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Biology Class 9 — Punjab Board (PECTAA)

CHAPTER 5

Tissues, Organs and Organ Systems

Key Concepts · Definitions · Short & Long Questions · MCQs · Diagrams · Exam Tips

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Chapter 5: Tissues, Organs and Organ Systems

Chapter 5 explains how a multicellular organism is built in layers. Cells with the same job form tissues, different tissues work together in an organ, organs form organ systems, and systems together make the whole organism. Each new level has abilities that the level below it does not have on its own.

The notes use two worked examples, the leaf of a plant and the human stomach, to show how several tissues combine in one organ. They then describe the root and shoot systems of plants, the main human organ systems, and homeostasis: how the systems keep the internal environment steady.

Learning Objectives

- List the levels of organisation from atom to organism and explain emergent properties.
- Describe the tissues of a leaf and relate each to its function.
- Describe the root and shoot systems of a plant.
- Describe the tissues in the wall of the stomach and their roles.
- Name the main human organ systems and state the role of each.
- Explain homeostasis with examples of organ systems working together.

Key Concepts

5.1 Levels of Organisation

Living things are organised in a hierarchy. Atoms join to form molecules, such as water and proteins; molecules make up organelles; organelles work together in a cell, the basic unit of life. In multicellular organisms, similar cells working together form a tissue; two or more tissues combine in an organ; organs that cooperate for one main function make an organ system; and all the systems together make the organism.

At every level new characteristics appear that are not present in the parts alone. These are called emergent properties. A single heart muscle cell can contract, but only the whole heart, with muscle, nerve and connective tissues together, can pump blood around the body.

5.2 Plant Organs: The Leaf

The main organs of a flowering plant are roots, stems and leaves (vegetative organs) and flowers, fruits and seeds (reproductive organs). The leaf is the main site of photosynthesis, and its structure shows how different tissues share the work.

The upper and lower epidermis are single layers of cells that protect the leaf. They secrete a waxy cuticle that reduces water loss. The lower epidermis has many stomata, each surrounded by two guard cells that open and close the pore to control gas exchange and transpiration.

The mesophyll lies between the two epidermal layers. Palisade mesophyll, just below the upper epidermis, has tall, closely packed cells full of chloroplasts, so most photosynthesis happens here.

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Spongy mesophyll, below it, has loosely arranged cells with air spaces that allow carbon dioxide and oxygen to diffuse.

Veins run through the mesophyll. Each contains xylem, which brings water and minerals from the root, and phloem, which carries the sugar made in the leaf to other parts of the plant.

5.2 Plant Organ Systems

A flowering plant has two organ systems. The root system lies mostly underground and anchors the plant, absorbs water and minerals and, in plants such as carrot and radish, stores food.

The shoot system lies above ground and is made of the stem, leaves, buds, flowers and fruits. The stem supports the leaves and carries materials between root and leaves, the leaves make food, and the flowers, fruits and seeds carry out reproduction.

5.3 Animal Organs: The Stomach

Major human organs include the brain, heart, lungs, stomach, liver, kidneys and skin. The stomach, a muscular J-shaped bag in the upper left abdomen, stores food, churns it and begins the digestion of proteins. Its wall contains four kinds of tissue.

The innermost layer is epithelial tissue. It forms gastric glands that secrete hydrochloric acid, which kills microbes and activates enzymes, and pepsinogen, which becomes the protein-digesting enzyme pepsin. Other cells secrete mucus, which protects the stomach wall from its own acid.

Beneath the epithelium is connective tissue carrying blood vessels and nerves. Then come three layers of smooth muscle (arranged in different directions) whose contractions churn food and mix it with gastric juice. A thin outer layer of connective tissue covers and protects the stomach.

5.3 Human Organ Systems

The digestive system (mouth, oesophagus, stomach, intestines, liver, pancreas) breaks food down and absorbs nutrients. The respiratory system (nose, trachea, lungs) takes in oxygen and removes carbon dioxide. The circulatory system (heart, blood, blood vessels) transports materials. The excretory system (kidneys, ureters, bladder) removes nitrogenous wastes and balances water and salts.

The nervous system (brain, spinal cord, nerves) detects changes and coordinates rapid responses, while the endocrine system (glands such as pancreas, thyroid and adrenals) controls slower processes with hormones. The skeletal and muscular systems give support and movement, the integumentary system (skin, hair, nails) protects the body, the immune system defends against disease, and the reproductive system produces offspring.

5.4 Homeostasis

Homeostasis is the maintenance of a steady internal environment, for example a constant body temperature, blood glucose level and water content, despite changes outside. No single system can do this alone; several systems work together.

Temperature: when the body heats up, the nervous system triggers sweating from the skin and wider blood vessels near the surface, so heat is lost; in cold, muscles shiver to produce heat and

skin vessels narrow. Blood glucose: after a meal the pancreas releases insulin, which makes the liver and muscles take up glucose. Exercise: muscles need more oxygen, so the breathing rate and heart rate rise together to deliver it and remove carbon dioxide.

Important Definitions

Tissue
A group of similar cells that work together to perform a particular function.

Organ
A structure made of two or more tissues that work together to perform specific functions.

Organ system
A group of organs working together to perform a major function of the body.

Emergent property
A new characteristic that appears at a higher level of organisation and is absent in the separate parts.

Cuticle
A waxy layer on the epidermis of a leaf that reduces water loss.

Guard cells
A pair of bean-shaped cells that surround a stoma and control its opening and closing.

Stomata
Small pores, mainly in the lower epidermis of leaves, for gas exchange and transpiration.

Palisade mesophyll
Tall, tightly packed, chloroplast-rich cells below the upper epidermis where most photosynthesis occurs.

Spongy mesophyll
Loosely packed leaf cells with air spaces that allow gases to diffuse.

Xylem
Vascular tissue that carries water and minerals upward from the roots.

Phloem
Vascular tissue that carries food made in the leaves to other parts of the plant.

Root system
The underground part of a plant that anchors it, absorbs water and minerals and may store food.

Shoot system

The above-ground part of a plant: stem, leaves, buds, flowers and fruits.

Gastric glands
Glands in the stomach lining that secrete hydrochloric acid, pepsinogen and mucus.

Pepsin
A protein-digesting enzyme formed in the stomach from pepsinogen.

Smooth muscle
Involuntary muscle found in the walls of internal organs such as the stomach.

Homeostasis
The maintenance of a stable internal environment in the body.

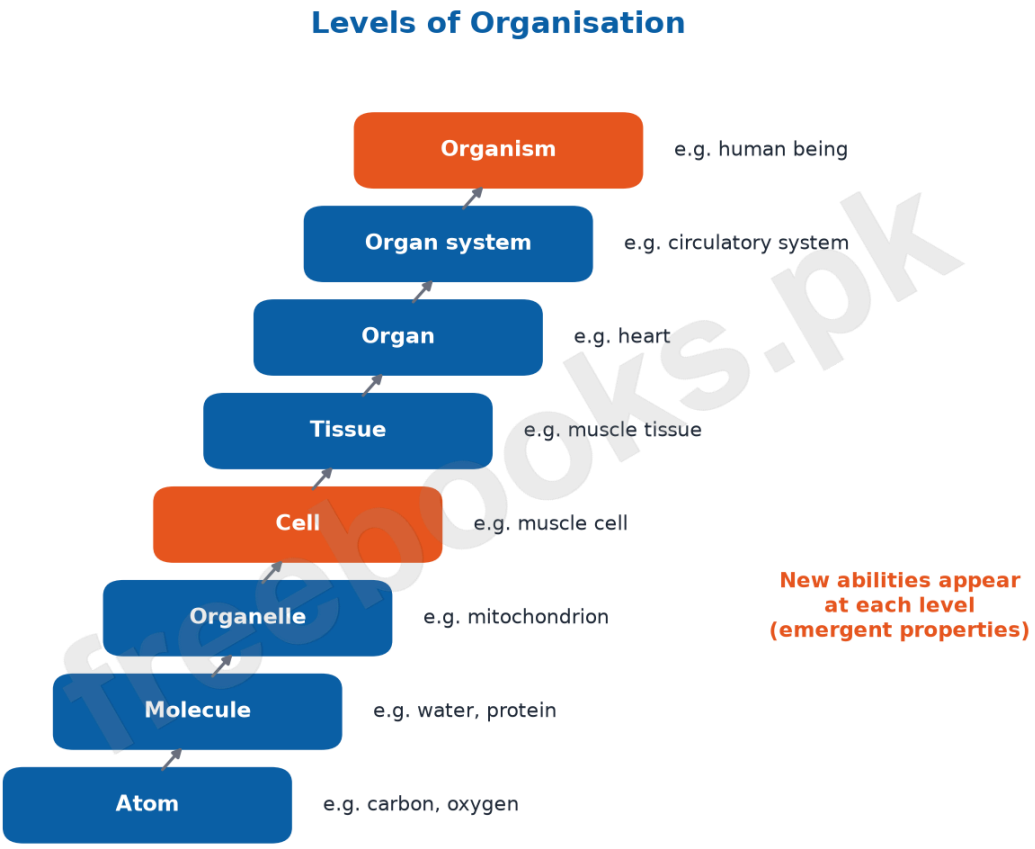
Insulin
A hormone from the pancreas that lowers blood glucose by helping cells take it up.

Key Facts at a Glance

Organ system	Main organs → main role
Digestive	Stomach, intestines, liver → digest food, absorb nutrients
Respiratory	Trachea, lungs → take in O2, remove CO2
Circulatory	Heart, blood vessels → transport materials
Excretory	Kidneys, bladder → remove wastes, balance water
Nervous	Brain, spinal cord, nerves → fast coordination
Endocrine	Pancreas, thyroid → hormones, slow control
Skeletal + Muscular	Bones, muscles → support, movement
Integumentary	Skin, hair, nails → protection
Immune	White blood cells, lymph nodes → defence
Reproductive	Testes / ovaries → produce offspring
Plant root system	Roots → anchor, absorb, store
Plant shoot system	Stem, leaves, flowers → support, food, reproduction

Diagrams

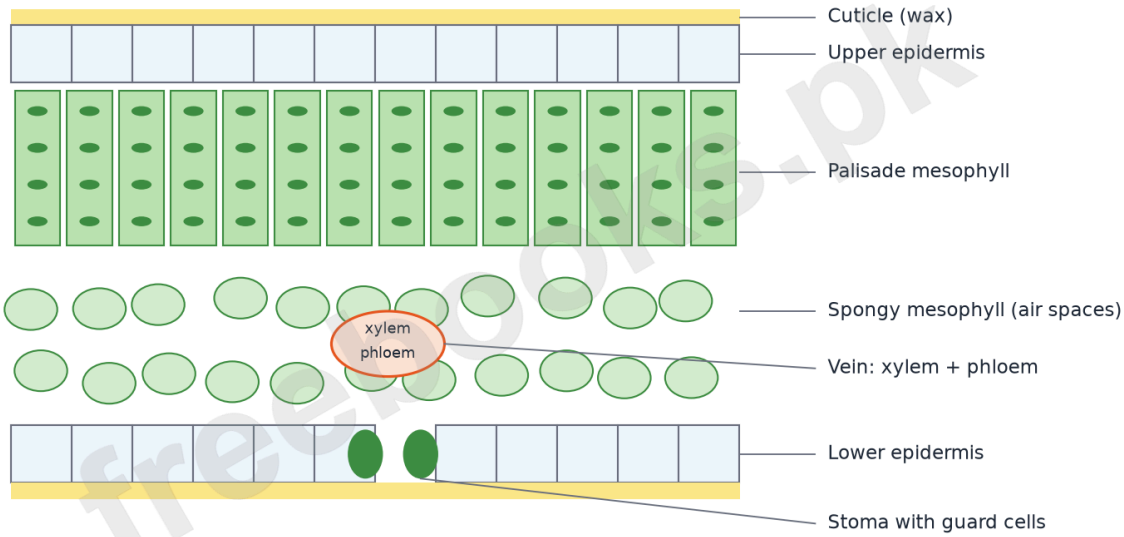
Levels of organisation: A ladder from atom to organism with a human example at each level.



Tissues of a leaf: A simplified section of a leaf showing cuticle, epidermis, palisade and spongy mesophyll, vein and stoma.

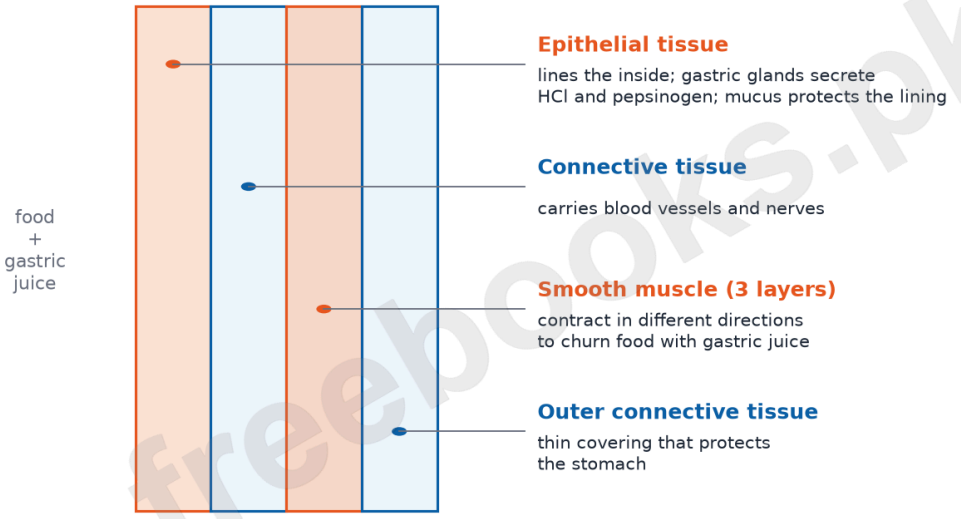
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Simplified Section of a Leaf



Tissues of the stomach wall: The four layers of the stomach wall from inside to outside with the job of each.

Tissues of the Stomach Wall (inside → outside)



Short Questions and Answers

Why is a cell called the basic unit of life?

Because it is the smallest level of organisation that shows all the characteristics of life; molecules

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and organelles alone are not alive.

Give an example of an emergent property.
Individual heart muscle cells can contract, but only the whole heart, with its muscle, nerve and connective tissues, can pump blood.

Why are most stomata found in the lower epidermis?
The lower surface is shaded and cooler, so less water is lost by transpiration when the stomata are open.

Why is palisade mesophyll the main site of photosynthesis?
It lies just under the upper surface where light is strongest, and its tall cells are packed with chloroplasts.

What is the role of air spaces in spongy mesophyll?
They let carbon dioxide reach the photosynthesising cells and let oxygen and water vapour move out through the stomata.

Name the two transport tissues in a leaf vein and their roles.
Xylem brings water and minerals into the leaf; phloem carries sugars made in the leaf to the rest of the plant.

State two functions of the root system.
It anchors the plant in the soil and absorbs water and minerals; in some plants it also stores food.

Why does the stomach not digest its own wall?
Mucus secreted by epithelial cells covers the lining and protects it from acid and pepsin.

What are the two main secretions of gastric glands and their roles?
Hydrochloric acid kills microbes and provides acidic conditions; pepsinogen is converted into pepsin, which digests proteins.

What is the job of smooth muscle in the stomach wall?
Its three layers contract in different directions to churn food and mix it with gastric juice.

How does the nervous system differ from the endocrine system?
The nervous system sends rapid electrical signals through nerves, while the endocrine system releases hormones into the blood for slower, longer-lasting control.

What happens to body temperature control on a hot day?
The skin produces sweat, which cools the body as it evaporates, and blood vessels near the skin widen to release heat.

How does insulin keep blood glucose steady?
After a meal the pancreas releases insulin, which makes liver and muscle cells take up glucose,

lowering its level in the blood.

Long Questions and Answers

Explain the levels of organisation in a multicellular organism.

What are the chemical and cellular levels?

Atoms combine to form molecules such as water, glucose and proteins. Molecules build organelles such as mitochondria and ribosomes, and organelles together form a cell, the basic unit of life.

What are tissues and organs?

A tissue is a group of similar cells doing one job, such as muscle tissue. An organ, such as the stomach or a leaf, is made of two or more tissues working together.

What are organ systems and the organism?

Organs that work together for one major function form an organ system, such as the digestive system. All the organ systems together make the complete organism.

What are emergent properties?

At each level new abilities appear that the separate parts do not have; for example, the coordinated pumping of the heart emerges only when its tissues work together.

Describe the leaf as an organ made of different tissues.

What protects the leaf?

The upper and lower epidermis protect the inner tissues. They secrete a waxy cuticle that reduces water loss.

How are gases exchanged?

Stomata, mostly in the lower epidermis, allow carbon dioxide in and oxygen and water vapour out. Each stoma is controlled by two guard cells.

Where does photosynthesis take place?

Mainly in the palisade mesophyll, whose tall, tightly packed cells are full of chloroplasts. The spongy mesophyll, with its air spaces, helps gases diffuse to these cells.

How are materials transported?

Veins containing xylem bring water and minerals to the leaf, and phloem carries the sugars made in photosynthesis to other parts of the plant.

Describe the tissues of the stomach and the role of each.

What is the stomach and what does it do?

The stomach is a muscular J-shaped organ in the upper left abdomen. It stores food, churns it and starts the digestion of proteins.

What is the role of the epithelial tissue?

It lines the stomach and forms gastric glands that secrete hydrochloric acid and pepsinogen, while mucus-secreting cells protect the lining.

What are the roles of connective tissue and muscle?

Connective tissue under the epithelium carries blood vessels and nerves. Three layers of smooth muscle contract to churn food and mix it with gastric juice.

What covers the outside of the stomach?

A thin outer layer of connective tissue covers and protects the stomach and attaches it to surrounding structures.

Explain how organ systems work together to maintain homeostasis.

What is homeostasis?

It is the keeping of a stable internal environment, such as steady temperature, blood glucose and water balance, even when conditions outside change.

How is body temperature controlled?

When the body is hot, the nervous system causes sweating and widening of skin blood vessels so heat is lost. When cold, muscles shiver to produce heat and skin vessels narrow to conserve it.

How is blood glucose controlled?

After a meal blood glucose rises; the pancreas (endocrine system) releases insulin, which makes the liver and muscles take up and store glucose.

How do systems cooperate during exercise?

Working muscles need more oxygen and produce more carbon dioxide, so the respiratory system speeds up breathing and the circulatory system raises the heart rate to supply oxygen and remove wastes.

Multiple Choice Questions (MCQs)

Which sequence is correct? (A) Cell → organ → tissue → system (B) Cell → tissue → organ → organ system (C) Tissue → cell → organ → system (D) Organ → tissue → cell → system

Correct answer: (B) Cell → tissue → organ → organ system. Cells form tissues, tissues form organs, organs form systems.

Most photosynthesis in a leaf occurs in the: (A) Upper epidermis (B) Palisade mesophyll (C) Spongy mesophyll (D) Phloem

Correct answer: (B) Palisade mesophyll. Palisade cells are packed with chloroplasts.

The waxy cuticle mainly helps to: (A) Absorb light (B) Reduce water loss (C) Make food (D) Transport sugar

Correct answer: (B) Reduce water loss. Wax prevents evaporation.

Stomata are opened and closed by: (A) Palisade cells (B) Guard cells (C) Xylem vessels (D) Root hairs
Correct answer: (B) Guard cells. Guard cells control the pore.

Sugar made in the leaf is carried by: (A) Xylem (B) Phloem (C) Cuticle (D) Stomata
Correct answer: (B) Phloem. Phloem transports food.

Which of these belongs to the shoot system? (A) Root hair (B) Tap root (C) Flower (D) Root cap
Correct answer: (C) Flower. Flowers are part of the above-ground shoot.

A carrot stores food in its: (A) Leaf (B) Stem (C) Root (D) Flower
Correct answer: (C) Root. The carrot is a swollen storage root.

The stomach lining is protected from its own acid by: (A) Pepsin (B) Mucus (C) Insulin (D) Bile
Correct answer: (B) Mucus. Mucus forms a protective layer.

Pepsinogen is converted into: (A) Insulin (B) Pepsin (C) Mucus (D) Glucose
Correct answer: (B) Pepsin. Pepsin digests proteins.

Churning of food in the stomach is done by: (A) Epithelial tissue (B) Smooth muscle (C) Nervous tissue (D) Bone
Correct answer: (B) Smooth muscle. Three layers of smooth muscle churn the food.

Which system removes nitrogenous waste? (A) Respiratory (B) Excretory (C) Digestive (D) Skeletal
Correct answer: (B) Excretory. The kidneys remove urea in urine.

Hormones are produced by the: (A) Nervous system (B) Endocrine system (C) Integumentary system (D) Skeletal system
Correct answer: (B) Endocrine system. Endocrine glands secrete hormones.

Shivering on a cold day is an example of: (A) Digestion (B) Homeostasis (C) Excretion (D) Reproduction
Correct answer: (B) Homeostasis. It produces heat to keep body temperature steady.

After a meal, which hormone lowers blood glucose? (A) Adrenaline (B) Insulin (C) Thyroxine (D) Pepsin
Correct answer: (B) Insulin. Insulin promotes glucose uptake.

Quick Revision Summary

- Atom → molecule → organelle → cell → tissue → organ → organ system → organism. New abilities appear at each level (emergent properties).
- Leaf = organ: epidermis + cuticle (protection), guard cells/stomata (gas exchange), palisade (most photosynthesis), spongy (air spaces), veins (xylem water, phloem food).
- Plant organ systems: root system (anchor, absorb, store) and shoot system (stem, leaves, flowers, fruits).
- Stomach wall: epithelium (HCl, pepsinogen, mucus) → connective tissue → three smooth muscle layers → outer connective tissue.
- Human systems: digestive, respiratory, circulatory, excretory, nervous, endocrine, skeletal, muscular, integumentary, immune, reproductive.
- Homeostasis = steady internal environment; examples: sweating/shivering, insulin after a meal, faster breathing and heartbeat during exercise.

Exam Tips

- Learn the levels of organisation in order; a jumbled sequence is a favourite MCQ trap.
- When describing an organ, always name the tissue first and then link it to its job (structure → function).
- Draw and label a simple leaf section: cuticle, upper epidermis, palisade, spongy mesophyll, vein, lower epidermis, stoma, guard cells.
- For the stomach, list the layers from inside to outside; examiners often ask which layer secretes acid or mucus.
- In homeostasis answers, name the organ systems involved and what each one does, not just the change.

Note on Facts

The textbook lists the stomach wall as epithelial tissue, connective tissue, muscle and an outer connective layer. Standard anatomy names these layers mucosa, submucosa, muscularis externa (three smooth muscle layers) and serosa; the descriptions match, only the names differ.

The textbook describes six human organ systems (skeletal, digestive, respiratory, muscular, nervous and blood circulatory) as examples. These notes also mention the excretory, endocrine, integumentary, immune and reproductive systems for completeness; for exam answers, the six in the textbook are the core list.