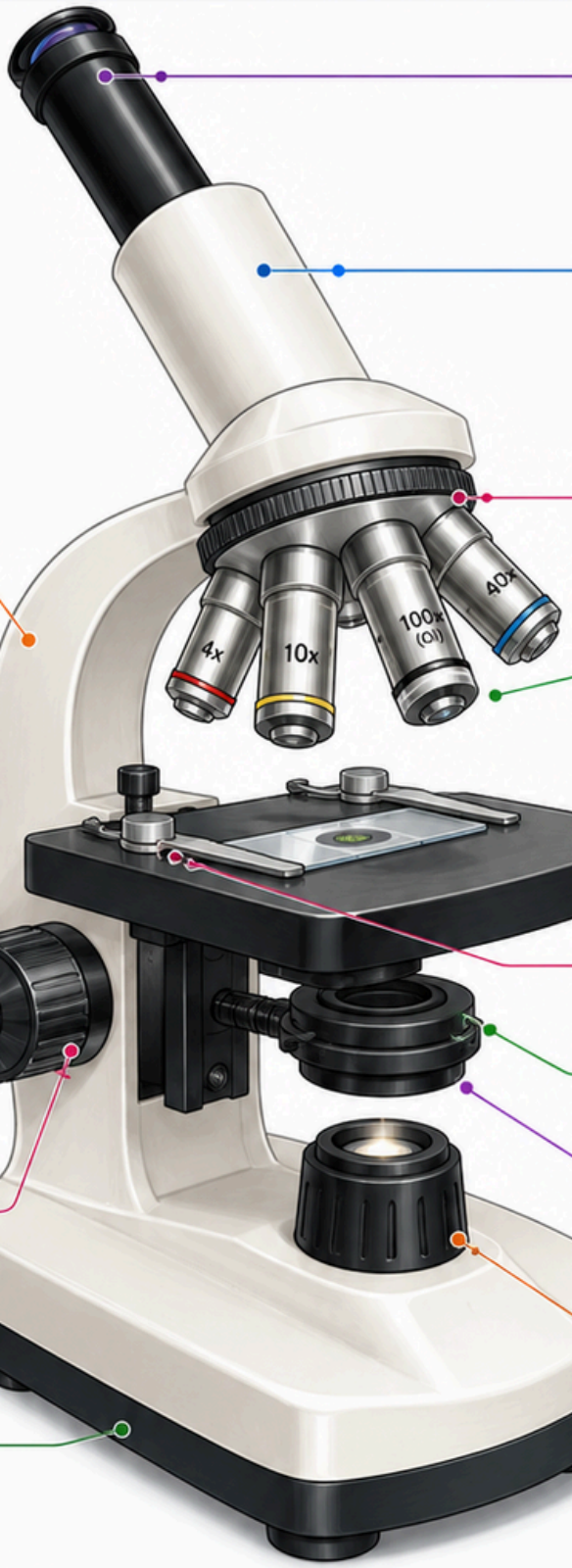
LIGHT MICROSCOPE – DETAILED LABELLED DIAGRAM



1. Eyepiece (Ocular lens)
Lens you look through. Usually 10x or 15x magnification.

2. Body Tube
Holds the eyepiece and keeps it at the correct distance from the objective lenses.

3. Revolving Nosepiece
Holds the objective lenses and can be rotated to change or select different magnification.

4. Objective Lenses
Primary magnifying lenses of different powers. Commonly: 4x (Scanning), 10x (Low power), 40x (High power), 100x (Oil immersion).

5. Arm
Supports the upper parts of the microscope. Used to carry the microscope.

6. Stage
Flat platform where the slide is placed.

7. Stage Clips
Hold the slide in position on the stage.

8. Condenser
Concentrates light on the specimen for better illumination.

9. Iris Diaphragm
Regulates the amount of light passing through the specimen. It has adjustable aperture.

10. Coarse Adjustment Knob
Moves the stage up or down rapidly for rough focusing.

11. Fine Adjustment Knob
Moves the stage up or down slowly for sharp and clear focusing.

12. Illuminator (or Light Source)
Built-in light source that provides light to the specimen.

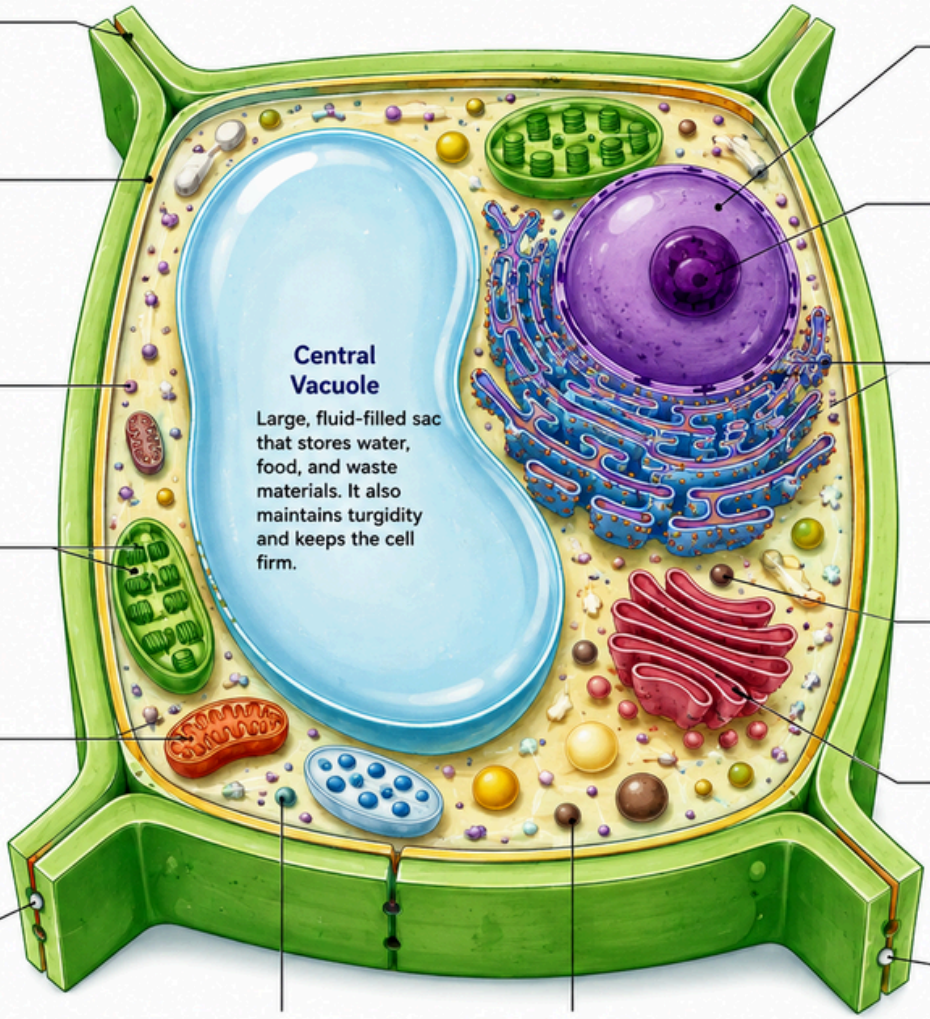
13. Base
Provides stability and supports the entire microscope.

TOTAL MAGNIFICATION =

Magnification of Eyepiece × Magnification of Objective Lens

Example:
If Eyepiece = 10x and Objective Lens = 40x
Total Magnification = 10 x 40 = 400x

PLANT CELL – DETAILED LABELLED DIAGRAM



Cell Wall
Rigid, non-living outer covering made of cellulose. It protects, supports and gives shape to the cell.

Cell Membrane
A thin, flexible, living membrane just inside the cell wall. It controls the movement of substances in and out of the cell.

Cytoplasm
Jelly-like substance that fills the cell. All the organelles are suspended in it.

Chloroplast
Green plastids containing chlorophyll. Site of photosynthesis – helps in making food for the plant.

Mitochondria
Powerhouse of the cell. Releases energy in the form of ATP.

Plasmodesmata
Tiny channels in the cell wall that connect the cytoplasm of neighbouring cells.

Central Vacuole
Large, fluid-filled sac that stores water, food, and waste materials. It also maintains turgidity and keeps the cell firm.

Amyloplast (Leucoplast)
A type of leucoplast that stores starch (food) in the form of granules.

Other Inclusions
Storage granules, calcium oxalate crystals, pigments, oil droplets, etc.

Nucleus
Control centre of the cell. It contains genetic material (DNA) and controls all cell activities.

Nucleolus
A small, dense body inside the nucleus. It helps in the formation of ribosomes.

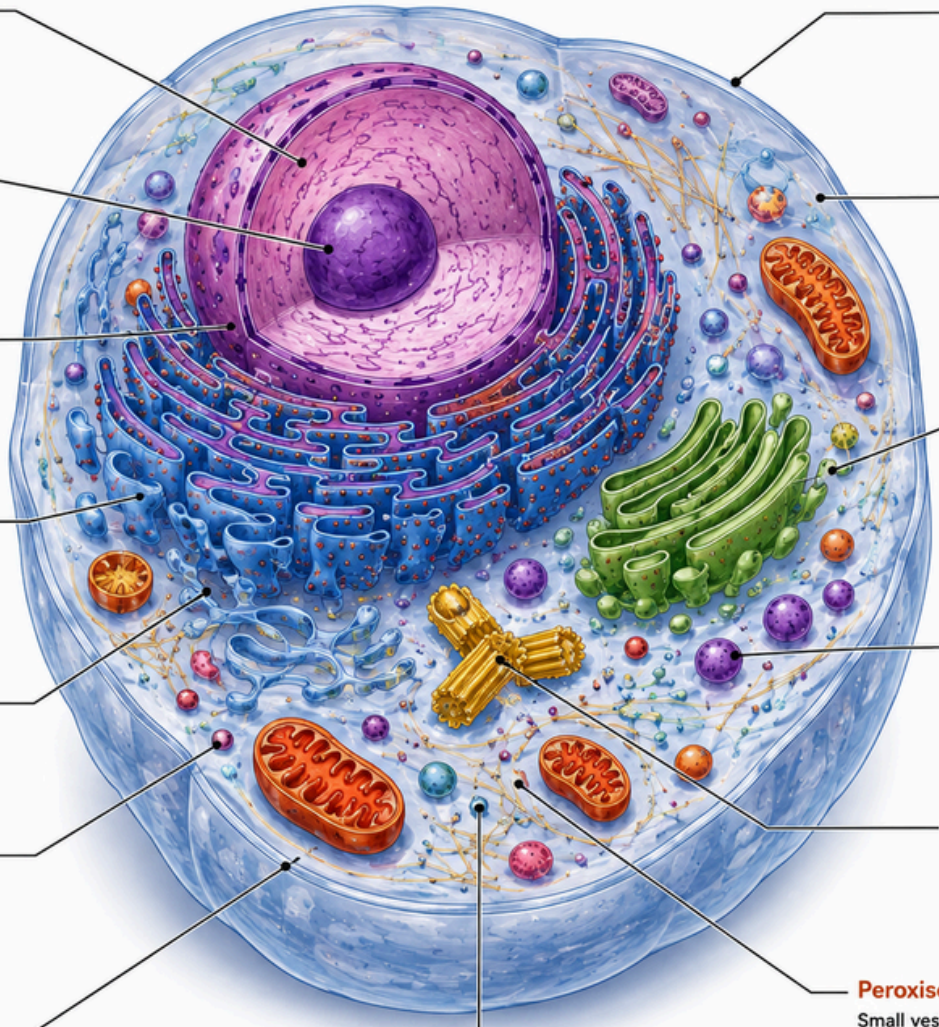
Endoplasmic Reticulum (ER)
A network of membranes involved in the transport of substances inside the cell.
- Rough ER (with ribosomes) – helps in protein synthesis
- Smooth ER (without ribosomes) – helps in lipid synthesis and detoxification

Ribosomes
Tiny particles (seen on RER or free in cytoplasm) that are the site of protein synthesis.

Golgi Body (Apparatus)
Stack of flattened sacs that modifies, packages and transports proteins and lipids to different parts of the cell.

Peroxisomes
Small, spherical bodies that help in the breakdown of fatty acids and detoxify harmful substances.

ANIMAL CELL – DETAILED LABELLED DIAGRAM



Nucleus
Control centre of the cell. It contains genetic material (DNA) and controls all cell activities.

Nucleolus
A small, dense body inside the nucleus. It helps in the formation of ribosomes.

Nuclear Envelope
Double membrane surrounding the nucleus. It has pores that allow movement of materials in and out.

Rough Endoplasmic Reticulum (RER)
Network of membranes studded with ribosomes. It helps in the synthesis and transport of proteins.

Ribosomes
Tiny particles (free in cytoplasm or attached to RER) that are the site of protein synthesis.

Smooth Endoplasmic Reticulum (SER)
Network of membranes without ribosomes. It helps in lipid synthesis, detoxification and storage of calcium ions.

Mitochondria
Powerhouse of the cell. They release energy in the form of ATP.

Cell Membrane
Thin, flexible membrane that surrounds the cell. It protects the cell and regulates movement of substances in and out.

Cytoplasm
Jelly-like substance that fills the cell. It holds organelles in place and is the site of many metabolic reactions.

Golgi Body (Apparatus)
Stack of flattened, membrane-bound sacs. It modifies, packages and transports proteins and lipids.

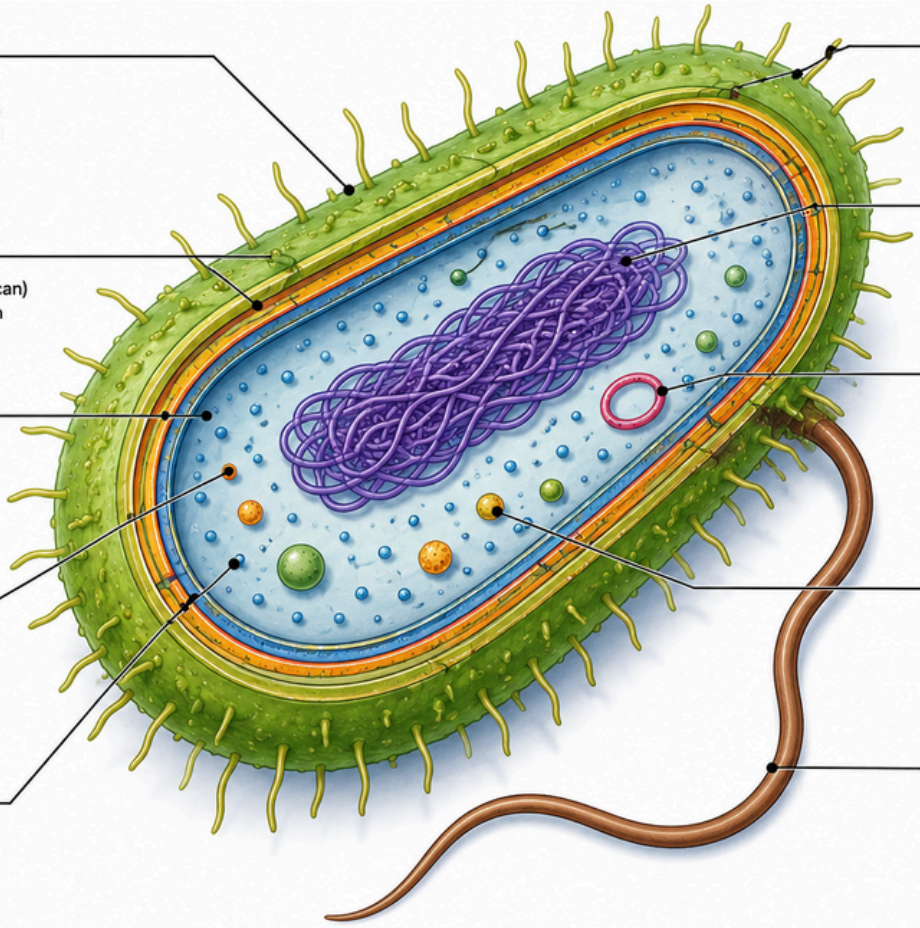
Lysosomes
Small, sac-like structures containing digestive enzymes. They break down waste materials and worn-out cell parts.

Centrioles
Pair of short cylindrical structures (in centrosome). They help in cell division by forming spindle fibres.

Peroxisomes
Small vesicles that help in breakdown of fatty acids and detoxify harmful substances.

Small Vacuoles
Membrane-bound sacs that store water, ions or other materials.

PROKARYOTIC CELL (BACTERIAL CELL) – DETAILED LABELLED DIAGRAM



Capsule (Glycocalyx)
Outermost slimy layer made of polysaccharides. It protects the bacterium from drying, harmful substances and helps in attachment to surfaces.

Cell Wall
Rigid layer (made of peptidoglycan) that gives shape and protection and prevents osmotic lysis.

Plasma (Cell) Membrane
Thin, flexible membrane inside the cell wall. It regulates the movement of substances in and out of the cell.

Cytoplasm
Jelly-like substance in which all the cellular components are present. Site of many metabolic activities.

Ribosomes (70S)
Tiny particles, not bound by membrane. Site of protein synthesis.

Pili / Fimbriae
Short, hair-like structures used for attachment to surfaces or to other bacterial cells.

Nucleoid (Chromosomal DNA)
Single, circular DNA molecule located in the cytoplasm. It is not enclosed by a nuclear membrane.

Plasmid
Small, circular DNA molecules that are separate from the chromosomal DNA. They carry extra genes, often useful (such as antibiotic resistance).

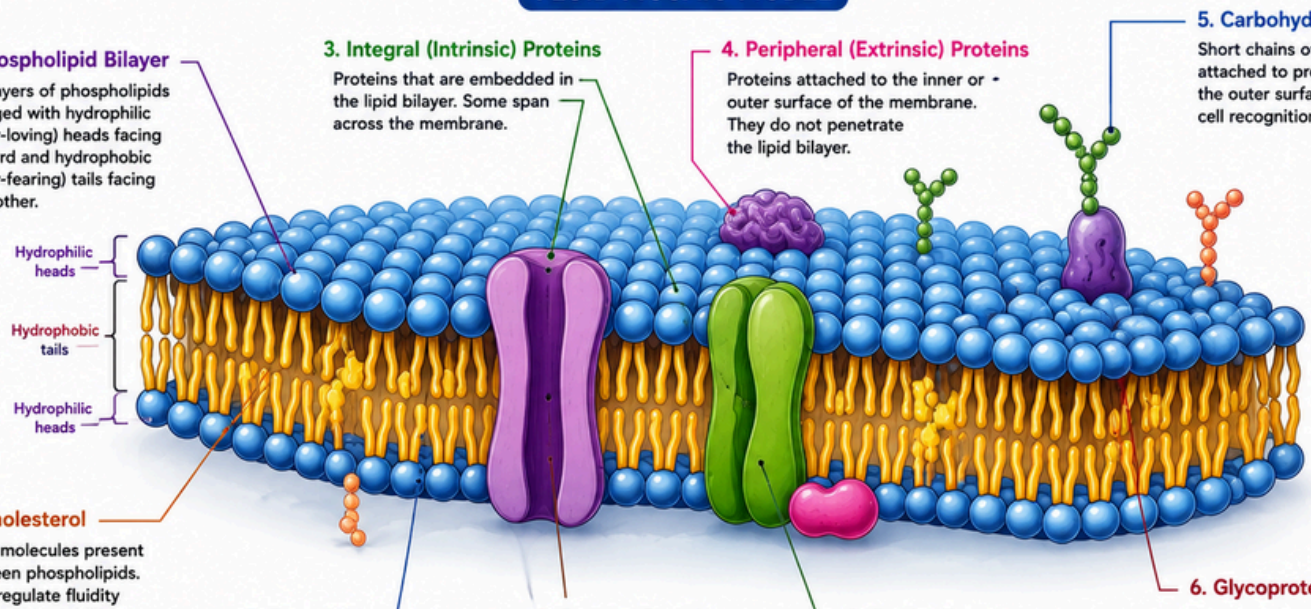
Inclusion Bodies
Storage granules of food reserves such as glycogen, polyphosphate, sulphur compounds, etc.

Flagellum
Long, whip-like structure used for locomotion (movement).

CELL MEMBRANE (PLASMA MEMBRANE)

A thin, flexible, living membrane that surrounds the cell. It separates the cell from its environment, protects the cell and regulates the movement of substances in and out.

FLUID MOSAIC MODEL



1. Phospholipid Bilayer

Two layers of phospholipids arranged with hydrophilic (water-loving) heads facing outward and hydrophobic (water-fearing) tails facing each other.

2. Cholesterol

Small molecules present between phospholipids. They regulate fluidity and provide stability to the membrane.

3. Integral (Intrinsic) Proteins

Proteins that are embedded in the lipid bilayer. Some span across the membrane.

4. Peripheral (Extrinsic) Proteins

Proteins attached to the inner or outer surface of the membrane. They do not penetrate the lipid bilayer.

5. Carbohydrate Chain

Short chains of sugar molecules attached to proteins or lipids on the outer surface. They help in cell recognition and signaling.

6. Glycoprotein

Protein with a carbohydrate chain attached. Involved in cell recognition, immune response and signaling.

7. Glycolipid

Lipid with a carbohydrate chain attached. Helps in cell recognition and adhesion.

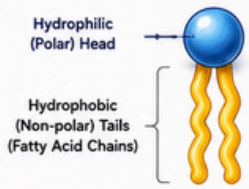
8. Channel Protein

Integral protein that forms a channel or pore through which specific substances can pass.

9. Carrier Protein

Integral protein that changes shape to bind and transport specific molecules across the membrane.

PHOSPHOLIPID – THE BASIC UNIT



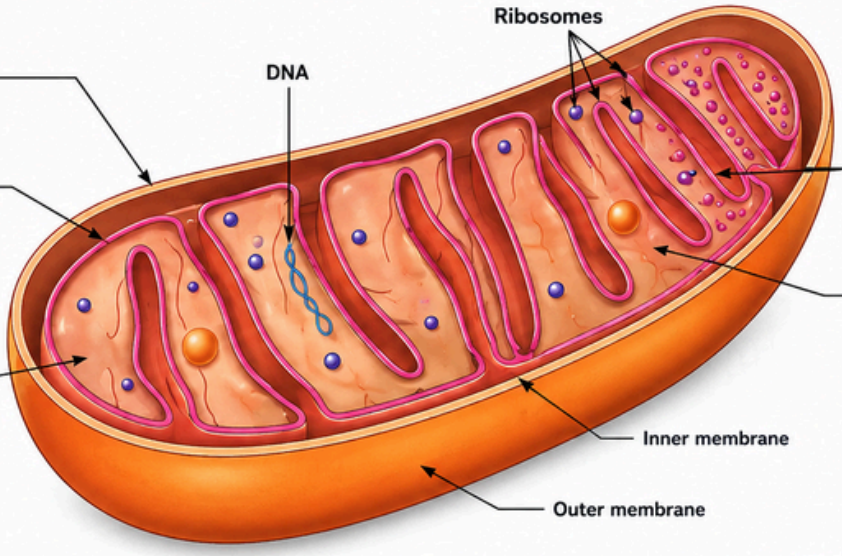
Phospholipid has a polar head that interacts with water and non-polar tails that repel water. This arrangement forms the bilayer structure.

FUNCTIONS OF CELL MEMBRANE

- Acts as a protective barrier.
- Regulates the movement of substances in and out of the cell.
- Maintains the shape of the cell.
- Enables cell communication and recognition.
- Helps in transport, secretion and endocytosis/exocytosis.

MITOCHONDRION – THE POWERHOUSE OF THE CELL

Mitochondria are double-membraned organelles present in most eukaryotic cells.
They are the site of **aerobic respiration** and generate most of the cell's **ATP (energy)**.



1 Outer Membrane
Smooth outer boundary.
It is permeable to small molecules and ions.

2 Intermembrane Space
The narrow space between outer and inner membrane.
It contains enzymes and is rich in H^+ ions.

3 Inner Membrane
Highly selective and impermeable to most molecules and ions.
It is folded to form cristae.

4 Cristae
Folded infoldings of the inner membrane that increase surface area. They contain enzymes and proteins for ATP synthesis.

5 Matrix
The fluid-filled inner compartment. It contains enzymes, mitochondrial DNA, ribosomes and granules. It is the site of Krebs cycle (citric acid cycle).

FUNCTIONS

- Site of aerobic respiration.
- Generates ATP (energy) for the cell.
- Helps in metabolism of fats, proteins and carbohydrates.
- Plays a role in calcium storage and cell signalling.
- Helps in apoptosis (programmed cell death).

KEY FACTS

- **Number:** Varies from a few hundred to several thousand per cell depending on energy requirement.
- **Shape:** Oval, rod-shaped or thread-like.
- **Size:** 0.5 – 1.0 µm in diameter and 1 – 10 µm in length.
- They are semi-autonomous because they contain their own DNA and ribosomes.

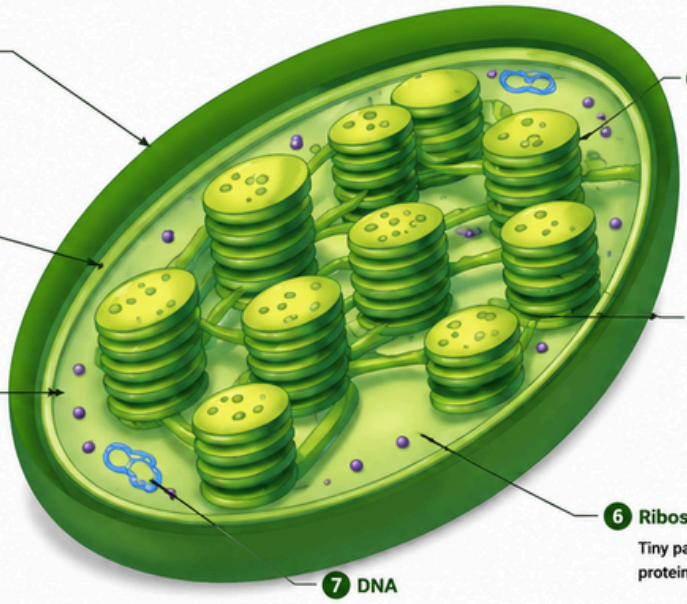
COMPOSITION & LOCATION

Composition:
Proteins, lipids, enzymes, DNA, RNA and ribosomes.

Location:
Found in the cytoplasm of eukaryotic cells (animal and plant cells).

CHLOROPLAST – THE SITE OF PHOTOSYNTHESIS

Chloroplasts are double-membrane organelles found in plant and algal cells.
They contain **chlorophyll** and are the site of **photosynthesis**.



1 Outer Membrane
Smooth and permeable to small molecules.
It protects the chloroplast and gives it shape.

2 Inner Membrane
Highly selective and regulates the movement of substances in and out of the chloroplast.

3 Stroma
A fluid-filled matrix inside the inner membrane.
It contains enzymes, DNA, ribosomes and starch grains.

4 Granum (Grana)
A stack of thylakoids (flattened, disc-shaped membranes).
Grana are the site of light-dependent reactions of photosynthesis.

5 Thylakoid
Flattened membrane sacs arranged in stacks.
They contain chlorophyll, photosynthetic pigments and proteins.

6 Ribosomes
Tiny particles involved in protein synthesis.

7 DNA
Circular DNA present in the stroma.
It helps the chloroplast to make some of its own proteins.

KEY FUNCTIONS
- Site of photosynthesis.
- Traps light energy using chlorophyll.
- Converts light energy into chemical energy (glucose).
- Helps in the synthesis of carbohydrates.
- Some chloroplasts store starch.

STRUCTURE AT A GLANCE
1. Outer membrane
2. Inner membrane
3. Stroma
4. Granum (grana)
5. Thylakoid
6. Ribosomes
7. DNA

DETAIL OF THYLAKOID SYSTEM


- Each thylakoid contains chlorophyll and other pigments.
- Stacks of thylakoids are called grana (singular: granum).
- The thylakoids of different grana are connected by stroma lamellae (intergranal lamellae).
- Light-dependent reactions occur on the thylakoid membranes.

IMPORTANT FACTS
- **Shape:** Oval or disc-shaped.
- **Size:** 4 – 10 µm in length and 2 – 3 µm in width.
- **Number:** Usually 20 – 40 in a plant cell, but may vary.
- Contain their own DNA and ribosomes, so they can synthesize some of their own proteins.
- They are semi-autonomous organelles.

COMPOSITION
Outer & inner membranes:
Made of lipids and proteins.

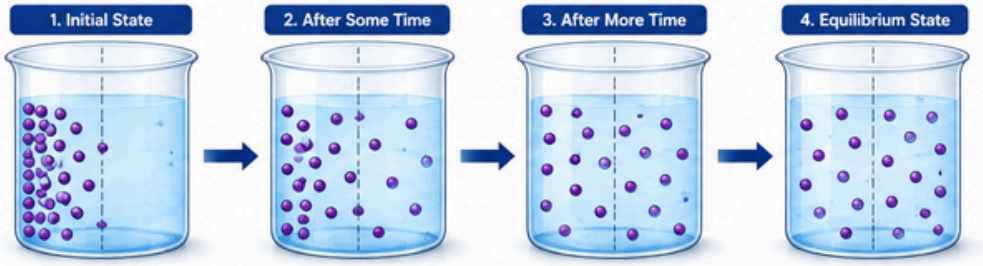
Stroma:
Water, enzymes, proteins, DNA, ribosomes, starch grains.

Thylakoid membranes:
Contain chlorophyll, carotenoids, proteins and lipids.

REMEMBER: Chloroplasts capture sunlight and convert it into food for the plant. Without them, plants cannot make their own food.

DIFFUSION

Diffusion is the movement of particles from a region of higher concentration to a region of lower concentration, down the concentration gradient, until equilibrium is reached. It is a passive process and does not require energy.



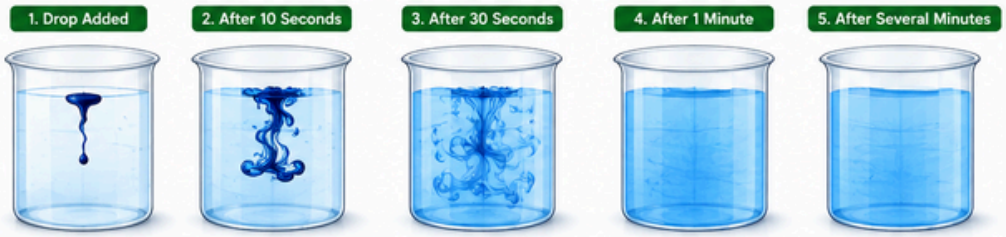
Particles (solute) are more concentrated on the left side.

Particles start moving from higher concentration (left) to lower concentration (right).

Particles continue to move in both directions but concentration is becoming equal.

Dynamic equilibrium is reached. Particles are equally distributed. No net movement of particles.

EXAMPLE: DIFFUSION OF A DROP OF INK IN WATER



A drop of ink is added to the water.

Ink starts spreading from the region of higher concentration.

Ink spreads further in all directions.

Ink is almost evenly distributed.

Ink is evenly distributed throughout the water (equilibrium achieved).

REMEMBER:
Diffusion is essential for many life processes such as breathing (exchange of gases), absorption of nutrients, removal of waste products and maintaining balance inside the body.

KEY POINTS

- Movement is from higher concentration to lower concentration.
- Occurs in gases, liquids and (to some extent) solids.
- Does not require energy (ATP).
- Stops when equilibrium is reached (equal concentration everywhere).
- Example: Perfume smell spreading in a room.

EXAMPLES OF DIFFUSION

- Smell of perfume spreading across a room.
- Drop of ink spreading in water.
- Oxygen diffusing from alveoli into blood.
- Carbon dioxide diffusing into leaves through stomata.

FACTORS AFFECTING DIFFUSION

- **Temperature ↑** – Higher temperature increases the speed of diffusion.
- **Concentration Gradient ↑** – Greater difference in concentration increases diffusion rate.
- **Surface Area ↑** – Larger surface area increases the rate.
- **Molecular Size ↓** – Smaller particles diffuse faster.
- **Nature of Medium** – Diffusion is faster in gases than liquids and slowest in solids.

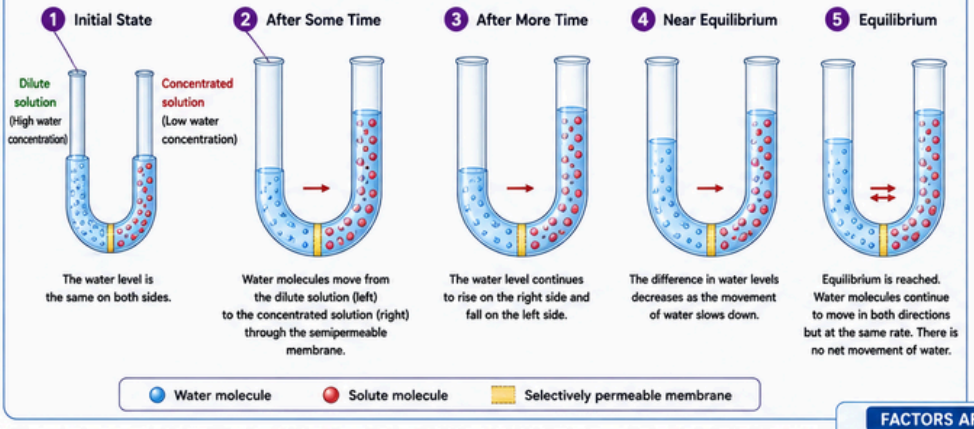
OSMOSIS

Osmosis is the movement of water molecules from a region of higher water concentration (lower solute concentration) to a region of lower water concentration (higher solute concentration) through a selectively permeable membrane, until equilibrium is reached.

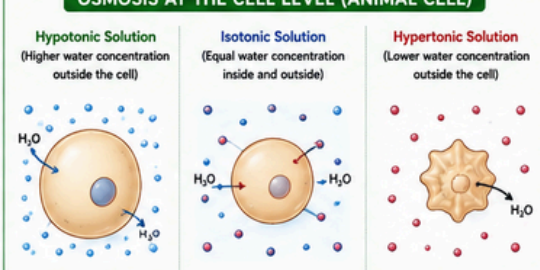
KEY POINTS

- Involves only water molecules.
- Occurs through a selectively permeable membrane.
- Water moves from high water concentration to low water concentration.
- Does not require energy (passive process).
- Stops when equilibrium is reached (equal water concentration on both sides).

OSMOSIS IN A U-TUBE



OSMOSIS AT THE CELL LEVEL (ANIMAL CELL)



EXAMPLES OF OSMOSIS

Absorption of water by root hairs from the soil.

Raisins swell when placed in water.

Cucumber pieces shrink when sprinkled with salt.

Red blood cells shrink in concentrated salt solution.

Plants wilt if there is loss of water from cells (exosmosis).

IMPORTANCE OF OSMOSIS: Essential for absorption of water by plants, maintaining cell shape and turgidity, removal of waste, and many other life processes.

FACTORS AFFECTING OSMOSIS

Concentration Gradient
Greater the difference in concentration, faster is osmosis.

Temperature
Increase in temperature increases the rate of osmosis.

Nature of Membrane
More permeable the membrane, faster is osmosis.

Surface Area
Larger surface area allows faster movement of water.

Size of Molecules
Smaller water molecules pass through the membrane more easily.

REMEMBER

Endosmosis
Movement of water into the cell.
Example: Water entering a plant cell in hypotonic solution.

Exosmosis
Movement of water out of the cell.
Example: Water leaving a plant cell in hypertonic solution.

Turgidity in Plant Cells
Water enters the cell (endosmosis), vacuole fills up and cell becomes turgid (firm and rigid).

MITOSIS – THE PROCESS OF EQUATIONAL CELL DIVISION

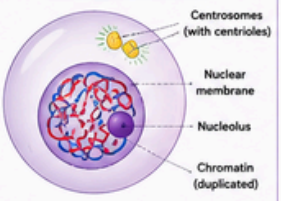
Mitosis is a type of cell division in which a parent cell (somatic cell) divides once to form two daughter cells that are genetically identical to each other and to the parent cell. It maintains the same chromosome number.

KEY POINTS

- Occurs in somatic (body) cells.
- Produces two genetically identical daughter cells.
- Chromosome number remains the same.
- Important for growth, repair and replacement of worn out cells.
- Involves 5 main stages: PMAT + Cytokinesis.

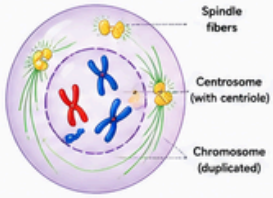
STAGES OF MITOSIS

1. INTERPHASE (Preparatory Stage)



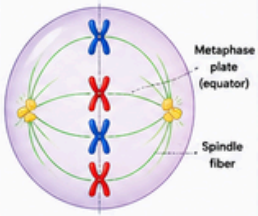
- Cell grows and prepares for division.
- DNA gets replicated. Each chromosome consists of two sister chromatids.
- Centrosomes duplicate and move to opposite poles.
- Nuclear membrane and nucleolus are clearly visible.

2. PROPHASE



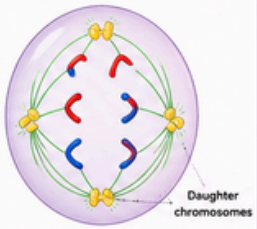
- Chromatin condenses into visible chromosomes (each with two sister chromatids joined at centromere).
- Nuclear membrane and nucleolus disappear.
- Spindle fibers start forming from centrosomes.
- Centrosomes move toward opposite poles.

3. METAPHASE



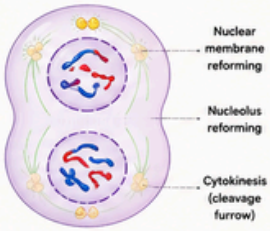
- Chromosomes align at the equatorial plate (middle of the cell).
- Each chromosome is attached to spindle fibers by its centromere from opposite poles.
- This arrangement ensures equal distribution of chromosomes.

4. ANAPHASE



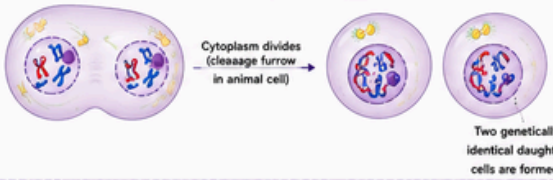
- Centromeres split.
- Sister chromatids separate and become daughter chromosomes.
- Daugher chromosomes move toward opposite poles due to spindle fiber shortening.

5. TELOPHASE



- Chromosomes reach the poles and start decondensing.
- Nuclear membrane and nucleolus reappear around each set of chromosomes.
- Spindle fibers disappear.
- Cytokinesis begins.

6. CYTOKINESIS (Division of Cytoplasm)



SIGNIFICANCE OF MITOSIS

- Growth of multicellular organisms (increase in cell number).
- Repair and replacement of damaged or worn out cells.
- Asexual reproduction in some organisms (e.g., Amoeba, Hydra).
- Maintains chromosome number and genetic stability.

DIFFERENCE BETWEEN MITOSIS AND MEIOSIS

Feature	Mitosis	Meiosis
Type of Cells	Somatic (body) cells	Germ (sex) cells
Number of Divisions	One	Two
Number of Daughter Cells	Two	Four
Chromosome Number in Daughter Cells	Same as parent cell (2n → 2n)	Half of parent cell (2n → n)
Genetic Nature	Genetically identical	Genetically different
Function	Growth, repair, replacement	Formation of gametes, variation

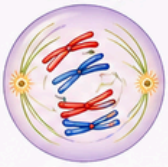
REMEMBER: Mitosis ensures that every new cell has the same number of chromosomes and the same genetic information as the parent cell.

MEIOSIS – REDUCTION DIVISION

Meiosis is a type of cell division in germ (sex) cells.
It involves two successive divisions (Meiosis I and Meiosis II) to produce four genetically different haploid daughter cells.

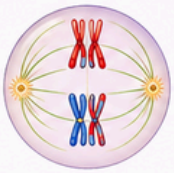
MEIOSIS I – REDUCTIONAL DIVISION

1. PROPHASE I
(Longest stage)



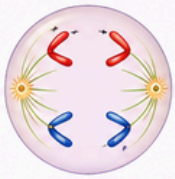
- Homologous chromosomes pair up (synapsis) forming bivalents (tetrads).
- Crossing over occurs at chiasmata.
- Nuclear membrane disappears.
- Spindle fibres begin to form.

2. METAPHASE I



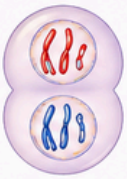
- Bivalents align at the equatorial plate.
- Sister kinetochores of homologous chromosomes are attached to spindle fibres from opposite poles.

3. ANAPHASE I



- Homologous chromosomes separate and move to opposite poles.
- Sister chromatids remain together.

4. TELOPHASE I



- Nuclear envelopes may re-form.
- Cytokinesis occurs.
- Two haploid daughter cells are formed.

RESULT OF MEIOSIS I
Two haploid cells (n)

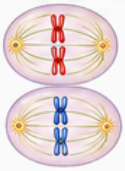
Chromosomes are still in duplicated form (each has two sister chromatids).

MEIOSIS II – EQUATIONAL DIVISION

1. PROPHASE II

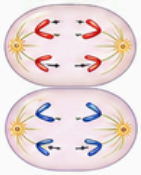
- Spindle fibres form.
- Nuclear membrane disappears (if present).

2. METAPHASE II



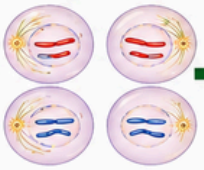
- Chromosomes align at the equatorial plate.

3. ANAPHASE II



- Centromeres split.
- Sister chromatids separate and move to opposite poles.

4. TELOPHASE II



- Nuclear envelopes re-form.
- Cytokinesis occurs.

RESULT OF MEIOSIS II
Four haploid cells (n)

Chromosome number is halved and cells are genetically different.

CROSSING OVER (In Prophase I)

- Exchange of segments between non-sister chromatids of homologous chromosomes.
- Occurs at chiasmata.
- Produces new gene combinations.

OVERVIEW OF MEIOSIS

Parent cell (2n) → Meiosis I (Reductional) → Two haploid cells (n) → Meiosis II (Equational) → Four haploid cells (n)

End result: Four genetically different haploid daughter cells

REMEMBER: Meiosis reduces chromosome number by half and creates genetic variation, which is essential for evolution and survival of species.

KEY FEATURES

- Occurs in germ cells (ovaries and testes).
- Two successive divisions (Meiosis I & II).
- Reduces chromosome number to half (2n → n).
- Produces four genetically different haploid cells.
- Includes crossing over and independent assortment.
- Important for sexual reproduction and variation.

IMPORTANCE / SIGNIFICANCE

- Maintains chromosome number of the species from generation to generation.
- Produces genetic variation among offspring.
- Important for sexual reproduction.
- Variation helps species adapt and evolve.

MEIOSIS I vs. MEIOSIS II

Feature	Meiosis I (Reductional)	Meiosis II (Equational)
Type of division	Reductional	Equational
Purpose	Reduces chromosome number (2n → n)	Separates sister chromatids
No. of cells produced	Two haploid cells	Four haploid cells
Chromosomes	Homologous chromosomes separate	Sister chromatids separate
DNA content	Reduced to half	Same as after Meiosis I
Genetic variation	Yes (crossing over & assortment)	No (only assortment of chromatids)