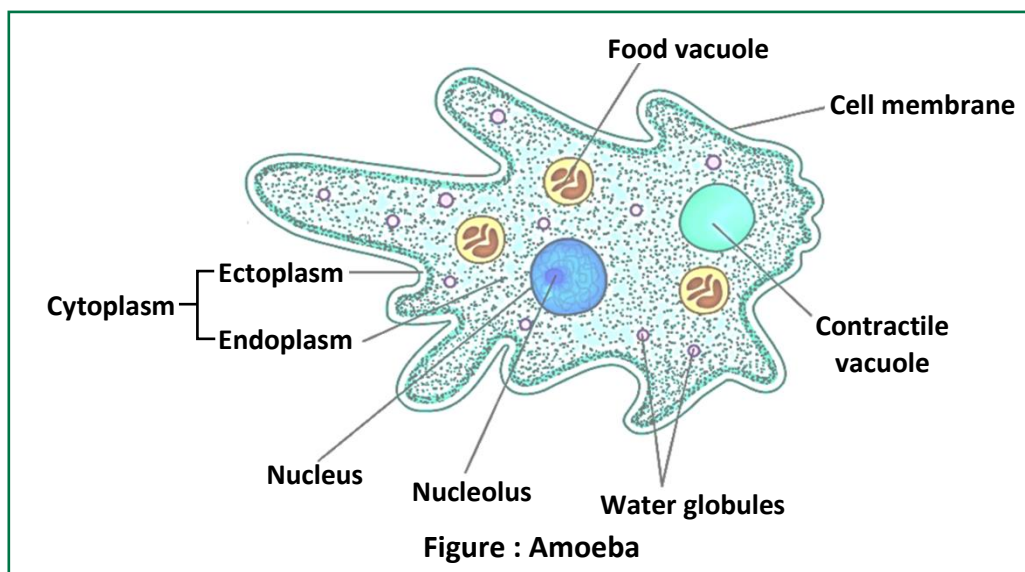


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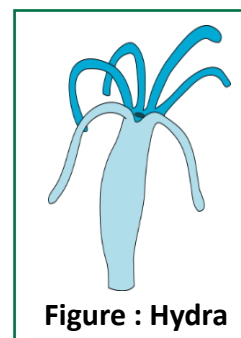
Structural Organisation in Animals (Animal Tissue)

01. INTRODUCTION

- In **unicellular organisms**, all functions like digestion, respiration and reproduction are performed by a single cell.



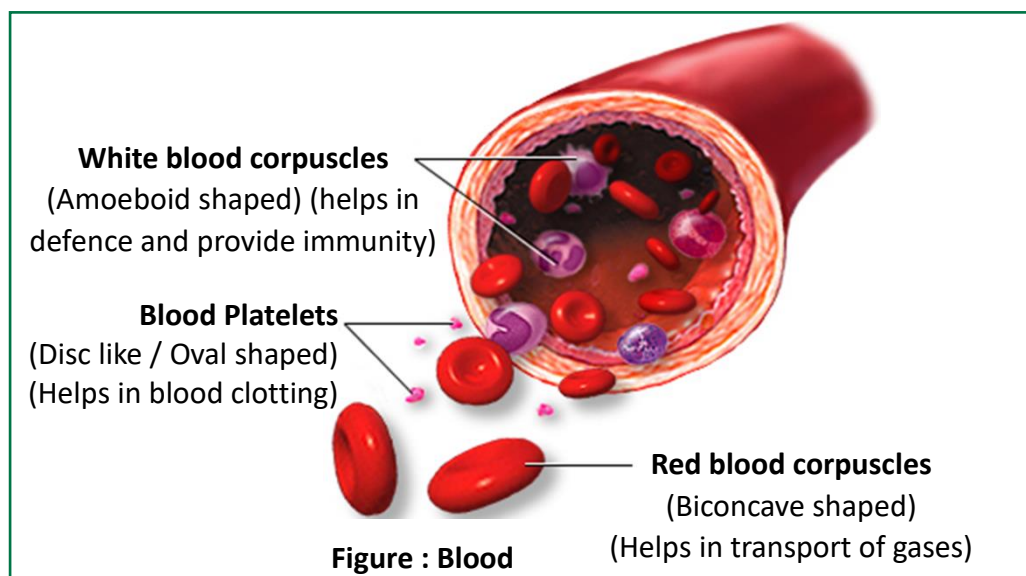
- In the complex body of **multicellular animals** the same basic functions are carried out by different groups of cells in a well organised manner.
- The body of a simple organism like **Hydra** is made of different types of cells and the number of cells in each type can be in thousands.
- The **human body** is composed of billions of cells to perform various functions.
- How do these cells in the body work together?



Tissue :

- In **multicellular animals**, a group of similar cells along with intercellular substances perform a specific function. Such an organisation 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.
- In a tissue, cells may be dissimilar in structure and function but they are always similar in origin.



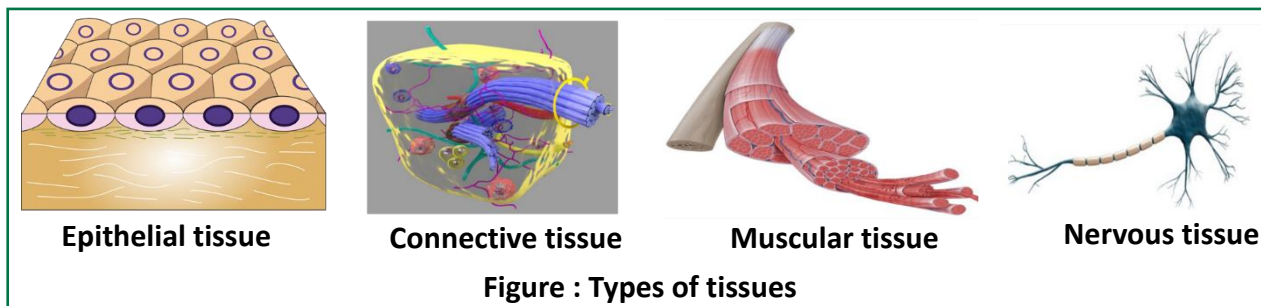
- Blood is a fluid connective tissue and is mesodermal in origin. Blood has two components – plasma and formed elements. Formed elements include RBC, WBC and blood platelets. These formed elements have different shapes and different functions but all are mesodermal in origin.

Origin of Tissues :

1. Epithelium/Epithelial Tissue – Ectoderm, Mesoderm, Endoderm
2. Connective Tissue – Mesoderm
3. Muscle Tissue – Mesoderm
4. Nervous tissue – Ectoderm

On The Basis of Functions and Structure Tissues are of Four Types :

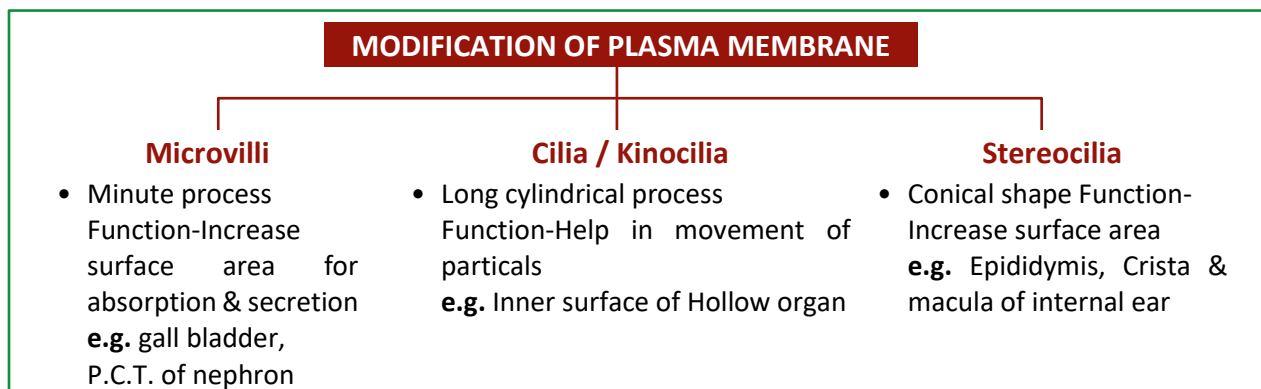
1. **Epithelium/Epithelial Tissue** – Covering & protective tissue.
2. **Connective Tissue** – To connect structures, provide support to the body and transport substances in the body.
3. **Muscular Tissue** – Helps in contraction & locomotion.
4. **Neural tissue** – To generate and conduct nerve impulses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



02. EPITHELIAL TISSUE

- Word epithelium is derived from two words – epi and thelia
- Epi – upon, thelia – growth
- These tissues develop first during embryonic development.
- Power of regeneration is present in this tissue while power of regeneration is absent or least power is found in nervous tissue.
- Epithelium cells are compactly packed with little intercellular matrix.
- Because of very little intercellular spaces blood capillaries and lymph capillaries are absent.
- It always rest upon underlying connective tissue.
- Cells of epithelial tissues derive their nutrition from underlying connective tissue.
- In between epithelium and connective tissue, basement membrane is present.
- **Basement membrane** : Between epithelium and connective tissue, a thin non-living acellular basement membrane is present which is highly permeable.
- This tissue has a free surface, which faces either a body fluid (examples epithelium of blood vessels, epithelium of nephron, epithelium of stomach and intestine etc.) or the outside environment (examples nails, horns, hoof, feathers, scales) and thus provides a covering or a lining for some part of the body.

MODIFICATION OF PLASMA MEMBRANE AND CELL JUNCTIONS :



INTERCELLULAR JUNCTION

Adhering Junction

- Perform cementing to keep neighbouring cell together

Tight Junction

- Help to stop substances from leaking across a tissue

Gap Junction

- Facilitate the cell to communicate with each other by connecting the cytoplasm of adjoining cells, for rapid transfer of ions, small molecules and sometime big molecules.



BEGINNER'S BOX-1

EPITHELIAL TISSUE

1. Tissues differ from group of cells in :-

- | | |
|-----------------|---------------------------------|
| (1) Function | (2) Division of labour |
| (3) Association | (4) Organisation as a structure |

BSA128

2. Which of the following is an incorrect statement from the following?

- (1) In unicellular organisms, all functions like digestion, respiration and reproduction are performed by a single cell.
- (2) RBC transport carbon dioxide and oxygen.
- (3) WBC helps in blood clotting.
- (4) Blood is mesodermal in origin.

BSA129

3. Select the odd one out :-

- | | | | |
|----------------|----------------|--------------|------------|
| (1) Epithelial | (2) Connective | (3) Lymphoid | (4) Neural |
|----------------|----------------|--------------|------------|

BSA130

4. Which of the following is a function of connective tissue?

- | | |
|------------------------|--------------------------------------|
| (1) Transport of gases | (2) To connect various parts of body |
| (3) Both (1) & (2) | (4) Form lining and covering |

BSA131

5. Which of the following tissue type is responsible for generation and conduction nerve impulses in body?

- | | | | |
|--------------------|-------------------|-----------------------|---------------------|
| (1) Nervous tissue | (2) Muscle tissue | (3) Connective tissue | (4) Lymphoid tissue |
|--------------------|-------------------|-----------------------|---------------------|

BSA132

6. Epithelial tissue originate from :-

- | | | | |
|--------------|--------------|--------------|------------------|
| (1) Ectoderm | (2) Endoderm | (3) Mesoderm | (4) All of these |
|--------------|--------------|--------------|------------------|

BSA133

7. Correct statement about epithelial tissue is :-

- (1) Tissue has a free surface
- (2) Faces either a body fluid or the outside environment
- (3) Provides a covering or a lining for some part of the body/organ
- (4) All of the above

BSA134

8. Tissue which provide support to the body is :-

- (1) Epithelial tissue
- (2) Connective tissue
- (3) Muscular tissue
- (4) Nervous tissue

BSA135

9. Ciliated Epithelium found in :-

- (1) Oviduct
- (2) Trachea
- (3) Brain ventricles
- (4) All of these

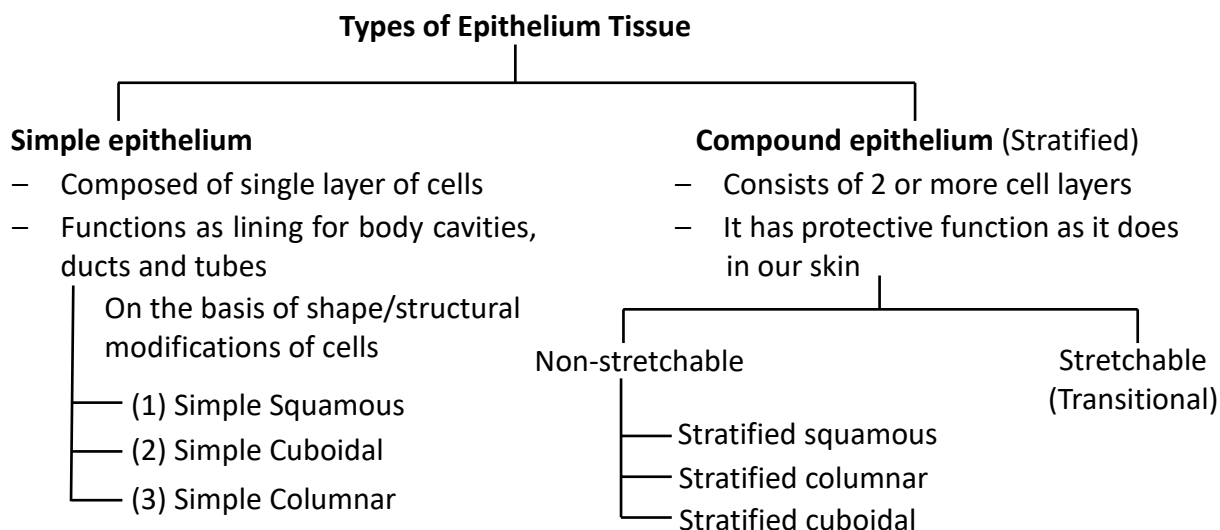
BSA136

10. Gap junctions :-

- (1) help to stop substances from leaking across a tissue.
- (2) perform cementing to keep neighbouring cells together
- (3) provide stretchability to the epithelium
- (4) facilitate the cells to communicate with each other by connecting the cytoplasm of adjoining cells.

BSA137

CLASSIFICATION OF EPITHELIAL TISSUE :



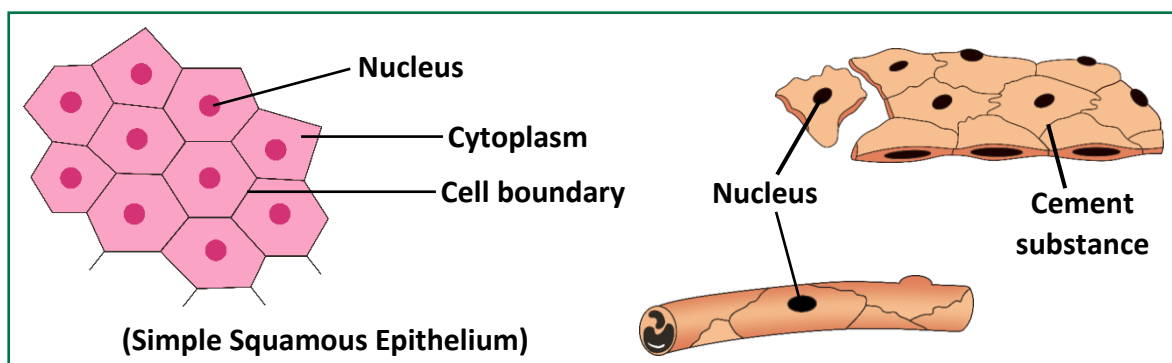
- All the cells of simple epithelium rest upon basement membrane.
- Only the cells of lowermost layer rest upon basement membrane.

SIMPLE EPITHELIUM:

- Made up of single layer of cells.
- All the cells rest upon basement membrane.
- Functions as lining for body cavities, ducts and tubes.

Simple Squamous Epithelium :

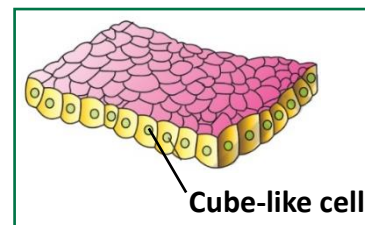
- The squamous epithelium is made up of a single thin layer of flattened cells with irregular boundaries.
- They are found in the **walls of blood vessels** and **air sacs of lungs** and are involved in a function like forming a **diffusion boundary**.
- It is also called **pavement epithelium** due to its tile like appearance.
- Also called **Tesselated** epithelium due to its wavy appearance in blood vessel and coelom.



- Also found in **Bowman's capsule** (Podocyte), thin parts of loop of henle, Pleura, Pericardium, Peritoneum etc.

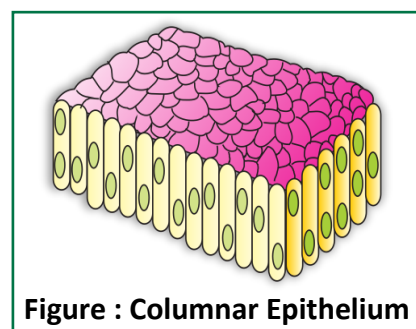
Simple Cuboidal Epithelium :

- The cuboidal epithelium is composed of a single layer of cube-like cells.
- This is commonly found in **ducts of glands** and **tubular parts** of nephrons in kidneys.
- Its main functions are **secretion** and **absorption**.
- This epithelium is also called **Germinal epithelium** because in gonads (testis & ovaries) cuboidal cells divide to form egg & sperm.
- Epithelium of proximal convoluted tubule (PCT) of nephron in the kidney has microvilli.
- Also found in thyroid follicles.

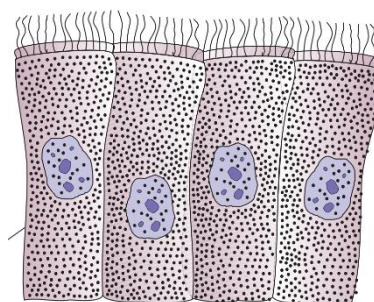


Simple Columnar Epithelium:

- The columnar epithelium is composed of a single layer of tall and slender cells.
- Nucleus is present at the base of the cell.
- **Function** : It helps in absorption and secretion.



If the columnar or cuboidal cells bear cilia on their free surface they are called ciliated epithelium. Their function is to move particles or mucus in a specific direction over the epithelium. They are mainly present in the inner surface of hollow organs like bronchioles and fallopian tubes. Some of the columnar or cuboidal cells get specialised for secretion and are called glandular epithelium.



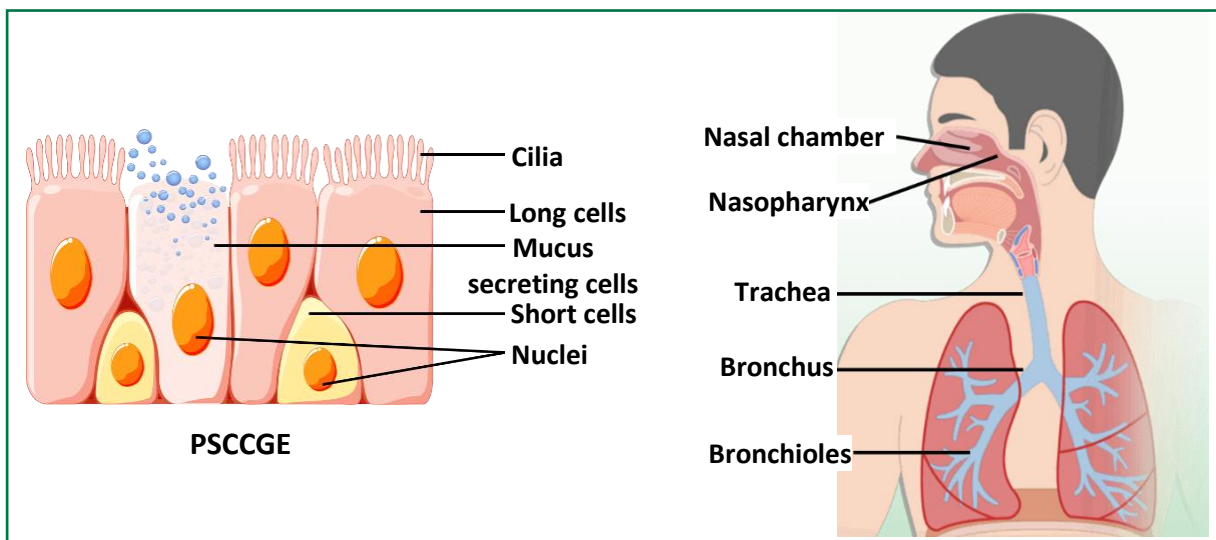
Pseudostratified Epithelium :

- These cells are pillar like in shape so it is also a modification of columnar epithelium.
- In this epithelium two types of cells are present i.e. Long cells, Short cells.
- 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.

Pseudostratified Epithelium Columnar Ciliated Glandular Epithelium (PSCCGE) :

- In this epithelium **cilia** are present of free end of long cells and **mucus secreting cells** are also present in this epithelium.

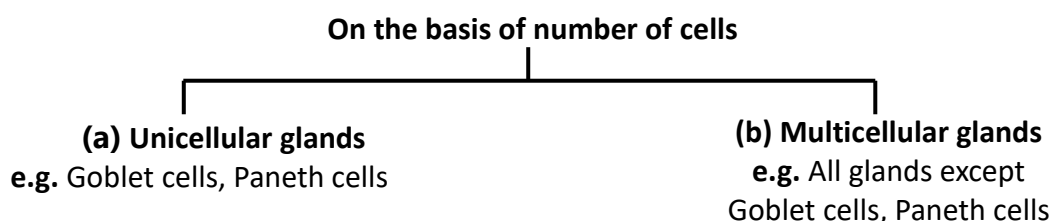
e.g. Nasopharynx, Trachea, Bronchus, Bronchioles, Respiratory epithelium of nasal chambers.



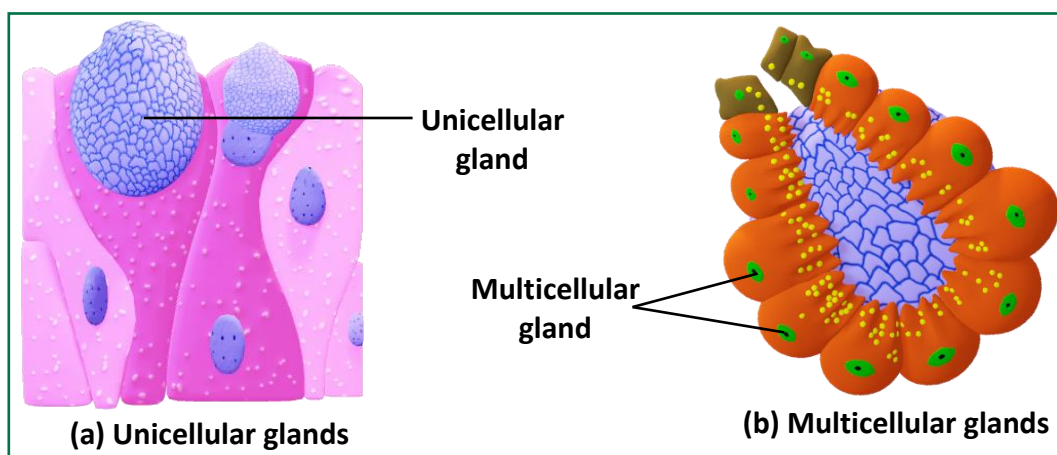
GLANDS :

- A cell or a group of cells which secretes chemical substances are called glands.
- All glands are composed of epithelial tissue.

- Glands can be originate from all the three germinal layers.
- Ectoderm – Sweat gland
- Mesoderm – Gonads
- Endoderm – Thyroid gland



Some of the columnar or cuboidal cells get specialised for secretion and are called glandular epithelium (Figure). They are mainly of two types: unicellular, consisting of isolated glandular cells (goblet cells of the alimentary canal), and multicellular, consisting of cluster of cells (salivary gland).



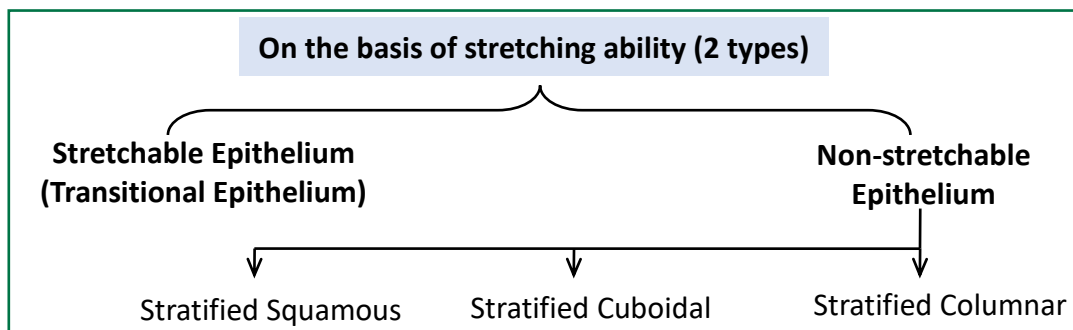
(On the basis of nature of secretion :- 3 types of glands are) or

On the basis of presence of secretory duct glands are of 3 types :-

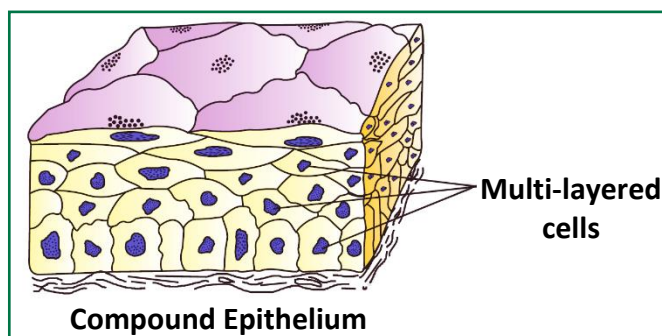
- Endocrine glands** :- Secretory duct absent.
e.g. Thyroid, pituitary, thymus, pineal, parathyroid, adrenal
- Exocrine gland** :- Secretory duct present – Liver (largest gland), Salivary gland, Gastric glands, intestinal glands etc. Exocrine glands secrete mucus (Goblet cells), saliva (Salivary glands), earwax (Ceruminous glands), oil (Sebaceous glands), milk (Mammary glands), digestive enzymes (Gastric glands, Intestinal glands) and other cell products.
- Heterocrine/mixed gland** :- Both endocrine & exocrine parts are present.
e.g. Pancreas, Gonads etc.

COMPOUND EPITHELIUM :

- It is multi-layered and have limited role in secretion and absorption.
- Main function is to provide protection against chemical & mechanical stress.



- **Compound epithelium** is made of more than one layer (multi-layered) of cells and thus has a limited role in secretion and absorption. Their main function is to provide protection against chemical and mechanical stresses.



- They cover the **dry surface of the skin (stratified squamous keratinised epithelium)**, the **moist surface of buccal cavity (stratified squamous nonkeratinized epithelium)**, **pharynx (stratified squamous non-keratinised epithelium)**, **inner lining of ducts of salivary glands (stratified cuboidal epithelium)** and of **pancreatic ducts (stratified cuboidal epithelium)**.

**BEGINNER'S BOX-2****TYPES OF EPITHELIUM AND GLANDS**

1. The correct statement with respect to epithelial tissue is :-

- A – cells are compactly packed
 B – cells have no intercellular matrix
 C – cells have little intercellular material
 D – it is single or multi-layered

(1) A & D

(2) B & C

(3) A, C & D

(4) All of these

BSA138

2. Which of the following tissue functions as lining for body cavities, ducts, and tubes?

- (1) Epithelial tissue (2) Connective tissue
(3) Muscles (4) Neural tissue

BSA139

3. Based on shape/structural modifications of cells, how many type of division of simple epithelium are there?

- (1) Zero (2) One (3) Two (4) Three

BSA140

4. Which of the following consists of simple squamous epithelium?

- (1) Blood vessels (2) Alveoli of lungs
(3) Outer surface of intestine (4) All of the above

BSA141

5. Which of the following tissue covers moist surface of buccal cavity and pharynx?

- (1) Cuboidal epithelium (2) Columnar epithelium
(3) Transitional epithelium (4) Compound epithelium

BSA142

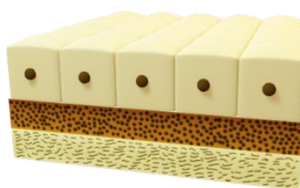
6. Which of the following epithelium is also known as Germinal epithelium?

- (1) Simple columnar epithelium
(2) Simple cuboidal epithelium
(3) Stratified columnar epithelium
(4) Transitional epithelium

BSA143

7. Identify the following diagram :-

- (1) Simple columnar epithelium
(2) Transitional epithelium
(3) Simple cuboidal epithelium
(4) Simple squamous epithelium



BSA144

8. Main function of simple cuboidal epithelium is :-

- (1) Diffusion (2) Absorption only
(3) Secretion only (4) Secretion and absorption both

BSA145

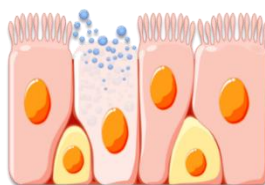
9. Pseudostratified epithelium is present in :-

- (1) Nephron & Neuron (2) Larynx & Pharynx
(3) Trachea & Bronchi (4) Urinary Bladder & Intestine

BSA146

10. Identify the following diagram :-

- (1) Simple squamous
- (2) Stratified cuboidal
- (3) Pseudostratified epithelium
- (4) Transitional epithelium



BSA147

11. Pseudostratified epithelium is the modification of :-

- (1) Transitional epithelium
- (2) Cuboidal epithelium
- (3) Columnar epithelium
- (4) Squamous epithelium

BSA148

12. The main function of protection against chemical and mechanical stress is provided by which type of epithelium?

- (1) Simple Squamous epithelium
- (2) Brush border epithelium
- (3) Columnar epithelium
- (4) Compound epithelium

BSA149

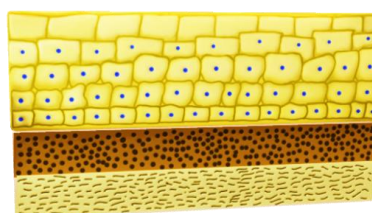
13. Compound epithelium mainly provides covering for :-

- (1) Dry surface of the skin
- (2) The moist surface of buccal cavity
- (3) Inner lining of ducts of salivary glands and of pancreatic ducts
- (4) All the above

BSA150

14. Identify the epithelium type in the following diagram :-

- (1) Squamous epithelium
- (2) Compound epithelium
- (3) Ciliated columnar epithelium
- (4) Columnar epithelium



BSA151

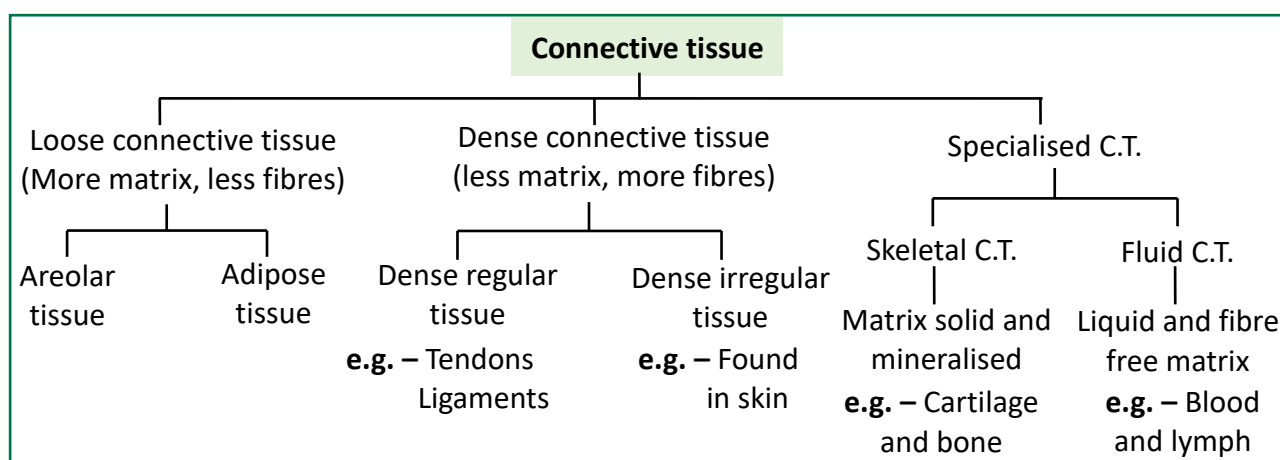
15. Inner lining of gut, stomach & liver is made up of :-

- (1) Simple squamous
- (2) Simple cuboidal
- (3) Simple columnar
- (4) Pseudo stratified epithelium.

BSA152

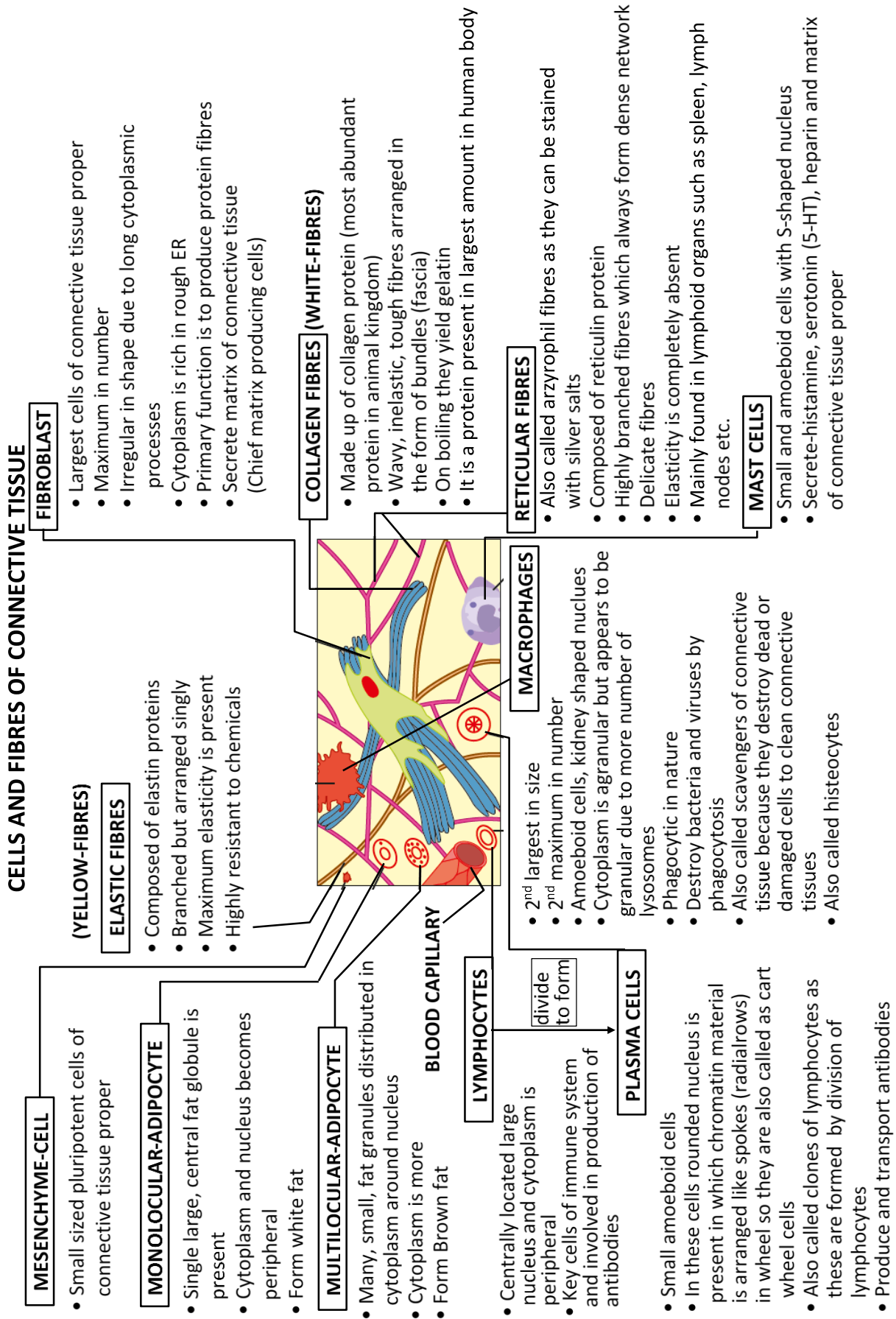
03. CONNECTIVE TISSUE

- Connective tissues are the most abundant and widely distributed in the body of complex animals.
- They are named connective tissue 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 (collagen fibres), elasticity (elastin fibres) and flexibility to the tissue.
- These cells also secrete modified polysaccharide or mucopolysaccharides which accumulate between cells and fibres and acts as matrix (ground substance).



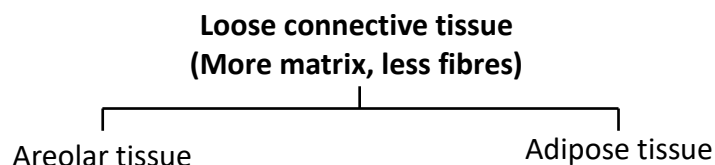
The functions of connective tissues are :-

1. To connect structures.
2. To form packing around organs.
3. To form a supporting framework.
4. To replace tissues which have been destroyed by injury.



LOOSE CONNECTIVE TISSUE :

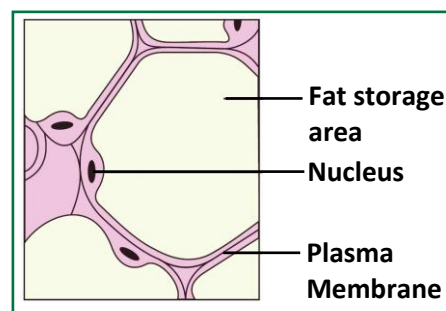
- It has more matrix and less fibres.
- The cells and fibres are loosely arranged in a semifluid ground substance.
- It is of two types :- Areolar and adipose connective tissue.

**(A) Areolar Connective Tissue :**

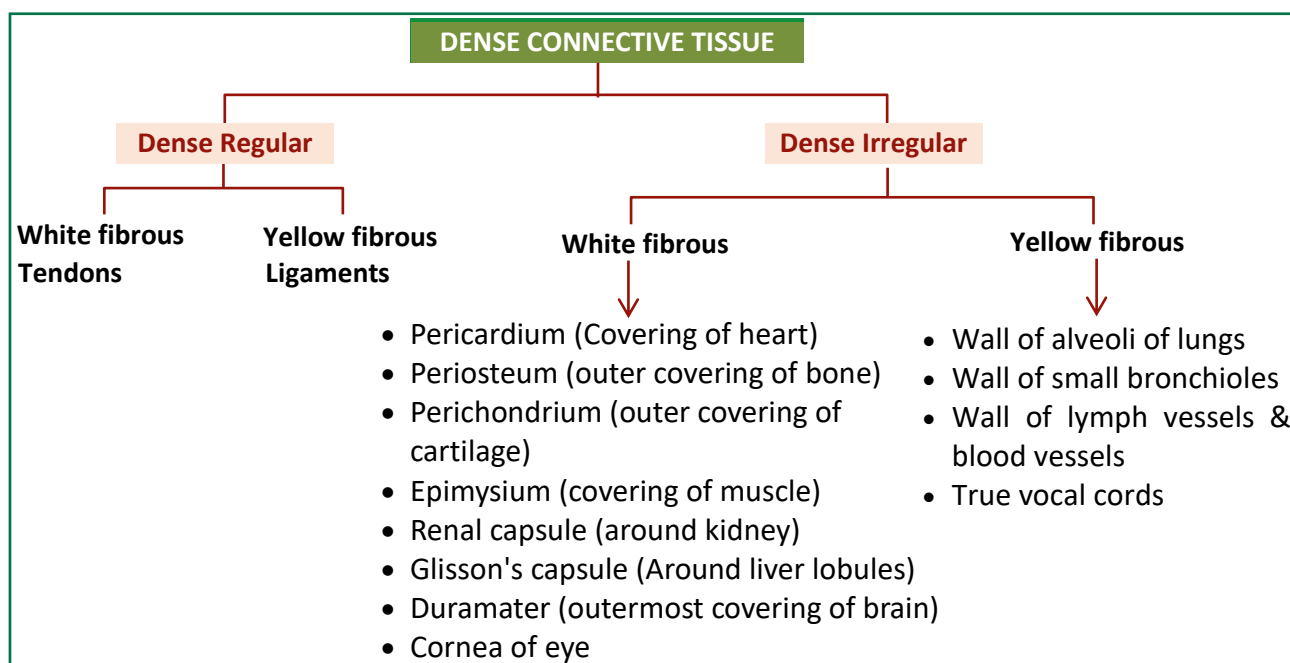
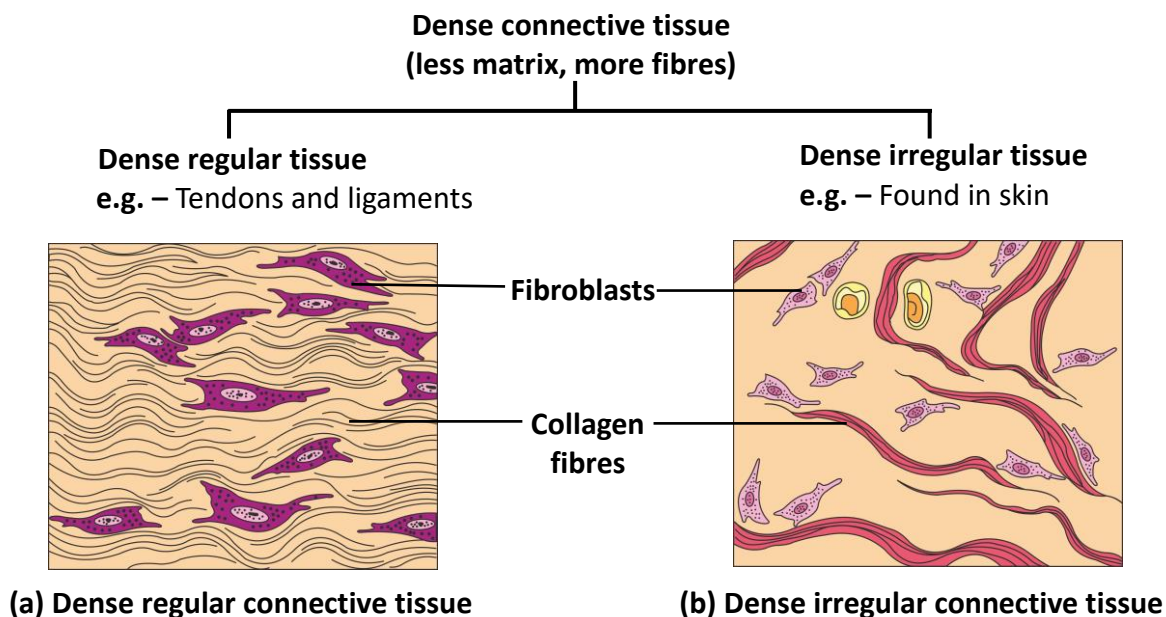
- Also known as **spongy** connective tissue.
 - It is most widely distributed tissue in the body.
 - In this tissue maximum intercellular space and matrix is present.
 - Due to irregular arrangement of bundle of collagen fibres many gaps are present. These gaps are called Areolae.
 - It contains fibroblasts (cells that produce and secrete fibres), macrophages and mast cells.
 - Areolar tissue present beneath the skin.
 - **Function** :- It serves as a support framework for epithelium.
- e.g. Tela Subcutanea** :- A thin continuous layer which connect skin with underlying skeletal muscles (Panniculus carnosus).

(B) Adipose Connective Tissue :

- Adipose tissue is another type of loose connective tissue located mainly beneath the skin.
- It contains adipocytes / fat cells abundantly.
- The cells are specialised to store fats, the excess of nutrients which are not used immediately are converted into fats and are stored in this tissue.

**DENSE / FIBROUS CONNECTIVE TISSUE :**

- It contains more fibres and less matrix.
- Fibres and fibroblast cells are compactly packed in dense connective tissue.
- Orientation of fibres show a regular or irregular pattern and are called dense regular and dense irregular tissue.



Reticular Fibrous Connective Tissue :

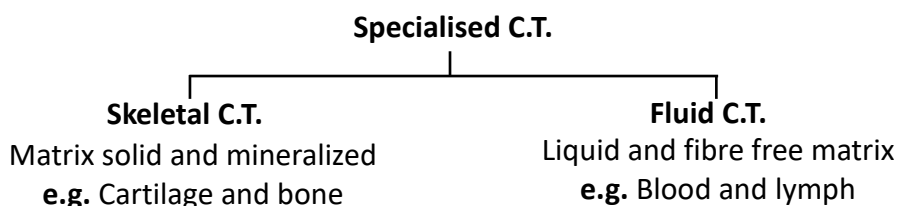
- It is also called lymphoid tissue.
 - It is mostly found in lymphoid organs.
 - Matrix of this tissue is like lymph.
 - Reticular fibres are more in amount & form dense network around reticular cells.
 - Lymphocytes are also more in number.
 - Provide support and strength and form the stroma (frame work) of soft organs.
- e.g. – **Spleen, Lymph nodes** (Tonsils, Payer's Patches).



BEGINNER'S BOX-3

CONNECTIVE TISSUE

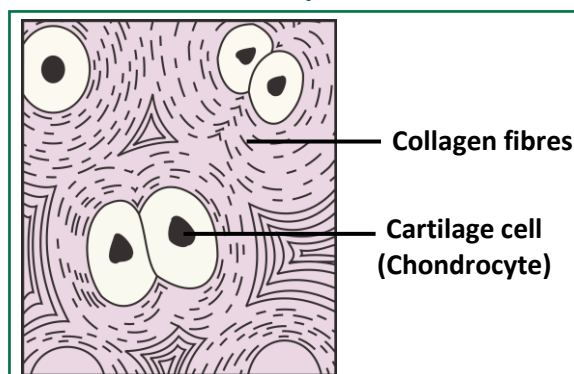
1. Find the pair of loose connective tissue –
 (1) Areolar, adipose (2) Areolar, white fibrous
 (3) White fibrous, Yellow fibrous (4) Yellow fibrous, Adipose
BSA153
2. Which of the following is not an example specialised connective tissue?
 (1) Blood (2) Bone
 (3) Areolar connective tissue (4) Cartilage
BSA154
3. Yellow, White fibres made up of protein :
 (1) Elastin, Reticulin respectively (2) Reticulin, Elastin respectively
 (3) Collagen, Elastin protein (4) Elastin, Collagen protein
BSA155
4. In all connective tissues except _____, the cells secrete fibres of structural proteins called collagen or elastin or reticulin.
 (1) blood (2) bone
 (3) areolar connective tissue (4) cartilage
BSA156
5. Which of the following is known as spongy connective tissue :
 (1) Dense fibrous connective tissue (2) Adipose connective tissue
 (3) Areolar connective tissue (4) Reticular fibrous connective tissue
BSA157
6. The connective tissue that connects the skin to the underlying structures is :
 (1) Areolar tissue (2) Dense regular connective tissue
 (3) Reticular tissue (4) Dense irregular connective tissue
BSA158
7. Collagen fibre and fibroblast arrangement is regular in :
 (1) Tendon (2) Ligament (3) Dura mater (4) Both (1) and (2)
BSA159
8. Ligament is an example of –
 (1) White fibrous dense regular connective tissue.
 (2) Yellow fibrous dense regular connective tissue.
 (3) Yellow fibrous dense irregular connective tissue.
 (4) White fibrous dense irregular connective tissue.
BSA160

Specialised Connective Tissue :**Skeleton Connective Tissue :**

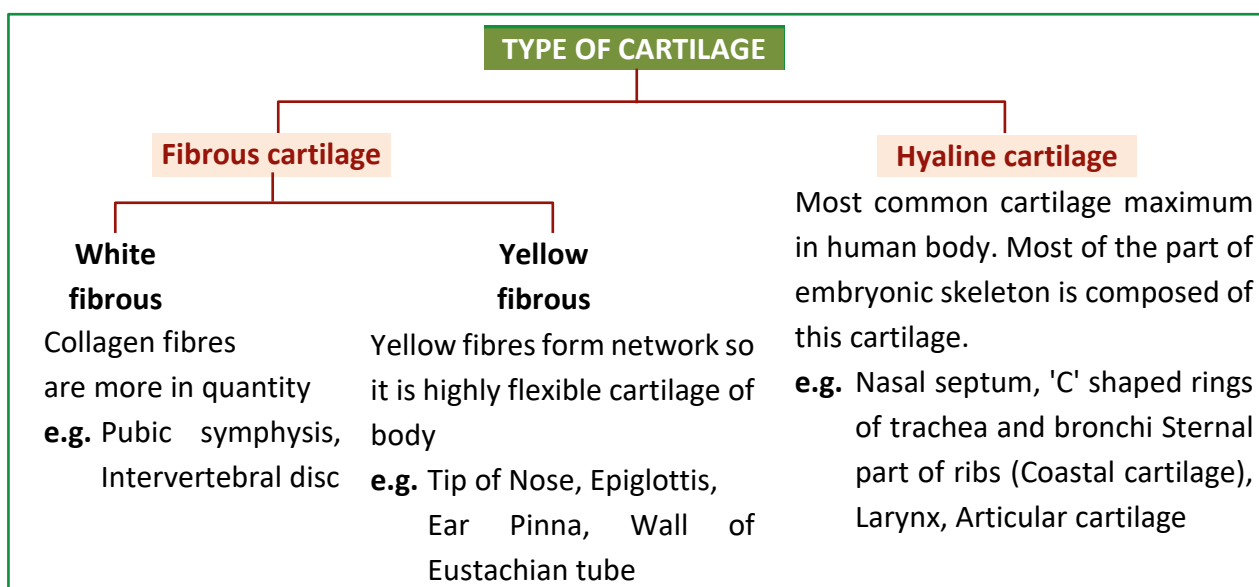
- Matrix is dense & mineralised. Due to deposition of minerals it becomes hard.
- Also known as **Supporting Tissue** i.e. Provide support to the body.
- It is of 2 types : **1. Cartilage** **2. Bone**

CARTILAGE :

- Most of the cartilages in vertebrate embryos are replaced by bones in adults
- Matrix (inter-cellular materials) is solid, pliable and can resist compression.**
- Cells of this tissue (Chondrocytes) are enclosed in small cavities (Lacuna), within the matrix secreted by them. (occur singly or in groups within the lacunae)
- Matrix of cartilage provides rigidity and elasticity to cartilage.



e.g. - Cartilage is present in the tip of nose, outer ear joints, between adjacent bones of the vertebral column, limbs and hands in adults.

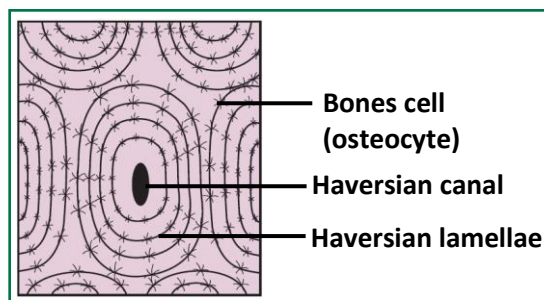


NOTE : If there is deposition of calcium ions in hyaline cartilage than called Calcified cartilage.

e.g. Head of femur & humerus in man.

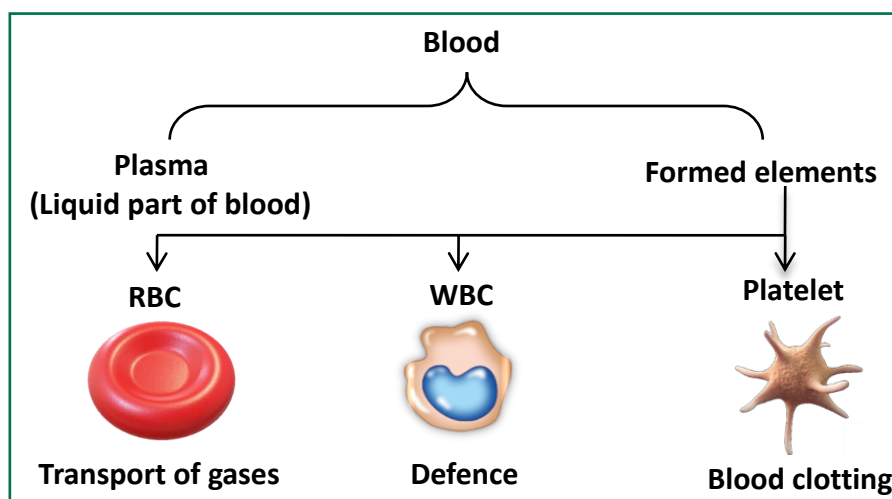
BONE :

- Bones have a **hard and non-pliable ground substance rich in Ca-salts and collagen fibres** which gives bone its strength.
- It is the main tissue that provide structural framework to the body.
- Bones support and protect softer tissues and organs.
- Mature cell of bone is called **Osteocyte** which is found in lacuna. Only one osteocyte is found in one lacuna.
- Limb bones, such as the long bones of the legs, serve weight bearing functions.
- They also interact with skeletal muscles attached to them, to bring about movements.
- The bone marrow in some bones is the site of production of blood cells.



BLOOD :

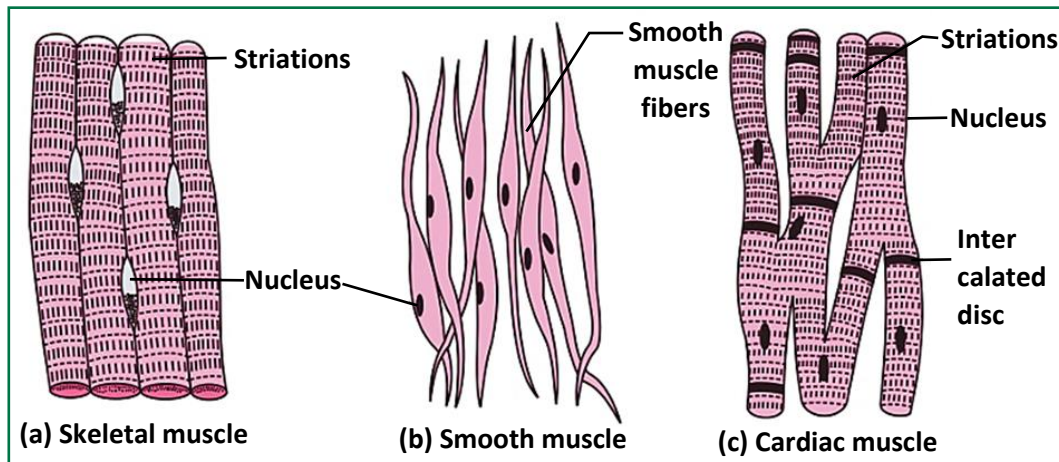
- Blood is a fluid connective tissue containing plasma, red blood cells (RBC), white blood cells (WBC) and platelets.
- It is the main circulating fluid that helps in the transport of various substances.

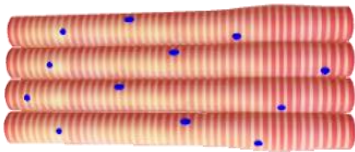
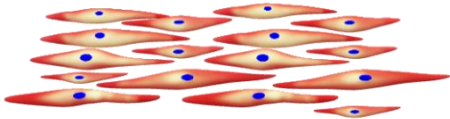
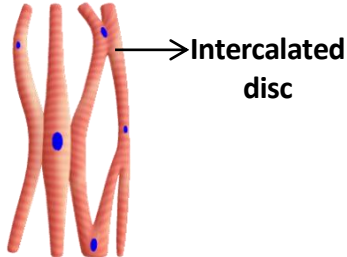


MUSCLE TISSUE :

- 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.

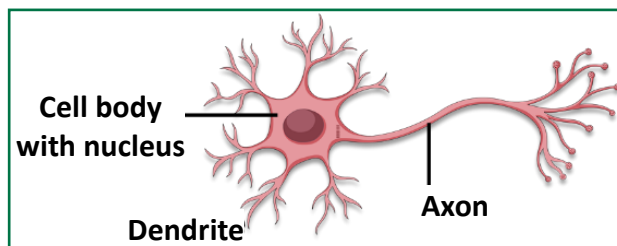
- Their action moves the body to adjust to the changes in the environment and to maintain the positions of the various parts of the body.
- In general, muscles play an active role in all the movements of the body. Muscles are of three types, skeletal, smooth, and cardiac.

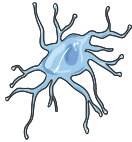


Skeletal muscle	Smooth muscle	Cardiac muscle
		
• Skeletal muscle tissue is closely attached to skeletal bones. In a typical muscle such as the biceps, striated (striped) skeletal muscle fibres are bundled together in a parallel fashion. • A sheath of tough connective tissue encloses several bundles of muscle fibres.	• The smooth muscle fibres taper at both ends (fusiform) and do not show striations. Cell junctions hold them together and they are bundled together in a connective tissue sheath. • The wall of internal organs such as the blood vessels, stomach and intestine contains this type of muscle tissue. • 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.	• Cardiac muscle tissue 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.

NERVOUS 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.



	Astrocytes	Oligodendrocytes	Microgliocytes
Morphology	Large cell having numerous process	Smaller cells with few processes.	Smallest cells with Branching.
Function	It forms blood brain barrier	Formation & preservation of Myelin sheath in CNS.	Scavenger cells of CNS and phagocytic in nature.
			

- 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.

ORGAN AND ORGAN SYSTEM :

- The basic tissues mentioned above organise to form organs which in turn associate to form organ systems in the multicellular organisms.
- Such an organisation is essential for more efficient and better coordinated activities of millions of cells constituting an organism.
- Each organ in our body is made of one or more type of tissues. For example, our heart consists of all the four types of tissues, i.e., epithelial, connective, muscular and neural.
- Morphology refers to study of form or externally visible features.
- In the case of plants or microbes, the term morphology precisely means only this.
- In case of animals this refers to the external appearance of the organs or parts of the body.
- The word anatomy conventionally is used for the study of morphology of internal organs in the animals.

**BEGINNER'S BOX - 4****SPECIALISED CONNECTIVE TISSUE,
MUSCLES, NERVOUS TISSUE**

1. Major Inorganic components of bone :-

(1) Calcium phosphate

(2) Calcium carbonate

(3) Sodium hydroxide

(4) Potassium hydroxide

BSA161

2. Eustachian tube is supported by :-

(1) Elastic cartilage

(2) White fibrous cartilage

(3) Calcified cartilage

(4) Hyaline cartilage

BSA162

3. Which of the following is incorrect statement about cartilage?

(1) Cartilage producing cells are arranged on periphery of cartilage known as chondroblast.

(2) Chondroblast are active cells & divide to form chondrocytes, and synthesize the matrix of cartilage.

(3) Elastic cartilage is the most common cartilage of human body.

(4) White fibrous cartilage is the strongest cartilage.

BSA163

4. How many statements are incorrect for bones?

(a) Bones have hard and pliable ground substance

(b) Matrix is rich in collagen fibres

(c) Bone is a specialized connective tissue

(d) They serve weight-bearing function

(e) Osteocytes are present in lacunae

(1) three

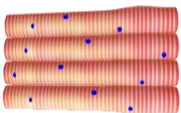
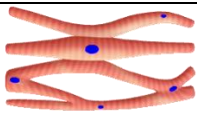
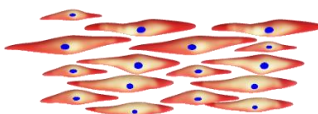
(2) four

(3) one

(4) two

BSA164

5. Match the columns I, II and III and choose the correct combination from the options given.

Column-I		Column-II	
a.		K.	Wall of blood vessels
b.		L.	Nodal tissue
c.		M.	Biceps

(1) a-M, b-L, c-K

(2) a-L, b-K, c-M

(3) a-L, b-M, c-K

(4) a-M, b-K, c-L

BSA165

6. Fill in the blanks:

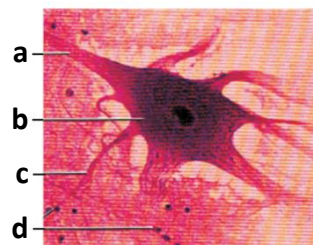
- (a) The 1 tissue is closely attached to skeletal bones.
 (b) The 2 fibres taper at both ends (fusiform).
 (c) The 3 fibres are found in wall of internal organs such as stomach and intestine.
 (d) Communication junctions of intercalated discs are found in 4 tissue.

- (1) 1 and 3–skeletal muscle, 2–smooth muscle, 4–cardiac muscle
 (2) 2 and 4–skeletal muscle, 3–smooth muscle, 1–cardiac muscle
 (3) 1–skeletal muscle, 2 and 3–smooth muscle, 4–cardiac muscle
 (4) 1 and 4–skeletal muscle, 3–smooth muscle, 4–cardiac muscle

BSA166

7. Recognise the figure and find out the correct matching.

- (1) b–cell body, c–dendrite, d–neuroglia, a–axon
 (2) b–cell body, a–dendrite, d–neuroglia, c–axon
 (3) d–cell body, c–dendrite, b–neuroglia, a–axon
 (4) d–cell body, a–dendrite, b–neuroglia, c–axon



BSA167

8. Which is characteristic feature of neurons?

- (1) Excitable cells
 (2) Totipotent cells
 (3) Power of regeneration
 (4) All of the above

BSA168

9. Which statement is correct?

- (1) A few organ in our body is made of one or more type of tissues
 (2) Each organ in our body is made of single type of tissues
 (3) Each organ in our body is made of one or more type of tissues
 (4) Each organ in our body is made of two type of tissues

BSA169



BEGINNER'S BOX

ANSWERS KEY

BEGINNER'S BOX-1	Que.	1	2	3	4	5	6	7	8	9	10
	Ans.	2	3	3	3	1	4	4	2	4	4

BEGINNER'S BOX-2	Que.	1	2	3	4	5	6	7	8	9	10
	Ans.	3	1	4	4	4	2	3	4	3	3
	Que.	11	12	13	14	15					
	Ans.	3	4	4	2	3					

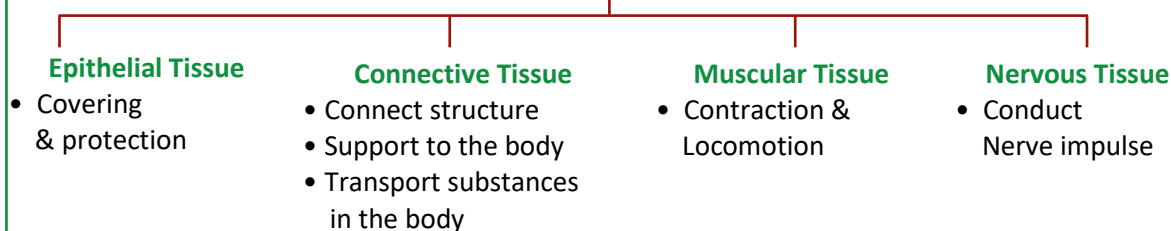
BEGINNER'S BOX-3	Que.	1	2	3	4	5	6	7	8		
	Ans.	1	3	4	1	3	1	4	2		

BEGINNER'S BOX-4	Que.	1	2	3	4	5	6	7	8	9		
	Ans.	1	1	3	3	1	3	1	1	3		

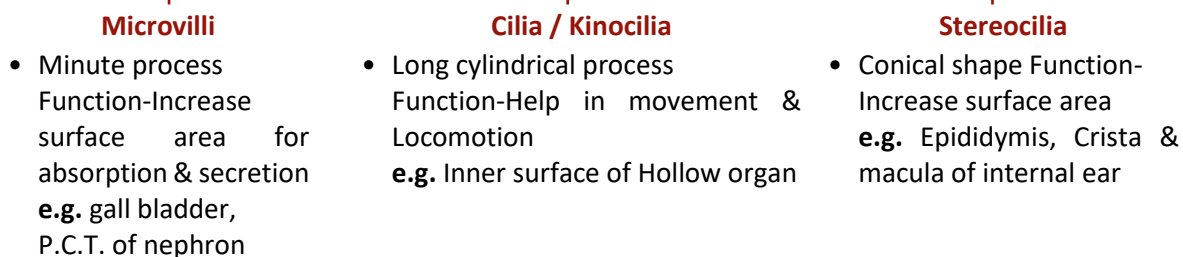


- Group of similar cells along with intercellular substance perform a specific function called tissue.

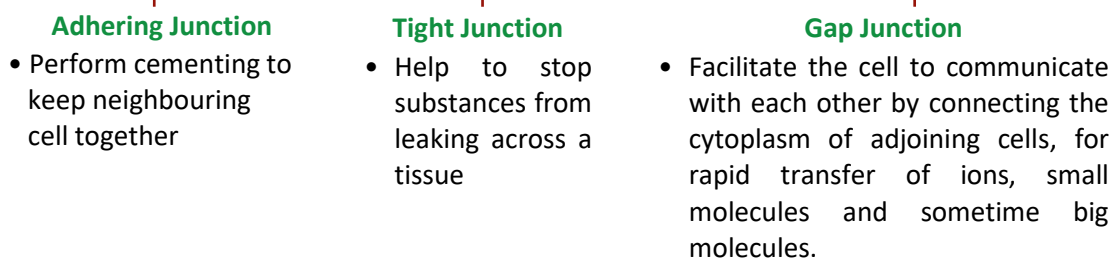
ON THE BASIS OF FUNCTION & STRUCTURE TISSUE ARE 4 TYPES

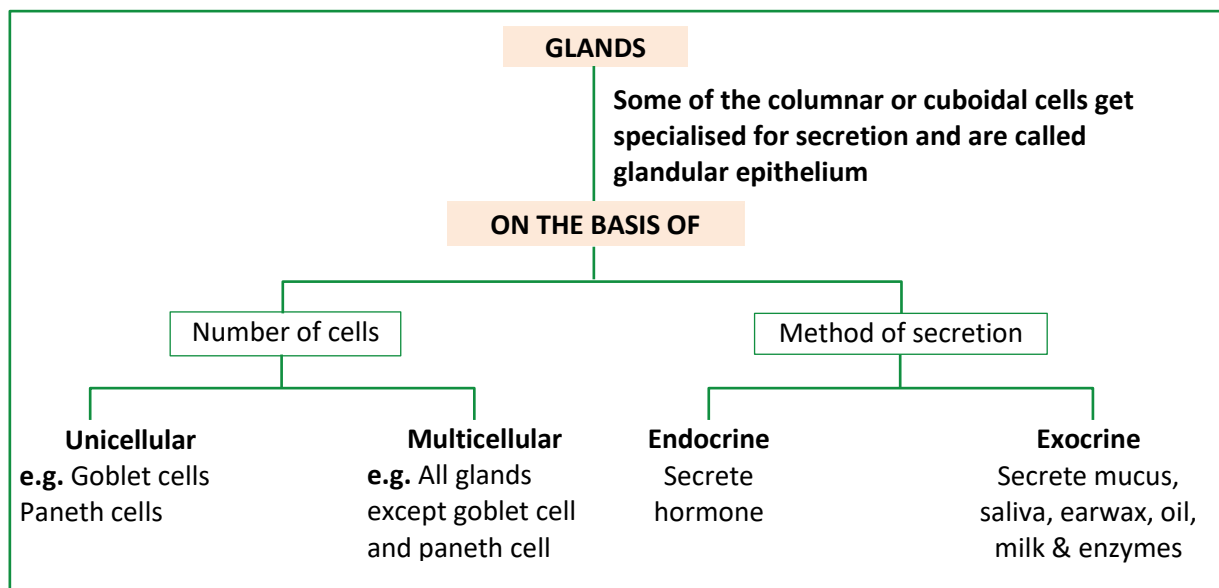
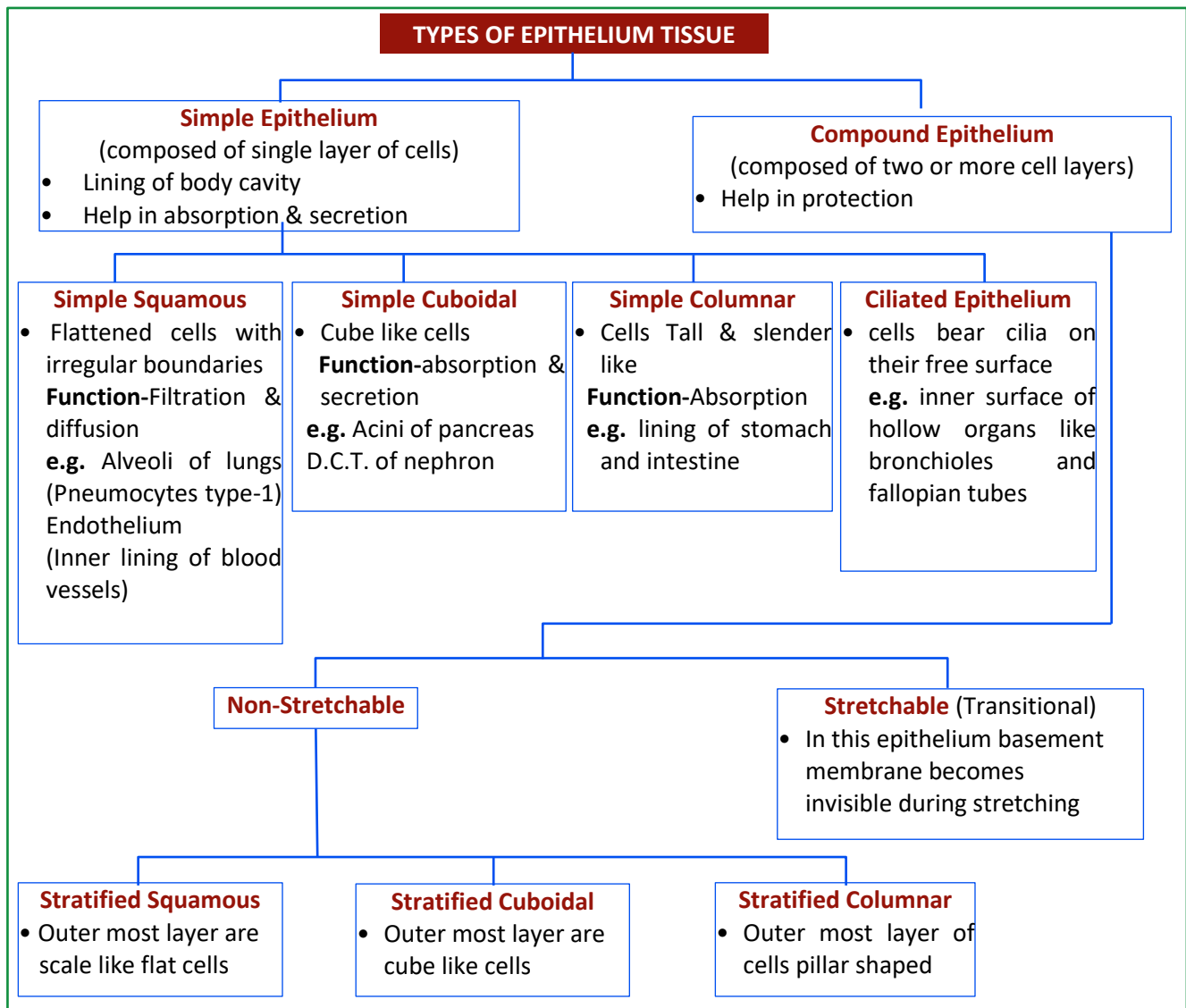


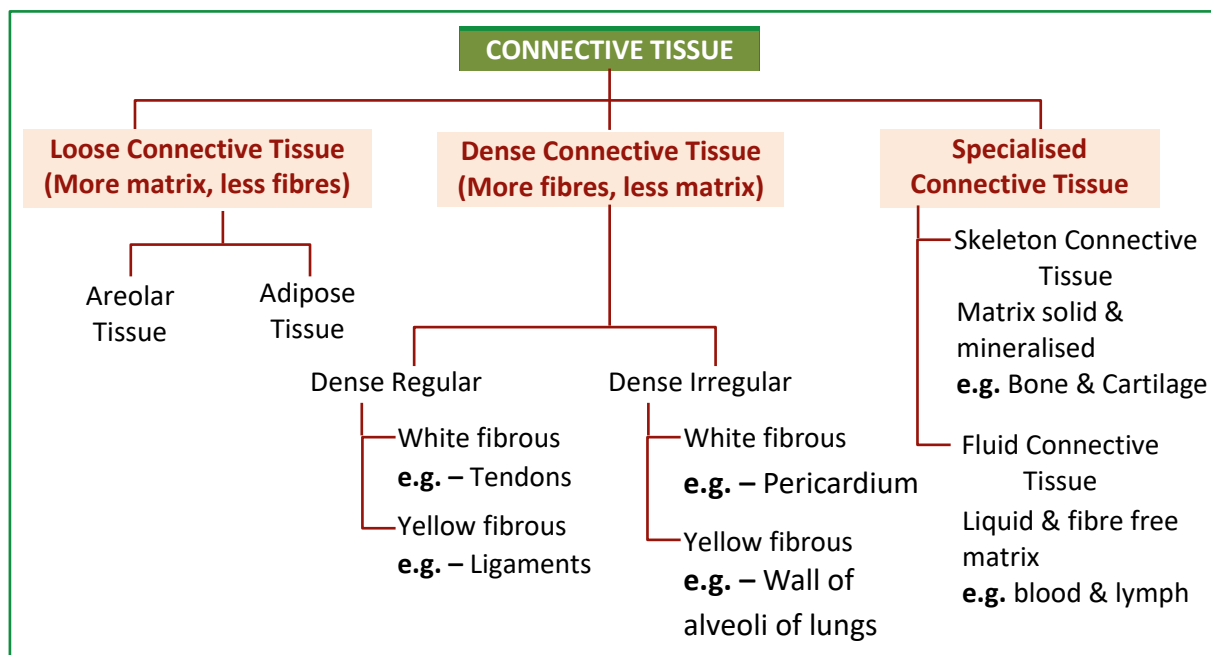
MODIFICATION OF PLASMA MEMBRANE



INTERCELLULAR JUNCTION







NCERT SUMMARY

Cells, tissues, organs and organ systems split up the work in a way that ensures the survival of the body as a whole and exhibit division of labour. A tissue is defined as group of cells along with intercellular substances performing one or more functions in the body. Epithelia are sheet like tissues lining the body's surface and its cavities, ducts and tubes. Epithelia have one free surface facing a body fluid or the outside environment. Their cells are structurally and functionally connected at junctions.

Diverse types of connective tissues bind together, support, strengthen, protect, and insulate other tissue in the body. Soft connective tissues consist of protein fibres as well as a variety of cells arranged in a ground substance. Cartilage, bone, blood, and adipose tissue are specialised connective tissues. Cartilage and bone are both structural materials. Blood is a fluid tissue with transport functions. Adipose tissue is a reservoir of stored energy. Muscle tissue, which can contract (shorten) in response to stimulation, helps in movement of the body and specific body parts. Skeletal muscle is the muscle tissue attached to bones. Smooth muscle is a component of internal organs. Cardiac muscle makes up the contractile walls of the heart. Connective tissue covers all three types of tissues. Nervous tissue exerts greatest control over the response of body. Neurons are the basic units of nervous tissue.

04

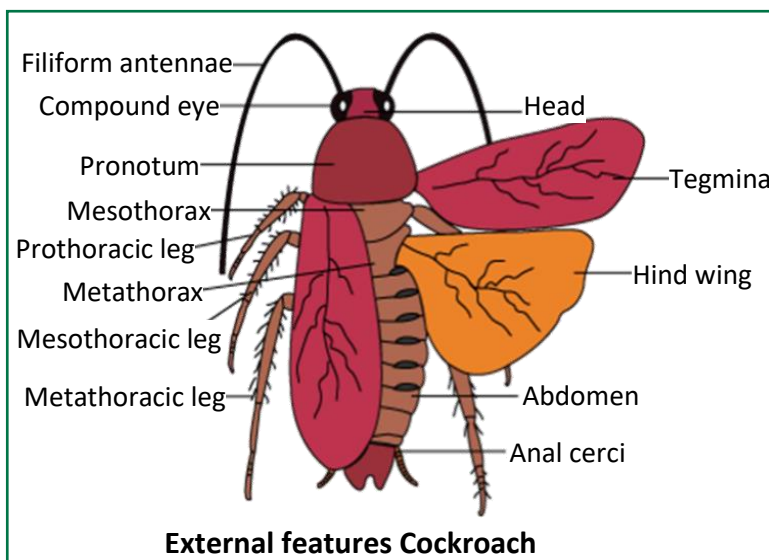
Structural Organisation in Animals (Cockroach)

01. INTRODUCTION

- Cockroaches are brown or black bodied animals.
- Bright yellow, red and green coloured cockroach have also been reported in tropical regions.
- Cockroaches are included in **class Insecta**, of **Phylum Arthropoda**.
- Their size ranges from $\frac{1}{4}$ inches to 3 inches (0.6-7.6 cm) and have long antenna, legs and flat extension of the upper body wall that conceals head.
- They are **nocturnal omnivores** that live in damp places throughout the world.
- Cockroaches are **cursorial insects**, i.e., they run very fast.
- They have become residents of human homes.
- Cockroaches are serious pests and vectors of several diseases like :-
 - (i) Typhoid fever (ii) Cholera (iii) Dysentery (iv) Giardiasis

MORPHOLOGY :

- The adults of the common species of cockroach, ***Periplaneta americana*** are about **34-53 mm long** with wings that extend beyond the tip of the abdomen in males.
- The body of the cockroach is segmented and divisible into three distinct regions – head, thorax and abdomen.



Body	=	Head	+	Thorax	+	Abdomen	
	=	6	+	3	+	11	= 20 segments in embryo.
	=	1	+	3	+	10	= 14 segments in adults.

- The entire body is covered by a hard **chitinous exoskeleton** (brown in colour).
- In each segment, exoskeleton has hardened plates called **sclerites** (**tergites dorsally, sternites ventrally** and **pleurites laterally**) that are joined to each other by a thin and flexible **articular membrane (arthrodial membrane)**.

Sclerites of dorsal side - **tergum or tergite**

Sclerites of ventral side - **sternum or sternite**

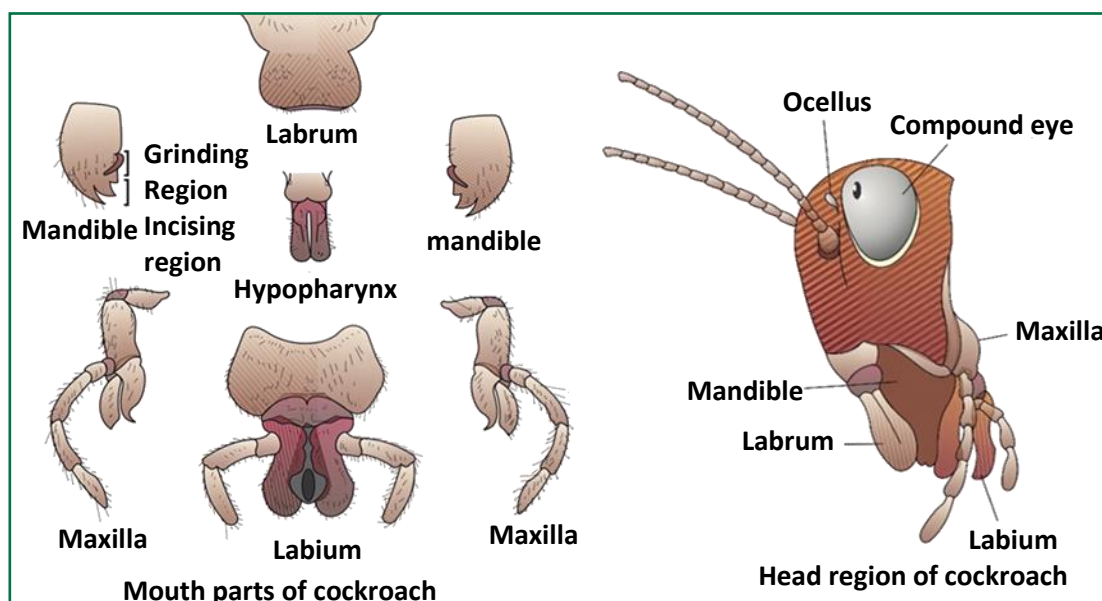
Sclerites of lateral side - **pleurons or pleurites.**

02. HEAD

- Head is triangular in shape and lies anteriorly at **right angles** to the longitudinal body axis (**hypognathous**).
- It is formed by the fusion of six segments and shows great mobility in all directions due to **flexible neck**.



Triangular head at 90° to the longitudinal body axis.



- In adult all sclerites of the head are fused to form a **head capsule**. The head capsule bears a pair of **compound eyes**.
- A pair of thread like **antennae** arise from membranous sockets lying in front of eyes.
- Antennae have sensory receptors that help in monitoring the environment.
- Anterior end of the head bears appendages forming biting and chewing type of mouth parts.
- The **mouthparts** consisting of a labrum (upper lip (movable)), a pair of mandibles, a pair of maxillae and a labium (lower lip).
- A median flexible lobe, acting as tongue (hypopharynx), lies within the cavity enclosed by the mouthparts.



BEGINNER'S BOX-1

HEAD OF COCKROACH

1. Cockroach belong's to phylum :
 (1) Annelida (2) Arthropoda (3) Porifera (4) Mollusca
BSA263
2. Which of following all tegmata of cockroach fused in adult stage ?
 (1) Head (2) Abdomen (3) Thorax (4) (1) & (2)
BSA264
3. How many segment are found in adult cockroach :
 (1) 12 (2) 15 (3) 20 (4) 14
BSA265
4. Which movable chitineous plate joined with dorsal part of head :-
 (1) Labrum (2) Clypeus (3) Labium (4) Forhead or frons
BSA266
5. Which is the correct location of mandibles in mouth of cockroach :
 (1) Upper side (2) Lateral side (3) Lower side (4) Anterior side
BSA267
6. Function of arthroidial membrane is _____.
 (1) Circulation (2) Respiration
 (3) Joining/Articulation (4) Excretion
BSA268
7. Cockroach belongs to class _____ of phylum arthropoda.
 (1) Crustacea (2) Arachnida (3) Insecta (4) Myriapoda
BSA269
8. Size of cockroach is :
 (1) from 3 cm to 15 cm (2) from 0.6 cm to 7.6 cm
 (3) from 7.6 cm to 20 cm (4) from 1 m to 3 m
BSA270
9. In each segment, exoskeleton has hardened plates called _____, _____ dorsally and _____ ventrally.
 (1) sclerites, tergites, sternites (2) tergites, sclerites, sternites
 (3) tergites, sternites, sclerites (4) sternites, tergites, sclerites
BSA271
10. The entire body is covered by a hard exoskeleton made up of :
 (1) Cellulose (2) Chitin (3) Glycogen (4) Glucose
BSA272

11. Head of cockroach is _____ in shape and lies anteriorly at _____ angles to the longitudinal body axis.

- (1) triangular, acute (2) triangular, obtuse
(3) triangular, right (4) circular, right

BSA273

12. A median flexible lobe, acting as tongue (_____), lies within the cavity enclosed by the mouthparts.

- (1) hyperpharynx (2) hypopharynx (3) labial palp (4) maxilla

BSA274

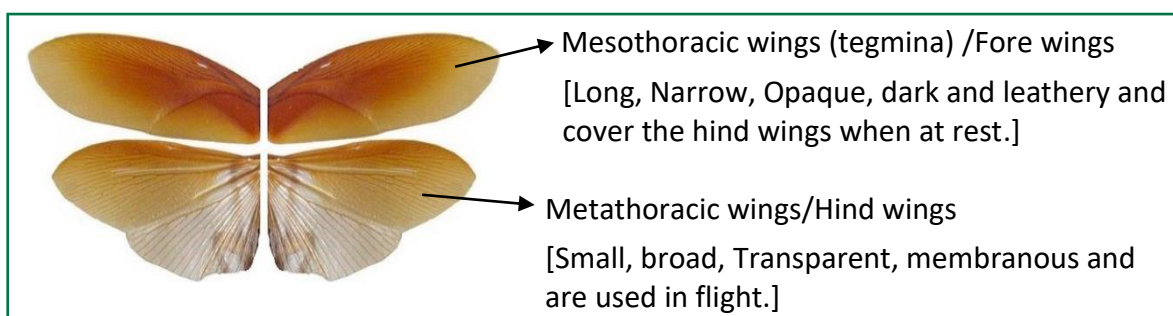
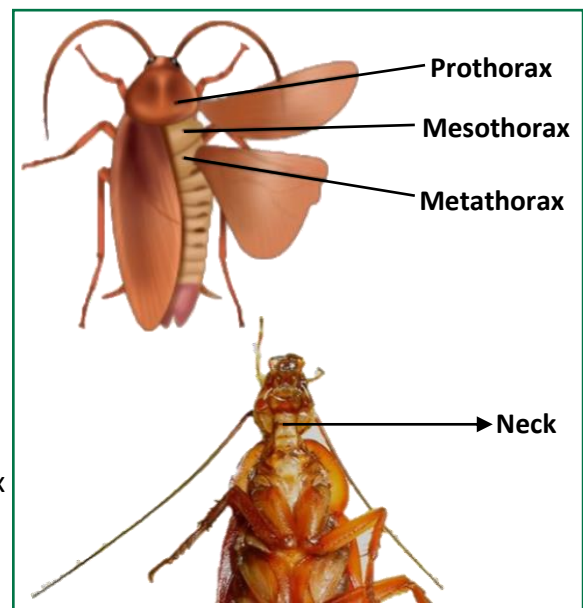
13. What will happen when mandibles are removed from the mouth parts of a cockroach?

- (1) Only grinding of food will be affected
(2) Only incisor of food will be affected
(3) No incisor and grinding of food take place
(4) No effect on biting & chewing of food

BSA275

03. THORAX

- Thorax consists of three parts—
prothorax, **mesothorax** and **metathorax**
- The head is connected with thorax by a short extension of the prothorax known as the **neck**.
- The thorax bears **three pairs of legs** and **two pairs of wings**.
- Two pairs of wings are found in cockroach.
- The **first pair** of wings arises from mesothorax and the **second pair** from metathorax.



04. ABDOMEN

- The abdomen in **both males** and **females** consists of **10 segments**.
- In **females**, the **7th sternum is boat shaped** and together with the 8th and 9th sterna forms a **brood** or **genital pouch** whose anterior part contains **female gonopore**, **spermathecal pores** and **collateral glands**.
- In **males**, genital pouch or chamber lies at the hind end of abdomen bounded dorsally by 9th and 10th terga and ventrally by the 9th sternum.
- It contains dorsal anus, ventral **male genital pore** and **gonapophysis**.
- Males bear a pair of short, threadlike **anal styles** which are absent in females.
- In both sexes, the 10th segment bears a pair of jointed filamentous structures called **anal cerci**.



BEGINNER'S BOX-2

THORAX AND ABDOMEN OF COCKROACH

1. How many segments present in thorax ?

- (1) 2 (2) 4 (3) 1 (4) 3

BSA276

2. Which is the structure act as sound receptor in cockroach :-

- (1) Anal style (2) Anal cerci (3) Antenna (4) Both (2) and (3)

BSA277

3. Identify the correct labelling-

- (1) Middle leg
(2) Thoracic leg
(3) Mesothoracic leg
(4) Prothoracic leg



BSA278

4. Second pair of wings in cockroaches arises from :-

- (1) Pronotum (2) Metathorax (3) Mesothorax (4) Prothorax

BSA279

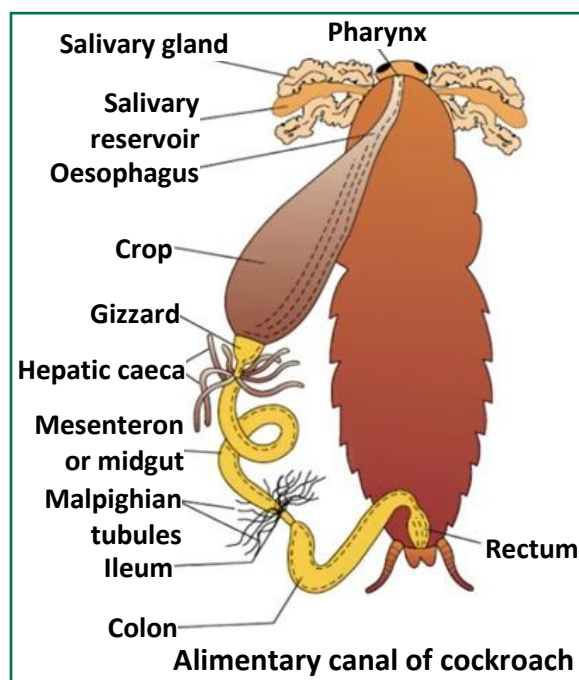
5. Identify the wrong statement :-

- (1) Males bear a pair of short, thread like anal styles.
(2) Males have anal styles which are absent in females.
(3) Males do not have anal styles which are present in females.
(4) Anal styles are present in male on 9th sternum.

BSA280

05. DIGESTIVE SYSTEM

- The alimentary canal present in the body cavity is divided into three regions: -
 - Foregut**
 - Midgut (Mesenteron)**
 - Hindgut**
- Foregut comprises the **preoral cavity, mouth, pharynx, oesophagus, crop** and **gizzard**.
- The **mouth** opens into a short tubular **pharynx**, leading to a narrow tubular passage called **oesophagus**.
- This in turn opens into a sac like structure called **crop** used for storing of food.
- The crop is followed by **gizzard** or **proventriculus**. It has an outer layer of thick circular muscles and thick inner cuticle forming **six highly chitinous plate** called **teeth**.
- Gizzard helps in grinding the food particles.
- The **entire foregut is lined by cuticle**.
- A ring of **6-8 blind tubules** called **hepatic** or **gastric caeca** is present at the junction of foregut and midgut, which secrete digestive juice.
- At the junction of midgut and hindgut is present another ring of **100-150 yellow coloured** thin filamentous Malpighian tubules. They help in removal of excretory products from haemolymph.
- The hindgut is broader than midgut and is differentiated into **ileum, colon** and **rectum**.
- The rectum opens out through **anus**.

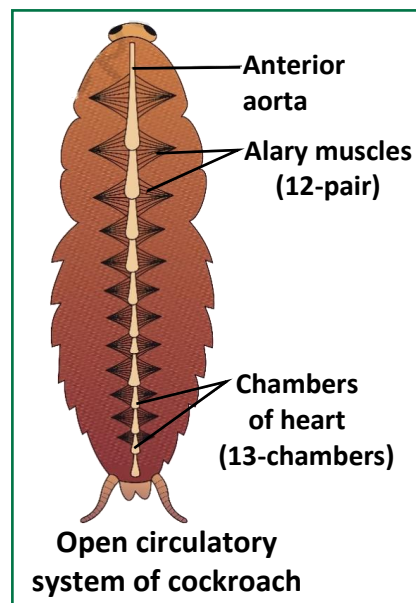


06. RESPIRATORY SYSTEM

- The respiratory system consists of a network of **trachea**, that open through **10 pairs** of small holes called **spiracles** present on the lateral side of the body.
- Thin branching tubes (**tracheal tubes subdivided into tracheoles**) carry oxygen from the air to all the parts. The opening of the spiracles is regulated by the **sphincters**.
- Exchange of gases take place at the tracheoles by diffusion.

07. BLOOD VASCULAR SYSTEM

- Blood vascular system of cockroach is an **open type**.
- Blood vessels are poorly developed and open into space (**haemocoel**).
- Visceral organs located in the haemocoel are bathed in **blood (haemolymph)**.
- The haemolymph is composed of **colourless plasma** and **haemocytes**.
- **Heart** of cockroach consists of **elongated muscular tube** lying along **mid dorsal line** of thorax and abdomen.
- It is differentiated into **funnel shaped chambers with ostia** on either side.
- Blood from sinuses enter heart through ostia and is pumped anteriorly to sinuses again.



BEGINNER'S BOX-3

DIGESTION AND RESPIRATION

- Gastric caeca are present at _____.
 (1) Junction of fore gut and midgut (2) Foregut
 (3) Hindgut (4) Junction of midgut and Hindgut
 BSA281
- Cockroach can digest _____.
 (1) Protein (2) Carbohydrate (3) Fat (4) All of them
 BSA282
- Which of the following is the correct function of crop in cockroach?
 (1) Grinding of food (2) Cutting of food
 (3) Storage of food (4) All of the above
 BSA283
- In cockroach which of the following help in exchange of gases ?
 (1) Spiracles (2) Respiratory tubule
 (3) Tracheoles (4) Abdomen
 BSA284
- Spiracles present on the which side of the body :-
 (1) Dorsal side (2) Ventral side (3) Lateral side (4) Medially
 BSA285

08. EXCRETORY SYSTEM

- Excretion is performed by **Malpighian tubules** (**100-150 yellow coloured**) which are present at the junction of midgut and hindgut. Each tubule is lined by glandular and ciliated cells.
- They absorb nitrogenous waste products and convert them into uric acid which is excreted out through the hindgut.
- Therefore, this insect is called **uricotelic**.
- In addition, the **Fat body**, **Nephrocytes** (*pericardial cells*) and **Uricose glands** also help in excretion.

09. NERVOUS SYSTEM

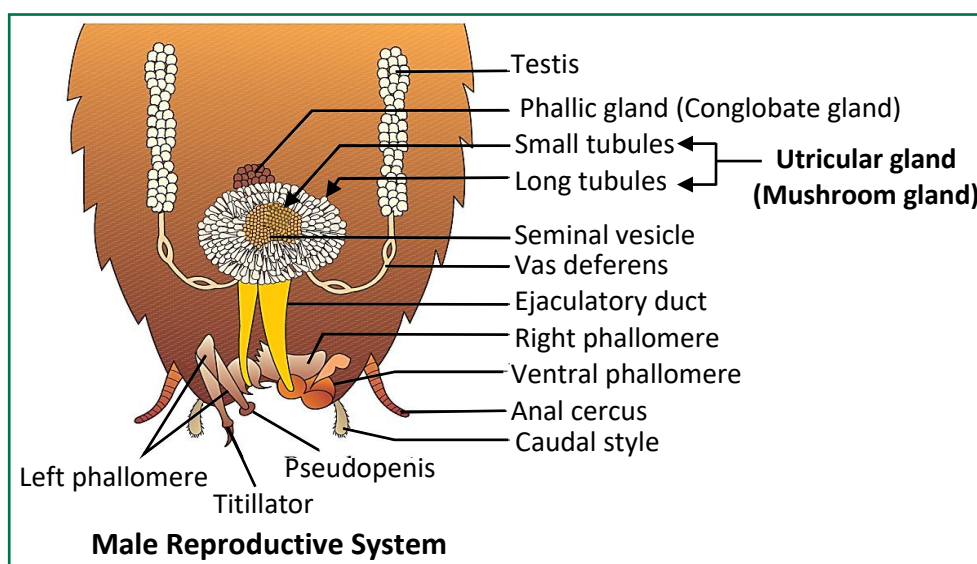
- The nervous system of cockroach consists of a series of fused, segmentally arranged **ganglia** joined by paired **longitudinal connectives** on the ventral side.
- **Three ganglia** lie in the **thorax**, and **six** in the **abdomen**.
- The nervous system of cockroach is spread throughout the body.
- The **head holds a bit of a nervous system** while the rest is situated along the ventral (belly-side) part of its body. **So, now you understand that if the head of a cockroach is cut off, it will still live for as long as one week.**
- In the head region, the brain is represented by **supra-oesophageal ganglion** which supplies nerves to antennae and compound eyes.
- In cockroach, the **sense organs** are **antennae, eyes, maxillary palps, labial palps, anal cerci, etc.**
- The **compound eyes** are situated at the dorsal surface of the head.
- Each eye consists of about **2000** hexagonal **ommatidia** (sing.: *ommatidium*). With the help of several ommatidia, a cockroach can receive several images of an object.
- This kind of vision is known as mosaic vision with more sensitivity but less resolution, being common during night (hence called nocturnal vision).

10. REPRODUCTIVE SYSTEM

Cockroaches are **dioecious** and both sexes have well developed reproductive organs.

MALE REPRODUCTIVE SYSTEM :

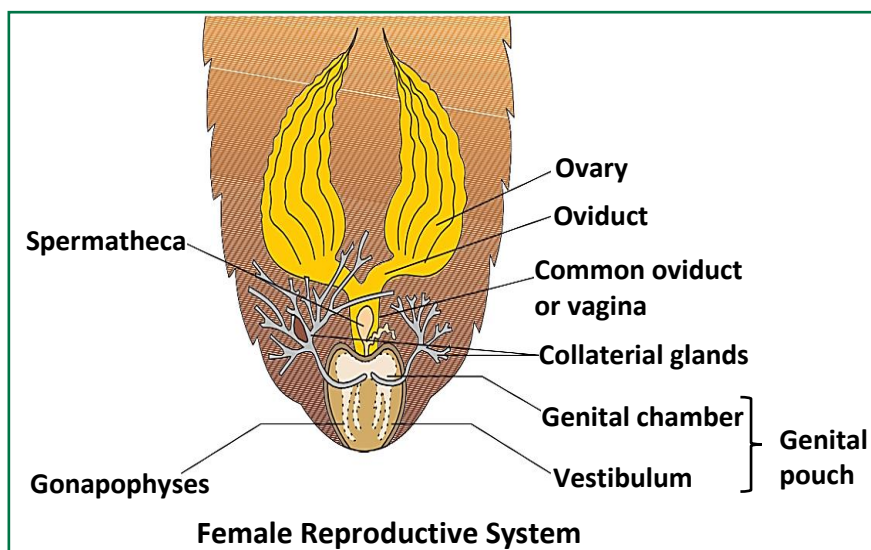
- Male reproductive system consists of a **pair of testes** one lying on each lateral side in the **4th-6th abdominal segments**. Each testis consists of 3 or 4 interconnected lobes.
- From each testis arises a thin **vas deferens**, which opens into **ejaculatory duct** through **seminal vesicle**.
- The ejaculatory duct opens into **male gonopore** situated **ventral to anus**.
- A characteristic **mushroom shaped gland (Utricular gland)** is present in the **6th-7th abdominal segments** which functions as an accessory reproductive gland.



- The **external genitalia** are represented by **male gonapophyses** or **phallomeres** (chitinous asymmetrical structures surround the male gonopore)
- The sperms are stored in the seminal vesicles and are glued together in the form of bundles called spermatophores which are discharged during copulation.

FEMALE REPRODUCTIVE SYSTEM :-

- The female reproductive system consists of **two large ovaries**, lying laterally in the **2nd – 6th abdominal segments**. Each ovary is formed of a group of **eight ovarian tubules** or **ovarioles**, containing a chain of developing ova.



- **Oviducts** of each ovary unite into a **single median oviduct** (also called **vagina**) which opens into the **genital chamber**.
- Oviducts of each ovary unite into a single median oviduct (also called vagina) which opens into the genital chamber. A pair of spermatheca is present in the 6th segment which opens into the genital chamber.
- Sperms are transferred through spermatophores. Their fertilised eggs are encased in capsules called oothecae. Ootheca is a dark reddish to blackish brown capsule, about $\frac{3}{8}$ " (8 mm) long.
- **They are dropped or** glued to a suitable surface, usually in a crack or crevice of high relative humidity near a food source.
- On an average, females produce 9-10 oothecae, each containing 14-16 eggs. The development of *P. americana* is paurometabolous, meaning there is development through nymphal stage.
- The nymphs look very much like adults. The nymph grows by **moulting about 13 times** to reach the adult form.
- The next to **last nymphal stage has wing pads** but only **adult cockroaches have wings**.
- Many species of cockroaches are wild and are of no known economic importance yet.
- A few species thrive in and around human habitat.
- They are pests because they spoil food and contaminate it with their smelly excreta.
- They can transmit a variety of bacterial diseases by contaminating food material.

**BEGINNER'S BOX-4****CIRCULATION, EXCRETION, NERVOUS SYSTEM AND REPRODUCTION**

1. Blood vessels are poorly developed and open into space known as?

(1) Lymphocoel	(2) Blood Cavity
(3) Circulatory Cavity	(4) Haemocoel

BSA286
2. Visceral organs located in the haemocoel :

(1) Supplied by blood vessels.
(2) Bathes directly in the haemocoel.
(3) Do not need any circulatory structure.
(4) Receives blood from ostia.

BSA287
3. Heart of cockroach consists of elongated muscular tube lying along :

(1) Mid ventral line of thorax	(2) Mid ventral line of abdomen
(3) Lateral to the alimentary canal	(4) Mid dorsal line of thorax and abdomen

BSA288
4. If the head of cockroach is cut-off, it will still live for as long as one week, because :

(1) Head holds a large mass of nervous system.
(2) Most of the Nervous system is present in ventral part of its body.
(3) Nervous system present only in abdominal part.
(4) No control of brain over the body.

BSA289
5. On the basis of nature of excretory products, cockroaches are :

(1) Ammonotelic	(2) Uricotelic	(3) Ureotelic	(4) Guanotelic
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BSA290
6. In cockroach which of the following features is not associated with conservation of water?

(1) Wall of rectum is provided with six rectal papillae.
(2) Uricotelism.
(3) Presence of waxy layer above the epicuticle.
(4) Presence of thin and transparent chitinous membrane on the inner lining of mesenteron.

BSA291
7. Antennae of cockroach function as :

(1) Tactile, olfactory, thermal and gustatory receptor.
(2) Only tactile and Auditory.
(3) Only Auditory, Olfactory.
(4) Only Auditory receptor.

BSA292
8. Which of the following is not a sensory organ in cockroach?

(1) Antennae	(2) Wings	(3) Maxillary palps	(4) Anal cerci
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BSA293

9. Main character for the distinction between male and female cockroach is :

- (1) Antennae (2) Mandibles (3) Anal cerci (4) Anal Style

BSA294

10. Find out the incorrect pair for cockroach :

- (1) A pair of testis – 4th-6th abdominal segmental
(2) Mushroom gland – 6th-7th abdominal segmental
(3) Titillator – Left phallomere
(4) Mushroom gland – Phallic gland

BSA295

11. Mark the incorrect match in the given option :

- (1) Seminal vesicle – Storage of sperm
(2) Phallic gland – Covering of spermatophore
(3) Collateral gland – Oothecal covering
(4) Phallomeres – Nourishing sperms

BSA296

12. In male cockroach, outermost layer of spermatophore is secreted by :

- (1) Ejaculatory duct, during copulation.
(2) Phallic gland, during copulation.
(3) Mushroom gland, during copulation.
(4) Conglobate gland, after copulation.

BSA297

13. Nymph differs from adult cockroach in :

- (1) Absence of wings
(2) Smaller in size
(3) Absence of mature reproductive organs
(4) All of these

BSA298

14. In cockroach, ootheca is produced by secretion of :

- (1) Conglobate gland (2) Prothoracic gland
(3) Gonapophyses (4) Collateral gland

BSA299

15. During metamorphosis, under the ecdysone hormone moulting occurs _____ times in *Periplaneta* :-

- (1) 3–5 (2) 15–20 (3) 13 (4) 1–2

BSA300

16. The haemolymph helps in removal of :

- (1) Excretory products (2) Digestive products
(3) Respiratory products (4) Circulatory products

BSA301



BEGINNER'S BOX

ANSWERS KEY

BEGINNER'S BOX-1	Que.	1	2	3	4	5	6	7	8	9	10
	Ans.	2	1	4	1	2	3	3	2	1	2
	Que.	11	12	13							
	Ans.	3	2	3							

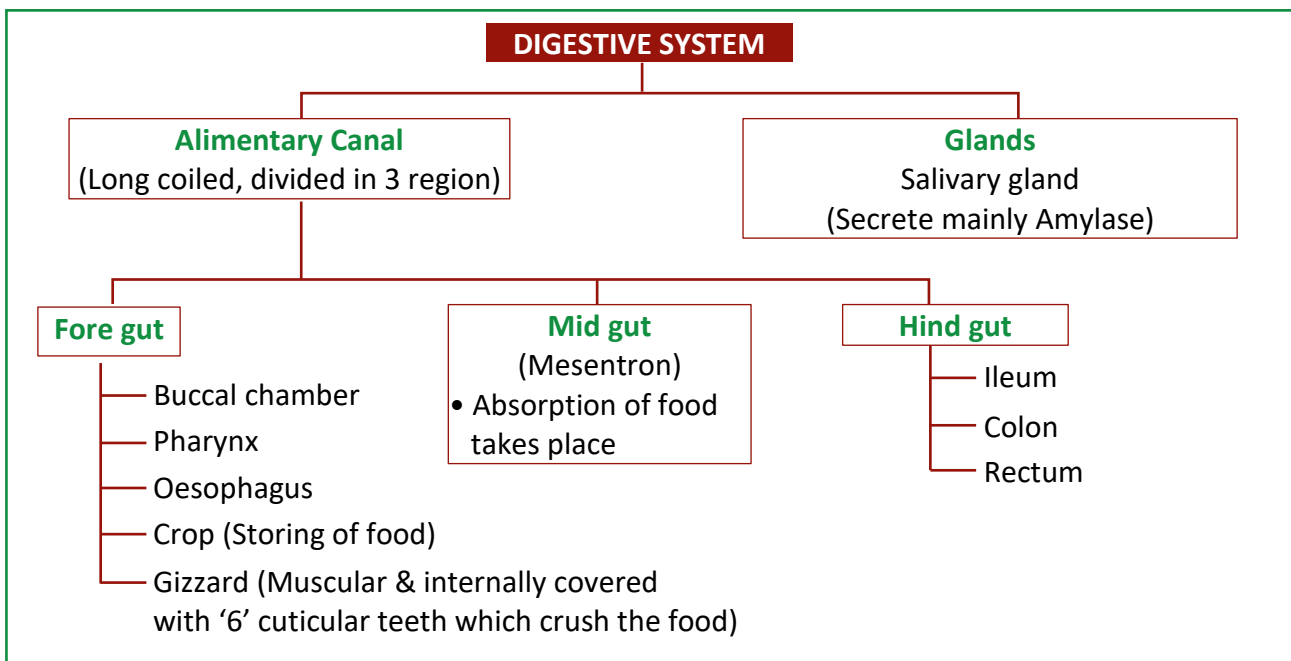
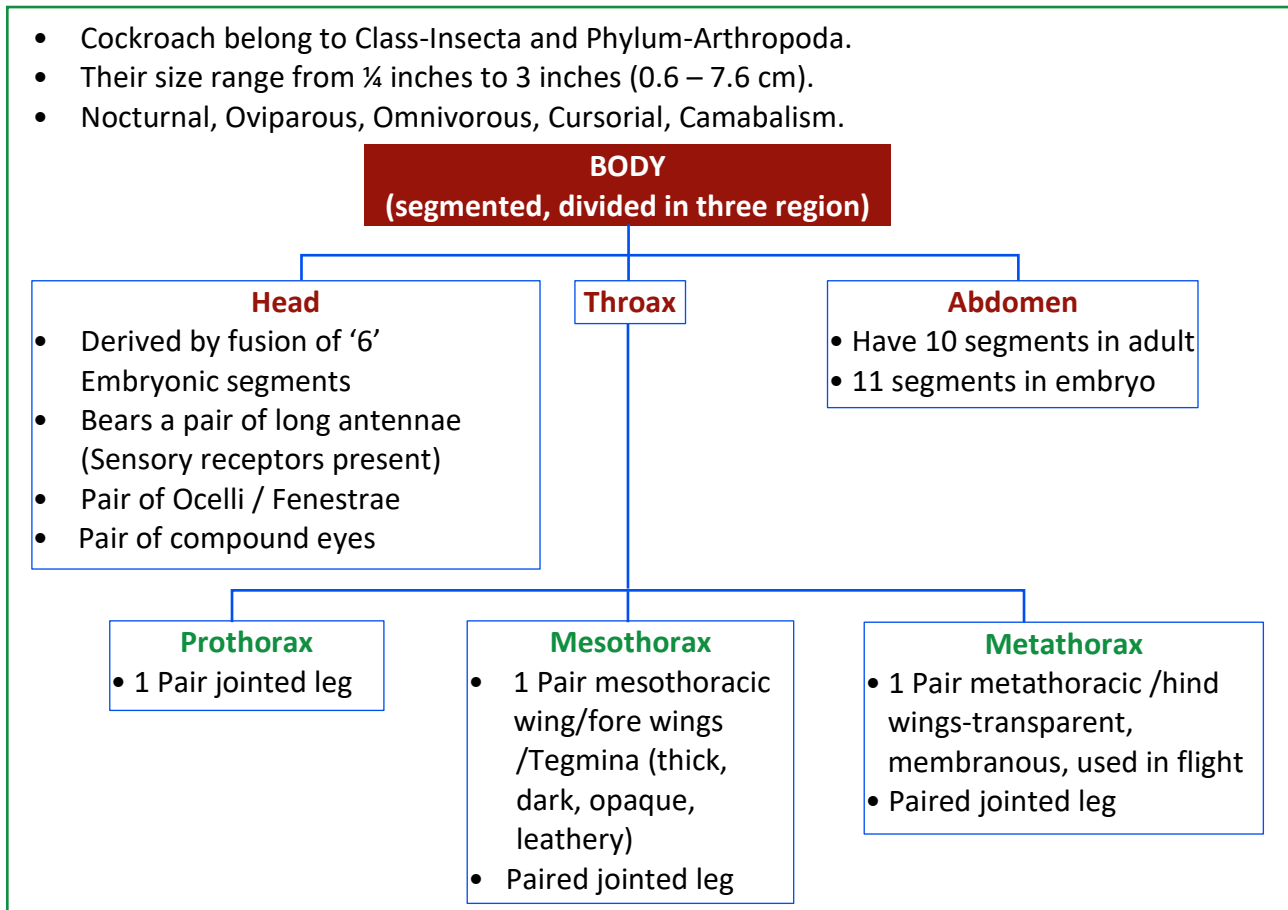
BEGINNER'S BOX-2	Que.	1	2	3	4	5					
	Ans.	4	4	4	2	3					

BEGINNER'S BOX-3	Que.	1	2	3	4	5					
	Ans.	1	4	3	3	3					

BEGINNER'S BOX-4	Que.	1	2	3	4	5	6	7	8	9	10
	Ans.	4	2	4	2	2	4	1	2	4	4
	Que.	11	12	13	14	15	16				
	Ans.	4	2	4	4	3	1				



- Cockroach belong to Class-Insecta and Phylum-Arthropoda.
- Their size range from $\frac{1}{4}$ inches to 3 inches (0.6 – 7.6 cm).
- Nocturnal, Oviparous, Omnivorous, Cursorial, Camabalism.



CIRCULATORY SYSTEM

Open type and blood is filled in haemocoel

- * Heart is 13 chambered
- * Blood circulation maintained by 12 pairs of Alary muscles
- * Heart is neurogenic

RESPIRATORY SYSTEM

Consist of tracheal system, open outside by 10 pairs of spiracles (2 pairs thoracic and 8 pairs abdominal)

EXCRETORY SYSTEM

Excretory Organ
Malpighian Tubules

Excretory Product
Uric acid (Uricotelic)

NERVOUS SYSTEM

Consists of a series of fused, segmentally arranged ganglia joined by paired longitudinal connectives on the ventral side. The brain is represented by supra-oesophageal ganglion.

Nerve cord (Double, ventral, solid with 3 thoracic and 6 abdominal ganglia)

SENSORY ORGAN

Compound Eyes (Composed of about 2000 ommatidia) **Mosaic vision** (More sensitivity but less resolution) antennae, maxilla, Labial palp, labium, hypopharynx, Anal cerci.

NCERT SUMMARY

The body of Cockroach (*Periplaneta americana*) is covered by chitinous exoskeleton. It is divided into head, thorax and abdomen. Segments bear jointed appendages. There are three segments of thorax, each bearing a pair of walking legs. Two pairs of wings are present, one pair each on 2nd and 3rd segment. There are ten segments in abdomen. Alimentary canal is well developed with a mouth surrounded by mouth parts, a pharynx, oesophagus, crop, gizzard, midgut, hindgut and anus. Hepatic caecae are present at the junction of foregut and midgut. Malpighian tubules are present at the junction of midgut and hindgut and help in excretion. A pair of salivary gland is present near crop. The blood vascular system is of open type. Respiration takes place by network of tracheae. Trachea opens outside with spiracles. Nervous system is represented by segmentally arranged ganglia and ventral nerve cord. A pair of testes is present in 4th-6th segments and ovaries in 2nd-6th segments. Fertilisation is internal. Female produces 9-10 ootheca bearing developing embryos. After rupturing of single ootheca sixteen young ones, called nymphs come out.