Systemic 1[B]

Chapter 13: FEEDING MECHANISMS • DIGESTIVE SYSTEMS

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

- Describe different types of feeding mechanisms in various organisms.
- Explain the process of feeding in protozoa and coelenterates.
- Discuss filter feeders and their importance.
- Outline feeding adaptations in carnivorous plants.
- Explain feeding mechanisms in saprophytes.
- Describe the alimentary canal and digestion in mammals.
- Differentiate between digestion in herbivores and carnivores.
- Detail the digestive anatomy and processes in common insects, flatworms, earthworms, and birds.

13.1 Types of Feeding Mechanisms

Organisms have evolved diverse ways to obtain food, depending on their environment and diet.

- **1. Feeding in Protozoa (e.g., *Amoeba*, *Paramecium*):**
  - **Phagocytosis (Endocytosis):** *Amoeba* uses pseudopodia to engulf food particles, forming a food vacuole. Lysosomes containing digestive enzymes then fuse with the food vacuole to digest the food. Digested nutrients diffuse into the cytoplasm, and undigested waste is expelled by exocytosis.
  - **Ciliary Feeding:** *Paramecium* uses cilia around its oral groove to create water currents that sweep food particles (bacteria, small algae) into its mouth opening (cytostome) and then into a food vacuole.
- **2. Feeding in Coelenterates (e.g., *Hydra*, Jellyfish):**
  - **Tentacles and Stinging Cells (Nematocysts):** *Hydra* uses tentacles equipped with stinging cells (nematocysts) to capture and paralyze small prey (e.g., small crustaceans). The tentacles then push the prey into the mouth.
  - **Gastrovascular Cavity:** Digestion occurs partially extracellularly within the gastrovascular cavity, and then intracellularly within specialized cells lining the cavity.
- **3. Filter Feeders (Suspension Feeders):**
  - **Definition:** Organisms that obtain food by filtering suspended particles (plankton, detritus) from water.
  - **Importance:** Crucial for aquatic food webs, often consuming microscopic organisms and helping to clarify water.

    - **Examples:**
        - **Clams and Oysters:** Filter water through gills.
        - **Whale Sharks, Baleen Whales:** Filter plankton through specialized structures in their mouths.
        - **Flamingos:** Filter small organisms from water using specialized beaks.
- **4. Carnivorous Plants:**
    - **Adaptation:** Adapted to grow in nutrient-poor soils (especially nitrogen-deficient) by trapping and digesting insects and other small animals. They still perform photosynthesis.
    - **Examples:**
        - **Venus Flytrap:** Has hinged leaves that snap shut when trigger hairs are touched.
        - **Pitcher Plants:** Have modified leaves forming pitcher-like traps filled with digestive fluid.
        - **Sundews:** Have sticky tentacles that trap insects.
- **5. Saprophytes:**
    - **Definition:** Organisms that obtain nutrients by secreting digestive enzymes onto dead or decaying organic matter and then absorbing the digested soluble products. They are crucial decomposers.
    - **Examples:** Fungi (e.g., bread mould, mushrooms), most bacteria.

13.2 Alimentary Canal and Digestion in Mammals

- **Alimentary Canal (Digestive Tract):** A long, muscular tube extending from the mouth to the anus, through which food passes and is digested and absorbed.
- **Accessory Digestive Organs:** Organs that aid digestion but food does not pass through them (e.g., salivary glands, liver, gallbladder, pancreas).
- **Process of Digestion:** The breakdown of large, complex, insoluble food molecules into smaller, simpler, soluble molecules that can be absorbed into the bloodstream.
- **Stages of Digestion in Mammals:**
    1. **Ingestion:** Taking food into the mouth.
        - **Mouth:** Mechanical digestion (chewing by teeth) and chemical digestion (salivary amylase starts starch digestion).
        - **Pharynx & Esophagus:** Muscular tube that transports food to the stomach by peristalsis (wave-like muscle contractions).
    2. **Digestion:**
        - **Stomach:**
            - Mechanical: Churning action of muscular walls.
            - Chemical: Gastric juice (hydrochloric acid and pepsin) begins protein digestion. HCl provides acidic pH for pepsin, kills bacteria.
        - **Small Intestine:**
            - **Duodenum:** Receives bile from the liver (emulsifies fats) and pancreatic juice from the pancreas (contains amylase for starch, trypsin for proteins, lipase for fats).
            - **Jejunum & Ileum:** Main sites of chemical digestion and absorption. Intestinal wall secretes intestinal juice (e.g., maltase, sucrase, lactase, peptidases). Villi and microvilli increase surface area for absorption.

3. **Absorption:** Digested nutrients (glucose, amino acids, fatty acids, glycerol) pass from the small intestine into the bloodstream and lymphatic system. Water and mineral salts are absorbed in the large intestine.
4. **Assimilation:** Absorbed nutrients are transported to cells and used for energy, growth, and repair.
5. **Egestion (Defecation):** Undigested and unabsorbed food material (feces) is eliminated from the body via the anus.

13.3 Digestion in Herbivores vs. Carnivores

Adaptations in their digestive systems reflect their specialized diets.

- **Herbivores (e.g., Cow, Rabbit):**
  - **Diet:** Primarily plant material (cellulose-rich).
  - **Adaptations:**
    - **Longer Alimentary Canal:** Provides more time and surface area for digestion of tough plant material.
    - **Specialized Teeth:** Broad, flat molars for grinding plant matter; often have a diastema (gap) for tongue manipulation of food.
    - **Symbiotic Microorganisms:** Possess specialized chambers (e.g., rumen in ruminants like cows; cecum in non-ruminants like rabbits) where bacteria and protozoa ferment cellulose.
    - **Ruminants (e.g., cows, sheep):** Four-chambered stomach (rumen, reticulum, omasum, abomasum). Rumen contains vast microbial populations for cellulose digestion. Regurgitate and re-chew cud (rumination).
    - **Non-Ruminants (e.g., rabbits, horses):** Large cecum for microbial fermentation. Rabbits practice coprophagy (re-ingesting soft feces to re-digest nutrients).
- **Carnivores (e.g., Lion, Cat):**
  - **Diet:** Meat (protein and fat-rich, less cellulose).
  - **Adaptations:**
    - **Shorter Alimentary Canal:** Meat is easier to digest than plant matter.
    - **Specialized Teeth:** Sharp canines for tearing flesh, carnassial teeth for shearing meat and crushing bone.
    - **Strong Stomach Acid:** High acidity to break down proteins and kill bacteria in raw meat.
    - **Efficient Protein/Fat Digestion:** High levels of proteases and lipases.

13.4 Digestive Anatomy and Processes in Other Animals

- **A. Insects (e.g., Grasshopper):**
  - **Alimentary Canal:** Generally includes foregut (mouth, esophagus, crop for storage, gizzard for grinding), midgut (stomach/ventriculus for digestion and absorption), and hindgut (intestines, rectum for water reabsorption and waste elimination).
  - **Specializations:** Vary greatly depending on diet (e.g., piercing-sucking mouthparts in mosquitoes, chewing mouthparts in grasshoppers).
- **B. Flatworms (e.g., Planaria):**
  - **Incomplete Digestive System:** Has a single opening (mouth/anus).

    - **Gastrovascular Cavity:** Highly branched, allowing for digestion and distribution of nutrients throughout the body without a separate circulatory system. Food is ingested through a muscular pharynx. Digestion is both extracellular and intracellular.
- **C. Earthworms:**
    - **Complete Digestive System:** Straight tube from mouth to anus.
    - **Components:** Mouth \rightarrow Pharynx (sucks in soil/organic matter) \rightarrow Esophagus \rightarrow Crop (storage) \rightarrow Gizzard (grinds food) \rightarrow Intestine (digestion and absorption) \rightarrow Anus.
    - **Nutrients:** Obtain nutrients from organic matter in ingested soil.
- **D. Birds:**
    - **Adaptations for Flight and Diet:** Lack of teeth.
    - **Components:**
        - **Beak:** Adapted for specific feeding (e.g., seed cracking, insect catching, nectar sipping).
        - **Esophagus:** Leads to a **Crop** (storage of food).
        - **Two-part Stomach:**
            - **Proventriculus:** Glandular stomach, secretes digestive enzymes and acid.
            - **Gizzard (Ventriculus):** Muscular, grinds food (often with ingested grit/stones) to compensate for lack of teeth.
        - **Small Intestine:** Digestion and absorption.
        - **Large Intestine & Cloaca:** Water absorption and elimination of waste.
    - **Pellet Formation (Raptors):** Indigestible parts (bones, fur, feathers) are regurgitated as pellets.