CHAPTER 6: TISSUES

CBSE CLASS 9 SCIENCE • COMPREHENSIVE EXAM-ORIENTED STUDY MANUAL

1. Introduction to Tissues

In multicellular organisms, millions of individual cells work together in a coordinated manner. Instead of every cell performing all tasks, there is a clear **division of labour**. Cells specializing in a particular function are grouped together at specific locations in the body. This structural arrangement is known as a tissue.

Definition: A tissue is a organized collection of morphologically similar cells that share a common embryonic origin and work together to execute a specific physiological function.

Significance of Tissue Differentiation:

- Establishes an efficient division of labour in multicellular frameworks.
- Improves functional efficiency by dedicating specialized groups of cells to targeted tasks.
- Enables complex body plans and better coordination across vital organ systems.

2. Plant Tissues

Plant tissues are grouped into two primary classes based on their capacity for cellular division: **Meristematic Tissues** and **Permanent Tissues**.

A. Meristematic Tissue (The Growth Engine)

Meristematic tissues consist of actively dividing cells that continuously add new cells to the plant body. These cells are highly active metabolically.

Key Cellular Characteristics:

- Possess thin, elastic primary cellulose cell walls.
- Contain rich, dense cytoplasm with a prominent nucleus.
- Lack large central vacuoles because they function in active division rather than nutrient storage.

Core Functions:

- Acts as the primary source of growth across all plant organs.
- Continuously produces cells that eventually mature into specialized permanent tissues.

Spatial Distribution & Types of Meristems:

- **Apical Meristem:** Located at the growing tips of roots and shoots. It drives primary growth, increasing the overall length of the plant.
- **Intercalary Meristem:** Situated at the base of leaves or near nodes (internodes). It facilitates rapid longitudinal regrowth, allowing grasses to recover quickly after grazing.
- **Lateral Meristem (Cambium):** Runs parallel along the sides of roots and stems. It drives secondary growth, increasing the thickness (girth) of woody stems and tree trunks.

B. Permanent Tissue (The Structural Framework)

When cells produced by meristematic tissue lose their capacity to divide, they undergo a structural transition. They take on a fixed shape, definitive size, and specific function through a process called **differentiation**, becoming permanent tissue cells.

1. Simple Permanent Tissues (Single Cell Type)

Composed of cells that are structurally and functionally identical throughout the tissue layer.

Feature	Parenchyma	Collenchyma	Sclerenchyma
Living State	Living cells	Living cells	Dead cells at maturity
Cell Wall Structure	Thin, unspecialized cellulose primary wall.	Unevenly thickened at corners with pectin/ cellulose deposits.	Uniformly thickened with a rigid layer of **lignin**.
Intercellular Spaces	Large spaces present.	Very little or no space.	Completely absent.
Primary Functions	Nutrient storage, support, metabolic packing.	Provides flexibility and mechanical tensile support.	Provides structural strength and rigid protection.
Special Variants & Examples	**Chlorenchyma** (photosynthetic); **Aerenchyma** (buoyancy in water plants).	Found in leaf stalks (petioles) beneath the epidermis.	Husk of coconuts, hard shells of nuts, seed coats.

2. Complex Permanent Tissues (Multiple Cell Types)

Composed of more than one type of cell working together as a coordinated unit to manage transport pathways. These are known as vascular or conducting tissues.

Xylem (Water Conducting Network)

Responsible for transporting water and vital dissolved minerals upward from the roots to the leaves.

Four Main Components:

- *Tracheids:* Elongated tubular dead cells with pitted walls.
- *Vessels:* Long, tube-like structures arranged end-to-end for continuous flow.
- *Xylem Fibres:* Thickened dead cells providing mechanical support.
- *Xylem Parenchyma:* The **only living component**; functions in lateral water transport and starch storage.

Phloem (Food Conducting Network)

Responsible for translocating organic nutrients (food) manufactured in the leaves to all other parts of the plant in both directions.

Four Main Components:

- *Sieve Tubes:* Perforated elongated columns that lack a nucleus at maturity.
- *Companion Cells:* Living cells that regulate sieve tube transport.
- *Phloem Parenchyma:* Functions in storage and lateral transport.
- *Phloem Fibres:* The **only dead component**; provides structural strength.

3. Plant Protective Tissues

- **Epidermis:** A single outer layer of protective cells covering all surfaces of the plant. Epidermal cells on leaves secrete a waxy, water-resistant layer called a cuticle to minimize water loss. It also houses **stomata**, guarded by kidney-shaped guard cells, which regulate gas exchange and transpiration.
- **Cork (Phellem):** As woody stems grow older, peripheral tissues turn into cork. Cork cells are dead at maturity and lack intercellular spaces. Their walls contain a waterproof chemical called **suberin**, making them highly resistant to gases, water, and infection.

3. Animal Tissues

Animal tissues are broadly categorized into four primary types based on their specialized functions: **Epithelial**, **Connective**, **Muscular**, and **Nervous**.

A. Epithelial Tissue (The Protective Covering)

Epithelial tissue forms a continuous protective sheet covering body surfaces, lining internal cavities, and protecting internal organs from mechanical damage and infection.

Epithelial Type	Cellular Morphology	Primary Locations & Functions
Simple Squamous	Extremely thin, flat, tile-like cells forming a delicate lining.	Lining of blood vessels, lung alveoli. Facilitates rapid diffusion of gases and nutrients.
Stratified Squamous	Multiple layers of squamous cells stacked sequentially.	Skin surface. Prevents wear, tear, and external injury.
Cuboidal	Cube-shaped cells with central round nuclei.	Kidney tubules, salivary gland ducts. Provides mechanical support and aids secretion/absorption.
Columnar	Tall, pillar-like elongated cells with basal nuclei.	Inner lining of the stomach and intestine. Maximizes nutrient absorption and mucus secretion.
Ciliated Columnar	Columnar cells equipped with hair-like surface projections (cilia).	Respiratory tract lining. Cilia beat rhythmically to move mucus and dust particles forward.
Glandular	Inwardly folded epithelial layers specialized for chemical release.	Sweat glands, tear ducts, salivary glands. Manages specialized chemical secretions.

B. Connective Tissue (The Binding Matrix)

Connective tissue connects separate organs, protects delicate structures, and transports materials throughout the body. Its cells are loosely spaced and embedded within an extracellular matrix.

- **Blood:** A fluid connective tissue containing a liquid matrix called **plasma**, which holds Red Blood Cells (RBCs), White Blood Cells (WBCs), and platelets. It transports gases, digested nutrients, and hormones throughout the body.
- **Bone:** A rigid connective tissue with a hard matrix composed of calcium and phosphorus compounds. It forms the skeletal framework that supports and protects the body.
- **Cartilage:** A flexible connective tissue with widely spaced cells embedded in a solid matrix of proteins and sugars. It smoothens bone surfaces at joints and supports structures like the nose, outer ear, and trachea.

- **Ligaments & Tendons:**
  - **Ligaments:** Highly elastic, strong connective tissue that joins **bone to bone** at joints, allowing movement.
  - **Tendons:** Fibrous, tough connective tissue with limited flexibility that secures **skeletal muscle to bone**.
- **Areolar Tissue:** Found between the skin and muscles, surrounding blood vessels and nerves. It acts as a supportive packing material, filling internal spaces and helping repair damaged tissues.
- **Adipose Tissue:** Located beneath the skin and between internal organs. It contains specialized cells that store fat, serving as an energy reserve and providing thermal insulation against heat loss.

C. Muscular Tissue (The Motor System)

Muscular tissue consists of elongated cells called muscle fibers. These cells contain specialized contractile proteins (actin and myosin) that slide over one another to generate mechanical movement.

[Image of types of muscle tissue showing striated smooth and cardiac muscle fibers under microscope]

Feature	Striated (Skeletal)	Smooth (Visceral)	Cardiac Muscle
Control Nature	Voluntary (under conscious control).	Involuntary (cannot be controlled consciously).	Involuntary rhythmic contraction.
Microscopic Bands	Shows distinct alternating light and dark stripes (striations).	Smooth appearance; completely unstriated.	Shows faint striations with specialized intercalated discs.
Cellular Structure	Long, cylindrical, unbranched, and **multinucleated**.	Spindle-shaped with pointed ends, containing a single nucleus.	Short, cylindrical, **branched**, and single nucleus.
Primary Locations	Attached to bones (limbs, arms, legs).	Walls of hollow organs (alimentary canal, blood vessels).	Exclusively in the walls of the **heart**.

D. Nervous Tissue (The Communication Network)

Nervous tissue is highly specialized to receive stimuli and rapidly transmit electrical impulses from one part of the body to another, regulating coordination.

[Image of a typical neuron diagram showing cell body dendrites axon myelin sheath and nerve endings]

Structure of a Single Nerve Cell (Neuron):

- **Cell Body (Cyton):** Contains the central nucleus and cytoplasm, acting as the metabolic hub of the cell.
- **Dendrites:** Short, branched projections extending from the cell body that receive incoming electrical signals.
- **Axon:** A long, single cylindrical fiber that carries electrical impulses away from the cell body toward the nerve endings.

4. Core NCERT Laboratory Activities

Activity 1: Demonstrating Apical Meristem Growth in Root Tips

Place two onion bulbs over separate glass jars filled with water until roots develop. On day three, cut the root tips of the second jar by 1 cm and monitor growth for another week. **Observation & Conclusion:** The roots in the first jar grow continuously, while the roots in the second jar stop growing immediately. This proves that apical meristems at root tips are essential for primary vertical growth.

Activity 2: Identification of Simple Tissues under a Microscope

Examine prepared slides of plant stem cross-sections under high power to observe parenchyma, collenchyma, and sclerenchyma cells. **Observation & Conclusion:** Parenchyma shows thin-walled cells with large spaces; collenchyma exhibits uneven corner thickening; sclerenchyma appears as thick, dead walls with no empty space, matching their functional roles.

5. Chapter Summary & Core High-Yield Keywords

Chapter Summary: Tissues are groups of similar cells working together to streamline body organization. Plant growth is driven by meristematic zones, which transition into simple storage tissues or complex transport structures like xylem and phloem. In animals, four primary tissue systems work together: epithelial sheets provide protection, connective tissue establishes support, muscle fibers enable movement, and specialized neurons manage internal coordination.

Essential Exam Keywords for High Scoring:

`Division of Labour` `Apical Meristem` `Lignified Sclerenchyma` `Complex Permanent` `Ciliated Epithelium` `Fluid Connective` `Contractile Proteins` `Neuron Axon`