Chapter 02 *Structural Organisation in Animals*

CONTENT

ANIMAL TISSUE

INTRODUCTION:

- In unicellular organisms, all functions like digestion, respiration and reproduction are performed by a single cell. In the complex body of multicellular animals, the same basic functions are carried out by different groups of cells in a well organised manner.
- The body of a simple organism like *Hydra* is made of different types of cells and the number of cells in each type can be in thousands. The human body is composed of billions of cells to perform various functions.
- In multicellular animals, a group of similar cells along with intercellular substances perform a specific function. Such an organization is called **tissue**.
- All complex animals consist of only four basic types of tissues. These tissues are organised in specific proportion and pattern to form an organ like stomach, lung, heart and kidney. When two or more organs perform a common function by their physical and/or chemical interaction, they together form organ system, e.g., digestive system, respiratory system, etc.
- Cells, tissues, organs and organ systems split up the work in a way that exhibits ***division of labour*** and contribute to the survival of the body as a whole.

ANIMAL TISSUES

A group of cells in which cells are similar in structure, function and origin is called tissue.
These cells may be **dissimilar in structure and function** but they are **always similar in origin**.

- Study of tissue – Histology
- Father of Histology – Bichat

On the basis of functions & structure, tissues are of four types:

1. **Epithelium/Epithelial Tissue:** Covering and protective tissue
2. **Connective Tissue:** To connect structures, provide support to the body and transport substances in the body
3. **Muscular Tissue:** Helps in contraction and locomotion.
4. **Neural tissue:** To generate and conduct nerve impulses in body.

EPITHELIAL TISSUE: (**Epi –** Upon**; Thelia –** growth)

- "A tissue which grows upon another tissue is called Epithelium."
- Epithelium is the only tissue in which cells are always arranged in uniform layer.
- During embryonic development epithelium originates first.

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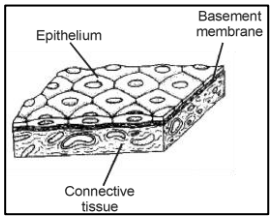
- Power of regeneration is present in this tissue.
- It always rests upon underlying connective tissue.
- Epithelium cells are closely packed with no/little inter cellular space.



- Due to absence of intercellular spaces blood vessels, lymph vessels & capillaries are unable to pierce this tissue so **blood circulation is absent** in epithelium. Hence, cells depend for their nutrition on underlying connective tissue.
- Between epithelium and connective tissue, a thin non-living acellular basement membrane is present which is highly permeable.

Origin of Epithelial Tissue: It is the only tissue which originated from all the three primordial germinal layers.

- Ectoderm – Epidermis (stratified squamous Epithelium)
- Mesoderm – Mesothelium(simple quamous Epithelium)
- Endoderm – Endothelium (simple squamous Epithelium)

Types of Epithelial Tissue:

SIMPLE EPITHELIUM:

- Composed of single layer of cells.

Epithelial Tissue

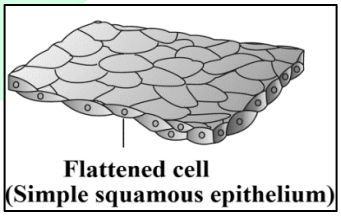
- Simple
  - (On the basis of shape/ structural modifications of cells)
    - Squamous
    - Cuboidal
    - Columnar
    - Pseudostratified
- Compound
  - Stratified
    - Stratified squamous
      - Keratinised
      - Non- Keratinised
    - Stratified cuboidal
    - Stratified columnar
  - Transitional

- Functions as lining for body cavities, ducts and tubes.

(1) Simple squamous epithelium

- Single layered
- Shape of cells are flat or scale like.
- Flattened / rounded nucleus is.
- Cells are more in width and less in length so in vertical section they appear rectangular in shape.
- It is also called **pavement epithelium** (Tile like appearance) and Tesselated **epithelium** (Wavy appearance)**.**

- This epithelium is associated with **filtration & diffusion.**

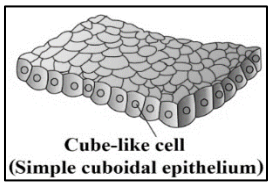


Example: It is found in the lining of:

- ➢ Bowman's capsule (Podocyte)
- ➢ Thin part of loop of Henle.
- ➢ Alveoli of lungs (Pneumocytes).
- ➢ Endothelium – Inner lining of blood vessels, lymph vessels and heart wall.

(2) Simple Cuboidal Epithelium

- Shape of cells are cube like.
- A rounded nucleus is present in the centre of cell.



- Cells are same in length & width so they appear square shaped in vertical section.
- This epithelium helps in **absorption**, **secretion** &**excretion**.
- This is commonly found in:
  - ➢ Ducts of glands
  - ➢ Thick part of ascending limb of loop of henle
  - ➢ DCT of nephron
  - ➢ Thyroid follicles
  - ➢ Acini of Pancreas
- This epithelium is also called **Germinal epithelium** because in gonads (testis & ovaries) cuboidal cells divide to form egg & sperm.

SPOT LIGHT

Modifications of simple cuboidal epithelium:

•**Brush bordered simple cuboidal epithelium**- eg. PCT of nephron.

- **Ciliated simple cuboidal epithelium** – e g. Neck of nephron and collecting duct.

(3) Simple Columnar Epithelium

- Cells are tall, slender and pillar like in shape.
- Elongated nucleus is present at the base of cell.
- Cells are more in length and less in width so they appear pillar shaped in vertical section.
- It helps in absorption and secretion.
- They are found in the: lining of stomach and intestine

Modifications of Simple Columnar epithelium:

(i) Brush Bordered Columnar epithelium: eg.Gall bladder, Intestinal mucosa

(ii) Glandular columnar epithelium: Unicellular mucous secreting **goblet cells** are also present in between columnar cells.eg. Stomach, Large intestine, uterus.

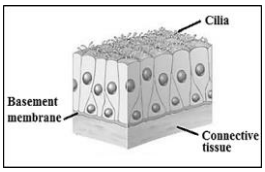
(iii) Glandular Brush bordered columnar epithelium: eg. Small intestine.

(iv) Ciliated Columnar epithelium: eg. Fallopian Tube, Ependymal epithelium

(v) Stereo ciliated columnar epithelium: eg.Epididymis, Vasa-deferens, internal ear

(4) Pseudostratified Epithelium:

- In this epithelium two types of cells are present i.e. long cells and short cells.



- All these cells are pillar like in shape so it is also a *modification of columnar epithelium* .
- In long cells, elongated nucleus is present at the base of cell and in short cells rounded nucleus is present in the centre of cell.
- Nucleus in both cells are present on different level so it appears bilayered because few cells are too short to reach the top surface. But all cells are present on single basement membrane so it is unilayered.

eg..Middle part of male Urethra

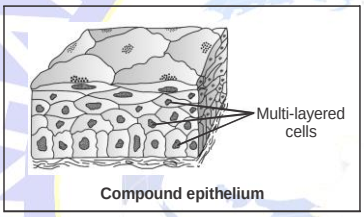
SPOT LIGHT

Modification of Pseudostratified Epithelium:

- **Pseudostratified ciliated columnar glandular epithelium (PSCCGE):**
  In this epithelium cillia are present of free end of long cells and goblet cells are alsopresent in this epithelium.
  eg. Trachea, Bronchi, Respiratory pithelium of nasal chambers, nasopharynx.

COMPOUND EPITHELIUM:

- Multilayered
- Limited role in secretion and absorption
- Provides protection against chemical and mechanical stresses



On the basis of stretching ability it is of 2 types:
(i) **Transitional epithelium:** Stretchable
(ii) **Stratified epithelium:** Non-stretchable

1. TRANSITIONAL EPITHELIUM (UROTHELIUM)

- It is only tissue in which basement membrane is very thin.
- In this epithelium 4-6 layers of cells are present.
  - Inner most layer of cell is composed of **cube like cells**.
  - At outermost layer a thin cuticle is present which makes this tissue water proof.
    Eg. Renal Pelvis, Ureter, Urinary Bladder, Proximal part of male urethra.

2. STRATIFIED EPITHELIUM

- On the basis of shape of the cells of outermost layer, it is of three types:
  (I) Stratified squamous epithelium
  (II) Stratified cuboidal epithelium
  (III)Stratified columnar epithelium

(I) STRATIFIED SQUAMOUS EPITHELIUM

- Innermost layer of cells is of cuboidal or columnar shaped, which is called as **Germinative** layer.
- Middle layers are made up of polygonal cells.
- These cells are interconnected with desmosomes which provide rigidity or mechanical support.
- Cells of outermost layer are scale like flat cells.
- On the basis of presence of keratin protein in the outer most cells this epithelium is of two types.

(i) Keratinized Stratified squamous pithelium:
If keratin protein is present in scaly cells and cells become non-nucleated dead cells.
eg. Epidermis of skin, Scale, Horn, Nails, Hoofs, Hair, Feathers etc.

(ii) Non-Keratinized Stratified squamous epithelium:
If keratin protein is absent. Cells are nucleated and living.
eg. Buccal cavity or oral cavity of mammals, Pharynx, Anal canal, Cornea of eye

(II) STRATIFIED CUBOIDAL EPITHELIUM

- Inner most layer cuboidal/Columnar.
- Middle layer - polygonal shaped cells.
- Outermost layer of cells are cube like & cells are nucleated & living.
  eg. Secretory duct of sweat glands, mammary glands and sebaceous gland, Secretory duct of salivary glands, Pancreatic duct, Female Urethra.

(III) STRATIFIED COLUMNAR EPITHELIUM

Outermost layer is composed of pillar shaped cells, cells are nucleated. On the basis of presence of cilia this epithelium is of 2 types:

(i) Ciliated stratified columnar epithelium:

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eg. Buccopharyngeal cavity of Frog, Upper part of soft palate towards nasopharynx, Larynx, Uterus

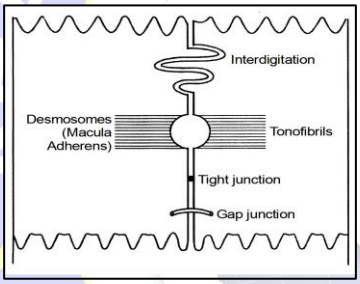
(ii) **Non-ciliated stratified columnar epithelium:** Cilia absent on free end
eg. Distal part of male urethra, Epiglottis.

CELL JUNCTIONS:

- To provide mechanical support for the tissue **plasma membrane of adjacent epithelium cells modified to form following structures (Intercellular Junctions):**

(i) **Adhering Junction**: This type of Junction consists of disc - like protein plate with intermediate fibre known as tonofibrils composed of keratin like sclero protein.

(ii) **Tight Junction (Zonula occludens):** At some places Plasma membrane of adjacent cells become fused to form tight Junction. It stops substances from leaking across a tissue. Mostly seen in **columnar epithelium**.



(iii) **Gap Junction:** Facilitate the cells to communicate with each other by onnecting cytoplasm of adjoining cells for rapid transfer of ions, small molecules and sometimes big molecules. Plasma membrane of free end get modified to form 3 types of functional structures:

SPOT LIGHT

Interdigitation: Finger like processes of plasma membrane which enter into cytoplasm of ad-jacent cell. Mainly found in **transitional epithelium**.

	Microvilli	Cilia or Kinocilia	Stereocilia
(1)	These are minute process which are non-motile, non-contractile.	Long cylindrical process which are Motile and contractile.	There are long process with are non-motile, non-contractile.
(2)	They help in absorption, secretion, excretion.	They help in conduction.	Found in: Epididymis, Vasa deferens
(3)	They increase surface more than 20 times.	Found in: Fallopian tube, Uterus, Trachea and Bronchioles	
(4)	Found in: Wall of intestine, Gall bladder, Proximal convulated tubule etc.		

Glandular epithelium - Some of the columnar or cuboidal cells get specialized for section and are called glandular epithelium.

On the basis of the mode pouring of their sections, glands are divided in following types.

Endocrine	Exocrine	Heterocrine or mixocrine

Ductless glands	Have ducts	Contain both conditions
Secret hormones directly into the blood	Secret enzymes into the duct	Secret both enzymes and hormones depending on action
Eg. Thyroid gland, Thymus gland, Adrenal gland etc.	Eg. Salivary gland, mucus gland, Gastric gland etc.	Eg. Pancreas

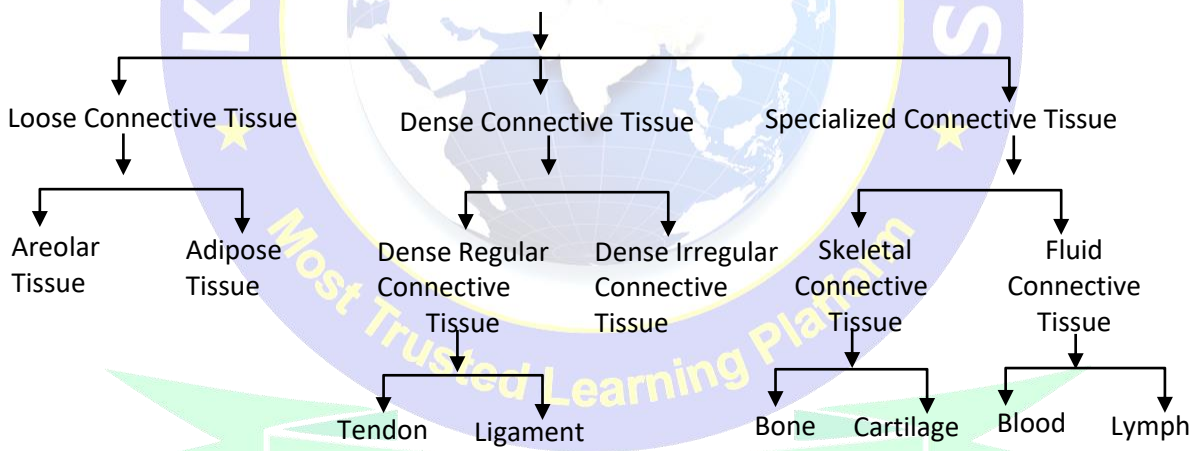
CONNECTIVE TISSUE:

- It is most abundant and widely distributed in the body of complex animals. They are named connective tissues because of their special function of linking and supporting other tissues/organs of the body.
- They range from soft connective tissues to specialised types, which include cartilage, bone, adipose, and blood. **In all connective tissues except blood, the cells secrete fibres of structural proteins called collagen or elastin.**
- The fibres provide strength, elasticity and flexibility to the tissue. These cells also secrete modified polysaccharides, which accumulate between cells and fibres and act as matrix (ground substance).

➢ On the basis of matrix connective tissue is of 3 types:

1. **Connective Tissue Proper:** Matrix soft and fibrous
2. **Connective Tissue Skeleton:** Dense and mineralised matrix. Due to deposition of minerals it becomes hard.
3. **Connective tissue Vascular:** Liquid and fibres free matrix.

Classification of Connective Tissue



❖ **CONNECTIVE TISSUE PROPER:**

Connective Tissue Proper is composed of three components:

(A) Cells

(B) Fibres

(C) Matrix

(A) CELLS

1. **FIBROBLAST CELLS:** Largest cell and maximum in number of connective tissue proper. Function: To produce fibres, to secrete major amount of matrix
2. **PLASMA CELL (CART WHEEL CELL):** Less in number, Small in size and amoeboidal in shape. Function: To produce, secrete & transport of antibody.
3. **MAST CELLS (MASTOCYTES):**These are like basophils of blood in structure and function.
   - secrete following substances:
   - **(a) Histamine:**(vasodilator),secrete during allergic reactions.
   - **(b) Serotonin:**(vasoconstrictor), secrete at the site of cut or injury which decrease high blood loss.
   - **(c) Heparin:** It is a natural anti coagulant.

4. **ADIPOSE CELLS:** Stores fat.
5. **MESENCHYMAL CELLS:** mother cells of connective tissue.
6. **MACROPHAGES (HISTEOCYTE):** Phagocytic, Scavenger cells
7. **LYMPHOCYTES:** Produce, transport & secretes antibodies.

SPOT LIGHT

Macrophages of :

Lung	→	Dust cells
Liver	→	Kupffer cells
Blood	→	Monocytes
Brain	→	Microglial cells
Thymus gland	→	Hessel's granules
Spleen	→	Reticulo-endothelial cells

(B) FIBRES:

I. Collagen fibres (White fibres):

- Bright & white fibres composed of collagen protein.
- Wavy & tough fibres always arranged in bundle.
- Bundle is called fascia

II. Elastic fibres (Yellow fibres):

- Yellow in colour and composed of elastin protein.
- Maximum elasticity is present.

III. Reticular Fibres:

- Elasticity is completely absent.

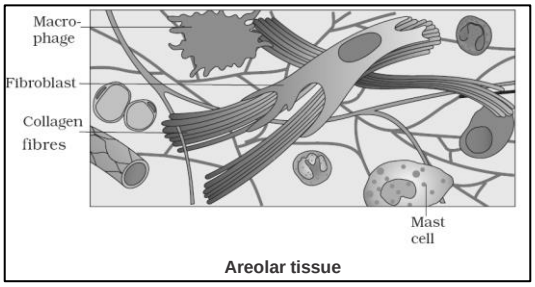
(C) MATRIX (Ground substance):

- Matrix is composed of muco-polysaccharide which is present in the form of hyaluronic acid.

➢ **TYPES OF CONNECTIVE TISSUE PROPER:**

1. LOOSE CONNECTIVE TISSUE

(I) AREOLAR CONNECTIVE TISSUE/SPONGY CONNECTIVE TISSUE



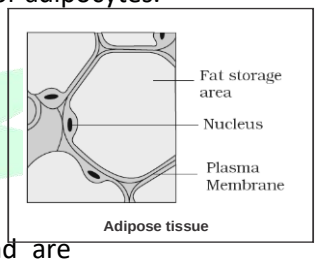
Areolar tissue

- It is most widely distributed tissue in the body.
- In this tissue maximum intercellular space or substances/matrix is present.
- Due to irregular arrangement of bundle of collagen fibres many gaps are present. These spaces are called **Areolae**.
- In areolae other components of connective tissue are distributed like fibres, cells & matrix.
- In cells mast cells, macrophage & fibroblast are more in number.
- In these areolae, blood vessels & nerve fibres are also present.

Eg. Present below skin, attaches muscles with skin, Alimentary canal

(II) ADIPOSE CONNECTIVE TISSUE

- Adipose tissue is another type of loose connective tissue located mainly beneath the skin.
- Adipose tissue contains fibroblasts, macrophages, collagen fibres, elastic fibres and large spherical fat cells or adipocytes.
- The cells of this tissue are specialised to store fats.
- The excess of nutrients which are not used immediately are converted into fats and are stored in this tissue.



Adipose tissue

- It serves as fat reservoir, shock absorber and insulator.

2. DENSE/FIBROUS CONNECTIVE TISSUE

Dense connective tissue consists of fibres and fibroblasts which are compactly packed in the matrix. It is the principal component of tendons and ligaments.

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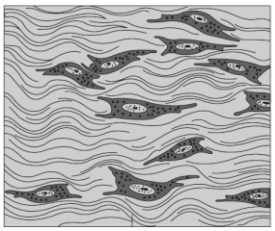
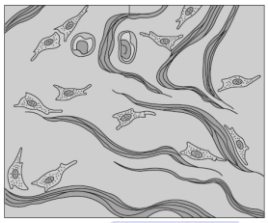
Orientation of fibres in the matrix show a figure or irregular pattern and thus there are two types of dense connective tissue:

(a) Dense regular

(b) Dense irregular connective tissue.



(a) Dense regular connective tissue



(b) Dense irregular connective tissue

(A) Dense regular connective tissue:

1. **<u>WHITE FIBROUS CONNECTIVE TISSUE (WFCT)</u>**

In this tissue bundle of collagen fibres are more in quantity & other components of connective tissue proper are less in quantity. On the basis of arrangement of fibres & matrix this tissue occurs in two forms.

(a) Cord :

- Bundle of collagen fibres & matrix are distributed in regular pattern (alternate pattern).
- Fibroblast cells are arranged in a series. Mast cells are scattered in matrix.

eg. **Tendon**: A structure which connects muscles & bones.

(b) Sheath: In this form there is no regular pattern of fibres & matrix. Cells and fibres are criss - crossed arranged.

eg.– Renal capsule, Glisson's capsule

2. **<u>YELLOW FIBROUS CONNECTIVE TISSUE (YFCT)</u>**

- In this tissue yellow fibres are more in quantity but collagen fibres are also present.
- On the basis of distribution of fibres & matrix they are of two types.

(a) Cord: In this form bundle of collagen fibres & matrix distributed in a regular pattern & in matrix yellow fibres form network. eg. **Ligaments** — A structure which connects bones.

(b) Sheath: Irregular distribution of fibres and matrix with elastic fibre.

eg. Wall of alveoli of lungs, Wall of lymph vessels & blood vessels, True vocal cords

(B) Dense irregular connective tissue: It has fibroblasts and may fibres (mostly collagen) that are oriented differently. This tissue is present in the skin.

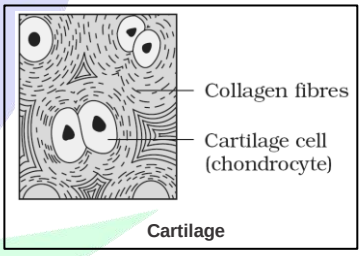
SPECIALISED CONNECTIVE TISSUE:

(I) <u>SKELETAL CONNECTIVE TISSUE:</u>

- Matrix is dense & mineralised. Due to deposition of minerals it becomes hard.
- Also known as **Skeletal/Supporting Tissue** i.e. Provide support to body.
- It is of 2 types:(A)Cartilage (B)Bone

(A) CARTILAGE:

- Outer most covering of cartilage is called **Perichondrium** which is composed of white fibres connective tissue.
- **Matrix is solid, pliable and resists compression**
- Cartilage producing cells are arranged on periphery of cartilage known as **Chondroblast**.



Cartilage

- These are active cell & divide to form chondrocytes, and synthesize the matrix of cartilage.
- Mature cells of cartilage are called **Chondrocytes**.
- They are found in vacuole like space in matrix called **Lacuna**. In which 1 - 4 Chondrocytes are present.
- **Chondroclast** are cartilage destroying cells

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- Matrix of cartilage is called **chondrin** Composed of chondromucoprotein having **Chondrotin-6-sulphate** and **mucopolysacchride (Hyaluronic acid)**
- Matrix of cartilage provides rigidity & elasticity to cartilage.
- **Blood circulation is absent** in the matrix of cartilage but blood supply present in perichondrium.

Type of Cartilage:

<table>
<tr><th>Hyaline cartilage</th><th colspan="2">Fibrous cartilage</th><th>Calcified cartilage</th></tr>
<tr><td rowspan="3">1. It is most common cartilage of human body.
2. Matrix of this cartilage is glass like clear because fibres are completely absent.
3. Colour of matrix is bluish & it is translucent.
Eg. Nasal septum, 'C' shaped rings of trachea and bronchi, Sternal part of ribs, larynx</td><td>(a) Elastic cartilage</td><td>(b) White fibrous cartilage</td><td rowspan="3">1. It is modified hyaline cartilage but due to deposition of calcium salts its matrix becomes hard like bones.
2. It is hardest cartilage of the body.
3. Ca^{+2} salt deposits in the form of Hydroxy apatite $[Ca_{10}(PO_4)_6(OH)_2]$.
Eg. Pubis of frog's pelvic girdle.
Head of femur and humerus in human.</td></tr>
<tr><td>It is highly flexible cartilage of body. Eg. Tip of Nose, Ear Pinna, Epiglottis, Eustachian tube.</td><td>It is strongest cartilage. Eg. Pubic symphysis (Connects both the pelvic halves with each other), intervertebral disc</td></tr>
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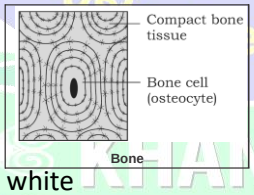
(B) BONE:

- Study of Bone – **Osteology**
- Process of bone formation – **Ossification**
- Outermost covering of bone is **Periosteum** composed of white fibrous connective tissue.



- Bone producing cell is called **Osteoblast.** They divide to form **Osteocyte** & synthesize organic part of matrix.
- Mature cell of bone is called as **Osteocyte** which is found in lacuna. Only one osteocyte is found in lacuna.
- Bone destroying cells are **Osteoclast** cells.

Matrix: It has two parts:

➢ **Inorganic Part:**65 - 68%

$Ca_3(PO_4)_2$: 80%, $CaCO_3$ (10%), $Mg_3(PO_4)_2$ (10%), Flourides (very less)

➢ **Organic part (Ossein):** 32 - 35%

Bundle of collagen fibres suspended in sulphated mucopolysaccharide.

➢ **<u>Structure of long bone</u>**

Long bone has three regions:

(a) Epiphysis (b) Diaphysis (c) Metaphysis

(a) <u>Epiphysis</u>

- Ends of long bone is called **Epiphysis**. This part is composed of spongy tissue.
- Cavity is present in the form of **trabeculae** filled with red bone marrow.

- It is composed of myeloid tissue which produce blood corpuscles. So, epiphysis act as a haemopoietic organ.

(b) Diaphysis

- Middle part or shaft of long bone is diap hysis.
- In this region hollow cavity is present called bone marrow cavity filled with yellow bone marrow composed of white fat. Function of YBM is storage of fat.

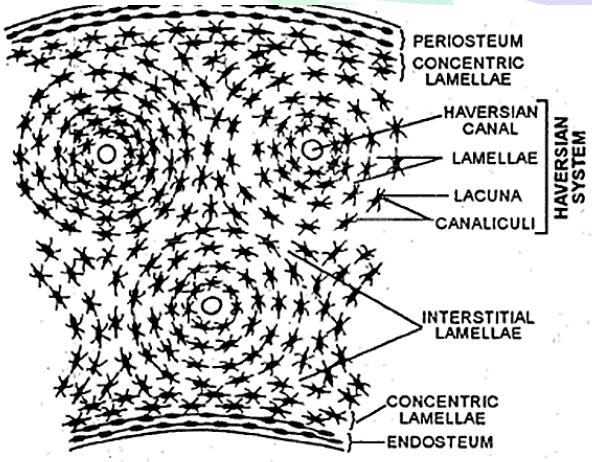
(c) Metaphysis

- It formed little part between Epiphysis & Diaphysis.
- In this region **epiphyseal plate** is present which is made up of osteoblast cells. They divide to form osteocyte and also synthesize matrix of bone, so epiphysial plate is responsible for elongation of bone.
- After complete development of long bone this plate is destroyed.

SPOT LIGHT

In complete developed bone only **2 regions (Epiphysis and Diaphysis)**are found while in a developing bone **3regions(Epiphysis, Diaphysis and Metaphysis)** are present.

Internal structure of mammalian bone:



(T.S. of Mammalian long bone)

It has following major structures:

1.Periosteum 2.Matrix

3. Endosteum 4. Bone marrow cavity

1. **PERIOSTEUM:** Outermost covering of bone

- It consists of two layers:
  - Outer layer consist of WFCT in which blood circulation is present.
  - **Inner layer:** consists of single layer of osteoblast cells. They divide to form osteocyte and secrete layers of matrix.

2. **MATRIX:** composed of inorganic & organic compounds.

- In the matrix of bone two types of canals are present:
  - (i) **Haversian Canal:** Longitudinal canals which are arranged parallel to long axis of bone. In these canals one or two blood capillaries and nerve fibres are present.
  - (ii) **Volkmann's canal:** These are transverse/horizontal or oblique canals.
- Haversian canals are interconnected by volkmann's canal.
- Matrix of bone is synthesized in the form of layer. These layers of matrix are called Lamellae**.**

3. **ENDOSTEUM:**

- Towards bone marrow cavity layer lined with reticular fibrous connective tissue.
- Towards matrix of bone endosteum lined with layer of osteoblast cells.

4. **BONE MARROW CAVITY:**

- In the central region hollow cavity is present which is filled with Yellow Bone Marrow. It is

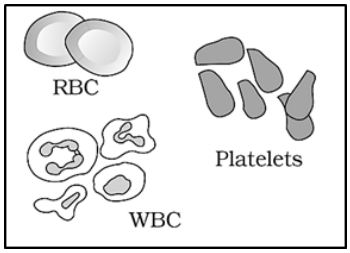
composed of white fat & its function is collection of fats or storage of fats.

Differences between Bone and Cartilage:

S.No.	Bone	Cartilage
1.	Matrix is composed of tough inflexible material, called ossein.	Matrix is composed of a firm, but flexible material called chondrin.
2.	Matrix is impregnated with salts, chiefly calcium phosphate and carbonate.	Matrix is impregnated with calcium salts only in calcified cartilage. In most cases, matrix is without salts
3.	Matrix occurs in concentric lamellae.	Matrix occurs in a homogenous mass.
4.	Matrix contains fibres, but these are in distinguishable	Matrix may contain fibres, which may or may not be distinguishable
5.	Bone cells (osteocytes) lie in lacunae	Cartilage cells (chondrocytes) lie singly or in groups of two or four.
6.	Osteocytes are irregular and give off branching processes.	Chondrocytes are oval and devoid of processes.
7.	Lacunae send out canaliculi the processes of bones cells, which extend into these minute canals.	Lacunae lack canaliculi
8.	There are outer and inner layers of the osteoblasts that produce new osteocytes, which secrete new lamellae of matrix	Cartilage grows by division of chondroblasts.
9.	Bone is surrounded by a tough sheath, called periosteum.	Cartilage is surrounded by a film sheath, called perichondrium

(II) <u>FLUID CONNECTIVE TISSUE:</u>

- It is made up of fibre-free fluid matrix and specialised living cells that can neither divide nor secrete matrix.
- Vascular tissue regularly circulates in the body and helps in the transportation of various materials such as nutritive elements, gases, excretory products, hormones, etc.



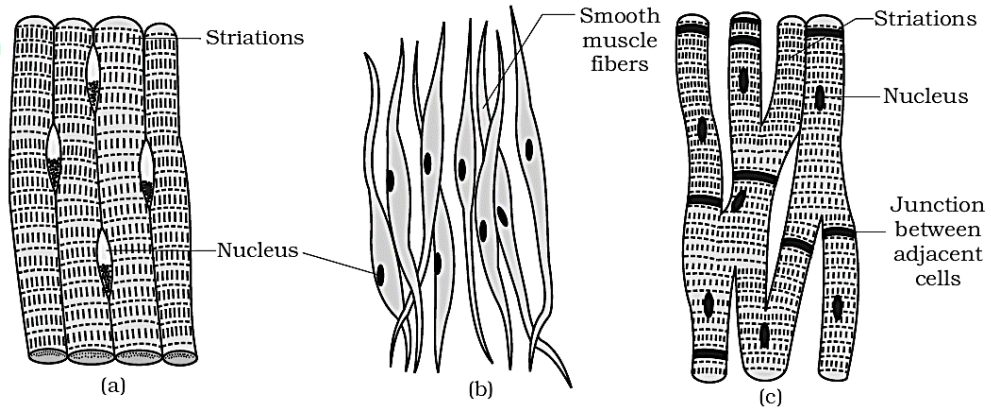
- The two main fluid connective tissue present in animals are blood and lymph.
- The erythrocytes or RBCs of most vertebrates are oval-shaped, nucleated and biconvex. However, erythrocytes of mammals are circular, biconcave, disc-like and lack nuclei.
- In this way, mammalian RBCs have the increased surface area for gaseous exchange and they accommodate much more haemoglobin in them than RBCs of other animals.
- Leucocytes or WBCs are rounded or irregular in shape. They can change their shape like Amoeba and are thus, capable of amoeboid movement. This enables them to squeeze out of blood capillaries into the tissues.
- Blood platelets also called thrombocytes are minute, non-nucleated, round or oval biconvex

fragments or giant bone marrow cells called megakaryocytes.

MUSCLE TISSUE:

- Each muscle is made of many long, cylindrical fibres arranged in parallel arrays.
- These fibres are composed of numerous fine fibrils, called myofibrils.
- Muscle fibres contract (shorten) in response to stimulation, then relax(lengthen) and return to their uncontracted state in a coordinated fashion.
- Their action moves the body to adjust to the changes in the environment and to maintain the positions of the various parts of the body.
- In general, muscles play an active role in all the movements of the body.
- Muscles are of three types:

(i) Skeletal muscles	(ii) Smooth muscles	(iii) Cardiac muscles
Skeletal muscle tissue	**Smooth muscle fibres**	**Cardiac muscle tissue**
• It is closely attached to skeletal bones. • In a typical muscle such as the biceps, striated (striped) skeletal muscle fibres are bundled together in a parallel fashion. • A sheath of tough connective tissue encloses several bundles of muscle fibres.	• The wall of internal organs such as the bold vessels, stomach and intestine contain this type of muscle tissue. • Taper at both ends (fusiform) and do not shows striations. • Cell junctions hold them together and they are bundled together in a connective tissue sheath. • Smooth muscles are 'involuntary' as their functioning cannot be directly controlled. • We usually are not able to make it contract merely by thinking about it as we can do with skeletal muscles.	• It is a contractile tissue present only in the heart. • Cell junctions fuse the plasma membranes of cardiac muscle cells and make them stick together. • Communication junctions (intercalated discs) at some fusion points allow the cells to contract as a unit, i.e., when one cell receives a signal to contract, its neighbours are also stimulated to contract.



NEURAL TISSUE:

- Neural tissue exerts the greatest control over the body's responsiveness to changing conditions.
- Neurons, the unit of neural system are excitable cells.
- The neuroglial cell which constitute the rest of the neural system protect and support neurons.
- Neuroglia make up more than one half the volume of neural tissue in our body.
- When a neuron is suitably stimulated, an electrical disturbance is generated which swiftly travels along its plasma membrane. Arrival of the disturbance at the neuron's endings, or output zone, triggers events that may cause stimulation or inhibition of adjacent neurons and other cells.

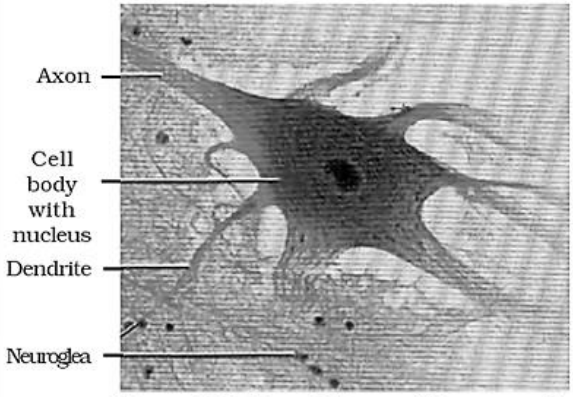


Figure 7.8 Neural tissue (Neuron with neuroglea)

SPOT LIGHT

- **Pneumatic Bone:** In the matrix of these bones air filled spaces are present so bone become light in weight.
  Eg. Bones of birds.
- **Largest sesamoid bone**: Patella (knee bone)
- Hardest substance – Enamel. (It is not a group of cells but it is formed by the secretion of ameloblast cells of teeth.)
- At the time of birth Red Bone Marrow is 70 ml, while in adult it is about 4 litre.

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