B.PHARMA SEM- 1

UNIT-1

PART-3

HUMAN ANATOMY & PHYSIOLOGY

CELLULAR LEVEL OF ORGANIZATION

CELL ORGANELLES
PLASMA MEMBRANE
CELL WALL,NUCLEUS
MITOCHONDRIA
RIBOSOMES,GOLGI APPARATUS

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CELLULAR LEVEL OF ORGANIZATION PART – 3

Plasma Membrane

- Allows only certain molecules in or out of a cell.
- Separates internal metabolic reactions from external environment.
- Allows cell to excrete wastes and interact with its environment.

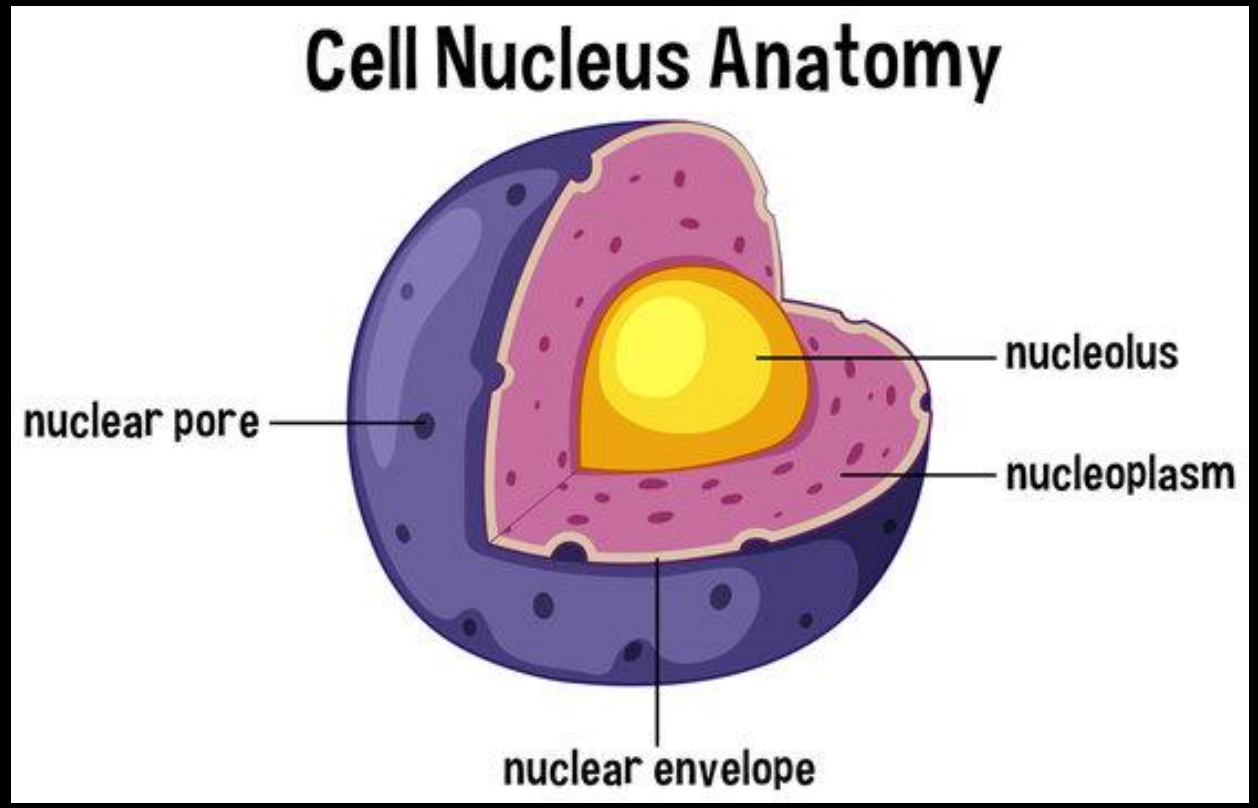
❖It is made primarily of phospholipids : **Phospholipid B-Layer**

Cell wall

- It is a rigid and stiff structure surrounding the cell membrane.
- It provides shape and support to the cells and protects them from mechanical shocks and injuries.

Nucleus

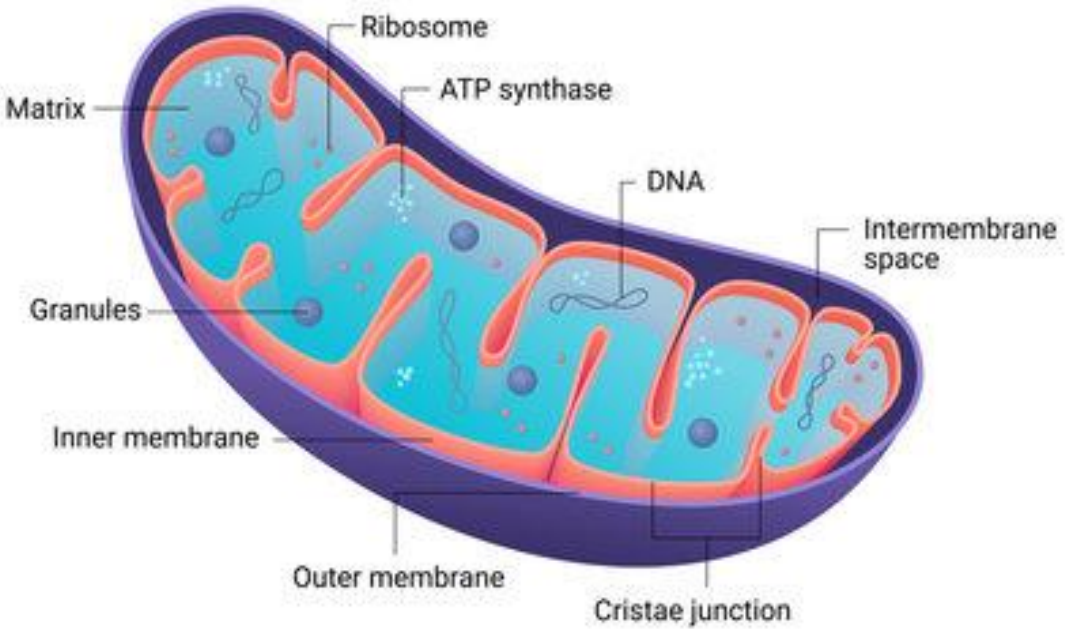
- The nucleus contains the hereditary material of the cell, the DNA.
- It sends signals to the cells to grow, mature, divide and die.
- The nucleus is surrounded by the nuclear envelope that separates the DNA from the rest of the cell.
- The nucleus protects the DNA and is an integral component of a plant's cell structure.


Cell Nucleus Anatomy
nucleolus
nuclear pore
nucleoplasm
nuclear envelope

Mitochondria

- The mitochondrial genome is inherited maternally in several organisms.
- It is a **double membrane-bound, sausage-shaped** organelle, found in almost all **eukaryotic cells.**
- Its size ranges from 0.5 to 1.0 micrometre in diameter.
- The membrane are made of proteins and phospholipid layers separated by the intermembrane space.
- The outer membrane covers the surface of the mitochondrion and has a large number of special proteins known as porins.

MITOCHONDRIA



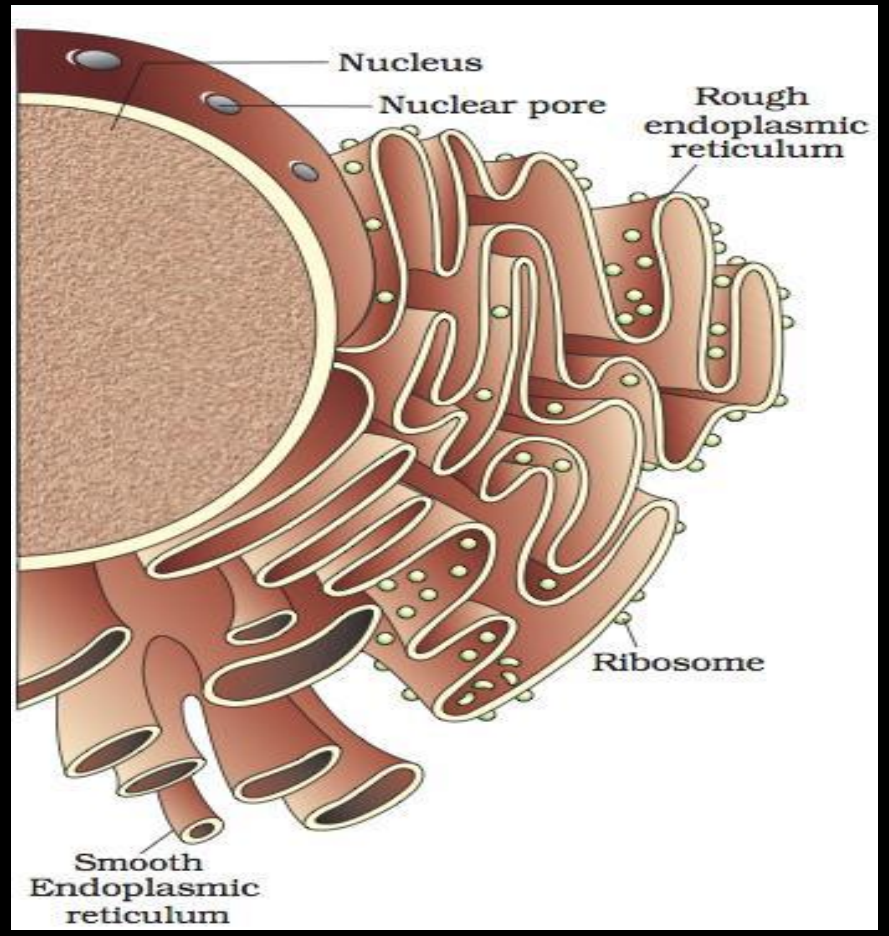
Ribosomes

- Small roughly spherical organelles that are responsible for building **protein**.

- Ribosomes do not have a membrane, they are made of protein and RNA molecules.
- They are named as the 70s **(found in prokaryotes)** or 80s **(found in eukaryotes).**

Rough Endoplasmic Reticulum	Smooth Endoplasmic Reticulum
It possesses ribosomes attached to its membrane.	It does not have ribosomes on its membrane.
Formed of cisternae and a few tubules.	Formed of vesicles and tubules.
It participates in the synthesis of enzymes and proteins.	Synthesises glycogen, lipids and steroids.
It helps in the formation of lysosomes.	Gives rise to Spherosomes/ Oleosomes

It is internal and connected with the nuclear envelope.	It is peripheral and may be connected to plasmalemma.
Ribophorins are present and help ribosomes attach to ER	Devoid of Ribophorins.
It might develop from the nuclear envelope	Develops from Rough Endoplasmic Reticulum.
Provides proteins and lipids for Golgi apparatus.	Provides vesicles for cis-face of Golgi apparatus.

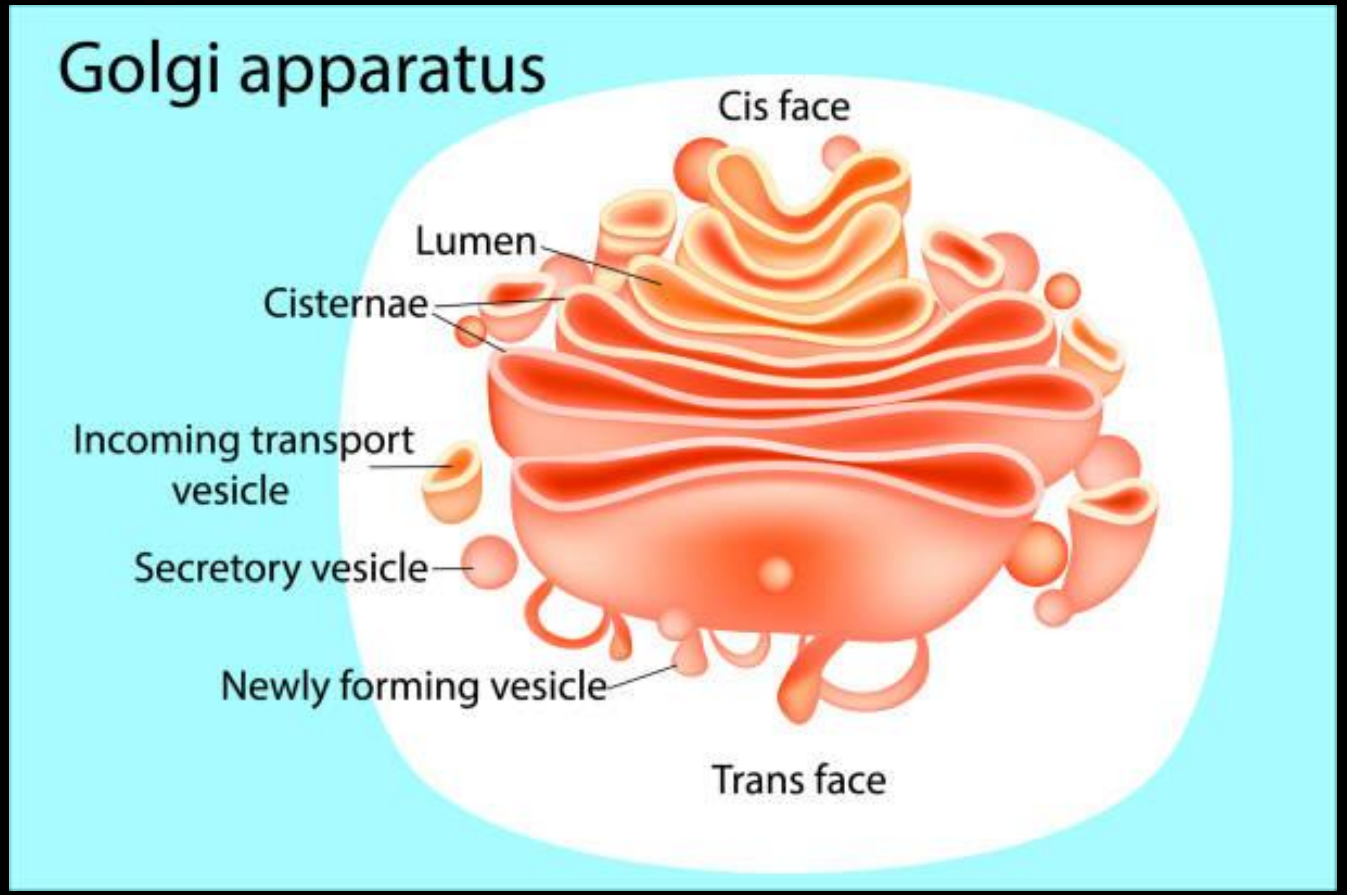


Endoplasmic Reticulum

Golgi Apparatus

- It is a **membrane-bound organelle**, which is mainly composed of a series of flattened, stacked pouches called **cisternae.**

- This cell organelle is primarily responsible for **transporting, modifying,** and **packaging proteins** and lipids to targeted destinations.


Golgi apparatus
Cis face
Lumen
Cisternae
Incoming transport vesicle
Secretory vesicle
Newly forming vesicle
Trans face

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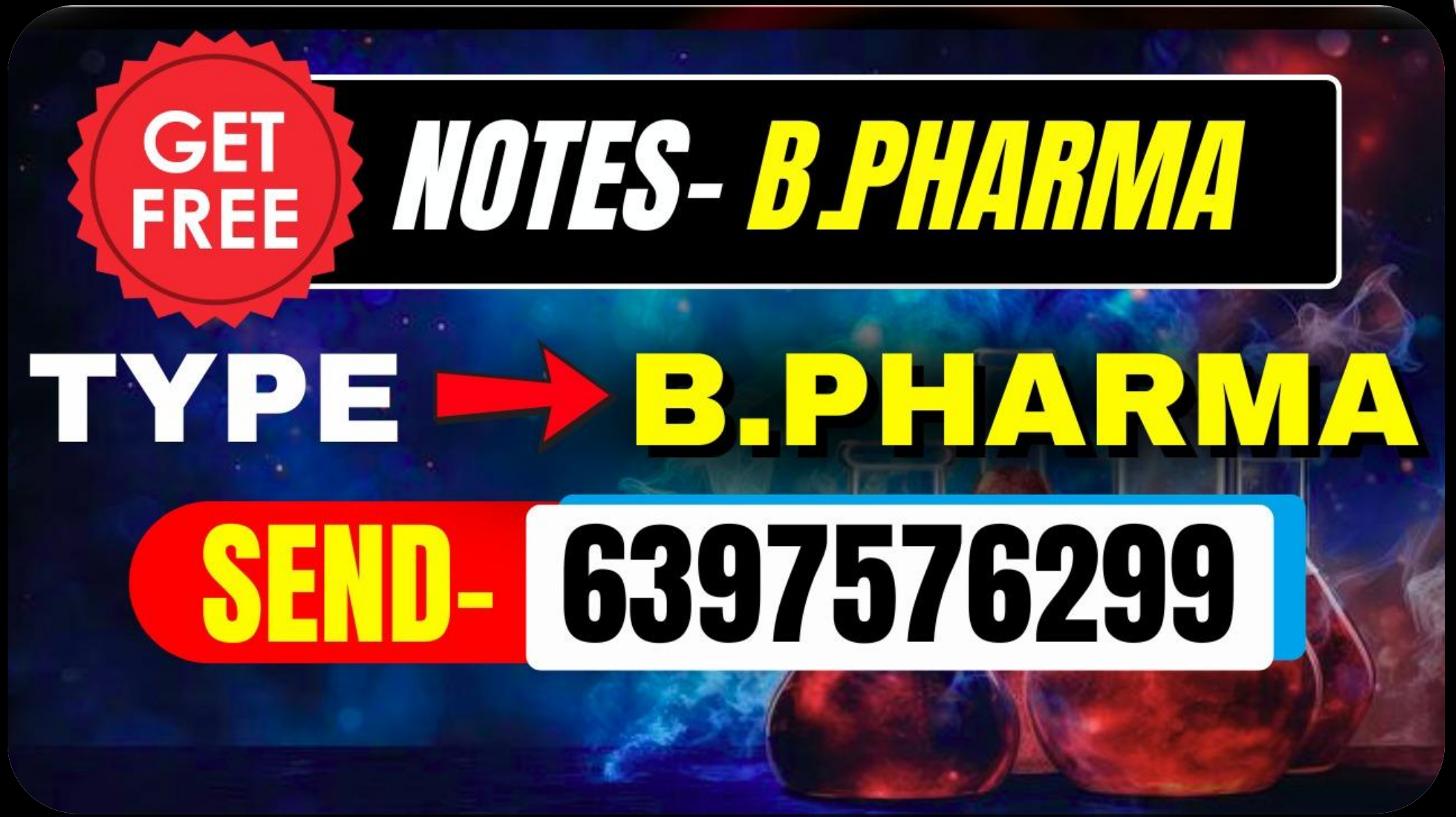
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PART- 4

HUMAN ANATOMY & PHYSIOLOGY

TRANSPORT ACROSS CELL MEMBRANE

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CELLULAR LEVEL OF ORGANIZATION PART – 3

Cytoskeleton

- It is a continuous network of filamentous **proteinaceous** structures that run throughout the cytoplasm, from the nucleus to the plasma membrane.
- The primary functions include providing the shape and mechanical resistance to the cell against deformation.
- The contractile nature of the filaments helps in motility during cytokinesis.

Vacuole

- In addition to this, it also stores and eliminate waste products.
- Compared to the animals, plant cells have **larger vacuoles.**
- Vacuoles are mostly defined as **storage bubbles** of irregular shapes which are found in cells.

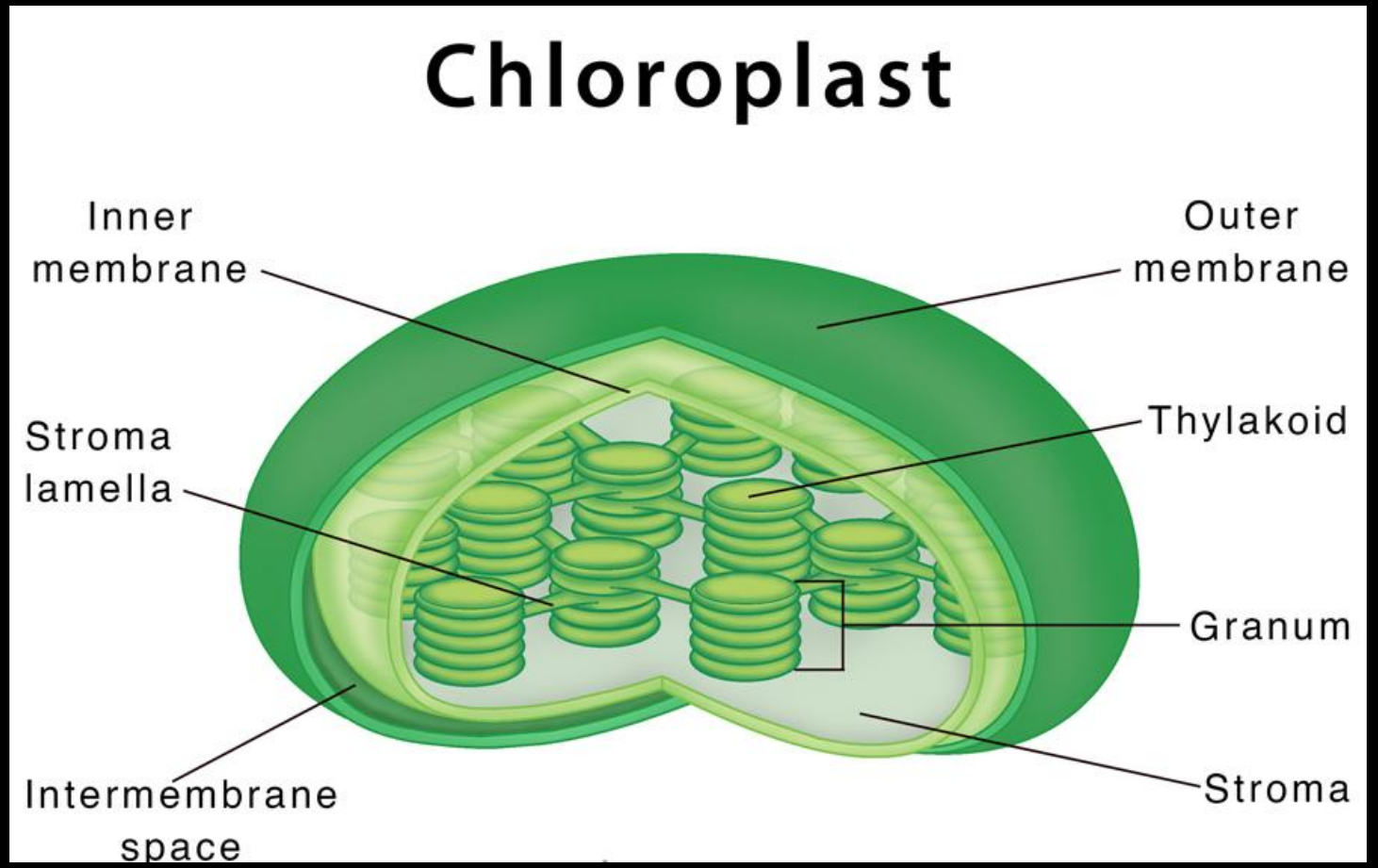
Character	Cilia	Flagella
Definition	Cilia are short, hair like cell organelle extending from the surface of a living cell.	Flagella are long, threadlike cell organelle present on the surface of a living cell.
Found in	It is found in Eukaryotic cell.	It is found in Prokaryotic cell as well as in eukaryotic cells.

Plastids

➢Chloroplasts:

- These are double membrane-bound organelles, which usually vary in their shape – from a disc shape to spherical, discoid, oval and ribbon.

- They are present in **mesophyll** cells of leaves.


Chloroplast
Inner membrane
Outer membrane
Stroma lamella
Thylakoid
Granum
Intermembrane space
Stroma

➢**Chromoplasts –** The chromoplasts include fat-soluble, carotenoid pigments like **xanthophylls, carotene**, etc.

- They provide the plants with their characteristic color – **yellow, orange, red, etc.**

- **Leucoplasts –** Leucoplasts are **colorless plastids** which store nutrients.

Amyloplast	Aleuroplast	Elaioplast
Stores carbohydrates (like starch in potatoes)	Stores proteins	Stores oils and fats

Lysosomes

- Contains enzymes that break down **proteins, nucleic acids, carbohydrates, and lipids.**
- Lysosomes work as the **waste discarding structures** of the cell by processing undesirable materials and degrading them.
- But sometimes, the digestive enzymes may end up damaging the lysosomes themselves, and this can cause the cell to die.

Transport across cell membrane

1. Passive Transport (no energy/ATP required)

- **Simple Diffusion**
  Direct movement of small, non-polar molecules (O_2, CO_2, lipid-soluble substances) across the phospholipid bilayer.

- **Facilitated Diffusion**
  Transport of larger or polar molecules (like glucose, amino acids, ions) through **carrier proteins** or **channel proteins**.
  Example: Glucose entry into RBC via GLUT transporters.

❑Osmosis

Diffusion of **water molecules** across a selectively permeable membrane through **aquaporins** from low solute concentration → high solute concentration.

2. Active Transport (requires energy/ATP)

❑Primary Active Transport

Direct use of ATP.

Example: **Na^+/K^+ pump** (pumps 3 Na^+ out and 2 K^+ in using ATP).

❑Secondary Active Transport

Uses energy stored in ion gradients created by primary active transport.

- **Symport**: Two molecules move in the same direction (e.g., Na^+-glucose symporter).
- **Antiport**: Molecules move in opposite directions (e.g., Na^+/Ca^{2+} exchanger).

3. Vesicular Transport)

- **Endocytosis** (into the cell)
  - *Phagocytosis*: "Cell eating" – engulfing solids (e.g., WBC engulfing bacteria).
  - *Pinocytosis*: "Cell drinking" – engulfing fluids.
  - *Receptor-mediated endocytosis*: Selective uptake using receptors (e.g., LDL uptake).
- **Exocytosis** (out of the cell)
  Vesicles fuse with plasma membrane and release contents (e.g., secretion of hormones, neurotransmitters).

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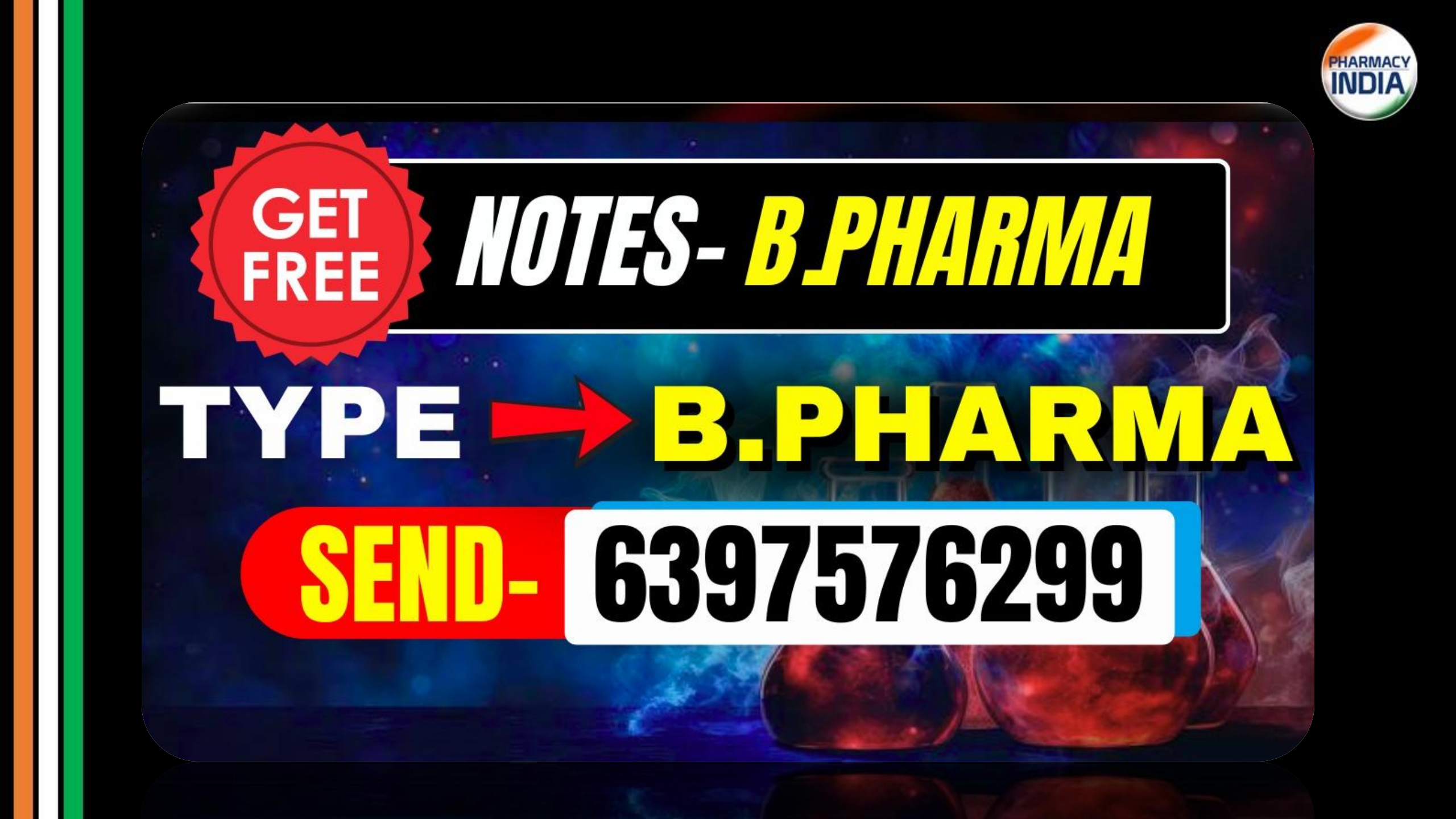
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PART- 5

HUMAN ANATOMY & PHYSIOLOGY

CELL & DIVISION

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CELLULAR LEVEL OF ORGANIZATION PART – 5

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Cell Division

❑Mitosis (Equational Division)

1. Interphase (not part of mitosis, but preparation)

G1 phase – Cell grows, organelles double.

S phase – DNA replication, chromosome duplication.

G2 phase – Cell prepares for division, proteins & enzymes made.

2. Mitotic Phase (M phase)

(i) Prophase

- Chromosomes condense and become visible.
- Nuclear envelope begins to break down.
- Centrioles move to opposite poles.
- Spindle fibers start forming.

(ii) Metaphase

- Chromosomes align at the **equatorial plate (metaphase plate)**.
- Spindle fibers attach to the centromeres (kinetochores).

(iii) Anaphase

- Centromeres split.
- Sister chromatids are pulled apart to opposite poles.

(iv) Telophase

- Chromatids (now chromosomes) reach poles.
- Nuclear membrane reforms.
- Chromosomes de-condense into chromatin.

(v) Cytokinesis

- Division of cytoplasm.
- In **animal cells** → cleavage furrow forms.
- In **plant cells** → cell plate forms.

❑**Result: 2 diploid identical daughter cells.**

Meiosis (Reduction Division)

- **Meiosis I (Reduction Division)**

1. Prophase I (very long, special)

- **Leptotene** – Chromosomes condense, become visible.
- **Zygotene** – Homologous chromosomes pair (synapsis).
- **Pachytene** – Crossing over occurs between non-sister chromatids.
- **Diplotene** – Homologous chromosomes start separating, but remain attached at **chiasmata**.
- **Diakinesis** – Chromosomes fully condensed, nuclear envelope breaks down.

2. Metaphase I

- Homologous pairs (bivalents) align at the equator.

3. Anaphase I

- Homologous chromosomes separate and move to opposite poles (sister chromatids stay together).

4. Telophase I

- Nuclear envelope reforms.
- Cytokinesis occurs → two haploid cells formed.

❑Meiosis II (Equational Division)

1. Prophase II

- Chromosomes condense again.
- New spindle forms.

2. Metaphase II

- Chromosomes align at the equator.

3. Anaphase II

- Centromeres split, sister chromatids separate to opposite poles.

4. Telophase II

- Nuclear membrane reforms, chromosomes de-condense.
- Cytokinesis occurs.

❑**Result: 4 haploid gametes (genetically different due to crossing over + independent assortment).**

Cell Junctions

Junction	Structure/Protein	Function	Example
Tight Junction (Zonula occludens)	Claudins, Occludins	Prevents leakage of molecules between cells (forms a seal)	Intestinal epithelium, Blood-brain barrier
Adherens Junction (Zonula adherens)	Cadherins, linked to actin filaments	Provides mechanical attachment between cells; maintains tissue shape	Epithelial tissues (just below tight junctions)
Desmosomes (Macula adherens)	Desmogleins, Desmocollins (cadherins), linked to intermediate filaments (keratin)	Provides strong adhesion; resists mechanical stress	Skin (epidermis), Cardiac muscle

Hemidesmosomes	Integrins, linked to basal lamina	Anchors epithelial cells to basement membrane (cell → ECM)	Basal surface of epithelial cells (skin, cornea)
Gap Junctions	Connexons (formed by connexins proteins)	Direct communication between cells; passage of ions & small molecules	Cardiac muscle (synchronization), Smooth muscle, Neurons

Cell Communication

Types of Cell Signaling (based on distance):

- **Autocrine signaling** – Cell signals itself (e.g., immune cells releasing interleukins).
- **Paracrine signaling** – Local signaling to nearby cells (e.g., neurotransmitters).
- **Endocrine signaling** – Hormones travel through blood to distant cells (e.g., insulin, thyroid hormones).
- **Juxtacrine signaling** – Direct physical contact between cells via membrane-bound molecules (e.g., immune cell interactions).
- **Synaptic signaling** – Specialized form of paracrine in neurons across synapses.

Stages of Cell Communication

❑**Reception** – Signal molecule (ligand) binds to receptor (membrane-bound or intracellular).

- Receptors:
  - ❖**G-protein coupled receptors (GPCRs)**
  - ❖**Receptor tyrosine kinases (RTKs)**
  - ❖**Ion channel receptors**
  - ❖**Intracellular receptors** (for steroid hormones).

- **Transduction** – Signal is relayed inside the cell through **secondary messengers** (cAMP, Ca^{2+}, IP_3, DAG).
- **Response** – Cellular change (gene expression, enzyme activation, secretion, apoptosis, etc.).
- **Termination** – Signal is stopped once response is achieved.

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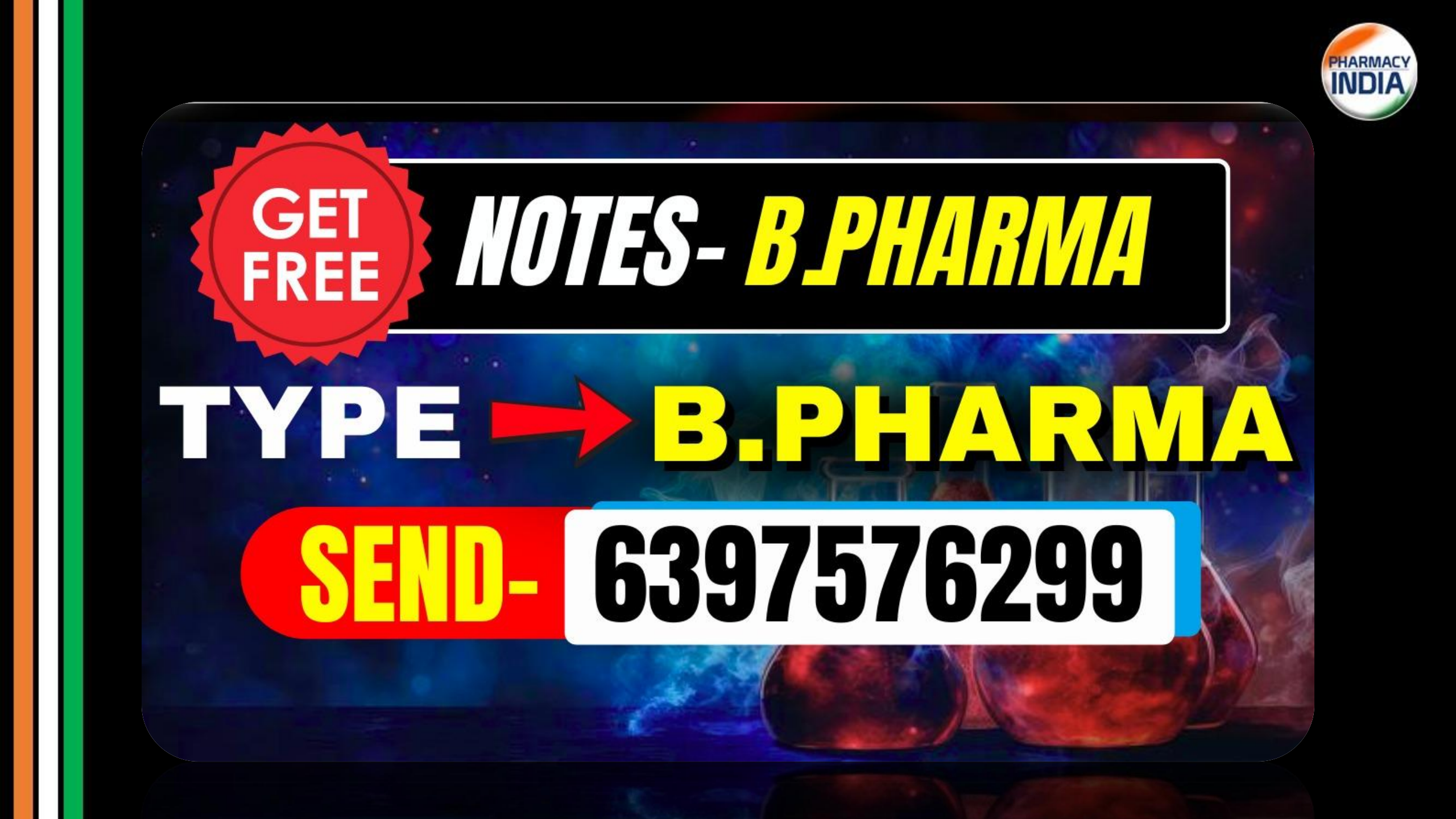
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HUMAN ANATOMY & PHYSIOLOGY

EPITHELIAL TISSUE
MUSCULAR TISSUE

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Human Anatomy and physiology

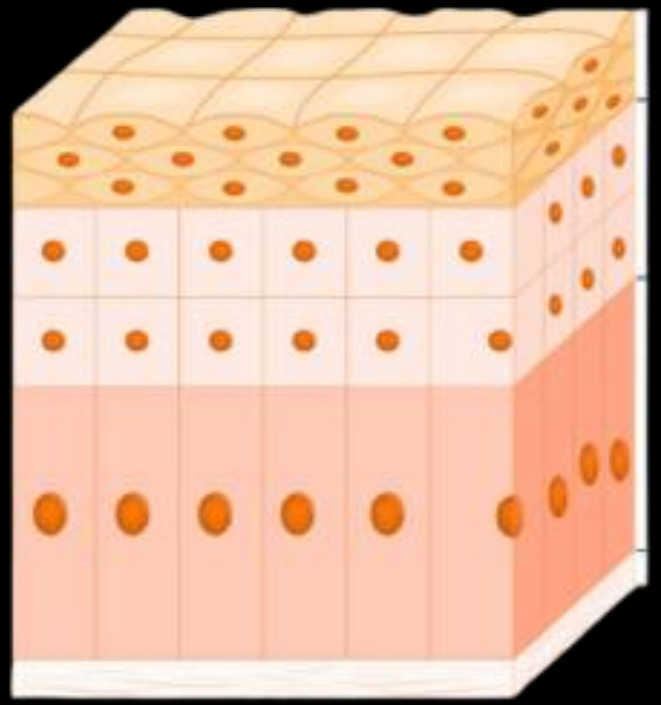
Tissue level of Organization Part – 1

Tissue

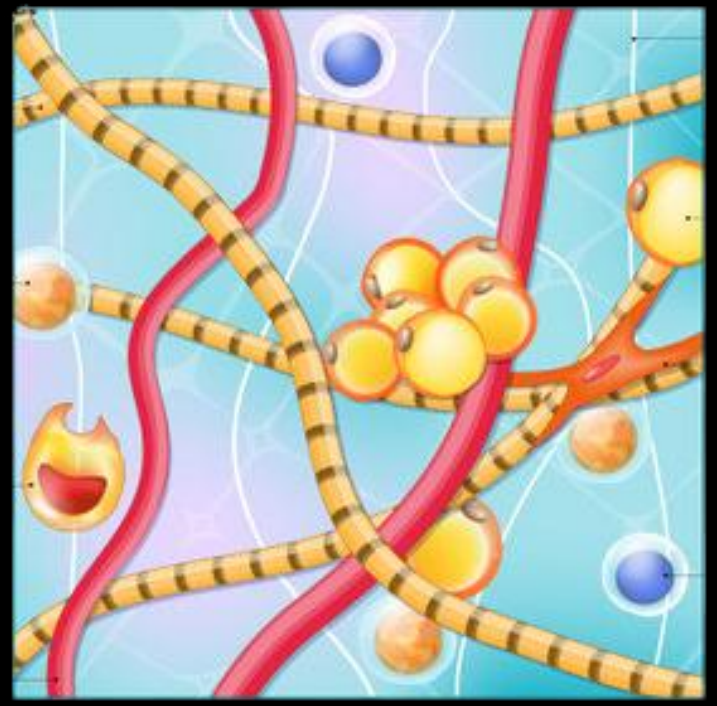
- In animals, a **tissue** is a group of cells that are **similar in structure** and **work together** to perform a particular function.
- Unlike a single cell, a tissue is an **organized unit** where many cells coordinate to carry out complex activities.
- Animal tissues form the **basic framework** of the body and are responsible for growth, repair, and proper functioning of organs.
- They provide **support, protection, movement, communication, and transport** within the animal body.

Classification of Tissue

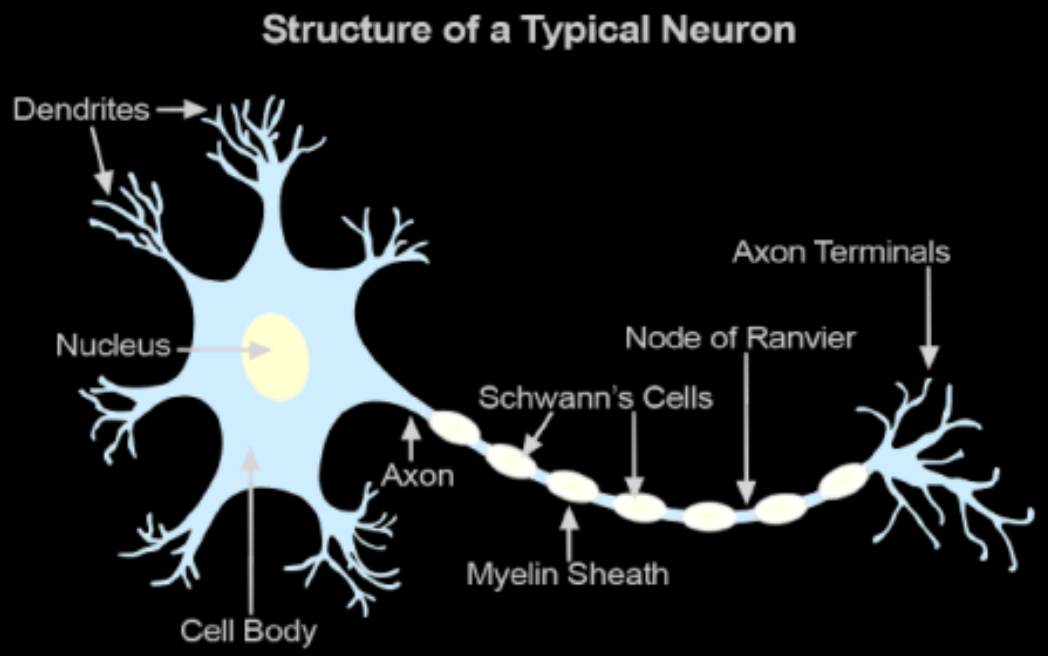
- Epithelial tissue
- Muscular tissue
- Nervous tissue
- Connective tissue



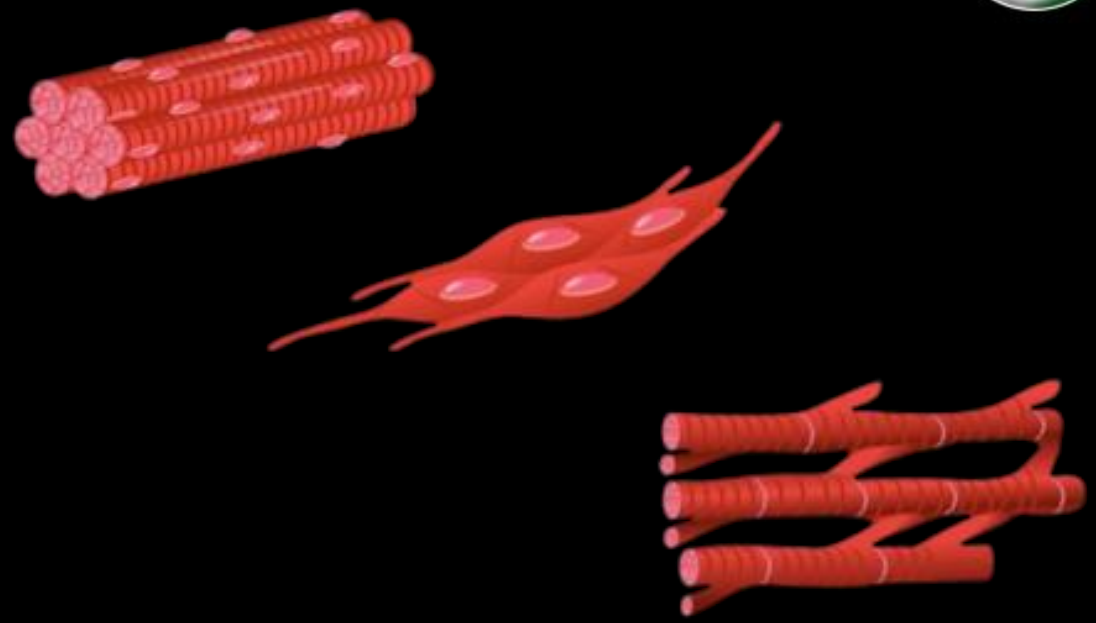
Epithelial Tissue



Connective Tissue



Nervous Tissue



Muscular Tissue

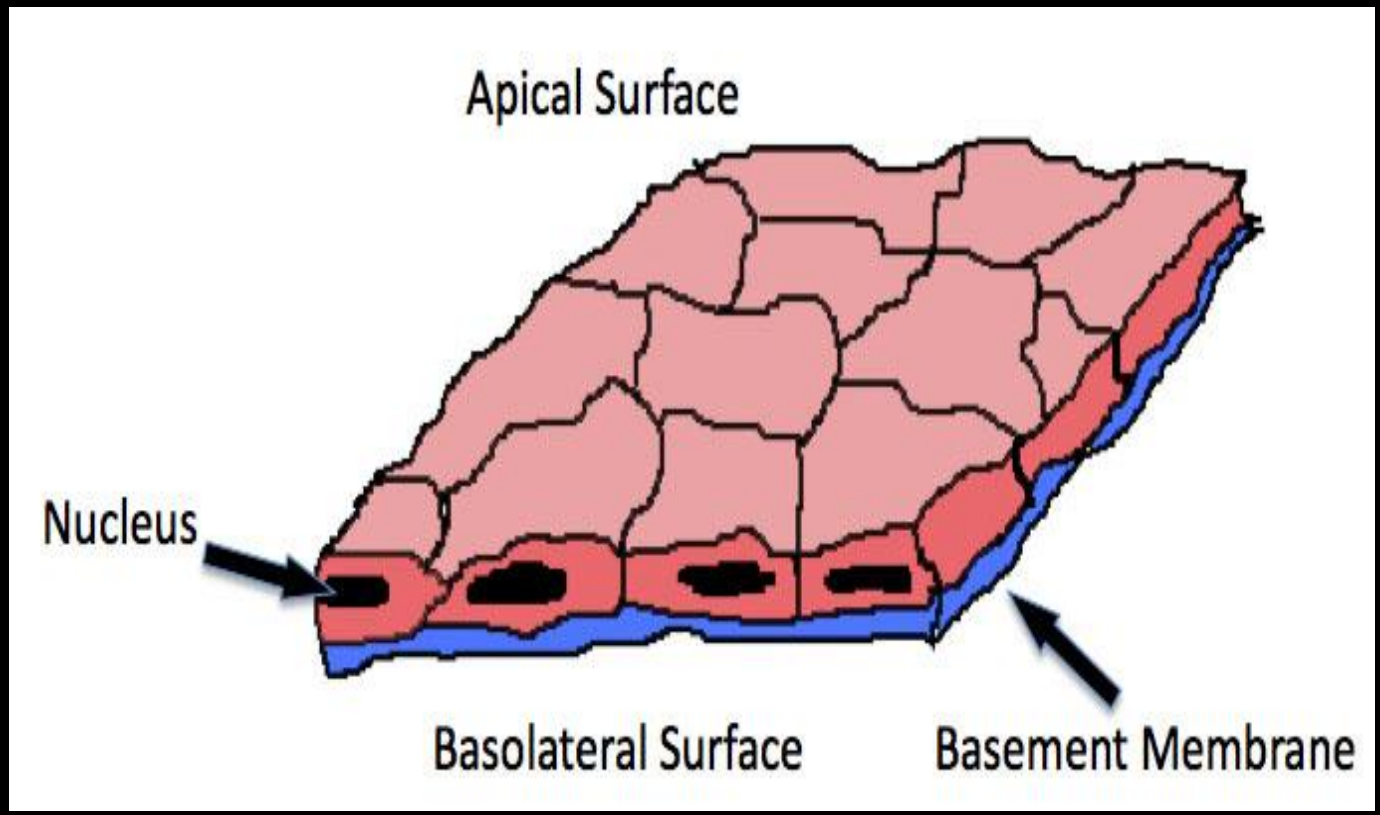
Epithelial Tissue

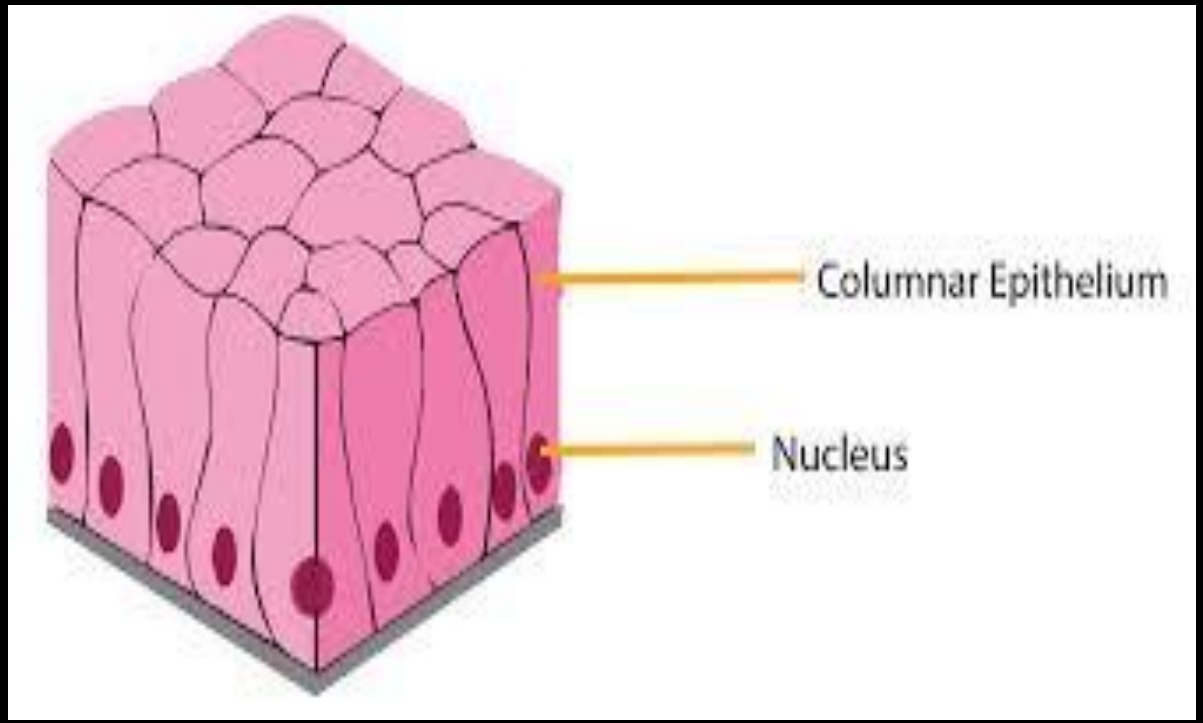
- They cover the surface of all internal as well as external organs. Epithelial tissue is highly permeable.
- Thus, it plays a significant role in the exchange of substances across the cells.
- Protects the internal organs against the invasions of **pathogens, toxins, physical trauma, radiation,** etc.
- Epithelial tissues are also involved in secreting **hormones**, **enzymes**, **mucus** and other products from ducts and transporting it to the circulatory system.

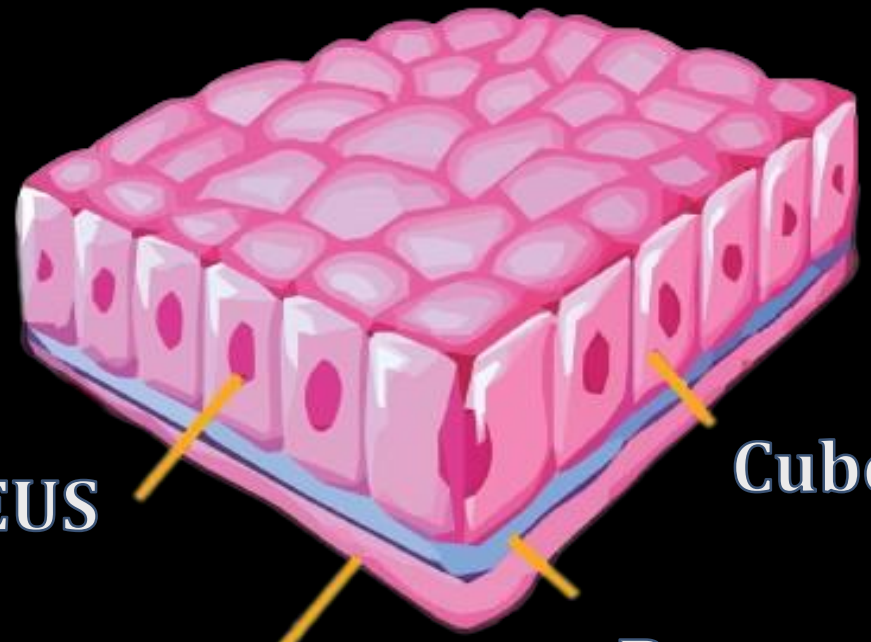
Types of Epithelial Tissue

Type of Epithelial Tissue	Location	Features
Simple Squamous Epithelium	Lining of alveoli (lungs), blood vessels (endothelium), Bowman's capsule of kidney	Single thin flat cells, allow diffusion and filtration
Simple Cuboidal Epithelium	Kidney tubules, thyroid gland, salivary gland ducts	Cube-shaped cells, secretion and absorption
Simple Columnar Epithelium	Lining of stomach, intestine, gall bladder	Tall column-like cells, secretion of mucus and absorption
Ciliated Columnar Epithelium	Respiratory tract, fallopian tubes	Columnar cells with cilia, help in movement of particles or ovum
Pseudostratified Columnar Epithelium	Trachea, bronchi	Appears multilayered but is single layer, cilia + goblet cells present

Stratified Squamous Epithelium	Skin, mouth, esophagus	Many layers, protective function against wear and tear
Keratinized Stratified Squamous Epithelium	Epidermis of skin	Upper layers contain keratin, waterproof and tough
Non-keratinized Stratified Squamous Epithelium	Mouth, pharynx, vagina	Soft, moist surface, no keratin
Transitional Epithelium	Urinary bladder, ureter	Cells can change shape (stretch & recoil), allows expansion


Apical Surface
Nucleus
Basolateral Surface
Basement Membrane


Columnar Epithelium
Nucleus

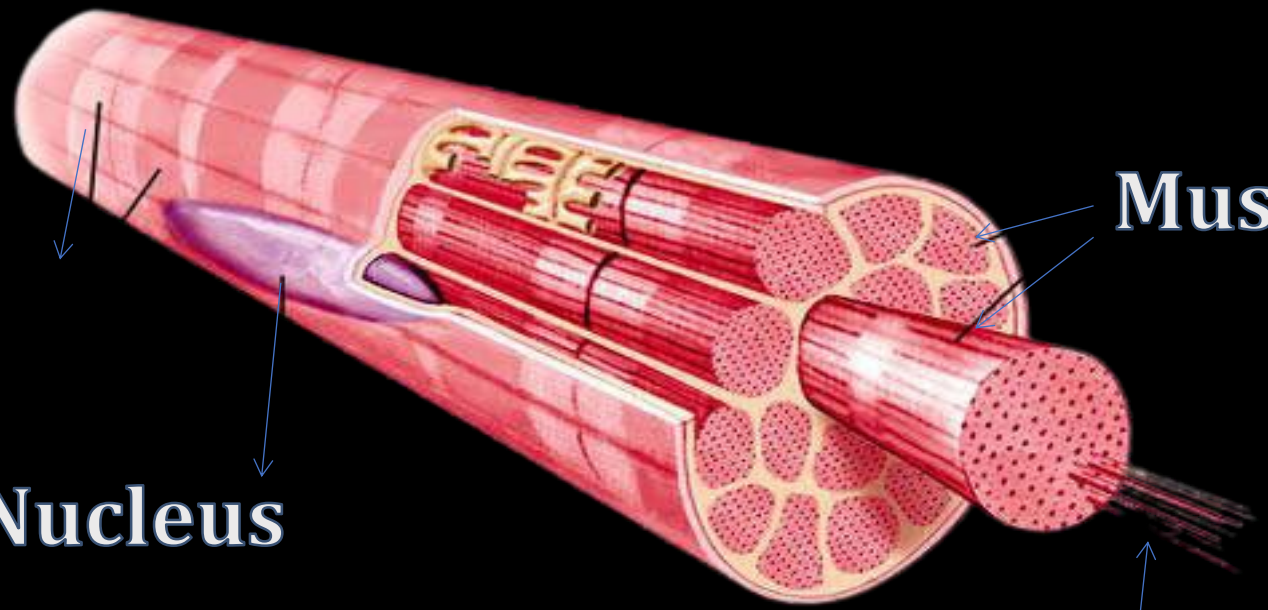

NUCLEUS
Cube cells
Connective Tissue
Basement membrane

Muscular tissue

- **Contractibility–** It is the ability of muscle cells to shorten forcefully.
- **Extensibility–** A muscle has the ability to be stretched.
- **Elasticity–** The muscles have the ability to recoil back to its original length after being stretched.
- **Excitability–** The muscle tissue responds to a stimulus delivered from a motor neuron or hormone.

Types of Muscular Tissue

Type	Structure	Location	Control	Function
Skeletal Muscle	Long, cylindrical, multinucleated fibers with striations	Attached to bones	Voluntary	Movement of body, posture maintenance, heat production
Cardiac Muscle	Branched, striated fibers with single nucleus and intercalated discs	Walls of the heart	Involuntary	Pumps blood continuously throughout the body
Smooth Muscle	Spindle-shaped, non-striated cells with single nucleus	Walls of hollow organs (stomach, intestines, blood vessels, bladder, uterus)	Involuntary	Controls movement of food, urine, blood; helps in peristalsis and organ contraction

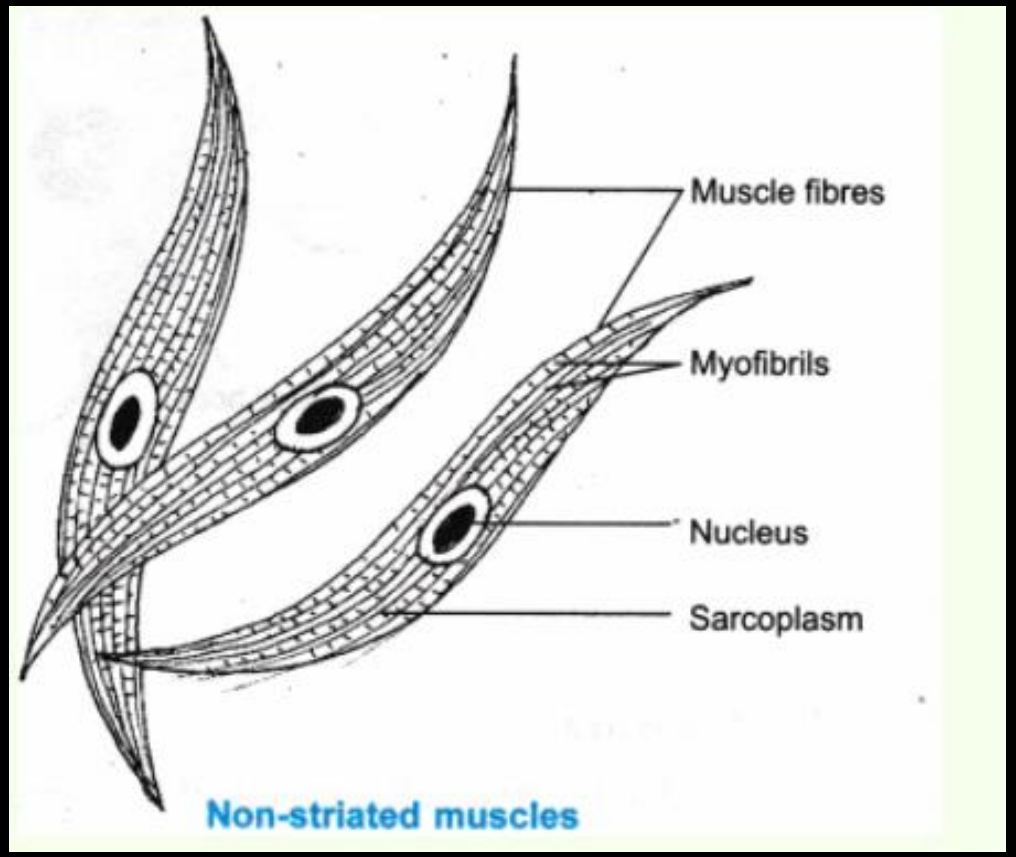


Striations

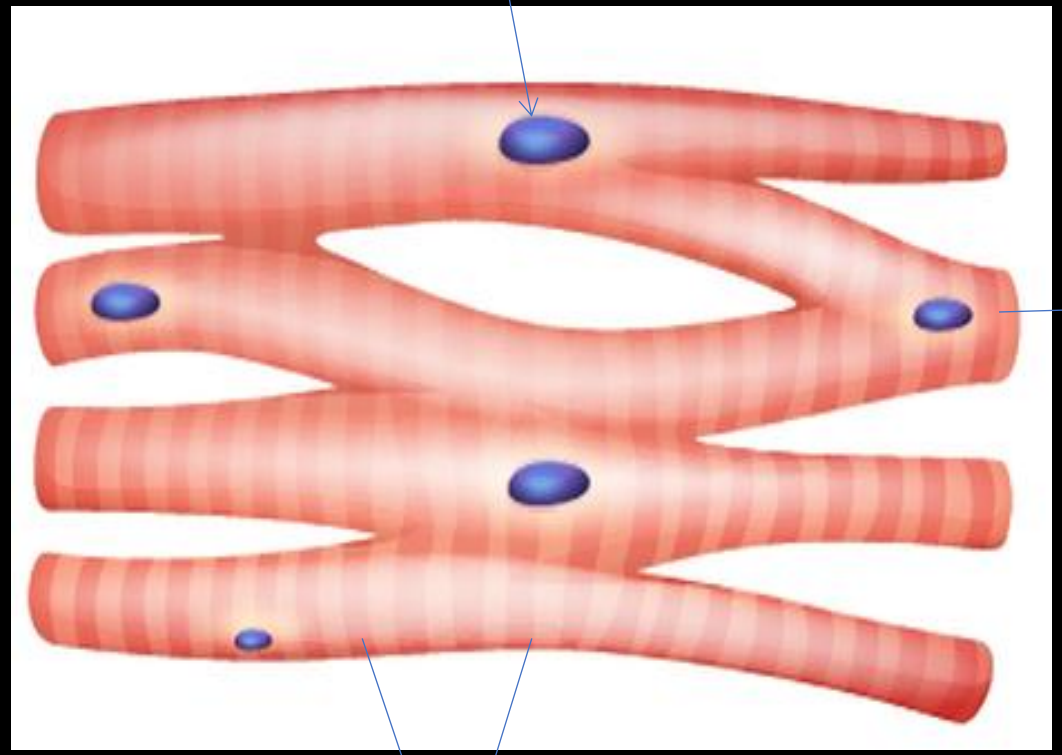
Nucleus

Muscle Fibres

Actin and Myosin Filaments


Muscle fibres
Myofibrils
Nucleus
Sarcoplasm
Non-striated muscles

Nucleus



Cardiac Muscle Fibres

Striations

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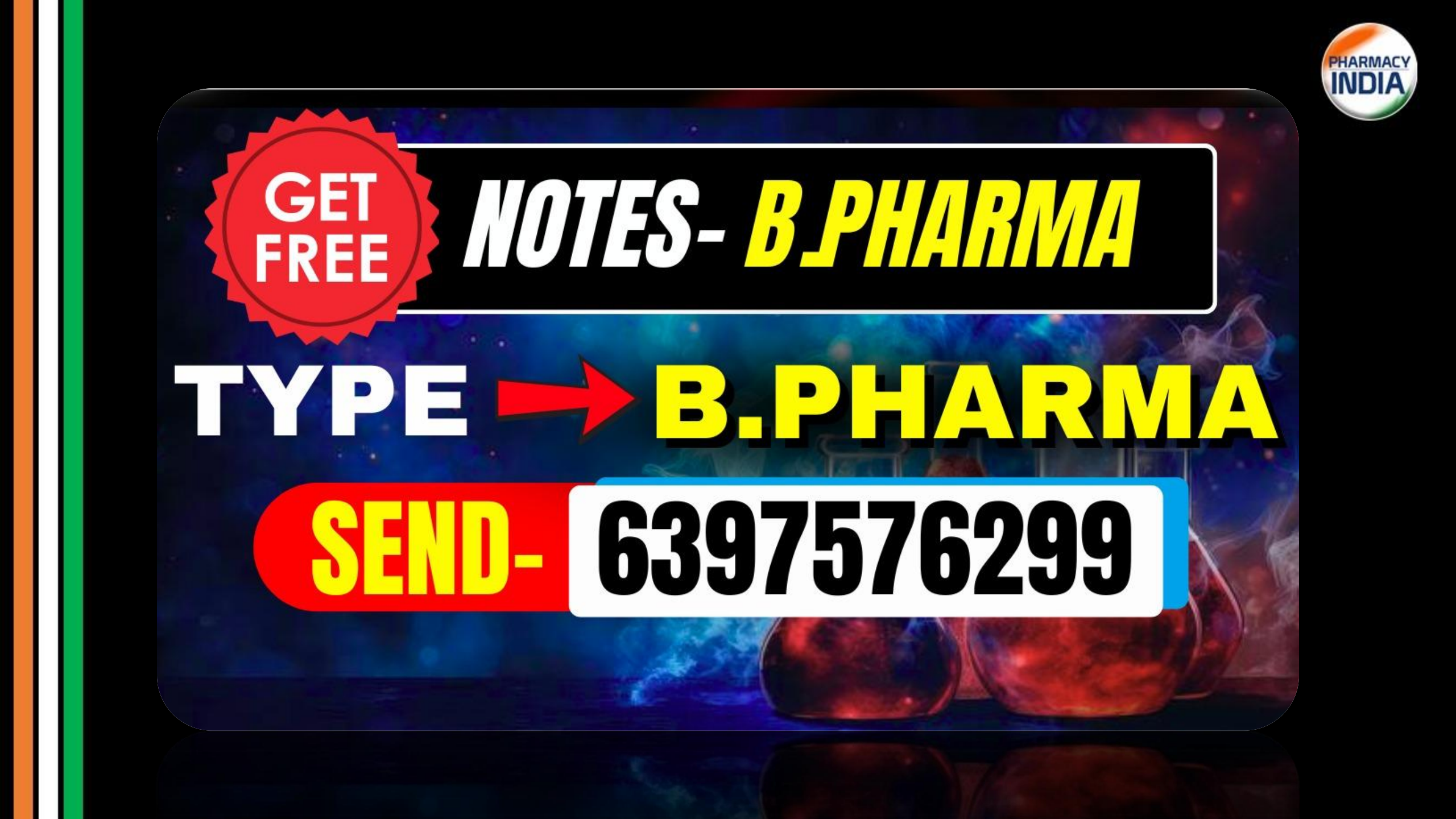
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HUMAN ANATOMY & PHYSIOLOGY

CONNECTIVE TISSUE
NERVOUS TISSUE

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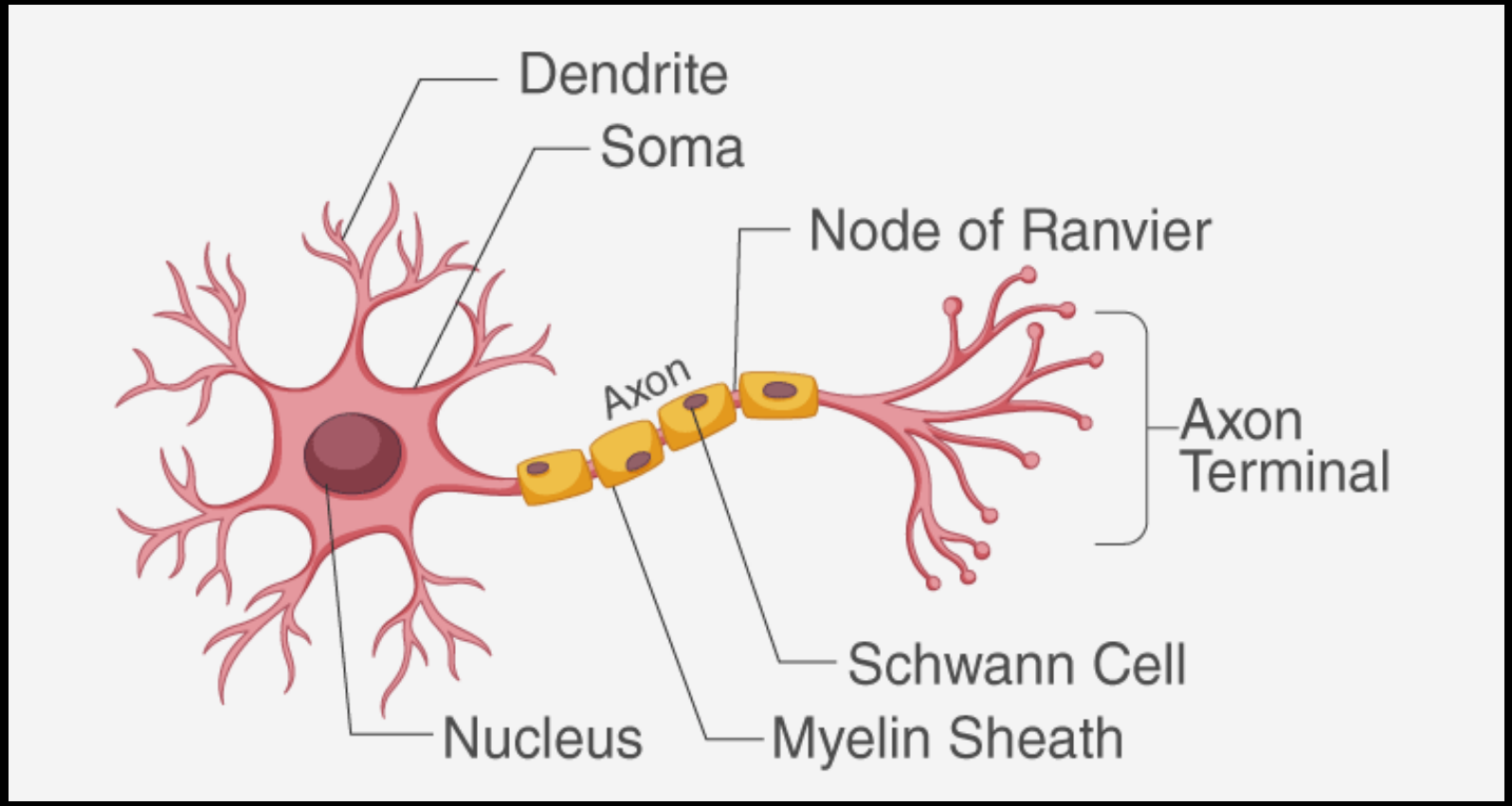
Human Anatomy and physiology

Tissue level of Organisation
PART – 2

Nervous Tissue

- Nervous or the nerve tissue is the main tissue of our nervous system.
- Brain, Spinal Cord, and nerves are composed of nervous tissue, they are specialized for being stimulated to transmit stimulus from one to another part of the body rapidly.
- It monitors and regulates the functions of the body.
- Nervous tissue consists of two cells: nerve cells or neurons and glial cells, which helps transmit nerve impulses and also provides nutrients to neurons.


Dendrite
Soma
Node of Ranvier
Axon
Axon Terminal
Schwann Cell
Nucleus
Myelin Sheath

Connective Tissue

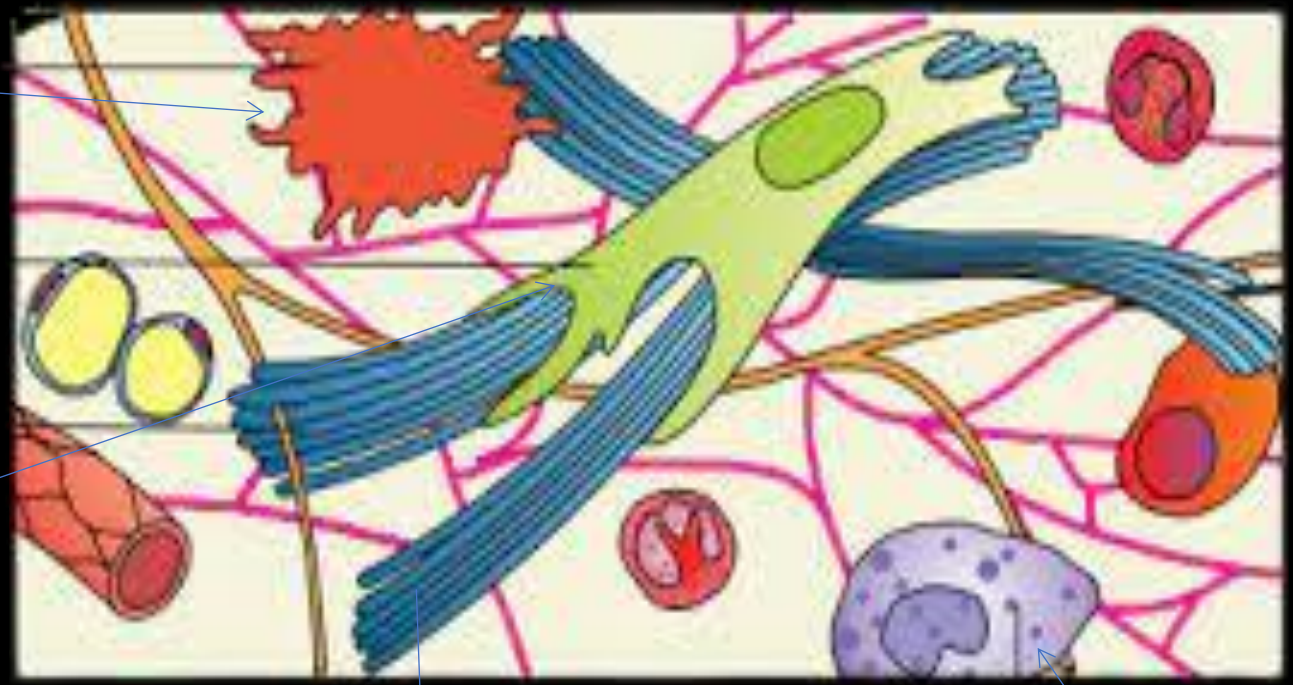
- Connective tissues, as the name implies, **support** and **connect** different tissues and organs of the body.
- They are widely distributed in **every part** of the body.
- They originate from the **mesoderm** (the middle germinal layer of the embryo).
- The **elasticity**, **flexibility** and **strength** of the connective tissues are due to **fibres**.

- Connective tissues contain **three** types of fibres:

Collagen Fibres	Elastic Fibres	Reticulate Fibres
made up of fibrous protein, collagen.	made up of Protein Elastin	made up of Collagen and Glycoproteins
Most Widespread, abundant	can be stretched like a rubber band.	thin and Forms a delicate network
Flexible, high tensile strength	Retain to their original size and shape	Join connective tissues to neighbouring tissues

macrophage

Fibroblast



Collagen Fibres

Mast cells

Types of connective tissue

Loose connective Tissue	Dense connective Tissue	Specialised connective tissue
▪ Areolar Tissue	▪ Dense regular	▪ Cartilage
▪ Adipose Tissue	▪ Dense irregular	▪ Bones
		▪ Blood

Type of Connective Tissue	Location
Areolar tissue	Beneath the skin, around blood vessels, nerves, and muscles
Adipose tissue	Below the skin, around kidneys, heart, eyeballs
Dense regular connective tissue	Tendons and ligaments
Dense irregular connective tissue	Dermis of skin, capsules of organs
Elastic connective tissue	Walls of large arteries, lungs, trachea

Reticular connective tissue	Lymph nodes, spleen, bone marrow
Cartilage	Tip of nose, ear pinna, joints, trachea
Bone	Skeleton of body, long bones, flat bones
Blood	Circulates throughout the body in blood vessels
Lymph	Lymphatic vessels and lymph nodes

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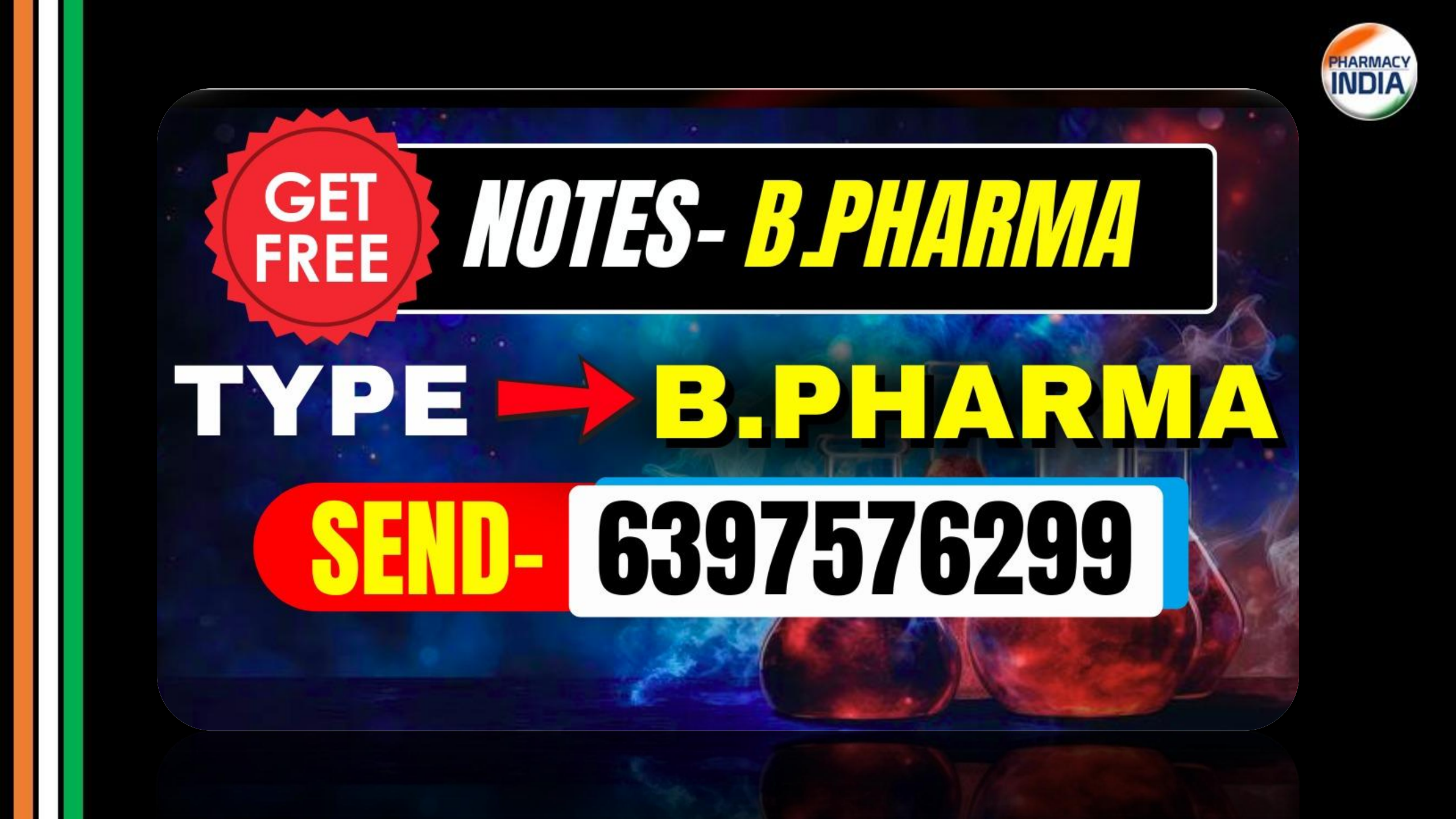
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UNIT-1

PART-1

HUMAN ANATOMY & PHYSIOLOGY

INTRODUCTION TO HUMAN BODY

SCOPE LEVELS OF STRUCTURAL ORGANIZATIONAND BODY SYSTEMS,
BASIC LIFE PROCESSES
HOMEOSTASIS

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INTRODUCTION TO HUMAN BODY

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Anatomy :

- The branch of biological science concerned with the **study of structure and relationship** of body parts (e.g., bones, muscles, organs).

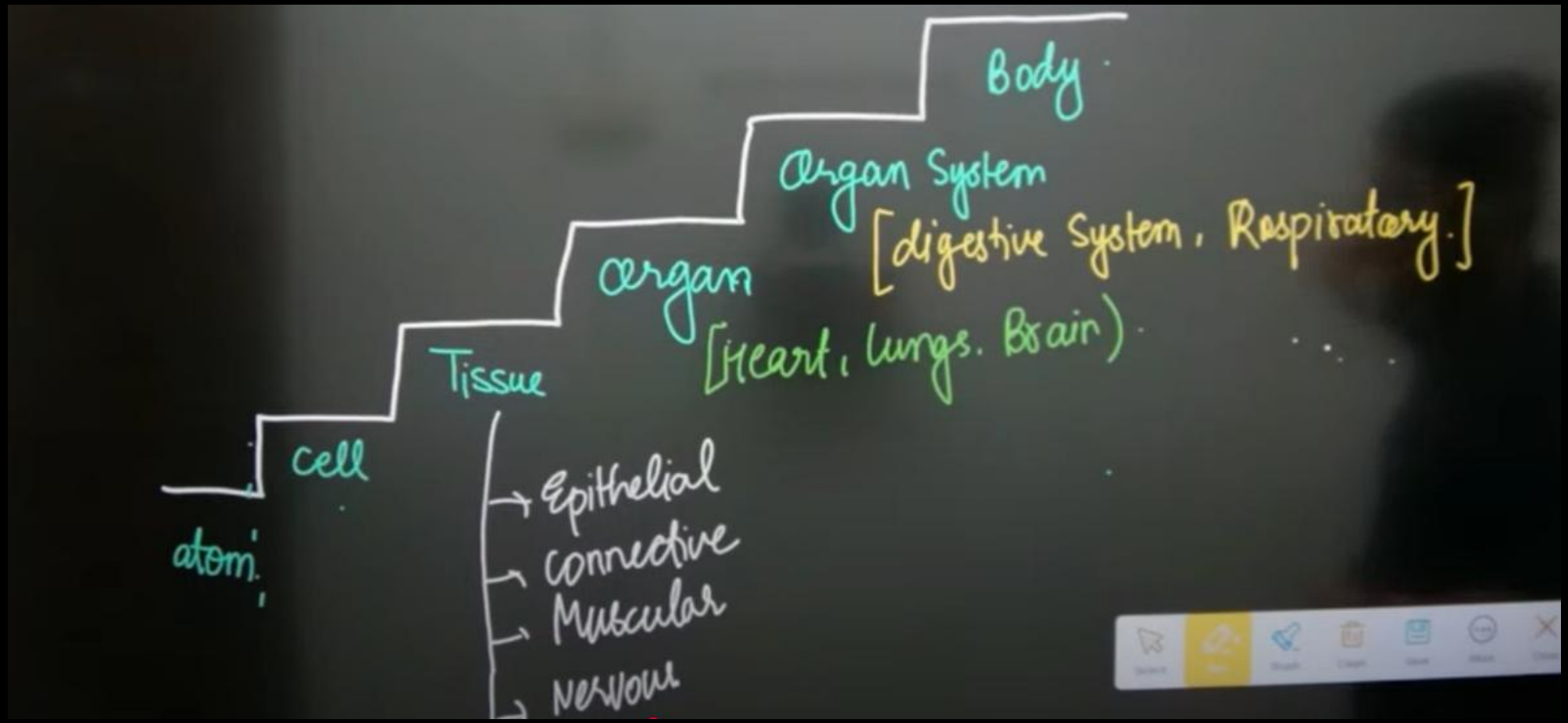
Physiology:

- The science that deals with the **functions of body parts** and how they work together to maintain life.

Scope:

- Helps pharmacists understand how drugs act on the body.
- Provides knowledge of **normal body structure & functions** → useful in understanding disease conditions.
- Essential for **drug dosage calculations, pharmacokinetics, and toxicology**.

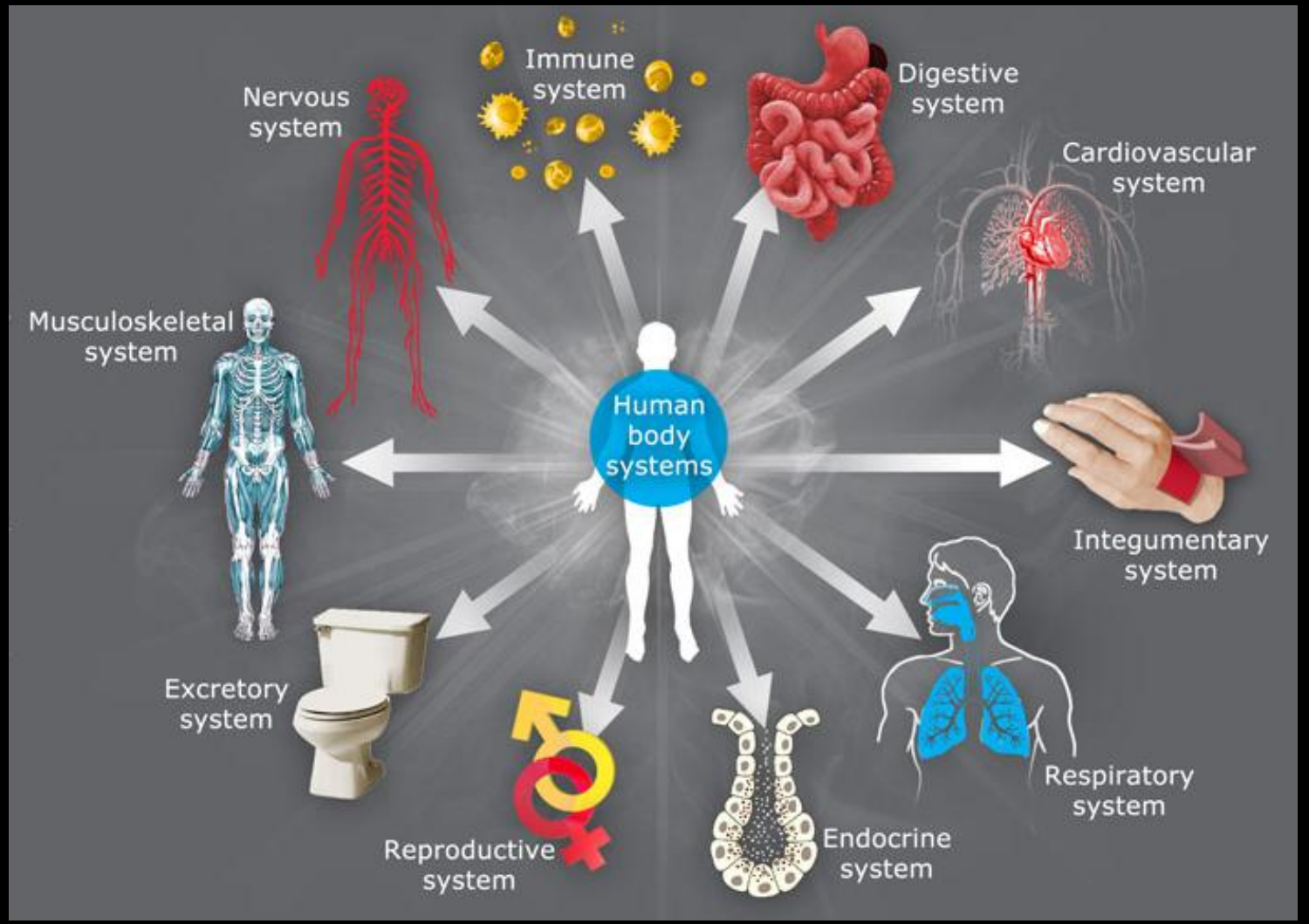
Levels of Structural Organization



Body systems

Body System	Major Organs	Main Functions
Integumentary	Skin, hair, nails, sweat & oil glands	Protects body, regulates temperature, prevents water loss, detects sensations.
Skeletal	Bones, joints, cartilage	Provides support & framework, protects organs, aids movement, produces blood cells, stores minerals.
Muscular	Skeletal muscles, smooth muscles, cardiac muscle	Produces movement, maintains posture, generates heat.
Nervous	Brain, spinal cord, nerves, sense organs	Controls body activities quickly via nerve impulses, detects and responds to stimuli, maintains homeostasis.
Endocrine	Pituitary, thyroid, adrenal, pancreas, gonads	Regulates body activities by releasing hormones, controls growth, metabolism, reproduction.
Cardiovascular	Heart, blood, blood vessels	Transports oxygen, nutrients, hormones, and wastes; regulates temperature and pH; protects via clotting and immunity.

Lymphatic / Immune	Lymph nodes, lymph vessels, spleen, thymus, tonsils	Returns excess fluid to blood, protects against infection and disease, carries dietary lipids.
Respiratory	Lungs, trachea, bronchi, diaphragm	Provides oxygen, removes carbon dioxide, helps regulate blood pH, aids in voice production.
Digestive	Mouth, esophagus, stomach, intestines, liver, pancreas	Breaks down food, absorbs nutrients, eliminates solid wastes.
Urinary	Kidneys, ureters, bladder, urethra	Removes nitrogenous wastes, regulates water, electrolytes, and pH of blood.
Reproductive	Male: testes, penis; Female: ovaries, uterus, vagina	Produces gametes (sperm/ova), secretes sex hormones, supports fertilization and development of offspring.


Immune system
Nervous system
Digestive system
Cardiovascular system
Musculoskeletal system
Human body systems
Integumentary system
Excretory system
Respiratory system
Reproductive system
Endocrine system

Basic Life Processes

- **Metabolism** – sum of all chemical reactions (catabolism + anabolism).
- **Responsiveness** – ability to detect and respond to changes.
- **Movement** – motion of body, organs, cells.
- **Growth** – increase in size due to cell number or size.
- **Differentiation** – unspecialized cells (stem cells) → specialized cells.
- **Reproduction** – formation of new cells/tissues or a new individual.

Homeostasis

- The **maintenance of stable internal conditions** despite external changes.
- Maintained mainly by **nervous and endocrine systems**.

Uses **feedback mechanisms**:

- **Negative feedback** → reverses a change (e.g., regulation of blood glucose, body temperature).
- **Positive feedback** → strengthens a change (e.g., childbirth contractions, blood clotting).

Basic Anatomical Terminology

❑Directional Terms:

- Superior (above) / Inferior (below)
- Anterior (front) / Posterior (back)
- Medial (towards midline) / Lateral (away from midline)
- Proximal (closer to trunk) / Distal (farther from trunk)
- Superficial (toward surface) / Deep (away from surface)

Types of Body Planes

❑**Sagittal Plane**

- Divides the body into **right and left parts**.

Midsagittal plane: divides into equal right and left halves.

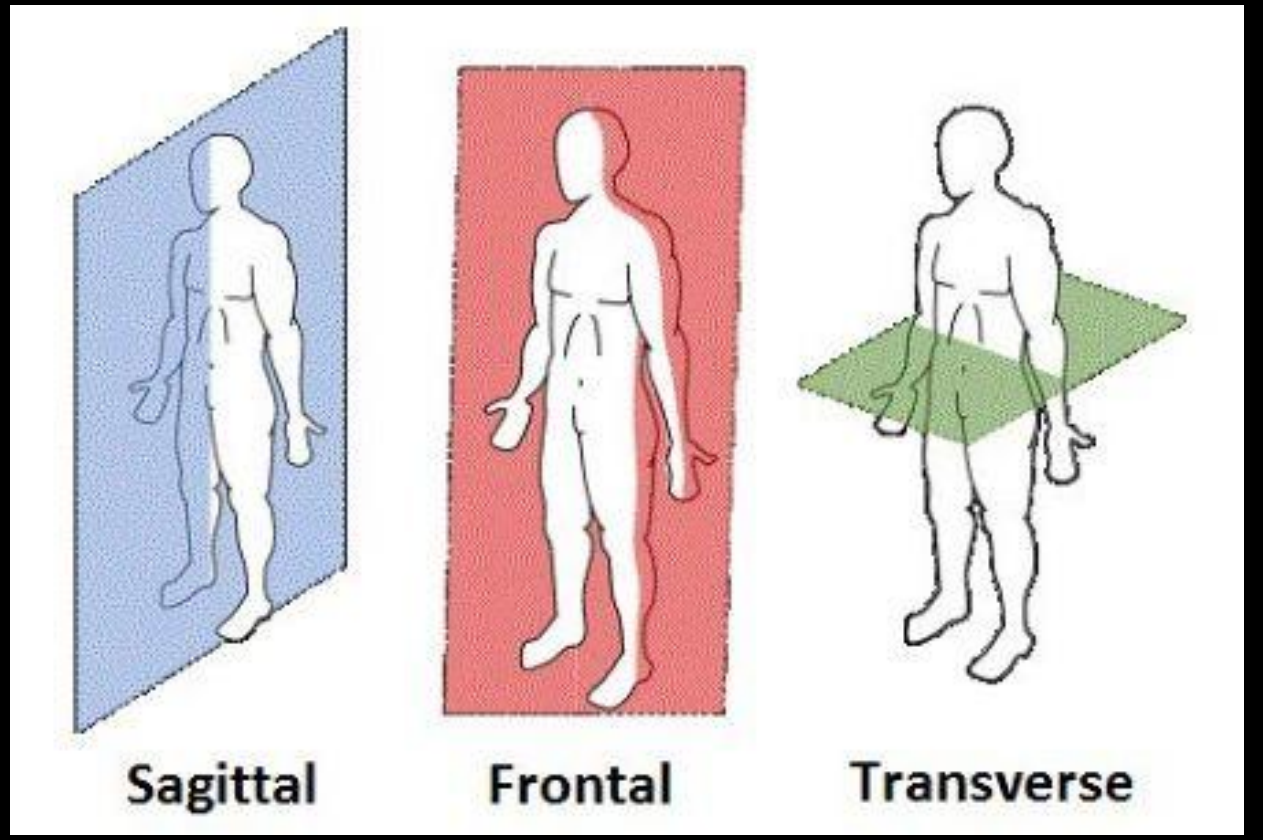
Parasagittal plane: divides into unequal right and left parts.

❑**Frontal (Coronal) Plane**

- Divides the body into **front (anterior)** and **back (posterior)** portions.

❑**Transverse (Horizontal) Plane**

- Divides the body into **upper (superior)** and **lower (inferior)** portions.


Sagittal
Frontal
Transverse

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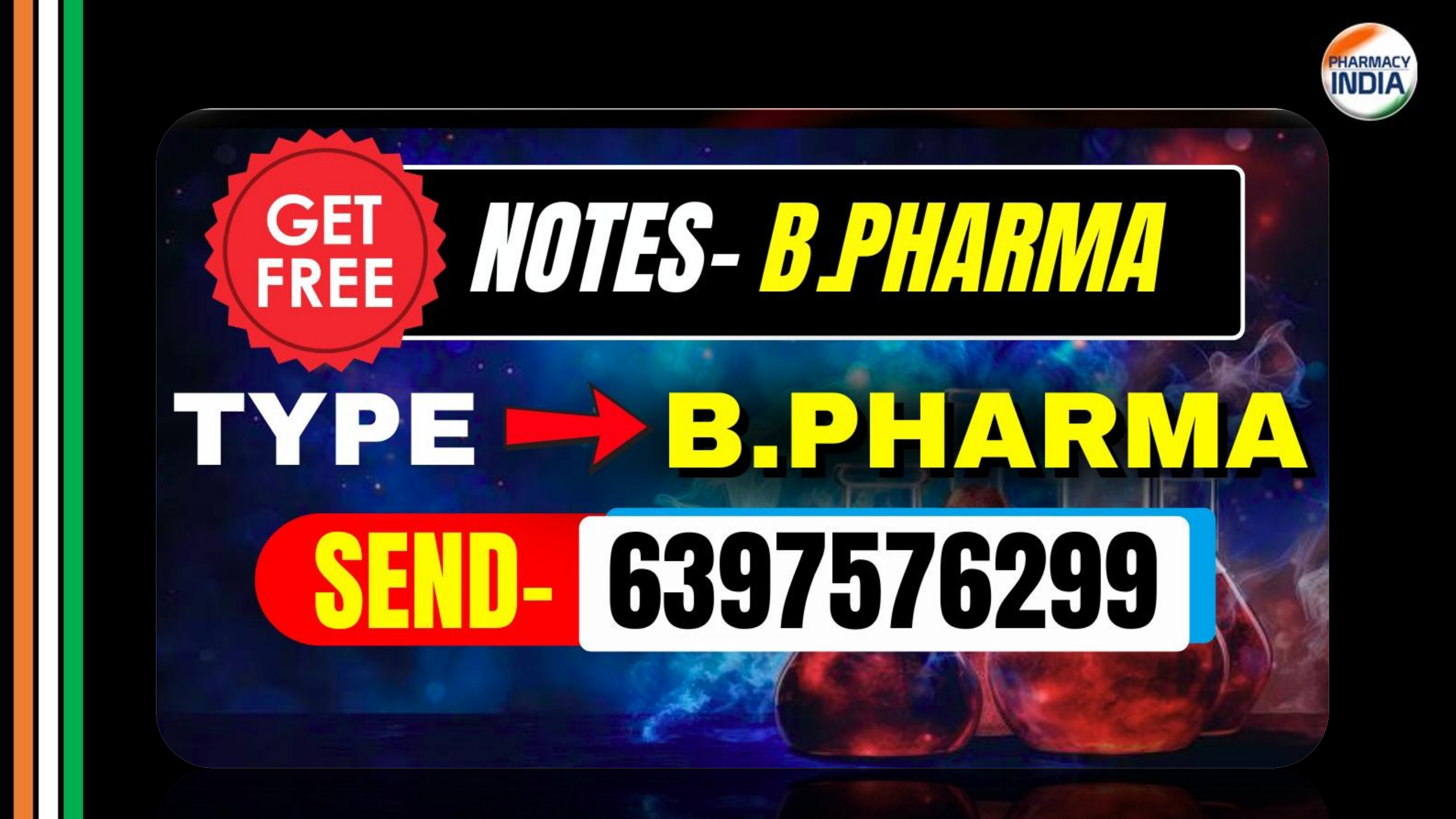
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PART-2

HUMAN ANATOMY & PHYSIOLOGY

CELLULAR LEVEL OF ORGANIZATION

THE CELL

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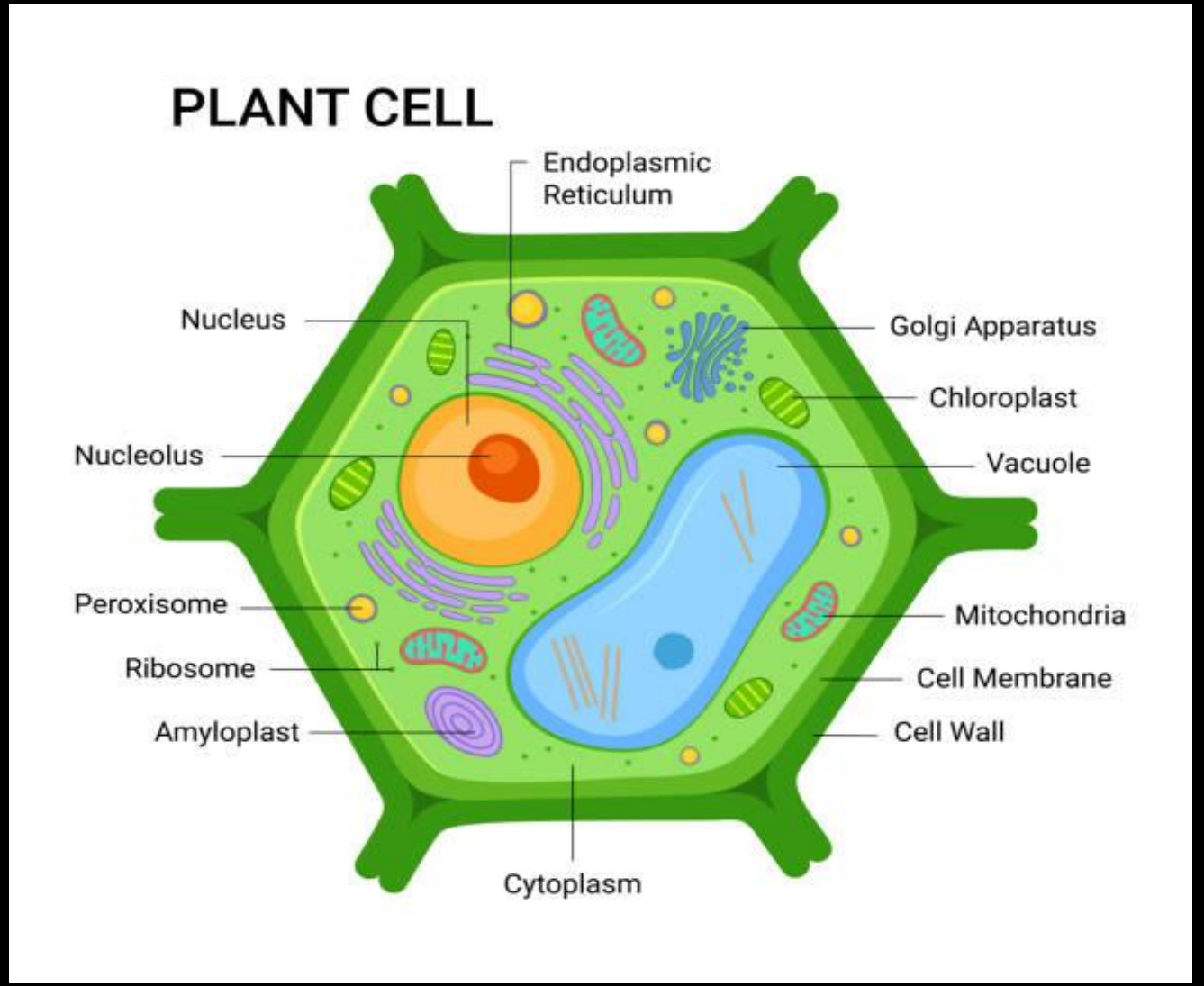
CELLULAR LEVEL OF ORGANIZATION PART – 1

CELL

- A cell can replicate itself independently.
- Robert Hooke was the first Biologist who discovered cells.
- In 1883, Robert Brown, a Scottish botanist, provided the very first insights into the cell structure.
- He was able to describe the nucleus present in the cells of orchids.



CELL THEORY

- There are three main postulates of cell theory are as follows:

❖**First, cells make up all living things.**

❖**Second, cells are the basic building blocks for developing tissues, organs, and fully developed living creatures.**

❖**most crucial, aspect of the hypothesis is that cells can only develop from other cells.**

Plant Cell	Animal Cell
Cell Shape	
Square or rectangular in shape	Irregular or round in shape
Cell Wall	
Present	Absent
Endoplasmic Reticulum	
Present	Present
Nucleus	
Present and lies on one side of the cell	Present and lies in the centre of the cell
Lysosomes	
Present but are very rare	Present

Golgi Apparatus	
Present	Present
Plastids	
Present	Absent
Vacuoles	
Few large or a single, centrally positioned vacuole	Usually small and numerous
Cilia	
Absent	Present in most of the animal cells
Mitochondria	
Present but fewer in number	Present and are numerous

	Prokaryotes	Eukaryotes
Type of Cell	Always unicellular	Unicellular and multi-cellular
Cell size	Ranges in size from 0.2 µm – 2.0 µm in diameter	Size ranges from 10 µm – 100 µm in diameter
Cell wall	Usually present; chemically complex in nature	When present, chemically simple in nature
Nucleus	Absent. Instead, they have a nucleoid region in the cell	Present
Ribosomes	Present. Smaller in size and spherical in shape	Present. Comparatively larger in size and linear in shape

DNA arrangement	Circular	Linear
Mitochondria	Absent	Present
Cytoplasm	Present, but cell organelles absent	Present, cell organelles present
Endoplasmic reticulum	Absent	Present
Plasmids	Present	Very rarely found in eukaryotes
Ribosome	Small ribosomes	Large ribosomes

Lysosome	Lysosomes and centrosomes are absent	Lysosomes and centrosomes are present
Cell division	Through binary fission	Through mitosis
Flagella	The flagella are smaller in size	The flagella are larger in size
Reproduction	Asexual	Both asexual and sexual
Example	Bacteria and Archaea	Plant and Animal cell

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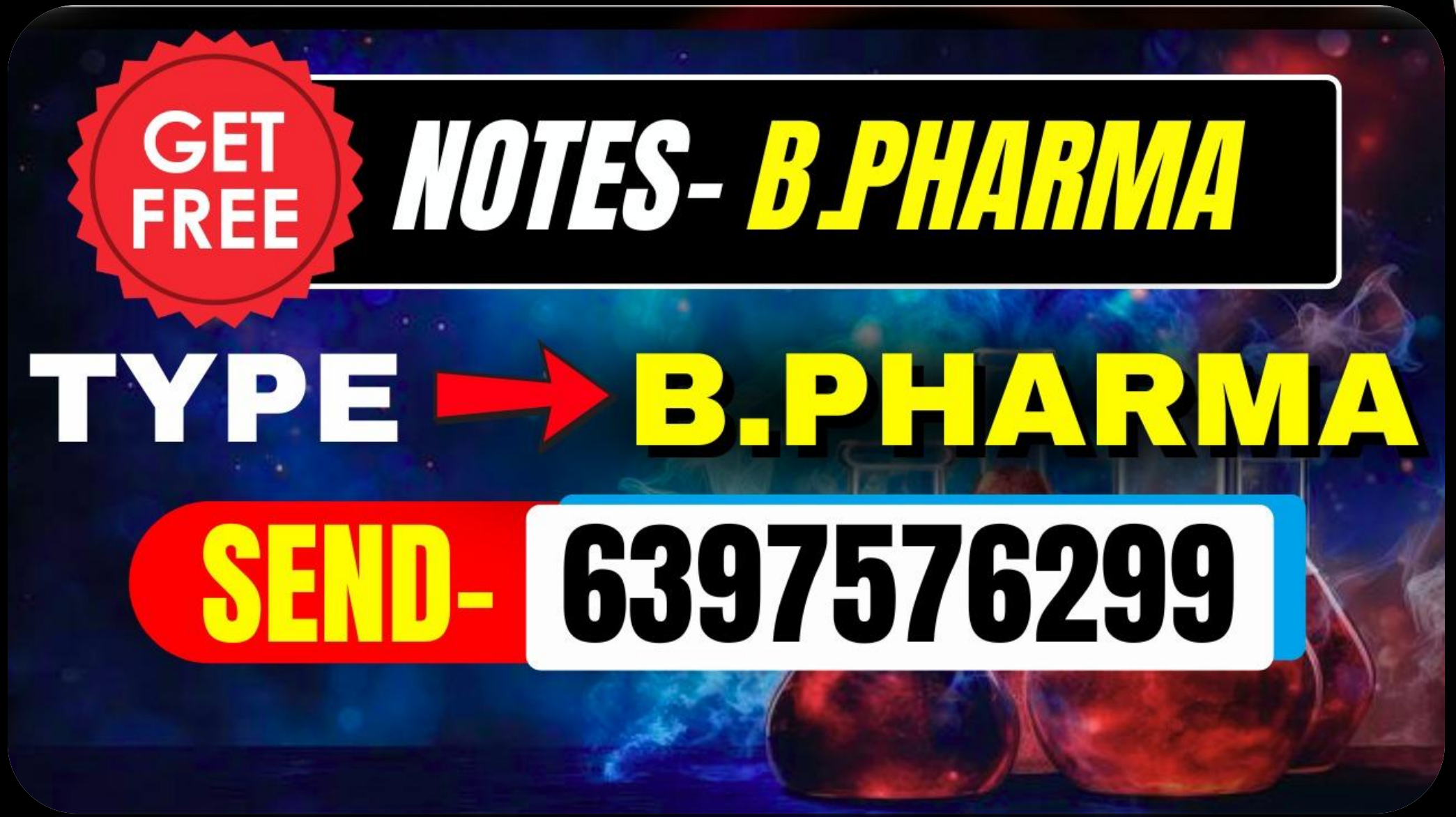
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