2 Nutrition and Food Preservation

B11CH2

Learning Objectives

Upon completion of this topic, learners will be able to:

- Explain the process of nutrition and state why living things need nutrients
- Outline and classify the types of nutrients found in food
- Classify food into groups
- Demonstrate the presence of various nutrient found in food
- Explain the concept of a balance diet
- Explain the concept of malnutrition
- Determine the dental formula of a mammal (amount and arrangement of teeth)
- Explain the importance of dental care in humans
- Name and discuss various methods of preserving and storing food
- Explain methods of preserving food using local resources
- Explain other methods of food preservation in West Africa
- Explain the biological basis for preserving and storing food

Nutrition is a basic characteristic of life which involves a series of processes by which living organisms obtain food substances and use them to provide energy and material for their growth, activities and reproduction. Food is a complex, energy-rich substance which living beings feed on to obtain nutrients necessary for sustaining their life. Green plants make food for all living beings. So, all living beings can take different types of food from plants. **Nutrition** is the process that deals with the digestion of food and how the body uses it to obtain energy. We need food to live. The food we eat, supplies the energy we need to do work. Food also provides substances that the body needs to build and repair tissues and regulate organs and organ systems.

2.1 NUTRITION

Definition: Nutrition is the process in which nutrients are taken up and utilised by an organism for its healthy growth, repair of worn out tissues and supply of energy.

2.1.1 Types of Nutrition

Every living organism has a general requirement for nutrition. However, different organisms have different ways to fulfil it. Some organisms like plants use inorganic nutrients (carbon dioxide and water) from nature to prepare their organic nutrients. Other organisms like animals utilize organic nutrients (from food). But food as a complex nutrient needs to be broken down into simpler form before it can be utilised by the body. Therefore, on the basis of various ways of obtaining nutrients, organisms can be classified into two major categories. They are:

1. Autotrophic nutrition
2. Heterotrophic nutrition
3. Holozoic nutrition

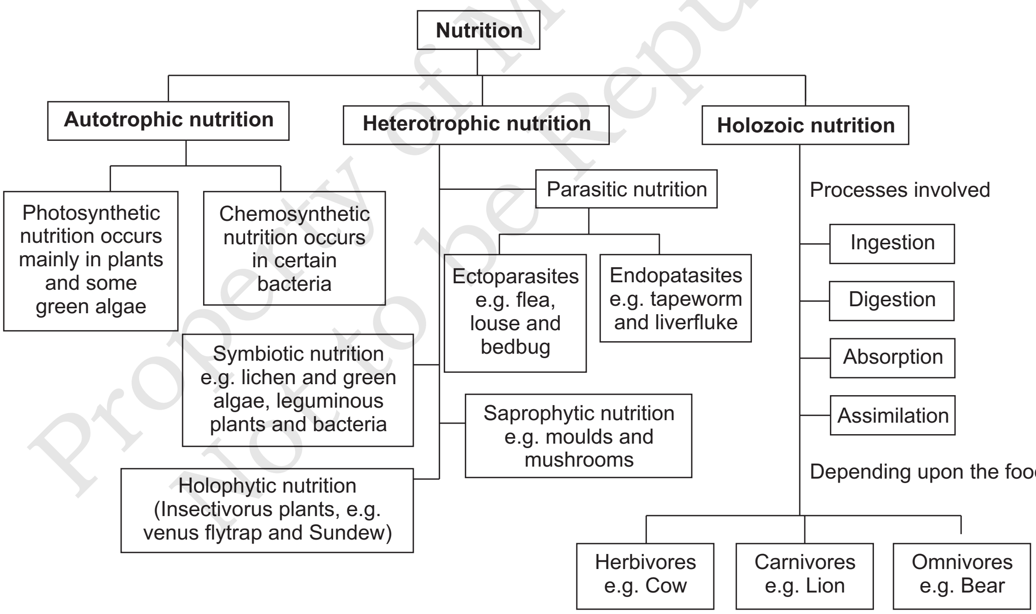


Fig. 2.1. Flow chart to show nutrition and its types

Autotrophic Nutrition

The term **autotroph** has been derived from two Greek words: *auto* means self and *trophe* means nutrition. In this mode of nutrition, the organisms prepare (synthesise) their own food from simple raw materials like water,

carbon dioxide and minerals present in the surroundings. Plants require organic nutrient like carbohydrates to sustain their life. They prepare their food from inorganic substances in the presence of sunlight and convert it into a regular organic substance like glucose.

Definition: The autotrophic nutrition is defined as the kind of nutrition in which the organisms synthesise their organic food from the inorganic raw materials present in the surroundings. Organisms which synthesise their food in this manner are called autotrophs and include all green plants and bacteria such as the nitrifying bacteria.

The autotrophic nutrition is further divided into:

1. **Photosynthetic Nutrition:** The photosynthetic nutrition usually occurs in green plants. However, some lower organisms like blue-green algae and bacteria contain chlorophyll and perform the process of photosynthesis for synthesising their own food. In photosynthesis, green plants are able to trap the solar energy to manufacture food and convert the solar energy to chemical energy. Photosynthesis involves the building of simple carbohydrates such as sugar (glucose) in the chloroplasts of green leaves in the presence of sunlight (as a source of energy) from carbon dioxide and water taken from the air and soil respectively. The sugar (glucose) in the presence of enzymes is converted to starch, cellulose and other forms of carbohydrates. The organisms capable of photosynthesis are called autotrophs.

Jan Ingenhousz

Jan Ingenhousz, (born December 8, 1730, Breda, Netherlands—died September 7, 1799, Bowood, Wiltshire, England), a Dutch-born British physician and scientist discovered the process of photosynthesis.

Definition of photosynthesis: Photosynthesis is a chemical process by which green plants obtain inorganic substances such as carbon dioxide and water from their surroundings and synthesise their own food in the presence of sunlight in the chlorophyll of chloroplast.

The overall chemical reaction of photosynthesis can be summarized as follows:

$$\underset{\text{Carbon dioxide}}{6CO_2} + \underset{\text{Water}}{6H_2O} \xrightarrow[\text{Chlorophyll}]{\text{Sunlight, enzymes}} \underset{\text{Glucose}}{C_6H_{12}O_6} + 6O_2(\text{gas})$$

During the process of photosynthesis, oxygen which is an important agent for all living organisms is released by the splitting of water molecules. This process is called **photolysis**.

2. **Chemosynthetic Nutrition:** Chemosynthetic nutrition is another type of autotrophic nutrition in which certain bacteria synthesise organic compounds from simple inorganic materials. These inorganic materials include carbon dioxide, ammonia, water and nitrite. In this type of nutrition, energy used for the synthesis of food comes from the oxidation of simple inorganic substances, hence the process is known as chemosynthesis. Examples of bacteria that exhibit chemosynthetic nutrition are as follow:

- Bacteria that live under sea hot springs oxidise hydrogen sulphide. With the help of carbon (IV) oxide and oxygen, they produce a type of simple sugar, sulphur and water. Due to this, they are known as **sulphur bacteria**.

$$CO_2 + 4H_2S + O_2 \longrightarrow CH_2O + 4S + 3H_2O$$

- **Nitrosomonas** which converts ammonia into nitrite.

$$\underset{\text{Ammonia}}{2NH_3} + \underset{\text{Oxygen}}{3O_2} \xrightarrow{\text{Nitrosomonas}} \underset{\text{Nitrite}}{2HNO_2} + \underset{\text{Water}}{2H_2O} + \text{Energy}$$

- **Nitrobacter** which converts nitrite to nitrate.

$$\underset{\text{Nitrite}}{2HNO_2} + \underset{\text{Oxygen}}{O_2} \xrightarrow{\text{Nitrobacter}} \underset{\text{Nitrite}}{2HNO_3} + \text{Energy}$$

Both phototrophs and chemotrophs do not take organic food hence, they are called autotrophs. Their modes of feeding individually termed as photoautotrophy and chemoautotrophy and are together referred to as autotrophy or autotrophic nutrition. Since the autotrophic nutrition is characteristics of plants, it is also called **holophytic nutrition**.

Heterotrophic Nutrition

The word **heterotroph** has been derived from two Greek words—*hetero* meaning different and *trophe* meaning nutrition. Heterotrophs are the organisms that do not make their food and their mode of nutrition is called **heterotrophic nutrition**. It is a type of nutrition in which the organisms derive their energy from intake of organic substances prepared by autotrophs and other sources. As the heterotrophs depend on plants and other organisms for their food, they are also known as consumers. Heterotrophic nutrition is further classified into the following types:

1. **Parasitic Nutrition:** In this type of nutrition, certain organisms feed on other organisms in order to derive nutrients from them. This type of nutrition is called **parasitic nutrition** and the organism that derives nutrients from other organism is called **parasite**, e.g. feeding mechanism

between tick and dog, louse and human and so on. Organism on which a parasite derives nutrients is called **host**. In such an association, the parasite gains from the association while the host suffers loss. Parasites can be classified as:

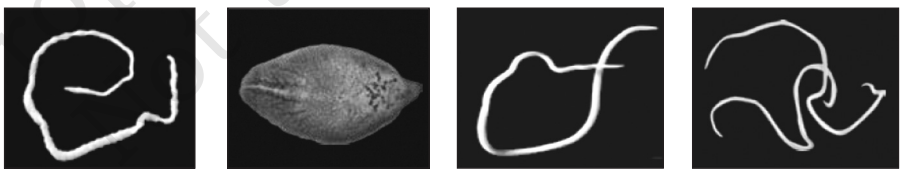
Ectoparasites: Parasites that live on the body of the host are called **ectoparasites**. Examples of ectoparasites are Flea, Body louse, Bedbug, Aphid and Tick. Ticks are found on dogs. Chickens and rats carry lice with them. Aphids are the ectoparasites of plants.

(a) Bedbug (b) Root aphids (c) Tick (d) Flea

Fig. 2.2. Examples of ectoparasites

Endoparasites: Parasites that live in the body of the host are called **endoparasites**. Examples of endoparasites (Fig. 2.2) are:

- Tapeworm (*Taenia solium*): It is associated with pigs which are the secondary host. The primary host is human beings.
- Liver fluke (*Fasciola hepatica*): It is commonly found in the liver of sheep.
- Roundworm (*Ascaris lumbricoids*): It is commonly found in the alimentary canals of pig and human being.
- Filaria worm (*Wuchereria bancrofti*): It is associated with sheep, goat, cattle and man. It causes elephantiasis in human beings.



(a) Tapeworm (b) Liver fluke (c) Roundworm (d) Filaria worm

Fig. 2.3. Examples of endoparasites

The **plant parasites** include:

- Dodder (*Cassytha filiformis*) which is a complete parasite.
- Mistletoe is known as **partial parasite** because the leaves (parasitic nutrition) perform photosynthesis. Its roots penetrate the xylem tissue of host to absorb water (parasitic nutrition). The water absorbed by the plant is used for photosynthesis.

(a) Dodder (b) Mistletoe

Fig. 2.4. Examples of plant parasites

2. **Symbiotic Nutrition:** This is the type of nutrition in which two organisms of different species called **symbionts** spend much of their lives in a close association and derive nutrients from each other. In symbiotic association, apart from nutrients, the symbionts can derive other benefits such as protection, shelter and reproduction.

Examples of organisms that exhibit symbiotic nutrition are as follow:

- **Lichens** are made up of the association of green algae and fungi. Both algae and fungi derive nutrients from each other. The fungus absorbs moisture from the atmosphere thereby providing water for itself while the green algae produce food for both plants by photosynthesis. The moisture provided by the fungus prevents the algae from dessication. This association enables the lichens to survive in unusual habitat.
- **Leguminous plants and bacteria:** In the root nodules of leguminous plants that grow in nitrogen-deficient soil, some nitrifying bacteria such as Nitromonas, fix the atmospheric nitrogen directly into the plant while the plant in turn provides food and shelter to the bacteria.
- **Protozoa inside the gut of termite:** In this symbiotic association, protozoa in the gut of termite help the termite to digest the cellulose eaten by termite while the termite provides food and protection for protozoa.

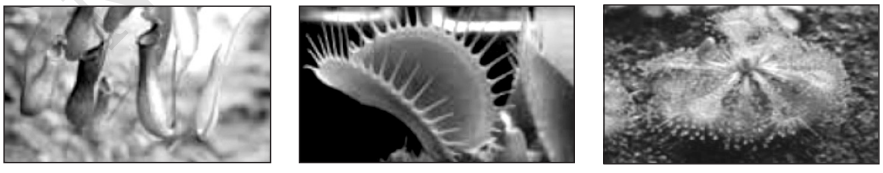
3. **Saprophytic Nutrition:** In saprophytic nutrition, organisms feed upon dead and decaying matter such as dead and decaying plants and animals. Organisms associated with this type of nutrition break down the organic matter of dead and decaying matter and therefore are described as **decomposers**. Examples of saprophytes include bacteria (moulds) and fungi (mushrooms), insects (termites), and worms.

Activity 1 (Individual Work)

Take a piece of bread and sprinkle some water on it. Put this bread in a plastic bag and close the bag tightly. Now keep the bag in a warm place for 3 to 4 days and observe the bag on daily basis. After a few days, some fungi are formed on the surface of bread and the bread becomes stale. Write down notes about the size and colour of fungus colony.

4. **Holophytic Nutrition (insectivorous Plants):** Insectivorous plants grow in nitrogen-deficient soil and they then use insects as their sources of nitrogen. For this, they are equipped with device used for trapping, digesting and absorbing nutrients from the insects. Examples of some insectivorous plants are as follow:

- **Pitcher plant or Nepenthes:** In the pitcher plant, the lamina of leaf is modified into a pitcher. The leaf apex forms the lid of pitcher and petiole coils like a tendril. The sugary secretion of lid attracts insects. As soon as the insect enters the pitcher, the lid closes and insect gets trapped. It is then digested by the enzymes secreted by the pitcher and the nutrient is then absorbed by the plant.
- **Venus flytrap:** In this plant, the edges of the leaves have long, pointed hairs. The lamina of the leaf is divided into two parts having a midrib in between like a hinge. When an insect visits the plant, the leaf suddenly closes and the insect gets trapped and digested by the enzymes secreted by the leaf.
- **Sundew (Drosera):** In Drosera plant, the upper surface of the leaf has glandular hair or tentacles. The leaf surface is sticky. The ends of tentacles secrete digestive enzymes capable of digesting insects caught. When the insect visits the plant, it stimulates the leaf to fold over and turn all the tentacles inwards. Secretions from the glands pour out and digest the insect.



(a) Pitcher plant (b) Venus flytrap (c) Drosera

Fig. 2.5. Examples of insectivorous plants

The differences between autotrophic nutrition and heterotrophic nutrition are tabulated in Table 2.1.

Table 2.1. Differences between autotrophic nutrition and heterotrophic nutrition

Autotrophic nutrition	*Heterotrophic nutrition*
Food is synthesised from simple inorganic raw materials such as carbon dioxide and water.	Food is obtained directly or indirectly from autotrophs.
The green pigment (chlorophyll) is necessary for this type of nutrition.	No pigment is needed for this type of nutrition.
Food is manufactured during the day time.	Food can be obtained at all times.
All green plants and certain types of bacteria and algae have this type of nutrition.	All animals, including human beings and fungi have this type of nutrition.

Holozoic Nutrition

Some organisms take in whole food and break it down internally in their bodies for absorbing nutrients. This type of nutrition is called **holozoic nutrition**. Unicellular organisms like *amoeba, paramecium* and other vertebrates and invertebrates including human beings show this type of nutrition. The **holozoic nutrition** is a typical method of nutrition in which organisms feed upon the solid organic substances synthesised by the plants. For this, they have specialised digestive tract or system in which the food is broken down internally for absorbing nutrients. Steps involved in holozoic nutrition are as follows:

1. **Ingestion:** It is the taking in of food into the mouth and chewing it.
2. **Digestion:** It is the breaking of complex food into simpler substances for absorption.
3. **Absorption:** It is the absorbing of digested food into the bloodstream of an organism.
4. **Assimilation:** It is the incorporation of digested food into the cells of living organisms.

Depending upon the food habit, holozoic organisms are divided into three categories. They are:

1. **Herbivores:** These animals feed on plants, e.g. Cow and Elephant
2. **Carnivores:** These animals feed on the flesh of other animals, e.g. Lion and Tiger
3. **Omnivores:** These animals feed on both plants and animals, e.g. Pig and Monkey

2.2 FOOD AND NUTRIENTS

Food is a substance which, when taken, digested, and incorporated into the body tissues, provides materials for energy, repair, growth, reproduction, regulation of life processes, and resistance to disease without harming the organism.

Definition: Substances that are essentially used in the body of organisms to sustain growth, repair of worn-out tissues and to furnish energy are called **food**.

2.2.1 Importance of Food

The food provides certain chemical substances which are needed for good health. These substances are important as they perform the following functions within the body of an organism:

1. They provide materials for building, repairing or maintaining normal and healthy body.
2. They help in regulating the body's metabolic processes.
3. They serve as a fuel to provide energy.
4. They produce hormones and enzymes.

2.2.2 Nutritional Role of Food Components

Nutrients may be organic or inorganic in nature. Depending on the nature of food and the type of nutrients they contain, food substances can be mainly classified into six classes:

1. Carbohydrates
2. Fats and oils (Lipids)
3. Proteins
4. Mineral salts
5. Vitamins
6. Water

Carbohydrates, fats and oils, and proteins are called **primary food substances** because they are required by the animals in large amounts. Vitamins, mineral salts and water on the other hand are called **welfare food substances** because they are required in small amounts for the growth and development of organisms. All the six mentioned above are essential for normal healthy life, and are needed in specific amounts in the diet. A deficiency of any of these materials results in abnormal functioning of the body. In addition to these materials, a proper diet should also contain roughage.

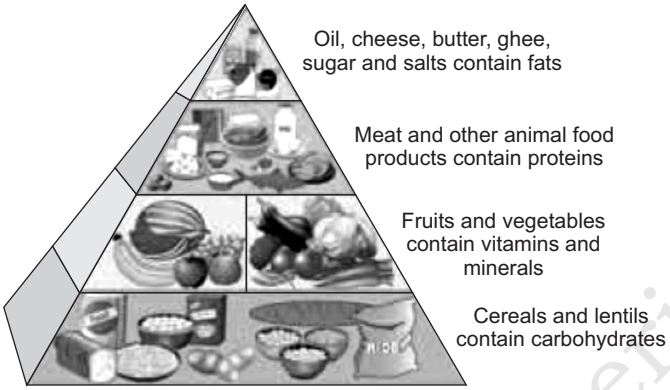


Fig. 2.6. Different classes of food

2.2.3 Carbohydrates

Composition: Carbohydrates are chemical compounds of carbon, hydrogen and oxygen in which hydrogen and oxygen are always present in the ratio of 2 : 1. They have the general formula of $C_x(H_2O)_y$.

Sources: The main sources of carbohydrates include Rice, Maize, Yam, Millet, Guinea Corn, Potato, Garri and Bread.

Types: Carbohydrates are broadly divided into three major types. These are:

1. **Monosaccharides:** These are **simple sugars** which are directly absorbed by the body cells. They have the general formula of $C_6H_{12}O_6$ with only one unit of simple sugar. Monosaccharides are of three types—**glucose** (most simple sugar), **fructose** (common in plants), and **galactose** (found in milk).

   Some forms of sugar associated with animals are the pentose sugars which include ribose and deoxyribose sugars. These sugars are linked with the formation of nucleic acids.
2. **Disaccharides:** These are **reducing sugars** which contain two units of simple sugars. They have the general formula of $C_{12}H_{22}O_{11}$. They are also of three types—**sucrose** (made up of glucose and fructose), **maltose** (made up of two molecules of glucose), and **lactose** (made up of glucose and galactose).
3. **Polysaccharides:** These are **complex sugars** which consist of more than two units of simple sugars. They have the general formula of $(C_6H_5O_6)_n$, where '*n*' represented a large number of molecules. Starch and cellulose are the examples of polysaccharides,

commonly found in plants. In animals, the only substance similar to starch is the glycogen, which is also known as animal starch.

Importance of Carbohydrates

1. Carbohydrate provides energy for proper functioning of the body.
2. It oxidizes to release heat which is used for maintaining the body temperature.
3. Carbohydrate is used to build exoskeleton of arthropods.
4. Mucus, which acts as lubricant in various metabolic activities of our body, is composed of carbohydrates.

2.2.4 Fats and Oils (Lipids)

Fats and oils are also known as **lipids**. Fats are the solid lipids at room temperature and known as **saturated fats**. Oils are the liquid lipids at room temperature and known as **unsaturated fats**. Both fats and oils are the macromolecules that can be hydrolysed during digestion to fatty acids and glycerol.

Composition: Fats and oils are composed of carbon, hydrogen and little oxygen.

Sources: The sources of fats and oils include Palm oil, Groundnut, Soybean oil, Melon oil, Butter, Fish, Cheese and Lard.

Importance of Fats and Oil (Lipids)

1. Fats and oils produce more energy than the carbohydrates. One mole of fat releases 9.45 kcal of energy.
2. They provide essential fatty acids to animals.
3. They help in maintaining the body temperature.
4. Fats and oils provide fat soluble vitamins.
5. Fats serve as stored food.
6. Fat under the skin protects the body against a rapid loss of heat.

2.2.5 Proteins

Proteins are complex molecules that are made up of smaller units of **amino acids**. As proteins are macromolecules, their breakdown during digestion take place in the following sequence:

Protein → Proteoses → Peptones →Polypeptides → Amino acids

Composition: Protein is composed of carbon, hydrogen, oxygen, nitrogen and sometimes phosphorus and sulphur.

Sources: The animal sources of proteins are Milk, Egg, Fish, Cheese, Meat and Chicken. The plant sources of proteins include Groundnut, Soybean and Cowpea.

Importance of Proteins

1. Proteins help in synthesis of ribonucleic acid and deoxyribonucleic acid.
2. They also used in the synthesis of new protoplasm and cells hence; they are needed for growth and replacement of dead cells in living organisms.
3. Proteins aid in reproduction.
4. They are also used in the production of hormones.

2.2.6 Mineral Salts

Various metabolic activities require different mineral salts for their proper functioning. Most of the minerals can be taken through the food that we eat. Only sodium chloride (table salt) and iron (in the form of tablets or capsules) can be taken directly. Lack of mineral salts causes nutritional deficiencies.

Classes of minerals include calcium, phosphorus, magnesium, sulphur, sodium, chlorine, iron, iodine, manganese, fluorine, copper and cobalt. Sources, functions and deficiency symptoms of minerals are tabulated in Table 2.2.

Fig. 2.7. An adult woman suffering from goitre due to iodine deficiency

Table 2.2. Minerals, their sources, functions and deficiency symptoms

Minerals	*Sources*	*Functions*	*Deficiency symptoms*
Calcium	Vegetables, fruits, eggs, cheese, milk	Muscles contraction, nerve action, blood clotting and formation of bones	Rickets in children
Phosphorus	Fish, eggs, cheese, milk	Bones and teeth formation, energy transfer from food, DNA, RNA and ATP formation	Rickets in young children
Magnesium	Green vegetables, nuts, seafood	Bone Formation, glycolytic activity in muscle	Depression, general body weakness, malfunctioning of muscles
Sulphur	Dairy products, meat eggs, broccoli	Formation of thiamine, keratin and amino acids	Stunted growth and yellowing of leaves in plants
Sodium	Salted food, meat, eggs, milk	Transmission of nerve impulses, maintenance of osmotic balance of cells	Muscles cramp, malfunctioning of kidney, dehydration
Chlorine	Table salt, seafood	Anion/cation balance, gastric acid formation	Malfunctioning of muscles
Iron	Liver, kidney, red meat, cocoa powder	Formation of haemoglobin in red blood cells	Leads to anaemia
Iodine	Seafood, iodised salt, fish	Production of thyroxine	Goitre, retardation in growth
Manganese	Seafood nuts, great vegetables	Required for noimal growth, activates glycolytic enzymes in muscles	General weakness, disruption in muscle contraction, depression

Fluorine	Milk	Resistance to dental decay	Dental decay
Copper	Meat, liver	Enzymes, melanin and haemoglobin formation	Poor growth, anaemia
Cobalt	Meat and yeast	Synthesis of vitamin B_{12}, formation of red blood cells	Anaemia

2.2.7 Vitamins

Vitamins are organic compounds needed in small quantities to support life. They do not supply energy. However, they do help the body to release energy from carbohydrates, fats and proteins. They also act as chemical enzymes in our body and play an important role in many chemical reactions throughout the body. There are two basic groups of vitamins—**fat soluble vitamins** and **water-soluble vitamins**. The fat-soluble vitamins include vitamin A, D, E and K while the water-soluble vitamins include vitamin C and vitamin B-complex. The B-complex vitamins are folic acid, thiamine (B_1), riboflavin (B_2), niacin (B_3), pantothenic acid (B_5), pyridoxine (B_6) and cyanocobalamine (B_{12}). Sources, functions and deficiency symptoms of vitamins are outlined in Table 2.3.

Table 2.3 Vitamins, their sources, functions and deficiency symptoms

Vitamins	*Sources*	*Functions*	*Deficiency symptoms*
Fat-soluble vitamins			
A (Retinol)	Sweet potatoes, milk, fish liver oil palm oil, spinach, red pepper	Proper vision in dim light, normal growth, proper functioning of skin	Reduced night vision, drying and hardening of skin
D (Calciferol)	Milk, fish-liver oil, egg yolk, margarine, early morning sunlight	Calcification of the bones and teeth, increased absorption of calcium and phosphorus from the alimentary canal	Rickets in young children and osteomalacia in adults

E (Tocopherol)	Margarine, green vegetables, milk, egg	Prevents breakdown of red blood cells	Causes anaemia due to breakdown of red blood cells in pregnant women
K	Cabbage, spinach, tomatoes and liver	Help in blood clotting	Slow blood clotting leads to haemorrhage
Water-soluble vitamins			
B_1 (Thiamine)	Yeast, liver, kidney, beans, groundnuts and unpolished rice	Synthesis of co-enzymes needed for cellular respiration	Beriberi, stunted growth and loss of appetite
B_2 (Riboflavin)	Yeast, liver, eggs, vegetables, groundnuts, yam	Helps in cellular respiration, promotes tissue repair and healthy skin	Weight loss, sometimes mental disorder, roughening of skin around the neck, nose, mouth and eyes
B_3 (Niacin)	Whole grain, liver, yeast, milk	Helps in cell metabolism	Causes pellagra
B_5 (Pantothenic acid)	Unpolished rice, yeast, eggs	Synthesis of co-enzymes needed for cellular respiration	Fatigue, poor, coordination of nervous system
B_6 (Pyridoxine)	Grains, vegetables, yeast, eggs, liver, kidney, fish	Essential for fat and protein metabolism	Insensitivity, depression, diarrhoea, dermatitis, anaemia
B_{12} (Cyanocobalamin)	Milk, kidney, liver, fish	Formation of red blood cells	Anaemia
C (Ascorbic acid)	Citrus fruits, tomatoes, guava, pawpaw, mango, green vegetables	Healthy bones and teeth	Scurvy
Folic acid	Liver, fish, green vegetables	Formation of red blood cells	Anaemia

2.2.8 Water

Water is a universal solvent that dissolves many substances.

Composition: Water is composed of two elements—hydrogen and oxygen in the ratio of 2 : 1.

Sources: Sources of water available to animals include metabolic water which is obtained from food that the animal eats. Physically, water is obtained from rivers, wells, ponds, taps, etc. Rain is the natural source of water.

Importance of Water

1. Water constitutes the major part of our body, 75% of our body is water.
2. It is required for metabolic activities in the body.
3. It helps in maintaining the temperature of our body.
4. It acts as solvent for soluble food substances and aids in the process of digestion.
5. It constitutes the major part of blood and provides medium for transportation of nutrients within the body along with the blood.
6. It also aids in excretion of metabolic wastes (such as urine) from the body.
7. It forms the basis of endocrinal secretions (hormones) in the body.

Activity 2

Observe the characteristics of following food items and classify them into different classes of food:

Garri, yam, rice, meat, butter, olive oil, common salt, fish, prawn, pepper, cowpea, onion, and crab.

2.3 BALANCED DIET

Our body requires carbohydrates, proteins, fats, vitamins, minerals and water in proper proportions. If there are not enough proteins, our body will not grow properly. If we do not have enough energy containing foods, we will feel very tired. If we have too much energy containing food we will become overweight. Therefore, a balanced diet must be eaten.

Definition: A diet that provides all the essential nutrients in a proper proportion required by the body for proper growth and good health is called **balanced diet**.

In terms of the percentage composition of the food substances, balanced diet should contain:

- 60% of carbohydrates
- 15% of proteins
- 10% of fats and oils
- 10% of vitamins, minerals and water
- Roughages are equally important as they help in proper digestion of food.

The condition in which people become weak and sick because of insufficient nutrients or poor diet or unbalanced food is called **malnutrition**.

2.3.1 Concept of Malnutrition

A lack of any nutrients in the balanced diet leads to **malnutrition**. For example, deficiency of proteins in diet causes a deficiency disease called **kwashiorkor.** This disease is common in tropics because of high cost of protein foods.

Fig. 2.8. A child suffering from kwashiorkor due to protein malnutrition

2.3.2 Food Tests

Tests for different classes of food such as carbohydrates, proteins, fats and oils are represented in Table 2.4.

Table 2.4. Food tests

Food	*Test*	*Observation*	*Inference*
Test for carbohydrates	**1. Benedict's test** (for simple sugars) Sucrose solution + 2% of Benedict's solution + boiling for 4-6 min.	A brick-orange red precipitate obtained	Sucrose present

	2. Fehling's test (for disaccharides) A small quantity of sucrose solution + few drops of Fehling solution + Few drops of HCl + Boiling	A yellow precipitate obtained	Sucrose present
	3. Test for starch (Polysaccharides) Food containing starch (yam) + few drops of iodine solution	Colour of food changes to blue-black	Starch present
Test for proteins	**1. Biuret test** Small quantity of milk + 1 cm^3 of protein + 1% copper (II) solution in drops + shake well	Colour of mixture changes to purple	Protein is present
	2. Million's test (a) Any proteinaceous food + Millon's reagent (b) Heat the above mixture	A white precipitate will be formed Precipitate turns deep red	Confirms the presence of protein
Test for fats and oils (lipids)	**1. Emulsion test** Take the sample in a test tube and add ethyl alcohol Shake vigorously and pour the solution into water.	a milky, white emulsion is formed.	Lipid is present in the sample which floats on the top of the white emulsion.

Activity 3 (Group Activity)

To test the presence of carbohydrates, proteins and lipids, collect some foods items such as juice of cane sugar, raw potato, milk, groundnut, yam, a slice of vegetable, cooked rice and boiled egg. You may perform the following tests to complete the activity:

- Benedict's test for simple sugar.
- Iodine test to test for non-reducing sugar.
- Lipid emulsion test for lipids.
- Biuret test for proteins.

2.4 TEETH AND DENTAL FORMULAE

Amount and arrangement of teeth in humans

Mammals have two sets of teeth in their life time—**temporary teeth** and **permanent teeth**.

The temporary or milk teeth appear from the age of about 6 months to 2 years and start getting replaced by the permanent teeth from the age of 5 or 6 years. Human beings have 20 temporary teeth which are replaced by the permanent teeth completely by the age of 12 to 13 years. The permanent set has 32 teeth, which lasts for the rest of our lives.

2.4.1 Structure of a Tooth

A **tooth** is embedded in the jaw bone of maxilla (upper jaw) and mandible (lower jaw). A fibrous tissue called periodontal membrane fixes the tooth into the jaw bone. Structurally, a tooth has three main parts—the **crown, neck** and **root.** The crown is the white part that can be seen sprouting in the mouth cavity. The root is the part of tooth embedded in the socket of jawbone. The neck is covered by the gum. It lies between the crown and the root of the tooth.

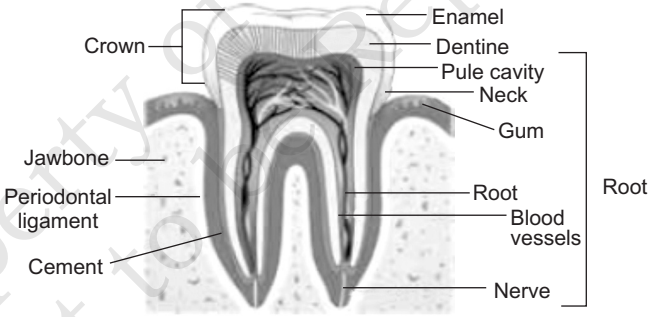


Fig. 2.9. Longitudinal section of a tooth

A tooth is made up of the following layers:

1. **Enamel:** It is the outer part of the tooth, and the hardest substance present in the body. It is white in colour and made up of the special cells of gum. It is a non-living substance made up of calcium salts. It protects the dentine and pulp cavity of the tooth.
2. **Dentine:** It makes up most of the tooth. It is harder than the bone. It is pierced by fine canals which help in transport of nutrients.
3. **Pulp cavity:** It is the innermost part of the tooth. It contains tiny blood capillaries and nerve fibres that enter the pulp cavity

through a passage in the root called the **root canal**. The nerves transmit sensation of pain to the brain, and blood capillaries supply nutrients to the tooth cells.

4. **Cement:** It covers the dentine in the root of the tooth. It has fibres growing out of it. These attach the tooth to the jawbone but allow it to move slightly while biting or chewing.

2.4.2 Dental Formula

Permanent mammalian teeth are indicated by a formula called the **dental formula**. It indicates number of each kind of teeth present in the mouth. The names of teeth are abbreviated as incisor (i), canine (c), premolar (pm), and molar (m). They are given strictly in the order of occurrence which represents half of the upper jaw as numerator and lower jaw as denominator. A general representation of dental formula is:

$$\text{Dental formula} = \frac{i}{i}, \frac{c}{c}, \frac{pm}{pm}, \frac{m}{m}$$

Adaptation of Dentition to Mode of Nutrition

The number and types of teeth present in each jaw of an organism is a reflection of special adaptation of mammalian teeth for nutrition.

The teeth of a human being (Omnivore)

The dental formula of a human being is:

$$\text{Human being} — \frac{i}{i}, \frac{c}{c}, \frac{pm}{pm}, \frac{m}{m} = \frac{2}{2}, \frac{1}{1}, \frac{2}{2}, \frac{3}{3} = 32$$

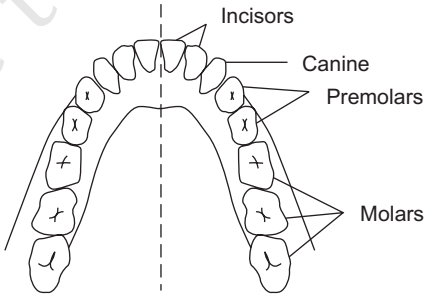


Fig. 2.10. Dentition of a human being (Omnivore)

Human being is an omnivore, this means he feeds upon both flesh and vegetables. Their teeth are adapted by the following ways:

1. Incisors are sharp and broad for cutting of food.

2. Canines are sharp and pointed for tearing of flesh.
3. Premolars and molars have strong cusps for chewing and grinding of food.

The teeth of a dog (Carnivore)

The dental formula of a dog is:

$$\text{Dog} — \frac{i}{i}, \frac{c}{c}, \frac{pm}{pm}, \frac{m}{m} = \frac{3}{3}, \frac{1}{1}, \frac{4}{4}, \frac{2}{3} = 42$$

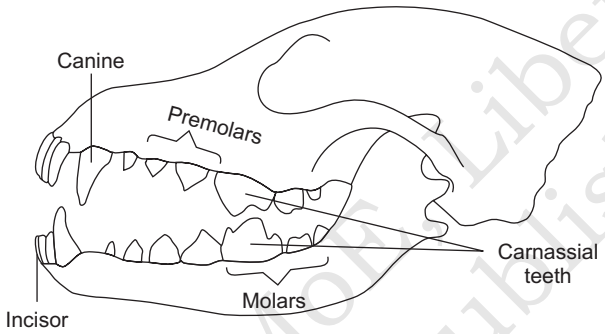


Fig. 2.11. Dentition of a dog (Carnivore)

Dog is a carnivorous animal that feeds on the flesh. Their teeth are adapted by the following ways:

1. Incisors are used to cut the small pieces of flesh from the bones.
2. Canines are pointed, sharp, curved and long used for tearing the flesh from bones. They also used for attack, defence and seizing of prey.
3. Premolars and molars are broad and thick. Their blunt flat surfaces are used for cutting and grinding food. The last premolar in the upper jaw and first molar in the lower jaw are large and modified to form **Carnassial teeth**. These teeth possess sharp edges which are used to cut up meat and tear it away from the bones.

The teeth of a rabbit (Herbivore)

The dental formula of a rabbit is:

$$\text{Rabbit} — \frac{i}{i}, \frac{c}{c}, \frac{pm}{pm}, \frac{m}{m} = \frac{2}{1}, \frac{0}{0}, \frac{3}{2}, \frac{3}{3} = 28$$

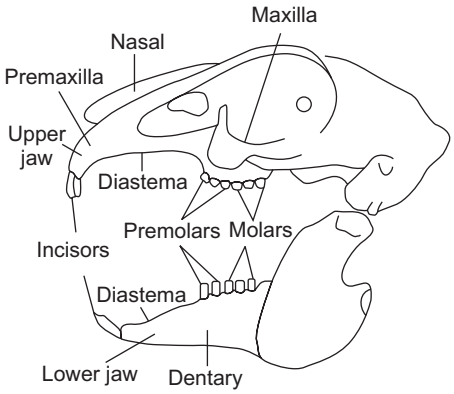


Fig. 2.12. Dentition of a rabbit (Herbivore)

Rabbit is an herbivorous animal that feeds on the vegetables and grasses. Their teeth are adapted by the following ways:

1. Incisors are flat with sharp cutting edges used for cutting of vegetables and grasses.
2. Canines are absent and create a space called **diastema**. It helps in manipulating grasses in the mouth.
3. Premolars and molars are large and have ridged surface area for grinding and cutting of food.

2.4.3 Dental Care

Small pieces of food get trapped between the teeth. If the teeth are not properly cleaned after eating food, the bacteria present in the mouth feed on the food and produce an acid which slowly dissolve the enamel and cause tooth decay. Hence, a proper care of teeth is a must. The ways by which teeth can be taken care of are as follows:

1. The teeth should be cleaned after every meal and before going to bed.
2. Rinse the mouth using hydrogen peroxide as it removes the stain of cola and tobacco on teeth.
3. Addition of vitamins and mineral-containing foods such as green vegetables, fruits, eggs, milk and butter in our diet to make the teeth healthy and strong.
4. Sugary foods and drinks must be avoided as the bacteria feed on sugar and produce acid which causes tooth decay.
5. Dentist should be visited at least twice a year for proper care of the teeth.

Activity 4 (Presentation)

Visit a dentist and find out the how to take care of your teeth properly. Based on the information received, prepare a presentation on Care of Teeth and represent it in the class.

2.5 FOOD POISONING AND PREVENTION

2.5.1 Preservation of Food

Food is spoilt by microorganisms, insects and enzymes. Microorganisms cause food poisoning by excess growth and the toxic produced. Moulds cause a cotton-like appearance on bread. Bacteria spoil milk, fruits and eggs. Thus, food preservation becomes important for us, especially because under Nigerian climatic conditions, foodstuffs are easily spoilt. Food can be preserved by providing conditions in which microorganisms cannot live. It is a process of creating unfavorable conditions for growth of microbes without changing the nutritional value, texture and flavour of food.

Methods of Food Preservation Along with their Biological Basis

The following are important methods employed in food preservation. They are:

1. **Salting:** We use common salt for preserving food. The salt increases the osmotic pressure of food to a particular level which cannot be tolerated by the microorganisms. Hence, the food can be preserved. Higher salt content prevents the growth of micro-organisms which may spoil the food. Meat, fish and locust bean seeds can be preserved by salting.
2. **Drying:** Drying involves the exposure of food items to direct sunlight. Due to process of drying, nutrients of food become concentrated and prevent the growth of microorganisms on the food. Drying also reduces the weight of food so the food can easily be transported at the points where they can be marketed. Cereals, melon seeds, pepper and fish can be preserved by drying.
3. **Smoking:** It is the use of gaseous chemicals that are used to produce smoke. The smoke produced kills the microorganisms of the food and prevent the entry of more microorganisms from the environment to the food. Fish, meat, tobacco and groundnut can be preserved by smoking.

4. **Refrigerating:** Refrigeration or freezing provides lowest temperature for preserving food. Cold storage and household refrigerators are the examples of this method. At very low temperature, say –18°C, growth of microorganisms that cause food spoilage is completely prevented. In the process of refrigeration, nutritive value of food can be conserved. Meat, fish, vegetables and fruits can be refrigerated.
5. **Heating:** This method involves the heating of food substance up to 72°C for about 15 minutes and then immediate cooling for storage. Heat preserved foods are foods that have been treated using a thermal process to extend their shelf life Examples include canned fruit and vegetable products, aseptically processed fruit juices in cartons and pasteurized ready meals.
6. **Parboiling:** Parboiling is the partial boiling of food as the first step in cooking. It is often used when referring to parboiled rice. Parboiling can also be used for removing poisonous or foul-tasting substances from foods, and to soften vegetables before roasting them. The three basic steps of parboiling are soaking, steaming and drying. These steps make the rice easier to process by hand, while also boosting its nutritional profile, changing its texture, and making it more resistant to weevils. This method of food preservation practiced in many parts of West Africa.
7. **Frying:** Frying is one of the methods of food preservation usually done with a shallow oil bath in a pan over a fire or as so-called deep fat frying, in which the food is completely immersed in a deeper vessel of hot oil. Simultaneous mass and heat transfer by hot oil modifies the food surface, forming a crust that preserves flavors and retains part of the juiciness of the food while it is cooked, making chewing and digestion easier.
8. **Use of oil:** Oil provides an airtight seal for the ingredients, thus improving their shelf life. When the food is preserved in the oil, the oil prevents oxidation from the air in the container which can lead to discolouration of some foods. By excluding air from the surface of the vegetable, it establishes anaerobic conditions which actually favor the growth of some types of bacteria.
9. **Dehydration:** Dehydration, in food processing, means by which many types of food can be preserved for indefinite periods by extracting the moisture, thereby inhibiting the growth of microorganisms. Dehydration is one of the oldest methods of food

preservation and was used by prehistoric peoples in sun-drying seeds.

Activity 5

In a group, collect local food samples found in your area such as, Cassava, Paw Paw, groundnuts, fish, milk, etc. Discuss about the methods used for their preservation. Also compare them with other food stuffs that have not been preserved.

Methods of Food Preservation in West Africa

The preparation of processes and preserved meat and seafood is a common practice in West Africa. Communities in various regions of West Africa have used food preservation methods as a means of prolonging the shelf life of meat for centuries. The indigenous ways of preservation have been used for centuries, and in West Africa, they are still popularly used today. Some of the methods of preserving food using local resources are described below.

Methods of Preserving Food using Local Resources

1. **Canning:** Canning is the process of pasteurizing food products at specific temperature and then immediately sealed in a vacuum seal. Canning works for almost all types of meat however, require the use of special jars or containers with sealed lids.
2. **Freezing:** Freezing is the most ideal and convenient way of preparing food for preservation. All types of meat and sea food can be freeze at temperature of 0°F in a regular refrigerator freezer.
3. **Fermenting:** Fermenting is one of the most popular methods of food preservation in West Africa. Foods that are fermented are technically aged; however, they age as a result of beneficial microbes. The process of fermentation occurs when one kind of microbe acts on a food substance and converted them into acids or alcohols. Fermented corn and maize are popular food in West Africa.
4. **Drying:** It is the process through which food is dehydrated until all the moisture that supports microbial activity is removed. The water removal from meat and seafood also concentrates the flavors in the food, therefore enhancing the taste. The process of drying can be done in food dehydrators.

Importance of Food Preservation

1. Food preservation decreases food wastage and saves food from throwing into the wet waste.
2. It increases the storage period of food.
3. It makes it possible for us to get fruits and vegetables even in off-seasons. Nowadays, we get cauliflower, capsicum and apples throughout the year.
4. It makes it possible for us to get perishable food such as fruits and vegetables from far-off places.
5. Food preservation prevents the food from being spoiled by the action of enzymes and microbial pathogens.
6. Food preservation retains the quality of food—colour, texture, flavour and nutritional value.

GLOSSARY

- **Autotrophs:** Organisms prepare (synthesise) their own food from simple raw materials like water, carbon dioxide and minerals present in the surroundings.
- **Balanced diet:** A diet that provides all the essential nutrients in a proper proportion.
- **Chemosynthesis:** A type of autotrophic nutrition in which certain bacteria synthesise organic compounds from simple inorganic materials.
- **Decomposers:** Organisms that feed on dead and decaying matter.
- **Dental formula:** Permanent mammalian teeth are indicated by a formula called the dental formula. It indicates number of each kind of teeth present in the mouth.
- **Dentition:** An arrangement and number of teeth in the mouth.
- **Heterotrophs:** Organisms those are not able to make their food.
- **Holozoic nutrition:** A type of nutrition in which the organism takes in whole food and breaks it down internally in its body for absorbing nutrients.
- **Homodont:** A type of dentition, in which organisms have same type of teeth.
- **Host:** Organism on which a parasite derives nutrients.

- **Malnutrition:** A condition caused due to a lack of nutrition in a balanced diet.
- **Nutrients:** Inorganic as well as organic substances, used by the organisms as a source of energy and maintain life.
- **Parasite:** The organism that derives nutrients from other organism.
- **Photosynthesis:** a chemical process by which green plants synthesise their own food in the presence of sunlight in the chlorophyll of chloroplast.
- **Symbionts:** A type of nutrition in which two organisms of different species spend much of their lives in a close association and derive nutrients from each other.

SUMMARY

- Nutrition is the process that deals with the digestion of food and how the body uses it to obtain energy.
- The ways by which all living organisms including plants, animals and human beings obtain their food are called modes of nutrition.
- There are following major types of nutrition— autotrophic nutrition, heterotrophic nutrition and holozoic nutrition.
- In autotrophic mode of nutrition, organisms are able to synthesise their own food and are called autotrophs.
- Autotrophic nutrition can be further divided into two types. These are photosynthetic nutrition and chemosynthetic nutrition.
- The photosynthetic nutrition is performed by green plants and chemosynthetic nutrition is performed by certain bacteria.
- Heterotrophs are the organisms that do not make their food and their mode of nutrition is called heterotrophic nutrition.
- Heterotrophic nutrition is of the following types— parasitic nutrition, symbiotic nutrition, saprophytic nutrition and holophytic nutrition (insectivorous plants).
- Substances that are essentially used in the body of organisms to sustain growth, repair of worn-out tissues and to furnish energy are called food.
- There are six classes of food—Carbohydrates, proteins, fats and oils, vitamins, mineral salts, and water.
- Fats and oils are also known as lipids. They are composed of carbon, hydrogen and little oxygen.

- Proteins are complex molecules that are made up of smaller units of amino acids.
- Mineral salts are needed for the proper metabolic functioning.
- Vitamins are the organic compounds needed in small quantities to support life. There are two basic groups of vitamins—fat soluble vitamins and water-soluble vitamins.
- Water constitutes the major part of our body. 75% of our body is water.

EXERCISES

A. Multiple Choice Questions

1. Another name for photosynthetic nutrition is
(a) Holophytic nutrition (b) Chemosynthetic nutrition
(c) Parasitic nutrition (d) Saprophytic nutrition

2. In symbiosis
(a) A mutual association occurs between two organisms of different species
(b) Only host organism gets benefitted
(c) Tick sucks the blood of a dog
(d) Plants traps insects for their nutrition

3. Which of the following processes are associated with photosynthesis?
(i) Energy from sunlight is absorbed.
(ii) Carbon dioxide is evolved.
(iii) Oxygen is given off.
(iv) Glucose is synthesised.
(a) (i) and (ii) only (b) (i), (ii) and (iv) only
(c) (i), (iii) and (v) only (d) (i), (ii), (iii) and (iv)

4. The outer hardest part of a tooth is called
(a) Enamel (b) Dentine
(c) Cement (d) Pulp cavity

5. Deficiency of protein in diet leads to
(a) Kwashiorkor (b) Malaria
(c) Diarrhoea (d) Tuberculosis

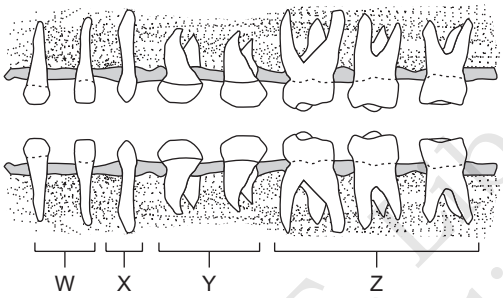
6. A disease that results from lack of iodine in the diet of human is
(a) Beriberi (b) Scurvy
(c) Rickets (d) Goitre

7. Soybean oil, Melon oil, Butter, Fish, Cheese and Lard are the examples of

(a) Carbohydrates (b) Fats

(c) Proteins (d) Vitamins

The diagrams below are illustrations of the dentition of an organism. Study them and answer questions 8 to 9.



8. The dentition belongs to

(a) Rabbit (b) Cat

(c) Frog (d) Man

9. The function of teeth labelled X is for

(a) Biting and grasping (b) Chewing and grinding

(c) Tearing and grasping (d) Chewing and tearing

10. Which of the following dental formulae represents the dentition in rabbits?

(a) $I\frac{2}{1}C\frac{0}{0}P\frac{3}{3}M\frac{3}{3}$ (b) $I\frac{3}{3}C\frac{1}{1}P\frac{2}{2}M\frac{3}{3}$

(c) $I\frac{1}{2}C\frac{0}{0}P\frac{2}{3}M\frac{3}{3}$ (d) $I\frac{2}{1}C\frac{0}{1}P\frac{3}{2}M\frac{3}{3}$

11. A process of pasteurizing food products at specific temperature and then immediately sealed in a vacuum seal is called

(a) Canning (b) Fermenting

(c) Freezing (d) Drying

B. Fill in the blanks

1. Food as a complex _____needs to be broken down into simpler form before it can be utilised by the body.

2. Plants require organic nutrient like _____to sustain their life.

3. The organisms capable of photosynthesis are called _____.

4. Bacteria that live under sea hot springs _____hydrogen sulphide.

5. Cellulose is a _____that makes the cell walls of the plants.

6. Lack of mineral salts causes nutritional _____.
7. A lack of any nutrients in the balanced diet leads to _____.
8. Teeth mainly help in ingestion and _____digestion of food in the mouth.
9. The salt increases the _____ pressure of food to a particular level which cannot be tolerated by the microorganisms.
10. _____ is the process through which food is dehydrated until all the moisture that supports microbial activity is removed.

C. Answer the following questions.

1. Describe three types of heterotrophic nutrition. Give one example of each of them.
2. Why is photosynthetic nutrition known as holophytic nutrition? Give reason.
3. State examples of bacteria that exhibit chemosynthetic mode of nutrition. Write the chemical equations for this.
4. Name the steps involved in holozoic mode of nutrition.
5. What is the difference between ectoparasites and endoparasites? Give two examples of each of them.
6. Write a balanced chemical equation for photosynthesis. Why is photosynthesis important?
7. Explain methods of food preservation and give one example each of products which can be preserved.
8. State the principles involved in the following methods of food preservation:
   (a) Refrigeration
   (b) Smoking
   (c) Salting
   (d) Drying