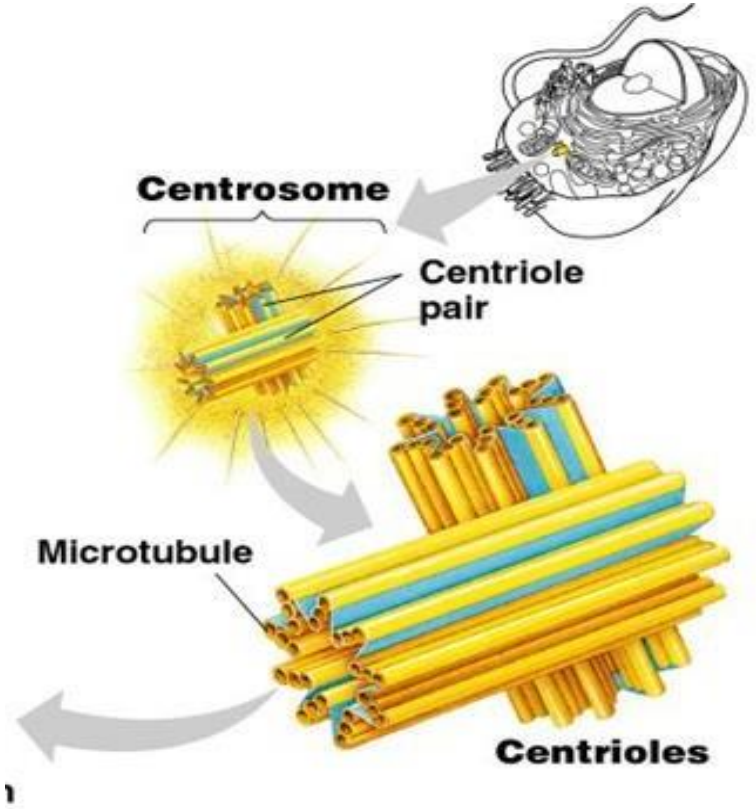
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Centriole

Structure

- Centriole:
  - a pair of short microtubules.
  - Two centrioles are at right angles to each other
  - Each is made up of nine sets of three microtubules

- Centrosome:
  - A region containing a pair of centrioles



2.2.18 Centriole

Function

- Involved in cell division (animal cell)

- Act as organizers of spindle fibres & are involved in the separation of chromosomes.

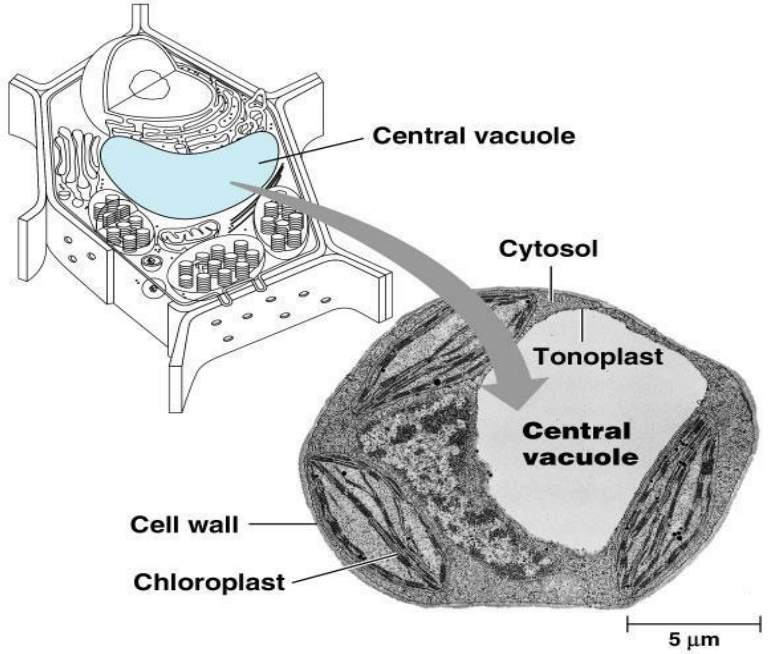
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Vacuole

Structure

- Membrane-bound sacs containing water or dilute solutions of salts and other solutes.
- Plant cells central vacuole are filled with **cell sap**.



2.2.19 Vacuole

Function :

- Very important in keeping the plant cell rigid or turgid.
- Some unicellular protists have:
  - **Food vacuoles** for digesting food
  - **Contractile vacuoles** for expelling water.

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Learning Outcome 2.3

At the end of the lesson, students should be able to :

1. Show the structure of plasma membrane based on Fluid Mosaic Modal. (CLO3)
2. Explain the structure of the plasma membrane and the function of each of its components. (CLO2)

2.2 b Structure and function of endomembrane system

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✓ Many of the different membrane enclosed organelles of the eukaryotic cells are part of endomembrane system, which includes nuclear envelop, endoplasmic reticulum, Golgi apparatus, lysosomes, various kind of vesicles and vacuoles and the plasma membrane.

This system carries out variety of task in the cell including:

- Synthesis of proteins
- Transport of proteins
- Metabolism and movement of lipid
- Detoxification of poisons

❖ The membranes of the system are related either through direct physical continuity or by transfer of membrane system as tiny vesicles

❖ Despite this relationship, the various membrane are not identical in structure and function.

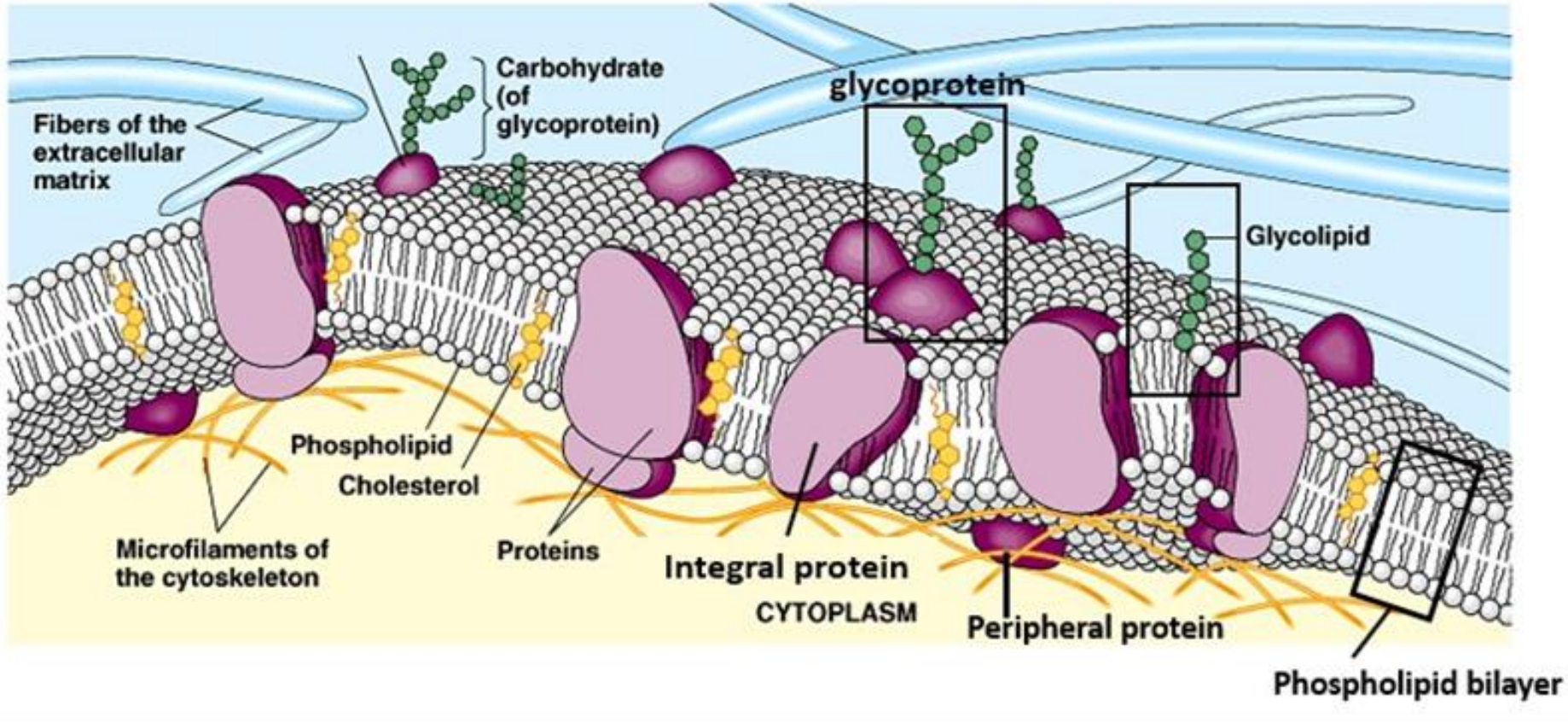
2.2 C. Structure of Plasma membrane based on Fluid Mosaic Model

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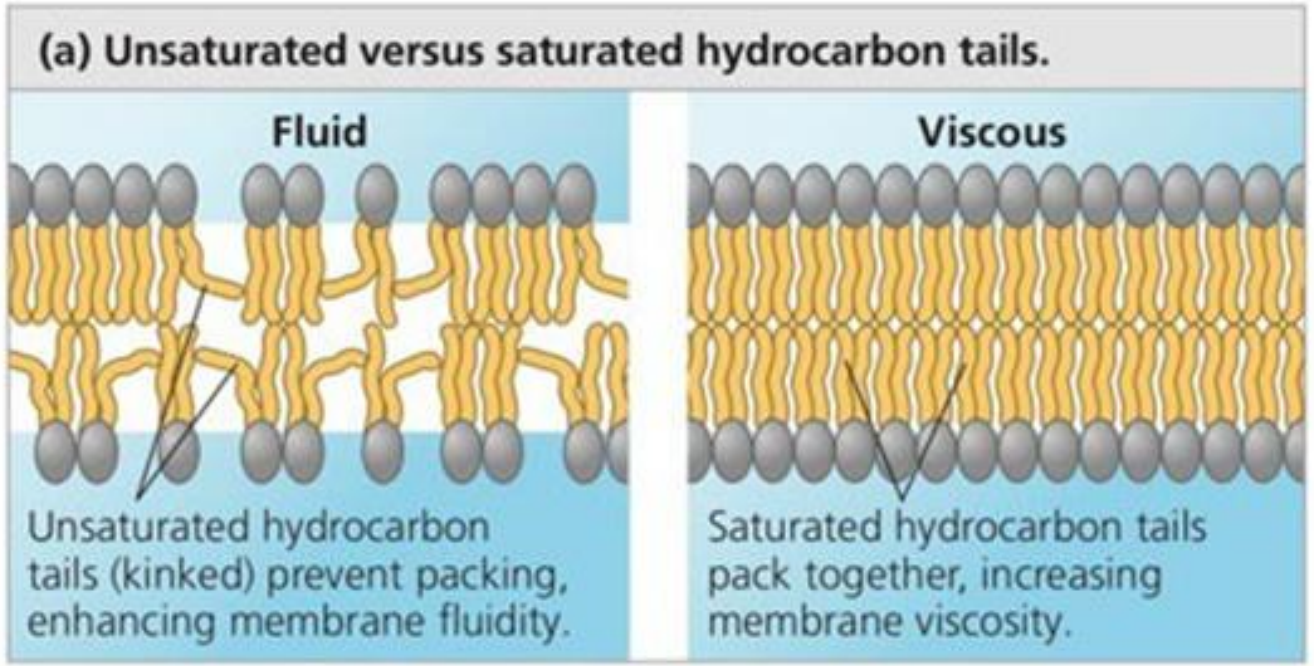
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- In 1972, S.J Singer and G.L Nicolson proposed the fluid Mosaic Model
- Cell membrane consisting of a bilayer of phospholipid with various protein molecule embedded & attached to it.
- The other component is carbohydrate and cholesterol.
- The structure is selectively permeable meaning that it allows the passage
- of some molecules (specially water), but not of others.
- According to this model, it is called a: Mosaic because the proteins are bobbing in the phosplipid bilayer. (Champell 12 th ed , page 197)
- Fluid because the proteins and phospholipids are free to move. They can only move from side to side (lateral movement) or Flip –flop across the membrane, switching from lipid to the other.

2.2 (c) Structure of plasma membrane based on Fluid Mosaic Model

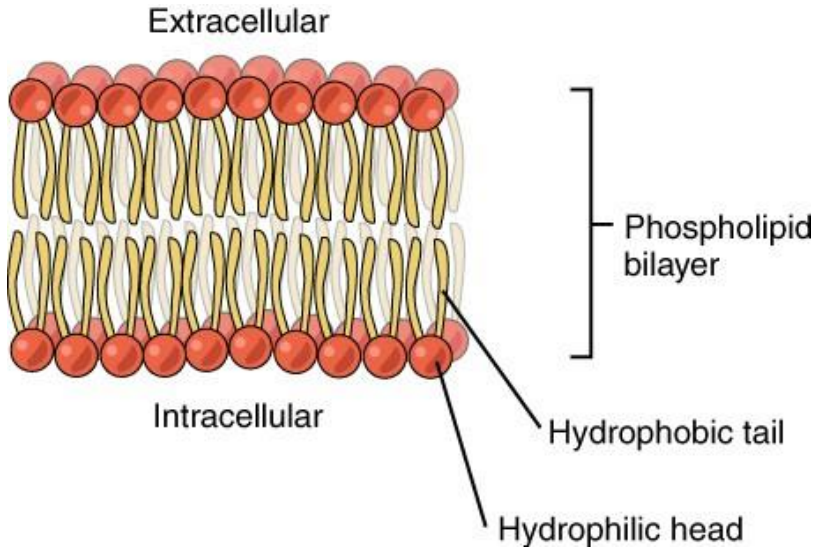


- Factors that affect the membrane fluidity:



2.2 (d) Functions of each components in plasma membrane

- A phospholipid is an **amphipathic** molecule meaning it has both hydrophilic region and hydrophobic region.
- The polar hydrophilic ("water- loving") head of phospholipids facing outwards.
- The non-polar hydrophobic ("water-fearing") tails facing in towards the middle of the bilayer.



Functions:

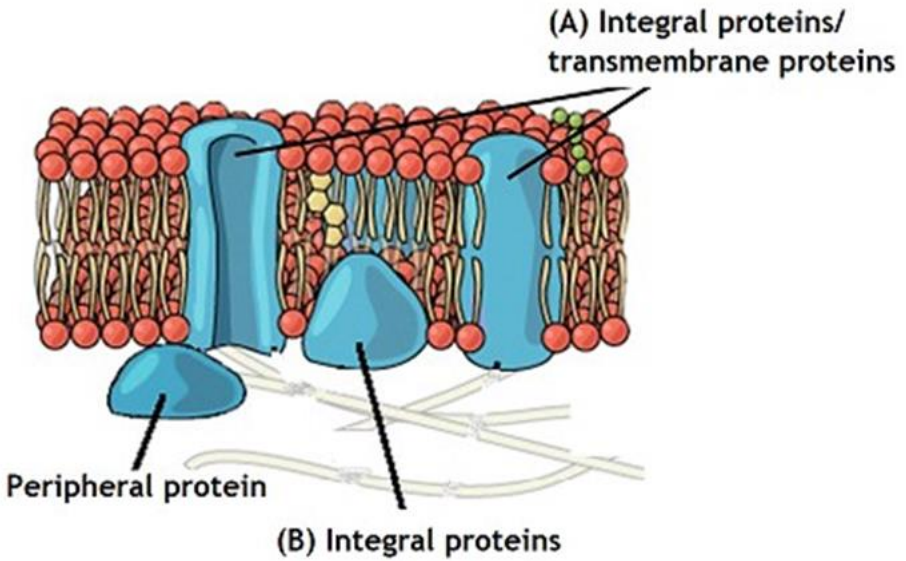
- Forms boundary to isolate cell contents from environment.
- Phospholipid bilayer is only one aspect of the gatekeeper system responsible for a cell's selective permeability.
- Restricts passage of hydrophilic substances across the membrane (selective permeable membrane).

STRUCTURE: GLOBULAR PROTEIN

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- Two types of globular proteins:
  - **Integral proteins** penetrate the hydrophobic interior of the lipid bilayer
  - The majority are **transmembrane protein**, which span the membrane (Refer A in the diagram)
  - The other integral proteins extend part-way into the hydrophobic interior (refer B in the diagram).
  - **Peripheral proteins** are not embedded in the lipid bilayer at all, they are loosely bound to the surface of the membrane, often to exposed parts of integral proteins.
- On the cytoplasmic side of the plasma membrane, some membrane proteins are held in place by attachment to the cyctoskeleton.
- On the extracellular side, certain membrane protein may attach to the materials outside the cell.



FUNCTIONS: GLOBULAR PROTEIN

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FUNCTIONS:

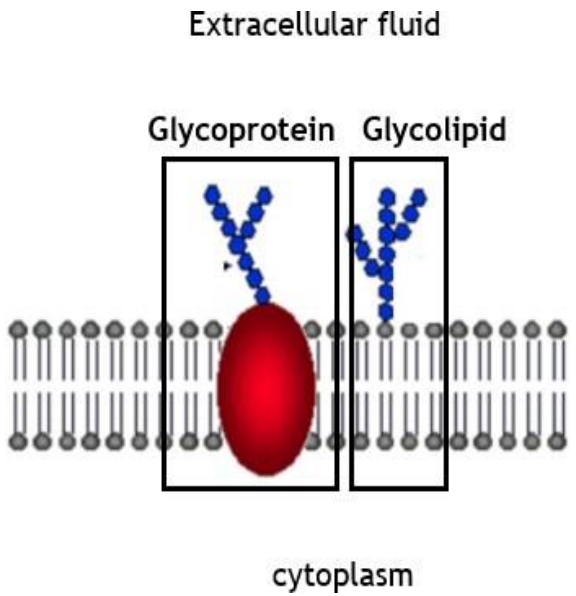
- **Transport:** A protein that spans the membrane may provide a hydrophilic channel across the membrane that is selective for a particular solute.
- **Enzymatic activity**: Some membrane proteins act as enzyme that ordered as a team that carries out sequential steps in metabolic pathway.
- **Signal transduction**: A membrane protein may have a bonding site with specific shape of a chemical messenger, such as a hormone.
- **Intercellular joining**: Membrane proteins of adjacent cell may be hooked together in various kinds of junction such as tight junction and gap junction.
- **Cell – cell recognition:** some glycoprotein serve as identification tags that are specifically recognized by other cells.
- **Attachment to the cytoskeleton & extra cellular matrix (ECM)**: helps maintain cell shape & fixes the location of certain membrane proteins.

CARBOHYDRATE

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- Membrane carbohydrates are usually short, branched chains of fewer than 15 sugar units.
- Glycoproteins are formed when proteins on the outer phospholipid layer covalently bonded with carbohydrate.
- Glycolipids are formed when short carbohydrate chain covalently bonded to lipid. This is exposed on the outer surface of the cell.



Functions:

- Glycoprotein: serve as identification tags that are specifically recognized by other cells (cell – cell recognition), protection & the immune response,& cell adhesion.

Glycolipid: Cell recognition and provide stability & help cells join to other cells to form tissues.

CHOLESTEROL

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Location:
Located between hydrophobic tail of phospholipid molecules in plasma membrane of animal cells.

- Functions:
- Maintain fluidity of membrane at different temperature.
- At moderate temperature, it reduces membrane fluidity by reducing phospholipid movements, but at low temperature, it prevents solidification of phospholipids by disrupting the regular packing of phospholipid.

*Plant have very low level of cholesterol; rather related steroid lipids buffer membrane fluidity in plant cell (Campbell 12th, page 198)

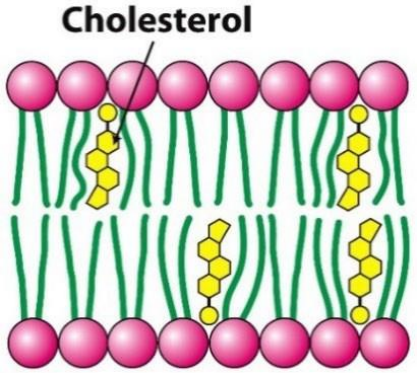


Figure 2.2.18: Cholesterol in plasma membrane

2.4 LEARNING OUTCOMES:

a) Describe animal tissues and plant tissues. (CLO 2)

b) Explain the following types of cells and tissues: (CLO 2)

Animal cells and tissues:

1. Epithelial cells (simple squamous, simple cuboidal, simple columnar, stratified squamous), nerve cell (motor neuron), muscle cells (smooth, striated and cardiac muscle), connective tissues (compact bone, hyaline cartilage and blood)

2. Plant cells and tissues:

3. Meristem, parenchyma, collenchyma, sclerenchyma, xylem and phloem.

2.4 (A) Animal and plant tissues

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- Cells as basic units of living organisms are **grouped into tissues & organs.**
- Cells in multicellular organisms **do not function in isolation.**
- Groups of cells of the same type (performing similar functions) form tissues & act as a unit.
- An organ consists of several types of tissues that work together to **perform specific functions.**

2.4 (B) Animal tissue.

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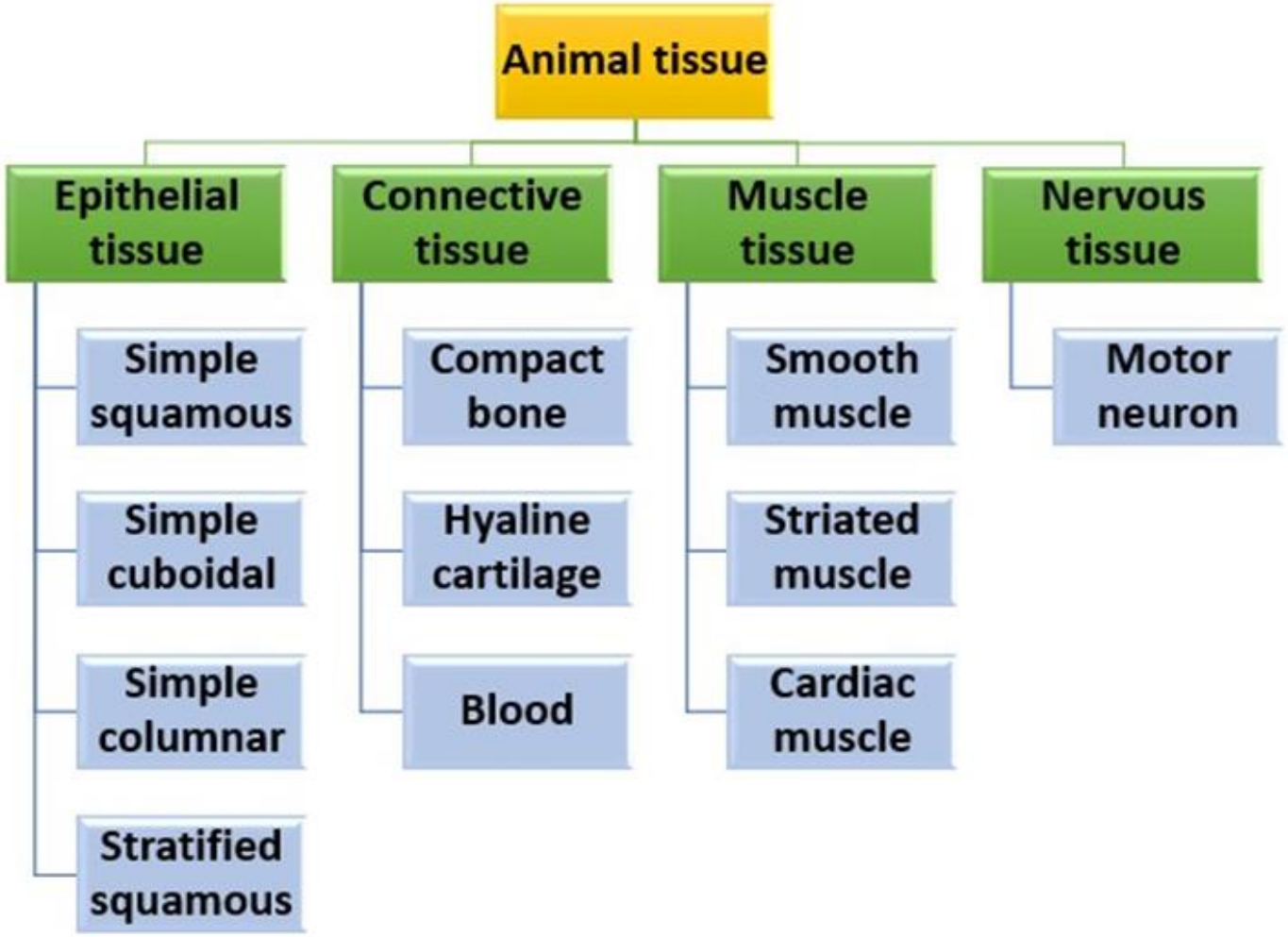


Figure 2.4.1: Overview of animal tissues

EPITHELIAL TISSUE

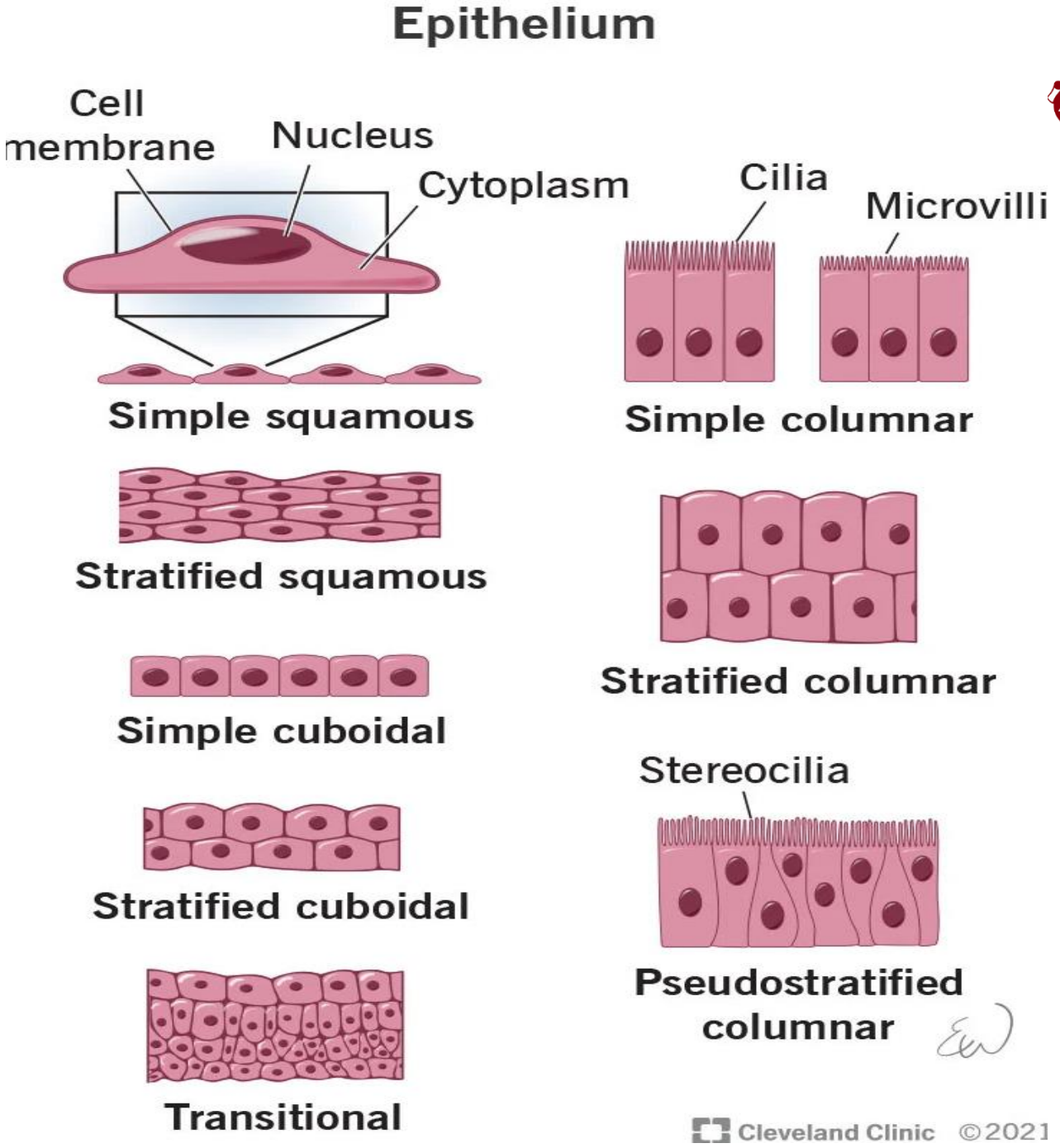
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- Cover the outside of the body and line organs and cavities within the body.
- Epithelial cells are closely packed, often with tight junction, they function as a barrier against mechanical injury, pathogens and fluid loss.

- Cover the outside of the body and line organs and cavities within the body.

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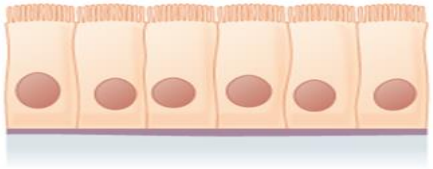
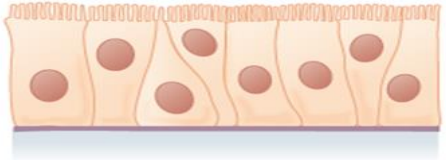
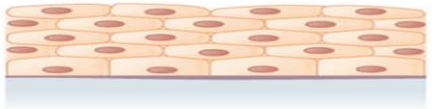
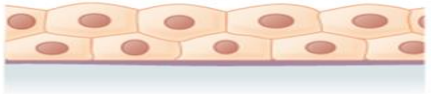
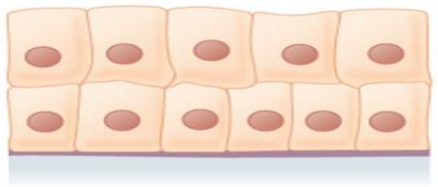
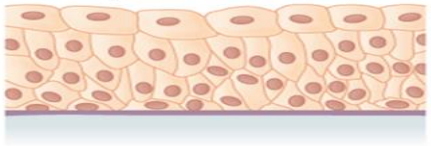


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Cells	Location	Function
Simple squamous epithelium 	Air sacs of lungs and the lining of the heart, blood vessels, and lymphatic vessels	Allows materials to pass through by diffusion and filtration, and secretes lubricating substance
Simple cuboidal epithelium 	In ducts and secretory portions of small glands and in kidney tubules	Secretes and absorbs
Simple columnar epithelium 	Ciliated tissues are in bronchi, uterine tubes, and uterus; smooth (nonciliated tissues) are in the digestive tract, bladder	Absorbs; it also secretes mucous and enzymes
Pseudostratified columnar epithelium 	Ciliated tissue lines the trachea and much of the upper respiratory tract	Secretes mucus; ciliated tissue moves mucus
Stratified squamous epithelium 	Lines the esophagus, mouth, and vagina	Protects against abrasion
Stratified cuboidal epithelium 	Sweat glands, salivary glands, and the mammary glands	Protective tissue
Stratified columnar epithelium 	The male urethra and the ducts of some glands	Secretes and protects
Transitional epithelium 	Lines the bladder, uretha, and the ureters	Allows the urinary organs to expand and stretch

Simple squamous epithelial tissue

- Structure:

Single layer of cells attached to the basement membrane.

- Cells are flattened and thin with central nucleus.
- View from the surface , they are polygonal-shape.

Distribution:

- Lining of the blood vessel.
- Lining of the alveoli of lungs
- Functions:
- Exchange of gaseous and nutrient across the membrane by diffusion.

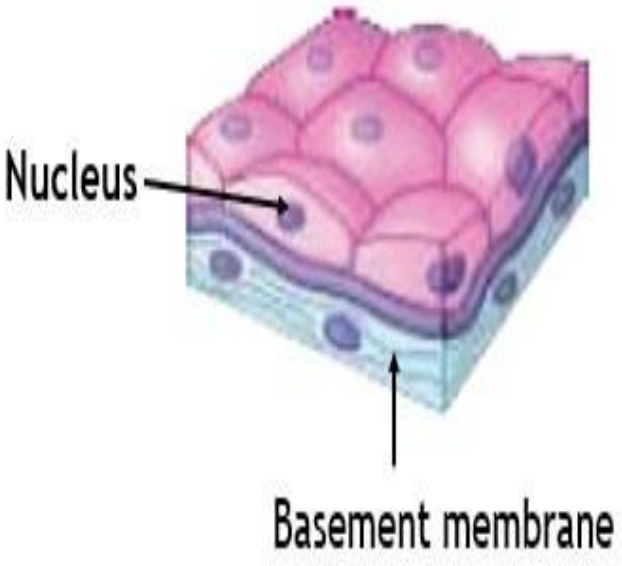


Figure 2.4.2: Simple squamous

Type of tissue

Simple cuboidal epithelial tissue.

Structures:

- Single layer of square/cuboidal shape cells.
- Central spherical nucleus.

Distributions:

- Lining of salivary glands, pancreatic duct, thyroid gland, kidney tubules.

Functions:

Secretion & absorption

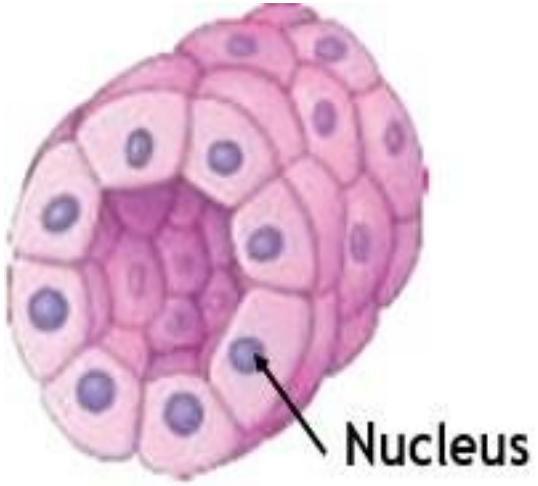


Figure 2.4.3: Simple cuboidal

Type of tissue

Simple columnar epithelial tissue

Structures:

- Columnar shape with oval nucleus near its basal end.
- Apical surface may have cilia/ microvilli.
- Cells are usually associated with goblet cells (are modified columnar cells that secrete mucus).

Distributions:

- Lining of digestive tract, small intestine, upper respiratory tract & oviducts.

Functions:

- Absorption & secretion.

The secreted mucus serves as a lubricant for the linings of the digestive & upper respiratory tracts

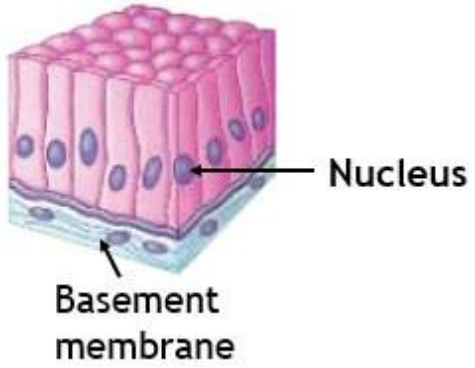


Figure 2.4.4: Simple columnar

Type of tissue

Simple columnar epithelial tissue

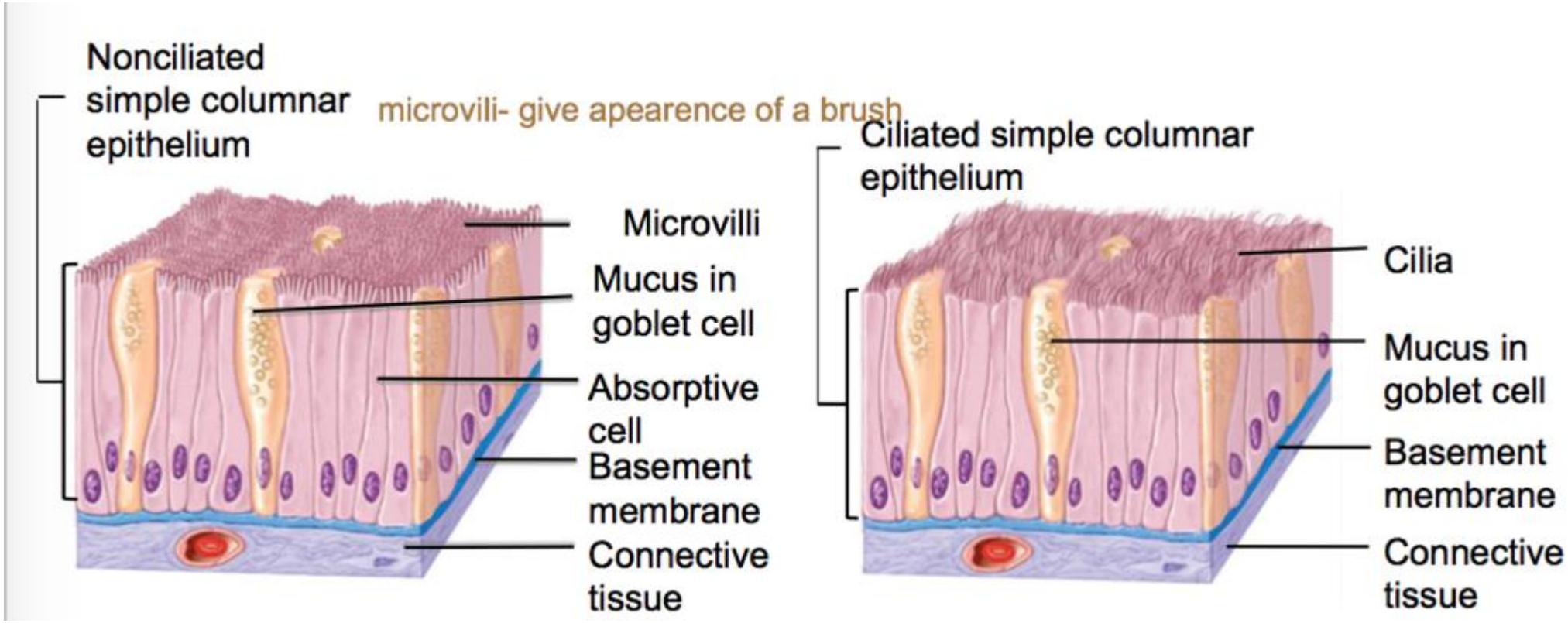


Figure 2.4.5: Simple columnar

Type of tissue

Stratified squamous epithelial tissue

Structures:

- Made up by multilayered of cells and regenerates rapidly.
- Only the cells of deepest layer attached to basement membrane.

New cells formed by division near the basal surface push outward, replacing cells that are sloughed off

Distributions:

- Lining of the oesophagus
- Lining outer skin
- Lining the vagina
- Lining the anus
- Lining the mouth

Functions:

- Resists abrasion.

Acts as a barrier (prevent water loss through skin).

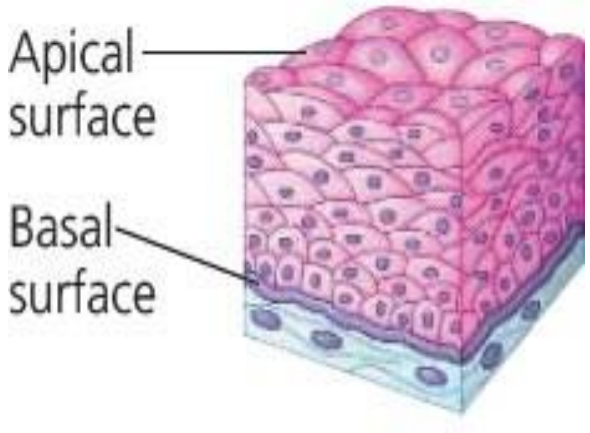


Figure 2.4.6: Stratified squamous

Structure:

NERVOUS TISSUE

- The functional "unit" of nervous tissue is the nerve cell called neuron.
- Each neuron is composed of 3 main parts:
  - Cell body - contains nucleus and most of the neuron organelles.
  - Dendrites - Highly branched extention studded of the cell body.
  - Axon – an extention that transmit signal to the other cell and much longer than dendrites.

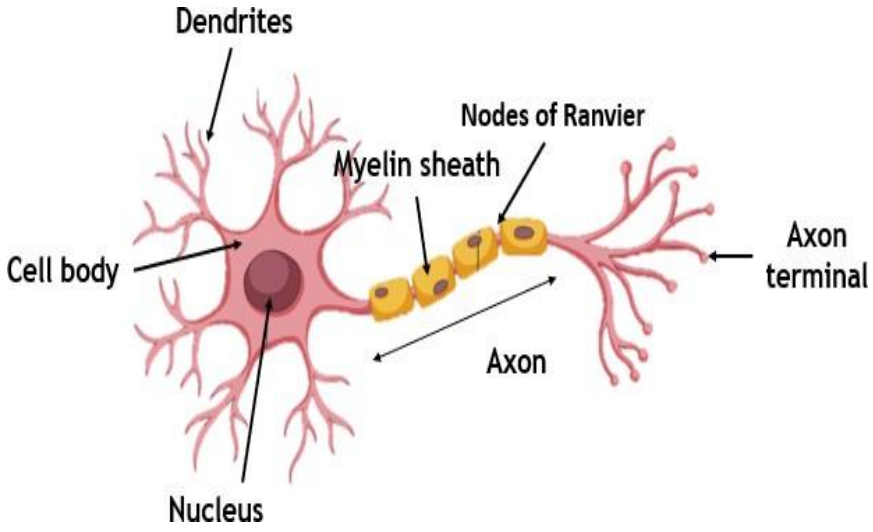


Figure 2.4.7: Motor neuron

Continue:

- Three types of neurons:

a. Afferent (sensory neurons)
b. Efferent (motor neurons)
c. Interneuron/ Intermediary (relay neurons)

- Myelin sheath – wrap around axon of the neuron and insulating coat of cell membrane from Schawann cell or oligodendrocytes.

- Nodes of Ranvier – gap in myelin sheath of certain axon where an action potential may be generated.

Distributions:

- Brain & spinal cord.

Functions:

- Conduct impulses out of central nervous system toward muscles & glands (effector).

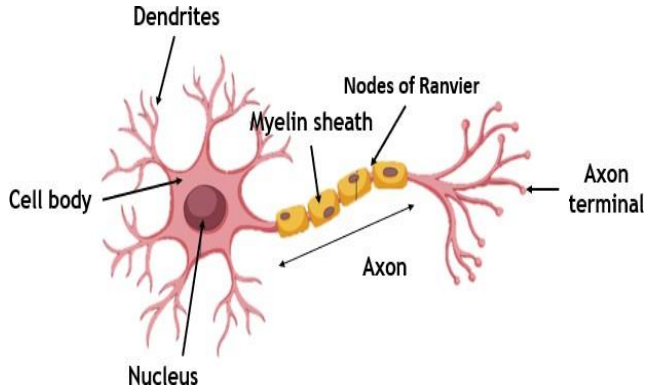


Figure 2.4.8: Motor neuron

Type of Muscle Tissues

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- **Smooth muscle:**
- The tissue responsible for nearly all types of body movement.
- All muscle cells consist of filaments containing the proteins actin and myosin, which together enable muscles to contract.

Structures:

- Each muscle fibre consists of a single, elongated spindle-shaped cell containing one centrally located nucleus.
- The muscle fibres lack striations.
- The contractile protein filaments are not arranged in the same patterns.

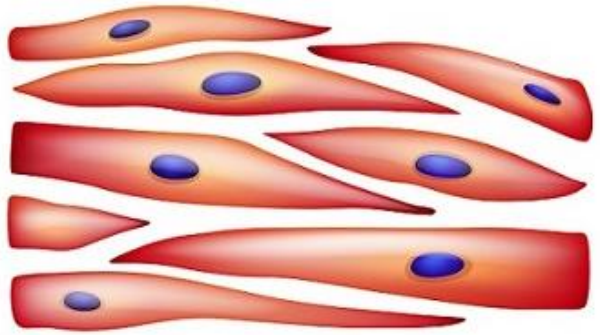


Figure 2.4.9: Smooth muscle

Distributions:

- **Lining** the walls of arteries & veins, the digestive tract, the urinary bladder, the stomach & the uterus.

Function:

Responsible for involuntary movement of the body.

Type of muscle tissue

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Striated/ Skeletal muscle

Structures:

- **Long, cylindrical shape** & are arranged parallel to one another.
- Each muscle fiber is **multinucleated** with the nuclei at the periphery & located just beneath the cell surface membrane.
- The arrangement of contractile units, or sarcomeres, along the fibers gives the cells a striped (striated) appearance.

Distribution:

- Attached to bones by tendons

Function:

Responsible for voluntary movement of the body.

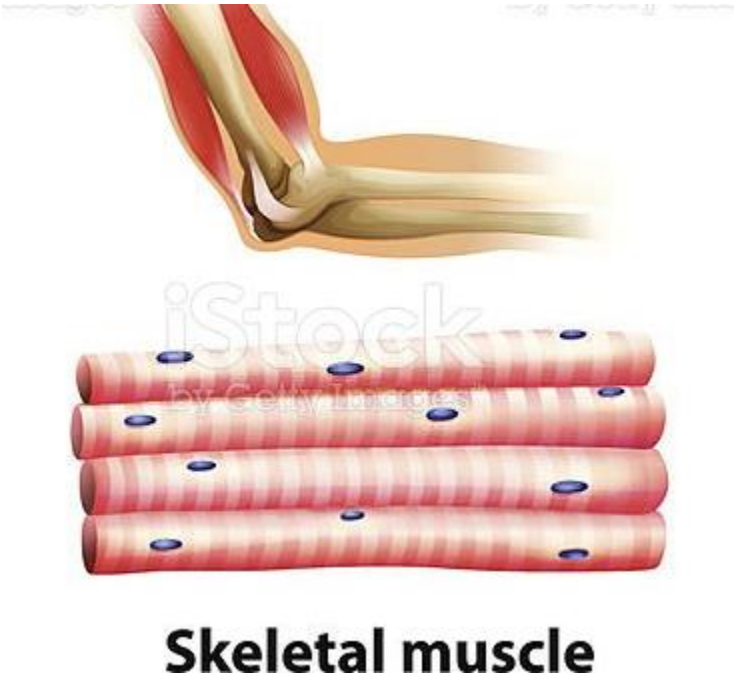


Figure 2.4.10: Striated muscle

Type of muscle tissue

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Cardiac muscle

Structures:

- Long, branches and cylindrical shape.
- Have one or two nuclei per fibre with many mitochondria.
- Muscle cells are connected to one another by intercalated discs.
- Intercalated disk relay signal from cell to cell and help synchronize heart contraction.
- The muscle fibres striated, branch & form bridges with one another to form a netlike arrangement.

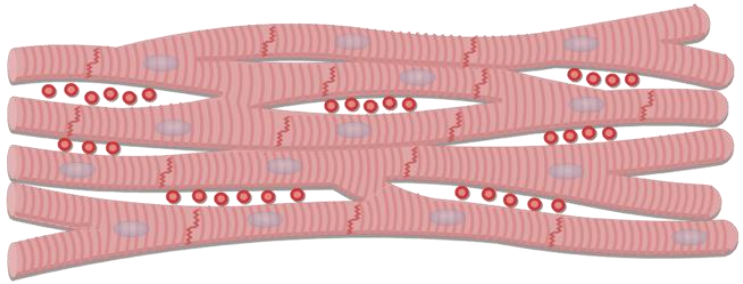


Figure 2.4.11: Cardiac muscle

Distribution:

- Lining at the wall of heart.

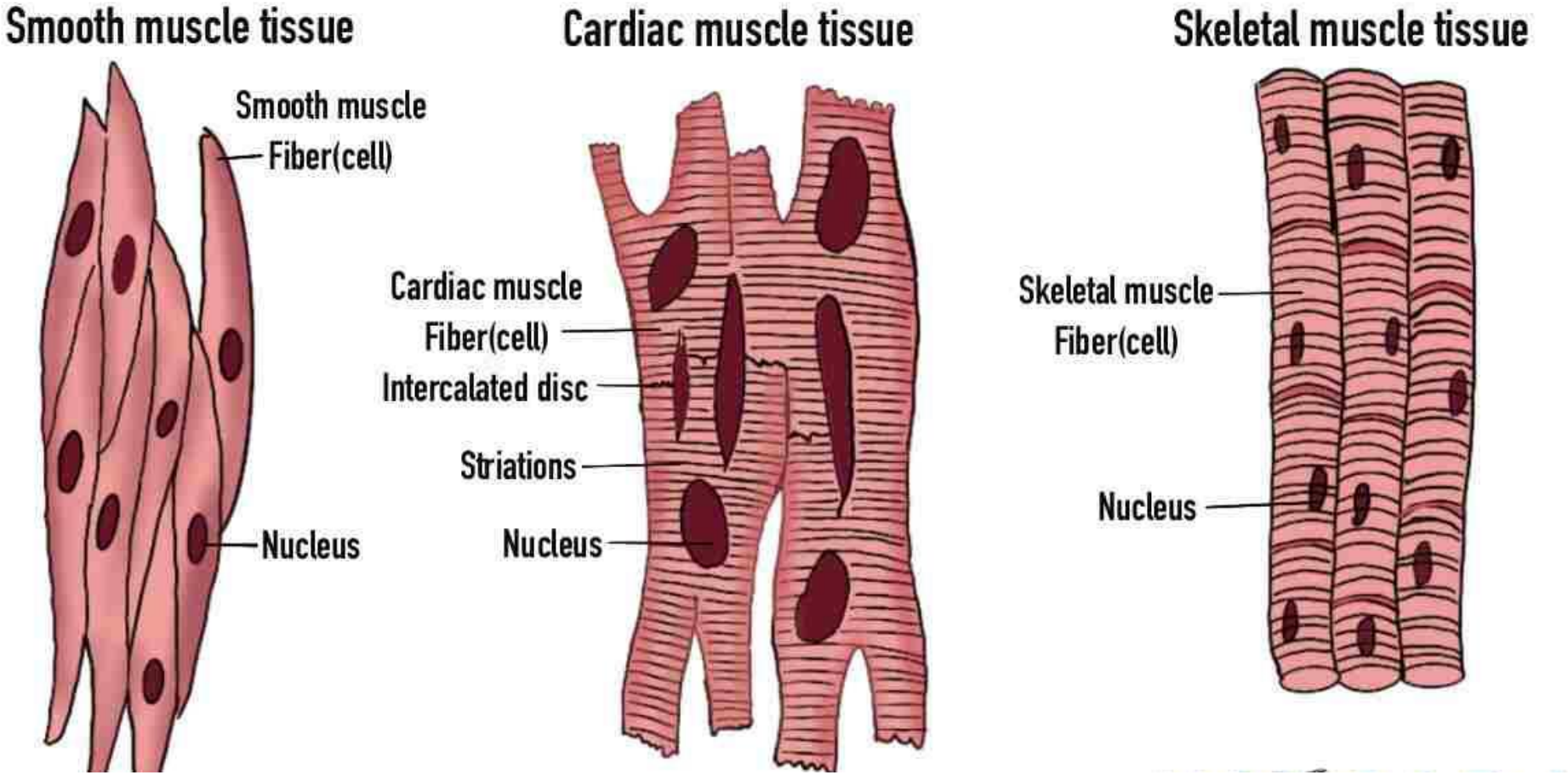
Function:

- Responsible for involuntary movement of the heart by form continuous, rhythmic contractions & allow heart pump blood throughout the body.

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Types of muscle



2.4.12 Types of muscle

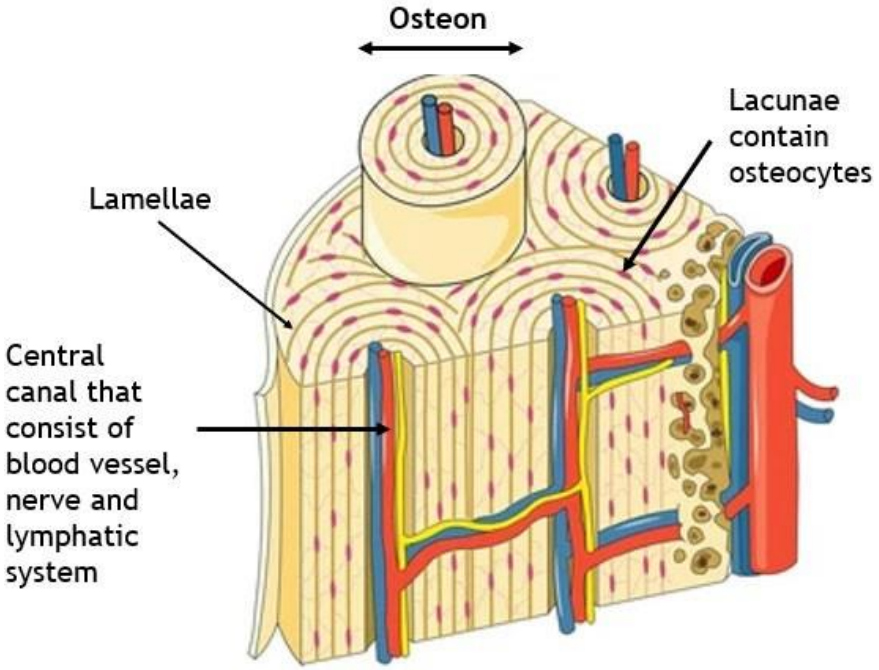
CONNECTIVE TISSUE

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- Consisting of a sparse (thinly dispersed or scattered population of cells scattered through an extracellular matrix, hold many tissues and organ together and in place.
- Matrix generally consist of a web of fibers embedded in a liquid, jellylike or solid foundation.

Type of connective tissue:



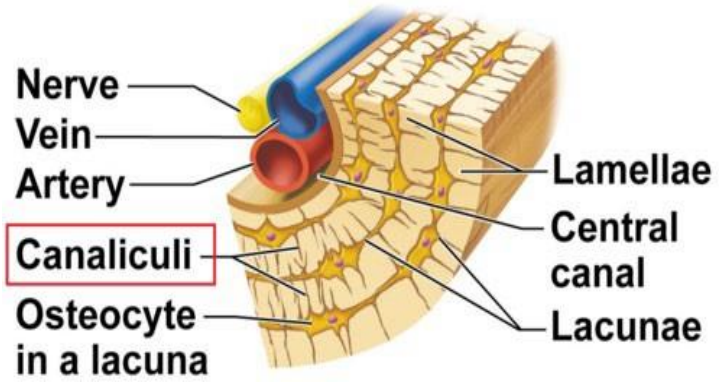


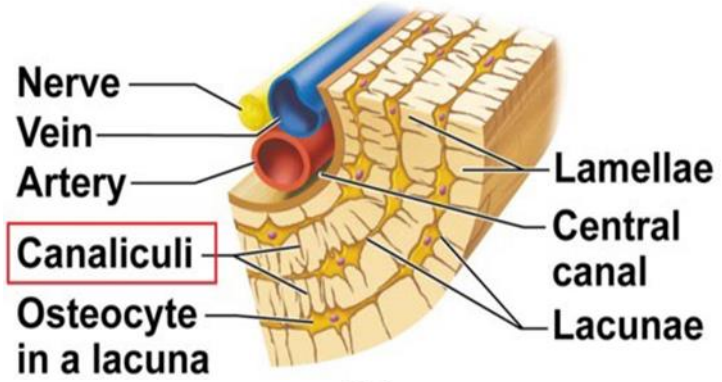
Figure 2.3.10:Compact bone

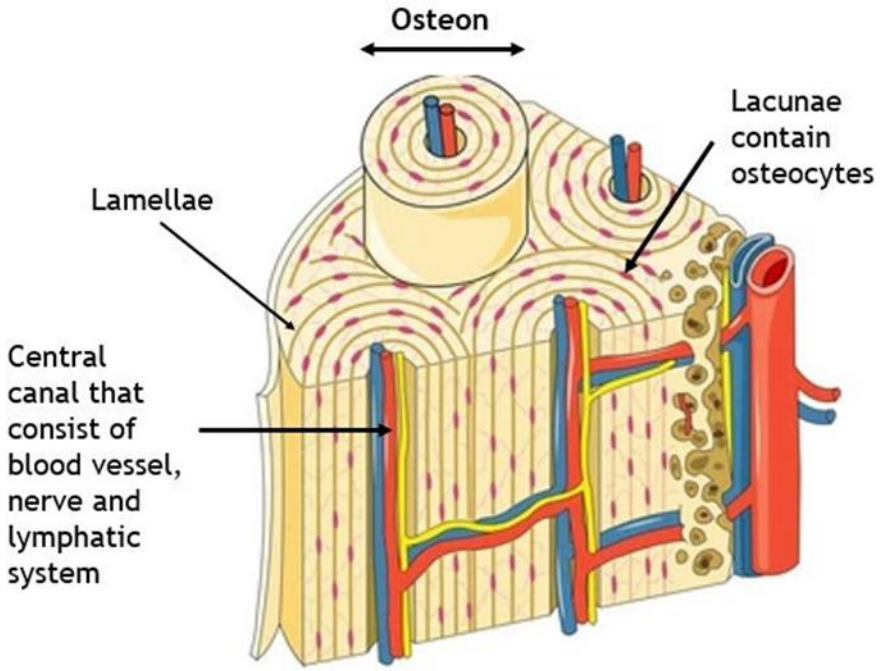
2.4.13 Connective tissue

CONNECTIVE TISSUE

Structures:

- Compact bone consists of living cells, collagen (give bone its strength) and inorganic substances (give bone its hardness).
- The bone cells called osteoblasts, matured called osteocytes.
- Osteoblasts deposit the matrix of collagen.
- Calcium, magnesium and phosphate ions combine into hard mineral within the matrix
- Compact bone consist of repeating units called osteons.
- Each osteon has concentric layers of the mineralized matrix called lamellae.,
- Osteocytes are found in spaces in the lamellae known as lacunae.
- Each osteon has a central canal that contain blood vessels and nerves.
- Canaliculi are microscopic canals between the neighbouring lacunae





CONNECTIVE TISSUE

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Distribution:

- Skeleton

Function:

- Give body shape & provide framework for support.
- Protect the internal organs
- Provide surfaces for attachment of skeletal muscles to enable movement.
- Act as a reservoir for calcium & phosphorus.
  Site for blood cell production in the bone marrow

Hyaline cartilage

Structures:

- The cell for hyaline cartilage is chondroblast, matured called chondrocytes.
- Has an abundance of collagenous fibres embedded in a rubbery matrix called chondroitin sulphate.
- Chondroitin sulphate & collagen are secreted by chondrocytes.
- Blood vessels do not penetrate cartilage; oxygen & nutrients reach these cells by diffusion, and waste products diffuse away.
- Each chondrocyte is placed within a scattered lacuna.
- Some lacunae may enclosed even two, four or eight chondrocytes

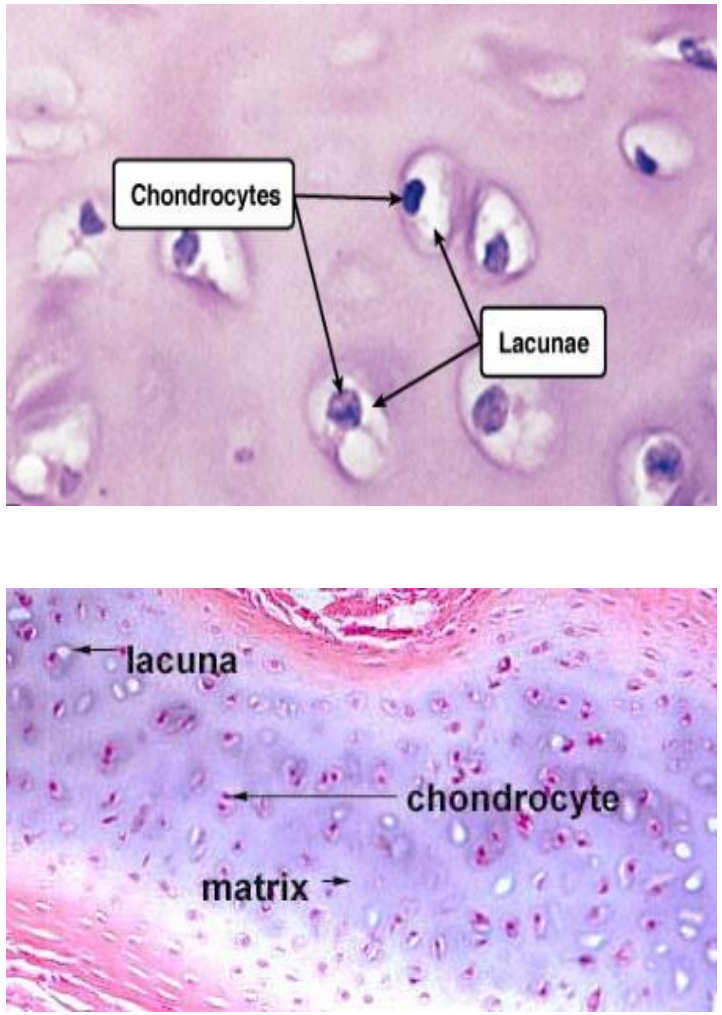


Figure2. 4.14: Hyaline cartilage

Distributions:

- Trachea & bronchi.
- It forms the embryonic skeleton in many bony vertebrates.
- It covers the end of bones & reduces friction between joints during movement.
- It forms the skeleton of cartilaginous fish rays.

Function:

- Give flexible support.

BLOOD CELLS

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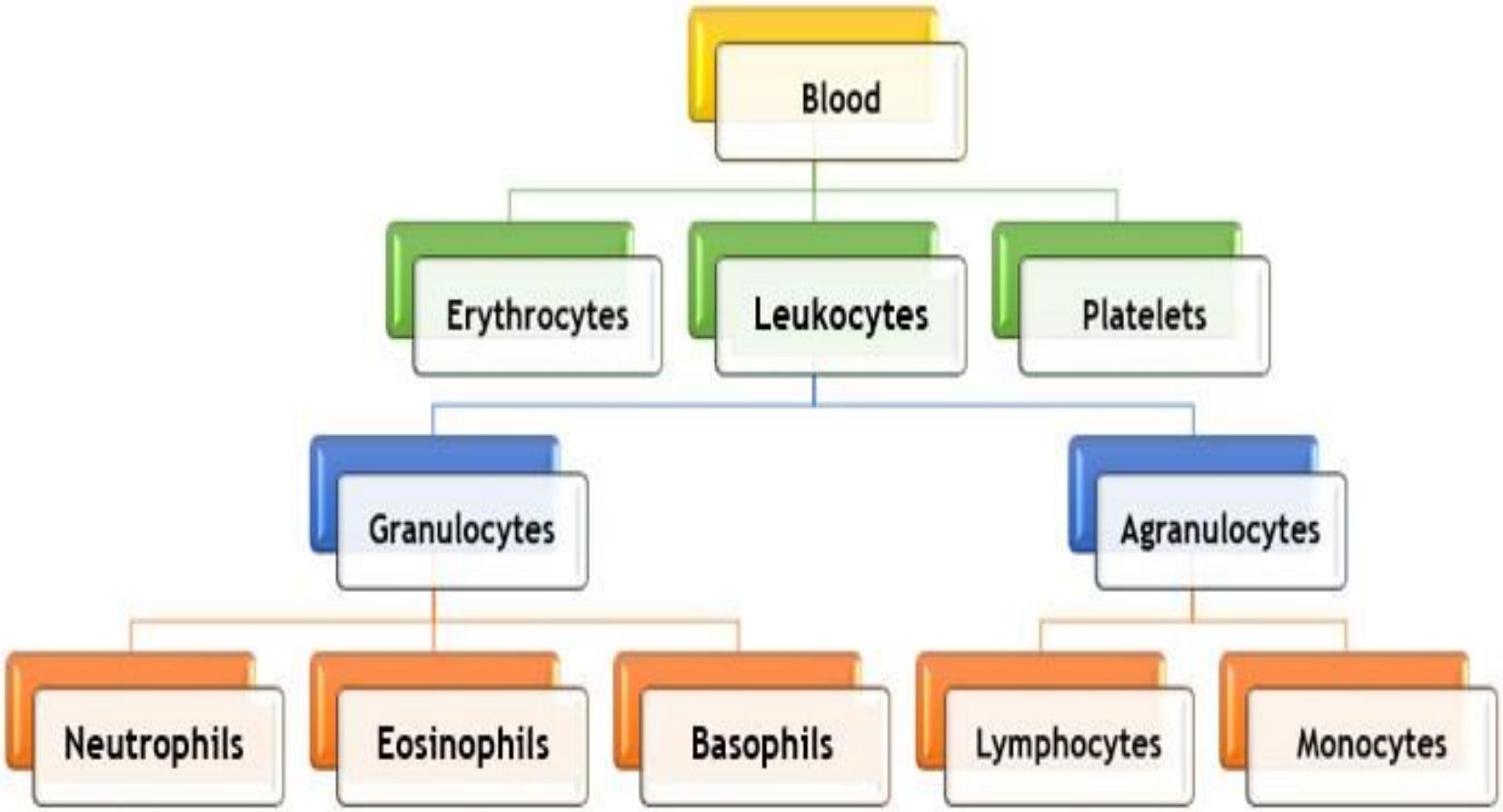
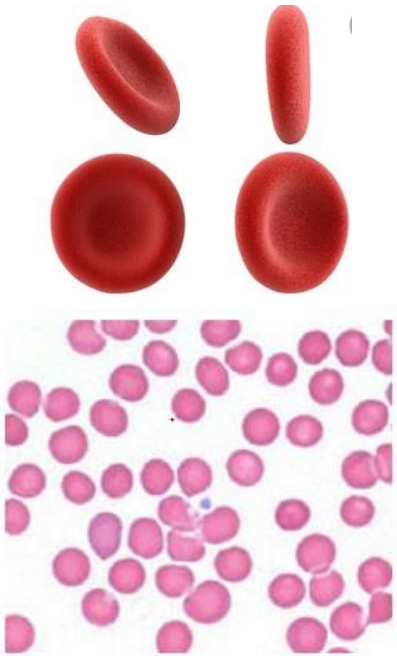


Figure 2.4.15: Components of blood

BLOOD CELLS

- Blood has a liquid extracellular matrix called plasma, which consists of water, salts and dissolved proteins.

Suspended in plasma are erythrocytes (red blood cells), leukocytes (white blood cells) and cell fragments called platelets.



Red blood cell
under microscope

Figure 2.4.16: Red blood cell

Structures:

- Small disk biconcave shape – thinner at the center than at the edge to increase the surface area for difussion of gaseous
- Covered by a thin & elastic plasma membrane (allow it to pass through small blood capillary).
- Lose their nucleus during maturation – give more space for haemoglobin
- Lack of mitochondria and generate ATP exclusively by anaerobic metabolism
- Contain pigment haemoglobin.

Functions:
Transport O_2 & CO_2

Structures:

- Contain five major types of white blood cell.
- Contain nucleus & organelles
- Lack of pigment haemoglobin.
- Irregular in shape.
- Some are phagocytic, engulfing and digesting microorganisms and debris from the body's own dead cells.
- Also found outside of the circulatory system, patrolling interstitial fluid and lymphatic system.
- The number of white cell increase temporarily whenever the body is fighting an infection.

Function:
Fight infection/ immune system

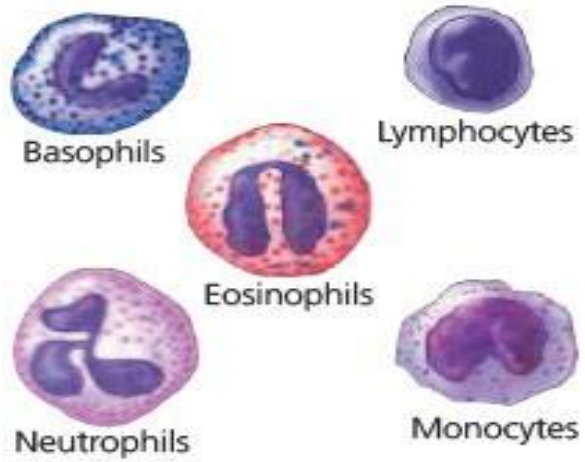


Figure 2.4.16: Types of white blood cell

Type of blood component: Platelet

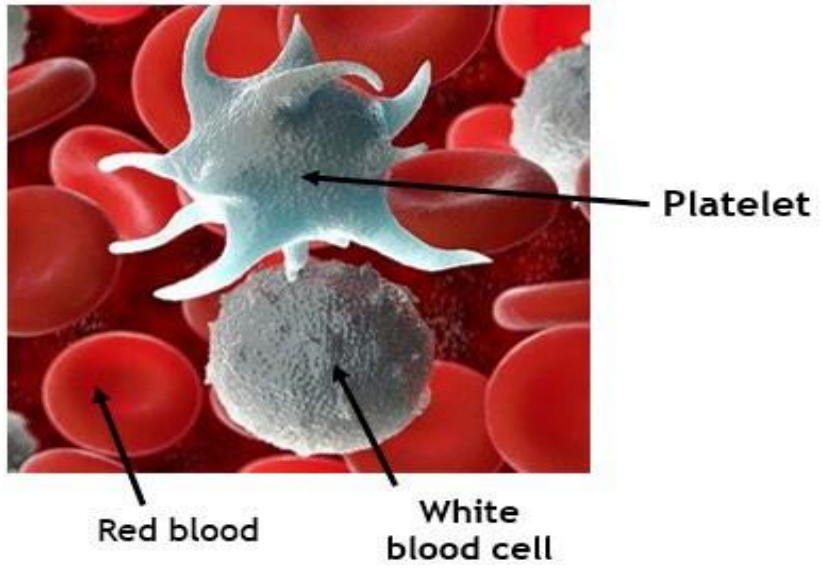


Figure 2.4.17: Platelets

Structures:

- Originate as pinched – off cytoplasmic fragments of specialized bone marrow cells.
- Fragments cells, about 2-3 µm in diameter.
- No nuclei

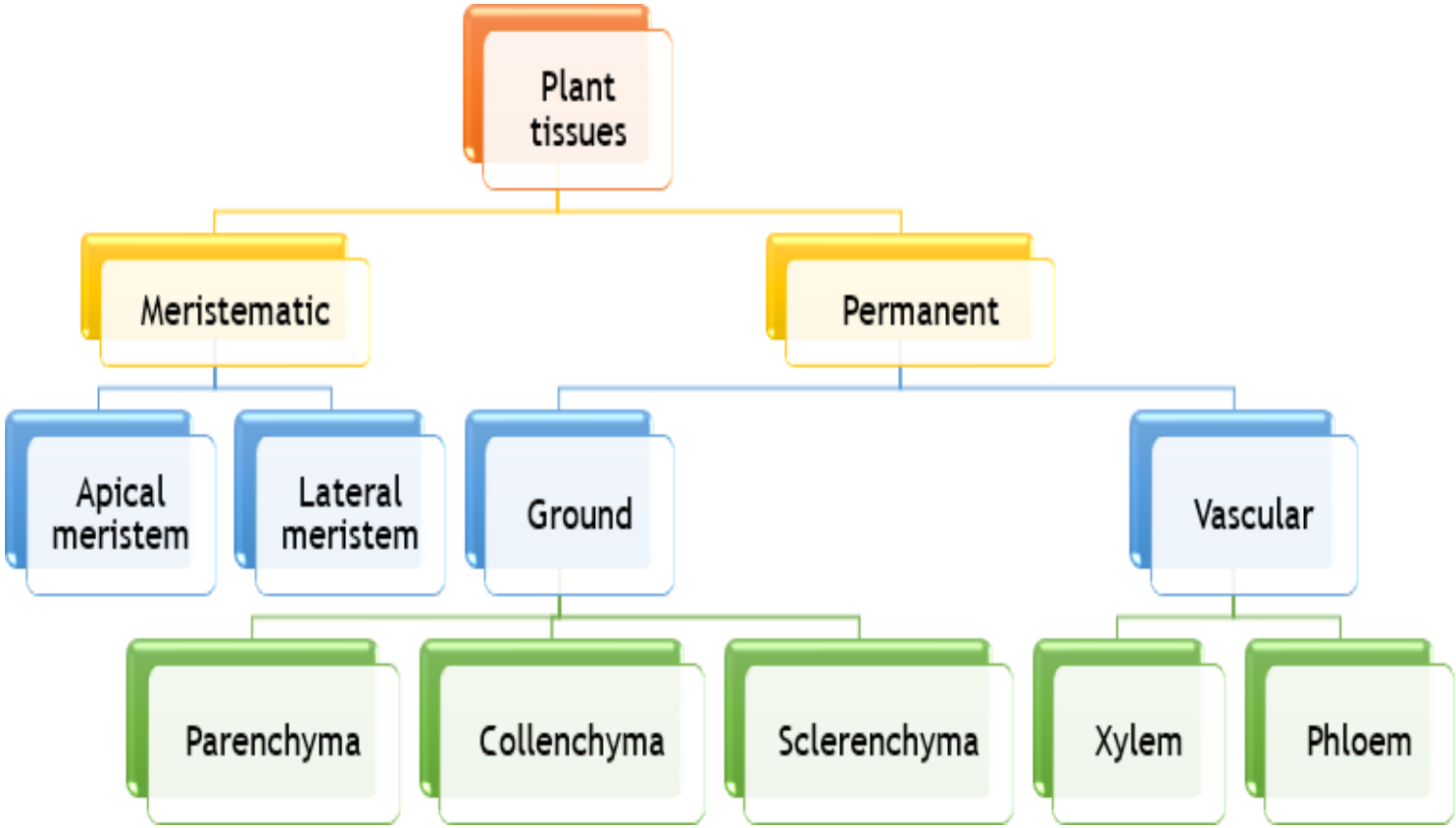
Function:

❖ Serve as both structural and molecular function in blood clotting

2.3 (b) Plant tissues

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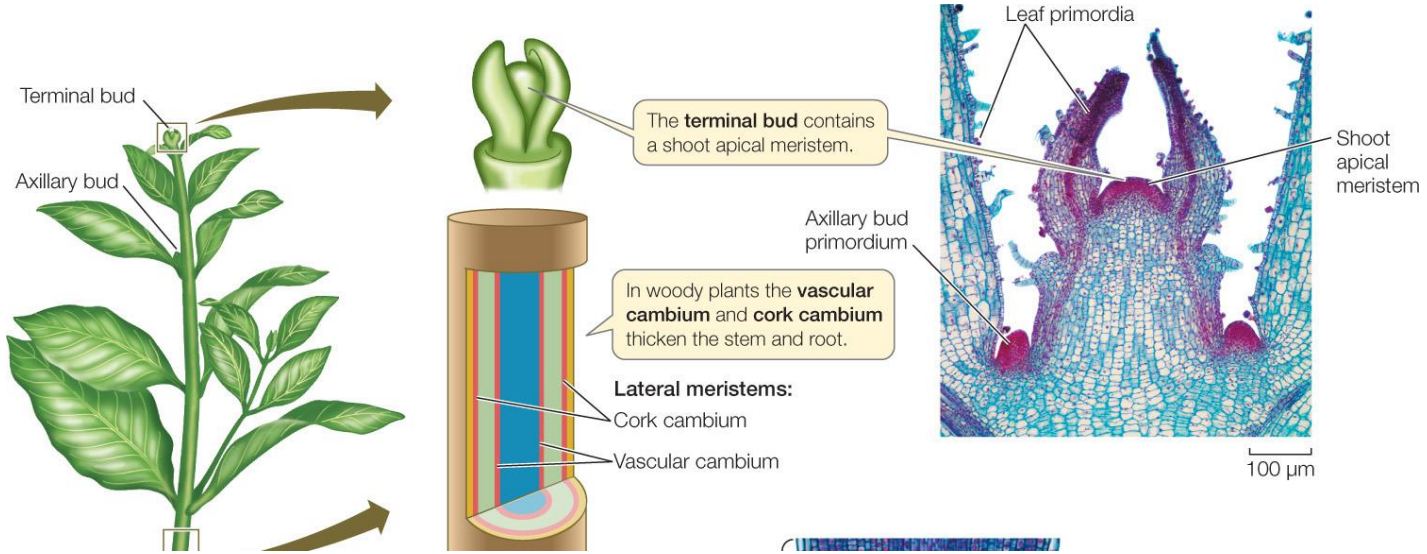
2.4.18: Classification of plant tissues

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MERISTEM TISSUE

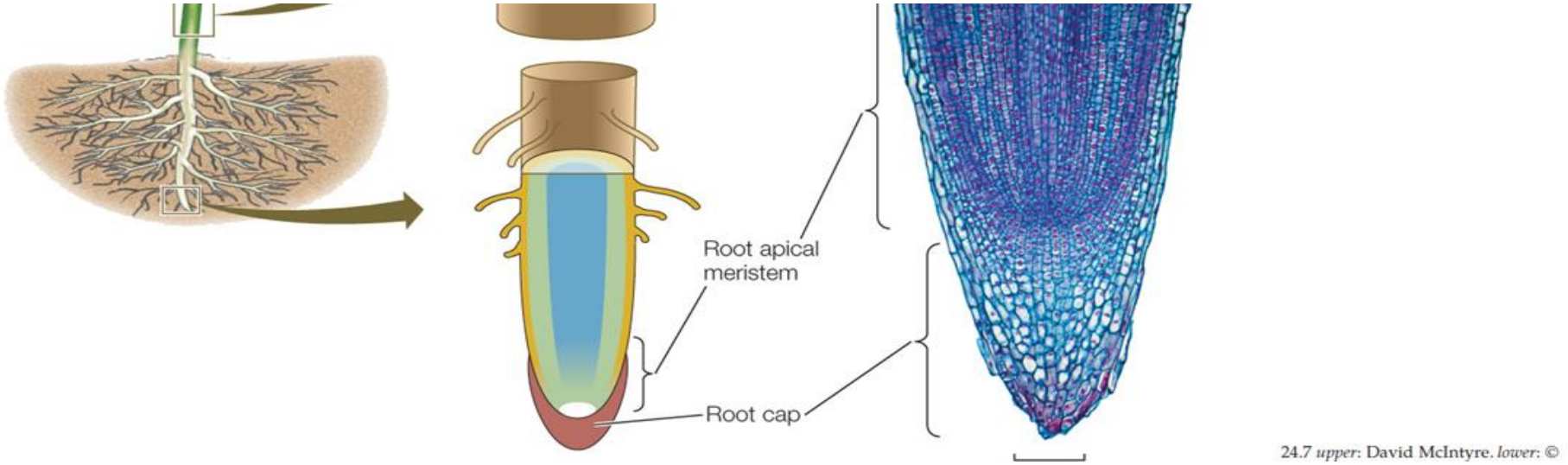
- In plant, growth occur throughout the life because they have undifferentiated tissues called meristems.
- Composed of young & immature cells which are in a state of division & growth cells.
- Have large nucleus located in the centre & dense cytoplasm.
- Cells are similar in structure & have thin cellulose cell walls.
- Cells are closely packed & without intercellular air spaces.
- Shape of the cell may be spherical, oval, polygonal or rectangular.
- Contain few vacuoles or no vacuoles at all.
- Have ability to divide by mitosis & differentiate into specialized cells.
- TWO type of meristem cells: apical meristem and lateral meristemt



2.4.18: Apical meristem

Structures:

- Consist of shoot apical meristem and root apical meristem.
  When they divide, some daughter cells remain in the apical meristem, ensuring continuing population of undifferentiated cells



24.7 *upper*: David McIntyre. *lower*: ©

2.4.18: Shoot meristem

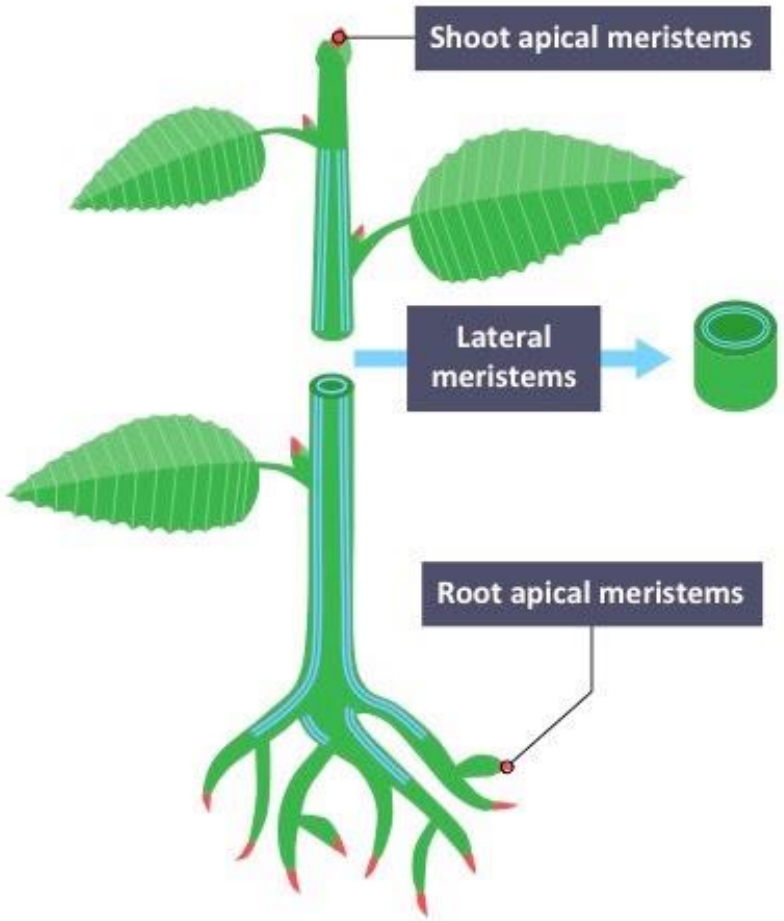
Distribution:

- Root and shoot tips

Function:

- Involve in primary growth, growth in length.

Primary growth allows roots to extend throughout the soil and shoot to increase exposure to light.



Apical Meristems

Causes **primary** growth
(i.e. lengthening of plant)

Occurs at tips of shoots and roots

Produces new leaves and flowers

Lateral Meristems

Causes **secondary** growth
(i.e. widening of plant)

Occurs at the cambium

Produces bark on trees

2.4.19: Shoot apical meristem and root apical meristem

LATERAL CAMBIUM

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Structures:

- 2 types, vascular cambium and cork cambium
- Cylinders of dividing cells that are one cell thick

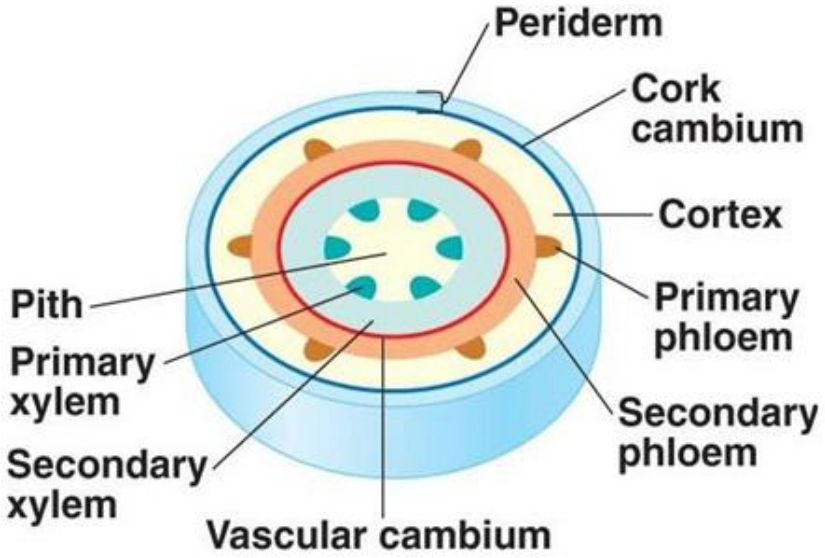
Distribution:

- Vascular cambium extend along the length of roots and stems within vascular bundle between xylem and phloem.
- Cork cambium found in the bark of root and stems of woody plant.

Function:

- Involve in secondary growth
- Vascular cambium add vascular tissue called secondary xylem and secondary phloem.

Cork cambium replaced the epidermis with the thicker, tougher periderm.



2. 4.20 Lateral meristem (cork cambium and vascular cambium)

GROUND TISSUES

- Tissues that are neither dermal nor vascular are part of the ground tissue system.
- Ground tissue that is internal to the vascular tissue is known as pith.

Ground tissue that is external to the vascular tissue is known as cortex

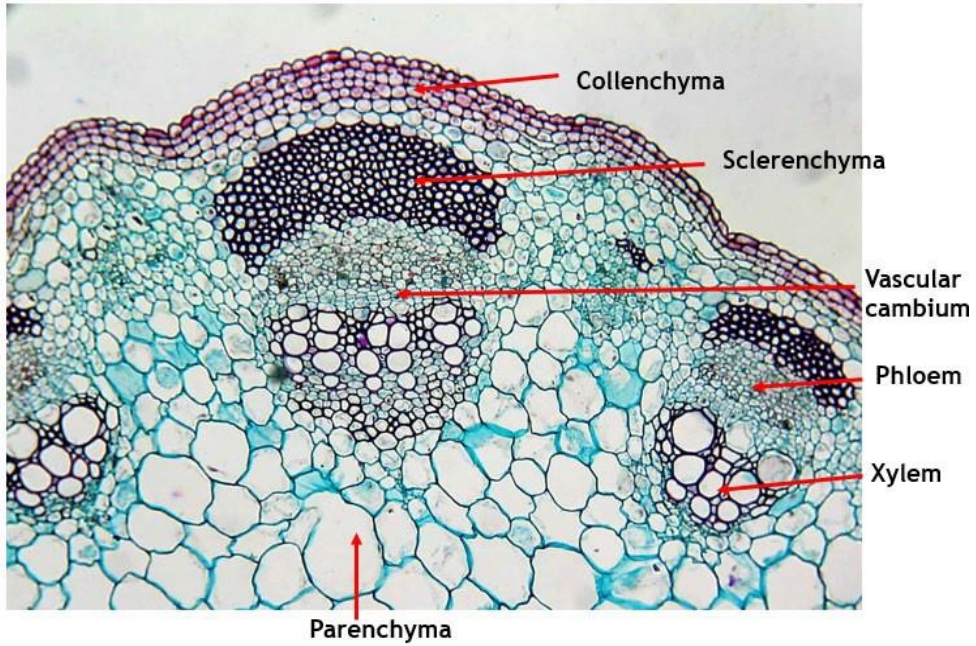


Figure 2.4.21: Plant tissues

PARENCHYMA TISSUE

Structures:

- Consist of unspecialized living cells, with nucleus present in the cells.
- Usually isodiametric or elongated cells.
- When mature, have a large central vacuole with the cytoplasm pushed to the cell periphery.
- Have primary cell walls that are thin and flexible and most lack secondary walls.
- Cell wall containing cellulose, hemicellulose & pectin.
- Cells are loosely packed together/ large intercellular space.

Distribution:

- Cortex & pith of stem.

PARENCHYMA TISSUE

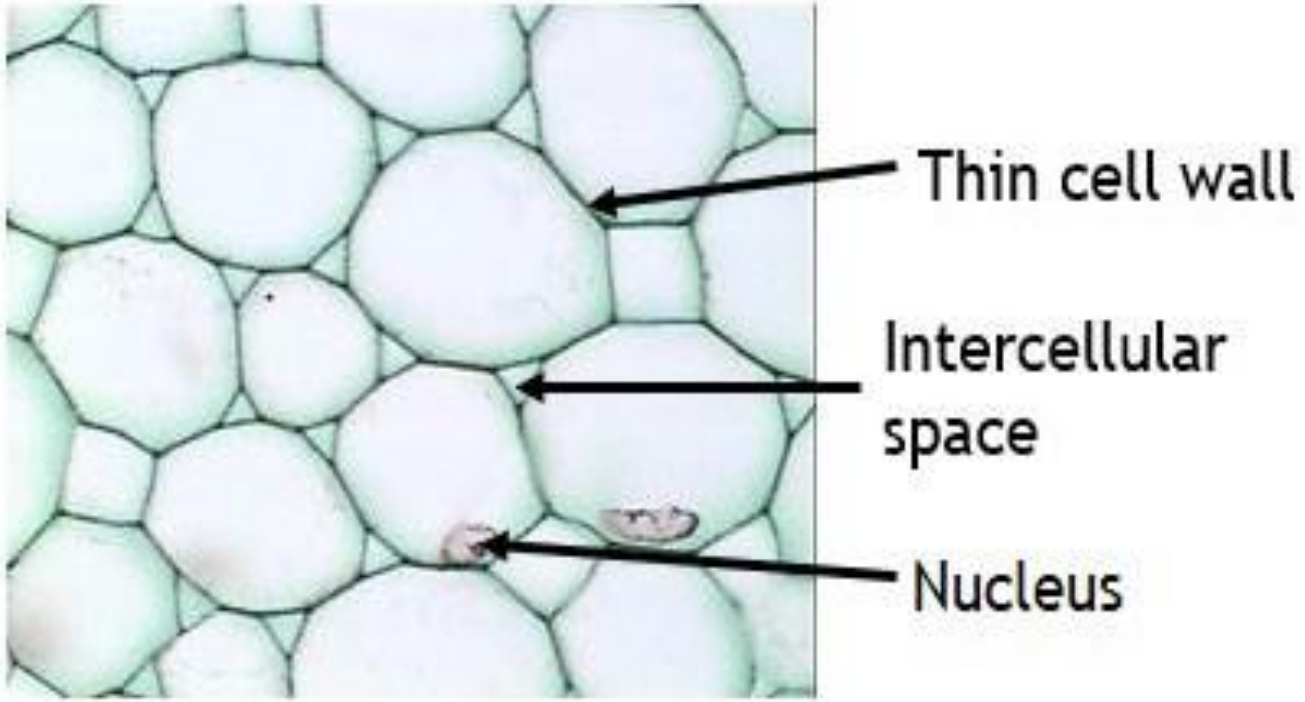


Figure 2.4.22: Parenchyma tissue

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PARENCHYMA TISSUE

Functions:

- Perform most of the metabolic functions of plants, synthesizing and storing various organic products.
- Retain the ability to divide and differentiate into other types of plants cell under particular condition.
- Large intercellular air space for gaseous exchange.
- Contain chloroplast for photosynthesis
- Form secondary tissue such as cambium.

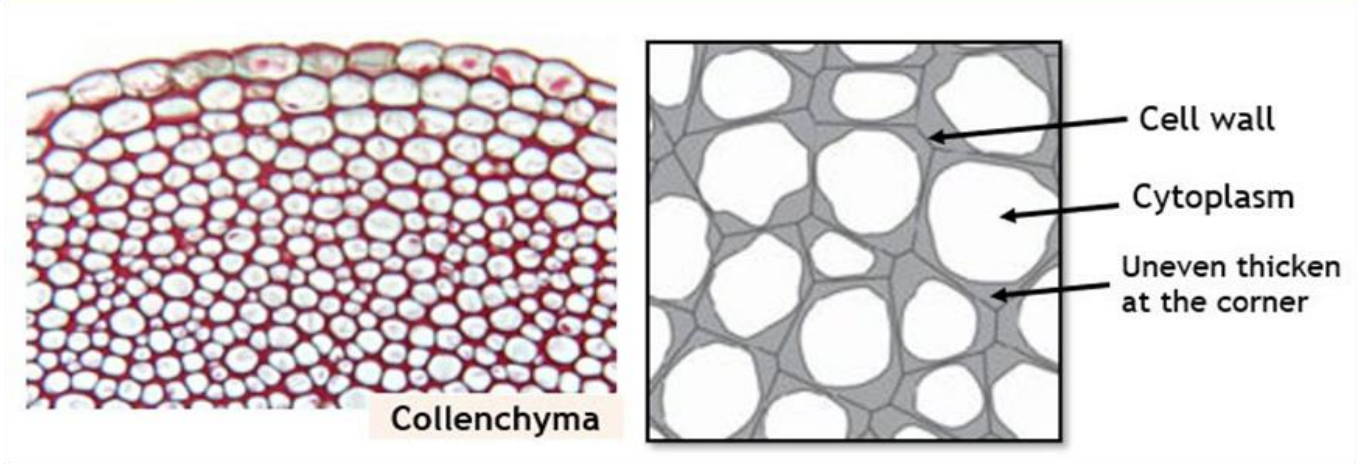


Figure 2.4.23: Collenchyma tissues

- STRUCTURE:
- Nucleus present, consist of living cells at maturity.
- Polygon-shaped & elongated.
- Cells are closely packed together with very small or no intercellular spaces.
- Have unevenly thickened primary cell wall with deposits of cellulose, pectin & hemicellulose
- The thickenings usually occur at the corners of the cell walls.
- Pits are present between cell wall

COLLENCHYMA TISSUES

Distribution:

- Along midrib of leaves. Just under stem epidermis.
- Below the epidermis in the outer region of the cortex & gradually merges into parenchyma towards inside.

Functions:

- Giving mechanical strength & flexibility.
- Elastic support.
- To provide supporting tissue for the herbaceous plants (non woody plants).

SCLERENCHYMA CELL

2 types of cell; sclereids and fibers

- Have primary & secondary cell wall.
- Have thick (secondary) cell wall containing lignin.
- Cell walls are evenly thickened.
- No nucleus when mature, these cells usually die after maturity.
- Fibers - Elongated, slender with tapering ends.
- Sclereids – irregular in shape and very thick lignified secondary walls.
- Cells have no protoplasm with narrow empty lumen.
- Pits are present in the cell walls.
- Cells are closely packed together/no intercellular aispace.

Distribution:

- Xylem & phloem
- Cortex below the epidermis of stems & roots.

Functions:

- Provide the plant with mechanical strength & rigidity.
- It acts as supporting tissue.

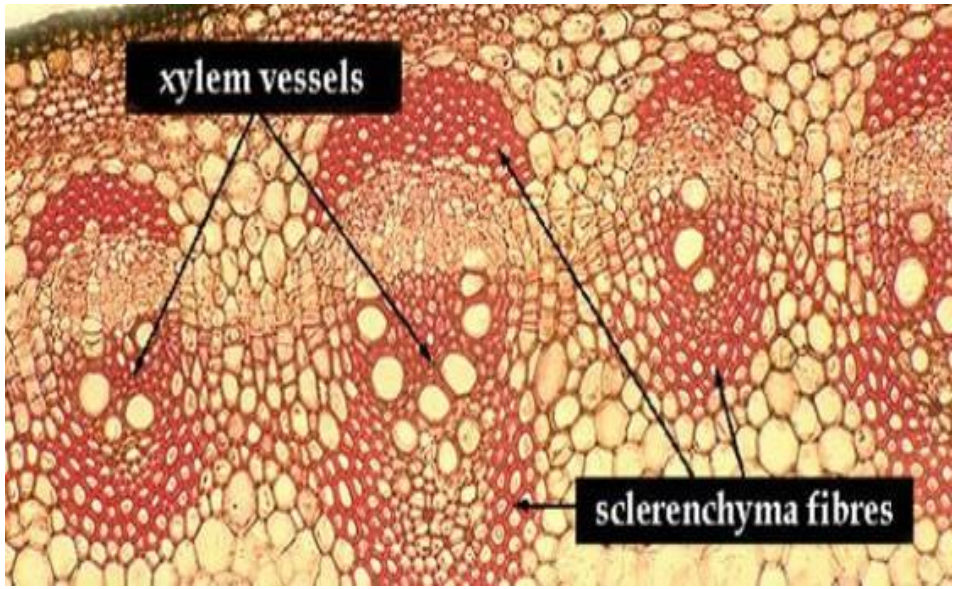
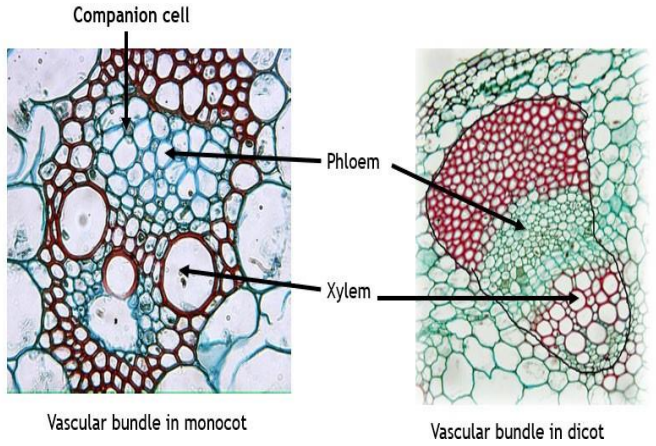


Figure 2.4.23: Sclerenchyma tissue

VASCULAR TISSUE

- Vascular tissue system are to facilitate the transport materials through the plant and to provide mechanical support.
- Two types of vascular tissue are xylem and phloem.
- The vascular tissue of a root or stem is collectively called the stele.

In angiosperm, the root stele is a solid central vascular cylinder of xylem and phloem whereas the stele of stem and leaves consist of vascular bundles, separate strand containing xylem and phloem.



2.4.25 Vascular bundle in monocot and dicot

XYLEM

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Structures:

- Consist of two cell type: tracheids & vessel element
- Tubular, elongated cell that are dead and lignified at functional maturity

TRACHEIDS

- Long, thin, tapered cells having lignin-hardened secondary wall with pits
- All vascular plants possess tracheids.
- Water flow from cell to cell through pits (water transport) & also function in mechanical support.

VESSEL ELEMENT

- Wider, shorter, thinner-walled & less tapered than tracheids.
- End walls of the vessel elements have perforation plates that enable water to flow freely through the vessels
- Have larger diameter & specialized for water transport & fibers for mechanical strength.

Function:

- Function in transporting water & dissolved mineral salts to the upper parts of the plant.
- Mechanical support

PHLOEM

Structures:

- Consist of two cell type: Sieve tube elements & Companion cells
- Alive at maturity, but usually with a much reduced cell contents & no nucleus.

SIEVE TUBES ELEMENTS

- Consists of sieve tube element joined together to form a long tube.
- Their end walls are perforated forming sieve plates with sieve pores.
- The sieve tube element does not have lignin in their walls (has cellulose).
- Their nuclei degenerate & are absent as they mature.

COMPANION CELLS

- Have nucleus, dense cytoplasm with a small vacuole.
- They are metabolically active & have numerous mitochondria & ribosomes.
- Linked by numerous plasmodesmata to sieve tube elements

Function:

- Specialized to transport organic substances from leaves to storage organs & growing parts of plant body.

2.5 LEARNING OUTCOMES:

1. Overview the various transport mechanisms across the membrane. (CLO 1)
2. Explain the various transport mechanisms across the membrane. (CLO 2)

a. Passive transport: simple diffusion, facilitated diffusion and osmosis

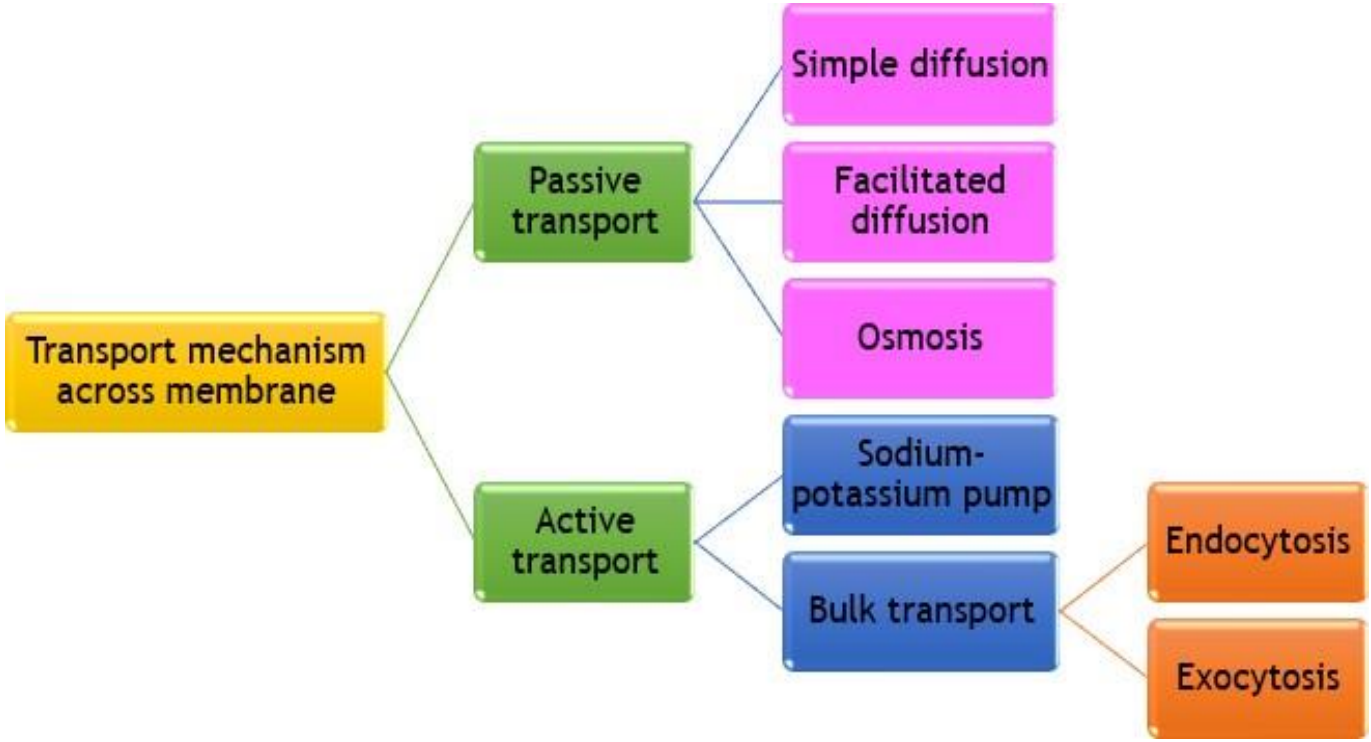
b. Active transport: Sodium – potassium pump and Bulk transport:

endocytosis and exocytosis

Overview of transport mechanism across membrane

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2.5.1 Overview of transport mechanism across membrane

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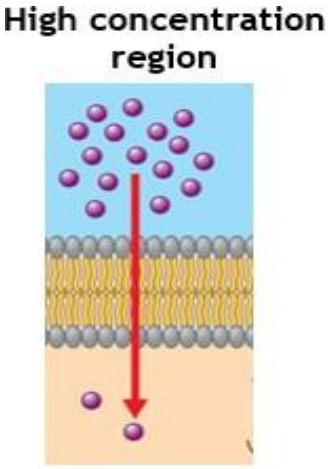
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1. Simple Diffusion

- Movement of molecule, ion & atoms across cell membrane from a region of higher concentration of substances to a region of lower concentration of substances.
- The process does not require energy. Occur in both living & non-living organisms

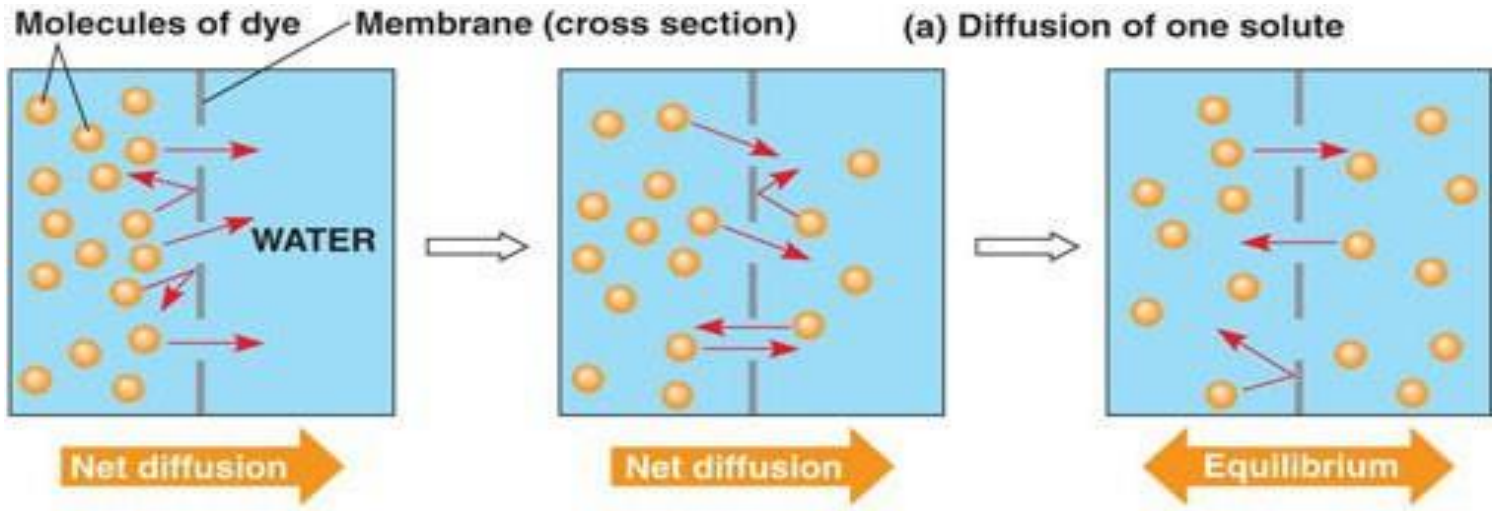
Definition:

- Movement of the substances (molecule, ion & atoms) from a region of higher concentration to a region of lower concentration.
- Does not require transport protein & energy.



Simple diffusion

2.5.2 Simple diffusion



2.5.3 Movement of water molecule based on concentration

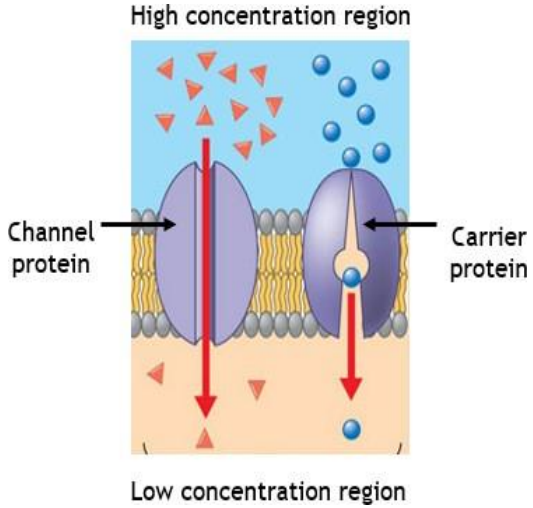
2. Facilitated Diffusion

Definition:

- The passage of molecules or ions down their electrochemical gradient / concentration gradient across a biological membrane with the assistance of specific transmembrane transport proteins, requiring no energy expenditure.

Two major groups of transmembrane transport membrane proteins are involved in facilitated diffusion:

- Carrier Proteins
- Channel proteins



2.5.4 Facilitated diffusion

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3. OSMOSIS

- Osmosis is the diffusion of free water molecules from a region of higher water potential to a region of lower water potential through a selectively permeable membrane and does not required energy.

Concept of water potential

- Water potential (Ψ) is the term given to the tendency for water molecules to enter or leave the solution by osmosis.
- Pure water therefore has the highest water potential, ψ = 0 kPa
- If two systems containing water are in contact, the random movements of water molecules occur.
- Result in the net movement of water molecules from the system with the higher water potential to the system with lower water potential until the concentration of water molecules in both system is EQUAL

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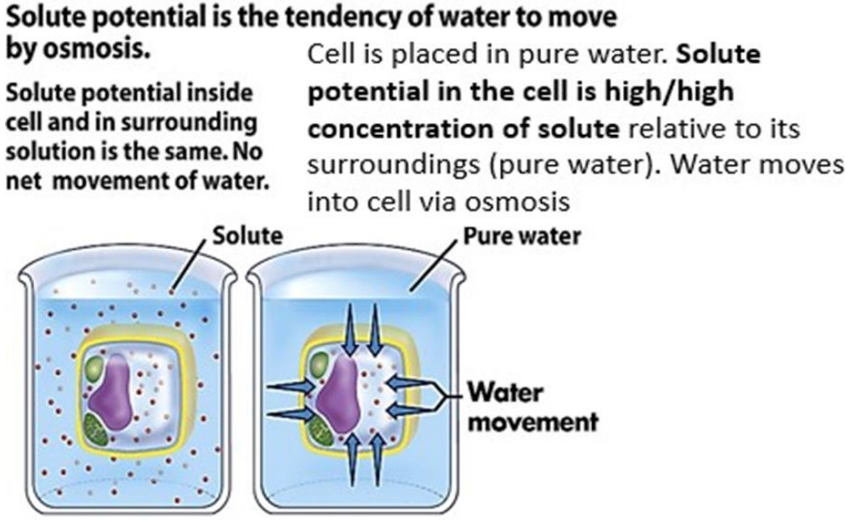
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- Water potential, Ψ predict/ measure the DIRECTION of water molecule in an osmotic system.
- Water molecule move:
  - From hypotonic solution to hypertonic solution.
  - From high [water] to low [water]
- Direction of water movement depends on: Solute potential (Ψs) & Pressure potential (ΨP)
- The formula to calculate the water potential is:

$$\Psi = \psi_S + \psi_P$$

- Water diffuses from region of high water potential (less negative or zero value) to a region of lower water potential (more negative value).
- Ψs (or osmotic potential) value is always negative. The greater solute concentration, the more negative its Ψs value. Ψs predict/ measure the change in Ψ with the presence of solute molecules.
- The effect of dissolving solute molecules in pure water is to reduce the concentration of free water molecules, resulting in a lower water potential (have less kinetic energy).
- All solutions therefore have lower water potential than pure water.
- The amount of this lowering is known as the solute potential (solute potential was previously referred to as osmotic potential).

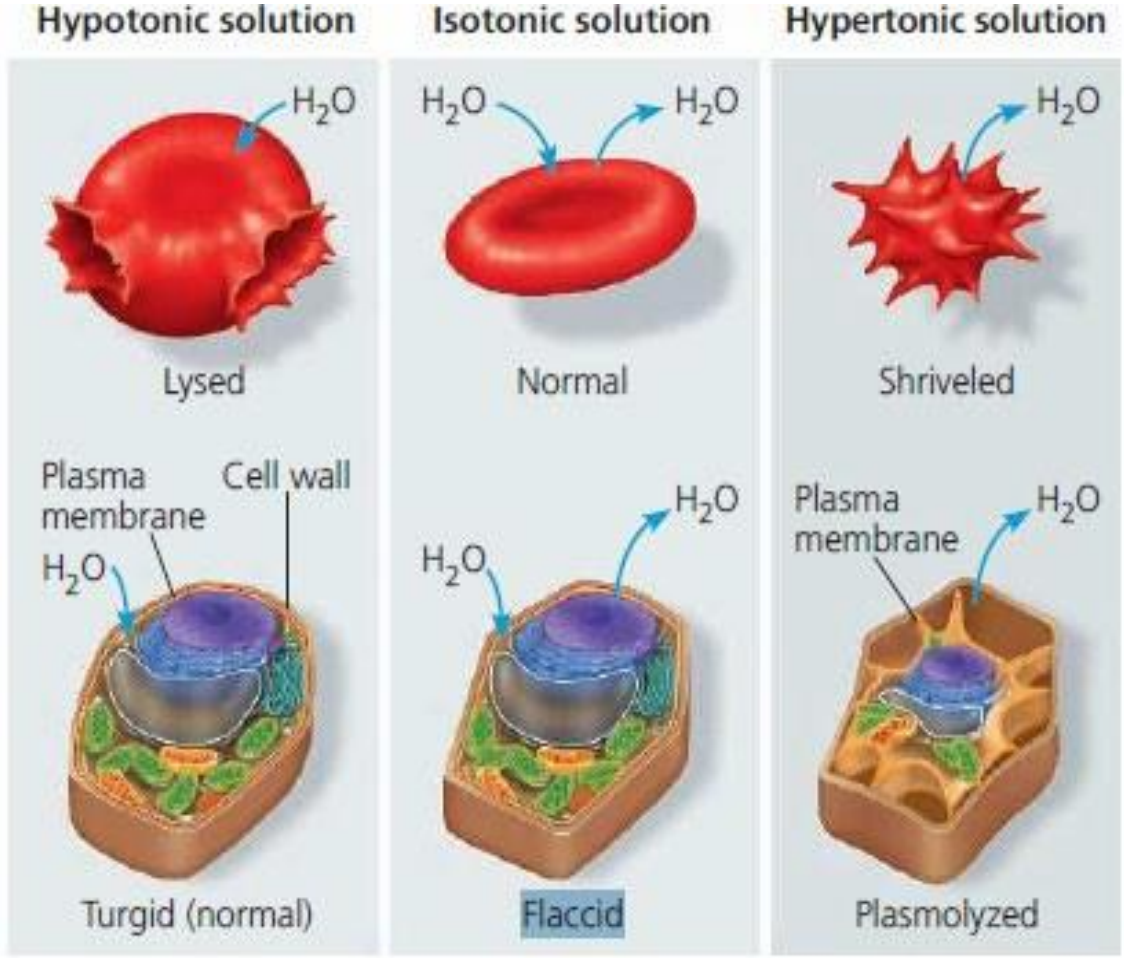
- Pressure potential (ψ_P) is a component of water potential that consist of the physical pressure on a solution, which can be positive, zero or negative.
- **Hydrostatic pressure** to which water is subjected is called pressure potential or refer to the component of water potential due to the hydrostatic pressure that is exerted on water in a cell
- For example, if solute potential inside the plant cell is higher than the outside of cell, water will enter the cell.
- Water enters plant cells by osmosis, pressure may build up inside the cell making the cell turgid & increasing the pressure potential.
- In turgid plant cells is usually has a positive value as the entry of water causes the protoplast to push against the cell wall.
- The cell content expand & pushes against the cell wall - TURGOR PRESSURE.
- Cell wall starts develop pressure, called the pressure potential.
- The cell wall in turn pushes back on the cell contents.



2.5.5 Movement of water based on water potential

(a) Animal cell. An animal cell, such as this red blood cell, does not have a cell wall. Animal cells fare best in an isotonic environment unless they have special adaptations that offset the osmotic uptake or loss of water.

(b) Plant cell. Plant cells are turgid (firm) and generally healthiest in a hypotonic environment, where the uptake of water is eventually balanced by the wall pushing back on the cell.



2.5.6 The water balance in living cells

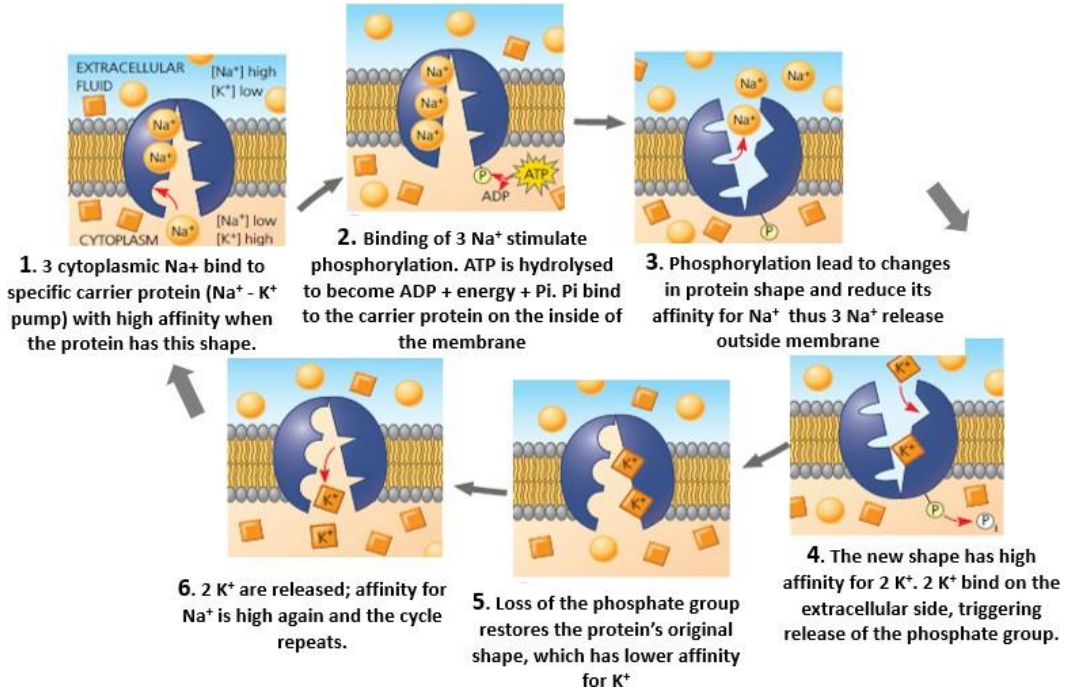
ACTIVE TRANSPORT

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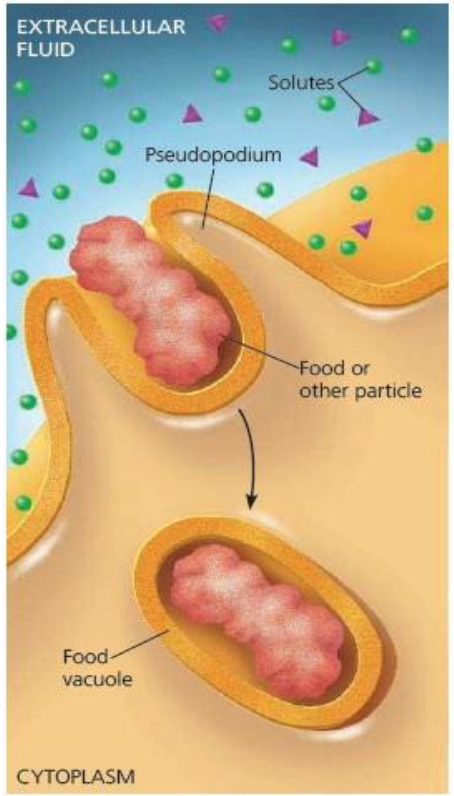
- Movement of substance across a cell membrane against its concentration/electrochemical gradient mediated by specific transport protein and requiring an expenditure of energy.
- Certain particles are either too large to pass through the small pores in the membrane or too hydrophilic to diffuse the phospholipids bilayer of the plasma membrane.
- These materials are transported into or out of cells by bulk transport.

  Bulk transport is defined as the transport of material into or out of a cell by enclosing it within a vacuole or vesicle.

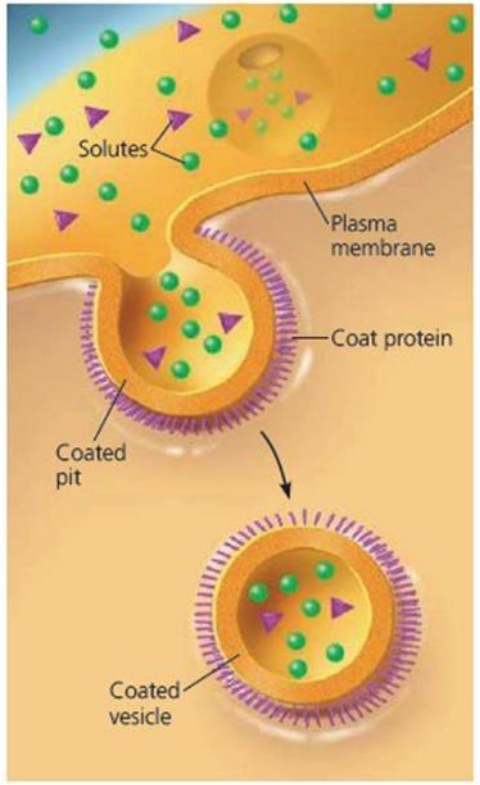


2.5.7 : Steps involve in Na^+-K^+ pump

- Cellular uptake of macromolecules & particulate substances by localized regions of the plasma membrane that surround the substance & pinch off to form an intracellular vesicle.



Phagocytosis



Pinocytosis

2.5.7: Phagocytosis & Pinocytosis

Phagocytosis	Pinocytosis
Material taken in is large particulate (food) / bacteria /large fragments / solid substance.	Material taken in is liquids/ fluids/ small particulate/ solutes.
Involves formation of vacuoles// pseudopodium// invagination of membrane	Involves formation of (small) vesicles // grooves.
Material are digested & absorbed into cytoplasm Involve lysosome.	Material // dissolved substances / fluids absorbed directly into cytoplasm & not involve lysosomes.
- Plasma membrane projects itself outward to form pseudopods.	- The membrane folds inward (invaginate) to form pinocytic vesicle and breaks off from the plasma membrane. No pseudopods formed.

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THANK YOU