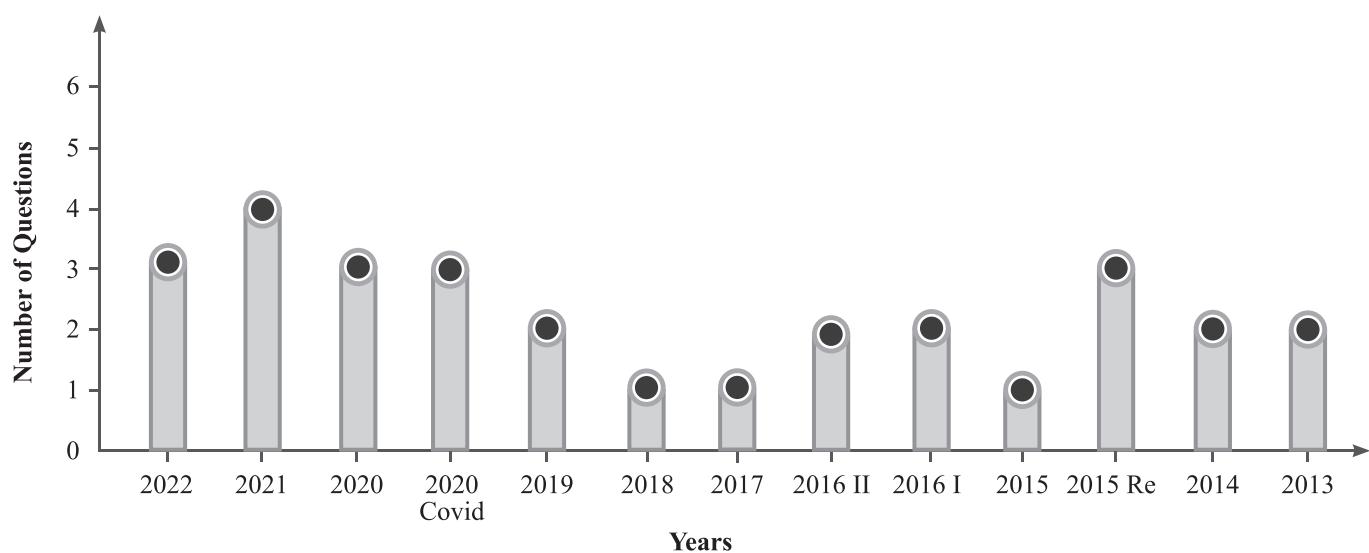
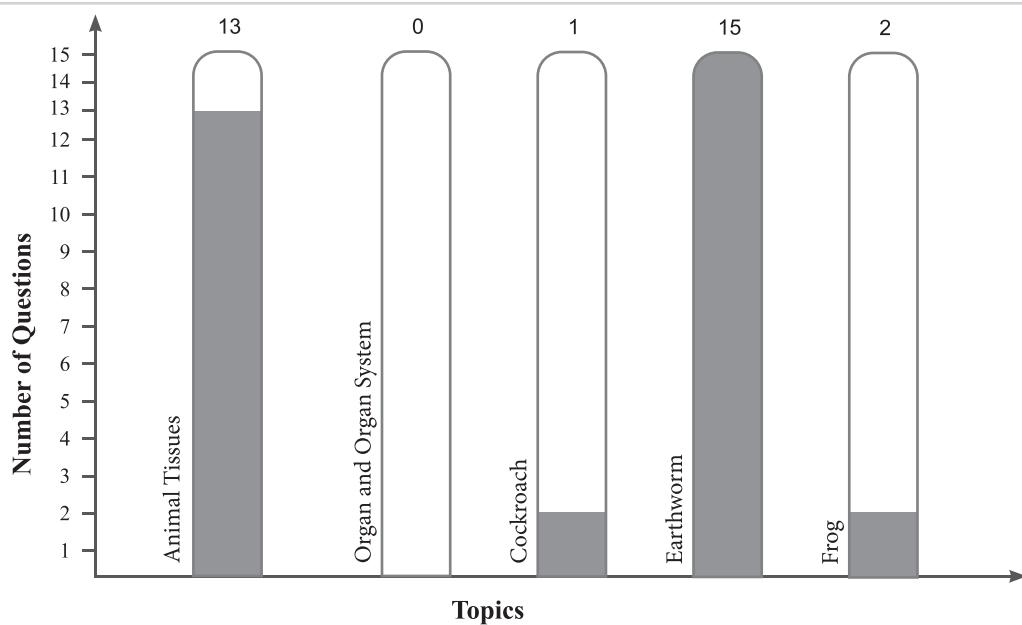


Structural Organisation in Animals

Year Wise Number of Questions Analysis (2022-2013)



Topicwise Number of Questions Analysis (2022-2013)



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.
- ❖ **Tissue** is a group of one or more types of cells having a similar origin and perform a specific function. It provides a basic framework in animals.
- ❖ Study of Tissue is called **Histology**
- ❖ Tissues are organised in specific proportion and pattern to form an organ like stomach, lung etc.
- ❖ 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.

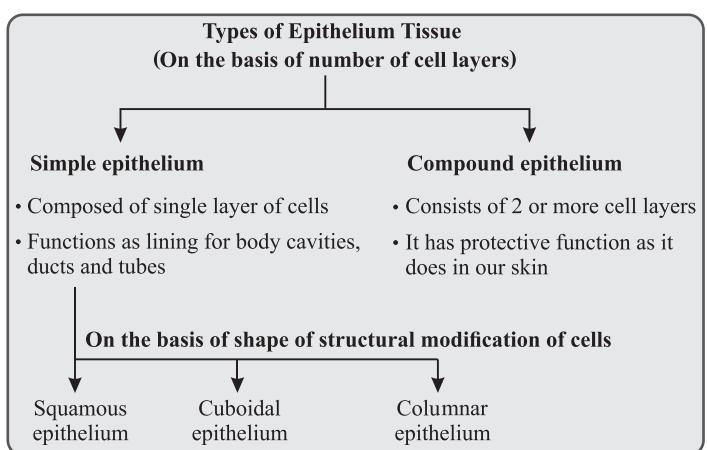
ANIMAL TISSUE

- ❖ The structure of the cells vary according to their function. Therefore, the tissues are different and are broadly classified into **four types**:
 1. Epithelial tissue
 2. Connective tissue
 3. Muscular tissue
 4. Neural tissue

1. Epithelial Tissue

- ❖ An epithelium is a tissue composed of one or more layers of cells thus provides a covering or lining for some part of the body.
- ❖ The cells are compactly packed with little intercellular matrix.

Classification of Epithelium Tissue



Types of Epithelial Tissue

(i) Simple epithelium

A. Simple squamous epithelium

- Single thin layer of flattened cells with irregular boundaries.
- They are found in the lining of blood vessels, lymph vessel, heart, peritoneum, pleura, Bowman's capsule, thin segment of loop of Henle and air sacs of lungs.

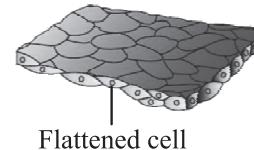


Fig. 1: Simple squamous epithelium



Need to Know

- It is also known as pavement epithelium due to its tile-like appearance.
- This epithelium is involved in functions like filtration & diffusion.

B. Simple Cuboidal Epithelium

- Single layer of cube like cells resting on a basement membrane.
- The nuclei is situated centrally.
- Found in the ducts of glands (salivary and pancreating duct) PCT of nephrons in the kidney.
- Its main functions are secretion and absorption.
- The epithelium of PCT of nephron in the kidney has microvilli.

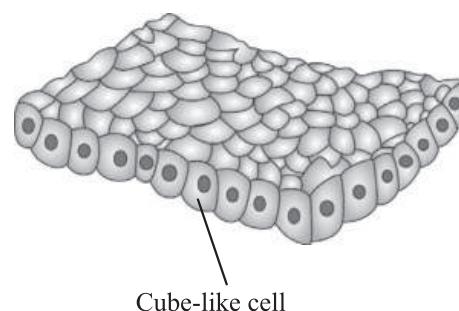


Fig. 2: Simple cuboidal epithelium

C. Simple Columnar Epithelium

- It is composed of 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 absorption.

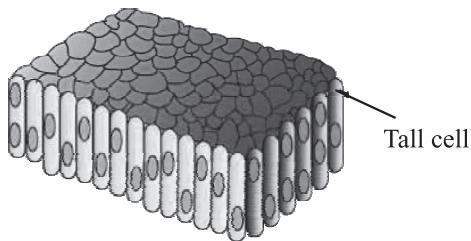


Fig. 3: Simple columnar epithelium

- When cilia are present on free surface of columnar cells. E.g., Fallopian tube.

Key Note

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.

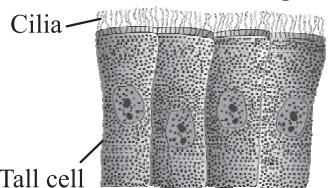


Fig. 4: Columnar cells bearing cilia



Need to Know

Pseudostratified Epithelium

- Single layer of irregularly shaped columnar cells, touches the basement membrane.
- Two types of cells are present, i.e., Long cells and Short cells.
- The **long cells** have oval or elongated nuclei however, **short cells** have rounded nuclei although epithelium is one cells thick, but it gives the appearance of a stratified epithelium, hence it is called **pseudostratified epithelium**.

D. Glandular epithelium

(i) Glands

- Some of the columnar or cuboidal cells get specialised for secretion and are called **glandular epithelium**.
- They are mainly of **two types: unicellular**, consisting of isolated glandular cells (goblet cell of the alimentary canal), and **multicellular**, consisting of cluster of cells (salivary gland).
- On the basis of the mode of pouring of their secretions, glands are divided into two categories namely **exocrine** and **endocrine** glands.
- Exocrine gland** secrete mucus, saliva, earwax, oil, milk, digestive enzymes and other cell products. Their products are released through ducts.

- Endocrine glands** do not have ducts. Their products called hormones are secreted directly into the fluid bathing the gland

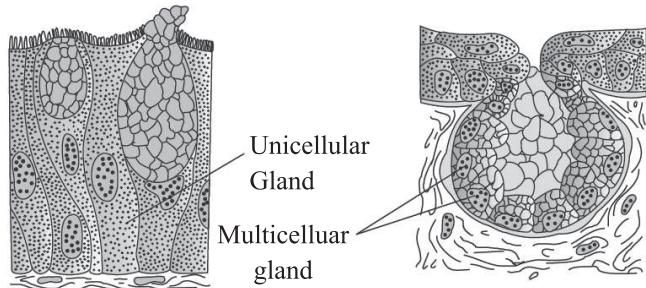


Fig. 5: Glandular epithelium : (a) Unicellular (b) Multicellular



Need to Know

- Glandular epithelium are specialised for secretion.
- A cell, tissue or organ which secretes chemical substances is called gland.
- Liver is the **largest gland** of the body and lined by glandular epithelium.

(ii) Compound Epithelium

- It is formed of two or more than two layers of cells (multi-layered).

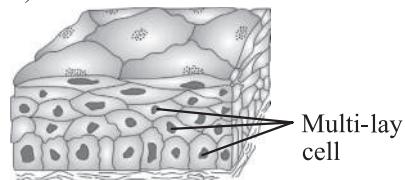


Fig. 6: Compound epithelium

- 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.

Cell Junctions

- All cells in epithelium are held together with little intercellular material. 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.

1. Adhering junctions

- Perform cementing to keep neighbouring cells together.

2. Gap Junction

- The adjacent cells form gap junctions for intercellular communication and chemical exchange. These junctions do not provide physical support.

- Gap junctions 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.

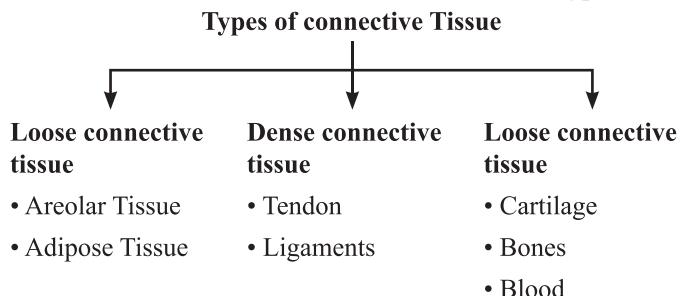
3. Tight junctions (Zona occludens)

- Tight junctions help to stop substances from leaking across a tissue.
- At certain places, the plasma membranes of adjacent cells are tightly packed or even fused together.

2. Connective Tissue

- Connective tissues are the **most abundant** and **widely distributed** in the body of complex animals.
- Because of their special function of connecting and supporting other tissues/organs of the body, they are named **connective tissues**.
- They range from soft connective tissues to specialised types (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).

Connective tissues are classified into **three types**:



(i) Loose Connective Tissue

They have cells and fibres loosely arranged in a semi - fluid ground substance.

A. Areolar Tissue

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

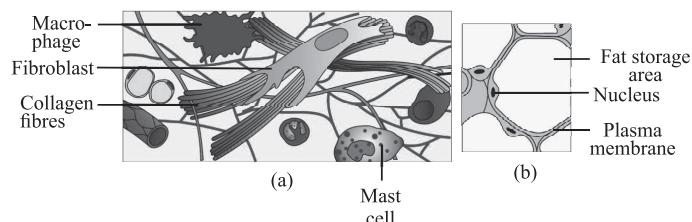


Fig. 7: Loose connective tissue: (a) Areolar tissue (b) Adipose tissue

B. Adipose tissue

- It is another type of loose connective tissue 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.

(ii) Dense Connective Tissue

- Fibres and fibroblasts** are compactly packed in the dense connective tissues.
- Orientation of fibres show a regular or irregular pattern and are called dense regular and dense irregular tissues

(a) Dense regular

- In the dense regular connective tissues, the collagen fibres are present in rows between many parallel bundles of fibres. E.g., Tendons and Ligament

Tendons	Ligament
♦ It joins the muscles to bones.	♦ It joins bone to bone

(b) Dense irregular

- It has fibroblast and many fibres (mostly collagen) that are oriented differently.
- This tissue is present in the skin.

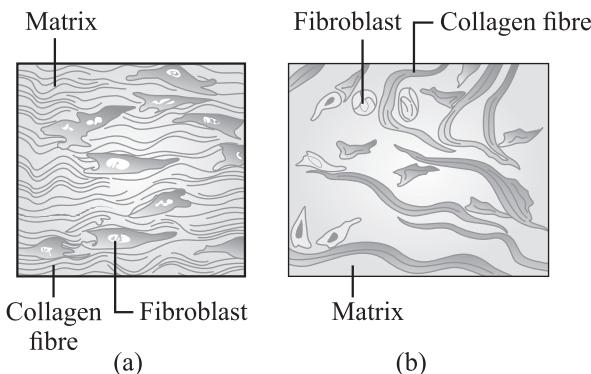


Fig. 8: Dense connective tissue: (a) Dense regular (b) Dense irregular

(iii) Specialised Connective Tissue

- It is of various types:** Cartilage, Bones and Blood.

Cartilage

- The intercellular material of cartilage is solid and pliable and resists compression.
- 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

Key Note

- Chondroblast:** Cartilage producing cells are arranged on periphery of cartilage.
- Chondrocytes:** Mature cells of cartilage.
- Lacuna:** Vacuole-like space in matrix in which 1 - 4 chondrocytes are present.

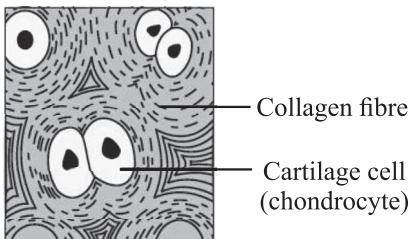


Fig. 9: Cartilage

Bones

- It is the main tissue that provides **structural frame** to the body.
- They have a hard and non-pliable ground substance rich in calcium salts and collagen fibres which gives strength to the bones.
- The bone cells (**osteocytes**) are present in the spaces called **lacunae**.
- 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.

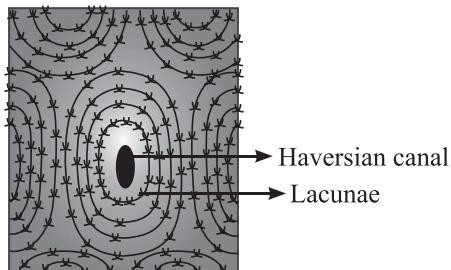


Fig. 10: Specialised connective tissues : Bone



Need to Know

Functions of Bone

- Support:** Bones form the framework of the body and contribute to the shape, alignment and positioning of the body.
- Protection:** Bones support and protect softer tissues and organs.
- Movement:** Bones with their joints constitute levers that move as muscle contract. 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.
- Haematopoiesis:** 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.

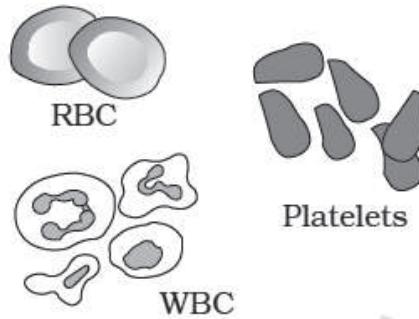


Fig. 11: Blood Cell

3. 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.
- Muscles play an active role in all the movements of the body.
- Muscles are of **three types**, skeletal, smooth and cardiac.

1. Skeletal 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. Skeletal muscles are 'voluntary' as their functioning can be directly controlled.

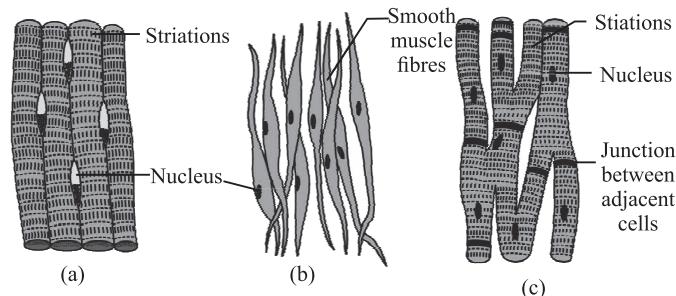


Fig. 12: Muscle tissue : (a) Skeletal (striated) muscle tissue (b) Smooth muscle tissue (c) Cardiac muscle tissue

2. Smooth Muscle

- 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.

3. Cardiac Muscle

- 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.

4. Neural Tissue

- The most complex tissue in the body composed of densely packed interconnected nerve cells called **neurons** (excitable cells and unit of neural system).
- Neural tissue exerts the greatest control over the body’s responsiveness to changing conditions.
- The Neuroglial cell which constitute the rest of neural system protect and support neuron and make up more than 50% volume of neural tissue.
- It is specialised in communication between the various parts of the body and in integration of their activities.
- 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.

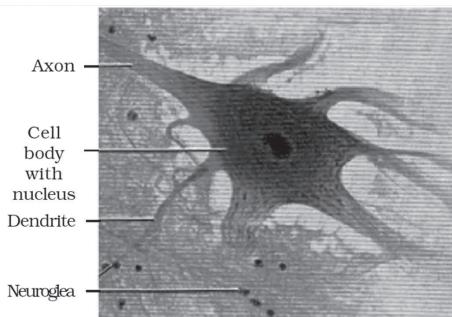


Fig. 13: Neural tissue (Neuron with neuroglia)

ORGAN & ORGAN SYSTEM

- The basic tissues 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.
- The complexity in organ and organ systems displays certain discernable trend. This discernable trend is called **evolutionary trend**.
- 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.



Concept Application

Fill in the blanks:

- _____ epithelium is made of a single thin layer of flattened cells with irregular boundaries.
- The epithelium of PCT of nephron in the kidney has _____.
- The cells of _____ tissue are specialised to store fats.

True and False:

- Adhering junctions facilitate the cells to communicate with each other.
- Loose connective tissue has cells and fibres loosely arranged in a semi-fluid ground substance.
- Smooth muscle tissue is closely attached to skeletal bones.
- Compound epithelium is made of more than one layer of cells.

EARTHWORM

- Earthworm is a reddish-brown terrestrial invertebrate that inhabits the upper layer of the moist soil. During day time, they live in burrows made by boring and swallowing the soil.
- In the gardens, they can be traced by their faecal deposits known as worm castings.
- The **common Indian** earthworms are *Pheretima* and *Lumbricus*.

1. Morphology

- Earthworms have **long cylindrical body**. The body is divided into more than hundred short segments which are similar (**metameres** about 100-120 in number).
- The dorsal surface of the body is marked by a dark median mid dorsal line (dorsal blood vessel) along the longitudinal axis of the body.
- The ventral surface is distinguished by the presence of genital openings (pores).
- Anterior end consists of the mouth and the **prostomium**, a lobe which serves as a covering for the mouth and as a wedge to force open cracks in the soil into which the earthworm may crawl. The prostomium is sensory in function.
- The first body segment is called the **peristomium** (buccal segment) which contains the mouth.

- ❖ In a mature worm, segments 14-16 are covered by a prominent dark band of glandular tissue called **clitellum**.
- ❖ The body of the earthworm can be differentiated into 3 regions:
 - Pre-clitellar region** (1st to 13th segments)
 - Clitellar region** (14th, 15th and 16th segments)
 - Post-clitellar region** (17th to last segment)
- ❖ Four pairs of spermathecal apertures are situated on the ventro-lateral sides of the intersegmental grooves, i.e., 5th -9th segments.

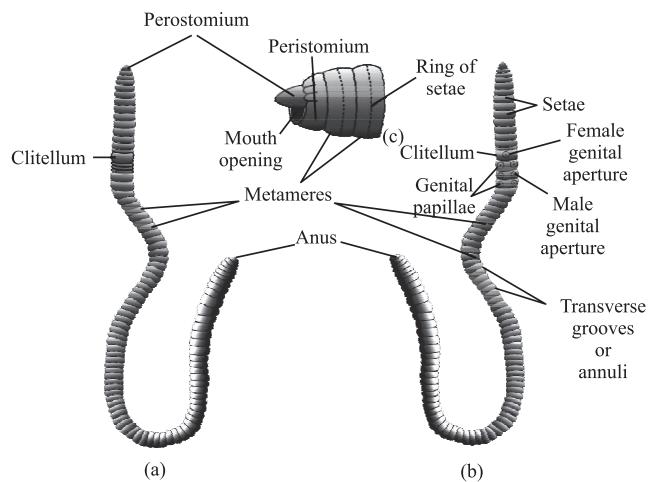


Fig. 14: Body of earthworm : (a) dorsal view (b) ventral view (c) lateral view showing mouth opening

- ❖ A single **female genital pore** is present in the mid-ventral line of 14th segment.
- ❖ A pair of **male genital pores** are present on the ventro-lateral sides of the 18th segment.
- ❖ Numerous minute pores called **nephridiopores** open on the surface of the body.



Need to Know

Setae: In each body segment, except the first, last and clitellum, there are rows of S-shaped setae, embedded in the epidermal pits in the middle of each segment. Setae can be extended or retracted. Their principal role is in locomotion.

2. Anatomy

(i) Body wall

- ❖ The body wall of the earthworm is covered externally by a thin non-cellular cuticle below which is the epidermis, two muscle layers (circular and longitudinal) and an innermost **coelomic epithelium**.
- ❖ The epidermis is made up of a single layer of columnar epithelial cells which contain secretory gland cells.

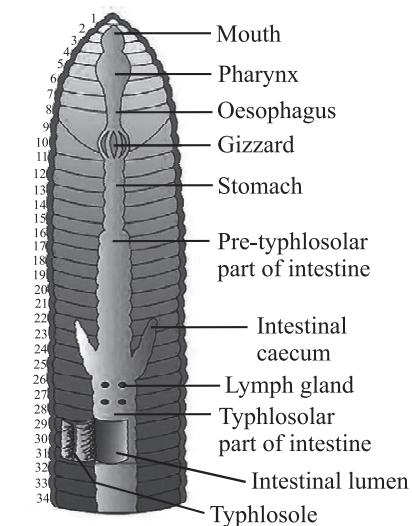


Fig. 15: Alimentary canal of earthworm

(ii) Digestive System

- ❖ The **alimentary canal** is a straight tube and runs between first to last segment of the body.
- ❖ A terminal mouth opens into the **buccal cavity** (1-3 segments) which leads into muscular pharynx.
- ❖ A small narrow tube, oesophagus (5-7 segments), continues into a muscular **gizzard** (8-9 segments). It helps in grinding the soil particles and decaying leaves etc.
- ❖ The **stomach** extends from 9-14 segments.
- ❖ The food of the earthworm is decaying leaves and organic matter mixed with soil.
- ❖ **Calciferous glands**, present in the stomach, neutralise the humic acid present in humus.
- ❖ **Intestine** is differentiated into 3-parts, namely-
 - Pre-typhlosolar region** (15th to 26th segment)
 - Typhlosolar region** (From the 27th segment to last from the 25th segment)
 - Post-typhlosolar region** (last 25th segments)
- ❖ A pair of short and conical **intestinal caecae** project from the intestine on the 26th segment.
- ❖ The **characteristic feature of the intestine** after 26th segment except the last 23rd-25th segments is the presence of internal median fold of dorsal wall called **typhlosole**. This increases the effective area of absorption in the intestine.
- ❖ The alimentary canal opens to the exterior by a small rounded aperture called **anus**.
- ❖ The ingested organic rich soil passes through the digestive tract where digestive enzymes breakdown complex food into smaller absorbable units.
- ❖ These simpler molecules are absorbed through intestinal membranes and are utilised.

(iii) Circulatory System

- ❖ *Pheretima* exhibits a **closed type** of blood vascular system, consisting of blood vessels, capillaries and heart. Due to closed circulatory system, blood is confined to the heart and blood vessels.

- Contractions keep blood circulating in one direction.
- Smaller blood vessels supply the gut, nerve cord and the body wall.
- Blood glands** are present on the 4th, 5th and 6th segments.
- They produce blood cells and haemoglobin which is dissolved in blood plasma. Blood cells are **phagocytic** in nature.

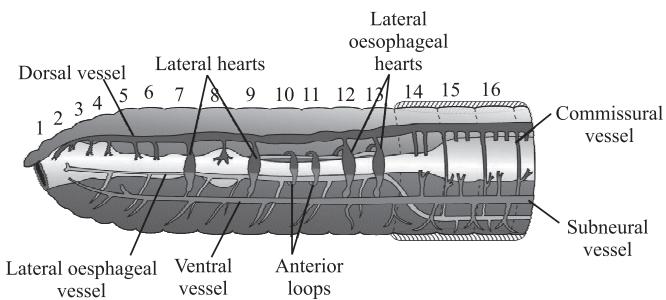


Fig. 16: Closed circulatory system

(iv) Respiratory System

- Earthworms **lack** specialised breathing devices.
- Respiratory exchange occurs through moist body surface into their blood stream.

(v) Excretory System

- The excretory organs occur as segmentally arranged coiled tubules called **nephridia** (sing.: nephridium).

They are of three types:

- Septal nephridia:** Present on both the sides of intersegmental septa of segment 15 to the last that open into intestine
- Integumentary nephridia:** Attached to lining of the body wall of segment 3 to the last that open on the body surface
- Pharyngeal nephridia**, present as three paired tufts in the 4th, 5th and 6th segments.

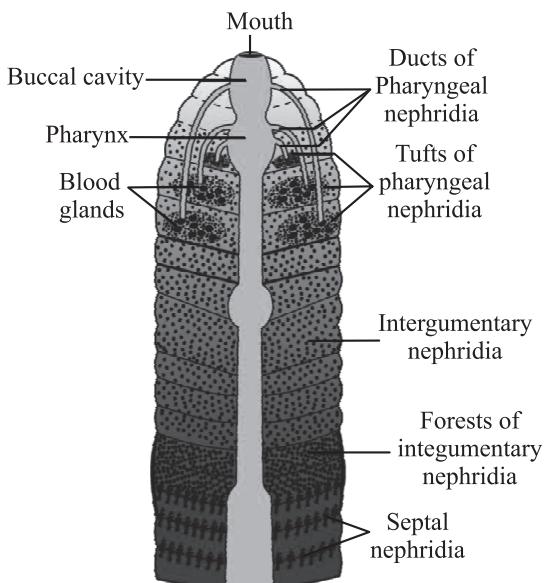


Fig. 17: Nephridial system in earthworm

- These different types of nephridia are basically similar in structure. **Nephridia** regulate the volume and composition of the body fluids.
- A nephridium starts out as a funnel that collects excess fluid from coelomic chamber.
- The funnel connects with a tubular part of the nephridium which delivers the wastes through a pore to the surface in the body wall into the digestive tube.

(vi) Nervous System

- Nervous system is basically represented by ganglia arranged segmentwise on the ventral paired nerve cord.
- The nerve cord in the anterior region (3rd and 4th segments) bifurcates, laterally encircling the pharynx and joins the cerebral ganglia dorsally to form a nerve ring.
- The cerebral ganglia alongwith other nerves in the ring integrate sensory input as well as command muscular responses of the body.

(vii) Sensory Organs

- Sensory system does not have eyes but does possess light and touch sensitive organs (receptor cells) to distinguish the light intensities and to feel the vibrations in the ground.
- Worms have specialised chemoreceptors (taste receptors) which react to chemical stimuli.
- These sense organs are located on the anterior part of the worm.

(viii) Reproductive System

- Earthworm is **hermaphrodite** (bisexual) i.e., testes and ovaries are present in the same individual.
- There are **two pairs of testes** present in the 10th and 11th segments.
- Their vasa deferentia run up to the 18th segment where they join the prostatic duct.
- Two pairs of accessory glands** are present one pair each in the 17th and 19th segments.
- The common prostate and spermatic duct (vasa deferentia) opens to the exterior by a pair of male genital pores on the ventro-lateral side of the 18th segment.
- Four pairs of spermathecae** are located in 6th-9th segments (one pair in each segment). They receive and store spermatozoa during copulation.
- One pair of ovaries** is attached at the inter-segmental septum of the 12th and 13th segments.
- Ovarian funnels are present beneath the ovaries which continue into oviduct, join together and open on the ventral side as a **single median female genital pore on the 14th segment**.

(ix) Fertilisation and Development

- A mutual exchange of sperm occurs between two worms during mating.
- One worm has to find another worm and they mate juxtaposing opposite gonadal openings exchanging packets of sperms called **spermatophores**.

- Mature sperm and egg cells and nutritive fluid are deposited in cocoons produced by the **gland cells of clitellum**.
- **Fertilisation and development** occur within the cocoons which are deposited in soil.
- The ova (eggs) are fertilised by the sperm cells within the cocoon which then slips off the worm and is deposited in or on the soil.
- The **cocoon** holds the worm embryos.
- After about 3 weeks, each cocoon produces two to twenty baby worms with an average of four. Therefore, development is **direct**, i.e., there is no larva formed.

Key Note

Economic importance of Earthworms

- Earthworms are known as **friends of farmers** because they make burrows in the soil and make it porous which helps in respiration and penetration of the developing plant roots. The process of increasing fertility of soil by the earthworms is called **vermicomposting**.
- They are also used as bait in game fishing.



Concept Application

Fill in the blanks:

8. The common Indian earthworms are _____ and _____.
9. The first body segment in earthworms is called the _____.
10. The excretory organs in earthworms are called _____.

True and False:

11. *Pheretima* exhibits a open type of blood vascular system.
12. Typhlosole increases the effective area of absorption in the intestine.

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 **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. They have become residents of human homes and thus are serious pests and vectors of several diseases.

1. 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 – **head, thorax and abdomen**.

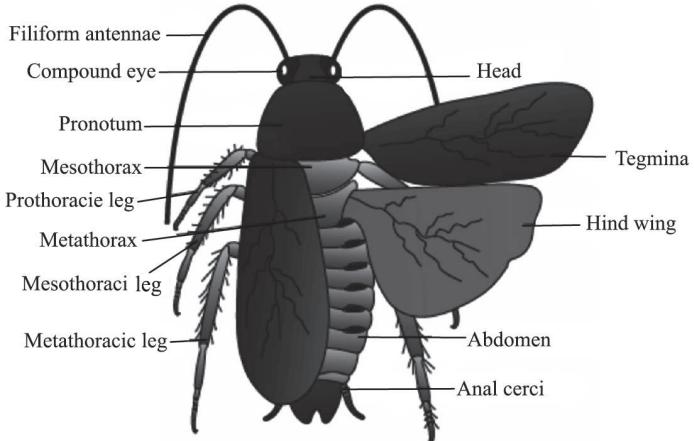


Fig. 18: External features of cockroach

(i) Head

- Triangular in shape and lies anteriorly at right angles to the longitudinal body axis.
- It is formed by the fusion of **six segments** and 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.
- **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**.

Key Note

Mouthparts of Cockroach

- The mouthparts consisting of a labrum (upper lip), 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.

(ii) 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**.
- 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.

(iii) 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, thread-like **anal styles** which are absent in females.
- In both sexes**, the 10th segment bears a pair of jointed filamentous structures called **anal cerci**.

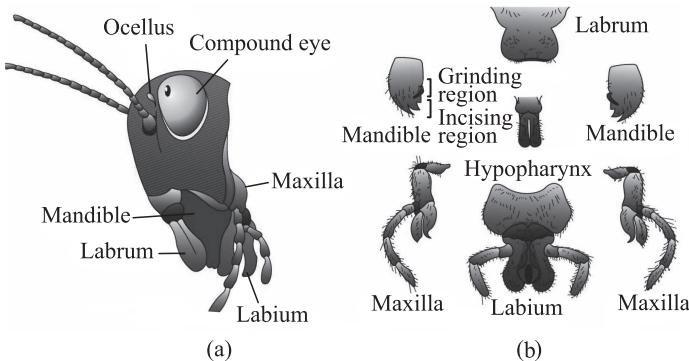


Fig. 19: Head region of cockroach (a) Parts of head region (b) Mouth parts

2. Anatomy

(i) Digestive System

- The alimentary canal present in the body cavity is divided into **three regions**: foregut, midgut and hindgut.
- 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.
- 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.

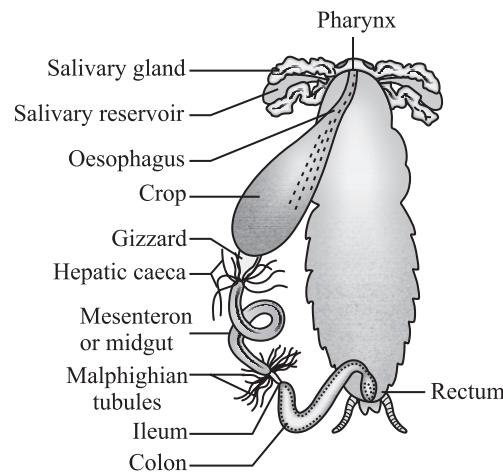


Fig. 20: Alimentary canal of cockroach

(ii) Circulatory System

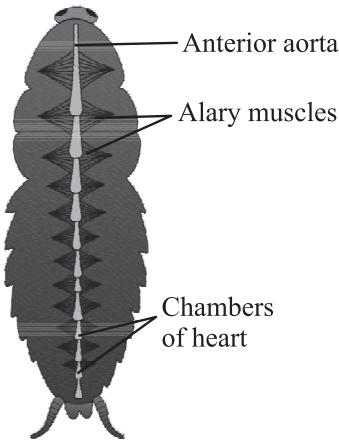


Fig. 21: Open circulatory system of cockroach

- Blood vessels are poorly developed and open into space (**haemocoel**), therefore blood vascular system of cockroach is an open type.
- 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.

(iii) Respiratory System

- The respiratory system consists of a network of **trachea**, that open through 10 pairs of small holes called **spiracles** (**two pairs thoracic and eight pairs of abdominal**) 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**.

(iv) Excretory System

- Excretion is performed by **Malpighian tubules**. 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.
- Cockroach is uricotelic.

Key Note

In Cockroach, following structures help in excretion

1. Malpighian tubules
2. Fat Bodies
3. Nephrocytes
4. Urecose glands
5. Cuticle

(v) Nervous System

- It 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, 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**).

(vi) Reproductive System & Development

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

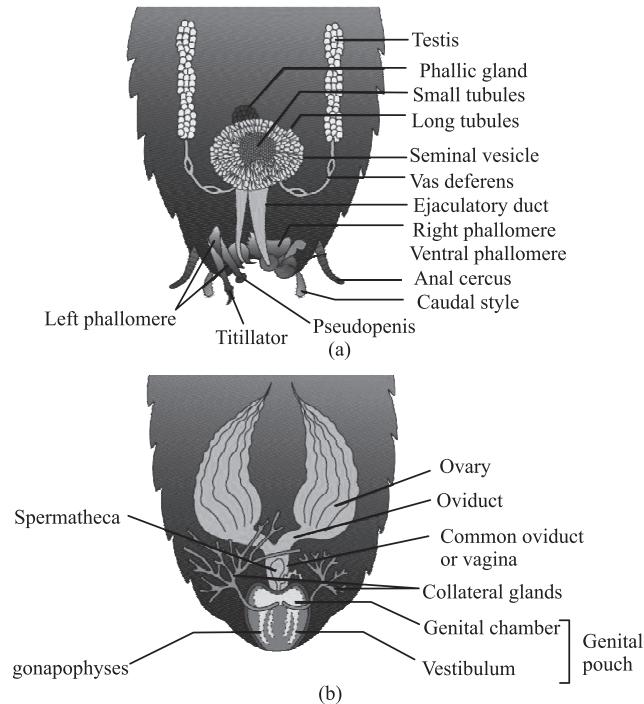


Fig. 22: Reproductive system of cockroach : (a) male (b) female

Male Reproductive System

- Male reproductive system consists of **a pair of testes** lying one 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** is present in the **6th-7th** abdominal segments which functions 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 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.
- 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 **oøthecae**.
- Oøtheca** is a dark reddish to blackish brown capsule, about **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 oøthecae, each containing 14-16 eggs**.
- The development of *P. americana* is **paurometabolous**, 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.

Key Note

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.



Concept Application

Fill in the blanks:

- Sclerites are joined to each other by a thin and flexible _____.
- The mouthpart in cockroaches acting as tongue is _____.
- In cockroaches, sperms are stored in the _____.

True and False:

- The size of cockroaches ranges from $\frac{1}{4}$ inches to 3 inches.
- Head of cockroaches is formed by the fusion of sixteen segments.
- The development of *P. americana* is paurometabolous.

FROG

- Frogs can live both on land and in freshwater and belong to **class Amphibia of phylum Chordata**. The most **common** species of frog found in India is *Rana tigrina*.

- They do not have constant body temperature i.e., their body temperature varies with the temperature of the environment. Such animals are called **cold blooded** or **poikilotherms**. While they are in grasses and on dry land, they have the ability to change the colour to hide them from their enemies (camouflage) i.e. they can change colour. This protective coloration is called **mimicry** respectively.
- During peak summer and winter period, they take shelter in deep burrows to protect them from extreme heat and cold. This is called as summer sleep (**aestivation**) and winter sleep (**hibernation**).

1. Morphology

- The skin is smooth and slippery due to the presence of mucus. The skin is always maintained in a moist condition.
- The colour of dorsal side of body is generally olive green with dark irregular spots. On the ventral side, the skin is uniformly pale yellow.
- The frog never drinks water but absorb it through the skin.
- Body of a frog** is divisible into head and trunk. A neck and tail are absent.

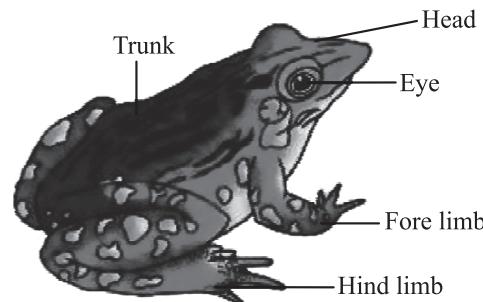


Fig. 23: External features of frog

- Above the mouth, a pair of nostrils is present. Eyes are bulged and covered by a nictitating membrane that protects them while in water.
- On either side of eyes, a membranous tympanum (ear) receives sound signals.
- The **forelimbs and hind limbs** help in swimming, walking, leaping and burrowing.
- The hind limbs end in five digits and they are larger and muscular than fore limbs that end in four digits. Feet have **webbed digits** that help in swimming.

Key Note

Frogs exhibit sexual dimorphism. Male frogs can be distinguished by the presence of sound producing vocal sacs and also a copulatory pad on the first digit of the fore limbs which are absent in female frogs.

2. Anatomy

The body cavity of frogs accommodate different organ systems such as digestive, circulatory, respiratory, nervous, excretory and reproductive systems with well developed structures and functions.

(i) Digestive System

- The digestive system consists of alimentary canal and digestive glands.

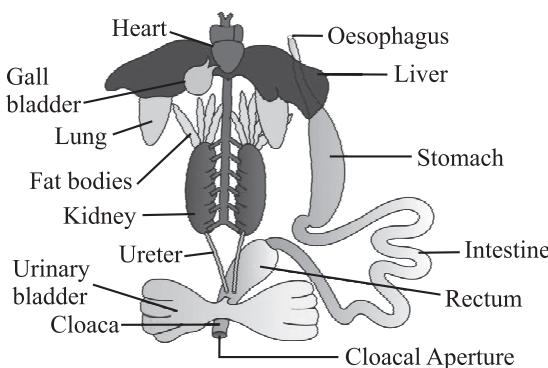


Fig. 24: Diagrammatic representation of internal organs of frog showing complete digestive system

- The alimentary canal is short because **frogs are carnivores** and hence the length of intestine is reduced. The mouth opens into the buccal cavity that leads to the oesophagus through pharynx.
- Oesophagus is a short tube that opens into the stomach which in turn continues as the intestine, rectum and finally opens outside by the cloaca.
- Liver secretes bile that is stored in the gall bladder.
- **Pancreas**, a digestive gland, produces **pancreatic** juice containing digestive enzymes.
- Food is captured by the bilobed tongue. Digestion of food takes place by the action of HCl and gastric juices secreted from the walls of the stomach.
- Partially digested food called **chyme** is passed from stomach to the **first part of the intestine, the duodenum**.
- The duodenum receives bile from gall bladder and pancreatic juices from the pancreas through a common bile duct.
- Bile emulsifies fat and pancreatic juices digest carbohydrates and proteins.
- **Final digestion** takes place in the intestine.
- Digested food is absorbed by the numerous finger-like folds in the inner wall of intestine called **villi and microvilli**.
- The undigested solid waste moves into the rectum and passes out through cloaca.

(ii) Respiratory System

- Frogs respire on land and in the water by two different methods. In water, skin acts as aquatic respiratory organ (**cutaneous respiration**). Dissolved oxygen in the water is exchanged through the skin by **diffusion**.
- On land, the buccal cavity, skin and lungs act as the respiratory organs.

• The respiration by lungs is called **pulmonary respiration**. The **lungs** are a pair of elongated, pink coloured sac-like structures present in the upper part of the trunk region (thorax).

- Air enters through the nostrils into the buccal cavity and then to lungs.
- During aestivation and hibernation, gaseous exchange takes place through skin.

(iii) Circulatory System

- The vascular system of frog is **well-developed closed type**.
- Frogs have a lymphatic system also.
- The **blood vascular system** involves heart, blood vessels and blood.
- The **lymphatic system** consists of lymph, lymph channels and lymph nodes.
- **Heart** is a muscular structure situated in the upper part of the body cavity.
- It has three chambers, two atria and one ventricle and is covered by a membrane called **pericardium**.
- A triangular structure called **sinus venosus** joins the right atrium. It receives blood through the **major veins called vena cava**.
- The ventricle opens into a sac-like **conus arteriosus** on the ventral side of the heart.
- The blood from the heart is carried to all parts of the body by the arteries (arterial system).
- The veins collect blood from different parts of body to the heart and form the **venous system**.
- Special venous connection between liver and intestine as well as the kidney and lower parts of the body are present in frogs. The former is called **hepatic portal system** and the latter is called **renal portal system**.
- The **blood** is composed of plasma and cells. The blood cells are RBC (red blood cells) or erythrocytes, WBC (white blood cells) or leucocytes and platelets.
- RBC's are nucleated and contain red coloured pigment namely **haemoglobin**.
- The **lymph** is different from blood. It lacks few proteins and RBCs.
- The blood carries nutrients, gases and water to the respective sites during the circulation.
- The circulation of blood is achieved by the pumping action of the muscular heart.

(iv) Excretory System

- The elimination of nitrogenous wastes is carried out by a well-developed excretory system.
- The **excretory system** consists of a pair of kidneys, ureters, urinary bladder and cloaca.
- These are compact, dark red and bean-like structures situated a little posteriorly in the body cavity on both sides of vertebral column.

- Each kidney is composed of several structural and functional units called **uriniferous tubules** or nephrons.
- Two ureters emerge from the kidneys in the male frogs.
- The **ureters act as urinogenital duct** which opens into the cloaca. In females, the ureters and oviduct open separately in the cloaca.
- The **thin-walled urinary bladder** is present ventral to the rectum which also opens in the cloaca.
- The frog excretes urea and thus is a **ureotelic** animal.
- Excretory wastes are carried by blood into the kidney where it is separated and excreted.

(v) Nervous System & Endocrine System

- The system for control and coordination is **highly evolved** in the frog. It includes both neural system and endocrine glands.
- The chemical coordination of various organs of the body is achieved by **hormones** which are secreted by the endocrine glands.
- The prominent **endocrine glands** found in frog are pituitary, thyroid, parathyroid, thymus, pineal body, pancreatic islets, adrenals and gonads.
- The **nervous system** is organised into a central nervous system (brain and spinal cord), a peripheral nervous system (cranial and spinal nerves) and an autonomic nervous system (sympathetic and parasympathetic).
- There are **ten pairs** of cranial nerves arising from the brain. Brain is enclosed in a bony structure called **brain box** (cranium).
- The brain is divided into fore-brain, mid-brain and hind-brain. **Forebrain** includes olfactory lobes, paired cerebral hemispheres and unpaired diencephalon.
- Midbrain** is characterised by a pair of optic lobes. **Hind-brain** consists of cerebellum and medulla oblongata. The medulla oblongata passes out through the foramen magnum and continues into spinal cord which is enclosed in the vertebral column.
- Frog has different types of **sense organs**, namely organs of touch (sensory papillae), taste (taste buds), smell (nasal epithelium), vision (eyes) and hearing (tympanum with internal ears).
- Out of these, eyes and internal ears are well-organised structures and the rest are cellular aggregations around nerve endings.
- Eyes in a frog are a pair of spherical structures situated in the orbit in skull.
- These are **simple eyes** (possessing only one unit).
- External ear is absent in frogs and only tympanum can be seen externally.
- The ear is an organ of hearing as well as balancing (**equilibrium**).

(vi) Reproductive System and Development

- Frogs have well organised male and female reproductive systems.
- Male reproductive organs** consist of a pair of yellowish ovoid testes which are found adhered to the upper part of kidneys by a double fold of peritoneum called **mesorchium**.

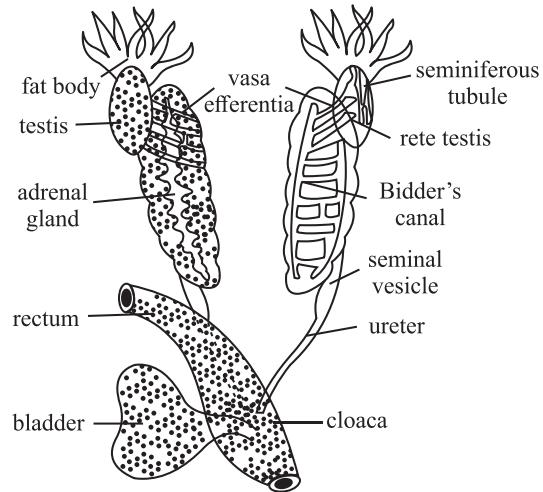


Fig. 25: Male reproductive system

- Vasa efferentia are **10-12** in number that arise from testes.
- They enter the kidneys on their side and open into **Bidder's canal**.
- Finally it communicates with the urinogenital duct that comes out of the kidneys and opens into the cloaca. The cloaca is a small, median chamber that is used to pass faecal matter, urine and sperms to the exterior.
- The **female reproductive organs** include a pair of ovaries.

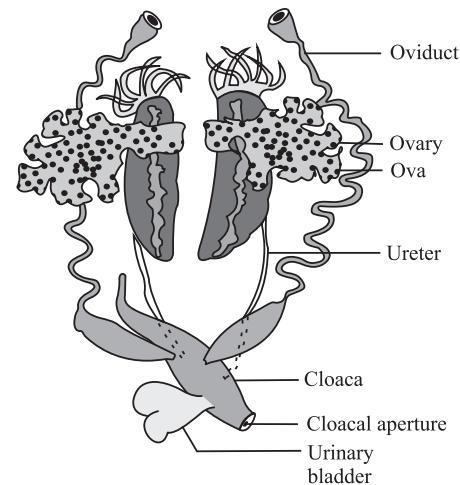


Fig. 26: Female reproductive system

- The ovaries are situated near kidneys and there is no functional connection with kidneys.
- A pair of oviduct arising from the ovaries opens into the cloaca separately.

- A mature female can lay 2500 to 3000 ova at a time. Fertilisation is external and takes place in water.
- Development involves a larval stage called tadpole. Tadpole undergoes metamorphosis to form the adult.

Key Note

Economic importance of frog

- Frogs are **beneficial for mankind** because they eat insects and protect the crop.
- Frogs maintain **ecological balance** because these serve as an important link of food chain and food web in the ecosystem.
- In some countries, the **muscular legs of frog** are used as food by man.



Concept Application

Fill in the blanks:

19. The skin is smooth and slippery in frogs due to the presence of _____.
 20. Male frogs have a copulatory pad on the _____ digit of the fore limbs.
- True and False:**
21. Male frogs can be distinguished by the presence of sound producing vocal sacs.
 22. During aestivation and hibernation gaseous exchange in frogs takes place through lungs.



Short Notes

- ❖ A tissue is defined as group of cells along with intercellular substances performing one or more functions in the body
Cell → Tissues → Organ → Organ system
- ❖ The structure of the cells vary according to their function
- ❖ The tissues are different and are broadly classified into four types:
- ❖ (i) Epithelial (ii) Connective (iii) Muscular and (iv) Neural Epithelial Tissue

- ❖ Has a free surface (faces either a body fluid or the outside environment)
 - ❖ Compactly packed (with little intercellular matrix)
- I. Simple epithelium** (Composed of a single layer of cells)
- Function- Diffusion, secretion and absorption
 - Simple epithelium can be of following types on the basis of structural modifications of cells

Features	Squamous	Cuboidal	Columnar	Ciliated	Glandular
Cells	Flattened cells	Cube-like cells	Tall and slender cells	Cells bear cilia	Cells get specialised for secretion
Location	Walls of blood vessels and air sacs of lungs	In ducts of glands and tubular parts of nephrons in kidneys	In the lining of stomach and intestine	In the inner surface of hollow organs	Goblet cells of alimentary canal and salivary gland

- II. Compound epithelium** (Composed of a multiple layer of cells)
- Function - Provide protection
 - Location - Dry surface of the skin, the moist surface of buccal cavity,

Connective Tissue

- ❖ The cells secrete fibres of structural proteins called collagen or elastin (except blood), also secrete modified polysaccharides (ground substance)

I. Loose connective tissue

- Cells and fibres loosely arranged in a semi-fluid ground substance

Areolar tissue	Adipose tissue
<ul style="list-style-type: none"> ❖ Present beneath the skin ❖ Contains fibroblasts (cells that produce and secrete fibres), macrophages and mast cells 	<ul style="list-style-type: none"> ❖ Located mainly beneath the skin ❖ Specialised to store fat

II. Dense connective tissue

Dense regular tissues	Dense irregular tissues
<ul style="list-style-type: none"> ❖ Regular pattern in orientation of fibres ❖ Tendons & Ligaments 	<ul style="list-style-type: none"> ❖ Irregular pattern in orientation of fibres ❖ Present in the skin

III. Specialised connective tissues

Cartilage	Bones	Blood
<ul style="list-style-type: none"> ❖ Solid and pliable intercellular material ❖ Cells Chondrocytes ❖ Functions ❖ Tip of nose, outer ear joints, for protection, etc. 	<ul style="list-style-type: none"> ❖ Hard and non-pliable intercellular material ❖ Cells Osteocytes ❖ Functions ❖ Provides structural frame to the body, etc. 	<ul style="list-style-type: none"> ❖ Fluid connective tissue ❖ Cells WBC, RBC and platelets ❖ Functions ❖ Circulating fluid that help in transportation of substances

Muscles Tissue

Myofibrils (fine fibrils) → Fibres → Muscle

Muscles are of three types- skeletal, smooth, and cardiac

Skeletal muscle	Smooth muscle	Cardiac muscle
<ul style="list-style-type: none"> ❖ Closely attached to the skeletal bones ❖ Striated and voluntary ❖ Location- Closely attached to skeletal bones 	<ul style="list-style-type: none"> ❖ Fibres taper at both ends (fusiform) ❖ Non-striated and involuntary ❖ Location- Wall of internal organs such as the blood vessels, stomach and intestine 	<ul style="list-style-type: none"> ❖ Contractile tissue ❖ Striated and involuntary ❖ Intercalated discs present at some fusion points ❖ Location- Present only in the heart

Neural Tissue

- ❖ Exerts the greatest control over the body's responsiveness to changing conditions

	Neurons	Neuroglial Cells
Composition	Unit of neural system	Make more than one-half the volume of neural tissue
Excitability	Yes	No
Function	Respond to various stimuli	Protect and support neurons

COCKROACH

Size - 1/4 inches to 3 inches (0.6-7.6 cm)

Classification

Kingdom- Animalia, Phylum- Arthropoda, Class- Insecta, Genus- Periplaneta, Species- americana

Morphology

- ❖ 34-53 mm long

Exoskeleton

- ❖ Hardened plates called sclerites joined to each other by articular/arthrodial membrane

Head	Thorax	Abdomen
<ul style="list-style-type: none"> ❖ Triangular in shape ❖ Anteriorly at right angles to the longitudinal body axis ❖ Formed by the fusion of six segments ❖ Bears a pair of compound eyes, a pair of antennae (monitor environment) ❖ Mouthparts (biting and chewing type) - labrum, a pair of mandibles, a pair of maxillae, a labium, hypopharynx 	<ul style="list-style-type: none"> ❖ Three parts- prothorax, mesothorax and metathorax ❖ Each thoracic segment bears a pair of walking legs ❖ Two pairs of wings- Mesothoracic wings (Forewings/Tegmina) <ul style="list-style-type: none"> ❖ Opaque dark and leathery ❖ Cover the hind wings when at rest Metathoracic wings (Hindwings) <ul style="list-style-type: none"> ❖ Transparent and membranous ❖ Used in flight 	<ul style="list-style-type: none"> ❖ Consists of 10 segments ❖ 7th (boat shaped), 8th and 9th sternum forms a brood or genital pouch in females ❖ 9th and 10th terga and 9th sternum forms genital pouch in males ❖ Anal styles present in males only & anal cerci (on 10th segment) present in both sexes

Anatomy

Digestive System

- Three regions: foregut, midgut and hindgut
- Mouth → Pharynx → Oesophagus → Crop → Gizzard/ Proventriculus → Midgut → Ileum → Colon → Rectum

Circulatory System

- Open type
- Haemolymph = Colourless plasma and haemocytes
- Heart of cockroach = Elongated muscular tube

Respiratory System

- Takes place by a network of trachea & 10 pairs of small holes called spiracles (regulated by the sphincters)

Excretory System (Uricotelic)

- Performed by Malpighian tubules.
- The fat body, nephrocytes and urecose glands also help in excretion

Nervous System

- Segmentally arranged ganglia and ventral nerve cord
- Brain - represented by supra-oesophageal ganglion

Sensory System

- Antennae, eyes, maxillary palps, labial palps, anal cerci
- Reproductive system

Male reproductive system	Female reproductive system
<ul style="list-style-type: none"> A pair of testes (4th -6th abdominal segments) → vas deferens → seminal vesicle (stored and glued sperms) → ejaculatory duct → male gonopore Mushroom shaped gland (6th-7th segments) - An accessory reproductive gland External genitalia - Represented by male gonapophysis or phallomere 	<ul style="list-style-type: none"> Two large ovaries (2nd – 6th abdominal segments) → oviducts → vagina → genital chamber Produce 9-10 ootheca (containing 14-16 eggs each) Development = paurometabolous (through nymphal stage by moulting about 13 times)

Earthworm

Common Indian earthworms are *Pheretima* and *Lumbricus*

Morphology

- Segmented body (metameres about 100-120 in number)
- Anterior end -consists of mouth and the prostomium (sensory in function)
- Prostomium- Serves as a covering for the mouth & helps in open cracks in the soil
- Clitellum- dark band of glandular tissue (14-16 segments)
- Setae (S-shaped) - Helps in locomotion

Anatomy

1. Digestive system

- Mouth → Buccal cavity → Pharynx → Oesophagus → Gizzard → Stomach → Intestine → Anus

- Calciferous glands (in stomach) - neutralise the humic acid present in humus

- Typhlosole (in intestine) -increases the effective area of absorption

2. Respiratory system

- Through moist body surface

3. Circulatory system

- Closed type of blood vascular system

- Blood glands (4th-6th segments)- produce blood cells (phagocytic) and haemoglobin (dissolved in blood plasma)

4. Excretory system (uricotelic)

- Through coiled tubules called nephridia

5. Nervous system

- Represented by ventral nerve cord

6. Reproductive system

- Hermaphrodite (bisexual)
- Protandrous animal with cross fertilisation
- Two pairs of testes occur (10th and 11th segment) in males
- A pair of ovaries are present (12th and 13th intersegmental septum)
- Fertilisation and development take place in cocoons (secreted by the glands of clitellum)

Frog

Morphology

- Dorsal body is olive green and ventral side is pale yellow
- Body is divisible in head and trunk

Anatomy

1. Digestive system

- Mouth → Buccal cavity → Pharynx → Oesophagus → Stomach → Intestine → Cloaca
- Secretion from liver and pancreas help in digestion
- Final digestion take place in the intestine

2. Respiratory system

- On land it respire with the help of buccal cavity, skin and lungs
- In water it respire through skin

3. Circulatory system

- Well-developed closed type
- It involves heart, blood vessels and blood
- Heart consists of 3 chambers, two atria and one ventricle

4. Excretory system

- It consists of a pair of kidney, ureters, urinary bladder and cloaca
- Each kidney composed of numerous nephrons as a structural and functional unit

5. Nervous system

- Nervous system consists of central nervous system(brain and spinal cord), peripheral nervous system(cranial and spinal nerves) and autonomic nervous system (sympathetic and parasympathetic)

6. Reproductive system

- Well organized male and female reproductive system



Solved Examples

1. Identify X, Y and Z -

Structure	Location	Function
Spermatheca	X	Receive and store the spermatozoa during copulation
Malpighian tubules	At the junction of midgut and hindgut	Y
Z	At the end of foregut	Helps in grinding the food particles

- (1) $X=9^{\text{th}}$ segment, $Y=$ Helps in excretion, $Z=$ Gizzard
- (2) $X=6^{\text{th}}$ segment, $Y=$ Helps in digestion, $Z=$ Proventriculus
- (3) $X=6^{\text{th}}$ segment, $Y=$ Helps in excretion, $Z=$ Proventriculus
- (4) $X=9^{\text{th}}$ segment, $Y=$ Helps in respiration, $Z=$ Phallic gland

Sol. (3) A pair of spermatheca is present in the 6th segment which opens into the genital chamber. Excretion in cockroaches is performed by Malpighian tubules. Gizzard or proventriculus present at the end of the foregut helps in grinding the food particles.

2. The spaces in which the bone cells are present are called _____

- (1) Legumes (2) Lacunae
- (3) Lacquey (4) Lacteals

Sol. (2) The bone cells or osteocytes are present in the spaces called lacunae.

3. When you look at cockroaches closely, you will find small holes on their lateral sides. These holes are _____ present _____ in numbers.

- (1) Caeca; 10
- (2) Spiracles; 20
- (3) Caeca; 20
- (4) Spiracles; 10

Sol. (4) There are 10 pairs of small holes called spiracles present on the lateral side of the body of cockroaches. Spiracles help in respiration.

4. Which one of the given cells is not the part of connective tissue are called

- (1) Macrophages (2) Fibroblasts
- (3) Glial Cells (4) Mast cells

Sol. (3) Glial cells also called neuroglia are the part of neural tissue and its primary function is to protect and support the neurons.

5. Which of the given facts about Ootheca in cockroaches is / are correct

- (1) Produce 9-10 in numbers
- (2) Contains 14-16 eggs
- (3) About 8mm long
- (4) All are correct

Sol. (4) Ootheca is a dark reddish to blackish brown capsule, about 3/8" (8 mm) long. On an average, females produce 9-10 ootheca, each containing 14 -16 eggs.

6. Communication junctions are present at some fusion points between the cells of cardiac muscle tissue. What do you think is the function of them?

- (1) To adhere the cells together
- (2) To stop leakage across the tissue
- (3) To contract the cell as a unit
- (4) To transfer substances from one cell to another

Sol. (3) Communication junctions of intercalated discs allow the cells of cardiac tissues to contract as a unit.

7. Compound eyes of a cockroach contain about _____ numbers of ommatidia

- (1) 4000 (2) 3000
- (3) 2000 (4) 1000

Sol. (1) Each eye of a cockroach consists of about 2000 hexagonal ommatidia (or 4000 in total).

8. Which of the following is correct about collateral glands in Cockroaches ?

- (1) Present in only female
- (2) open into anterior region of genital pouch
- (3) Two in number
- (4) All of these

Sol. (4) Anterior part of female genital pouch contains female gonopore, spermathecal pores and collateral glands.



Exercise-1 (Topicwise)

ANIMAL TISSUES

1. In multicellular animals, a group of similar cells along with intercellular substances perform a specific function. Such an organisation is called
 - (1) Epithelium
 - (2) Organ
 - (3) Tissue
 - (4) Organ system
2. Animal tissues are broadly classified into four types as
 - (1) Squamous, Columnar, Cuboidal and Ciliated
 - (2) Simple, Compound, Special and Glandular
 - (3) Epithelial, Connective, Neural and Skeletal
 - (4) Neural, Connective, Epithelial and Muscular
3. On the basis of structural modification of the cells, simple epithelium is further divided into
 - (1) Two types – Ciliated and Glandular epithelium
 - (2) Three types – Squamous, Cuboidal and Columnar epithelium
 - (3) Four types – Squamous, Cuboidal, Columnar and Ciliated epithelium
 - (4) Two types – Unicellular and Multicellular epithelium
4. **Fill in the blanks**
 - A. The ... 1 ... consists of two or more cell layers and has protective function as it does in our skin
 - B. The ... 2 ... is composed of single layer of cells and functions as a lining for body cavities, ducts and tubes
 - (1) 1–Squamous epithelium, 2–Cuboidal epithelium
 - (2) 1–Columnar epithelium 2–Squamous epithelium
 - (3) 1–Simple epithelium, 2–Compound epithelium
 - (4) 1–Compound epithelium, 2–Simple epithelium
5. Epithelium present in salivary gland and pancreatic ducts is
 - (1) Compound Epithelium
 - (2) Cuboidal Epithelium
 - (3) Ciliated epithelium
 - (4) Columnar epithelium
6. Single layer of flattened cells with irregular boundaries is observed in all of the following except
 - (1) Blood capillary
 - (2) Lining of oesophagus
 - (3) Air sacs of lungs
 - (4) Both (1) & (3)

7. Which of the following pair is not having similar epithelial tissue?
 - (1) Blood vessels and alveoli
 - (2) Stomach and intestine
 - (3) Blood vessels and bronchioles
 - (4) Buccal cavity and pharynx
8. The epithelium found in the lining of stomach and intestine is
 - (1) Columnar
 - (2) Squamous
 - (3) Stratified
 - (4) Ciliated
9. Mucus, Saliva, Earwax, Oil, Milk and Digestive enzymes are secreted by
 - (1) Exocrine glands
 - (2) Endocrine glands
 - (3) Heterocrine glands
 - (4) Compound glands
10. Type of junction helps to stop substance from leaking across a tissue
 - (1) Tight junction
 - (2) Gap junction
 - (3) Adhering junction
 - (4) None of these
11. Which of the following tissues perform special function of linking and supporting other tissues and organs of the body?
 - (1) Epithelial tissue
 - (2) Connective tissue
 - (3) Muscular tissue
 - (4) Neural tissue
12. Which of the following connective tissue often serves as a support framework for epithelium?
 - (1) Areolar tissue
 - (2) Adipose tissue
 - (3) Dense regular connective tissue
 - (4) Dense irregular connective tissue
13. Fibroblast, Macrophages and Mast cells are seen in
 - (1) Epithelial tissues
 - (2) Loose connective tissue
 - (3) Skeletal muscle tissue
 - (4) Smooth muscle tissue
14. Cartilage is present
 - A. In the tip of nose and outer ear joints
 - B. Between adjacent bones of vertebral column
 - C. Between adjacent bones of limbs and hands in adults
 - (1) A, B and C
 - (2) A and B
 - (3) B and C
 - (4) A and C
15. Each muscle is made of many long, cylindrical fibres arranged in parallel arrays. These fibres are composed of numerous fine fibrils called
 - (1) Fascicles
 - (2) Myofibrils
 - (3) Myofilaments
 - (4) Both (2) and (3)

16. What type of muscle tissue is found in the wall of internal organs?
 (1) Smooth muscles (2) Cardiac muscle
 (3) Skeletal muscle (4) Striated muscle
17. Which of the following tissue exerts the greatest control over the body's responsiveness to changing conditions?
 (1) Epithelial tissue
 (2) Connective tissue
 (3) Muscular tissue
 (4) Neural tissue
18. Which statement is not correct regarding **neural tissue**?
 (1) Neurons are the unit of neural system
 (2) Neuroglial tissues are more than half the volume of neural tissues of body
 (3) Neural tissue exerts the greatest control over the body's responsiveness
 (4) Neurons and neuroglial cells, both are excitable cells
19. Find P, Q and R
- | Tissues | Structure | Location |
|---------------------|--------------------------------------|--|
| P | Fusiform fibres | Walls of stomach and intestine |
| Cartilage | Q | Between adjacent bones of the vertebral column |
| Compound epithelium | Made of more than one layer of cells | R |
- (1) P = Skeletal muscles, Q = Solid & Pliable, R = Moist surface of buccal cavity
 (2) P = Smooth muscles, Q = Solid & Non-Pliable, R = Moist surface of buccal cavity
 (3) P = Skeletal muscles, Q = Solid & Non-Pliable, R = Proximal convoluted tubules
 (4) P = Smooth muscles, Q = Solid & Pliable, R = Dry surface of the skin
20. The cells which secretes the matrix of cartilage is _____.
 (1) Platelets (2) Osteocytes
 (3) Chondrocytes (4) None of these
21. The cells present in the connective tissue are responsible for
 (1) Secretion of fibres
 (2) Secretion of ground substance or matrix
 (3) Both (1) and (2)
 (4) None of these
22. Out of the given tissues, how many are types of connective tissue- Adipose, bones, skeletal, dense irregular, simple squamous, areolar
 (1) Two (2) Four
 (3) Six (4) Five

23. Loose connective tissue is
 (1) Areolar (2) Bone
 (3) Blood (4) Cartilage
24. Epithelial tissue with thin flat cells occurs on
 (1) Inner lining of blood vessels
 (2) Inner lining of stomach
 (3) Inner lining of fallopian tubes
 (4) Outer surface of ovary
- ## ORGAN AND ORGAN SYSTEM
25. The complexity in organ and organ systems displays certain discernable trend. This discernable trend is called
 (1) Morphological trend (2) Anatomical trend
 (3) Complexity trend (4) Evolutionary trend
26. Conventionally, the word **anatomy** refers to
 (1) Study of morphology of internal organs
 (2) Study of morphology of external organs
 (3) Study of morphology of both internal and external organs
 (4) None of these
27. I. epithelial, II. connective, III. muscular IV. neural
 Human heart is made up of which of the given tissues-
 (1) (i), (iii) (2) (ii), (iii), (iv)
 (3) (i), (iii), (iv) (4) (i), (ii), (iii), (iv)
28. Arrange the following in decreasing order on the basis of their complexity-
 (1) Organ system → Tissues → Organ
 (2) Organ system → Organ → Tissues
 (3) Organ → Organ system → Tissues
 (4) Tissues → Organ → Organ system
29. The organisation of tissue to form organs and then to form organ system is essential for-
 (1) For better coordinated activities
 (2) To look organism better
 (3) Both (1) and (2)
 (4) None of these
- ## COCKROACH
30. Cockroaches excretes nitrogenous waste through A in the form of B. Identify A and B respectively.
 (1) Malpighian tubules, uric acid
 (2) Green gland, urea
 (3) Malpighian tubule, ammonia
 (4) Antennal gland, uric acid
31. Head of cockroach is formed by the fusion of
 (1) Six segments and triangular in shape
 (2) Ten segments and trigonal in shape
 (3) Eleven segments and rectangular in shape
 (4) Three segments and tetragonal in shape

32. Which of the following is incorrect for forewings of cockroach?
- Also called mesothoracic wings or tegmina
 - Opaque, dark and leathery
 - Cover the hind wings when at rest
 - Used in flight
33. In female cockroaches, ovaries are found in
- 2nd - 6th abdominal segment
 - 2nd - 6th sternum segment
 - Whole of the abdomen
 - Both (1) and (2)
34. In cockroach, labium, labrum and hypopharynx are commonly called
- Upper lip, lower lip and crop, respectively
 - Upper lip, lower lip and tongue, respectively
 - Lower lip, upper lip and tongue, respectively
 - Lower lip, upper lip and jaw, respectively
35. A ring of 6–8 blind tubules present at the junction of foregut and midgut and are called
- Gastric caecae which secrete digestive juice
 - Hepatic caecae which secrete digestive juice
 - Intestinal caecae which help in grinding the food
 - Both (1) and (2)
36. Which part of alimentary canal of cockroach has an outer layer of thick circular muscles and inner cuticle forming six highly chitinous plates called teeth?
- Gizzard
 - Crop
 - Proventriculus
 - Both (1) and (3)
37. Which of the following features is not related to cockroach?
- Body divisible into head, thorax and abdomen
 - Two pairs of wings are found
 - Head lies posteriorly at right angles to the longitudinal body axis
 - Presence of anal cerci in both sexes
38. The **correct sequence** of the parts of alimentary canal in cockroach is
- Mouth → Pharynx → Oesophagus → Crop → Gizzard → Midgut → Caecum → Colon → Rectum → Anus
 - Mouth → Pharynx → Oesophagus → Gizzard → Crop → Midgut → Ileum → Colon → Rectum → Anus
 - Mouth → Pharynx → Oesophagus → Crop → Proventriculus → Midgut → Ileum → Colon → Rectum → Anus
 - Mouth → Pharynx → Oesophagus → Stomach → Crop → Midgut → Hindgut → Anus
39. In cockroaches, the respiratory system consists of a network of trachea that open outside through small holes that are present on lateral side of the body are called
- Tracheoles and are of 9 pairs
 - Spiracles and are of 10 pairs
 - Sphincters and are of 8 pairs
 - Ostia and are of 13 pairs
40. In female cockroach, genital (or brood) pouch possess
- Collateral glands only
 - Female gonopore only
 - Female gonopore + collateral glands
 - Female gonopore + collateral glands + spermathecal pore
41. Which part of alimentary canal of cockroach is used for storing of food?
- Crop
 - Gizzard
 - Stomach
 - Gastric caecae
42. Nitrogenous waste in malpighian tubule of cockroach passes into
- Haemocoel
 - Intestine
 - Vacuole
 - Duodenum
43. Basic unit in the eye of cockroach/Insect is
- Retina
 - Rhabdome
 - Corneal facet
 - Ommatidium
44. With the help of several ommatidia, a cockroach can receive several images of an object. This kind of vision is called
- Nocturnal vision, being common during daytime
 - Mosaic vision, with more sensitivity but less resolution
 - Mosaic vision, with more resolution but less sensitivity
 - Nocturnal vision, with more sensitivity and more resolution

EARTHWORM

45. In earthworm, the body segment which contains mouth is called-
- Prostomium
 - Peristomium
 - Peristaltium
 - None of these
46. In earthworms, typhlosole is present in X helps in Y. Identify the X and Y.
- X = Stomach, Y = Absorption
 - X = Intestine, Y = Absorption
 - X = Stomach, Y = Digestion
 - X = Intestine, Y = Digestion
47. Read the given statements about earthworms and find the one which is not correct-
- Earthworms have chemoreceptors and other receptors which are sensitive for light and touch.
 - There are three types of nephridia present in the earthworms
 - Typhlosole increases the effective area of absorption in the intestine
 - Red colour of the earthworm blood is due to the hemoglobin present in the blood cells

48. "Earthworms are cross-fertilisation hermaphrodites". Select the correct reason which justify the given statement-
- Earthworms are protogynous animals
 - Earthworms are protandrous animals
 - Both A and B are correct
 - None of these
49. Find the statement which is not correct about earthworm-
- Used as bait in game fishing
 - Blood cells helps in the transportation of respiratory gasses in them
 - They exhibit a closed type of blood vascular system
 - They make burrows in the soil and make it porous
50. The type of nephridia present in the earthworms is
- Septal nephridia
 - Integumentary nephridia
 - Pharyngeal nephridia
 - None of these
51. Fertilisation and development in earthworms occurs within structures called _____ produced by gland cells of _____.
 (1) Cocoons; phallic gland
 (2) Ootheca; clitellum
 (3) Cocoons; clitellum
 (4) Ootheca; phallic gland

FROG

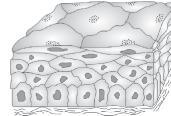
52. Which of the given statement (s) is/are correct about frogs-
- Belongs to the class reptiles of phylum chordata
 - Are poikilotherms
 - Show camouflage
 - Both (2) and (3)
53. The phenomena in which organisms hide themselves & take shelter in moist and cool deep burrows to prevent water loss and internal body damages due to the extreme heat is called
- Hibernation
 - Mimicry
 - Aestivation
 - None of these

54. Read the given statements about frogs and find the incorrect one
- The skin of frog is smooth and slippery
 - The Frogs drink water to keep their body hydrated.
 - Dorsal side of body is olive green with dark irregular spots.
 - Body is divisible into head and trunk
55. "Frogs exhibit sexual dimorphism". Select the option which justify the given statement-
- Male frogs have a copulatory pad on the first digit of the forelimbs
 - Presence of sound producing vocal sacs in male frogs
 - Presence of Webbed-digit feet
 - Both (1) and (2)
56. A mature female frogs, can lay ____ ova at a time.
- 2000-5000
 - 2500-3000
 - 4000-5000
 - 1000-2000
57. Special venous connection between the liver and the intestine of the body is known as
- Renal portal system
 - Hypophyseal portal system
 - Hepatic portal system
 - (1) and (3)
58. During aestivation and hibernation gaseous exchange in frogs takes place through-
- Buccal cavity
 - Skin
 - Lungs
 - All of the above
59. The numbers of cranial nerves present in frogs are-
- 12 Pairs
 - 15 Pairs
 - 20 Pairs
 - 10 Pairs
60. Testes, in male frogs adhere to the upper part of the kidneys by
- Vasa efferentia
 - Urino
 - Mesorchium
 - Cloaca

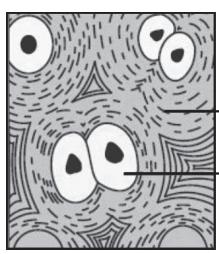


Exercise-2 (Learning Plus)

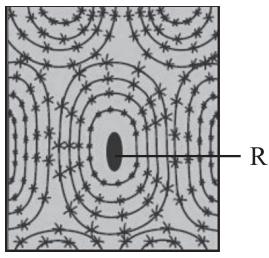
- Epithelial tissues are of
 - Three types, namely squamous, cuboidal and columnar epithelium
 - Four types, namely squamous, cuboidal, columnar and ciliated epithelium
 - Two types, namely, simple and compound epithelium
 - Two types, namely, simple and complex epithelium
- Based on their location, muscles are classified into
 - Three types — Skeletal, smooth and cardiac muscle
 - Three types — Skeletal, visceral and cardiac muscle
 - Three types — Voluntary, involuntary and cardiac muscle
 - Both (1) and (2)
- Clitellum is a distinct part in the body of earthworm, it is found in

- (1) Segment 13 - 14 - 15 (2) Segment 14 - 15 - 16
 (3) Segment 12 - 13 - 14 (4) Segment 15 - 16 - 17
4. Setae help in locomotion in earthworm but are not uniformly present in all the segments. They are present in
 (1) 1st segment (2) Last segment
 (3) Clitellar segment (4) 20th – 22nd segment
5. Which of the following part of alimentary canal of earthworm helps in grinding the soil particle and decaying leaves?
 (1) Pharynx (2) Gizzard
 (3) Stomach (4) Typhlosole
6. Malpighian tubule in cockroaches are present at the junction of
 (1) Foregut and midgut and help in the secretion of digestive enzymes
 (2) Midgut and hindgut and help in the grinding the food particles
 (3) Foregut and midgut and help in the removal of excretory products from haemolymph
 (4) Midgut and hindgut and help in the removal of excretory products from haemolymph
7. Malpighian tubules are
 (1) 100—120 yellow coloured filamentous structure
 (2) 100—120 brown coloured filamentous structure
 (3) 100—150 yellow coloured filamentous structure
 (4) 100—150 yellow coloured chitinous structure
8. Which is correct statement about respiration in earthworm?
 (1) O₂ from atmosphere diffuses into blood and combines with haemoglobin of blood plasma
 (2) Blood does not have any important role in O₂ transport
 (3) Respires anaerobically
 (4) O₂ diffused from air combines with haemoglobin of RBCs
9. Compound tissue is defined as
 (1) Similar types of cells held together by connective tissue
 (2) Different types of cells which are different in structure and functions
 (3) Different types of cells performing one function
 (4) Similar cells at different regions performing many functions
10. What will happen if ligaments are cut or broken
 (1) Bones will move freely at joints
 (2) No movement at joint
 (3) Bone will become unfix
 (4) Bone will become fixed
11. Difference between blood and lymph is
 (1) Blood has WBCs while lymph has RBCs
 (2) Blood has dissolved salt while lymph has no cells
 (3) Blood has RBCs and WBCs while lymph has no cell
 (4) Blood has RBCs and WBCs while lymph has only WBCs
12. Cockroach's blood does not contain respiratory pigment. It means
 (1) It does not respire
 (2) Cockroach respires anaerobically
 (3) Oxygen passes to all the tissue through diffusion
 (4) Oxygen reaches tissue through tracheoles
13. Mouth parts of cockroach are of
 (1) Piercing and sucking type
 (2) Chewing and lapping type
 (3) Biting and chewing type
 (4) Siphoning type
14. Which of the following organs in earthworm neutralises humic acid present in humus?
 (1) Typhlosole
 (2) Calciferous glands
 (3) Intestinal caecum
 (4) Gizzard
15. Read the following statements
 (1) It is made up of a single thin layer of flattened cells with irregular boundaries
 (2) They are found in the walls of blood vessels and air sacs of lungs
 (3) They are involved in functions like forming a diffusion boundary
 Which of the following characteristics of tissue is being described by the above statements?
 (1) Squamous epithelium
 (2) Columnar epithelium
 (3) Ciliated epithelium
 (4) Compound epithelium
16. Which of the following types of connective tissue is mismatched with its matrix?
 (1) Areolar- Loosely packed matrix of protein fibres
 (2) Bone- Mineralised matrix
 (3) Cartilage- Highly vascular matrix
 (4) Blood- Liquid matrix
17. Read the following statements and find out how many of these are related to given figure
- 
- (1) Multilayered epithelium
 (2) Limited role in secretion and absorption
 (3) Main function is to provide protection against chemical and mechanical stresses.
 (4) They cover the dry surface of skin, moist surface of buccal cavity and pharynx
- (1) Four (2) Three
 (3) Two (4) One

18. Identify the correct matching



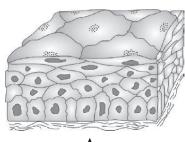
A



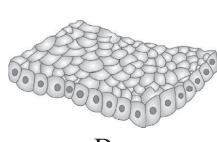
B

- (1) A - Cartilage, P - Elastic fibres
- (2) A - Bone, Q - Osteocyte
- (3) B - Cartilage, R - Chondrocyte
- (4) B - Bone, R - Haversian canal

19. Identify the correct option with respect to the figures (A & B) given below



A



B

- (1) A: Provide protection against chemical and mechanical stresses: Stomach
- (2) A: Secrete mucus, saliva, earwax, oil, milk, digestive enzymes: Stomach
- (3) B: Found in ducts of glands: Secretion and absorption
- (4) B: Mainly present in the inner surface of hollow organs: Secretion and absorption

20. Read the given statements about blood vascular system of cockroach

- A. Circulatory system is of closed type
- B. It contains no blood vessels except aorta of heart
- C. Heart is six chambered
- D. Haemolymph is composed of colourless plasma and haemocytes

Which of the statement (s) given above is/are incorrect?

- (1) Only A
- (2) A, B and C
- (3) A and C
- (4) Only D

Exercise-3 (Multiconcept)

MATCH THE COLUMN MCQS

1. Match the Column I and Column II find the correct combinations.

Column-I		Column-II	
A.	Walls of alveoli	p.	Simple Ciliated epithelium
B.	PCT of nephron	q.	Simple squamous epithelium
C.	Bronchioles & fallopian tubes	r.	Brush-border columnar epithelium
D.	Lining of stomach and intestine	s.	Brush-bordered cuboidal epithelium

- (1) A-(q); B-(r); C-(p); D-(s)
- (2) A-(q); B-(p); C-(r); D-(s)
- (3) A-(q); B-(s); C-(p); D-(r)
- (4) A-(s); B-(r); C-(p); D-(q)

2. Match the Column I and Column II find the correct combinations.

Column-I		Column-II	
A.	Skeletal muscles	p.	Involuntary & unstriated
B.	Smooth muscles	q.	Voluntary & striated
C.	Cardiac muscles	r.	Have neurotransmitters
D.	Neurons	s.	Involuntary & striated

- (1) A-(q); B-(r); C-(p); D-(s)
- (2) A-(q); B-(p); C-(s); D-(r)
- (3) A-(q); B-(s); C-(p); D-(r)
- (4) A-(s); B-(r); C-(p); D-(q)

3. Match the Column I and Column II find the correct combinations:

Column-I		Column-II	
A.	Gizzard	p.	Labium
B.	Malpighian tubules	q.	Proventriculus
C.	Lower lip	r.	6-8 in numbers
D.	Hepatic Caeca	s.	100-150 in numbers

- (1) A-(q); B-(r); C-(p); D-(s)
- (2) A-(s); B-(q); C-(p); D-(r)
- (3) A-(q); B-(s); C-(p); D-(r)
- (4) A-(s); B-(r); C-(p); D-(q)

4. Match the columns I and Column II and find the correct combinations:

Column-I		Column-II	
A.	Alary muscles	p.	Helps in Digestion
B.	Hepatic Caeca	q.	Secretes the oothecal case
C.	Collateral glands	r.	Helps in Circulation
D.	Ciliated Epithelium	s.	Helps in to move particles or other substance

- (1) A-(r); B-(p); C-(s); D-(q)
- (2) A-(s); B-(p); C-(q); D-(r)
- (3) A-(r); B-(p); C-(q); D-(s)
- (4) A-(s); B-(r); C-(p); D-(q)

5. Match the column I and Column II with reference to cockroach and choose the correct option.

Column-I		Column-II	
A.	Phallomere	p.	Chain of developing ova
B.	Gonopore	q.	Bundles of sperm
C.	Spermatophore	r.	Opening of the ejaculatory duct
D.	Ovarioles	s.	External genitalia

- (1) A-(r); B-(s); C-(q); D-(p)
- (2) A-(s); B-(r); C-(q); D-(p)
- (3) A-(s); B-(q); C-(r); D-(p)
- (4) A-(q); B-(s); C-(r); D-(p)

CORRECT-INCORRECT PAIR MCQS

6. Select the incorrect match.

- (1) Skeletal muscle – Protects the heart
- (2) Compound epithelium – Protection against chemical and mechanical stress
- (3) Bones – Protects soft tissues and organ
- (4) Neuroglia – Protects and support neurons

7. Find the incorrect match about *P. americana*.

- (1) Ovaries – 2nd-6th abdominal segments
- (2) Mushroom glands – 6th -7th abdominal segments
- (3) Testis – 4th-6th abdominal segments
- (4) Spermatheca – 9th abdominal segments

8. Select the incorrect match.

- (1) Cerumen, mucus, oil, saliva – Secretion of exocrine gland
- (2) Fibres – Secretion of fibroblasts
- (3) Oothecal case – Secretion of conglobate gland
- (4) Growth hormones – Secretion of endocrine gland

9. Select the incorrect match.

- (1) Smooth muscles – Uninucleated cells
- (2) Columnar epithelium – Nuclei are located in the center of the cells
- (3) Red blood cells – Anucleated
- (4) Skeletal muscles – Multinucleated cells

10. Select the incorrect match.

- (1) Female accessory gland – Conglobate gland
- (2) Excretory organ – Malpighian tubules
- (3) Alary muscles – Helps in circulation
- (4) Mosaic vision – More sensitivity & less resolution

11. Select the incorrect match.

- (1) Fibroblasts – Cells that secrete and produce fibres
- (2) Osteocytes – Present in the spaces called lacunae
- (3) Blood – Contain RBC, WBC & platelets only
- (4) Chondrocytes – Cells of cartilage

STATEMENT BASED QUESTIONS

12. Find the incorrect statement

- (1) Cockroaches belongs to the class Insecta of phylum Arthropoda
- (2) Body is divided into three distinct region: head, Thorax and abdomen in Cockroaches
- (3) Triangular head lies anteriorly at acute angles to the longitudinal body axis in *P. americana*
- (4) In frog, bile emulsifies fat and pancreatic juices digest carbohydrates and proteins.

13. Read the following statements and find the correct one.

- (1) Cell secretes fibres of structural proteins called collagen or elastin in all connective tissues without any exception
- (2) Dense irregular connective tissue is present in the skin
- (3) The excess of nutrients which are not used immediately are stored in tendons and ligaments
- (4) In *Pheretima* septal nephridia present on both the side of segment 13

14. Find the incorrect statement from the following-

- (1) Only male cockroaches bears a pair of short, thread-like anal styles
- (2) Anterior part of genital pouch of female cockroach contains gonopore, spermathecal pores and Collateral glands
- (3) *Pheretima* exhibits a closed type of blood vascular system, consisting of blood vessels, capillaries and heart.
- (4) In cockroaches, each thoracic segment bears a pair of wings

15. Read the following statements and find the incorrect one-

- (1) The cells columnar epithelium of gut specialized to secrete mucus
- (2) The columnar epithelium of the proximal convoluted tubule of nephron has microvilli.
- (3) The main function of compound epithelium is to provide protection against chemical and mechanical stress
- (4) The bone marrow in same bones is the site of production of blood cells.

16. Read the following statements and find the incorrect one.

- (1) In mature earthworm segments 14-16 are covered by a dark band of glandular tissue called clitellum.
- (2) In female Cockroaches, the 7th, 8th and 9th Sternae form a brood or genital pouch.

- (3) In cockroaches, the mandibles also act as the sense organ due to the presence of sensory receptors on mandibular palps.
- (4) Frog respire on land in water by two different methods.
17. Read the following statements and choose the incorrect one
- (1) Structural modification of cells in different tissues is due to their different functions
 - (2) In our hollow visceral organs, ciliated epithelium helps in the movement of substances
 - (3) Blood is the only connective tissue in which structural fibres, called collagen, are secreted by liver
 - (4) Compound epithelium covers the dry surface of skin and moist surface of buccal cavity
18. Choose **correct option** which have all right statement for bones
- (1) Bones have a hard and non-pliable ground substance
 - (2) Matrix of bone is rich in calcium salt and free from collagen fibres
 - (3) Bone marrow in some bones is the site of production of blood cells
 - (4) Bone is a type of specialised connective tissue
- (1) A, B and C
 - (2) A, C and D
 - (3) A and D only
 - (4) All of these
19. Read the following statements and choose how many statements are **incorrect**?
- A. In the case of earthworm, malpighian tubules are present at the junction on midgut and hindgut
 - B. Adipose tissue is a dense irregular connective tissue and it is a reservoir of stored food
 - C. In animals like earthworm, cells, tissues, organs and organ system split up the work in a way that ensures the survival of body
 - D. Epithelia have two free surfaces one facing a body fluid and one faces the outside environment
 - E. Smooth muscles are the component of internal organs.
- (1) 3
 - (2) 4
 - (3) 1
 - (4) 5

Directions: In the questions from 20 to 24 two statements are given as **statement-I** and **statement-II**.

Mark the correct choice as:

- (1) Both Statement-I and Statement-II are correct.
- (2) Both Statement-I and Statement-II are incorrect.
- (3) Statement-I is correct & Statement-II is incorrect.
- (4) Statement-I is incorrect & Statement-II is correct.

20. **Statement-I:** Epithelial tissues are specialized for linking and connecting other tissues/organs.

Statement-II: Tendon and ligament are the types of dense irregular connective tissues.

21. **Statement-I:** The exoskeleton of cockroach has hardened plates called sclerites.
- Statement-II:** Collateral glands secrete the oothecal case in male Cockroaches.
22. **Statement-I:** Sclerites are joined together by a membrane called arthrodial membrane.
- Statement-II:** Gap junctions is for rapid transfer of ions, small molecules and sometimes big molecules.
23. **Statement-I:** Cells of epithelial tissue are tightly packed with little intercellular matrix.
- Statement-II:** Fibres and fibroblasts are compactly packed in dense connective tissues.
24. **Statement-I:** Short extension of the Mesothorax known as the neck connects the head and the thorax in cockroaches.
- Statement-II:** Head in Cockroaches is formed by the fusion of six segments.
- Directions:** In the following questions, a statement of assertion is followed by a statement of reason.
- Mark the correct choice as:
- (1) If both Assertion (A) and Reason (R) are True and the Reason (R) is a correct explanation of the Assertion (A).
 - (2) If both Assertion (A) and Reason (R) are True but Reason (R) is not a correct explanation of the Assertion (A).
 - (3) If Assertion (A) is True but the Reason (R) is False.
 - (4) If Assertion (A) is False but the Reason (R) is True.
25. **Assertion (A):** The exoskeleton of cockroach has hardened plates called sclerites.
- Reason (R):** Sclerites are joined together by a thin and flexible membrane called tergites.
26. **Assertion (A):** Inner surface of bronchioles and fallopian tubes consists of ciliated epithelium.
- Reason (R):** Ciliated epithelium in them helps in to move mucus or other particles in a specific direction over the epithelium.
27. **Assertion (A):** The development of *Periplaneta americana* is Paurometabolous.
- Reason (R):** In *P. americana*, larvae have no similarity with the adult and there is always a pupal stage.
28. **Assertion (A):** Tendon and ligaments are the example of dense irregular connective tissue.
- Reason (R):** The orientation of fibres shows irregular pattern in dense irregular connective tissue.
29. **Assertion (A):** Skeletal muscles are voluntary in nature.
- Reason (R):** Skeletal muscles show patterns of light and dark bands.



Exercise-4 (Past 10 Years Questions)

1. Which of the following is present between the adjacent bones of the vertebral column? **(2022)**
 - (1) Smooth muscle
 - (2) Intercalated discs
 - (3) Cartilage
 - (4) Areolar tissue
 2. Which of the following is not a connective tissue? **(2022)**
 - (1) Neuroglia
 - (2) Blood
 - (3) Adipose tissue
 - (4) Cartilage
 3. Tegmina in cockroach, arises from **(2022)**
 - (1) Prothorax and Mesothorax
 - (2) Prothorax
 - (3) Mesothorax
 - (4) Metathorax
 4. Which of the following characteristics is incorrect with respect to cockroach? **(2021)**
 - (1) Hypopharynx lies within the cavity enclosed by the mouth parts
 - (2) In females, 7th-9th sterna together form a genital pouch
 - (3) 10th abdominal segment in both sexes, bears a pair of anal cerci
 - (4) A ring of gastric caeca is present at the junction of midgut and hind gut
 5. Which of the following statements wrongly represents the nature of smooth muscle? **(2021)**
 - (1) They are involuntary muscles
 - (2) Communication among the cells is performed by intercalated discs
 - (3) These muscles are present in the wall of blood vessels
 - (4) These muscle have no striations
 6. Identify the types of cell junctions that help to stop the leakage of the substances across a tissue and facilitation of communication with neighbouring cells via rapid transfer of ions and molecules **(2021)**
 - (1) Tight junctions and Gap junctions, respectively
 - (2) Adhering junctions and Tight junctions, respectively
 - (3) Adhering junctions and Gap junctions, respectively
 - (4) Gap junctions and Adhering junctions, respectively
 7. Following are the statements about prostomium of earthworm
 (2021)
 - A. It serves as a covering for mouth
 - B. It helps to open cracks in the soil into which it can crawl
 - C. It is one of the sensory structures
 - D. It is the first body segment
- Choose the correct answer from the options given below.
- (1) A, B and D are correct
 - (2) A, B, C and D are correct
 - (3) B and C are correct
 - (4) A, B and C are correct
8. Cuboidal epithelium with brush border of microvilli is found in **(2020)**
 - (1) Ducts of salivary glands
 - (2) Proximal convoluted tubule of nephron
 - (3) Eustachian tube
 - (4) Lining of intestine
 9. If the head of cockroach is removed, it may live for few days because **(2020)**
 - (1) The cockroach does not have nervous system
 - (2) The head holds a small proportion of a nervous system while the rest is situated along the ventral part of its body
 - (3) The head holds a 1/3rd of a nervous system while the rest is situated along the dorsal part of its body
 - (4) The supra-oesophageal ganglia of the cockroach are situated in ventral part of abdomen
 10. Goblet cells of alimentary canal are modified from **(2020)**
 - (1) Columnar epithelial cells
 - (2) Chondrocytes
 - (3) Compound epithelial cells
 - (4) Squamous epithelial cells
 11. In cockroach, identify the parts of the foregut in correct sequence: **(2020 Covid)**
 - (1) Mouth → Crop → Pharynx → Oesophagus → Gizzard
 - (2) Mouth → Gizzard → Crop → Pharynx → Oesophagus
 - (3) Mouth → Pharynx → Oesophagus → Crop → Gizzard
 - (4) Mouth → Oesophagus → Pharynx → Crop → Gizzard
 12. Match the following columns with reference to cockroach and select the correct option **(2020 Covid)**

Column – I	Column – II
A. Grinding of the food particles	p. Hepatic caecae
B. Secrete gastric juice	q. 10 th segment
C. 10 pairs	r. Proventriculus
D. Anal cerci	s. Spiracles

A	B	C	D
(1) (s)	(r)	(t)	(q)
(2) (p)	(s)	(r)	(q)
(3) (q)	(r)	(p)	(s)
(4) (r)	(p)	(s)	(q)
 13. Select the incorrectly matched pair from following **(2020 Covid)**
 - (1) Neurons - Nerve cells
 - (2) Fibroblast - Areolar tissue
 - (3) Osteocytes - Bone cells
 - (4) Chondrocytes - Smooth muscle cells

14. Ciliated epithelial cells are required to move particles or mucus in a specific direction. In humans, these cells are mainly present in **(2019)**
- Bile duct and Bronchioles
 - Fallopian tubes and Pancreatic duct
 - Eustachian tube and Salivary duct
 - Bronchioles and Fallopian tubes
15. Select the correct sequence of organs in the alimentary canal of cockroach starting from mouth **(2019)**
- Pharynx → Oesophagus → Crop → Gizzard → Ileum → Colon → Rectum
 - Pharynx → Oesophagus → Gizzard → Crop → Ileum → Colon → Rectum
 - Pharynx → Oesophagus → Gizzard → Ileum → Crop → Colon → Rectum
 - Pharynx → Oesophagus → Ileum → Crop → Gizzard → Colon → Rectum
16. Which of the following features is used to identify a male cockroach from a female cockroach? **(2018)**
- Presence of a boat shaped sternum on the 9th abdominal segment
 - Presence of caudal styles
 - Forewings with darker tegmina
 - Presence of anal cerci
17. Select the correct route for the passage of sperms in male frogs **(2017- Delhi)**
- Testes → Bidder's canal → Kidney → Vasa efferentia → Urinogenital duct → Cloaca
 - Testes → Vasa efferentia → Kidney → Seminal Vesicle → Urinogenital duct → Cloaca
 - Testes → Vasa efferentia → Bidder's canal → Ureter → Cloaca
 - Testes → Vasa efferentia → Kidney → Bidder's canal → Urinogenital duct → Cloaca
18. Which of the following structures does not open into the genital chamber of female cockroaches? **(2017-Gujarat)**
- A pair of collateral glands
 - A single median oviduct
 - Spermatheca
 - A pair of anal cerci
19. Select in incorrect option with respect to features present in three animals **(2017-Gujarat)**

	Characters	Cockroach	Earthworm	Frog
(1)	Development	Direct	Indirect	Indirect
(2)	Blood vascular system	Open	Closed	Closed
(3)	Body surface	Dry	Moist	Moist
(4)	Eyes	Compound	Absent	Simple

20. Smooth muscles are **(2016-II)**
- Involuntary, cylindrical, striated
 - Voluntary, spindle-shaped, uninucleate
 - Involuntary, fusiform, non-striated
 - Voluntary, multinucleate, cylindrical
21. In male cockroaches, sperms are stored in **(2016-II)**
- Testes
 - Vas deferens
 - Seminal vesicles
 - Mushroom glands
22. Which of the following features is not present in *Periplaneta americana*? **(2016-I)**
- Schizocoelom as body cavity
 - Indeterminate and radial cleavage during embryonic development
 - Exoskeleton composed of N-acetyl glucosamine
 - MetamERICALLY segmented body
23. Which type of tissue correctly matches with its location? **(2016-I)**
- | | Tissue | Location |
|-----|-------------------------|-------------------|
| (1) | Smooth muscle | Wall of intestine |
| (2) | Areolar tissue | Tendons |
| (3) | Transitional epithelium | Tip of nose |
| (4) | Cuboidal epithelium | Lining of stomach |
24. The terga, sterna and pleura of cockroach body are joined by **(2015)**
- Arthrodial membrane
 - Cartilage
 - Cementing glue
 - Muscular tissue
25. The body cells in cockroach discharge their nitrogenous waste in the haemolymph mainly in the form of **(2015 Re)**
- Potassium urate
 - Urea
 - Calcium carbonate
 - Ammonia
26. Which of the following is not a function of the skeletal system? **(2015 Re)**
- Storage of minerals
 - Production of body heat
 - Locomotion
 - Production of erythrocytes
27. Function of the gap junction is to **(2015 Re)**
- Facilitate communication between adjoining cells by connecting the cytoplasm for rapid transfer of ions, small molecules and some large molecules
 - Separate two cells from each other
 - Stop substance from leaking across a tissue
 - Performing cementing to keep neighboring cells together
28. Choose the correctly matched pair **(2014)**
- Cartilage - Loose connective tissue
 - Tendon - Specialised connective tissue
 - Adipose tissue - Dense connective tissue
 - Areolar tissue - Loose connective tissue

29. Choose the correctly matched pair (2014)
- Inner surface of bronchioles - Squamous epithelium
 - Inner lining of salivary ducts - Ciliated epithelium
 - Moist surface of Buccal cavity - Glandular epithelium
 - Tubular parts of nephrons - Cuboidal epithelium
30. Select the correct option with respect to cockroaches (2013)
- Malpighian tubules convert nitrogenous wastes into urea
 - Males bear short anal styles not present in females
- (3) Nervous system comprises of a dorsal nerve cord and ten pairs of ganglia
- (4) Forewings are tegmina which are used in flight
31. What external changes are visible after the last moult of a cockroach nymph? (2013)
- Labium develops
 - Mandibles become harder
 - Anal cerci develop
 - Both fore wings and hind wings develop

ANSWER KEY

CONCEPT APPLICATION

- | | | | | | | | | | | | |
|--------------------------------|----------------|---------------|-----------|----------|------------------------|-----------------|----------------------|----------|-----------|----------|-----------|
| 1. Squamous | 2. Microvilli | 3. Adipose | 4. False | 5. True | 6. False | 7. True | | | | | |
| 8. <i>Pheretima, Lumbricus</i> | 9. Peristomium | 10. Nephridia | 11. False | 12. True | 13. Articular membrane | 14. Hypopharynx | 15. Seminal vesicles | 16. True | 17. False | 18. True | 19. Mucus |
| 20. First | 21. True | 22. False | | | | | | | | | |

EXERCISE-1 (TOPICWISE)

- | | | | | | | | | | |
|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| 1. (3) | 2. (4) | 3. (2) | 4. (4) | 5. (1) | 6. (2) | 7. (3) | 8. (1) | 9. (1) | 10. (1) |
| 11. (2) | 12. (1) | 13. (2) | 14. (1) | 15. (4) | 16. (1) | 17. (4) | 18. (4) | 19. (4) | 20. (3) |
| 21. (3) | 22. (2) | 23. (1) | 24. (1) | 25. (4) | 26. (1) | 27. (4) | 28. (2) | 29. (1) | 30. (1) |
| 31. (1) | 32. (4) | 33. (1) | 34. (3) | 35. (4) | 36. (4) | 37. (3) | 38. (3) | 39. (2) | 40. (4) |
| 41. (1) | 42. (2) | 43. (4) | 44. (2) | 45. (2) | 46. (2) | 47. (4) | 48. (2) | 49. (2) | 50. (4) |
| 51. (3) | 52. (4) | 53. (3) | 54. (2) | 55. (4) | 56. (2) | 57. (3) | 58. (2) | 59. (4) | 60. (3) |

EXERCISE-2 (LEARNING PLUS)

- | | | | | | | | | | |
|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| 1. (3) | 2. (4) | 3. (2) | 4. (4) | 5. (2) | 6. (4) | 7. (3) | 8. (1) | 9. (3) | 10. (3) |
| 11. (4) | 12. (4) | 13. (3) | 14. (2) | 15. (1) | 16. (3) | 17. (1) | 18. (4) | 19. (3) | 20. (3) |

EXERCISE-3 (MULTICONCEPT)

- | | | | | | | | | | |
|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| 1. (3) | 2. (2) | 3. (3) | 4. (3) | 5. (2) | 6. (1) | 7. (4) | 8. (3) | 9. (2) | 10. (1) |
| 11. (3) | 12. (3) | 13. (2) | 14. (4) | 15. (2) | 16. (3) | 17. (3) | 18. (2) | 19. (1) | 20. (2) |
| 21. (3) | 22. (1) | 23. (1) | 24. (4) | 25. (3) | 26. (1) | 27. (3) | 28. (4) | 29. (2) | |

EXERCISE-4 (PAST 10 YEARS QUESTIONS)

- | | | | | | | | | | |
|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| 1. (3) | 2. (1) | 3. (3) | 4. (4) | 5. (2) | 6. (1) | 7. (4) | 8. (2) | 9. (2) | 10. (1) |
| 11. (3) | 12. (4) | 13. (4) | 14. (4) | 15. (1) | 16. (2) | 17. (4) | 18. (4) | 19. (1) | 20. (3) |
| 21. (3) | 22. (2) | 23. (1) | 24. (1) | 25. (1) | 26. (2) | 27. (1) | 28. (4) | 29. (4) | 30. (2) |
| 31. (4) | | | | | | | | | |