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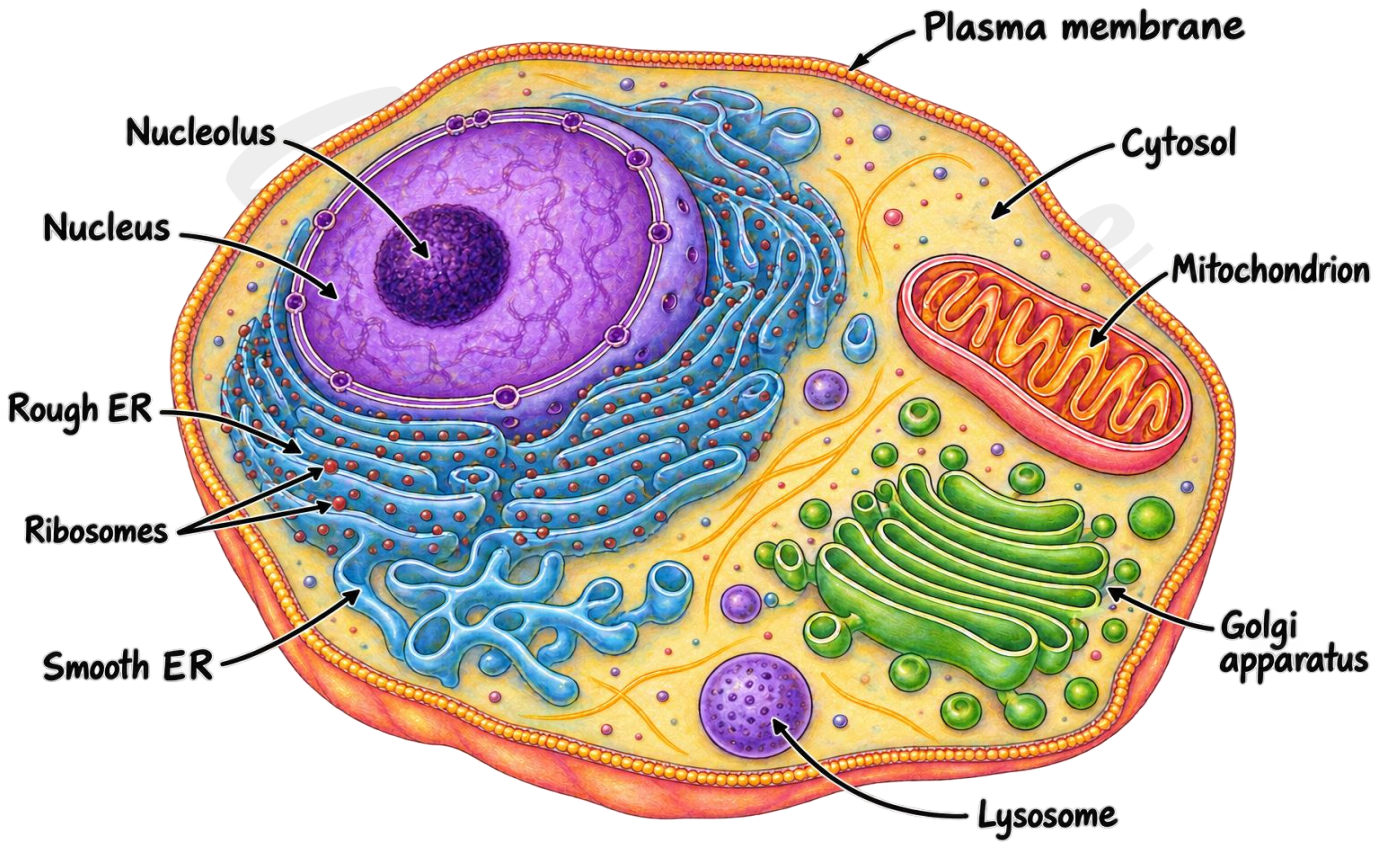
Physiology - Topic 1 - General Physiology

Structure and Functions of a Cell

Physiology as the Study of Function

- **Physiology** explains how living structures work and how their activities are coordinated.
    - It connects molecular events with the functions of cells, tissues, organs and the whole person.
- The **internal environment** is the extracellular fluid that surrounds the cells.
    - Cells depend on this fluid for oxygen and nutrients and release waste products into it.
- A physiological value must be interpreted in its setting.
    - Age, sex, posture, meals, exercise, temperature and the method of measurement may change the expected result.

Functional Organisation of a Cell



The major organelles work together to maintain cell structure, metabolism and communication

1. Plasma Membrane

Lipid Bilayer and Membrane Proteins

- The **plasma membrane** separates the cell from its surroundings and controls the movement of substances across it.
- Its phospholipid bilayer has water-loving heads facing the fluids and water-repelling tails facing one another.

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- Small lipid-soluble molecules can cross the lipid layer relatively easily.
- Ions and most large polar molecules require membrane proteins or vesicles.
- Membrane proteins act as channels, carriers, pumps, receptors, enzymes and attachment points.
- Cholesterol modifies membrane fluidity and stability.
- Integral proteins are embedded in the lipid bilayer, whereas peripheral proteins attach to its inner or outer surface.
- The **fluid mosaic model** describes a mobile lipid layer containing a changing arrangement of proteins.

Surface Carbohydrates and Cell Recognition

- Carbohydrates attached to proteins and lipids form the outer **glycocalyx**.
- This layer contributes to cell recognition, adhesion and protection.

2. Nucleus and Ribosomes

A. Nucleus

- The **nucleus** contains most of the cell's genetic information.
- Transcription produces RNA, which helps control protein synthesis and cell activity.

B. Nucleolus and Ribosomes

- The nucleolus forms ribosomal RNA and assembles ribosomal subunits.
- Ribosomes translate messenger RNA into proteins.
- Free ribosomes mainly produce proteins used in the cytosol.
- Ribosomes attached to rough endoplasmic reticulum produce many proteins for secretion, membranes and lysosomes.

3. Endoplasmic Reticulum and Golgi Apparatus

A. Rough Endoplasmic Reticulum

- The **rough endoplasmic reticulum** folds and begins processing newly formed proteins.
- Incorrectly folded proteins are retained or removed through quality-control pathways.

B. Smooth Endoplasmic Reticulum

- The **smooth endoplasmic reticulum** participates in lipid synthesis, detoxification and calcium storage.
- Its specialised form in muscle is the sarcoplasmic reticulum.

C. Golgi Apparatus

- The **Golgi apparatus** modifies, sorts and packages proteins and lipids.

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- Secretory vesicles then carry their contents towards the cell membrane.

4. Mitochondria, Lysosomes and Peroxisomes

A. Mitochondria

- **Mitochondria** generate most cellular ATP during aerobic metabolism.
- Their inner membrane contains the electron transport chain and ATP synthase.
- Mitochondria also help regulate **calcium** and programmed cell death.
- Mature red blood cells have no mitochondria and depend on glycolysis for ATP.

B. Lysosomes

- **Lysosomes** contain enzymes that digest material delivered by endocytosis or autophagy.
- Autophagy helps recycle damaged cellular components.

C. Peroxisomes

- **Peroxisomes** take part in selected oxidation reactions and the breakdown of very-long-chain fatty acids.
- Catalase helps remove the hydrogen peroxide produced in these reactions.

5. Cytoskeleton and Cell Junctions

Cytoskeletal Components

- Microfilaments, intermediate filaments and microtubules support cell shape and movement.
- They also help move vesicles and organise cell division.
- Actin microfilaments support the cell cortex and contraction, while intermediate filaments provide tensile strength.
- Microtubules form intracellular tracks, the mitotic spindle and the core of cilia and flagella.

Junctions Between Cells

- Tight junctions restrict movement between adjacent cells and help maintain epithelial polarity.
- Their permeability differs between tissues.
- Anchoring junctions resist mechanical stress.
- Gap junctions form channels through which ions and small molecules can pass directly between cells.
- Adherens junctions connect actin filaments between cells, while desmosomes connect intermediate filaments.
- Hemidesmosomes attach an epithelial cell to the underlying basement membrane.

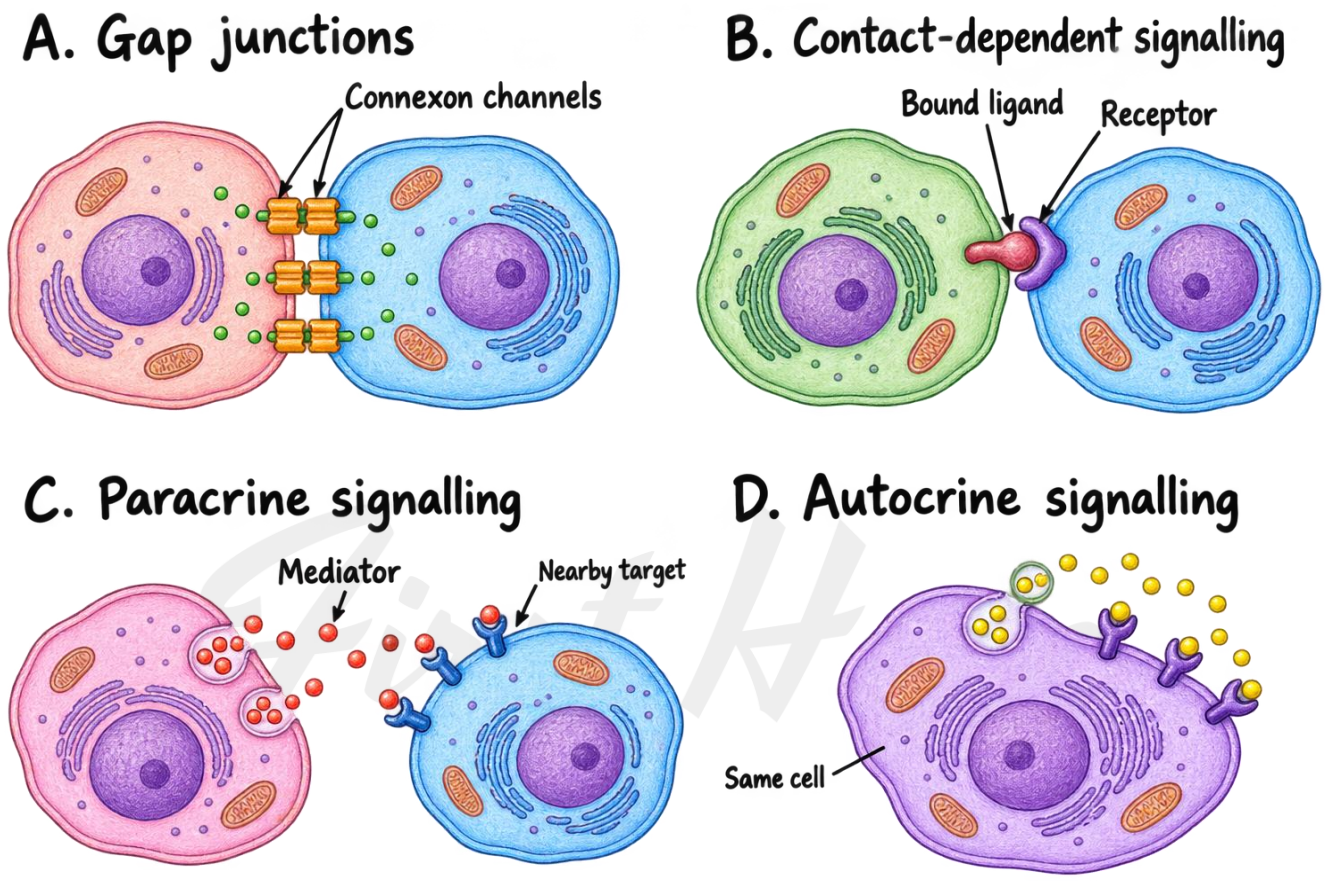
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- Gap-junction channels are formed by paired connexons and pass ions and small signalling molecules between neighbouring cells.

Intercellular Communication

Modes of Cell Signalling

1. Direct and Local Communication



Direct and local signalling includes gap junctions, contact-dependent signals, paracrine signals and autocrine signals

A. Gap-Junction Communication

- **Gap junctions** allow electrical and chemical communication between neighbouring cells.
- They help coordinate activity in cardiac muscle and some smooth muscles.

B. Contact-Dependent Signalling

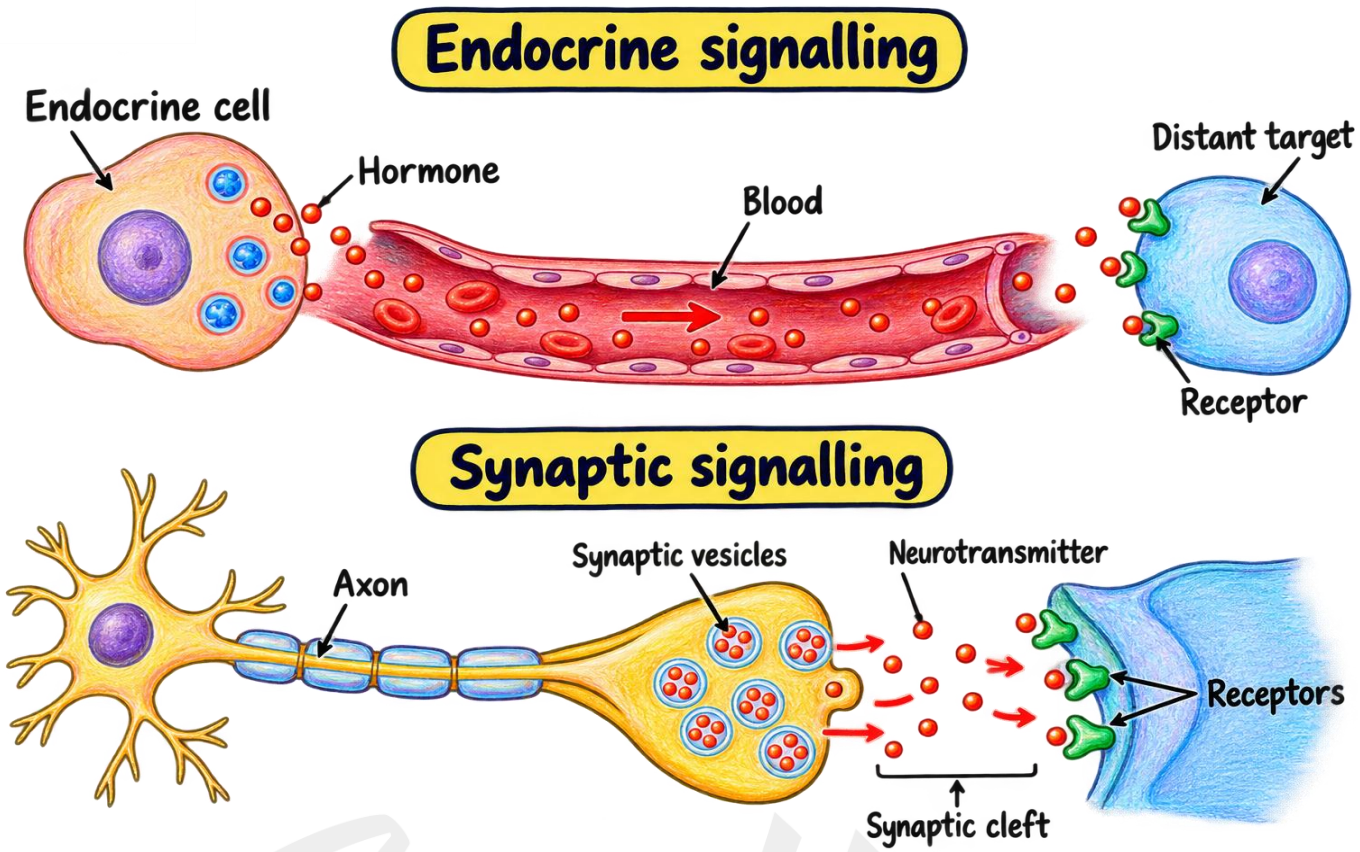
- In **contact-dependent signalling**, a surface molecule on one cell binds to a receptor on another cell.
- Immune-cell interactions provide important examples.

C. Paracrine and Autocrine Signalling

- In **paracrine signalling**, a mediator acts on nearby cells.
- In **autocrine signalling**, it acts on the same cell that released it.

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2. Long-Distance Communication



Endocrine signals travel through blood, while a synapse releases neurotransmitter across a narrow cleft to a target cell

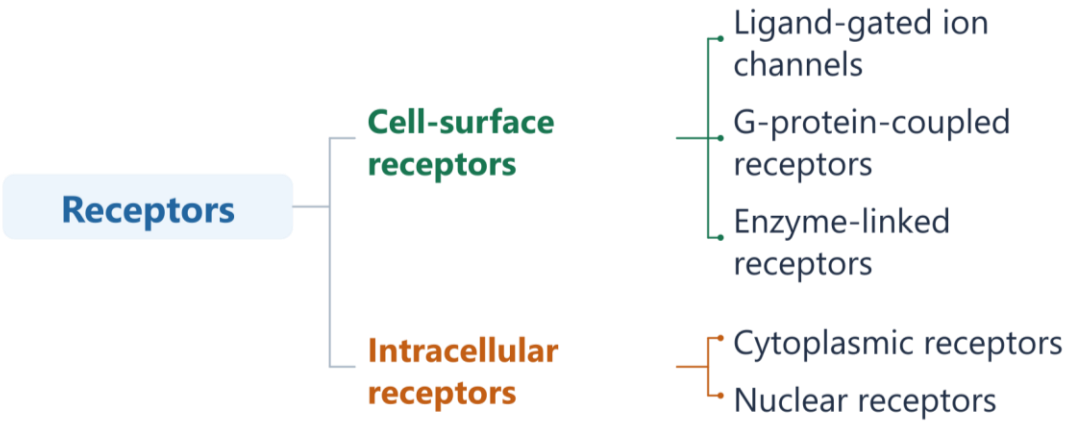
A. Endocrine Signalling

- In **endocrine signalling**, a hormone enters the circulation and acts on cells that have the appropriate receptor.
- The hormone's concentration alone does not determine the response; receptor availability also matters.

B. Synaptic Signalling

- In **synaptic signalling**, a neuron releases a neurotransmitter across a narrow synaptic cleft.
- This arrangement provides precise communication with a selected target.

Receptors and Intracellular Responses



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