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Structural Organisation in Animals

Class 11 Notes | CBSE Biology

Chapter 7

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Structural Organisation in Animals Class 11 Notes | CBSE Biology Chapter 7

Structural Organisation in Animals is Chapter 7 of CBSE Class 11 Biology — the chapter that teaches you how billions of cells team up to build a working animal. It starts with the four basic animal tissues, climbs up to organs and organ systems, and then puts it all together using three classic study animals: the earthworm, the cockroach, and the frog.

By the end of these notes you will be able to name every animal tissue and its function, classify epithelial and connective tissues, and recall the organ-system-level morphology and anatomy of the earthworm, cockroach and frog. This is a fact-heavy, high-yield chapter for NEET, and reliably carries marks in your board exam — so getting the labels and locations exact is what wins you the answer.

Table of Contents

- Key Concepts — Animal tissues, organ systems, earthworm, cockroach, frog
 - Weightage in Board & Entrance Exams
 - Important Definitions
 - Solved Examples & NEET Facts
 - Important Questions for Board Exams
 - Quick Revision Points
-

Key Concepts

1. Levels of Organisation

In a multicellular animal, similar cells doing the same job group into a **tissue**; different tissues build an **organ**; and organs working together form an **organ system**. This rising ladder — cells → tissues → organs → organ systems → organism — is called the levels of organisation.

A **tissue** is a group of similar cells along with intercellular substances that perform a specific function. The study of tissues is called **histology**. In animals there are exactly four basic tissue types: epithelial, connective, muscular and neural.

2. Epithelial Tissue

Epithelial tissue (epithelium) is the covering and lining tissue of the body. It has a free surface facing a body fluid or the outside, and its cells sit on a non-cellular **basement membrane**. There is little intercellular material between the tightly packed cells.

Simple Epithelium (single layer)

- **Squamous:** flat, tile-like cells; forms walls of blood vessels and air sacs (alveoli); helps in diffusion and filtration.
- **Cuboidal:** cube-shaped cells; lines ducts of glands and tubules of nephrons; helps in secretion and absorption.
- **Columnar:** tall, pillar-like cells; lines the stomach and intestine; helps in secretion and absorption. With cilia it becomes **ciliated columnar** (lines bronchioles, fallopian tubes — moves particles/mucus).

Compound Epithelium (many layers)

Made of two or more cell layers; mainly gives protection. It covers the dry surface of the skin, the moist lining of the buccal cavity, pharynx, and the inner lining of ducts of salivary glands.

Cell Junctions

- **Tight junctions:** stop substances from leaking across a tissue.
- **Adhering junctions:** cement neighbouring cells to keep them together.
- **Gap junctions:** connect cytoplasm of adjacent cells for rapid transfer of ions and small molecules.

[DIAGRAM: Simple squamous, cuboidal and columnar cells sitting on a basement membrane, each labelled with one function.]

3. Connective Tissue

Connective tissue is the most abundant and widely distributed tissue. Its cells secrete fibres and a **matrix (ground substance)**, and it is the matrix that decides the tissue's properties. Its job is to link and support other tissues and organs.

(a) Loose Connective Tissue

- **Areolar tissue:** found beneath the skin; a support framework for epithelium; contains fibroblasts, macrophages and mast cells.
- **Adipose tissue:** stores fat; located mainly below the skin; acts as a fuel store and insulator.

(b) Dense Connective Tissue

- **Dense regular:** orderly fibres — **tendons** (attach skeletal muscle to bone) and **ligaments** (attach bone to bone).
- **Dense irregular:** fibroblasts and many fibres oriented differently; present in the skin.

(c) Specialised Connective Tissue

- **Cartilage:** solid yet pliable matrix that resists compression; cells are **chondrocytes** in spaces called lacunae; found in tip of nose, outer ear, between adjacent bones of the vertebral column.
- **Bone:** hard, non-pliable matrix rich in calcium salts and collagen; cells are **osteocytes**; provides the framework and protects soft organs; bone marrow makes blood cells.

- **Blood:** a fluid connective tissue with plasma matrix and RBCs, WBCs and platelets; the main circulating fluid for transport of substances.

Note: Cartilage and bone are skeletal tissues; blood is a fluid (vascular) connective tissue.

4. Muscular Tissue

Muscular tissue is made of long cells called **muscle fibres** that contract and relax to produce movement. Each fibre contains many fine fibrils called **myofibrils**. There are three types.

Type	Striations	Control	Location
Skeletal (striated)	Striated, cylindrical, multinucleate	Voluntary	Attached to bones
Smooth (visceral)	Unstriated, spindle-shaped, uninucleate	Involuntary	Walls of stomach, intestine, blood vessels
Cardiac	Striated, branched, with intercalated discs	Involuntary	Wall of the heart

NEET point: Intercalated discs (communication junctions at fusion points) are unique to cardiac muscle and let heart fibres contract as a single unit.

5. Neural Tissue

Neural tissue controls and coordinates the body's activities. Its functional unit is the **neuron**, a cell that can be stimulated and that conducts impulses very rapidly from one place to another.

Supporting **neuroglial cells** protect and hold together the neural tissue (they make up more than half the volume of neural tissue). When a neuron is suitably stimulated, an electrical disturbance — a nerve impulse — travels along its membrane.

6. Organ and Organ System

An **organ** is made of two or more tissues working together for a common function — the stomach, for example, has all four tissue types. An **organ system** is a group of organs that together carry out one major life process, such as digestion or circulation.

As we move from lower to higher animals, the body shows progressive specialisation and division of labour, so the organ systems become more efficient and complex.

7. Earthworm (*Pheretima*) — Morphology & Anatomy

The earthworm is a reddish-brown **terrestrial invertebrate** that lives in moist soil and feeds on decaying organic matter — making it a “farmer’s friend.” Its body is long, cylindrical and divided into about 100–120 **segments (metameres)**.

Morphology

- The dark **dorsal surface** has a mid-dorsal line (dorsal blood vessel); the lighter **ventral surface** bears genital openings.
- The first segment is the **peristomium**, which carries the mouth and overhanging **prostomium** (a sensory wedge that helps push into soil).
- In a mature worm, segments 14–16 carry a glandular band, the **clitellum**, dividing the body into pre-clitellar, clitellar and post-clitellar regions.
- **Setae** (S-shaped bristles) help in locomotion; the male genital pores are on the 18th segment, the single female genital pore on the 14th.

Anatomy (organ-system level)

- **Digestive system:** a straight tube — mouth → buccal cavity → pharynx → oesophagus → muscular gizzard (grinds soil) → stomach → intestine → anus. **Typhlosole** increases the absorptive area of the intestine.
- **Circulatory system:** closed type, with blood vessels and hearts; blood has haemoglobin dissolved in plasma.
- **Excretory system:** segmentally arranged coiled tubules called **nephridia**.
- **Nervous system:** a nerve ring and a double, solid, ventral nerve cord.
- **Reproduction:** earthworms are **hermaphrodite (monoecious)** — each worm has both ovaries and testes — but cross-fertilisation occurs.

[DIAGRAM: External view of *Pheretima* showing prostomium, mouth, clitellum (segments 14–16), male pores on segment 18, and setae.]

8. Cockroach (*Periplaneta americana*) — Morphology & Anatomy

The cockroach is a brown-to-black **insect** with a segmented body divided into three regions — **head, thorax and abdomen** — and a hard chitinous **exoskeleton** made of plates called sclerites joined by an arthrodial membrane.

Morphology

- **Head:** triangular, bears a pair of compound eyes, thread-like antennae and biting-and-chewing mouthparts.
- **Thorax:** three segments (pro-, meso-, metathorax); bears three pairs of walking legs and two pairs of wings (forewings = tegmina, hindwings = membranous).
- **Abdomen:** 10 segments; females have a boat-shaped structure that forms the **ootheca** (egg case); males bear anal styles, females do not.

Anatomy (organ-system level)

- **Digestive system:** mouth → pharynx → oesophagus → crop (stores food) → gizzard/proventriculus (grinds food) → midgut with **hepatic caecae** → ileum, colon, rectum → anus. **Malpighian tubules** at the midgut-hindgut junction handle excretion.
- **Circulatory system: open type;** blood (haemolymph) is colourless and bathes the organs in sinuses; a tubular heart lies along the dorsal mid-line.
- **Respiratory system:** a network of **tracheal tubes** opening out through 10 pairs of **spiracles**; air moves directly to tissues.
- **Nervous system:** a series of segmentally arranged fused ganglia joined by paired nerve cords on the ventral side; if the head is cut off, a cockroach may live for a week.
- **Excretory system:** Malpighian tubules remove nitrogenous waste, mainly as **uric acid (uricotelic)**.

NEET point: Cockroaches are dioecious (sexes separate) and show sexual dimorphism; blood vascular system is open with colourless haemolymph.

9. Frog (*Rana tigrina*) — Morphology & Anatomy

The frog is a cold-blooded (**poikilothermic**) **amphibian** that lives both on land and in water and shows **aestivation** (summer sleep) and **hibernation** (winter sleep). Its moist skin helps it breathe and it changes colour to escape enemies (mimicry/camouflage).

Morphology

- Body divided into **head and trunk** (no neck or tail in the adult); skin is smooth and slippery.
- Forelimbs have 4 digits, hindlimbs 5 webbed digits for swimming; in breeding males the forelimb has a **copulatory pad** on the first digit.
- Males have sound-producing **vocal sacs**; females lack them (sexual dimorphism).

Anatomy (organ-system level)

- **Digestive system:** mouth → buccal cavity → pharynx → oesophagus → stomach → intestine → rectum → cloaca; liver and pancreas pour secretions in; digestion is mostly in the stomach and intestine.
- **Respiration:** through moist **skin (cutaneous)** in water, and through **lungs (pulmonary)** on land; also through the buccal cavity.
- **Circulatory system: closed;** heart has **three chambers** — two atria and one ventricle; RBCs are nucleated; lymphatic system also present.
- **Excretory system:** a pair of **kidneys (mesonephric)**; frog is **ureotelic**, excreting urea.
- **Nervous & sensory system:** brain, spinal cord and nerves; the brain has forebrain, midbrain and hindbrain; sense organs include eyes, internal ears (tympanum) and taste/smell receptors.
- **Reproduction:** sexes are separate (dioecious); fertilisation is **external** in water; development is indirect through a **tadpole** larva (metamorphosis).

[DIAGRAM: Three-chambered frog heart — left and right atria above, single ventricle below — and webbed hindlimb.]

Weightage in Board & Entrance Exams

Exam	Typical Weightage	Most-Tested Areas
CBSE Board (Class 11)	4–6 marks (Unit: Structural Organisation)	Animal tissues, frog organ systems, definitions
NEET	2–3 questions	Tissue types, cockroach digestive/excretory facts, earthworm setae & pores, frog heart
State CETs	1–2 questions	Epithelium classification, muscle types, hermaphrodite vs dioecious

[TABLE: Question-type split — VSA (1 mark): one-word tissue/animal facts; SA (2–3 marks): differences (tendon vs ligament, striated vs unstriated, open vs closed circulation); LA (5 marks): epithelial classification with examples, frog/earthworm organ systems.]

Important Definitions

Term	Definition
Tissue	A group of similar cells with intercellular material performing a specific function
Epithelial tissue	Covering/lining tissue resting on a basement membrane with a free surface
Connective tissue	Tissue that links and supports other tissues; cells embedded in a matrix
Tendon	Dense regular connective tissue attaching skeletal muscle to bone
Ligament	Dense regular connective tissue attaching bone to bone
Neuron	The structural and functional unit of neural tissue that conducts impulses
Clitellum	Glandular band on segments 14–16 of an earthworm, involved in reproduction
Nephridia	Segmental coiled excretory tubules of the earthworm
Malpighian tubules	Excretory organs of the cockroach removing uric acid
Ureotelic	Excreting nitrogenous waste mainly as urea (as in the frog)

Solved Examples & NEET Facts

Example 1

Name the tissue that forms the lining of blood vessels and air sacs, and state why it suits the job.

Answer: Simple squamous epithelium. Its flat, thin cells allow easy diffusion and filtration, ideal for gas exchange in alveoli and for vessel walls.

Example 2

Differentiate between tendon and ligament.

Answer: A tendon joins skeletal muscle to bone; a **ligament** joins bone to bone. Both are dense regular connective tissue, but ligaments are more elastic.

Example 3

Which muscle is branched, striated and involuntary, and where is it found?

Answer: Cardiac muscle, found only in the wall of the heart; its branched fibres are joined by intercalated discs.

Example 4

On which segment of the earthworm are the male genital pores located, and what is the clitellum's segment range?

Answer: Male genital pores are on the **18th segment**; the **clitellum** covers segments **14–16**.

Example 5

State the type of circulatory system in the cockroach and the colour of its blood.

Answer: The cockroach has an **open circulatory system**; its blood (haemolymph) is **colourless** as it carries no respiratory pigment.

Example 6

How many chambers does a frog's heart have, and what is the frog's mode of nitrogenous excretion?

Answer: The frog's heart has **three chambers** (two atria, one ventricle). The frog is **ureotelic**, excreting urea through a pair of kidneys.

Important Questions for Board Exams

1-Mark Questions (VSA)

1. Name the four basic types of animal tissues.
2. What is the functional unit of neural tissue?
3. Which excretory organs are found in a cockroach?
4. Why is the earthworm called a hermaphrodite?
5. Name the structure that grinds food in the earthworm.

2–3-Mark Questions (SA)

1. Distinguish between simple and compound epithelium with one example each.
2. Differentiate between striated, unstriated and cardiac muscle.
3. Describe the digestive system of the cockroach up to the midgut.
4. Compare open and closed circulatory systems using the cockroach and the frog.

5-Mark Questions (LA)

1. Classify connective tissue and give one example and one function of each major type.
 2. Describe the external morphology of the earthworm, naming the prostomium, clitellum, setae and genital pores.
 3. Explain the organ systems of the frog (digestive, respiratory, circulatory and excretory) at the system level.
-

Quick Revision Points

- Four animal tissues: epithelial, connective, muscular, neural
 - Epithelium: simple (squamous, cuboidal, columnar, ciliated) and compound; rests on a basement membrane
 - Connective tissue types: loose (areolar, adipose), dense (tendon, ligament), specialised (cartilage, bone, blood)
 - Muscles: skeletal (voluntary, striated), smooth (involuntary, unstriated), cardiac (involuntary, striated, intercalated discs)
 - Earthworm: clitellum on segments 14–16, male pores on 18th, gizzard grinds, nephridia excrete, hermaphrodite
 - Cockroach: open circulation, colourless haemolymph, tracheal respiration via spiracles, Malpighian tubules, uricotelic, dioecious
 - Frog: poikilothermic amphibian, 3-chambered heart, cutaneous + pulmonary respiration, ureotelic, external fertilisation, tadpole larva
 - Tendon = muscle to bone; Ligament = bone to bone
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Next Chapter: Chapter 8 — Cell: The Unit of Life



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