

10

NUTRITION

[NUTRITION IN GENERAL]

Unit-5

Human Anatomy and Physiology

Syllabus : Classes of food, balanced diet. Malnutrition and deficiency diseases.

Functions of carbohydrates, fats, proteins, mineral salts (calcium, iodine, iron and sodium), vitamins and water in proper functioning of the body. Sources of vitamins, their functions, and deficiency diseases. Meaning and importance of a 'Balanced Diet'. Role of cellulose in our diet. Causes, symptoms and prevention of Kwashiorkor and Marasmus.

THE TERMS NUTRITION, FOOD AND DIET.

Nutrition means supply of the essential organic and inorganic chemical compounds (*proteins, vitamins, salts, etc.*) to the body. All such chemical compounds are called **nutrients**.

Food is any substance which we eat or drink, and which contains the nutrients. Examples : Milk, bread, egg, fish, apple.

Diet. The combination of food items which we eat in our meals. A **balanced diet** is one which includes food items which supply all the necessary nutrients. [Meal is the food taken at one time to satisfy appetite. **Appetite** means the desire to eat and **hunger** is the uneasy sensation due to lack of food.]

10.1 NEED OF NUTRITION

All living organisms require food. It is needed for six main purposes :

- (i) **Growth** : Building up new protoplasm or cells for growth,
- (ii) **Repair** : Providing material for the **repair** of worn-out or injured cells,
- (iii) **Energy** : Providing **energy** needed by the body to carry out various life functions.
- (iv) **Maintenance** of chemical composition of cells
- (v) **Provision of raw materials** for the manufacture of various secretions such as enzymes, hormones, sweat, milk, etc.
- (vi) **Protection** from disease and infection.

10.2 CLASSES OF NUTRIENTS (FOOD SUBSTANCES)

There are **six** classes of food substances called nutrients. These are **carbohydrates, fats, proteins, mineral salts, vitamins** and **water**.

1. **CARBOHYDRATES** are the compounds of carbon, hydrogen and oxygen, with hydrogen and oxygen always in the ratio of 2 : 1. They are oxidised in the cells to **release energy**. Carbohydrates include sugars, starch, cellulose, etc.

SUGARS

Sugars are soluble in cold water and taste sweet. Broadly, the sugars in our foods are of two major categories :

- A. Monosaccharides or single (simple) sugars** with a general chemical formula $C_6H_{12}O_6$. These need no digestion and are straightaway absorbed into the body. Three types of such simple sugars are:
 - (i) **Glucose**, popularly known as grape-sugar, is the most common and simplest sugar found in organisms. (When we say blood sugar, it means the glucose level in blood).
 - (ii) **Fructose** is common in plants and is popularly called fruit sugar.
 - (iii) **Galactose** is another simple sugar found in milk.
- B. Disaccharides or double sugars** have a general chemical formula $C_{12}H_{22}O_{11}$. These are also three and require digestion.
 - (i) **Sucrose** is our commercial sugar. It is commonly obtained from sugarcane in our country. Another source of sucrose is the sugar-beet. Sucrose is a double-sugar made up of two simple sugars, **glucose** and **fructose**.
 - (ii) **Maltose** or malt-sugar made up of **two glucose molecules**.
 - (iii) **Lactose** or milk-sugar made up of **glucose** and **galactose**.

STARCH

Starch is an insoluble carbohydrate. It is in this form that plants commonly store carbohydrates.

Potatoes, grains (rice, maize, wheat and barley) and bread, are chief sources of starch. The starch has a chemical formula $(C_6H_{10}O_5)_n$ and is called **polysaccharide**.

Two other insoluble polysaccharide carbohydrates are **cellulose** and **glycogen**.

- **Cellulose** is found in cell walls of plants. It is unused in our body but it contributes in providing **roughage** for proper functioning of the gut.
- **Glycogen** is the form in which carbohydrates are stored in animals (mainly liver and some also in muscles)

Carbohydrates are the principal energy sources in the body. (1 mole of glucose releases 686 kilocalories of energy)

ROUGHAGE (Non-digestible cellulose)

The cells of all plants have cell walls made of cellulose. When we eat fruit, raw vegetables and other plant material, cellulose is not digested in our food canal. This is because we have no cellulose digesting enzyme. The undigested cellulose, being fibrous in nature, acts as roughage.

ROLE OF ROUGHAGE

- Being fibrous, cellulose absorbs a lot of water and retains it, thus helps in keeping the faecal matter soft and prevents constipation.
- The movement of the undigested food through the intestine becomes easier.
- It stimulates the muscle contraction in the intestinal wall, making the movement of faecal matter easy.

SOURCES OF ROUGHAGE

Vegetables, fruit, corn, half-crushed wheat (*Dalia*) are the chief sources of roughage in our food. Cabbage is one vegetable which provides a lot of roughage.

2. FATS are also composed of carbon, hydrogen and oxygen. The oxygen content in these nutrients is much less. They produce **more energy** than carbohydrates do—one mole of fat releases 9.45 Kcal of energy. Common foods rich in fats are butter, cream, vegetable oils, fats of meat and fish liver oils. Fats and oils are made up of fatty acid and glycerol.

FUNCTIONS OF FAT

1. Fat produces energy in the body like carbohydrates.
2. It is an important storage form of food.
3. It serves as a solvent for fat-soluble vitamins
4. Fat under the skin protects the body against a rapid loss of heat (insulation)

3. PROTEINS are large chemical molecules. They contain carbon, hydrogen, oxygen and nitrogen. **Nitrogen** is the most essential element in proteins. Some proteins may also contain sulphur and phosphorus.

Amino acids are the simple, smaller units of proteins.

Proteins provide chemical material for the **growth** and **repair of body cells** and tissues. In the time of emergency they may also be oxidised to **release energy**.

Foods rich in proteins include lean meat, fat-free muscles, fish, eggs, milk, cheese, nuts, beans, peas, etc. Deficiency of proteins leads to weakness but its severe deficiency causes the two diseases **Kwashiorkor** and **Marasmus**.

(i) **Kwashiorkor** (Hindi *Sookha Rog*) – It is a severe protein deficiency disease usually affecting young children. This disease is caused when mothers stop breast-feeding their babies at an early age, and the child is given a diet **poor in proteins**. Mother's milk is rich in protein, and after weaning, the child is given a diet mainly consisting of carbohydrates and poor in proteins. The suffering child may die before the age of five years.

Symptoms of Kwashiorkor :-

- Underweight.
- Belly protruding out.
- Skin getting dark and scaly.
- Stunted growth.
- Loss of appetite.
- Repeated diarrhoea.
- Enlarged liver and anaemia.
- Oedema (swelling) of the feet and the face (accumulation of water in the tissues of the feet and the face).

Control/treatment : The child suffering from kwashiorkor should be given a protein-rich diet like pulses, milk, egg, fish and meat. A mixed diet of wheat, gram, peanuts, soybean and jaggery is also useful.

KWASHIORKOR

The name "Kwashiorkor" is a Ghanian term (in Africa) which means "the sickness the baby gets when the new baby comes." This is so because the elder child's source of protein (mother's milk) is no longer available and now he is usually fed on a starchy diet consisting mostly of fruit and vegetables.

(ii) **Marasmus** : Marasmus usually affects infants below the age of one year, and is due to the deficiency of carbohydrates, fats and proteins in the diet. This disease is caused due to the sudden stoppage of breast feeding, followed by a diet **poor in energy-giving foods like carbohydrates, fats and proteins.**



Fig. 10.1 A child suffering from marasmus

Symptoms :

- Less body weight.
- Degenerations resulting in a very weak body as if formed of muscles, skin and bones only.
- Skin becomes loosely folded.
- Thin face, thinning of limbs.
- Retarded physical and mental growth.
- Ribs appearing prominent.

Table. 10.1 Differences between Kwashiorkor and Marasmus

Kwashiorkor	Marasmus
1. It affects children from 1-5 years of age.	1. It affects infants up to 1 year of age.
2. It is due to the deficiency of proteins in the diet.	2. It is due to deficiency of carbohydrates, proteins and fats in the diet.
3. Oedema of legs and face.	3. No oedema.
4. The skin of the patient becomes dark and scaly.	4. No darkening of the skin.
5. No degeneration of the muscles.	5. Degeneration of the muscles, with the body becoming very weak.

Control/treatment : The child suffering from marasmus should be given a diet rich in proteins and carbohydrates.

4. **MINERAL SALTS** are needed in the diet in small quantities. Table salt contains mainly sodium chloride. Many other mineral elements are obtained from various foodstuffs such as green vegetables and fruit. Some important mineral elements and their nutritional values are as follows :

Calcium and phosphorus for strengthening the bones and the teeth. Calcium is also required in the process of clotting of blood. **Phosphorus** is required in various chemical processes, as in the production of chemical energy (ATP) during cell respiration. **Rich sources** : milk, meat, eggs, fish, pulses, vegetables, etc.

Iron for forming haemoglobin; its deficiency leads to anaemia. **Source** : green leafy vegetables, liver, etc.

Iodine for proper working of thyroid; its deficiency leads to goitre. **Source** : vegetables, mineral water, etc.

Potassium and sodium for cell permeability, especially in nerve cells. **Source** : most foods and table salt.

[A detailed list of essential mineral elements, their sources, functions and the related deficiency diseases are given in the Table 12.2 on the next page]

5. **VITAMINS** are chemical substances needed in minute amounts, which help maintain a healthy body. Most vitamins act as catalysts or enzymes in essential chemical changes in the body but each vitamin has also some special function in our body.

Vitamins are contained in foods naturally but a couple of them are also synthesized in our body.

Some vitamins (A, D, E and K) are **fat-soluble** and can be stored in the body, for a longer period of time but some others (B complex containing several vitamins named B₁, B₂, etc., and C) are **water-soluble** and cannot be stored for a longer period of time.

Absence or shortage of vitamins in diet over a continued period causes **deficiency diseases.**

In a low concentration, vitamins have a catalytic and regulatory function in cell metabolism. Excess

Table 10.2 Some essential mineral elements and their sources, functions, etc., in human body

ELEMENT	SOURCE	FUNCTION	DEFICIENCY DISEASES
I Macronutrients (needed in large quantity)			
1. Calcium	Dairy foods, beans, cabbage	Constituent of bone, enamel, Required for muscle contraction, clotting of blood.	Rickets , poor skeletal growth
2. Sodium	Table salt	Regulates acid base equilibrium,	Muscular cramps, nerve impulses do not get transmitted
3. Potassium	Banana, potato, citrus fruit	Nerve and muscle activity, fluid balance, secretion of neurotransmitter (acetylcholine)	Nerve impulses do not get transmitted
4. Phosphorus in phosphate	Dairy products, cereals, beans, nuts, meat, egg,	Synthesis of nucleic acid, ATP, NADP, bones, enamel, for muscle contraction, conduction of nerve impulse.	Soft bone
5. Magnesium	Vegetables, whole grain, nuts, sea food, meat	Bone and tooth structure, synthesis of enzymes	Increased irritability of nervous system
6. Sulphur in sulphate	Dairy products, onion, garlic, radish, meat, egg	Component of protein and co-enzymes	Skin problems.
7. Chlorine	Table salt	Water balance, secretion of HCl in gastric juice	Muscular cramps
II Micronutrients (needed in small quantity)			
1. Iron	Whole cereals, fish, nut, egg yolk, liver, kidney	Synthesis of haemoglobin associated with oxidation, reduction reactions.	Anaemia (deficiency of haemoglobin in blood)
2. Cobalt	Milk, cereals, pulses, liver, red meat	Development of red blood cells, component of vitamin B ₁₂	Pernicious anaemia
3. Copper	Nuts, legumes, liver, kidney	Production of melanin, cell oxidation, synthesis of enzymes	Loss of body weight, anaemia
4. Zinc	Cereals, pulses, nuts, meat, liver oil	Needed for synthesis of enzymes, carbon dioxide transport in blood.	Retarded growth, skin lesions, albinism
5. Iodine	Iodised salt, water, sea foods	Component of thyroxin hormone secreted by thyroid gland	Goitre, cretinism in children (poor mental and physical growth)
6. Fluorine	Water, milk	Component of tooth enamel and bone	Dental decay
7. Manganese	Vegetables	Bone development, nitrogen-metabolism	Poor bone development
8. Molybdenum	Pulses, cereals, meat	Nitrate assimilation	Slight retardation of growth

of vitamins may also be harmful. Excess water-soluble vitamins are easily excreted out.

Table 10.3 on page 92 summarises some important facts about common vitamins.

6. **WATER** is indispensable. About 2/3 of our body weight is water. It serves several functions.

- It acts as a solvent in the body for thousands of substances both organic and inorganic.
- It is used to produce digestive juices.
- It helps in the transportation of digested foods and oxygen throughout the body,

- It is used in the excretion of soluble wastes.
- It is involved in the maintenance of body temperature.

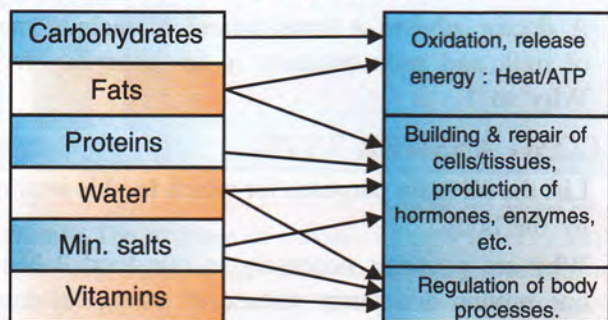
Loss and replacement. Water is regularly lost from the body through sweat, urine, and as water vapour in breath. Therefore, it must be constantly replaced. The liquids we drink and our foods, such as fruit and vegetables, which we eat supply water to the body still we should drink sufficient water every day.

Table 10.3 Summary of vitamins, their sources, functions, and the related deficiency diseases

VITAMIN	RICH SOURCES	CHIEF FUNCTIONS	DEFICIENCY DISEASES
(a) FAT-SOLUBLE VITAMINS			
A (<i>Retinol</i>)	Butter, egg yolk, liver, milk, carrots, leafy green vegetables, yellow fruit, fish liver oils.	Promotes growth, resists infection of the skin and mucous membrane, component of visual purple in retinal cells of eye for perception of image.	Night-blindness: Poor vision in dim light, Xerophthalmia : dryness of the cornea and ulceration
D (<i>Calciferol</i>)	Fish liver oils, milk, eggs. Produced by ultraviolet rays in the skin.	Helps the body to use calcium and phosphorus to form the bones and the teeth.	Rickets in children (bones lack calcium and turn soft). Osteomalacia in adults, fractures may occur
E (<i>Tocopherol</i>)	Meat, milk, whole wheat.	Prevents oxidation of vitamin A.	Sterility in rats.
K (<i>Phylloquinone</i>)	Leafy green vegetables, specially cabbage and spinach. Also synthesised in intestines.	Needed in normal clotting of the blood.	Haemorrhage. (delay in clotting time)
(b) WATER-SOLUBLE VITAMINS			
B ₁ (<i>Thiamine</i>)	Whole grains, yeast, liver, eggs and lean meat.	Increases growth and appetite, helps in digestion and functioning of nervous system.	Beriberi. (a disease marked by inflammatory or degenerative changes of the nerves, muscles become weak)
B ₂ (<i>Riboflavin</i>)	Eggs, liver, milk, yeast, green vegetables	Regulates oxidation of food.	Irritation in eyes and the skin and intestinal disorders, inflammation of the tongue.
B ₃ (<i>Niacin</i>)	Lean meat, liver, milk, eggs, groundnuts, whole grains.	Promotes health of the skin and the nervous system.	Pellagra, Dermatitis (skin inflammation), loss of memory, diarrhoea, skin lesions, rashes.
B ₅ (<i>Pantothenic acid</i>)	Several foods		Fatigue, loss of coordination
B ₆ (<i>Pyridoxine</i>)	Meat, fish, eggs, cereal bran	Interconversion of amino acids	Skin problems, nerve disorder
B ₁₁ (<i>Folic acid</i>)	Liver, leafy vegetables	Synthesis of haemoglobin.	Anaemia (blood deficient in red blood cells, haemoglobin low in total volume).
B ₁₂ (<i>Cobalamine</i>) (Cyanocobalamine is its commercial form)	Liver, meat, milk, cereals, pulses.	Normal functioning of red blood cells.	Pernicious anaemia (a severe anaemia coupled with great weakness and gastrointestinal disturbance, degeneration of spinal cord.
C (<i>Ascorbic acid</i>)	Fresh citrus fruit (lemon, orange, grape-fruit), tomatoes, germinating seeds. (It gets readily destroyed by heat).	Promotes functioning of capillary walls.	Increases susceptibility to infections. Scurvy (spongy and bleeding gums, loosening of teeth).

Table 10.4 A balanced diet menu for an adult doing moderate physical work

S. No.	FOOD	VEGETARIAN	NON-VEGETARIAN	Importance of Cellulose in our Diet
		g / Day	g / Day	
1.	Cereal (rice/wheat)	350	350	Cellulose constitutes the roughage in our food. ROUGHAGE is the undigestible portion of the diet. The fruit, vegetables and the outer coats of the seeds and grains (e.g. "chokar" of wheat flour) are particularly rich in roughage. The roughage enables the food to move easily through the intestines. It stimulates secretion from the digestive tract and helps in the removal of cholesterol (fatty excretory substance) and toxins. <i>Constipation</i> can often be avoided by including sufficient roughage in food. Salads, green vegetables, whole fruit such as guava (along with its seeds) are not only nutritious but they also provide roughage.
2.	Pulses (dal)	90	60	
3.	Meat / fish	—	50	
4.	Milk	300	100	
5.	Vegetables (carrot, cabbage, etc.)	100	100	
6.	Potato	75	75	
7.	Green leafy vegetables	100	100	
8.	Egg	—	one	
9.	Fat and oil	50	40	
10.	Sugar	40	40	
11.	Lemon	one	one	
12.	Seasonal fruit (mango, guava, apple, orange, pear, melon, etc.)	one (about 250 m)	one (about 250 m)	



Category of people	Requirement of Kcal/day
An adult labourer	3500
A clerk	1800 – 2500
A child (about 6 years)	1100
An adult lying at rest	1600
A woman at complete rest	1450

existing food stores of the body are oxidized and the capacity for work is reduced.

10.3 BALANCED DIET

A balanced diet is one which contains **all** the **principal constituents** of food in **proper quantity**.

One special aspect of a balanced diet is the **sufficient number of calories** which it will provide. A **calorie** is the amount of heat required to raise the temperature of one gram of water by one degree Celsius. In considering the energy value of foods usually the term “**Kilocalorie**” is used which is written as “**Kcal**”. Kilocalorie is 1000 times of the unit calorie.

If the daily intake of food does not provide sufficient calories a person would lose weight (as it rapidly happens during fasting). In that situation the

Malnutrition is the condition in which a person suffers due to lack or deficiency of one or more essential elements of food.



PROGRESS CHECK

- Define malnutrition.
- Categorise the following items into carbohydrates and proteins :
Cellulose, Starch, Egg albumen, Milk, Pea, Glycogen, Cane-sugar
- What is the approximate requirement of calories for the following :
 - An adult physical labourer.
 - An active child of about six years.
 - An adult woman at complete rest.

POINTS TO REMEMBER

- All living organisms require food (nutrients) for growth, repair, energy, maintenance, etc.
- Six classes of nutrients are the carbohydrates, fats, proteins, mineral salts, vitamins and water. Carbohydrates and fats provide energy, proteins are needed for growth and repair, mineral salts are needed as constituents of body substances and vitamins serve some special functions.
- Prolonged deficiency of food elements (especially the vitamins and minerals) causes diseases.
- A balanced diet includes all the principal constituents of food in proper quantity.

REVIEW QUESTIONS

A. MULTIPLE CHOICE TYPE

- Which one of the following pairs of nutrients includes **both as simple sugars** (monosaccharides) ?
 - Sucrose and glucose
 - Glucose and maltose
 - Fructose and glucose
 - Maltose and lactose
- Which one of the following is the **correct** matching of a nutrient **mineral** element and its one **rich source**?
 - Calcium – Potato
 - Sodium – Citrus fruits
 - Iodine – Dairy milk
 - Potassium – Banana

3. Marasmus is due to deficiency of :
 - (a) Vitamin C
 - (b) Carbohydrates
 - (c) Fat
 - (d) Food
4. Fat soluble vitamins are :
 - (a) A, D and E
 - (b) B, C and D
 - (c) B, D and E
 - (d) A, B and C
5. Which of the following is the best source of Vitamin A :
 - (a) Apple
 - (b) Honey
 - (c) Carrot
 - (d) Peanuts
6. Ascorbic acid is Vitamin :
 - (a) C
 - (b) D
 - (c) B
 - (d) A

B. VERY SHORT ANSWER TYPE

1. Mention whether the following statements are **true (T)** or **false (F)**
 - (a) Cellulose in our food passes out undigested (T/F)
 - (b) Kwashiorkor is a severe vitamin deficiency disease (T/F)
 - (c) Iron is required for the proper working of thyroid. (T/F)
 - (d) Foods protect us from disease and therefore antibiotics which protect us from disease are also foods. (T/F)
 - (e) Mineral salts contribute in regulating body processes. (T/F)
2. **Name** the mineral element that is needed for the following respectively :
 - (i) Strong teeth
 - (ii) Proper working of thyroid
 - (iii) Synthesis of haemoglobin

C. SHORT TYPE

1. Give **two examples each** of the following and their usefulness, if any, in our body.
 - (i) Monosaccharides
 - (ii) Disaccharides
 - (iii) Polysaccharides

2. **Define** and give one **example** of a balanced diet.
3. A doctor advises a bone patient to include more of milk and milk products in his everyday food. **Why so ?**

D. LONG ANSWER TYPE

1. List the *six* main purposes for which food is required by the body.
2. Why are **proteins** necessary in our food ? Name one protein deficiency disease of young children.
3. Taking the examples of whole grain atta, fruit and green leafy vegetables, describe how **roughage** in our diet is useful.

E. STRUCTURED/APPLICATION/SKILL TYPE

1. Given below is an incomplete table of vitamins, their rich sources and the related deficiency diseases. **Fill in the blanks [(i)-(viii)]** with only one suitable word for each.

Vitamin	Rich Source	Deficiency disease
(i)	Whole grain	Beri-beri
Niacin	Milk	(ii)
(iii)	(iv)	Scurvy
Calciferol	(v)	(vi)
(vii)	Carrot, yellow fruit	(viii)

2. Complete the following table by filling the blanks.

Mineral	Function	Rich Source
Iodine
.....	Formation of Haemoglobin
Calcium
Potassium