



PLANT TISSUES – CLASSIFICATION

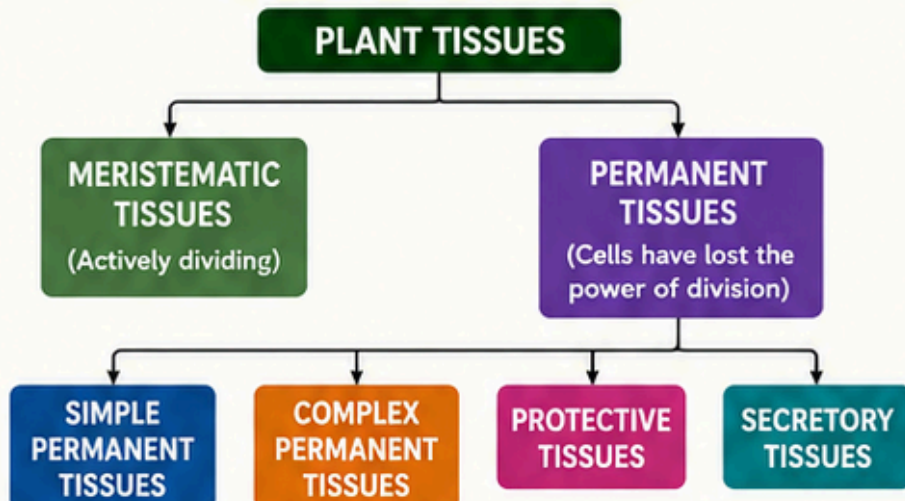


Plant tissues are groups of cells with similar **structure** and **function** that work together to carry out specific activities in the plant.

KEY POINTS

- ✓ All plants are made of tissues.
- ✓ Cells with similar structure and origin form a tissue.
- ✓ Tissues perform specific functions.
- ✓ Plant tissues are of two main categories:
Meristematic and **Permanent tissues**.

BROAD CLASSIFICATION



IMPORTANCE OF PLANT TISSUES

- Help in growth and development.
- Provide support and strength.
- Transport water, minerals and food.
- Protect the plant from injury and infection.
- Secrete useful substances like gums, latex, oils, etc.

TYPES OF PLANT TISSUES

1. MERISTEMATIC TISSUES

Cells are small, thin-walled, with dense cytoplasm and prominent nucleus. Actively divide to produce new cells.

TYPES

Apical Meristem

- Present at the tips of roots and shoots.
- Increases length.



Intercalary Meristem

- Present at the base of leaves or at nodes.
- Helps in regrowth of leaves and internodes.



Lateral Meristem

- Present along the sides of stems and roots.
- Increases girth.



2. SIMPLE PERMANENT TISSUES

Made of one type of cells. Perform basic functions like photosynthesis, storage and support.

TYPES

Parenchyma

- Living cells with thin cell wall.
- Intercellular spaces present.
- Functions: Storage, photosynthesis, buoyancy, healing.



Collenchyma

- Living cells with unevenly thickened cell wall.
- Provides mechanical support and flexibility.



Sclerenchyma

- Dead cells with thick, lignified cell wall.
- Provides strength and rigidity.



3. COMPLEX PERMANENT TISSUES

Made of more than one type of cells working together for transport of materials.

TYPES

Xylem

- Conducts water and minerals from roots to other parts.
- Components: Tracheids, Vessels, Xylem fibres, Xylem parenchyma.



Phloem

- Transports food from leaves to other parts.
- Components: Sieve tubes, Companion cells, Phloem parenchyma, Phloem fibres.



4. PROTECTIVE TISSUES

Cover and protect the plant body from mechanical injury, infection and water loss.

TYPES

Epidermis

- Single layer of cells covering leaves, young stems, roots and flowers.
- Cuticle present on the outer side.



Cork

- Made of dead, compact cells.
- Replaces epidermis in older parts.
- Resists water loss and protects from injury.



5. SECRETORY TISSUES

Produce, store and secrete various substances useful to the plant.

TYPES

Glandular Hairs

- Secrete oils, nectar or other substances.



Laticifers

- Produce and store latex.



Oil Glands

- Store and secrete essential oils.



Resin Ducts

- Secrete resins and gums.



SUMMARY COMPARISON

Tissue Type	Meristematic Tissues	Simple Permanent Tissues	Complex Permanent Tissues	Protective Tissues	Secretory Tissues
Cell Nature	Living, actively dividing	Living (Parenchyma, Collenchyma) or Dead (Sclerenchyma)	Living and Dead	Living (Epidermis) or Dead (Cork)	Living
Main Function	Growth	Storage, Photosynthesis, Support	Transport (Water & Food)	Protection	Secretion, Storage
Examples	Apical, Intercalary, Lateral Meristem	Parenchyma, Collenchyma, Sclerenchyma	Xylem, Phloem	Epidermis, Cork	Glandular Hairs, Laticifers, Oil Glands, Resin Ducts
Diagram Icon					



All plant tissues work together in harmony to ensure the growth, survival and functioning of the plant.





MERISTEMATIC TISSUES



Meristematic tissues are plant tissues consisting of **actively dividing cells**. They are responsible for **growth in plants**.

KEY POINTS

- ✓ Cells are small, thin-walled and **living**.
- ✓ Dense cytoplasm and prominent nucleus.
- ✓ Vacuoles are absent or **very small**.
- ✓ Cells are tightly packed with **no intercellular spaces**.
- ✓ Actively divide to produce new cells.
- ✓ Responsible for increase in length and girth of the plant.

LOCATION IN PLANTS

Shoot apex
(Apical meristem)

At the tips of shoots and branches.



Intercalary meristem

At the base of leaves or at nodes.



Lateral meristem

Along the sides of stems and roots.



Root apex
(Apical meristem)

At the tips of roots.



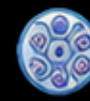
IMPORTANCE



Bring about increase in length (primary growth).



Bring about increase in girth (secondary growth).



Help in regeneration and healing of wounds.



Essential for growth and development of the plant.

TYPES OF MERISTEMATIC TISSUES

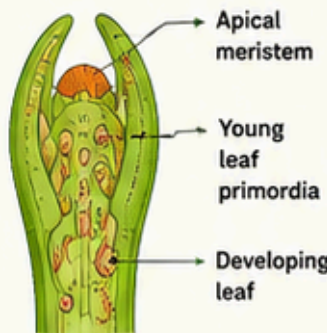
1. APICAL MERISTEM

LOCATION • At the tips of shoots, branches and roots.

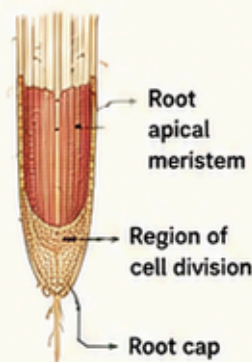
FUNCTION • Increases the length of the plant.

DIAGRAM & EXAMPLES

In Shoot (Shoot Apex)



In Root (Root Apex)



Examples: Tips of stems, branches and roots

2. INTERCALARY MERISTEM

LOCATION

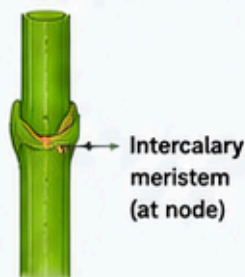
- At the base of leaves, at nodes, internodes or in the bases of grass leaves.

FUNCTION

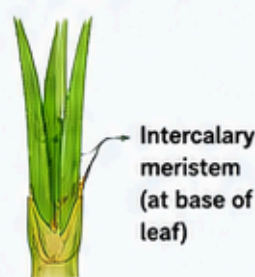
- Helps in the growth of internodes or elongation of leaves.

DIAGRAM & EXAMPLES

At Node



At Base of Leaf



Examples: Grasses (wheat, rice, sugarcane), some aquatic plants

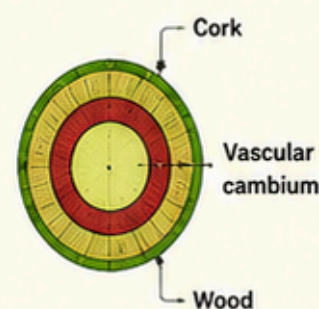
3. LATERAL MERISTEM

LOCATION • Along the sides of stems and roots.

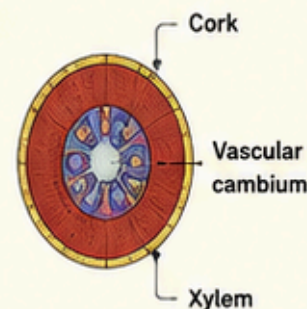
FUNCTION • Increases the girth (thickness) of the plant.

DIAGRAM & EXAMPLES

In Stem



In Root



Examples: Cambium in dicot stems and roots, cork cambium (phellogen)

COMPARISON OF MERISTEMATIC TISSUES

Feature	Apical Meristem	Intercalary Meristem	Lateral Meristem
Location	Tips of shoots, branches and roots	At nodes, internodes or base of leaves	Along the sides of stems and roots
Type of Growth	Primary growth (increase in length)	Primary growth (elongation)	Secondary growth (increase in girth)
Cells	Actively dividing, small, thin-walled, dense cytoplasm	Actively dividing, small, thin-walled, dense cytoplasm	Actively dividing, small, thin-walled, dense cytoplasm
Function	Increase in length of the plant	Increase in length of internodes or leaves	Increase in girth of the plant
Examples	Shoot apex, root apex	Base of leaves in grasses, nodes of stems	Vascular cambium, cork cambium

CHARACTERISTICS OF MERISTEMATIC TISSUES



- Thin cellulose wall
- Dense cytoplasm
- Prominent nucleus
- Vacuoles absent or very small
- No intercellular spaces



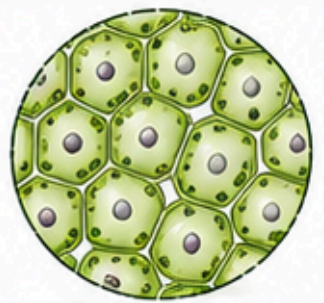
Note: Meristematic tissues are the growing regions of the plant. All other plant tissues are derived from these actively dividing cells.



ONLINE TEACHING
WITH NIKITA



PARENCHYMA

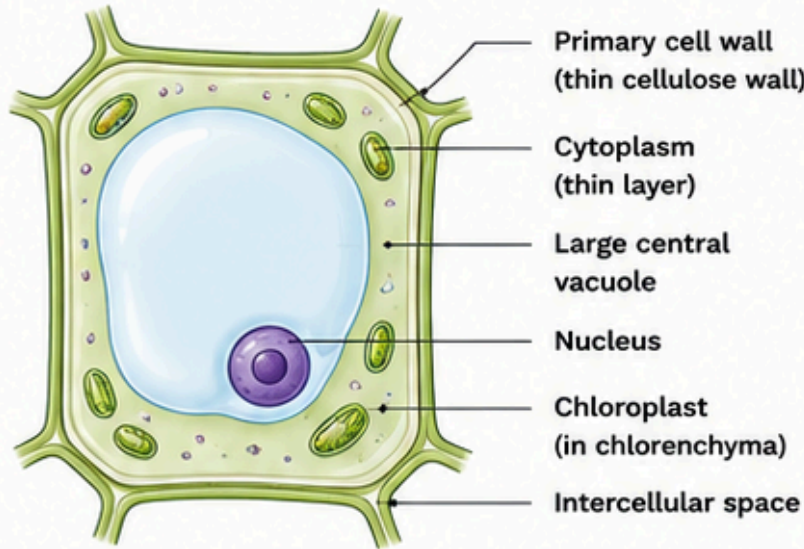


Parenchyma is a simple permanent tissue made up of **living** cells. It performs various functions such as **storage**, **photosynthesis**, **secretion**, **buoyancy**, healing and **support** in plants.

KEY POINTS

- ✓ Parenchyma cells are living, isodiametric or oval in shape.
- ✓ They have thin primary cell wall made of cellulose.
- ✓ Cells are loosely packed with intercellular spaces.
- ✓ Vacuoles are large and well developed.
- ✓ Nucleus is present and cytoplasm is thin layer.
- ✓ Found in all parts of the plant body.
- ✓ It is the most abundant ground tissue.

STRUCTURE OF PARENCHYMA CELL



FUNCTIONS

-  **Storage** – Stores food, water and other substances.
-  **Photosynthesis** – In chlorenchyma cells (rich in chloroplasts).
-  **Buoyancy** – Helps aquatic plants to float.
-  **Support** – Provides turgidity and mechanical support.
-  **Healing** – Helps in regeneration and repair of plant parts.
-  **Secretion** – Secretes gums, resins, oils, latex and other substances.

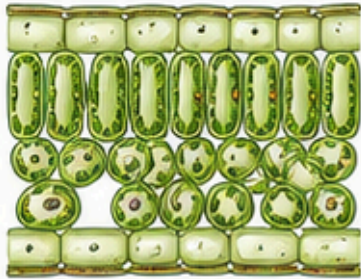
TYPES OF PARENCHYMA

1. CHLORENCHYMA

- Contains chloroplasts.
- Main site of photosynthesis.
- Found just below the epidermis of leaves and in green parts.

Example:

Palisade and spongy mesophyll of leaf.

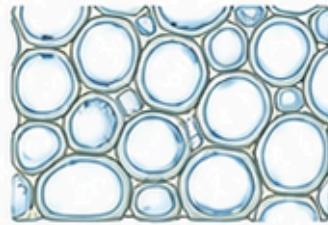


2. AERENCHYMA

- Cells are large, rounded or polygonal.
- Have large intercellular spaces (air cavities).
- Helps in buoyancy and gaseous exchange.

Example:

Stems of aquatic plants like Hydrilla, Nymphaea.

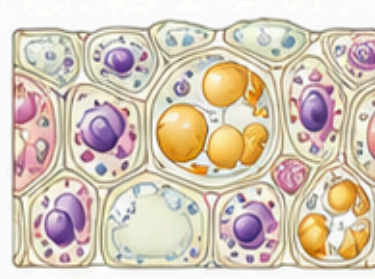


3. STORAGE PARENCHYMA

- Stores food materials such as starch, proteins, oils, etc.
- Cells are thin-walled with large vacuoles.

Example:

Cortex of roots, pith of stems, fleshy fruits, tubers.

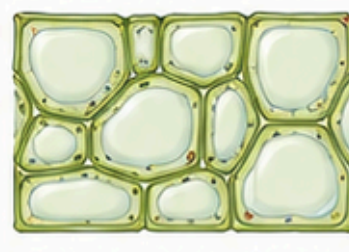


4. WATER STORAGE PARENCHYMA

- Stores water in large vacuoles.
- Helps in water retention in xerophytic plants.

Example:

Leaves and stems of succulents (Aloe, Cactus).

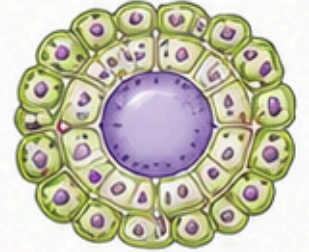


5. SECRETORY PARENCHYMA

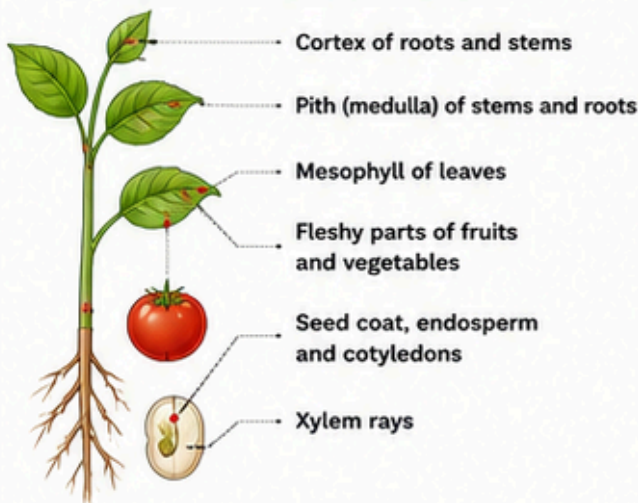
- Secretes various substances like resins, gums, latex, oils, mucilage, etc.
- Forms secretory canals and cavities.

Example:

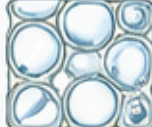
Gum in Acacia, Latex in Hevea, Oil in Citrus.



LOCATION IN PLANTS



COMPARISON OF DIFFERENT TYPES OF PARENCHYMA

Feature	Chlorenchyma	Aerenchyma	Storage Parenchyma	Water Storage Parenchyma	Secretory Parenchyma
Main Function	Photosynthesis	Buoyancy & Gaseous exchange	Storage of food	Storage of water	Secretion
Special Feature	Contains chloroplasts	Large intercellular spaces (air cavities)	Stores starch, oils, proteins, etc.	Large vacuoles store water	Secretes gums, resins, oils, latex
Location	Mesophyll of leaves, green parts	Aquatic plants – stems, petioles, leaf stalks	Cortex, pith, fruits, tubers, seeds	Succulent leaves and stems	Secretory canals, laticifers, oil glands
Diagram Icon					

SUMMARY

Parenchyma is a simple permanent tissue of living cells. It performs multiple functions such as storage, photosynthesis, buoyancy, support, healing and secretion, helping in the survival and adaptation of plants.



NOTE

Parenchyma cells can dedifferentiate and regain the ability to divide in certain conditions. Therefore, they play a key role in regeneration and healing of injured parts.



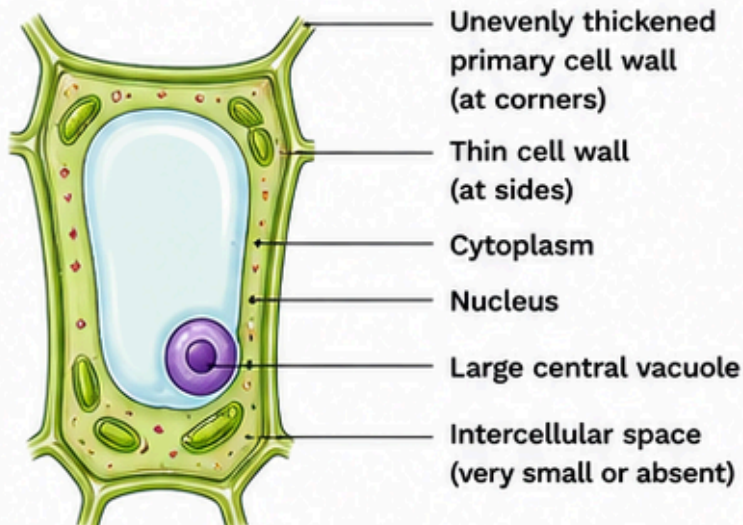
COLLENCHYMA

Collenchyma is a simple permanent tissue composed of living cells. It provides **mechanical support** and **flexibility** to growing parts of plants.

KEY POINTS

- Cells are living, elongated and with unevenly thickened primary cell walls.
- They have very little or no intercellular spaces.
- Provide strength with flexibility to growing parts.
- Found in dicotyledonous plants.
- Lignin is absent in cell walls.
- Found just below the epidermis.

STRUCTURE OF COLLENCHYMA CELL



FUNCTIONS

- Mechanical support** – Provides strength and flexibility to growing parts.
- Flexibility** – Allows bending without breaking.
- Protection** – Gives support to soft tissues.
- Growth support** – Supports the plant during growth.
- Helps in the maintenance of plant structure.

TYPES OF COLLENCHYMA (BASED ON CELL WALL THICKENING)

1. ANGULAR COLLENCHYMA

- Cell walls are thickened at the corners.
- Most common type.
- Provides strength with flexibility.



Example: Found in dicot stems, petioles of leaves.

2. LAMELLAR COLLENCHYMA

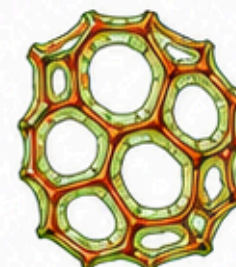
- Cell walls are thickened in tangential walls (layers).
- Forms layers or lamellae.
- Provides support and some degree of flexibility.



Example: Found in the cortex of dicot stems.

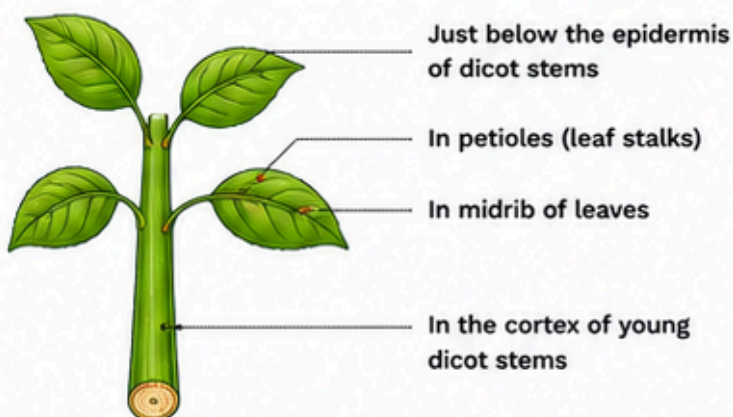
3. LACUNAR COLLENCHYMA

- Cell walls are thickened around the intercellular spaces.
- Intercellular spaces are large.
- Helps in storage and support.



Example: Found in the petioles and midrib of leaves.

LOCATION IN PLANTS

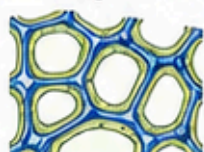


COMPARISON OF COLLENCHYMA WITH OTHER TISSUES

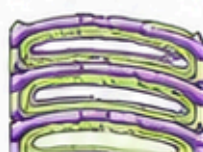
Feature	Collenchyma	Sclerenchyma	Parenchyma
Nature of Cells	Living	Dead	Living
Cell Wall	Unevenly thickened at corners	Very thick and lignified	Thin and uniformly thin
Lignin	Absent	Present	Absent
Intercellular Spaces	Very little or absent	Absent	Present
Function	Provides support and flexibility	Provides strength and rigidity	Storage, photosynthesis, buoyancy, etc.
Location	Just below epidermis of growing parts	In mature parts of plant	Throughout plant body
Diagram Icon			

DIAGRAMMATIC VIEW

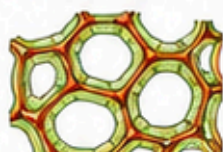
Angular



Lamellar



Lacunar



IMPORTANCE

- Provides mechanical strength to soft parts of the plant.
- Allows bending and movement in growing parts.
- Supports leaves, stems and flowers.
- Essential for growth and proper development of the plant.

SUMMARY

Collenchyma is a living permanent tissue with unevenly thickened cell walls. It provides support and flexibility to growing parts of the plant and plays an important role in their protection and development.



NOTE: Collenchyma is found in dicot plants and is absent in monocots. It helps the plant to bend without breaking.



SCLERENCHYMA

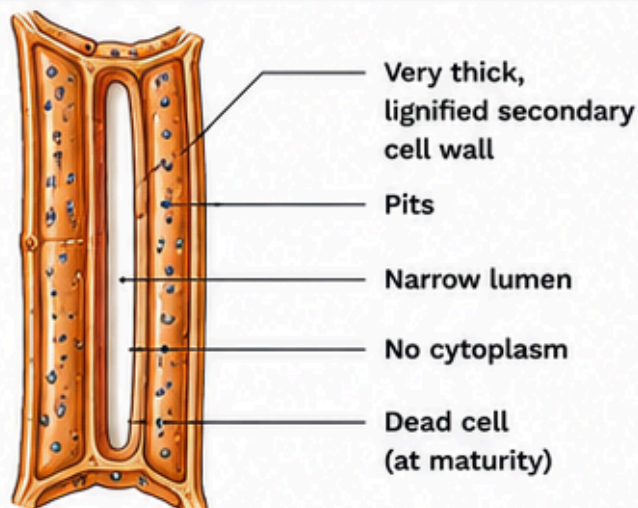


Sclerenchyma is a complex permanent tissue made up of dead cells. It provides **mechanical strength** and **rigidity** to the plant.

KEY POINTS

- ✓ Cells are dead at maturity.
- ✓ Cells have very thick, lignified secondary cell walls.
- ✓ Narrow lumen is present.
- ✓ Cells have pits in their walls.
- ✓ Provides strength and rigidity to plant parts.
- ✓ Found in all vascular plants.
- ✓ Two types:
Fibres and **Sclereids**.

STRUCTURE OF SCLERENCHYMA CELL



FUNCTIONS

- Provides **mechanical strength** and **rigidity**.
- Gives support to plant parts and prevents collapse.
- Protects soft tissues.
- Helps in withstanding mechanical stress.
- Forms hard protective coverings of seeds and nuts.

TYPES OF SCLERENCHYMA

1. FIBRES

- Long, narrow, spindle-shaped cells with tapering ends.
- Cells are arranged in groups or bundles.
- Provide tensile strength.
- Found in stems, leaf veins, around vascular bundles and in hard parts.

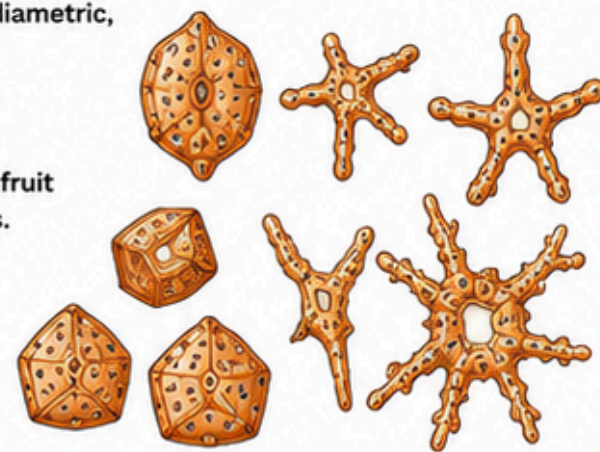
Examples:
Jute fibres, flax fibres, coconut coir, hemp.



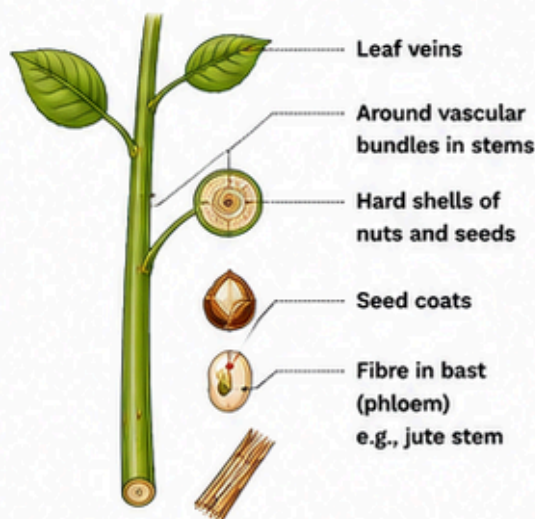
2. SCLEREIDS

- Cells are irregular in shape (isodiametric, branched or star-shaped).
- Occur singly or in small groups.
- Provide strength and hardness.
- Found in seed coats, nutshells, fruit pulp (stone cells) and leaf veins.

Examples:
Stone cells in pear, sclereids in nutshells (walnut), hard pulp of guava.



LOCATION IN PLANTS

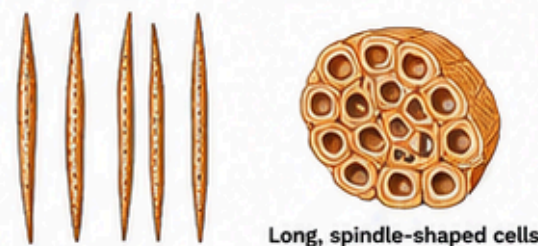


COMPARISON OF FIBRES AND SCLEREIDS

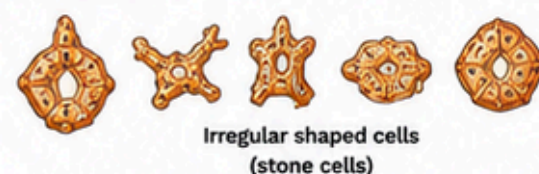
Feature	Fibres	Sclereids
Shape	Long, narrow, spindle-shaped with tapering ends	Irregular (round, oval, branched, star-shaped)
Size	Long and slender	Shorter and wider
Cell Nature	Dead	Dead
Cell Wall	Very thick and lignified secondary wall	Very thick and lignified secondary wall
Lumen	Very narrow	Narrow
Occurrence	In groups or bundles	Singly or in small groups
Function	Provides tensile strength and flexibility	Provides hardness and rigidity
Examples	Jute, flax, hemp, coconut coir	Stone cells in pear, nut shells, seed coats

DIAGRAMMATIC VIEW

FIBRES



SCLEREIDS



IMPORTANCE

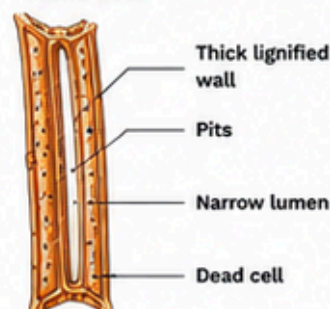
- Imparts strength and rigidity to plant body.
- Helps plants to grow upright.
- Provides protection to soft and delicate tissues.
- Useful fibres (jute, flax, hemp) are used in making ropes, mats, bags and textiles.
- Hard sclereids protect seeds and nuts.

SUMMARY

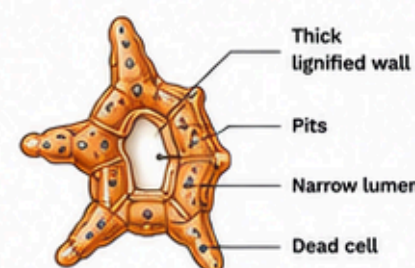
Sclerenchyma is a complex permanent tissue of dead cells with thick, lignified walls. It occurs in the form of fibres and sclereids. It provides mechanical strength, support and protection to different parts of the plant.



FIBRE CELL



SCLEREID CELL



NOTE: Sclerenchyma occurs in all vascular plants and is absent in algae and fungi.



Strength today, support tomorrow – thanks to sclerenchyma!



XYLEM – DETAILED STRUCTURE

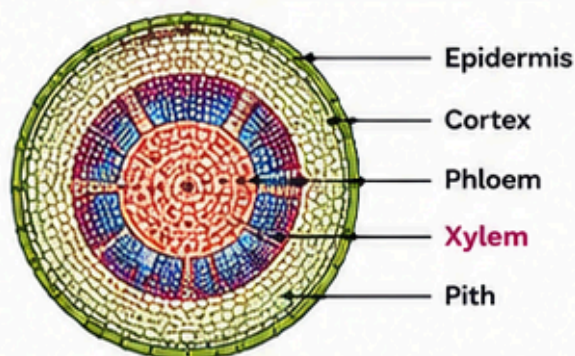


Xylem is a complex permanent tissue that conducts **water and minerals** from roots to all other parts of the plant. It also provides **mechanical support**.

KEY POINTS

- ✓ Xylem is composed of dead cells.
- ✓ It conducts water and dissolved mineral salts from roots to leaves and other parts.
- ✓ It also provides mechanical strength to the plant.
- ✓ Xylem tissue is unidirectional (upward only).
- ✓ It consists of tracheids, vessels, xylem fibres and xylem parenchyma.

LOCATION OF XYLEM



Xylem is present towards the inner side (inside) of the vascular bundle.

FUNCTIONS OF XYLEM



Conduction – Transport of water and mineral salts from roots to the rest of the plant.



Support – Provides mechanical strength and rigidity.



Storage – Xylem parenchyma stores food and other substances.



Helps in maintaining turgidity of cells.



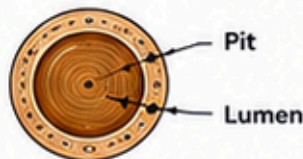
Helps in the upward movement of water against gravity.

COMPONENTS OF XYLEM

1. TRACHEIDS



- Long, narrow, spindle-shaped cells with tapering ends.
- Dead cells with thick, lignified secondary walls.
- Walls have pits.
- No end walls.
- Conduct water and provide mechanical support.



Found in :
All vascular plants – gymnosperms and angiosperms.

2. VESSELS



- Long, tube-like cells placed end to end.
- End walls are absent or perforated to form continuous tubes.
- Perforation plates have many pores.
- Wall is thick and lignified.
- Main water conducting elements in angiosperms.



Found in :
Mainly in angiosperms.

3. XYLEM FIBRES



- Very long, narrow and tapering cells.
- Dead cells with very thick, lignified walls.
- Narrow lumen.
- Provide mechanical strength and support to the plant.

Found in :
All vascular plants.

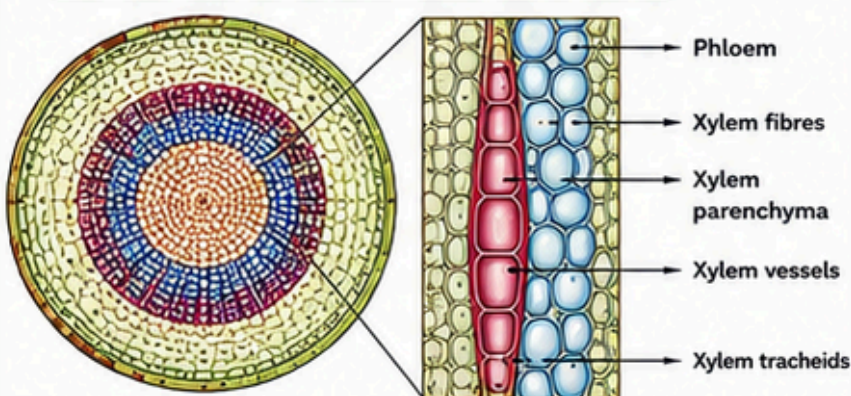
4. XYLEM PARENCHYMA



- Living cells with thin cellulose walls.
- Isodiametric or elongated.
- Store food, starch, tannins and other substances.
- Help in radial conduction (sideways movement).

Found in :
All vascular plants.

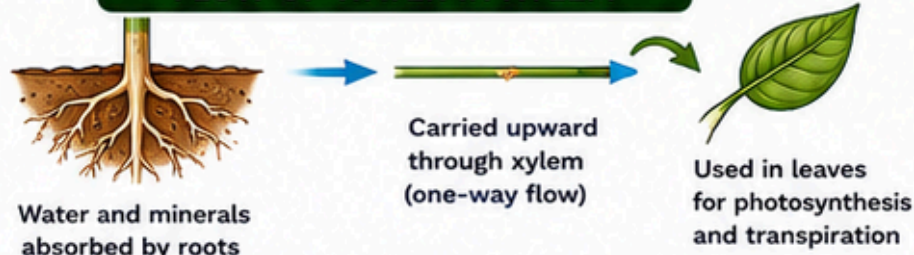
DIAGRAMMATIC VIEW (T.S. OF STEM)



COMPARISON OF XYLEM COMPONENTS

Feature	Tracheids	Vessels	Xylem Fibres	Xylem Parenchyma
Nature of Cells	Dead	Dead	Dead	Living
Shape	Long, narrow, spindle-shaped	Tube-like, cylindrical	Long, narrow, tapering	Isodiametric or elongated
End Walls	Absent	Absent or perforated	Absent	Present
Wall Thickness	Thick	Thick	Very thick	Thin
Lumen	Narrow	Wide	Very narrow	Large
Main Function	Conduction of water; support	Conduction of water	Mechanical support	Storage; radial conduction
Occurrence	All vascular plants	Mainly in angiosperms	All vascular plants	All vascular plants

FLOW OF WATER IN XYLEM



SUMMARY

Xylem is a complex permanent tissue of dead cells. It consists of tracheids, vessels, xylem fibres and xylem parenchyma. Together, they conduct water and minerals, provide mechanical strength and help in storage and radial conduction of substances.



NOTE: Xylem transports water and minerals upward only and gives strength to the plant.





PHLOEM – DETAILED STRUCTURE

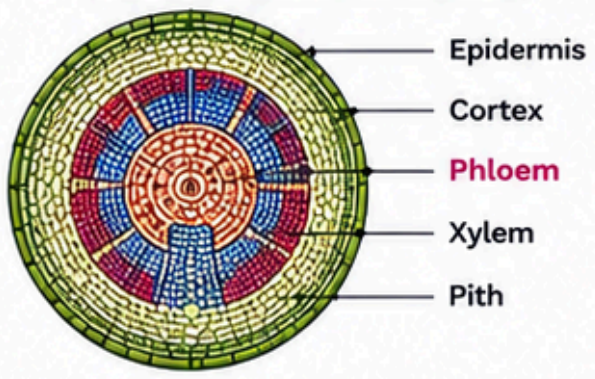


Phloem is a complex permanent tissue that **transports food (sugars)** and other organic substances from **leaves** to all parts of the plant.

KEY POINTS

- ✓ Phloem is composed of living cells.
- ✓ It transports prepared food from leaves to other parts of the plant.
- ✓ Food can move in both upward and downward directions.
- ✓ It also stores food and provides mechanical support.
- ✓ It consists of sieve tubes, companion cells, phloem parenchyma and phloem fibres.

LOCATION OF PHLOEM



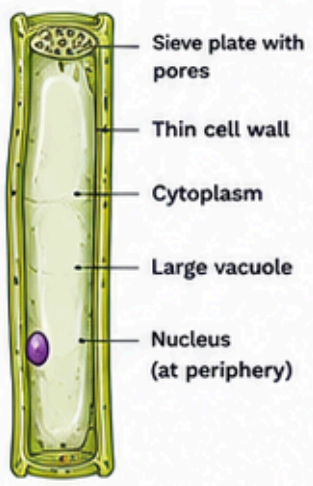
Phloem is present towards the outer side (outside) of the vascular bundle.

FUNCTIONS OF PHLOEM

- Translocation** – Transport of food, amino acids, hormones and other substances.
- Storage** – Stores food in phloem parenchyma cells.
- Support** – Provides mechanical strength with the help of phloem fibres.
- Bidirectional transport** – Food can move upward or downward as needed.
- Helps in distribution of nutrients and maintains plant activities.**

COMPONENTS OF PHLOEM

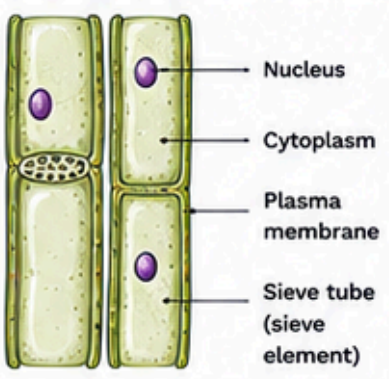
1. SIEVE TUBES (SIEVE ELEMENTS)



- Long, tube-like living cells.
- End walls have sieve plates with pores.
- Cytoplasm is present but nucleus is absent in mature cells.
- Main function is to transport food.

Found in :
All vascular plants (angiosperms, gymnosperms).

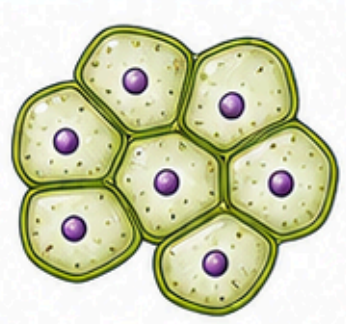
2. COMPANION CELLS



- Narrow, living cells associated with sieve tubes.
- Have nucleus and dense cytoplasm.
- Help sieve tubes in loading and unloading of food.
- Maintain the functioning of sieve tubes.

Found in :
Only in angiosperms.

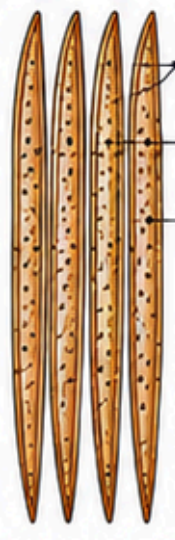
3. PHLOEM PARENCHYMA



- Living, thin-walled cells.
- Store food (starch, proteins, oils, etc.).
- Help in lateral transport of food.
- Help in healing of injured parts.

Found in :
All vascular plants.

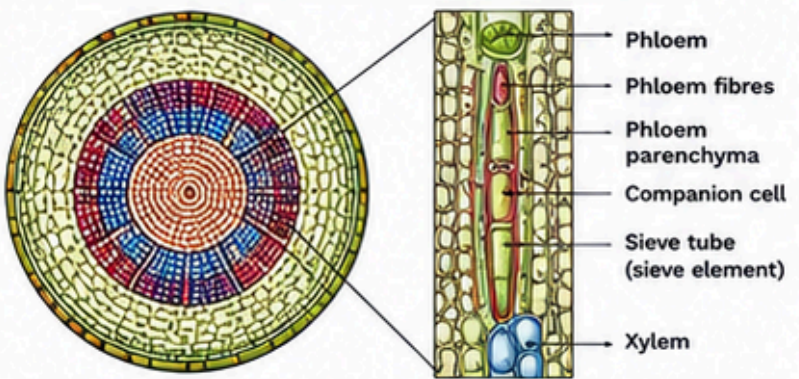
4. PHLOEM FIBRES (BAST FIBRES)



- Long, thick-walled cells with pointed ends.
- Dead at maturity.
- Provide mechanical strength to the phloem.

Found in :
All vascular plants.

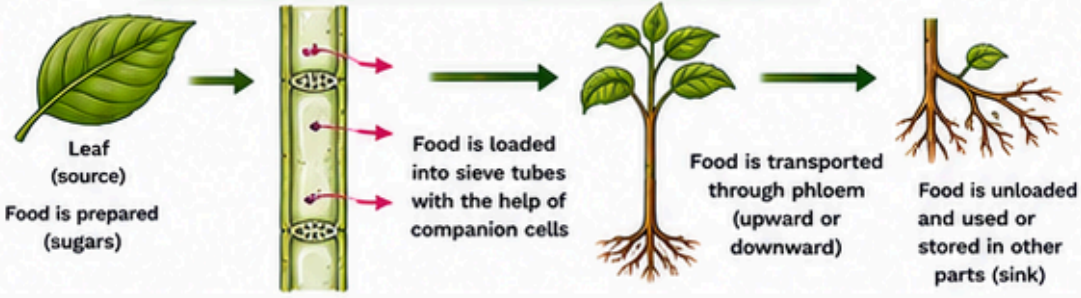
DIAGRAMMATIC VIEW (T.S. OF STEM)



COMPARISON OF PHLOEM COMPONENTS

Feature	Sieve Tubes (Sieve Elements)	Companion Cells	Phloem Parenchyma	Phloem Fibres (Bast Fibres)
Nature of Cells	Living (at maturity)	Living	Living	Dead (at maturity)
Shape	Long, tubular	Narrow, elongated	Isodiametric or elongated	Long, narrow with tapered ends
Cell Wall	Thin, non-lignified	Thin, non-lignified	Thin, non-lignified	Thick, lignified
Nucleus	Absent	Present	Present	Absent
Main Function	Transport of food	Aid in food transport	Storage and lateral transport	Mechanical support
Occurrence	All vascular plants	Only in angiosperms	All vascular plants	All vascular plants

FLOW OF FOOD IN PHLOEM (TRANSLOCATION)



SUMMARY

Phloem is a complex permanent tissue of living cells. It consists of sieve tubes, companion cells, phloem parenchyma and phloem fibres. It transports food prepared in leaves to all parts of the plant in both upward and downward directions and also provides storage and mechanical support.



NOTE: Phloem transports food in both upward and downward directions wherever needed. It is essential for growth and survival of the plant.





PLANT TISSUE CLASSIFICATION

COMPLETE CHART



Plant tissues are groups of cells with similar **structure** and **function**. They work together to perform various functions and help in the **growth** and **development** of plants.

MAJOR TYPES OF PLANT TISSUES

1. MERISTEMATIC TISSUES

Actively dividing cells
Responsible for growth

APICAL MERISTEM

Present at the tips of roots and shoots. Increases length.



LATERAL MERISTEM

Present along the sides of stems and roots. Increases girth.



FUNCTIONS

- Cell division
- Increase in length (apical)
- Increase in girth (lateral)
- Formation of permanent tissues

2. PERMANENT TISSUES

Cells lose the ability to divide and perform specific functions

SIMPLE PERMANENT

Made up of one kind of cells

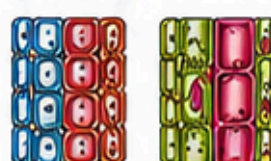
- Parenchyma
- Collenchyma
- Sclerenchyma



COMPLEX PERMANENT

Made up of more than one kind of cells working together

- Xylem
- Phloem



FUNCTIONS

- Simple tissues – Storage, support, photosynthesis, secretion, healing
- Complex tissues – Transport of water, minerals and food
- Provide strength and flexibility

3. PROTECTIVE TISSUES

Protect the plant from injuries and infection

EPIDERMIS

Single-layered cells covering the outer surface of plant parts.



CORK (PERIDERM)

Secondary protective tissue replacing epidermis in older parts.

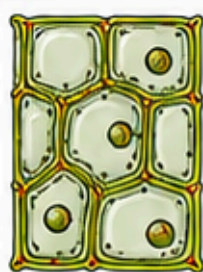


FUNCTIONS

- Protection from physical injury
- Prevents water loss
- Protects from pathogens
- Helps in absorption (in roots)

SIMPLE PERMANENT TISSUES – TYPES AND FUNCTIONS

1. PARENCHYMA



Structure : Living cells with thin wall and large vacuole.
Location : Cortex, pith, mesophyll, medullary rays, fruits, etc.
Functions : Storage, photosynthesis, secretion, healing and repair.

2. COLLENCHYMA



Structure : Living, elongated cells with unevenly thickened walls.
Location : Below epidermis of dicot stems, petioles, leaf midribs.
Functions : Provides flexibility and mechanical support to growing parts.

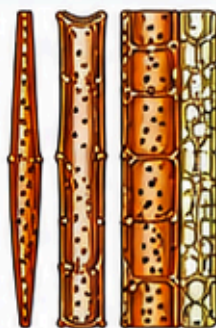
3. SCLERENCHYMA



Structure : Dead cells with very thick, lignified walls.
Location : Around vascular bundles, in seed coats, nutshells, leaf veins.
Functions : Provides mechanical strength and rigidity to mature parts.

COMPLEX PERMANENT TISSUES – TYPES AND FUNCTIONS

1. XYLEM

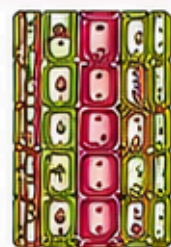


Components : Tracheids, Vessels, Xylem fibres, Xylem parenchyma
Function : Conduction of water and minerals from roots to other parts (upward only)
Support : Provides mechanical strength
Location : Towards the inner side of vascular bundle



Tracheid Vessel Xylem Fibre Xylem Parenchyma

2. PHLOEM



Components : Sieve tubes, Companion cells, Phloem fibres, Phloem parenchyma
Function : Transport of food (sugars) and other organic substances from leaves to all parts (upward and downward)
Support : Phloem fibres provide strength
Location : Towards the outer side of vascular bundle



Sieve Tube Companion Cell Phloem Fibre Phloem Parenchyma

QUICK COMPARISON OF ALL PLANT TISSUES

Feature	Meristematic Tissues	Parenchyma	Collenchyma	Sclerenchyma	Xylem	Phloem	Protective Tissues
Nature of Cells	Living, thin-walled, actively dividing	Living, thin-walled	Living, unevenly thickened walls	Dead, thick, lignified walls	Mostly dead (except parenchyma) with lignified walls	Living (except fibres)	Living (epidermis) / Dead (cork)
Main Function	Growth (increase in length & girth)	Storage, photosynthesis, secretion, healing	Support & flexibility	Strength & rigidity	Transport of water & minerals (upward)	Transport of food (up & down)	Protection
Location	Tips & sides of roots/shoots	All soft parts – cortex, pith, leaves	Below epidermis of young dicot parts	Mature parts – around bundles, seed coats, etc.	Inner side of vascular bundle	Outer side of vascular bundle	Outer covering of plant parts
Cell Wall	Thin (cellulose)	Thin (cellulose)	Unevenly thickened (cellulose & pectin)	Very thick (lignified)	Thick, lignified	Thin (cellulose) except fibres (thick)	Epidermis – thin Cork – thick, lignified
Ability to Divide	Yes	No	No	No	No	No	No



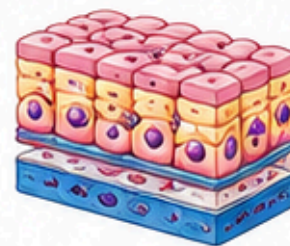
PLANT TISSUES WORK TOGETHER TO SUPPORT LIFE PROCESSES, ENSURE **GROWTH**, **TRANSPORT MATERIALS** AND **PROTECT** THE PLANT.



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EPITHELIAL TISSUE – TYPES



Epithelial tissue covers body surfaces, lines body cavities and forms glands.
It is made up of **closely packed cells** with very little intercellular space.

KEY FEATURES

- ✓ Cells are closely packed.
- ✓ Very little intercellular space.
- ✓ Avascular (no blood vessels).
- ✓ Rest on a basement membrane.
- ✓ High regenerative capacity.

FUNCTIONS

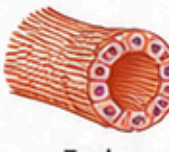
- Protection
- Absorption
- Secretion
- Excretion
- Filtration
- Sensory reception

BASED ON NUMBER OF LAYERS

- Simple Epithelium – Single layer of cells.
- Stratified Epithelium – Two or more layers of cells.
- Pseudostratified Epithelium – Cells appear in layers but all rest on basement membrane.

TYPES OF EPITHELIAL TISSUE

I. SIMPLE EPITHELIUM (Single layer of cells)

TYPE	STRUCTURE	LOCATION	FUNCTIONS	EXAMPLES / ILLUSTRATIONS
1. Simple Squamous Epithelium	Single layer of thin, scale-like cells.	- Alveoli of lungs - Walls of blood vessels and capillaries - Bowman's capsule in kidney	- Diffusion - Filtration - Reduces friction	 Alveoli  Capillary  Kidney (Bowman's capsule)
2. Simple Cuboidal Epithelium	Single layer of cube-shaped cells.	- Kidney tubules - Ducts of glands - Thyroid follicles - Surface of ovary	- Secretion - Absorption - Excretion	 Kidney tubule  Gland duct  Thyroid follicle
3. Simple Columnar Epithelium	Single layer of tall, column-shaped cells.	- Lining of stomach - Intestine - Gall bladder - Uterus	- Absorption - Secretion - Protection	 Stomach lining  Intestine lining  Gall bladder
4. Ciliated Columnar Epithelium	Columnar cells with ciliated free surface.	- Trachea - Bronchi - Fallopian tubes	- Moves mucus, dust and foreign particles - Moves ova	 Trachea  Bronchus  Fallopian tube
5. Pseudostratified Ciliated Columnar Epithelium	Single layer; appears stratified; all cells rest on basement membrane.	- Nasal cavity - Trachea - Upper part of respiratory tract	- Secretion of mucus - Moves mucus and traps dust - Protection	 Nasal cavity  Trachea  Respiratory tract

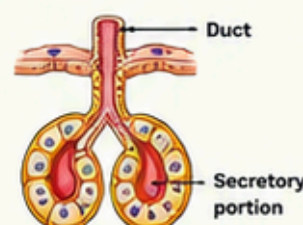
II. STRATIFIED EPITHELIUM (Two or more layers of cells)

TYPE	STRUCTURE	LOCATION	FUNCTIONS	EXAMPLES
1. Stratified Squamous Epithelium	Many layers; superficial cells are flat.	- Epidermis of skin - Mouth - Esophagus - Vagina	- Protection against wear and tear - Prevents water loss	 Skin (epidermis)
2. Stratified Cuboidal Epithelium	Two or more layers; superficial cells are cuboidal.	- Ducts of sweat glands - Ducts of salivary glands - Ovary	- Protection - Secretion	
3. Stratified Columnar Epithelium	Two or more layers; superficial cells are columnar.	- Ducts of large glands - Conjunctiva - Male urethra	- Protection - Secretion	 Salivary gland duct

III. GLANDULAR EPITHELIUM

EXOCRINE GLANDS

Have ducts. Secrete substances through ducts onto body surface or into body cavities.

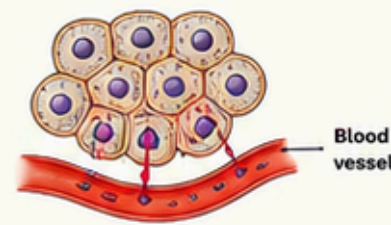


Examples:

- Sweat glands
- Salivary glands
- Mammary glands
- Gastric glands

ENDOCRINE GLANDS

Ductless. Secrete hormones directly into the blood.



Examples:

- Pituitary gland
- Thyroid gland
- Pancreas (islets of Langerhans)
- Adrenal gland



REMEMBER: Epithelial tissue covers, lines and protects. It absorbs, secretes and senses – keeping us healthy!



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CONNECTIVE TISSUE – TYPES

Strong Support • Flexible Connection • A Vital Part of Our Body

Connective tissues are widely distributed throughout the body. They bind, support, protect and connect different tissues and organs, and also help in resistance, transport, storage and repair.

Different Tissues One Amazing Body! ❤️

KEY FEATURES

- ✓ Cells are scattered and not closely packed (except blood).
- ✓ Abundant extracellular matrix (fibres and ground substance).
- ✓ Well vascularized (except cartilage).
- ✓ Generally non-living fibres (proteins and polysaccharides) provide strength and elasticity.
- ✓ Varying composition and appearance depending on type and location.

MAIN FUNCTIONS



Bind and support tissues and organs



Provide mechanical strength and protection



Help in transport of substances



Store energy, water and minerals



Give shape and maintain form



Aid in repair and regeneration



Provide immune defence



Create a supportive environment for cells

CLASSIFICATION

1. Connective tissue proper

- Loose (areolar) connective tissue
- Dense connective tissue
 - Dense regular
 - Dense irregular

2. Supporting connective tissue

- Cartilage
- Bone

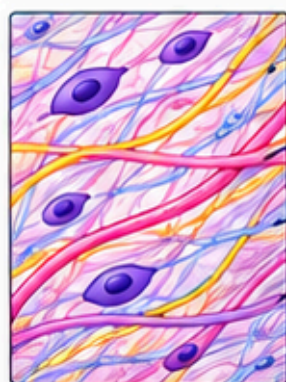
3. Fluid connective tissue

- Blood
- Lymph

DIFFERENT TYPES... SAME IMPORTANT ROLE!

1. CONNECTIVE TISSUE PROPER – FORMS THE MATRIX AND BINDS TISSUES

A. LOOSE (AREOLAR) CONNECTIVE TISSUE



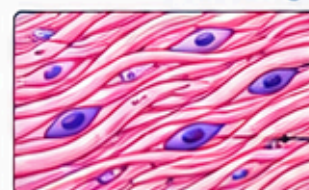
Fibroblast
Collagen fibre
Elastic fibre
Ground substance

Key Points

- Widely distributed under the skin, between organs and around blood vessels.
- Loose arrangement of fibres and cells.
- Provides flexibility and support.
- Rich in ground substance with collagen, elastic and reticular fibres.

B. DENSE CONNECTIVE TISSUE

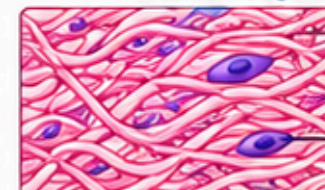
Dense Regular



Collagen fibres
Fibroblast

- Strong and well organized collagen fibres in parallel rows.
- Found in tendons, ligaments and aponeuroses.
- Provides great tensile strength in one direction.

Dense Irregular



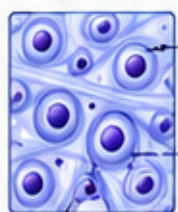
Collagen fibres
Fibroblast

- Irregularly arranged fibres in different directions.
- Found in dermis of skin, organs and joint capsules.
- Provides strength in multiple directions.

2. SUPPORTING CONNECTIVE TISSUE – GIVES STRENGTH & SUPPORT

A. CARTILAGE

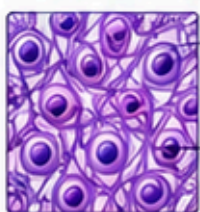
Hyaline cartilage



Chondrocyte (in lacuna)
Matrix

- Smooth, glassy matrix (Rich in type II collagen).
- Found in nose, trachea, articular surfaces.
- Provides smooth surface, flexibility and support.

Elastic cartilage



Elastic fibres
Chondrocyte

- Contains elastic fibres and fewer collagen fibres.
- Found in ear, epiglottis and eustachian tube.
- Provides flexibility and support.

Fibrocartilage



Collagen bundles
Chondrocyte

- Very tough, thick collagen fibres.
- Found in intervertebral discs, pubic symphysis, menisci.
- Withstands compression and resists shock.

B. BONE

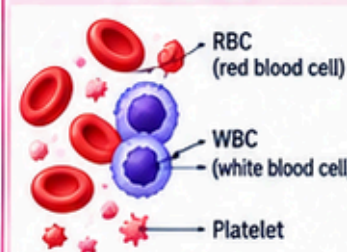


Osteon
Bone cell (osteocyte)
Matrix (hard)

- Hard, mineralized matrix (live tissue).
- Provides rigid support and protection.
- Stores minerals (calcium, phosphorus).
- Forms skeleton with many types of cells.

3. FLUID CONNECTIVE TISSUE – TRANSPORTS SUBSTANCES THROUGH THE BODY

A. BLOOD



RBC (red blood cell)
WBC (white blood cell)
Platelet

- Fluid matrix (plasma) with cells and platelets.
- Transports oxygen, nutrients, hormones and waste products.
- Helps in immunity and clotting.

B. LYMPH

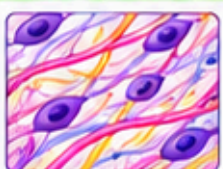


Lymphocyte
WBC
Lymphatic vessel

- Clear fluid with lymphocytes (WBCs).
- Helps in immunity.
- Returns excess fluid to bloodstream.
- Absorbs fats from intestines.

ALL TYPES OF CONNECTIVE TISSUE AT A GLANCE

LOOSE (AREOLAR)



Flexible • Connective • Supports
Under skin, around organs, between tissues, around blood vessels.

DENSE REGULAR



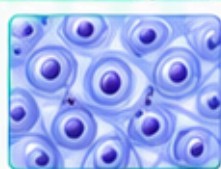
Strong • Tendon • Ligament
Tendons, ligaments, aponeuroses.

DENSE IRREGULAR



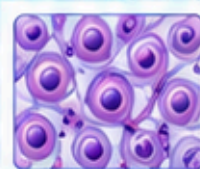
Strong • Multi-directional
Dermis of skin, organs, joint capsules.

CARTILAGE (Hyaline)



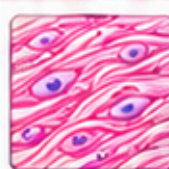
Smooth • Flexible • Support
Nose, trachea, articular surfaces.

CARTILAGE (Elastic)



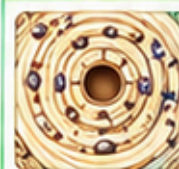
Flexible • Elasticity
Ear, epiglottis, eustachian tube.

CARTILAGE (Fibro-)



Tough • Shock resistance
Intervertebral discs, menisci.

BONE



Rigid • Support • Store
Skeleton (calcium & minerals).

BLOOD



Transport • Defence • Clotting
Oxygen, nutrients, hormones, waste.

LYMPH



Immunity • Drainage
Lymph nodes, lymphatic vessels.



REMEMBER:

Connective tissues build, bind, support and protect the body – they are the silent workers that keep us going!

Healthy Tissues A Stronger You



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LEARN • GROW • ACHIEVE



Know Your Body Appreciate Its Wonder! ❤️



STRIATED, SMOOTH & CARDIAC MUSCLES



THREE TYPES OF MUSCLE TISSUE IN HUMAN BODY

Muscles bring **movement**, maintain **posture** and support **vital** functions.

	1. STRIATED (SKELETAL) MUSCLE	2. SMOOTH (NON-STRIATED) MUSCLE	3. CARDIAC MUSCLE
APPEARANCE (DIAGRAM)			
STRUCTURE	- Long, cylindrical, unbranched fibers. - Multinucleate (many nuclei) and nuclei are at the periphery. - Prominent light and dark bands (striations) due to arrangement of actin and myosin.	- Spindle-shaped (tapered at ends) cells. - Uninucleate and nucleus is central. - No striations. - Cells arranged in sheets.	- Short, cylindrical, branched fibers. - Usually single nucleus (sometimes two) and central. - Striated but less regular. - Intercalated discs join the cells end to end.
LOCATION	Attached to bones of the skeleton (e.g., biceps, triceps, leg muscles, muscles of face, diaphragm).	Walls of internal organs and hollow structures (e.g., stomach, intestines, blood vessels, urinary bladder, uterus, bronchi, iris of eye).	Wall of heart (myocardium).
CONTROL / NATURE	- Voluntary (under conscious control). - Moves the body parts.	- Involuntary (not under conscious control). - Moves internal organs and maintains functions.	- Involuntary (myogenic – rhythmic by nature). - Continuous rhythmic contractions pump blood.
FUNCTION	- Brings about movement of body parts. - Maintains posture and balance. - Produces heat. - Helps in respiration (diaphragm).	- Propels food in digestive tract (peristalsis). - Regulates diameter of blood vessels. - Contracts urinary bladder. - Controls size of pupil and bronchi.	- Pumps blood continuously throughout the body. - Maintains blood pressure and circulation.
CONTRACTION	- Fast and powerful. - Tiring – fatigue occurs. - Under voluntary control.	- Slow and sustained. - Non-tiring – can work for long hours. - Not under voluntary control.	- Rhythmic and continuous. - Does not fatigue. - Myogenic (self-initiated).
CELL DIAGRAM	Striated (Skeletal) Muscle Fiber 	Smooth Muscle Cell 	Cardiac Muscle Cell

QUICK COMPARISON

FEATURE	STRIATED (SKELETAL)	SMOOTH (NON-STRIATED)	CARDIAC
Striations	Present	Absent	Present (less regular)
Shape	Long, cylindrical, unbranched	Spindle-shaped	Short, cylindrical, branched
Nuclei	Many, peripheral	Single, central	Single (sometimes two), central
Control	Voluntary	Involuntary	Involuntary (myogenic)
Location	Attached to skeleton	Walls of internal organs	Heart wall
Contraction	Fast, powerful, tiring	Slow, sustained, non-tiring	Rhythmic, continuous, non-tiring
Main Function	Body movement, posture, heat	Movement of organs, regulate diameter, peristalsis, other functions	Pumps blood, maintains circulation



Remember: **Striated** moves your body, **Smooth** works inside your body, **Cardiac** keeps your heart beating!



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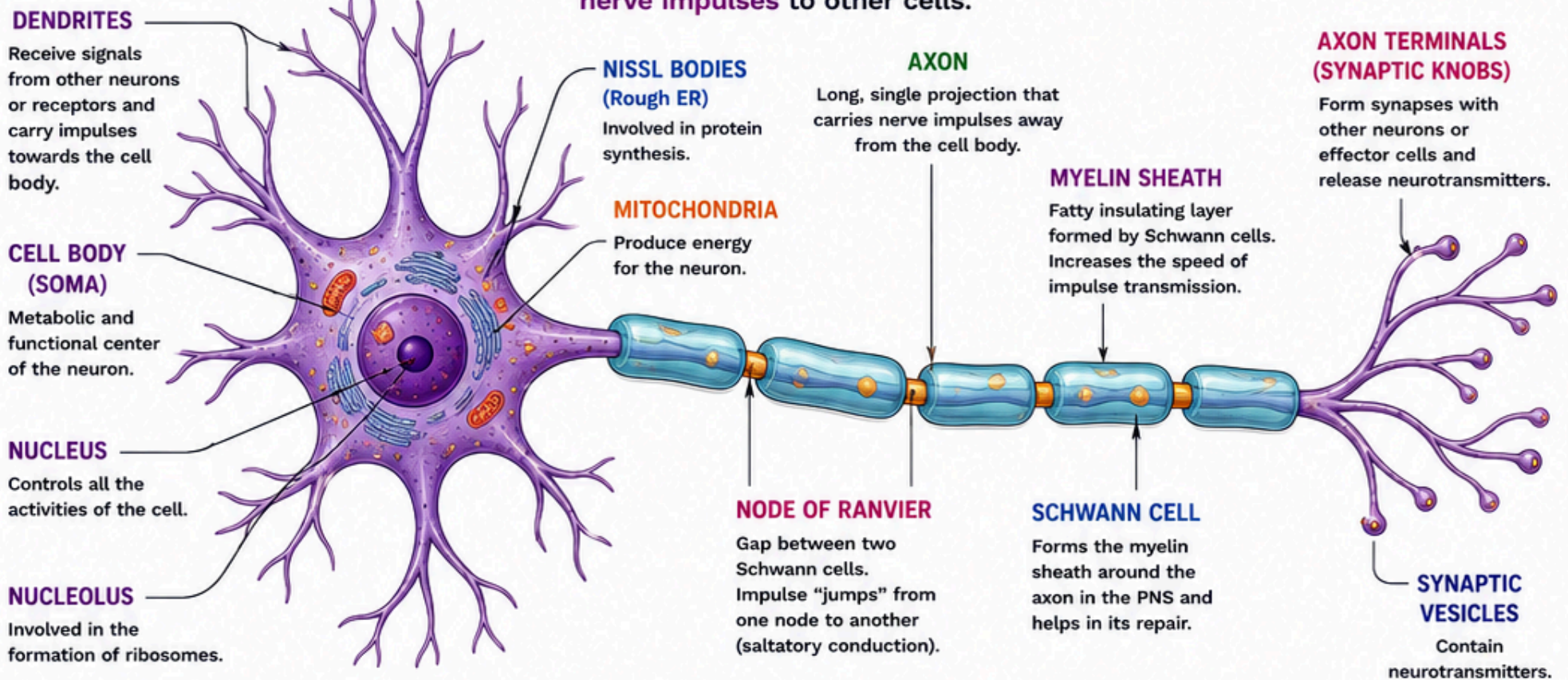


NEURON - DETAILED LABELLED DIAGRAM

THE STRUCTURAL AND FUNCTIONAL UNIT OF NERVOUS SYSTEM

Neurons receive signals, process them and transmit nerve impulses to other cells.

DID YOU KNOW?
The human brain contains around **86 billion** neurons!



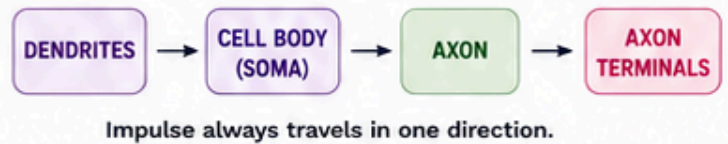
FUNCTIONS OF A NEURON

- SENSES:** Receives stimuli from internal or external environment.
- INTEGRATION:** Processes and integrates the information.
- TRANSMISSION:** Sends impulses to other neurons, muscles or glands.
- COMMUNICATION:** Facilitates coordination and control of the body.

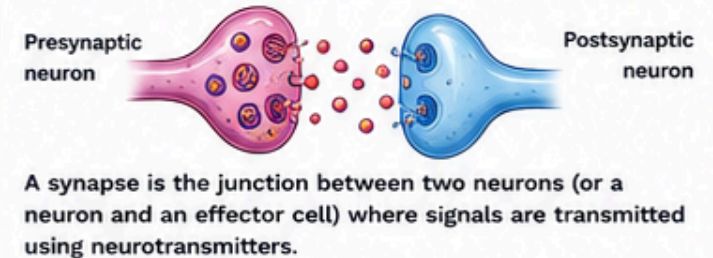
TYPES OF NEURONS

- SENSORY (AFFERENT) NEURONS**
Carry impulses from sense organs to the CNS.
- MOTOR (EFFECTOR) NEURONS**
Carry impulses from the CNS to muscles or glands.
- INTERNEURONS (ASSOCIATION)**
Connect sensory and motor neurons within the CNS.

DIRECTION OF NERVE IMPULSE



SYNAPSE

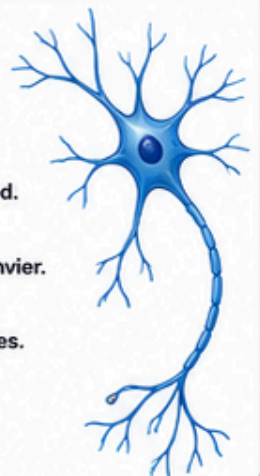


PARTS OF A NEURON - SUMMARY TABLE

PART	DESCRIPTION
Dendrites	Short, branched projections that receive impulses.
Cell Body (Soma)	Contains nucleus and organelles; maintains the neuron.
Nissl Bodies (RER)	Sites for protein synthesis.
Nucleus	Controls all activities of the neuron.
Nucleolus	Forms ribosomes.
Mitochondria	Produce energy (ATP) required for activities.
Axon	Long projection that carries impulses away from the soma.
Myelin Sheath	Insulating layer that increases speed of conduction.
Schwann Cell	Forms myelin in PNS and helps in axon repair.
Node of Ranvier	Gap between myelin sheaths; site of impulse "jump".
Axon Terminals	End branches that release neurotransmitters.
Synaptic Vesicles	Small sacs in terminals that store neurotransmitters.

KEY POINTS

- Neurons are excitable cells and do not divide.
- They have a high oxygen and energy requirement.
- Myelin sheath acts as an insulator and increases conduction speed.
- Saltatory conduction (jumping of impulse) occurs at Node of Ranvier.
- Neurotransmitters are chemical messengers released at synapses.
- The neuron is the basic unit of the nervous system.



REMEMBER:

Neurons work together in networks to help you think, move, feel and do everything every day!

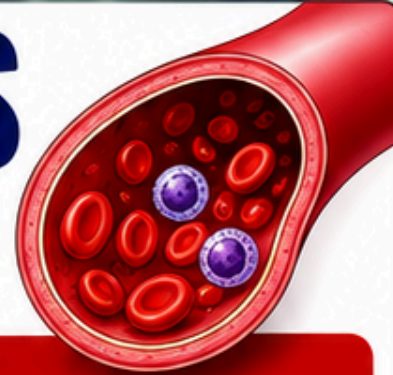


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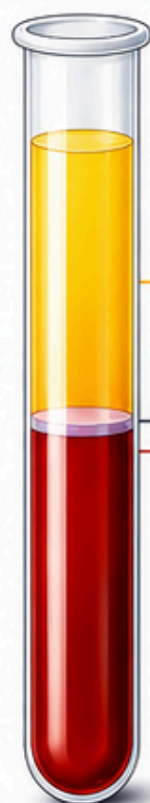


BLOOD – COMPONENTS



Blood is a fluid connective tissue that circulates in our body.
It is made up of **plasma** and **formed elements**.

COMPOSITION OF BLOOD



PLASMA 55%

Straw-colored liquid matrix in which all components are suspended.

BUFFY COAT <1%

Thin layer of white blood cells and platelets.

FORMED ELEMENTS 45%

Cellular components of blood.

FORMED ELEMENTS OF BLOOD

(They are produced in **Red Bone Marrow**)

1. RED BLOOD CELLS (ERYTHROCYTES)

- Most numerous cells in blood.
- Biconcave disc shaped, no nucleus.
- Contain hemoglobin (red pigment).
- Life span: about 120 days.

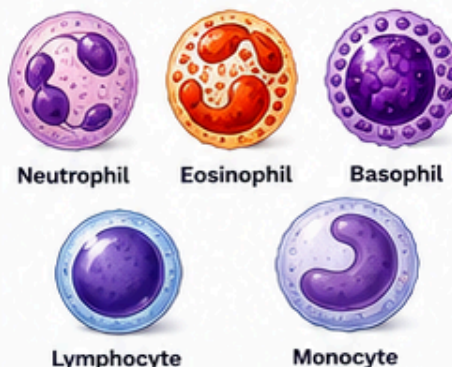


FUNCTIONS

- Transport oxygen from lungs to body tissues.
- Carry a small amount of carbon dioxide back to lungs.

2. WHITE BLOOD CELLS (LEUKOCYTES)

- Nucleated cells.
- Less in number than RBCs.
- Colorless.
- Life span: from a few hours to several years (varies).

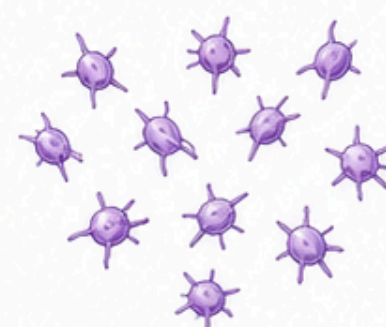


FUNCTIONS

- Protect the body against infections and foreign substances.
- Provide immunity.

3. PLATELETS (THROMBOCYTES)

- Smallest formed elements.
- Cell fragments, no nucleus.
- Irregular in shape.
- Life span: 5–10 days.



FUNCTIONS

- Help in blood clotting.
- Prevent excessive bleeding when blood vessels are injured.

PLASMA – LIQUID PART OF BLOOD

MAJOR CONSTITUENTS



**PLASMA
(55%)**



**Water
(90–92%)**

Maintains blood volume, helps in transport of substances.



**Proteins
(7–8%)**

Albumin – Maintains osmotic pressure.
Globulin – Immunity (antibodies).
Fibrinogen – Helps in clotting.



**Other Solutes
(1–2%)**

Electrolytes (Na^+ , K^+ , Cl^- , HCO_3^-),
Nutrients (glucose, amino acids, lipids),
Hormones, Vitamins, Enzymes,
Wastes (urea, uric acid, creatinine).

FUNCTIONS OF PLASMA



Transports nutrients, hormones, gases, and waste products.



Maintains blood volume and fluid balance.



Helps in regulation of pH and body temperature.



Proteins help in immunity and clotting.

BUFFY COAT – <1%

(At the junction between plasma and RBCs)

Contains:



**White Blood Cells
(Leukocytes)**



**Platelets
(Thrombocytes)**

FUNCTION: Defense against infection and helps in clotting.

COMPARISON OF FORMED ELEMENTS

Feature	Red Blood Cells (RBCs)	White Blood Cells (WBCs)	Platelets
Number	4.5 – 6 million / mm^3 of blood	4,000 – 11,000 / mm^3 of blood	1.5 – 4 lakh / mm^3 of blood
Shape	Biconcave disc	Spherical / Irregular	Irregular fragments
Nucleus	Absent	Present	Absent
Contains	Hemoglobin	Nucleus, enzymes	Clotting factors
Life span	~120 days	Few hours to several years	5–10 days
Function	Transport O_2 and some CO_2	Body defense / Immunity	Clotting of blood

NORMAL RANGE IN ADULTS

	RBC Count	4.5 – 6.0 million / mm^3
	WBC Count	4,000 – 11,000 / mm^3
	Platelet Count	1.5 – 4.0 lakh / mm^3
	Hemoglobin (Hb)	Male: 13 – 17 g/dL Female: 12 – 15 g/dL

KEY POINTS



- Plasma is the liquid part that transports and supports.
- RBCs carry oxygen, WBCs fight infection, Platelets help in clotting.
- All components together maintain life and health.

DID YOU KNOW?



One drop ($\approx 50 \mu\text{L}$) of blood contains about 2.5 million RBCs, 7,000 WBCs and 150,000 platelets!



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BONE – DETAILED STRUCTURE

Bones are living organs that provide **support**, **protection**, **movement** and also **store minerals** and **produce blood cells**.



DID YOU KNOW?

An adult human has **206** bones.

TYPES OF BONES (By Shape)



Long Bones

Longer than wide.
(e.g., Femur, Humerus)



Short Bones

Cube-like.
(e.g., Carpals, Tarsals)



Flat Bones

Thin, flat and often curved.
(e.g., Skull, Ribs, Sternum)



Irregular Bones

Complex shapes.
(e.g., Vertebrae)



Sesamoid Bones

Develop within tendons.
(e.g., Patella – Knee cap)

STRUCTURE OF A LONG BONE (e.g., FEMUR)

Proximal Epiphysis

The rounded end of the bone.

Metaphysis

Area of growth (growth plate in children).

Diaphysis

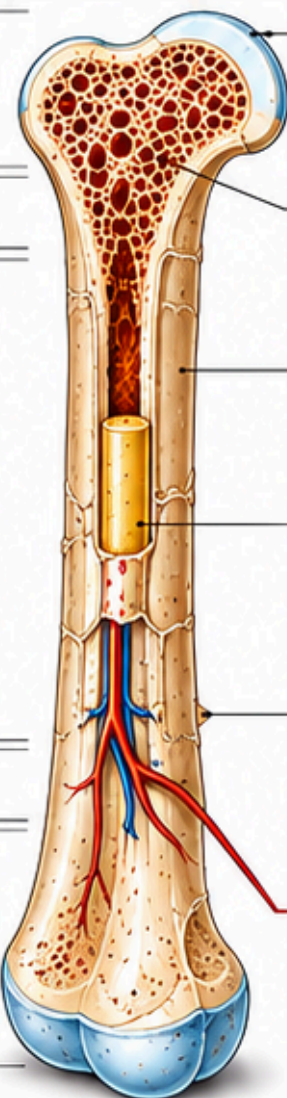
The shaft or main body.

Metaphysis

Area of growth (growth plate in children).

Distal Epiphysis

The rounded end of the bone.



Articular Cartilage

Smooth cartilage covering the ends of bones at joints; reduces friction.

Spongy Bone

Contains spaces (trabeculae) filled with red bone marrow.

Compact Bone

Dense, hard outer layer; gives strength and protection.

Medullary Cavity

Hollow cavity in the shaft; contains yellow bone marrow (fat storage).

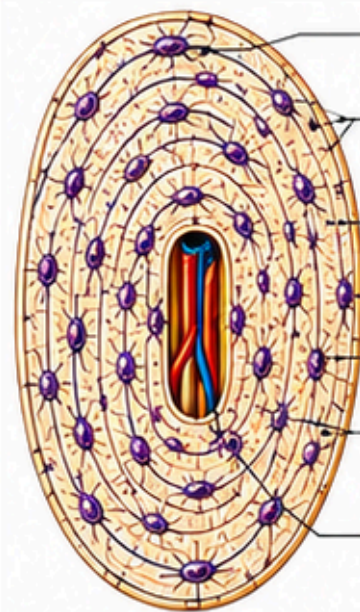
Periosteum

Tough, fibrous membrane covering the outer surface; has blood vessels and nerves.

Nutrient Foramen

Opening for blood vessels and nerves to enter the bone.

BONE TISSUE (Microscopic View)



Osteon (Haversian System)

Lamellae (Concentric rings)

Lacuna (Space containing osteocyte)

Osteocyte (Bone cell)

Canaliculi (Tiny channels connecting lacunae)

Haversian Canal (Contains blood vessels and nerves)

CELLS OF BONE



Osteoprogenitor Cells
Stem cells that develop into osteoblasts.



Osteoblasts
Form new bone matrix (bone-forming cells).



Osteocytes
Mature bone cells maintaining bone tissue.



Osteoclasts
Large cells that break down old bone (bone-resorbing).

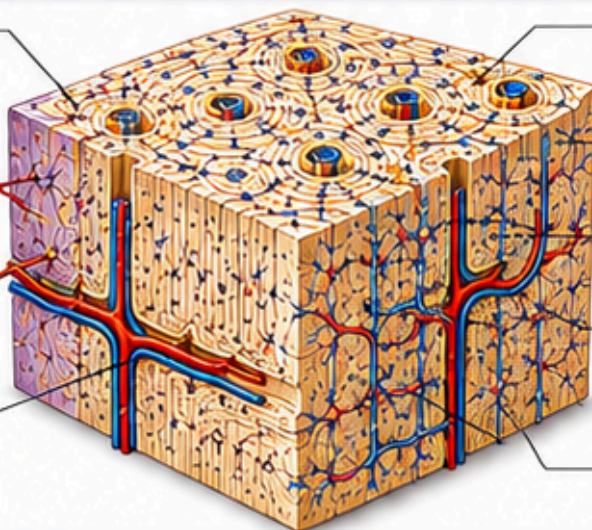
COMPACT BONE – CROSS SECTION

Periosteum (Outer Covering)
Protects the bone and contains blood vessels and nerves.

Sharpey's Fibers
Fibers that anchor the periosteum to bone.

Blood Vessels
Provide nutrients and oxygen.

Nutrient Foramen
Entry point for blood vessels and nerves.



Osteon (Haversian System)
Structural unit of compact bone.

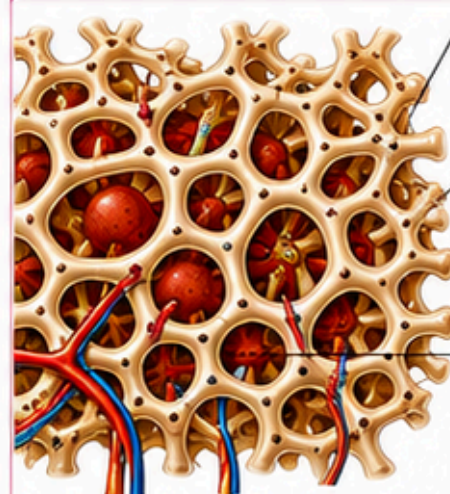
Lamellae
Concentric layers of bone matrix.

Lacunae with Osteocytes
Spaces that house mature bone cells.

Canaliculi
Microscopic channels that connect lacunae to each other and to Haversian canal.

Haversian (Central) Canal
Contains blood vessels and nerves.

SPONGY (CANCELOUS) BONE



Trabeculae
Bone spicules form a lattice structure.

Red Bone Marrow
Fills the spaces between trabeculae; site of blood cell formation.

Blood Vessels
Supply nutrients to marrow and bone cells.

FUNCTIONS OF BONE



Support

Provides framework and shape to the body.



Protection

Protects vital organs (e.g., Skull protects brain).



Movement

Works with muscles and joints to produce movement.



Blood Cell Formation

Red marrow produces RBCs, WBCs and platelets.



Mineral Storage

Stores calcium and phosphorus; helps in maintaining mineral balance.



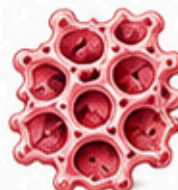
Fat Storage

Yellow marrow stores fat (energy reserve).

BONE MARROW

Red Bone Marrow

- Soft, vascular tissue.
- Found in spongy bone (epiphysis of long bones, flat bones, vertebrae, ribs, sternum, pelvis).
- Produces blood cells.



Yellow Bone Marrow

- Contains fat cells.
- Found in medullary cavity of long bones.
- Stores fat (energy).



GROWTH OF BONE



Cartilage Model

Bone begins as hyaline cartilage.

Growth Plate (Epiphyseal Plate)

Site of growth in length.

Bone Replacement

Cartilage is gradually replaced by bone.

Mature Bone

Growth plate closes after puberty; bone stops growing in length.



KEY POINTS

- ✓ Bone is a dynamic tissue that is constantly being built and broken down.
- ✓ A healthy diet, exercise and sunlight help in keeping bones strong.



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COMPLETE ANIMAL TISSUE CLASSIFICATION



Animal tissues are groups of **similar cells** that work together to perform **specific functions**.

FOUR MAIN TYPES OF ANIMAL TISSUES

1. EPITHELIAL TISSUE

Covers body surfaces, lines body cavities and forms glands.

TYPES

A. Covering / Lining Epithelium

1. Simple Squamous

Single layer of flat cells.
(Example: Alveoli of lungs)



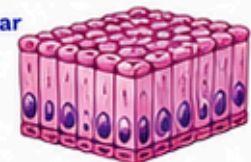
2. Simple Cuboidal

Single layer of cube-shaped cells.
(Example: Kidney tubules)



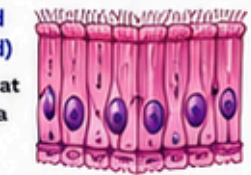
3. Simple Columnar

Single layer of tall cells.
(Example: Lining of intestine)



4. Pseudostratified Columnar (Ciliated)

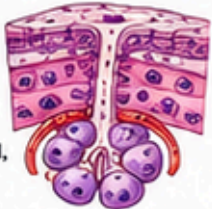
Single layer; nuclei at different levels; cilia present.
(Example: Trachea)



B. Glandular Epithelium

1. Exocrine Glands

Have ducts; secrete substances on body surface or into body cavities.
(Example: Salivary gland, Sweat gland)



2. Endocrine Glands

No ducts; secrete hormones directly into blood.
(Example: Thyroid gland, Pituitary gland)



2. CONNECTIVE TISSUE

Connects, supports, binds and separates different tissues and organs.

TYPES

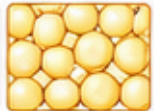
A. Proper Connective Tissue

1. Loose Connective Tissue

- Areolar Tissue (wraps organs, holds tissue)
- Adipose Tissue (stores fat, insulates)
- Reticular Tissue (forms supportive framework in organs)



Areolar



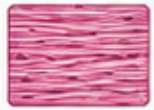
Adipose



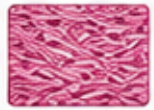
Reticular

2. Dense Connective Tissue

- Dense Regular (tendons, ligaments)
- Dense Irregular (dermis of skin)
- Elastic Tissue (walls of large arteries)



Dense Regular



Dense Irregular



Elastic Tissue

B. Supporting Connective Tissue

1. Cartilage

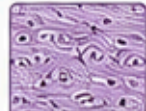
- Hyaline Cartilage (nose, trachea)
- Elastic Cartilage (pinna of ear)
- Fibrocartilage (intervertebral discs)



Hyaline



Elastic



Fibrocartilage

2. Bone (Osseous Tissue)

- Hard, non-flexible tissue.
- Forms skeleton, protects organs, stores minerals.



C. Fluid Connective Tissue

1. Blood

- Fluid matrix called plasma.
- Contains RBCs, WBCs & platelets.



2. Lymph

- Clear fluid; contains WBCs (lymphocytes).
- Helps in immunity and fat absorption.

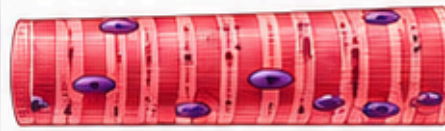


3. MUSCLE TISSUE

Brings about movement of body parts and internal organs.

TYPES

1. Striated (Skeletal) Muscle



- Long, cylindrical, unbranched fibers with obvious striations.
- Multinucleate; nuclei at periphery.
- Attached to bones.
- Voluntary in control.

2. Smooth (Non-striated) Muscle



- Spindle-shaped cells; no striations.
- Single, centrally placed nucleus.
- Present in walls of internal organs (intestine, blood vessels, uterus).
- Involuntary in control.

3. Cardiac Muscle



- Short, branched fibers; striated.
- Single or two nuclei; central.
- Intercalated discs present.
- Present in wall of heart (myocardium).
- Involuntary; rhythmic contractions.

FUNCTIONS OF MUSCLE TISSUE



Movement of body and organs



Maintains posture and stability



Circulates blood (heart muscle)



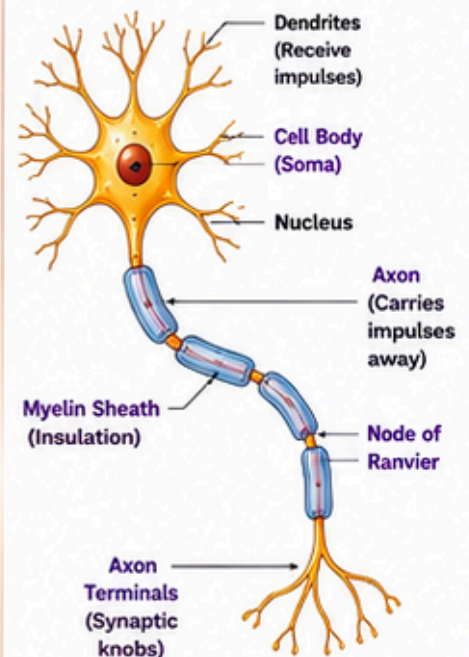
Generates heat

4. NERVOUS TISSUE

Detects stimuli, conducts impulses and coordinates body functions.

TYPES

A. Neurons (Nerve Cells)



B. Neuroglia (Supportive Cells)

1. Astrocytes – Provide support, maintain environment around neurons.
2. Oligodendrocytes – Form myelin sheath in CNS.
3. Schwann Cells – Form myelin sheath in PNS.
4. Microglia – Act as immune cells; remove debris.
5. Ependymal Cells – Line ventricles; help in fluid movement.

FUNCTIONS OF NERVOUS TISSUE



Receives and senses stimuli



Conducts nerve impulses



Processes and integrates information



Coordinates and controls all body activities

QUICK COMPARISON OF THE FOUR TISSUES

TISSUE TYPE	MAIN FUNCTION	CELL SHAPE	MATRIX	LOCATION	EXAMPLES
Epithelial	Covers, lines, protects, secretes	Flat, cuboidal, columnar	Very little (intercellular material)	Skin, lining of organs, glands	Skin epidermis, alveoli of lungs, salivary gland
Connective	Connects, supports, protects, transports	Varied	Abundant (intercellular material)	Throughout the body	Bone, cartilage, blood, areolar tissue
Muscle	Brings about movement and maintains posture	Long fibers (or spindle)	Very little	Attached to bones, walls of organs, heart	Biceps muscle, intestine wall, heart
Nervous	Detects, conducts and coordinates impulses	Neuron + Neuroglia	Very little	Brain, spinal cord, nerves	Brain tissue, spinal cord, peripheral nerves

KEY POINTS

- ✓ All animal tissues are made of cells.
- ✓ Cells with similar structure and function form tissues.
- ✓ Tissues work together to form organs and organ systems.
- ✓ Proper functioning of all tissues keeps the body healthy.



DID YOU KNOW?

Blood is the only fluid connective tissue in the body, and the heart is the only organ made entirely of muscle tissue!



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