Systemic 1[A]

Chapter 12: SUPPORTING TISSUES AND SYSTEMS

Learning Objectives: Upon completion of this chapter, students should be able to:

- Identify different types of skeletal materials in animals.
- Describe the structure and components of the human skeleton.
- Explain how muscles move bones.
- Discuss the concept of locomotion and support in protozoa and earthworms.
- Outline the functions of supporting tissues and systems in plants.
- Explain the types of supporting tissues in plants.
- Describe mechanisms of support and locomotion in various animals (e.g., invertebrate vertebrates).

12.1 Supporting Tissues and Systems in Animals

Animals require support to maintain their shape, protect internal organs, and facilitate movement.

- **A. Skeletal Materials:**
    1. **Chitin:** A tough, fibrous polysaccharide forming the exoskeleton of arthropods (insects, crustaceans, spiders).
        - *Function:* Provides external support, protection, and points of attachment for muscles. Limits growth, so organisms must shed (molt) their exoskeleton to grow.
    2. **Bone:** A rigid, living tissue forming the internal skeleton (endoskeleton) of vertebrates. Composed of collagen fibers strengthened by calcium phosphate.
        - *Function:* Provides strong internal support, protection for organs, mineral storage (calcium, phosphorus), and produces blood cells in bone marrow.
    3. **Cartilage:** A flexible connective tissue, softer and more elastic than bone. Found in joints, nose, ears, and embryonic skeletons.
        - *Function:* Provides flexible support, reduces friction at joints, acts as a shock absorber.
    4. **Hydrostatic Skeleton:** A fluid-filled cavity (coelom) surrounded by muscles. Muscle contractions against the incompressible fluid change the body shape, leading to movement.
        - *Examples:* Earthworms, jellyfish, sea anemones.

- **B. Human Skeleton:**
  - **Type:** Endoskeleton, made of bone and cartilage.
  - **Functions:**
    - **Support:** Provides a framework for the body.
    - **Protection:** Protects vital internal organs (e.g., skull protects brain, rib cage protects heart and lungs).
    - **Movement:** Provides attachment sites for muscles; bones act as levers.
    - **Mineral Storage:** Stores calcium and phosphorus.
    - **Blood Cell Production:** Red bone marrow produces red blood cells, white blood cells, and platelets.
  - **Components:**
    1. **Axial Skeleton:** Forms the central axis of the body.
       - **Skull:** Protects the brain and houses sensory organs.
       - **Vertebral Column (Spine/Backbone):** Protects the spinal cord, provides support, allows flexibility. Composed of individual vertebrae separated by intervertebral discs.
       - **Rib Cage:** Ribs and sternum (breastbone) protect the heart and lungs.
    2. **Appendicular Skeleton:** Consists of the limbs and the girdles that attach them to the axial skeleton.
       - **Pectoral Girdle:** Shoulder blades (scapulae) and collarbones (clavicles), connecting the upper limbs to the axial skeleton.
       - **Upper Limbs:** Humerus (upper arm), radius and ulna (forearm), carpals (wrist), metacarpals (palm), phalanges (fingers).
       - **Pelvic Girdle:** Hip bones, connecting the lower limbs to the axial skeleton.
       - **Lower Limbs:** Femur (thigh), patella (kneecap), tibia and fibula (lower leg), tarsals (ankle), metatarsals (foot), phalanges (toes).
  - **Joints:** Where two or more bones meet.
    - **Immovable (Fixed) Joints:** No movement (e.g., sutures in the skull).
    - **Slightly Movable Joints:** Limited movement (e.g., vertebrae).
    - **Freely Movable (Synovial) Joints:** Allow a wide range of movement.
      - *Components:* Articular cartilage (reduces friction), synovial fluid (lubricant), joint capsule (encloses joint), ligaments (connect bones to bones for stability).
      - *Types:* Hinge joint (e.g., knee, elbow), Ball-and-socket joint (e.g., shoulder, hip), Pivot joint (e.g., neck-atlas/axis), Gliding joint (e.g., carpals), Condyloid joint (e.g., wrist), Saddle joint (e.g., thumb).
- **C. Muscles and Bone Movement:**
  - **Antagonistic Muscles:** Muscles work in antagonistic pairs (e.g., biceps and triceps). When one muscle contracts (shortens), the other relaxes (lengthens) to produce movement at a joint.
    - *Example:* Biceps contracts to flex (bend) the arm; triceps contracts to extend (straighten) the arm.
  - **Tendons:** Strong, non-elastic connective tissues that attach muscles to bones.
- **D. Locomotion and Support in Protozoa:**
  - **Amoeba:** Moves by extending and retracting **pseudopodia** (false feet). The cytoplasm flows into these extensions, pulling the rest of the cell along. Also used for feeding (phagocytosis).

    - **Paramecium:** Moves by the coordinated beating of numerous short, hair-like structures called **cilia** on its outer surface. Cilia also create feeding currents.
    - **Euglena:** Moves by the lashing action of a long, whip-like structure called a **flagellum** at its anterior end.
- **E. Movement in Earthworm:**
    - **Hydrostatic Skeleton:** The coelomic fluid within its segmented body acts as a hydrostatic skeleton.
    - **Antagonistic Muscles:** Has two sets of muscles:
        - **Circular Muscles:** When they contract, the segment elongates and becomes thinner.
        - **Longitudinal Muscles:** When they contract, the segment shortens and becomes fatter.
    - **Setae (Bristles):** Small, stiff, bristle-like structures on each segment. They provide grip on the substrate, anchoring the worm.
    - **Mechanism:** Wave-like contractions of circular and longitudinal muscles, combined with anchoring by setae, allow the earthworm to burrow and move.

12.2 Supporting Tissues and Systems in Plants

Plants require support to stand upright, expose leaves to sunlight, and transport water and nutrients.

- **A. Functions of Supporting Tissues in Plants:**
    - **Mechanical Support:** Provides rigidity and strength, allowing stems to grow upright and resist bending by wind.
    - **Protection:** Protects internal tissues from mechanical stress and herbivores.
    - **Transport:** Associated with vascular tissues (xylem and phloem) for water and nutrient transport.
- **B. Types of Supporting Tissues in Plants:**
    1. **Parenchyma:**
        - **Characteristics:** Most common type of plant cell; thin-walled, loosely packed cells. Often contain chloroplasts (chlorenchyma).
        - **Support Function:** Provides **turgor support** when cells are turgid (full of water), pressing against the cell wall. This is crucial for non-woody parts like leaves and young stems. (Think of a wilted plant vs. a turgid one).
    2. **Collenchyma:**
        - **Characteristics:** Living cells with unevenly thickened primary cell walls (especially at corners). Found in growing regions and outer layers of young stems and petioles (leaf stalks).
        - **Support Function:** Provides flexible support to growing plant parts without hindering growth. Allows for bending without snapping.
    3. **Sclerenchyma:**
        - **Characteristics:** Cells with thick, lignified (hardened with lignin) secondary cell walls. Usually dead at maturity. Two main types:
            - **Fibers:** Long, slender cells, often in bundles (e.g., in xylem, phloem, flax, hemp).
            - **Sclereids (Stone Cells):** Irregularly shaped cells (e.g., in the gritty texture of pears, hard seed coats, nutshells).

        - **Support Function:** Provides rigid, strong, non-flexible support to mature plant parts. Also provides protection (e.g., in seed coats).
- **C. Other Supporting Structures/Mechanisms:**
    - **Cell Walls:** All plant cells have rigid cellulose cell walls that provide structural integrity.
    - **Turgor Pressure:** The internal pressure exerted by water against the cell wall. Essential for support in herbaceous (non-woody) plants and young stems.
    - **Woody Stems (Secondary Growth):** Accumulation of secondary xylem (wood) in woody plants provides massive structural support and strength.
    - **Vascular Bundles:** Xylem and phloem tissues, which conduct water and nutrients, also provide internal support within stems and leaves.