

SLO 8: Nutrition and Digestion

Process by which organisms obtain and use the nutrients required for maintaining life is called nutrition. Nutrition is the study of nutrients in food, how the body uses nutrients, and the relationship between diet, health, and diseases.

8.1 Mineral Nutrition in Plants

8.1.1 Describe The Concept Of Mineral Nutrition In Plants

The process involving the absorption, distribution and utilization of mineral substances by the plants for their growth and development is called mineral nutrition. Plants have the most efficient mechanism for preparing their food by using many elements essential for plant nutrition. Plants obtain nearly all of the nutrients they need from the soil, although some are synthesized or produced via photosynthesis.

8.1.2 Classify Minerals Into Macronutrients And Micronutrients

- Macronutrients: C, H, O, Nitrogen, Phosphorus, Potassium, Calcium, Magnesium Sulphur
- Micronutrients: Boron, Chlorine, Manganese, Iron, Zinc, Copper And Molybdenum

8.1.3 Describe Importance of Nitrogen And Magnesium

- Nitrogen is essential for plants to synthesize amino acids, which are the building blocks for protein synthesis and also required for the production of chlorophyll, nucleic acids, and enzymes. From all metabolic elements which plants use from soil, nitrogen needs in the largest amounts.
- Many enzymes in plant cells require magnesium in order to perform properly and is a constituent of the chlorophyll molecule, which is the driving force of photosynthesis.

8.1.4 Analyze Visual Symptoms And Growth Patterns To Diagnose Nitrate Deficiency And Magnesium Deficiency In Plants

- Nitrogen-deficient plants exhibit stunted growth, reduced yields and their foliage pale green.
- Magnesium deficiency is most prevalent on sandy-textured soils, which are subject to leaching, particularly during seasons of excess rainfall. The predominant symptom is interveinal chlorosis (dark green veins with yellow areas between the veins). The bottom leaves are always affected first.

8.2 Components of Human Food

8.2.1 Classify Carbohydrates As Monosaccharides, Disaccharides And Polysaccharides

Monosaccharides:

These are simple sugars (made of single sugar molecule). They are sweet in taste, are easily soluble in water, and cannot be hydrolyzed into simpler sugars. In nature monosaccharides with 3 to 7 carbon atoms are found. Examples include Ribose and Glucose.

Disaccharides:

These are comparatively less sweet in taste, and less soluble in water. Most familiar disaccharide is sucrose (cane sugar) which on hydrolysis yields glucose and fructose. Maltose is made up of two glucose molecules.

Polysaccharides:

Polysaccharides are large molecules composed of hundreds or thousands of monosaccharide units. They are insoluble in water and tasteless. They have high molecular weights and are only sparingly soluble in water. Some biologically important polysaccharides are starch, glycogen, cellulose, dextrin, agar, pectin, and chitin.

8.2.2 State The Composition And General Formula Of Carbohydrate

"Carbohydrate" means 'hydrated carbons'. They are the organic compounds in which the ratio of H and O is 2:1 (same as in water). They are also known as "Saccharides" (meaning sugar). They have the general formula $C_n(H_2O)_n$ where 'n' is the number of carbon atoms.

8.2.3 Identify The Food Sources And Metabolic Functions Of Carbohydrates

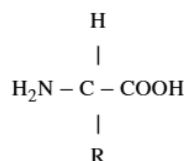
Sources:

- Monosaccharides: Glucose, fructose and galactose are found in fruits, vegetables, honey and cereals.
- Disaccharides: Sucrose is found in sugar beet, sugar cane and fruits. Lactose is found in milk and dairy products. Maltose is found in cereals.
- Polysaccharides: Starch is found in cereal crops; wheat, barley, maize, rice etc.

Functions:

- Carbohydrates are the primary source of energy. Glucose is used by cells to produce energy through cellular respiration.
- Dietary fiber contains undigestible carbohydrates e.g., cellulose. It helps for the proper bowel movements.
- Pentoses (ribose and deoxyribose) are essential parts of nucleic acids (RNA and DNA respectively).
- Plants convert their monosaccharides to disaccharides like sucrose to transport monosaccharides between body parts.
- Cellulose is the most abundant carbohydrate. It provides support to plant cells.

8.2.4 Illustrate The General Structure Of Amino Acid

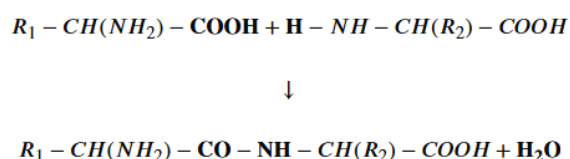


8.2.5 Describe The Linking Of Amino Acids Through Peptide Bonds To Form A Polypeptide Chain (Polymer)

Every amino acid has a central Carbon (C) atom bonded to an Amino group (NH_2), a Carboxyl group (COOH), a Hydrogen atom (H) and a Variable R-group (Side chain). The linking process is a condensation reaction (or dehydration synthesis) where a water molecule is removed.

The Hydroxyl group (OH) is removed from the Carboxyl group (COOH) of the first amino acid. A Hydrogen atom (H) is removed from the Amino group of the second amino acid. One molecule of H_2O is released as a byproduct. Once the water is removed, a covalent bond forms directly between the Carbon of the first amino acid and the Nitrogen of the second amino acid. This specific C – N link is called the Peptide Bond.

Two amino acids joined together is called Dipeptide. Three amino acids joined together is called Tripeptide. As this process repeats hundreds of times, a long string of amino acids is formed, known as a Polypeptide Chain. One end of the chain will have a free Amino group (the N-terminus). The other end will have a free Carboxyl group (the C-terminus).



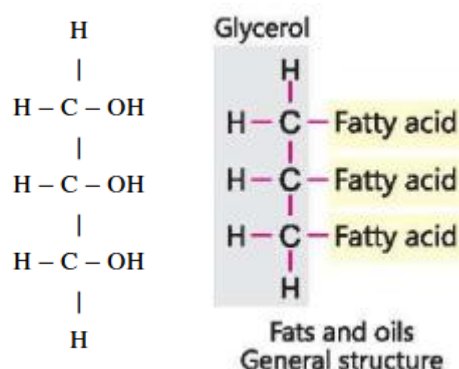
8.2.6 Identify The Food Sources And Functions Of Protein

Good sources of protein include meat (mutton, beef, chicken), fish, eggs, milk, pulses, beans etc. Proteins perform various functions in our bodies, including:

1. Proteins are an important part of all cell membranes.
2. Some proteins e.g. collagen and keratin make almost whole structures of cartilage, hair, and nails.
3. Enzymes are proteins that catalyze all biochemical reactions occurring in organisms.
4. Some proteins are hormones. They regulate body processes.
5. Hemoglobin protein transports oxygen in the blood.
6. Actin and myosin proteins are the main components of muscle cells. They are responsible for muscular contractions.
7. Fibrin is a blood clotting protein that makes blood clot to prevent the loss of blood after an injury.
8. Some proteins called antibodies defend the body against harmful pathogens.

8.2.7 Illustrate The General Structure Of Lipid (Triglyceride) Molecule (Head With Glycerol And Tail With Three Chains Of Fatty Acids)

Lipids are organic compounds that are insoluble in water but are soluble in organic solvents (e.g., alcohol, ether, benzene). They are composed of glycerol and fatty acids. Glycerol is an alcohol having 3 carbon atoms. Each carbon has a hydroxyl group (OH).



8.2.8 Describe The Food Sources And Functions Of Lipids/ Fats

Sources

Sources of lipids from animals are meat and dairy products, while the sources of lipids from plants are nuts, seeds, olive oil etc. Plants synthesize oils and store them in seeds, such as sunflower oil, coconut oil, groundnut oil and corn oil.

Functions

- Lipids are the most energy-rich biomolecules. They serve as a long-term energy reserve in the form of fats in adipose tissues. When the body requires energy, these stored lipids are broken down to release fatty acids and glycerol, which can be used as fuel for energy.
- Lipids are essential components of cell membranes.
- Lipids act as insulators and protect vital organs. For example, adipose tissue surrounding organs provides cushioning and heat insulation.
- Some lipids help in the synthesis of hormones. Steroid hormones are derived from a lipid i.e., cholesterol.
- Lipids help in the absorption of fat-soluble vitamins (A, D, E, and K) in the digestive system.

8.2.9 Calculate The Energy Content Of Carbohydrates, Proteins And Fats In A Food

Nutrient	Energy per Gram (kcal/g)	Energy per Gram (kJ/g)
Carbohydrates	4 kcal/g	17 kJ/g
Proteins	4 kcal/g	17 kJ/g
Fats (Lipids)	9 kcal/g	37 to 39 kJ/g

$$Total\ Energy = (m_{carb} \times 4) + (m_{protein} \times 4) + (m_{fat} \times 9)$$

8.2.10 Identify Food Sources And Metabolic Functions Of Vitamin A, B, C, D And K

Sources

- Vitamin A: Found in animal liver, egg yolks, and dairy, as well as orange/yellow vegetables like carrots and sweet potatoes.
- Vitamin B: Richly available in whole grains, legumes, meat, eggs, and leafy greens.
- Vitamin C: Primarily sourced from citrus fruits, bell peppers, strawberries, and broccoli.
- Vitamin D: Obtained through fatty fish and fortified dairy, though most is produced by the skin via sunlight exposure.
- Vitamin K: Found mostly in dark leafy greens (kale, spinach) and fermented foods like natto or cheese.

Metabolic Function

- Vitamin A: Essential for maintaining vision (especially at night), immune defense, and the healthy growth of cells and tissues.
- Vitamin B: Acts as a coenzyme to help the body convert food into energy and supports the formation of red blood cells.
- Vitamin C: Functions as a key antioxidant that facilitates collagen production for skin and bone repair while boosting iron absorption.
- Vitamin D: Regulates calcium and phosphorus levels in the blood to ensure strong bone mineralization and density.
- Vitamin K: Primary role is to activate proteins required for blood clotting and to help regulate bone and heart health.

8.2.11 Identify Food Sources And Metabolic Functions Of Calcium And Iron

Calcium metabolism refers to the movements and regulation of calcium ions (Ca^{+2}) in and out of various body compartments. Good calcium nutrition, along with low salt and high potassium intake, prevents from hypertension and kidney stones. Sources of calcium include milk, cheese, dairy foods, Green leafy vegetables, Soya beans, Nuts, Bread, Fish.

Iron plays a major role in oxygen transport and storage. It is a component of hemoglobin in red blood cells and myoglobin in muscle cells. Some of the best plant and animal sources of iron are beans and lentils, tofu, dark green leafy vegetables such as spinach.

8.2.12 Describe The Deficiency Diseases Of Vitamins And Minerals

Vitamin	Deficiency Diseases
Vitamin K	Bleeding disorder
Vitamin B	Beriberi
Vitamin D	Rickets and osteomalacia
Vitamin C	Scurvy
Vitamin A	Night blindness, eye-infection, rough skin, respiratory infections
Calcium	Fainting, Heart failure, Numbness and tingling sensations around the mouth or in the fingers and toes, Difficulty swallowing, Voice changes due to spasm of the larynx, Chest pains, Wheezing, Muscle cramps, particularly in the back and legs; may progress to muscle spasm (tetany)
iron	Extreme fatigue, Pale skin, Chest pain, fast heart beat or shortness of breath, Brittle nails, Weakness, Headache, dizziness, Inflammation or soreness of tongue, Poor appetite in infants

8.2.13 Identify Sources And Functions Of Water And Dietary Fiber In The Body

Water is the medium for various enzymatic and chemical reactions in the body. It moves nutrients, hormones, antibodies and oxygen through the blood stream and lymphatic system. Water maintains the body temperature through evaporation as in sweating. Severe dehydration causes cardio-vascular problems.

Dietary fiber is the edible part of plants, or similar carbohydrates, that can't be digested and absorbed in the small intestine. Fiber plays very important role to prevent from constipation. Soluble fiber helps in lowering the blood cholesterol and blood sugar level.

8.2.14 Analyze Different Scenarios To Identify The Specific Nutrient Deficiencies Based On Symptoms And Lifestyle Factors

8.2.15 Suggest Appropriate Solutions, Such As Dietary Adjustments, Supplementation To Correct The Deficiencies

Symptoms	Nutrient Deficiency	Lifestyle/Risk Factor	Dietary Adjustment
Severe weight loss, thinning of limbs, and visible ribs	Carbohydrates Protein (Marasmus)	Chronic starvation or lack of energy-dense foods.	High-calorie diet including bread, rice, and pulses.
Extremely weak, pale face, out of breath	Iron (Anemia)	Low intake of meat or dark green leafy vegetables.	Red meat, liver, spinach, and using iron-fortified flour.
Swollen ankles and a protruding (swollen) belly, thin elsewhere.	Protein (Kwashiorkor)	Diet consists only of carbs (rice/maize) with no meat or milk.	Increase eggs, milk, fish, and legumes (dal).
Frequent bone fracture	Calcium	Lack of dairy intake and sedentary indoor lifestyle.	Milk, yogurt, cheese, and calcium supplements.
Bleeding gums, loose teeth, and spots on the skin	Vitamin C (Scurvy)	Long periods without eating fresh fruits or vegetables.	Citrus fruits (lemons/oranges), guavas, and tomatoes.
poor vision at night or in dim light	Vitamin A	Diet lacking in colorful vegetables or animal fats.	Carrots, sweet potatoes, and liver.
constipation, abdominal pain, increased risk of hemorrhoids.	Dietary Fiber (Roughage)	Eating too much "refined" food (white bread, peeled fruit) and low intake of vegetables.	Switch to whole-wheat bread, eat fruits with skins, and increase lentils/beans.
Dark yellow urine, dry mouth, dizziness, infrequent urination	Water (Dehydration)	High physical activity without fluid replacement or high intake of salty snacks.	Drink more water; consume food like cucumber and watermelon.
Extreme fatigue, tingling in hands/ feet, and painful mouth ulcers, cracks mouth corners	Vitamin B	High intake of polished/white rice or strictly vegan diets without supplements.	Increase intake of whole grains, eggs, milk, and green leafy vegetables.
bow-legs (curved leg bones)	Vitamin D (Rickets)	Living in dark, indoor environments; lack of exposure to UVB rays.	Sunlight exposure (15 mins); consume fish liver oil, fortified milk, and eggs.
prolonged bleeding after a minor cut that does not stop or clot	Vitamin K	Long-term use of strong antibiotics that kill "good" gut bacteria.	Increase Spinach, Kale, Broccoli, and cabbage.

8.3 Balanced Diet

8.3.1 Define Balanced Diet

A balanced diet is a diet that contains all the essential nutrients—carbohydrates, fats, proteins, vitamins, minerals, and water—along with dietary fiber, in the correct proportions required for the normal growth, repair, and maintenance of the body.

8.3.2 Describe The Significance Of Balanced Diet

- Energy for Metabolic Activities
- Growth and Tissue Repair
- Disease Prevention and Immunity
- Maintenance of Chemical Balance (Homeostasis)

8.3.3 Analyze Importance Of A Balanced Diet And Variations In Energy Requirements

Importance	Biological Reason / Mechanism	Benefit to the Organism
Growth & Repair	Provides Amino acids to build new cells.	Essential for childhood development and healing injuries.
Energy Supply	Provides Glucose and Lipids for ATP.	Fuels physical activity and vital organ functions.
Immune Support	Vitamins boost white blood cell activity.	Increases resistance against infections and pathogens.
Metabolic Regulation	Minerals and Vitamins act as co-enzymes	Ensures smooth chemical reactions within the body.
Disease Prevention	Correct balance of nutrients	Prevents deficiency diseases like Anemia, Goiter, and Scurvy.

Factor	Trend	Biological Justification (The "Why")
Age (Children)	Higher	High rate of Cell Division and metabolic activity for growth.
Age (Elderly)	Lower	Decreased Basal Metabolic Rate (BMR) and reduced physical activity.
Gender (Male)	Higher	Typically have higher Muscle Mass (which burns more energy than fat).
Gender (Female)	Higher	To compensate for blood loss during Menstruation to prevent Anemia.
Activity Level	Higher	Muscles require more ATP during exercise or manual labor.
Pregnancy	Higher	Needed for the development of fetal tissues, skeleton, and extra blood
Lactation	Higher	Significant energy is required for the production of milk to nourish the infant.
Illness	Higher	Required to repair damaged tissues and support the immune system's fight.

8.4 Ingestion, Digestion and Absorption of Food in Human Beings

8.4.1 Explain Significance Of Ingestion, Digestion, Absorption, Assimilation Or Egestion

Digestion is the process in which large and non-diffusible molecules of food are converted into smaller and diffusible molecules that can cross the membranes. The digestion consists of following steps:

1. Ingestion: Intake of food.
2. Mechanical Digestion: Physical preparation of food for digestion.
3. Chemical Digestion: Carbohydrates, Fat, and Proteins are broken down by enzymes.
4. Absorption: Transfer of the digested portion of food into the blood from the digestive canal.
5. Egestion (Defecation): Removal/elimination of the waste products from the body.

8.4.2 Relate The Following Structures Of Alimentary Canal With Their Functions

- **Mouth:** food selection by taste, grinding by teeth, lubrication by saliva, conversion of food into bolus by muscles and tongue by chemical digestion, passing of bolus into esophagus (swallowing).
- **Esophagus:** epiglottis that reflexively closes to prevent choking, waves of rhythmic movements of muscle contractions and relaxation force down food through the esophagus to the stomach, sphincter allows food to enter the stomach and then squeezes shut to keep food or fluid from flowing back up.
- **Stomach:** churn and mix the food with acids and enzymes, breaking it into much smaller, digestible pieces. Stomach walls contract and relax to help in mixing of gastric juice and food (churning). By the time food is ready to leave the stomach, it has been processed into a thick paste like liquid called chyme.
- **Small Intestine:** excrete intestinal juices which contain enzymes to break down polysaccharides, proteins, fats, and nucleic acids. The villi are the vehicles through which nutrients can be absorbed into the body.
- **Large Intestine:** remove water from undigested matter and form solid waste (feces) that can be egested.
- **Rectum:** feces are stored until they leave the digestive system.
- **Anus:** opening through which feces are removed from body as a bowel movement.

8.4.3 Explain The Structure And Digestive Functions Of Organs And Glands Associated With The Alimentary Canal

Salivary Glands:

Three pairs of salivary glands are located under the tongue and near the lower jaw, begin producing saliva. This flow of saliva is coordinated with a brain reflex that triggered when we sense food or think about eating. In response to this sensory stimulation, the brain sends impulses through the nerves that control the salivary glands, telling them to prepare for a meal.

Liver:

The liver produces bile, which helps the body to digest and absorb fat. Bile travels through special channel (bile duct) directly into the small intestine. It also makes a substance that neutralizes stomach acid. The liver also plays a major role in the handling and processing of nutrients, which are carried to the liver in the blood from the small intestine. The liver is a metabolically active organ responsible for many vital life functions.

Gall Bladder:

It is a small, pear-shaped, muscular sac located tucked under the right lobe of the liver. It is connected to the liver via the common bile duct. It stores and concentrates bile by absorbing water and electrolytes, making the bile more potent for digestion.

Pancreas:

Pancreatic juice is a liquid secreted by the pancreas, which contains a variety of enzymes, including protease like trypsinogen, pancreatic lipase and amylase, which digest protein, lipids and carbohydrates respectively.

8.4.4 Explain The Mechanism Of Swallowing

- **Tongue:** It rolls the chewed food (mixed with saliva) into a small, lubricated ball called a bolus and pushes the bolus toward the back of oral cavity and the swallowing reflex is triggered.
- **Larynx:** As the bolus passes, the larynx moves upward. This upward movement causes the epiglottis to fold down over glottis. This temporarily seals the respiratory tract, forcing bolus to slide into esophagus.
- **Epiglottis:** A flap of cartilaginous tissue which folds down over the glottis (the opening of the windpipe).
- **Pharynx:** A passageway for food and air, is about 5 inches (12.7cm) long. As the bolus enters pharynx, soft palate moves upward to close the nasal opening. The muscular walls of the pharynx then contract to push the bolus downward toward the esophagus.

8.4.5 Describe The Coordination Of Circular And Longitudinal Muscles During Peristalsis To Propel The Food Forward Through The Digestive Tract

Peristalsis is a coordinated wave of contraction and relaxation of muscles that moves behind and ahead of the food bolus or chyme.

1. **Circular Muscles:** These wrap around the gut (like rings). When they contract, the lumen (opening) becomes narrower.
 2. **Longitudinal Muscles:** These run along the length of the gut. When they contract, the gut becomes shorter and wider.
- **Esophagus:** Simple, one-way wave to move the bolus from the pharynx to the stomach.
 - **Stomach:** Coordination here results in churning, which physically breaks food and mixes it with gastric juice to form chyme.
 - **Intestines:** Slow, rhythmic waves that not only move food but also ensure it stays in contact with the villi for maximum absorption.

8.4.6 Describe The Functions Of Hydrochloric Acid In The Stomach

Hydrochloric acid converts the inactive enzyme pepsinogen into active form called pepsin. HCl also kills microorganisms present in food. Stomach is protected against the action of acid by mucus.

8.4.7 Describe Digestion Of Food In Mouth, Esophagus, Stomach And Small Intestine

Digestion in the Oral Cavity (Mouth)

- **Selection:** Food is tasted and felt; hard objects or dirt, lead to rejection.
- **Mastication (Chewing):** Teeth grind food into small pieces to increase surface area for enzymes and allow smooth passage through the esophagus.
- **Salivation:** Saliva is secreted by salivary glands with two main functions:
 1. **Lubrication:** Adds water and mucus to soften food into a bolus.
 2. **Chemical Digestion:** Contains Salivary Amylase, which begins the partial digestion of starch.
- **Swallowing:** The tongue pushes the bolus back; the epiglottis (flap of tissue) reflexively closes the windpipe to prevent choking.

Digestion in the Esophagus

- **Transportation:** A muscular tube that carries the bolus from the pharynx to the stomach.
- **Peristalsis:** Rhythmic waves of muscular contraction move the food downward.
- **Cardiac Sphincter:** A muscular ring at the end of the esophagus that opens to let food enter the stomach and closes to prevent acid reflux.

Digestion in the Stomach

- **Structure:** A J-shaped bag with three regions: Cardiac (top), Fundus (middle), and Pyloric (bottom).
- **Mechanical Digestion (Churning):** The stomach walls contract and relax to mix food with gastric juice. This action also generates heat to melt lipid contents.
- **Chemical Digestion (Gastric Juice):** Secreted by gastric glands, containing:
 1. **Pepsinogen:** An inactive enzyme converted by HCl into Pepsin, which partially digests proteins into polypeptides.
 2. **Mucus:** Protects the stomach lining from self-digestion by acid.
- **Result:** Food is processed into a thick, acidic liquid paste called Chyme.
- **Pyloric Sphincter:** Controls the release of chyme into the small intestine.

Digestion in the Small Intestine

- Structure: Consists of three parts: Duodenum (25cm, C-shaped), Jejunum (coiled), and Ileum (final absorption site that leads into the large intestine).
- Duodenum (Main Site of Digestion): Receives secretions from two major glands:
 1. Liver: Contains bile salts that break large fat globules into microscopic droplets.
 2. Pancreas: Contains Trypsinogen (for proteins), Lipase (for lipids), and Amylase (for carbohydrates).
- Intestinal Juice: Enzymes produced by the small intestine walls complete the breakdown of all four molecule groups (polysaccharides, proteins, fats, and nucleic acids) into their simplest units.
- Neutralization: Secretions are alkaline to neutralize the acidic chyme and provide the optimum pH for intestinal enzymes.

8.4.8 Describe The Action Of Enzymes In Specific Regions Of The Alimentary Canal With Respect To Their Substrates And Products

Enzyme	Substrate (Food)	End Product
Salivary Amylase	Starch (Polysaccharides)	Maltose (Disaccharides)
Pepsin	Proteins	Polypeptides / Peptides
Trypsin	Proteins / Polypeptides	Peptides
Pancreatic Amylase	Remaining Starch	Maltose
Lipase	Emulsified Fats (Lipids)	Fatty Acids & Glycerol
Erepsin (Peptidases)	Peptides	Amino Acids
Maltase	Maltose	Glucose
Sucrase / Lactase	Sucrose / Lactose	Glucose & Fructose / Galactose

8.4.9 Describe The Structural Adaptations Of Small Intestine And Villi

The inner wall of the small intestine is covered with millions of microscopic, finger-like projections called villi (singular, villus). Each villus is connected and richly supplied with blood capillaries and lymphatic vessels, i.e. lacteal. The walls of villus are made up of only one layer of cells, in thickness.

8.4.10 Describe The Absorption Of Nutrients Through Intestinal Villi

The villi are the vehicles through which nutrients can be absorbed into the body. They increase the surface area over which absorption and digestion occur. These specialized cells help absorbed materials cross the intestinal lining into the bloodstream. Only one cell thick to allow rapid diffusion.

8.4.11 Transportation Of Absorbed Nutrients To The Liver Via The Hepatic Portal Vein

Simple sugars (glucose), amino acids, mineral salts, and water-soluble vitamins are absorbed by the blood capillaries inside the intestinal villi. These nutrients do not go directly to the heart. Instead, they are collected into a large vein called the Hepatic Portal Vein, which carries them straight to the Liver.

8.4.12 Function of Liver Associated With Assimilation of Sugar And Amino Acid

- Under the influence of the hormone Insulin, the liver absorbs excess glucose from the Hepatic Portal Vein.
- It converts glucose into Glycogen for storage. This process is called Glycogenesis.
- Under the influence of the hormone Glucagon, the liver converts stored glycogen back into glucose.
- This glucose is then released into the Hepatic Vein to maintain energy supply to the cells.
- The liver removes the nitrogen-containing amino group (NH_2) from the amino acid molecule.
- The amino group is converted into Ammonia (NH_3) which is highly toxic.
- The liver immediately converts ammonia into a less toxic substance called Urea.
- The urea is then released into the blood and eventually filtered out by the Kidneys to be excreted as urine.

8.4.13 Describe The Role Of Large Intestine In Water And Electrolyte Absorption, Formation And Storage Of Feces, Productions Of Vitamins (E.G. Vitamin K And Some B Vitamins) And Waste Processing

From the small intestine, food that has not been digested (and some water) travels to the large intestine through a muscular ring, that prevents food from returning to the small intestine. By the time food reaches the large intestine, the work of absorbing nutrients is nearly finished. The large intestine's main function is to remove water from the undigested matter and form solid waste that can be egested. The large intestine is made up of three parts:

1. The **caecum** is a pouch at the beginning of the large intestine that joins the small intestine to the large intestine. This transition area expands in diameter, allowing food to travel from the small intestine to the large.
2. The **appendix**, a small, hollow, finger-like pouch, hangs at the end of the cecum. It no longer appears to be useful to the digestive process.
3. The **colon** extends from the caecum up the right side of the abdomen, across the upper abdomen, and then down the left side of the abdomen, finally connecting to the rectum.

The colon has three parts:

1. Ascending colon, absorb fluids and salts.
2. Transverse colon, absorb fluids and salts.
3. Descending colon, which holds the resulting waste (feces).

Feces mainly consist of undigested material, large number of bacteria, sloughed off gastrointestinal cells, bile pigments and water. Bacteria in the colon help to digest the remaining food products. There's a lot of energy in cellulose, but most animals are simply unable to digest it because they don't have the necessary enzymes.

The colon harbors trillions of bacteria (mainly Bacteroidetes, Firmicutes, Actinobacteria). These microbes perform fermentation of the fiber we cannot digest and, as a by-product, synthesize vitamins that we then absorb.

8.5 Disorders of Gut

8.5.1 Describe The Symptoms, Causes, Treatment And Preventions of Gut Disorders

Irritable Bowel Syndrome (IBS):

- Description: A chronic functional disorder of the large intestine (colon) affecting the rhythm of muscular contractions.
- Symptoms: Alternating episodes of diarrhea and constipation, abdominal bloating, gas, and cramping.
- Causes: Emotional stress, specific food sensitivities (triggers), or abnormal muscle contractions in the gut.
- Treatment: Stress management, dietary changes (avoiding triggers like caffeine or gluten), and medicines to control muscle spasms.
- Prevention: Maintaining a consistent eating schedule and identifying/avoiding personal food triggers.

Diarrhea:

- Description: A condition where the sufferer has frequent watery, loose bowel movements due to fast peristaltic movement.
- Symptoms: Painful abdominal cramps, nausea, fever, and generalized weakness.

- Causes: Lack of adequate safe water, viral or bacterial infections, and the failure of the colon to absorb water into the blood.
- Treatment: Consumption of adequate amounts of water mixed with essential salts (ORS) and nutrients to replace fluid loss.
- Risk: In malnourished individuals, it leads to severe dehydration and can be life-threatening.

Constipation:

- Description: A condition where a person experiences hard feces that are difficult to eliminate.
- Symptoms: Infrequent bowel movements, straining, and a feeling of incomplete evacuation.
- Causes: Excessive absorption of water through the colon, insufficient intake of dietary fiber, dehydration, and use of certain medicines (containing iron, calcium, or aluminum).
- Treatment: Changes in diet (increasing fiber), improved exercise habits, and the occasional use of laxatives (e.g., paraffin).
- Prevention: It is generally easier to prevent through high-fiber intake and hydration than it is to treat.

Dyspepsia / Gastroesophageal Reflux Disease (Gerd):

- Description: Commonly known as "Indigestion" or "Heartburn," where stomach acid flows back into the esophagus.
- Symptoms: Heartburn (burning sensation in the chest), acid regurgitation (sour taste in the mouth), and difficulty swallowing.
- Causes: Weakness of the lower esophageal sphincter (the valve between the esophagus and stomach), obesity, pregnancy, or lying down immediately after a heavy meal.
- Treatment: Antacids (alkaline medicines) to neutralize acid, eating smaller meals, and elevating the head during sleep.
- Prevention: Avoiding late-night snacks, reducing oily/fatty foods, and maintaining a healthy weight.

Gastroenteritis (Stomach Flu):

- Description: Inflammation of the lining of the stomach and intestines, usually acute (short-term).
- Symptoms: Sudden onset of vomiting, watery diarrhea, fever, and stomach cramps.
- Causes: Infection by viruses (e.g., Rotavirus), bacteria, or parasites often found in contaminated food or water.
- Treatment: Primary focus is Rehydration (ORS - Oral Rehydration Salt) to prevent fluid loss; antibiotics are only used if the cause is bacterial.
- Prevention: Frequent hand washing, eating thoroughly cooked food, and drinking boiled or filtered water.

Ulcer:

- Description: A sore in the gut lining caused by the breakdown of tissues by acidic gastric juice.
- Types: Gastric ulcer (stomach), duodenal ulcer (duodenum), and esophageal ulcer (esophagus).
- Symptoms: Abdominal burning or pain after meals, a rush of saliva after regurgitation, nausea, loss of appetite, and weight loss.
- Causes: Long-term use of anti-inflammatory medicines (e.g., aspirin), smoking, excessive coffee/colas, spicy food, or H. pylori bacteria.
- Treatment: Medicines with an alkaline composition (antacids) to neutralize acid and strict avoidance of spicy foods.

Food Poisoning:

- Description: An illness caused by eating food contaminated with toxins produced by microbes.
- Symptoms: Severe nausea, vomiting, diarrhea, and sometimes high fever occurring shortly (2–6 hours) after eating.
- Causes: Bacteria like Salmonella or E. coli, or toxins from improperly stored/expired food (e.g., "Botulism" from canned goods).
- Treatment: Resting the stomach (fasting for a few hours), followed by clear fluids and electrolytes. Seek medical help if there is blood in the stool.
- Prevention: Proper food hygiene (separating raw meat from vegetables), checking expiry dates, and avoiding "street food" prepared in unhygienic conditions.

8.5.2 Analyze The Impact Of Malfunctions In Specific Features Or Structures Of The Gastrointestinal Tract On Digestion And Absorption Of Food

Feature	Specific Malfunction	Impact on Digestion / Absorption
Salivary Glands	Lack of Amylase secretion	Chemical digestion of Starch will not begin in the mouth; the bolus will be dry and difficult to swallow.
Epiglottis	Failure to close the Glottis	Food/liquid enters the Trachea (windpipe) instead of the esophagus, leading to choking or aspiration pneumonia.
Stomach Lining	Failure of Mucus secretion	Gastric juice (HCl) will corrode the stomach wall, leading to Gastric Ulcers and pain during protein digestion.
Pancreas	Enzyme Deficiency	Severe failure in the chemical breakdown of Proteins and Fats; nutrients remain in complex forms that cannot be absorbed.
Intestinal Villi	Flattening/Damage	Drastic reduction in Surface Area. Even if food is digested, nutrients (glucose, amino acids) cannot enter the blood, causing malnutrition.
Large Intestine	Slow Peristalsis	Excessive water absorption occurs, leading to hardening of feces and chronic Constipation.