Chapter 5
The Fundamental Unit of Life

{which can exist individually and performs it's functions}

Discovery of Cells:-

Pioneer	Year	Discovery
Marcello Malphigi (Microscopist)	1661	Tiny structural unit in plants – Utricles
Robert Hooke (English Scientist)	1665	"Dead cell" → via cork of tree.
Leeuwenhoek	1674	"Free living cells" in pond water.
Robert Brown	1831	Nucleus
Purkinje	1839	Coined the term "Protoplasm".
Schleiden & Schwann (Botanist) (Zoologist)	1838, 1839	Cell Theory ① All plants & animals are made of cells
Rudolf Virchow	1855	All cells arise from pre-existing cells. (Omnis-cellula-e-cellula) ↳ Cell theory expanded

How does Compound microscope work?

- Place the specimen on a glass slide.
- Place slide under an objective piece.
- Light reflected from the mirror reaches object.
- Magnified image of specimen.
- Turn knobs to sharpen image.

Shape of cell depends upon the specific function it performs.

Eg: The cell of Amoeba, change its shape for motility.
- Nerve cells have a fixed shape that suits the transmission of nerve impulse.

→ Discovery of Microscope led to identification of unicellular & multicellular organisms.

Unicellular Organisms	Multicellular Organisms
→ A single cell constitute the whole organism.	→ Multiple cells are grouped together to form tissues.
→ Examples: Amoeba, Chlamydomonas, Paramecium Bacteria, etc.	→ Examples: Fungi, Plants, Animals

Parts of Cell

	Cell Membrane	Cytoplasm	Nucleus
Animal cells	⇒ semi-permeable	Viscous jelly-like substance in which all cell organelles are suspended.	Also known as "Manager of Cell" or "coordinating centre"
Plant cells	Non-permeable		

Good Write

→ How do living organisms perform the basic functions of their body?

⇒ By division of labour between different organs

- All functions in a unicellular organism are carried out by the single cell.

For eg: In Amoeba, a single cell is ~~is~~ performs:
- movement
- exchange of gases
- intake of food
- egestion

In multicellular organisms, there are different organs to perform a specific function.

→ Classification of living organisms

↳ Based on cellular structure

Prokaryotes	Eukaryotes
→ Entangled chromatin, not bound by a membrane	→ DNA bounded by a membrane
→ No chromosomes	→ Chromosomes are present
→ No vacuoles	→ Vacuoles are present
→ Eg: Bacteria, Archea	→ Eg- Euglena, Fungi, plants, animals, paramecium

Structure of Bacteria

- Cell wall - Freely permeable
- Plasma Membrane - Semi-permeable
- Cytoplasm - Seat for cell functions
- Nucleoid - Regulates cell functions

Good Write

Ribosome - Synthesis proteins
Flagella - Locomotory appendages

Cell Structure

1) Cell Wall - * It is a non living, rigid covering that separates the cell contents from the surroundings and gives shapes and protection to the plant cell.

* It is made of cellulose and only seen in plant cells.
* It is permeable.

2) Plasma Membrane - * It is a living membrane, made up of lipoproteins (proteins & lipids)

* It is selectively permeable, as it allows the movement of some substances in and out of the cell.

→ Movement of Substances across Plasma Membrane

* Spontaneous movement of a substance ~~in and~~ from a region of high concentration to a region of low concentration producing homogeneous solution or mixture is called "diffusion"

* The diffusion solvent molecules through a semi-permeable membrane is called osmosis. It is a special case of Diffusion.

Good Write

Cases of Osmosis

Condition: When the cell is placed in a NaCl solution

Case 1: If the medium surrounding the cell has a higher water concentration than the cell, then → the cell gains water by osmosis & swells
→ such a sol" known as Hypotonic solution

Case 2: If the medium has the same water concentration as the cell then, there is no net movement of water through the membrane.
→ The cell stays the same size.
→ such a solution is called an isotonic solution

Case 3: If the medium has a lower concentration than the cell, then it loses water by osmosis and then shrinks.
→ Such a sol" is called a hypertonic solution.

Plasmolysis: When the cell loses water by osmosis, the cell contents shrink away from the cell wall. This is known as plasmolysis.

3) Nucleus
→ It is known as the brain of the cell as it regulates all major activities of the cell.
→ It is surrounded by double layered covering called as nuclear membrane which has tiny pores known as 'nucleopores'.
→ The fluid within the nucleus is called nucleoplasm. It contains two types of nuclear structures — Nucleolus and Chromatin
→ A small spherical structure called nucleolus is also present within the nucleus which help in making RNA (RiBo Nucleic Acid) molecules. It is a site where ribosomes are formed.
→ In the nucleoplasm, thread-like coiled structures are present called chromatin network
→ During cell division, chromatin get highly coiled and condensed to form chromosomes, which are composed of DNA (deoxy-RiBo Nucleic Acid). It is a site where ribosomes are formed.
→ Functional segments of the chromosomes are called genes which are the carriers of hereditary information from one generation to the next.

Cytoplasm
It is fluid medium present within a cell between cell membrane and nucleus in which all the cell organelles remain suspended. It is the main medium in which all cellular reactions take place in the cell.

— What is Endocytosis?

* It is the process which enables the cell to engulf in food and other material from its external environment. It takes place as cell membrane is highly flexible.

* Example— Unicellular organism Amoeba acquires its food through this process.

Cell Organelles

1) Endoplasmic Reticulum
- Gives mechanical support to the cell.
- It is an intracellular transport system for various substances.
- Protein & lipid synthesis.
- Synthesis plasma membrane (membrane biogenesis)

SER	RER
① Ribosomes not attached to their surface.	① Ribosomes attached to their surface.
② Appear smooth under microscope.	② Appear rough under microscope.
③ Involved in fat, lipid synthesis.	③ Involved in protein synthesis & secretion.
④ Involved in lipid like steroidal hormone synthesis.	④ Involved in formation of many protein enzymes.

2) Golgi Apparatus
- Described by — Camillo Golgi (1898)
- Membranous flattened sacs (cisterns)
- Involved in modification, packaging, storage, segretion and transports of substances.
* - Give rise to lysosomes.
- formation of complex sugars from simple sugar.

3) Lysosome
- Single membrane bound
- formed by Golgi Apparatus
- Rich in digestive enzymes → (formed by RER)
- Clean cell by digesting any foreign material (bacteria/virus), food, old damaged cell organelles
- known as suicidal bags of cell

Digest their own cell in case of cellular disturbance (Lysosome burst).

4) Vacuole
- Single membrane bound.
- Storage sac for liquid or solid content.
- ~~Size~~ Small sized in animal cells and large sized in plant cells.
- Contain water, amino acid, proteins, sugars and waste product.
- Maintain turgidity of cell.

⇒ Vacuole in Plant Cell:
- Can occupy upto 30 - 90% cell volume.
- Full of cell sap (liquid) and provide turgidity to cell.

- In unicellular organisms, food vacuoles are formed by engulfing the food particles.

4) Mitochondria
- Double - membraned structure, inner membrane (cristae) deeply folded → to increase surface area → more energy produced.
- Also called powerhouse of the cell.
- Release energy in the form of ATP (Adenosine Triphosphate)

Adenosine – Ⓟ – Ⓟ – Ⓟ

- It is called self-autonomous cell organelle as it contains its own DNA (for self-replication) and Ribosomes (for protein synthesis).

6) PLASTIDS • Only present in plant cell.

Chloroplast	Chromoplast	Leucoplast
• Green Plastid	• Coloured plastid (other than green)	• Colourless plastids
• Pigment – Chlorophyll	• Pigments – carotene, xanthophyll (orange) (yellow)	• Pigments absent
• Imparts green colour to plants	• Imparts yellow, orange or red colour to the plants.	• Storage of nutrients (starch, oils & proteins)
• Involved in photosynthesis		

Cell → Chloroplast → Chlorophyll (Green Pigment)

⇒ Chloroplast
- Double membraned structure
- Pile of thylakoid forms granum.
- Thylakoid membrane possesses chlorophyll pigment.
- Imparts green colour to plants
- Perform photosynthesis
- Contain own DNA and Ribosomes.

7) Ribosomes
- Membrane less cell organelles.
- Involved in synthesis of proteins (called protein factories)
- Present in both prokaryotic and eukaryotic cell.
  - Cytoplasm
  - Attached to surface of RER.
  - Cell Organelles (i) Mitochondria (ii) Plastids

Ribosomes
- Prokaryotes ⇒ 70 Svedburg or 70S (Complete Ribosome) → 30S & 50S (subunits)
- Eukaryotes ⇒ 80S (Complete Ribosome) → 40S + 60S (subunits)

* Ribosomes receives the "message" for protein synthesis from the nucleus via messenger RNA (mRNA), which is transcribed from DNA.

Good Write

➢ The DNA's genetic code is first copied into an mRNA molecule, a process known as transcription, and this mRNA then exits the nucleus to travel to a ribosome in the cytoplasm.

➢ The ribosome reads the sequence of mRNA and uses the information to assemble amino acids into a specific protein.

Receives msg from → DNA (~~single~~ double stranded)
→ RNA (single stranded)
- mRNA (m) – messenger
- t RNA (t) – transfer
- rRNA (r) – ribosomal

CELL ORGANELLES

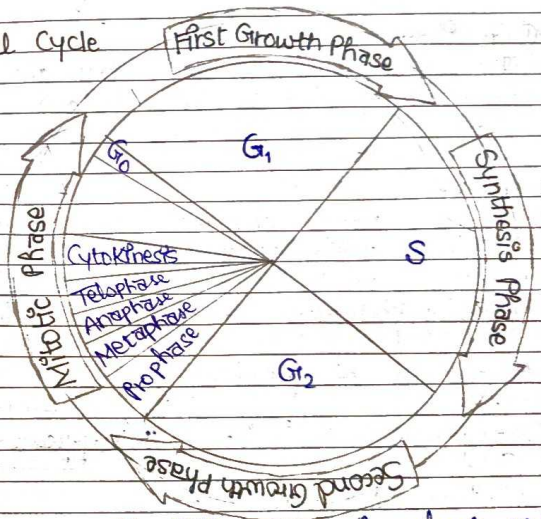
Single membrane bound	Double membrane bound	Membrane less
Vacuole	Nucleus	Ribosome
Lysosome	Mitochondria	Centrosome (Centriole)
Golgi Apparatus	Plastids	
Endoplasmic Reticulum	↳ Chloroplasts	

Plant Cell	Animal Cell
1) Cell wall present	1) Cell wall absent
2) Plastids present	2) Plastids absent
3) Vacuole single and large	3) Vacuole many and small.

4) Nucleus present near periphery and not in centre.	4) Nucleus present in centre.
5) Mitochondria less in number.	5) Mitochondria more in number
6) Golgi bodies are many and scattered called as Dictysomes	6) Golgi body single and near the nucleus.
7) Centriole absent	7) Centriole present with centrosomes.

Cell Division

➢ Cell Cycle



* Human cell divides once in about 24 hours.
* Yeast cell divided once in about 90 minutes

Good Write

Mitosis or Karyo Kinesis

- It is an "equational division"
- Two daughter cells are formed
- Daughter cells have same number of chromosomes as the parent cell.
- It helps in growth and repair of injured tissues

S Phase

→ chromatin (Dispersed chromosomes)
→ Centrosomes (with centriole pairs)

G_2 Phase

The cell continues to grow but the DNA molecules formed are intertwined and not distinct.

① Prophase

- Compact mitotic chromosomes are formed. (DNA untangling & condensation)
- Centrioles moving to opposite poles, initiating formation of mitotic spindles.

At the end of prophase,
Nucleolus
Endoplasmic Reticulum
Golgi complex
Nuclear envelope
} Are not visible under a microscope

② Metaphase

- Spindle fibres attach to the kinetochores of the chromosomes.
- Chromosomes move to the spindle equator & align along the metaphase plate.

③ Anaphase

- Centrosomes splits and chromatids separate
- Chromatids moves towards opposite poles

④ Telophase

- Chromosomes cluster at opposite spindle poles
- Chromosomes lose individuality as discrete elements.
- Nuclear envelope is formed.
- Nucleus, golgi complex and ER reappear.

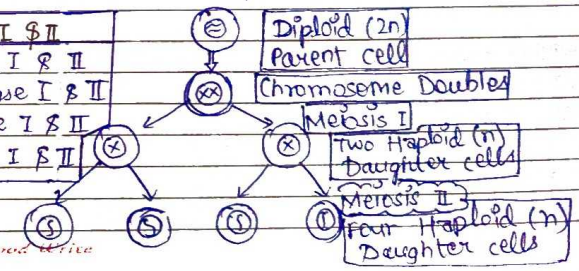
Cytokinesis (M Phase)

The physical process where the cell's cytoplasm divides to form two distinct daughter cells

Meiosis

- It is a reductional division
- Four daughter cells are formed.
- Daughter cells have half the number of chromosomes as the parent cell.
- It is responsible for the production of gametes

Meiosis I & II
Prophase I & II
Metaphase I & II
Anaphase I & II
Telophase I & II



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Significance of Meiosis

⇒ Restores the chromosome no. in the offspring of sexually reproducing organisms.

⇒ Leads to variation in offspring due to the crossing over in prophase I.