

CLASS 9 SCIENCE

Chapter 3 Notes

Tissues in Action

Chapter focus

A tissue is a group of cells working together for a specific function. This chapter connects cell specialisation with plant growth, protection, support and transport; animal protection, connection, movement and coordination; and the working of joints and the skeletal system.

1. From Cells to Tissues

- In multicellular organisms, similar cells performing similar functions group together to form tissues.
- More than one type of tissue forms an organ; organs form organ systems; organ systems form an organism.
- Division of labour among tissues increases efficiency and allows complex life processes.

Hierarchy of organisation

Cell → Tissue → Organ → Organ system → Organism

- Examples: muscle tissue enables movement; nervous tissue carries messages; xylem transports water and minerals; phloem transports food.

2. Why Plant and Animal Tissues Differ

Plants	Animals
Usually fixed in one place; need strong support.	Generally capable of locomotion; cells lack a rigid cell wall and are more flexible.
Have tissues associated with photosynthesis.	Have tissues involved in obtaining and digesting food.
Growth occurs in specialised growing regions.	Growth and movement require different specialised tissues.
Have specialised tissues for transport of water and food.	Have specialised tissues for transport, protection, movement and coordination.

3. Meristematic Tissues - Tissues for Plant Growth

- Meristematic tissue consists of actively dividing cells.
- Its cells are small, thin-walled, tightly packed, with dense cytoplasm and a large prominent nucleus.
- Vacuoles are generally absent and there is little or no intercellular space.

Type	Location	Function
Apical meristem	Tips of roots and shoots	Increase in length.
Lateral meristem	Along the circumference of stems	Increase in girth or diameter.
Intercalary meristem	Base of internode or just above a node, especially in grasses	Regrowth after cutting/grazing and contribution to branching.

Onion-root experiment

Roots with intact tips continue to grow. When the root tips are cut, growth stops. This demonstrates that actively dividing cells at root tips form the apical meristem.

- Annual growth rings in tree trunks reflect growth over successive years and can help estimate age and past growth conditions.

4. Differentiation and Permanent Tissues

- Some newly formed meristematic cells lose the ability to divide and become specialised.
- The process by which cells change in structure and function to become specialised is called differentiation.
- Permanent tissues may be simple (one type of cell) or complex (more than one type of cell).

5. Protective Tissue - Epidermis

- The epidermis is the outermost protective layer of the plant body.
- Its tightly packed cells protect against mechanical injury, water loss, harmful microorganisms and harsh environmental conditions.
- A waxy cuticle made of cutin reduces water loss; it may be especially thick in plants of dry habitats.
- Root hairs increase the surface area for absorption of water and minerals.
- Stomata in leaves allow gaseous exchange and transpiration.

Transpiration

Evaporation of water vapour through stomata contributes to transpiration pull in xylem and also helps eliminate some wastes.

6. Simple Permanent / Supporting Tissues

Tissue	Structure	Main functions / examples
Parenchyma	Living, thin-walled, loosely packed cells with intercellular spaces	Food storage; photosynthesis in green parts; air spaces in aquatic plants help floating.
Collenchyma	Living cells with unevenly thickened corners due to pectin	Support and flexibility; allows stems and tendrils to bend without breaking.
Sclerenchyma	Mostly dead cells with thick lignified walls	Hardness and strength; found in stems, leaf veins, coconut husk, walnut shell and seed coverings.

7. Complex Permanent / Conducting Tissues

Xylem	Phloem
Transports water and minerals from roots to other plant parts.	Transports food from leaves to other plant parts.
Also provides mechanical strength.	Mostly made of living cells.
Components: tracheids, vessels, xylem parenchyma and xylem fibres.	Components: sieve tubes, companion cells, phloem parenchyma and phloem fibres.
Xylem parenchyma is the living component.	Companion cells regulate loading and unloading of sugars in sieve tubes.

- Phloem parenchyma stores food materials and substances such as resin, tannins and latex.
- Phloem fibres provide strength.

8. Plant Tissue Systems

System	Main role
Dermal tissue system	Forms the outer covering; protects inner parts and reduces water loss.
Ground tissue system	Forms much of the plant body between dermal and conducting tissues; includes parenchyma, collenchyma and sclerenchyma.
Vascular tissue system	Contains conducting tissues - xylem and phloem.

Older stems

As plants age, cells below the epidermis can form cork cambium. Cork cells are dead, compactly arranged and impermeable to water and gases, contributing to bark.

9. Animal Tissues - Four Main Types

- Epithelial tissue: covering and lining; protection, exchange, secretion, sensory functions and absorption.
- Connective tissue: connects, supports and transports.
- Muscular tissue: produces voluntary and involuntary movement.
- Nervous tissue: receives, processes and transmits messages and coordinates body activities.

10. Epithelial Tissue

Function	Structural adaptation	Examples / location
Exchange	Single layer of thin, flat cells	Blood vessels and lungs.
Protection	Many layers; outer cells flat and tightly packed	Skin, mouth and oesophagus.
Secretion	Cells specialised to produce and release substances; may be cuboidal or columnar	Salivary glands, sweat glands and stomach lining.
Sensory functions	Specialised receptor cells, including cells with hair-like structures	Nostrils, taste buds and inner ear.
Absorption	Single layer of tall pillar-like cells, often with hair-like structures	Lining of small intestine.

11. Connective Tissues

- Connective tissue connects and supports other tissues. Its properties depend greatly on its matrix.

Tissue	Important feature / function
Blood	Fluid connective tissue; transports nutrients, gases and hormones.
Bone	Hard matrix containing calcium and phosphorus compounds; gives strength, support and protection.
Cartilage	Soft, jelly-like matrix; provides flexibility and cushions bone ends.
Tendon	Connects muscle to bone and transmits pulling force for movement.
Ligament	Connects bone to bone; stabilises joints, limits excessive movement and helps prevent dislocation.

Blood Components

- RBCs contain iron-rich haemoglobin, which gives blood its red colour; the RBCs live for about four months.
- Platelets help blood clot at an injury.
- WBCs collect at infected areas and contribute to inflammation and pus formation.
- During exercise, increased oxygen demand is accompanied by faster breathing and increased blood flow.

12. Muscular Tissue

Muscle type	Structure	Control / function
Skeletal muscle	Long cylindrical, unbranched, multinucleate, striated fibres	Voluntary movement; attached to skeleton.
Smooth muscle	Spindle-shaped cells, one nucleus, no striations	Involuntary, slow continuous movements; e.g., stomach and intestine.
Cardiac muscle	Cylindrical, branched fibres, single nucleus, faint striations	Involuntary rhythmic contraction of the heart; works continuously.

13. Nervous Tissue

- Nervous tissue forms the body's control and coordination network.
- Neurons are specialised to receive, process and transmit messages.

Neuron part	Function
Cell body	Contains nucleus and controls cell activities.
Dendrites	Receive signals from other neurons.
Axon	Long fibre carrying messages away from the cell body.
Axon terminals	Transmit messages to other cells.

- The brain coordinates activities, memory and responses; muscles act under instructions from nervous tissue.

14. Musculoskeletal System

- The musculoskeletal system includes bones, muscles, joints, cartilage, tendons and ligaments.
- It helps us stand upright, move, maintain posture and protect delicate organs.
- Muscles pull on bones; tendons transmit muscle force to bones, producing movement at joints.
- The nervous system controls and coordinates these movements.

Body mass

The adult human skeleton is stated to make up about 12-15% of body weight. The activity also gives approximate adult muscle percentages of 40-50% for males and 30-40% for females, while noting that these values vary.

15. Types of Joints

Joint	Movement / example
Ball and socket	Movement forwards, backwards, sideways and circularly; shoulder.
Hinge	Movement mainly in one direction; elbow and knee.
Pivot	Side-to-side turning; skull connected to backbone at the neck.
Fixed	No movement; bones of the skull.

16. Skeletal System

- The skeleton is a framework of bones that gives strength, support and protection.
- The vertebral column is made of vertebrae; cartilage discs between vertebrae cushion them and allow flexibility.
- Humans have 12 pairs of ribs forming the rib cage.
- The rib cage protects the heart and lungs and can expand and contract during breathing because ribs are connected with flexible cartilage.
- Correct posture, proper nutrition, regular exercise and yoga support healthy bones, muscles and joints.

17. Totipotency and Plant Tissue Culture

- In 1958, F. C. Steward demonstrated regeneration of a complete carrot plant from cultured phloem cells.
- The cultured mature cells first regained the ability to divide (dedifferentiation), formed an unspecialised mass and later redifferentiated into roots, shoots and a complete plant.

Totipotency

The ability of some mature plant cells to undifferentiate, divide and redifferentiate to form a complete plant under suitable conditions is called totipotency.

- Learn here the plant tissue culture work of Sipra Guha Mukherjee and S. C. Maheshwari, including development of a complete plant through anther culture.

18. Science and Society Connections

- Crown gall disease causes tumour-like swellings due to rapid, uncontrolled cell division and is caused by *Agrobacterium tumefaciens*.
- Knowledge of how *Agrobacterium* transfers genetic material into plant cells has been used in plant tissue culture and genetic engineering.
- The notes applications such as useful gene introduction, valuable phytochemicals, improved crops and disease-resistant varieties.
- Bone marrow contains stem cells that can divide and make new cells; the bone marrow transplantation in blood cancers such as leukemia and disorders such as thalassemia.
- Yoga is linked with flexibility, posture, breathing, stress reduction and well-being; 21 June is observed as International Yoga Day.

19. Quick Comparison Tables

Meristematic tissue	Permanent tissue
Cells actively divide.	Cells are specialised and generally lose the ability to divide.
Small cells, thin walls, dense cytoplasm, prominent nucleus.	Structure varies according to function.
Vacuoles generally absent; little/no intercellular space.	May perform protection, support, storage or conduction.
Tendon	Ligament
Connects muscle to bone.	Connects bone to bone.
Transmits force to produce movement.	Provides joint stability and limits excessive movement.

20. Key Terms

Term	Meaning
Tissue	Group of cells working together to perform a specific function.
Meristem	Plant tissue of actively dividing cells.
Differentiation	Process by which cells become structurally and functionally specialised.
Epidermis	Outermost protective tissue of a plant.
Cuticle	Waxy cutin layer over epidermal cells.
Stomata	Epidermal pores involved in gaseous exchange and transpiration.
Xylem	Complex tissue transporting water and minerals.
Phloem	Complex tissue transporting food.
Matrix	Material surrounding cells in connective tissue; its nature helps determine tissue properties.
Neuron	Nerve cell specialised for receiving and transmitting messages.
Joint	Junction between two or more bones.
Totipotency	Ability of certain plant cells to regenerate a complete plant under suitable conditions.

21. Common Misconceptions

Misconception	Correct idea
Plant growth occurs only at root and shoot tips.	Apical, lateral and intercalary meristems contribute to different kinds of growth.
Xylem and phloem are simple tissues.	They are complex permanent tissues made of more than one type of cell.
Tendons connect bone to bone.	Tendons connect muscle to bone; ligaments connect bone to bone.
All muscles are under conscious control.	Skeletal muscles are voluntary; smooth and cardiac muscles perform involuntary movements.
All joints allow movement.	Fixed joints, such as those between skull bones, do not allow movement.
Permanent plant cells can never regain division ability.	The totipotency section describes dedifferentiation of some mature plant cells under suitable conditions.

22. Exam-Oriented Self-Check Questions

1. Define tissue. Why is division of labour important in multicellular organisms?
2. Why are plant and animal tissues different?
3. Compare apical, lateral and intercalary meristems.
4. State the structural features of meristematic cells.
5. What is differentiation? How are permanent tissues formed?
6. Explain the protective role of epidermis, cuticle, root hairs and stomata.
7. Differentiate parenchyma, collenchyma and sclerenchyma.
8. Compare xylem and phloem and name their components.
9. What are the three tissue systems in plants?
10. List the major functions of epithelial tissue with suitable locations.
11. Why are blood and bone both called connective tissues despite their different consistency?
12. Differentiate tendon and ligament.
13. Compare skeletal, smooth and cardiac muscles.
14. Draw or describe the main parts of a neuron and state their functions.
15. How do muscles, bones, tendons, joints and the nervous system work together to produce movement?
16. Differentiate ball-and-socket, hinge, pivot and fixed joints with examples.
17. State the roles of the vertebral column and rib cage.
18. What is totipotency? Explain F. C. Steward's carrot-cell experiment in brief.
19. How did the study of crown gall disease contribute to biotechnology?
20. Why does a sugarcane cutting containing a suitable growth region regenerate more successfully than one without it?

One-Minute Chapter Summary

Revision paragraph

Tissues are specialised groups of cells that create division of labour in multicellular organisms. Plant growth depends on apical, lateral and intercalary meristems. Differentiated permanent tissues include protective epidermis, simple supporting tissues - parenchyma, collenchyma and sclerenchyma - and complex conducting tissues, xylem and phloem. Animal tissues are epithelial, connective, muscular and nervous. Bones, cartilage, tendons and ligaments support and connect the body; skeletal, smooth and cardiac muscles produce different movements; neurons coordinate responses. The musculoskeletal system works through coordinated action of muscles, bones, joints and nervous control. The chapter also introduces plant-cell totipotency, tissue culture and applications of biological knowledge in agriculture and health.

Prepared for student-friendly learning and revision | Tiwari Academy