

Chapter 7

Structural Organization In Animals

Animal Tissue

- Tissues are group of similar cells along with intercellular substances perform a specific function.
- Tissues are broadly classified into four types:

- A) Epithelial tissue
- B) Connective tissue
- C) Muscular tissue
- D) Neural tissue

A) Epithelial tissue

- This tissue has a free surface, which faces either a body fluid or the outside environment..
- Epithelial tissues provide a covering or a lining for some part of the body.
- The cells are compactly packed with little intercellular matrix.
- Based on the number of layers tissues are of two types namely

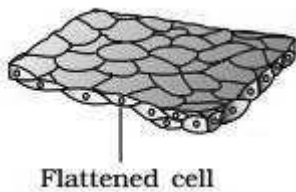
- a) simple epithelium
- b) Compound epithelium.

i) Simple epithelium

- it is composed of a single layer of cells
- it functions as a lining for body cavities, ducts, and tubes.
- On the basis of structural modification of the cells, simple epithelium is further divided into three types. These are

- i) Squamous epithelium
- ii) Cuboidal epithelium
- iii) Columnar epithelium

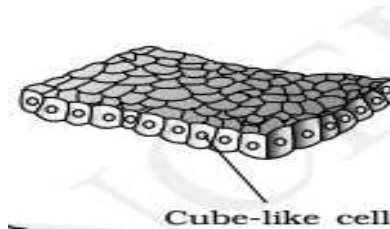
i) Squamous epithelium



- The squamous epithelium is made 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**
- They are involved in functions like forming a **diffusion** boundary.

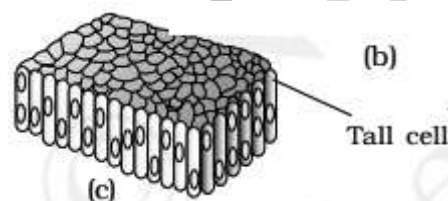


ii) Cuboidal epithelium



- 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**.
- The epithelium of proximal convoluted tubule (PCT) of nephron in the kidney has **microvilli**

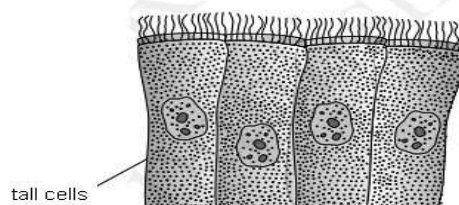
iii) Columnar epithelium



- The columnar epithelium is composed of a single layer of **tall and slender cells**.
- Their nuclei are located at the base.
- Free surface may have microvilli.
- They are found in the **lining of stomach and intestine** and help in **secretion and absorption**.

Ciliated Epithelium

- 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**



Functional modification of epithelium

Some of the columnar or cuboidal cells get specialized for secretion and are called **glandular epithelium**

They are mainly of two types:

i) Unicellular glandular epithelium:

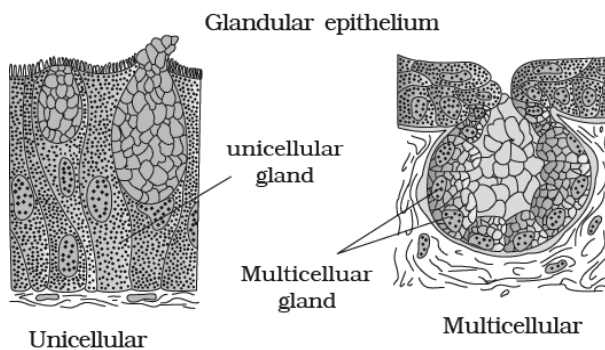
it consist of isolated glandular cells

eg: goblet cells of the alimentary canal

ii) Multicellular glandular epithelium,

it consist of cluster of cells

eg: salivary gland

**Types of glands**

On the basis of the mode of pouring of their secretions, glands are divided into two categories namely

i) Exocrine gland

ii) Endocrine glands.



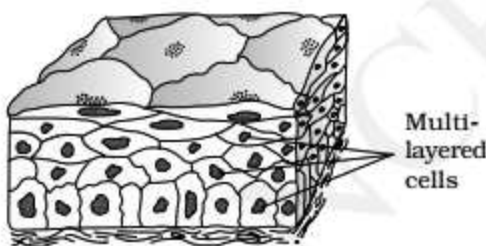
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i) Exocrine glands:

These glands secrete mucus, saliva, ear wax, oil, milk, digestive enzymes and other cell products. These products are **released through ducts or tubes**

ii) Endocrine glands

The secretion of these glands are called Hormones. they do not have ducts. The Hormones are secreted directly into the fluid (Blood). Hence this gland is called **ductless gland**.

ii)Compound Epithelium

- 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, the moist surface of buccal cavity, pharynx, inner lining of ducts of salivary glands and of pancreatic ducts.

Junctional Complex

. In nearly all animal tissues, specialised junctions provide both structural and functional links between its

individual cells. Three types of cell junctions are found in the epithelium and other tissues. These are called as

i) **Tight junction,**

ii) **Adhering junction**

iii) **Gap junctions.**

i) Tight junctions:

Tight junctions **help to stop** substances from leaking across a tissue.

ii) Adhering junctions

it perform **cementing** to keep neighboring cells together.

iii) Gap junctions

it facilitate the cells **to communicate** with each other by **connecting the cytoplasm** of adjoining cells, for rapid **transfer of ions, small molecules and sometimes big molecules**.

B) Connective tissue

- Connective tissues are 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.
- 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)**.

Connective tissues are classified into three types:

(i) **Loose connective tissue,**

(ii) **Dense connective tissue**

(iii) **Specialised connective tissue.**

(i) Loose connective tissue

Loose connective tissue has cells and **fibres loosely arranged** in a **semi-fluid ground substance**,

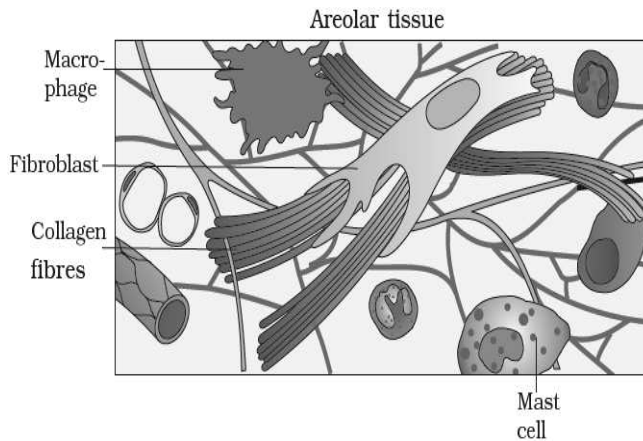
Examples:

1. Areolar tissue:

It is present beneath the skin. Often it serves as a **support framework for epithelium**. It contains **fibroblasts** (cells that produce and secrete fibres), **macrophages and mast cells**.



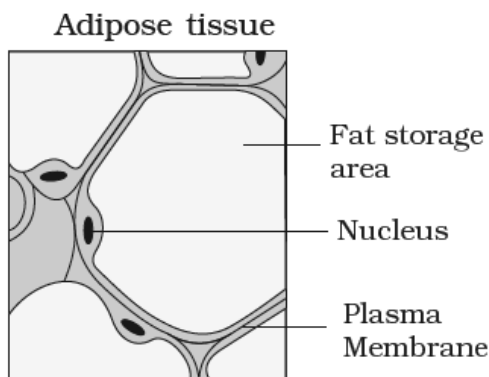
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2. Adipose tissue:

It is located mainly beneath the skin. 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



(ii) Dense connective tissue

In this type of connective tissue, Fibres and fibroblasts are compactly packed. Based on the orientation of fibres (regular / irregular), dense connective tissues are of 3 types

a) Dense regular connective tissue

In the dense regular connective tissues, the collagen fibres are present in rows between many **parallel bundles** of fibres.

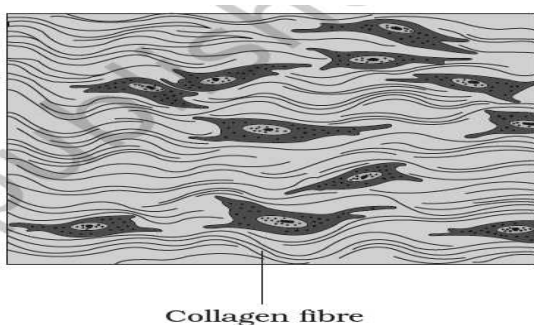
Examples:

1. Tendons:

It attaches skeletal muscles to bones

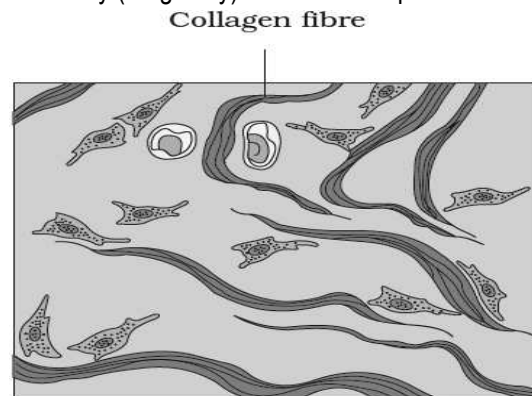
2. Ligaments

It attaches one bone to another bone



b) Dense irregular connective tissue

In dense irregular connective tissues, fibroblasts and many fibres (mostly collagen) that are oriented differently (irregularly). This tissue is present in the **skin**.

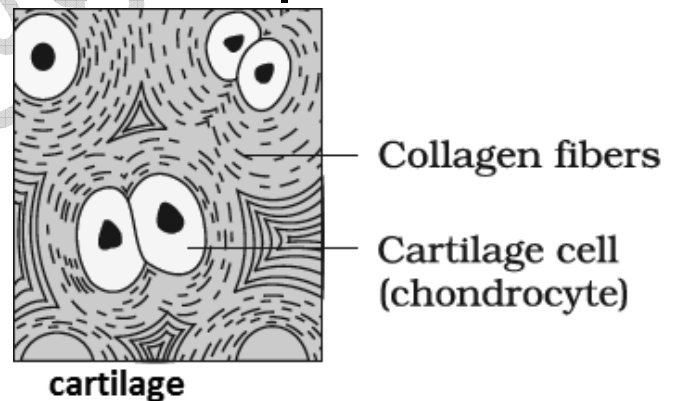


(iii) Specialised connective tissue.

Cartilages, Bones and blood are various types of specialised connective tissues.

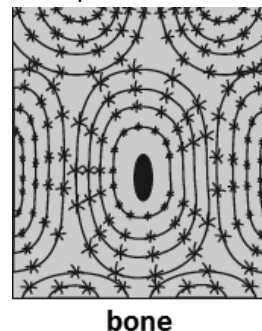
a) Cartilage:

Cells of this tissue (**chondrocytes**) are enclosed in small cavities within the matrix secreted by them. Most of the cartilages in vertebrate embryos are replaced by bones in adults. Cartilage is present **in the tip of nose, outer ear joints**, between adjacent bones of the vertebral column, limbs and hands in adults.



b) Bones

Bones have a hard and non-pliable ground substance rich in **calcium salts** and **collagen fibres** which give bone its strength. The bone cells (osteocytes) are present in the spaces called lacunae



The main functions of the bones are

1. It is the main tissue that provides structural frame to the body.
2. Bones support and protect softer tissues and organs. Limb bones, such as the long bones of the legs, serve weight-bearing functions.
3. It provide surface for the attachment of skeletal muscles to bring about movements.
4. The bone marrow in some bones is the site of production of blood cells.

c)Blood

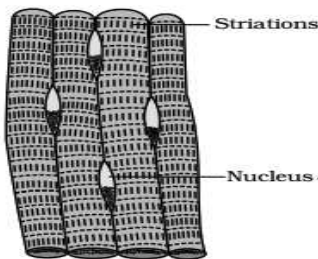
Blood is a fluid connective tissue containing plasma, red blood cells (RBC), white blood cells (WBC) and platelets.

C) Muscular tissue

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

i) Skeletal muscles



This tissue is **closely attached to skeletal bones**. This muscles are also called **striated muscles or striped muscles**

Eg: biceps and triceps muscles

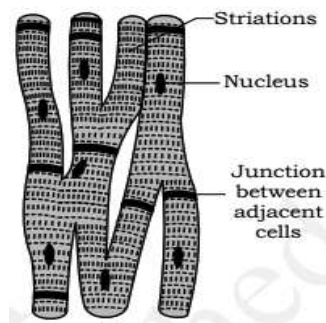
ii) Smooth muscles



The smooth muscle fibres **taper at both ends** (fusiform) and do not show striations, hence the name smooth muscles. Cell junctions hold them together and they are bundled together in a connective tissue sheath.

This type of muscles is present in the wall of internal organs such as the blood vessels, stomach and intestine. Smooth muscles are '**involuntary**' in functions.

iii) Cardiac muscles



They are the **muscles of heart**. **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.

D) Neural tissue

Neurons, the unit of neural system are excitable cells. The neuroglial cells **protect and support neurons**. Neuroglia make more than one half the volume of neural tissue in our body



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COCKROACH

- Cockroaches are brown or black bodied animals that are included in **class Insecta** of **Phylum Arthropoda**.
- Bright yellow, red and green coloured cockroaches have also been reported in tropical regions.
- 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.

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 entire body is covered by a hard **chitinous** exoskeleton (brown in colour).
- In each segment, exoskeleton has hardened plates called **sclerites (tergites dorsally and sternites ventrally)** that are joined to each other by a thin and flexible **articular membrane (arthrodial membrane)**.
- The body of the cockroach is segmented and divisible into three distinct regions –
a) head, b) thorax and c) abdomen

a) Head

- Head is **triangular in shape** It is formed by the fusion of **six segments**
- Head shows great mobility in all directions due to flexible **neck**
- The head capsule bears a pair of compound eyes
- A pair of thread like **antennae** arise from membranous sockets lying in front of eyes.
- Anterior end of the head bears appendages forming **biting and chewing type of mouth parts**.

Mouth parts:

- The mouth parts consisting of
- a labrum (upper lip),**
- a pair of mandibles,**
- a pair of maxillae**
- a labium (lower lip).**
- A median flexible lobe, acting as tongue (**hypopharynx**), lies within the cavity enclosed by the mouthparts



b) 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**.
- Each thoracic segment bears a pair of **walking legs**.

Wings:

- ✓ cockroaches have **two pairs** of wings.
- ✓ The **first pair** of wings arises from **mesothorax** and the **second pair** from **metathorax**.
- ✓ Forewings (mesothoracic) called **tegmina** are opaque dark and leathery and cover the hind wings when at rest.
- ✓ The hind wings are transparent, membranous and are **used in flight**.

Difference between fore wing and hind wings

Fore wings	Hind wings
1.it arises from mesothorax	1.it arise from meta thorax
2.they are opaque	2.they are transparent
3.they are leathery	3.they are membranous
4.they cover the hind wings at rest	4.it is used for flight

d)Abdomen

The abdomen in both males and females consists of **10 segments**.

Abdomen in female:

- ✓ 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.

Abdomen in male:

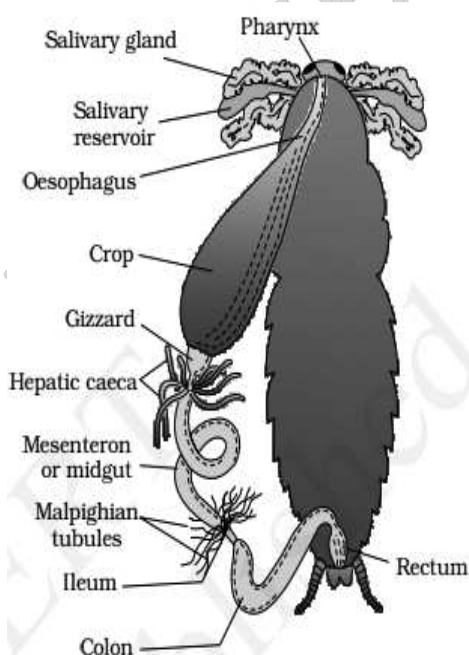
- ✓ In males, genital pouch or chamber lies at the hind end of abdomen bounded dorsally by 9th and 10th terga and ventrally by the 9th sternum. It contains dorsal anus, ventral male genital pore and gonapophysis.
- Males bear a pair of short thread like **anal style**, which are **absent in female**.
- In both sexes, the 10th segment bears a pair of jointed filamentous structures called **anal cerci**.

Digestive system

Digestive system consist of alimentary canal and digestive glands

A) alimentary canal

The alimentary canal is divided into three regions: foregut, midgut and hindgut

**a)foregut:**

- ❖ it starts with **mouth**.
- ❖ 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 caecae** is present at the junction of foregut and midgut, which secrete **digestive juice**.

b) midgut:

- ❖ 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.

c)Hindgut:

- ❖ The hindgut is differentiated into **ileum, colon and rectum**.
- ❖ The rectum opens out through anus

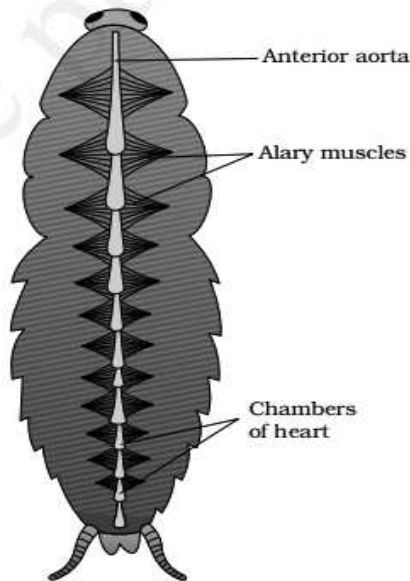


Circulatory system

- ❖ 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. 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

Haemocoel->ostia->heart->haemocoel



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**.

Excretory system

- ❖ Excretion is performed by **Malpighian tubules**.
- ❖ 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 and urecose** glands also help in excretion

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.** That is why if the head of a cockroach is cut off, it will still live for as long as one week.
- ❖ The brain is represented by **supra-oesophageal ganglion** which **supplies nerves to antennae and compound eyes**.

Sensory organs

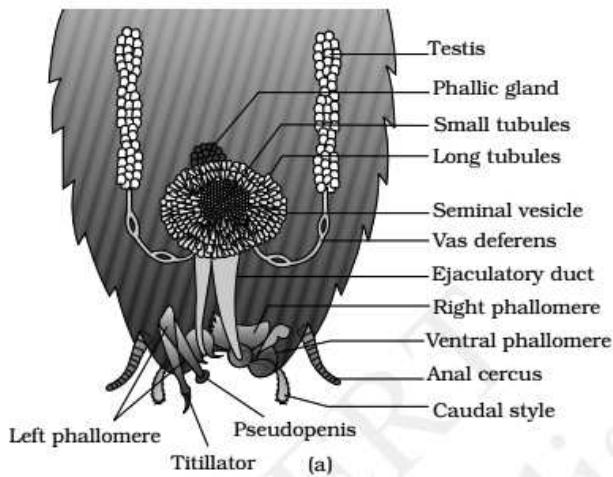
- ❖ In cockroach, the sense organs are **antennae, eyes, maxillary palps, labial palps, anal cerci**, etc.
- ❖ The compound eyes are situated at the dorsal surface of the head.
- ❖ Each eye consists of about **2000 hexagonal ommatidia** With the help of several ommatidia, a **cockroach can receive several 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).**
- ❖ Antennae have sensory receptors that help in monitoring the environment.

Reproductive system

- Cockroaches are **dioecious** and both sexes have well developed reproductive organs.
- The male and female cockroach can be identified by the difference in their morphological features . This phenomenon is called **sexual dimorphism**

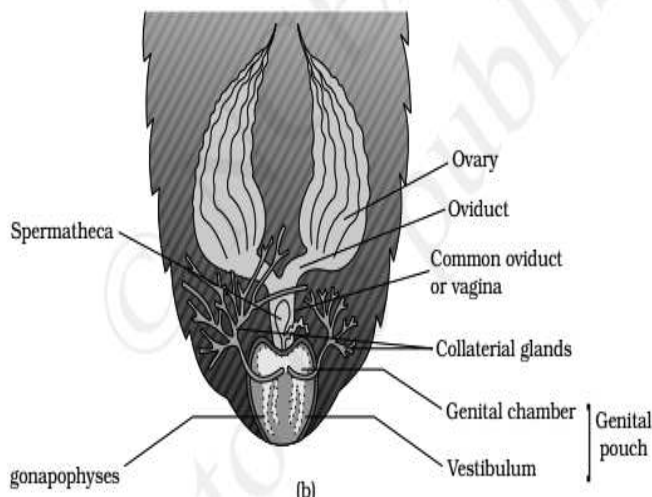
Male reproductive organs

- Male reproductive system consists of a **pair of testes** one lying on each lateral side in the 4th -6th abdominal segments.
- 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 present in the 6th to 7th abdominal segments** which function as an **accessory reproductive gland**.
- The external genitalia are represented by male **gonapophysis or phallomere** (chitinous asymmetrical structures, surrounding 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 organ



- 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.
- A pair of **spermatheca** is present in the **6th segment** which opens into the genital chamber.

Fertilization and development :

- Sperms are transferred through spermatophores. Their fertilised eggs are encased in capsules called **oothecae**.
- Ootheca is a **dark reddish to blackish brown capsule**, 8 mm long.
- They are dropped 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**.

Interaction to mankind/Economical importance

- Many species of cockroaches are wild and are of no economic importance.
- A few species thrive in and around human habitat.
- They are pests because they destroy food and contaminate it with their smelly excreta.
- They can transmit a variety of bacterial diseases by contaminating food material.



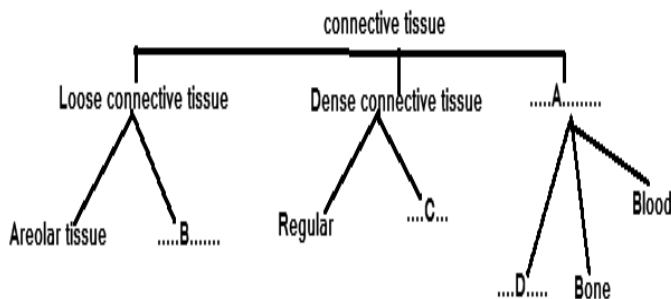
Previous Year Question Paper

1. "In cockroaches a special mode of vision is noticed" (HSE-July-2017)(2)
 - a) Write speciality of vision in cockroach
 - b) Name the organ and its basic units that perform vision in cockroach.
2. Select the connective tissues from the following and write one character of each tissue

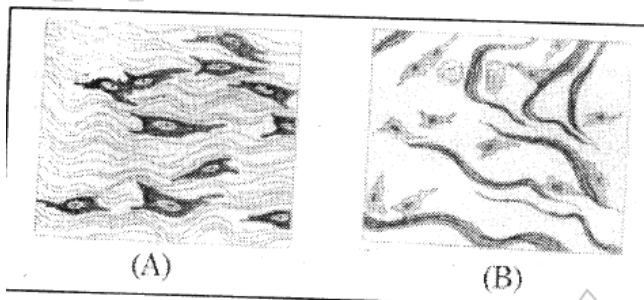
Areolar tissue
Neural tissue
Adipose tissue
Cardiac tissue

(HSE-JULY-2017)(2)

3. In cockroach spiracles are present in.....
 - a) Alimentary canal
 - b) Tracheal system
 - c) Malpighian tubule
 - d) Reproductive system
 (HSE-March-2017)(1)
4. Complete the given branching diagram based on connective tissue (HSE-March-2017)(2)



- 5.
6. a) Identify the given diagram of connective tissue A and B

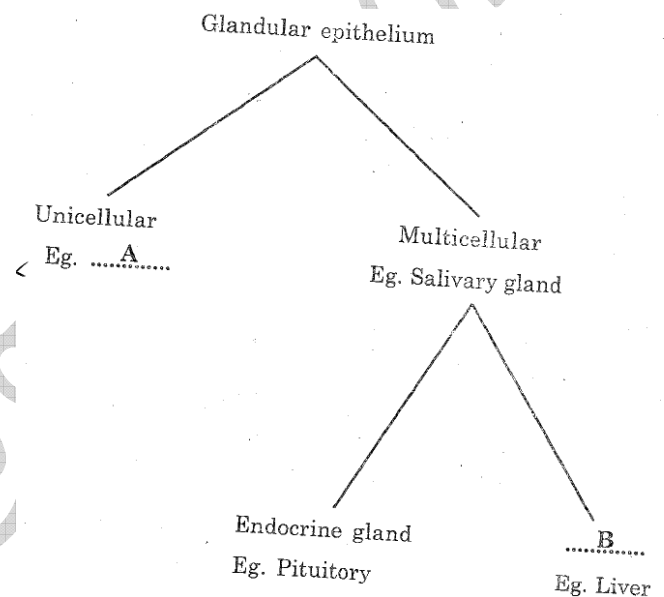


- b) Write the location of tissue B in the human body (HSE-Sept-2016) (2)

7. Prepare 2 correctly matching pairs from the given terms (HSE-Sept-2016) (2)

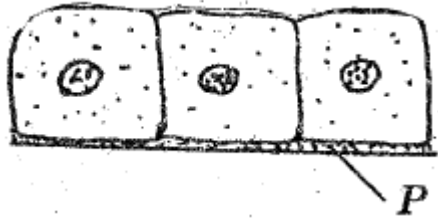
Ommatidia	
Hepatic caecae	
Genital pouch	
Sense organ	
Excretory organ	
Digestive gland	
Upper lip	

8. Observe the following chart and answer the following question (HSE-March-2016) (2)



Fill in the missing word A and B

9. Name any two secretions of exocrine glands? (HSE october-2015)(1)
10. Select the odd one out in the following series
 - a) Areolar tissue, blood, neuron, tendon
 - b) Hypopharynx, malpighian tubule, maxillae, labrum
 (HSE October-2015)(1)
11. In a laboratory session, your biology teacher exhibited blood smear (slides) of cockroach and human being under microscope. How will you distinguish them based on the nature of plasma and blood cell (HSE october-2015)(2)
12. If the head of cockroach is cut off, it will be alive as long as one week. Give clarification for this statement (HSE march-2015)(1)
13. The diagram below is a simple epithelium (HSE march-2015)(1)



- Name the part marked as P
- Write one function of simple epithelium

14. The male and female cockroach can be identified by the difference in their morphological features (HSE march-2015)(2)

- Name this phenomenon
- give one external difference between male and females

15. Names of two animal tissues are given (HSE august-2014)(2)

- cardiac muscle tissue
 - Adipose tissue
- Write the location of these tissues in our body
 - Select accurate characters of each tissue from the items given below
- Cells of this tissues are specialised to store fat
 - Cells of this tissues (Chondrocyte) are seen in small cavities within the matrix
 - presence of intercalated disc

16. Mention the function of the following (HSE august-2014)(1)

- Hepatic caeca of *periplaneta Americana*

17. Where do you find the following structure in human body (HSE march-2014)(2)

- Collagen fibre
- Axons
- Squamous epithelium
- Smooth muscle

18. Fill in the blanks with suitable terms according to the indicator shown below (HSE march-2014)(2)

Indicators a and b –food habits

C and d-Excretory organ

- Cockroach :.....
- Earthworm:.....
- Cockroach :.....
- Earthworm:.....

19. Features of a particular tissue visible through a microscopic observation is presented here

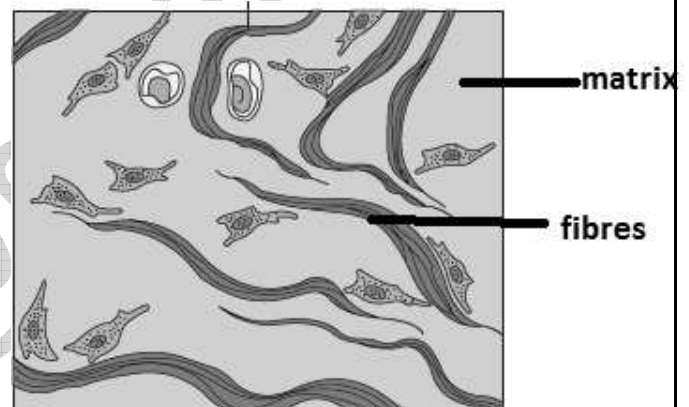
(HSE October-2013)(2)

- Cells are closely arranged
- Intercellular matrix absent
- Cells are supported by basement membrane

- Identify the animal tissue
- Classify this tissue based on number of cell layers
- Mention their functions

20. Observe the schematic diagram of a tissue (HSE September-2012) (2)

- Identify the type of this tissue
- The fibres in this tissue help the tissue to perform function. Substantiate



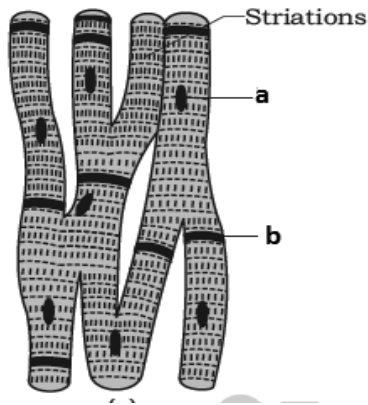
21. Facts related to two types of tissues are given below. Arrange them into two columns by giving suitable headings. Mention the location of each tissue in the human body

(HSE march-2012)(4)

- A sheath of tough connective tissue
- Striations absent
- Bundled together in a parallel fashion
- Fusiform shape
- Involuntary in function
- Striated appearance



22. Observe the following figure. No need to redraw the diagram (HSE-march-2011) (2)



- Label the parts a and b
- Write the functions of b

23. In an informal discussion in your class, your friend made a comment that "malpighian tubules are the kidneys of cockroach ". How will you evaluate this statement?

(HSE March-2010)(2)

24. A schematic sketch representing the alimentary canal of a cockroach is given below. Fill the box with the appropriate organs from the list. No need to redraw the diagram (HSE March -2010) (2)

- Crop Salivary gland Gizzard
Rectum Malpighiantubule
Hepatic caeca



25. Arrange the column A,B,C in the tale below and match them properly (HSE MARCH-2009)

A	B	C
Squamous epithelium	Intercalated disc	Present between vertebrae
Cartilage	Dendrite	Helps in gas

		diffusion in lung
Cardiac msucle	Chondrocyte	Impulse transmission
Neuron	Flattened cells	Helps in heart beat
	Volkman's canal	Antibody formation

26. Frogs and cockroaches shows sexual dimorphism (HSE march-2009)(1)

- Write any two morphological differences between male and female cockroach