Nutrition in Animals

i. Definition and Explanation

What is Nutrition? Nutrition is the process by which an organism takes in food (ingestion), breaks it down into simpler, absorbable substances (digestion), utilizes these substances for energy, growth, and repair (assimilation), and removes the undigested waste from the body (egestion).

Animal Nutrition Animals are heterotrophs, meaning they cannot make their own food like plants (autotrophs). They depend on other organisms (plants or other animals) for their food. Animal nutrition includes the nutrient requirements, the mode of taking in food, and its utilization in the body.

The process of nutrition in most animals is Holozoic, which involves 5 key steps:

- **Ingestion:** The process of taking food into the body.
- **Digestion:** The breakdown of complex, insoluble food substances into simple, soluble substances.
- **Absorption:** The process by which the digested food passes into the bloodstream.
- **Assimilation:** The process by which the absorbed food is used by the body's cells for energy, growth, and repair.
- **Egestion:** The process of removing undigested waste material from the body.

ii. Key Points and Important Terms

- **Nutrients:** Components of food like carbohydrates, fats, proteins, vitamins, and minerals that are essential for our body.
- **Heterotrophic Nutrition:** Mode of nutrition where an organism obtains food from other organisms.
    - Herbivores: Animals that eat only plants (e.g., cow, deer).
    - Carnivores: Animals that eat only other animals (e.g., lion, tiger).
    - Omnivores: Animals that eat both plants and animals (e.g., human, bear).
- **Digestion:**
    - Mechanical Digestion: Physical breakdown of food into smaller pieces (e.g., chewing with teeth).
    - Chemical Digestion: Breakdown of food using chemicals called enzymes.

- **Enzymes:** Biological catalysts that speed up the chemical reactions of digestion. For example, amylase breaks down starch into sugar.
- **Digestive System:** The group of organs responsible for digesting food. It consists of the alimentary canal (digestive tract) and associated glands.
- **Alimentary Canal:** A long, continuous tube starting at the mouth and ending at the anus. It includes the mouth, oesophagus, stomach, small intestine, large intestine, and rectum.
- **Glands:** Organs that produce and secrete substances. Key digestive glands are the salivary glands, liver, and pancreas.
- **Villi:** Tiny, finger-like projections on the inner wall of the small intestine that increase the surface area for absorption of digested food.
- **Ruminants:** Grazing animals like cows and buffaloes that have a special four-chambered stomach and chew the cud.
- **Cud:** Partially digested food that is returned from the stomach to the mouth for further chewing.
- **Rumination:** The process of chewing the cud.
- **Pseudopodia:** "False feet" used by Amoeba for movement and capturing food.

iii. Detailed Examples: The Process of Nutrition

A. Nutrition in Humans

The human digestive system is a perfect example of holozoic nutrition.

iv. Path of Food through the Alimentary Canal:

Mouth (Buccal Cavity):

- Ingestion: Food is taken in.
- Mechanical Digestion: Teeth cut, tear, and grind the food.
- Chemical Digestion: Salivary glands secrete saliva, which contains the enzyme salivary amylase. Amylase begins the digestion of starch into simple sugars. The tongue helps in mixing food with saliva.

Oesophagus (Food Pipe):

- The swallowed food is pushed down into the stomach by a wave-like muscular movement called peristalsis. No digestion occurs here.

Stomach:

- A J-shaped muscular bag. The inner lining of the stomach secretes:
    - Mucus: Protects the stomach lining from acid.
    - Hydrochloric Acid (HCl): Kills bacteria and creates an acidic medium for enzymes to work.
    - Digestive Juices (Pepsin): The enzyme pepsin begins the digestion of proteins.
- The food is churned into a semi-solid paste.

Small Intestine:

- A long, coiled tube where most of the digestion and absorption takes place.
- It receives secretions from two glands:
    - **Liver:** Secretes bile juice, which is stored in the gall bladder. Bile helps in the digestion of fats by breaking large fat globules into smaller ones (emulsification).
    - **Pancreas:** Secretes pancreatic juice, which contains enzymes to digest carbohydrates, fats, and proteins.
- The intestinal wall also secretes its own juice to complete the digestion.
- Absorption: The inner walls have millions of villi. These villi have a rich network of blood vessels. They absorb the digested nutrients and pass them into the blood.

Large Intestine:

- Wider and shorter than the small intestine.
- Its main function is to absorb water and some salts from the undigested food material.

Rectum and Anus:

- The remaining undigested waste (faeces) is stored in the rectum.
- Egestion: The faeces are eliminated from the body through the anus.

B. Nutrition in Ruminants (e.g., Cow)

- Ruminants quickly swallow grass and store it in a part of the stomach called the rumen.
- In the rumen, food is partially digested by bacteria that can break down cellulose (a carbohydrate humans cannot digest). This partially digested food is called cud.

- Later, the cud is brought back to the mouth in small lumps, and the animal chews it thoroughly. This process is called rumination.
- The re-chewed food is then swallowed again and passes through the other chambers of the stomach for complete digestion and absorption.

C. Nutrition in Amoeba

Amoeba is a single-celled organism that shows a simple form of holozoic nutrition.

1. Ingestion: Amoeba senses food. It pushes out its pseudopodia (false feet) to surround the food particle and engulf it, forming a food vacuole.
2. Digestion: Digestive enzymes are secreted into the food vacuole to break down the food.
3. Absorption: The digested food diffuses from the food vacuole into the cytoplasm.
4. Assimilation: The absorbed food is used for energy and growth.
5. Egestion: The food vacuole moves to the cell surface and the undigested waste is thrown out.

v. Common Misconceptions and Clarifications

- **Misconception:** Digestion only happens in the stomach.
    - **Clarification:** Digestion begins in the mouth (starch) and is completed in the small intestine (carbs, fats, proteins). The stomach primarily digests proteins.
- **Misconception:** The liver digests food.
    - **Clarification:** The liver produces bile, which helps in fat digestion but is not an enzyme. It acts like a detergent to break up fat. The actual digestion is done by enzymes from the pancreas and small intestine.
- **Misconception:** Egestion (pooping) is the same as excretion (urinating).
    - **Clarification:** Egestion is the removal of undigested solid food waste. Excretion is the removal of metabolic waste products (like urea) from the blood, primarily done by the kidneys to form urine.
- **Misconception:** Hydrochloric acid (HCl) in the stomach digests food.
    - **Clarification:** HCl does not digest food itself. Its main roles are to kill harmful bacteria and to create the acidic environment that the enzyme pepsin needs to digest proteins.

vi. Practice Problems with Step-by-Step Solutions

Q1. Fill in the blanks:

a. The breakdown of complex food components into simpler substances is called _____. b. The largest gland in the human body is the _____. c. The finger-like outgrowths on the inner wall of the small intestine are called _____. d. Amoeba digests its food in the _____.

Solution: a. digestion b. liver c. villi d. food vacuole

Q2. Match the following:

Column A	Column B
1. Salivary Gland	a. Bile Juice Secretion
2. Stomach	b. Storage of undigested food
3. Liver	c. Saliva Secretion
4. Rectum	d. Acid Release

Solution:

1. → c
2. → d
3. → a
4. → b

Q3. Where are fats digested in the body?

Step-by-step Solution:

1. Recall the path of food: Food travels from the mouth → oesophagus → stomach → small intestine.
2. Consider each organ's function: No fat digestion occurs in the mouth or stomach.
3. Focus on the small intestine: The small intestine receives bile from the liver. Bile breaks large fat globules into smaller ones (emulsification).
4. Enzymatic action: Then, enzymes from the pancreas (like lipase) act on these smaller fat globules and break them down into fatty acids and glycerol.
5. Conclusion: Therefore, fats are primarily digested in the small intestine.

Q4. Why can't humans digest grass like cows can?

Step-by-step Solution:

1. Identify the main component of grass: Grass is rich in a carbohydrate called cellulose.
2. Consider human digestion: The human digestive system lacks the specific enzymes needed to break down cellulose.
3. Consider cow digestion: Cows are ruminants. They have a special stomach chamber (the rumen) that contains bacteria and other microorganisms.
4. Role of bacteria: These microorganisms produce the enzymes that can digest cellulose.
5. Conclusion: Humans cannot digest grass because we lack the cellulose-digesting enzymes that are present in the digestive systems of ruminants like cows.

vii. Summary of Main Concepts

- Animals are heterotrophs that obtain food from other organisms.
- Most animals follow holozoic nutrition, which involves five steps: Ingestion, Digestion, Absorption, Assimilation, and Egestion.
- In humans, digestion starts in the mouth, continues in the stomach, and is completed in the small intestine.
- Enzymes are crucial for the chemical breakdown of food.
- The small intestine is the primary site for the absorption of nutrients, thanks to villi which increase its surface area.
- The large intestine absorbs water from undigested food.
- Ruminants like cows have a specialized digestive system to digest cellulose with the help of microorganisms.
- Amoeba, a single-celled organism, uses pseudopodia to engulf food and a food vacuole to digest it.