CHAPTER : 13

NUTRIENTS — MACRONUTRIENTS

There are many nutrients present in the food. These nutrients in food are important to perform complex chemical processes of the body. All nutrients— carbohydrates, protein, fat, mineral salts, vitamin, fibers and water should be present in adequate quantities. Nutrients can be divided into 2 types:—

1. **Macro nutrients—** In this category carbohydrate and fat provide energy and protein helps in growth and development. Fibers help in digestion of food and water is essential for all activities. The nutrients of this category are required in large quantities.
2. **Micro nutrients—** In this category different vitamins which participate in complex chemical processes and mineral salts perform formative functions. These nutrients are required in less quantity.

Carbohydrates— Carbohydrates is a major part of our food. A person takes 55-65% energy from carbohydrates present in the food. Carbohydrates are cheap and simple source of energy. The main source of carbohydrates is vegetation. Green leaves using carbon dioxide and water, in the presence of chlorophyll pigment and sunlight, form carbohydrates ($C_6H_{12}O_6$). These carbohydrates are stored in the form of sugar, starch, cellulose and hemi-cellulose.

Chlorophyll + $6CO_2$ + $6H_2O$ + sunlight $\rightarrow$ photosynthesis $\rightarrow$ $C_6H_{12}O_6$ + $6O_2$

Chemical Formation — The basic constituting unit of carbohydrate is sugar in which carbon, hydrogen and oxygen elements are present. The ratio of hydrogen and oxygen is same as water. That is why it is named carbohydrate. Its chemical formula is $C_n(H_2O)_n$

Classification— Carbohydrates are classified on the basis of molecular structure—

Table : 13.1

Carbohydrates		
Monosaccharide	**Disaccharides**	**polysaccharides**
Glucose	Sucrose	Starch
Fructose	Lactose	Glycogen
Galactose	Maltose	Dextrin
		Cellulose
		Hemi-cellulose
		Pectin

(1) Monosaccharides— This simple type of carbohydrate is made up of two words— Mono + saccharide or one sugar. After digestion all forms of carbohydrate changes into simple sugar form. There are 6 carbons. That is why they are called as hexoses. The three main hexoses are—

(i) Glucose— Glucose is also called as Dextrose,

'blood sugar' or 'grape sugar'. Most of the carbohydrates in the body get converted into glucose and give energy.

(ii) **Fructose—** Fructose is also called as 'fruit sugar'. This is the sweetest of all sugars. It gets absorbed by the body very fast.

(iii) **Galactose—** This is not present individually but in combination with other food items. Milk sugar lactose is made up of one molecule glucose and one molecule galactose. It is not found in any vegetation.

2. Disaccharides— When two molecules of monosaccharide combine by a condensation process then formation of disaccharides take place.

(i) **Sucrose—** Sucrose is formed using sugarcane juice or beetroot.

Sucrose → glucose+fructose (sucrase enzyme)

(ii) **Maltose—** It is formed from two molecules of glucose. It is also known as malt sugar and is formed during germination of grains.

Maltose → glucose + glucose (maltase enzyme)

(iii) **Lactose—** It is also known as milk sugar. It is less sweet and is less soluble in water compared to other sugars.

Lactose → glucose + galactose (lactase enzyme)

3. Polysaccharides— These are complex carbohydrates. That is why these are easily stored in plants and trees. From the point of nutrition starch, dextrin, cellulose, glycogen, pectin, hemicelluloses are main sugars.

(i) **Starch—** Starch is mainly made of amylase and amylopectin. Plants and trees are the main sources of starch. Starch is present in cereals like wheat, rice, millet, stem and root vegetables, dried seeds, peas; apple etc. in uncooked fruits carbohydrate is present in the form of starch which on cooking it changes into sweet sugar (mono and disaccharides).

(ii) **Glycogen—** Glycogen is also called as 'animal starch'. It is present in liver and muscles of living humans and animals. It changes into glucose when need arises.

(iii) **Dextrin—** It is obtained by partial hydrolysis of starch. It is less complex than starch. It is present in corn sugar, corn syrup, and honey.

Starch → dextrin → maltose → glucose

(iv) **Cellulose—**It is made up of many glucose units. It is present in cell walls. It is not digested in the human body. But it is helpful in maintaining contraction and relaxation rate and functioning of intestines and muscles. It is present in adequate quantities in bran flour, whole grains, salad, etc.

(v) **Hemi-cellulose—** This is not digested in the human body. But it is important for the health of the intestines. It is found sufficiently in shelled pulses and grains.

(vi) **Pectin—** It is present in the peels of ripened fruits and some root vegetables. This too like cellulose and hemi-cellulose does not get digested in human body. It is important for making jam and jelly in fruit industry.

Functions—

1. Providing energy— The main function of carbohydrate is providing energy. 1gram carbohydrates give 4.2 kilocalories of energy. It is the main source of energy. The excess of carbohydrates is stored as glycogen in liver and muscles which gets converted into glucose

when need arises.

2. **Protein saving—**The main function of protein is growth and development of body. But in the absence of carbohydrate and fat protein starts breaking to provide energy. As a result, formative functions of protein are affected.
3. **Synthesis of vitamin B group—** Lactose is essential for synthesis of vitamin B. The bacteria present in small intestines are auxiliary in the synthesis of vitamin B.
4. **In maintaining health of digestive system—** Cellulose, hemi-cellulose, pectin, etc are not digested by human body but these are important for cleaning the stomach and maintaining the contraction and relaxation rate of intestines which prevents constipation.
5. **Absorption of calcium—** Lactose present in milk is less soluble than other sugars and it gets converted into lactic acid in the presence of bacteria and increases the acidic medium important for absorption of calcium.
6. **Other functions—** Glucose helps in completion of oxygenation of fats and increase the use of fats. Consumption of fibrous and complex carbohydrates reduces blood cholesterol and glucose which in turn reduces chances of heart diseases and diabetes. Carbohydrates help in keeping liver and vascular system healthy and in removal of harmful substances.

Sources— All types of cereals— wheat, rice, millets, maize, some lentils, sugar, jaggery, honey; root vegetables such as potatoes, sweet potato, beetroot, taro root; dry fruits such as— raisins, figs, dates, apples, cottage cheese, etc. are main sources of carbohydrates.

Effects of deficiency— 55-66% of total energy required should be taken from carbohydrates present in the daily diet. In the absence of carbohydrate and fat, protein breaks up to provide energy. As a result the main function of protein becomes secondary. Thus, the growth and development is disrupted. Other effects are—

1. Loss of weight.
2. Lethargy, irritation and nervous behaviour.
3. Less physical activities
4. Occurrence of digestive system related disorders.

Effects of excess of carbohydrates— Excess of carbohydrates in food gets stored as fat in the body and leads to obesity. The working capacity reduces. Obesity leads to diseases such as heart disease, diabetes, ketosis, etc.

Importance of fibers in food—

1. The fibers (cellulose, hemi-cellulose, pectin, and lignin) present in food substances are not easily digested. Therefore, they do not provide energy and reduces the energy value of food. Low energy but fiber rich food substance only give satisfaction of eating.
2. Fibers present in food increase the rate of contraction and relaxation of intestines and solve the problem of constipation.
3. Fibers in the food get combined with other nutrients and reduce the absorption of those nutrients in the intestines, as a result they help in maintaining low levels of blood glucose and cholesterol. That is why fiber rich food is especially important for diabetic and people with heart diseases. These fibers combine with cholesterol from the gall bladder and reduce

the rate of absorption of food. They synthesize vitamins in the intestines. The decomposition products of fats by bacteria in intestines keep the intestines and mucous membrane healthy and prevent intestinal cancer.

Sources— Fresh fruits, vegetables, green leafy vegetables, whole grains and lentils are good sources of fibers.

Fats — Fats are a concentrated source of energy. Fat is an organic compound which is insoluble in water but soluble in organic solvents such as chloroform, benzene, ether, etc. These are smooth to touch.

Chemical Formation — Carbon, hydrogen and oxygen are main elements of fats. The quantity of oxygen is less than that of carbon and hydrogen. Fats are divided into 3 parts.

Table : 13.2 Classification

Fats		
simple	**complex**	**derivative**
Fat and oil	Sulpho-lipids	Fatty acid
wax	Glyco-lipids	Saturated
	Phospholipids	Unsaturated
	Lipoprotein	Glycerol
		Sterol
		Cholesterol

1. **Simple fat—** It is formed by combination of glycerol and fatty acids.

   Glycerol + fatty acid = simple fat

   1 molecule 3 molecules

(i) **Neutral fat—** Fat and oil are included in this category. Fats are the substances that condense at 20^0 Celsius to become solids while those which are in liquid state at this temperature are called oil. Fats and oils are made up of glycerol and fatty acids.

Glycerol + fatty acid = fat and oil

(ii) **Wax—** Wax is a lipid made up of a chain of alkanes or esters from alcohols and fatty acids.

2. **Compound fat—** when some organic compounds combine with fatty acids and glycerol compound fats are formed.

   Fat + ———— = compound fat

   (Glycerol + fatty acid) + (organic or inorganic substance)

(i) Fat + carbohydrates + sulphuric acid = sulpholipid

(ii) Fatty acid + glycerol+ carbohydrates = glycolipid

(iii) Fatty acid + glycerol + phosphoric acid + nitrogen bases = phospholipids

(iv) Fat + protein = lipoprotein

3. **Derivative fat —** The new products formed by the hydrolysis of simple and compound fat are called derivative fat.

(i) **Fatty acid—** Fatty acids are obtained by hydrolysis of fats. Fatty acids are differentiated on the basis of difference in composition occurring at different positions of carbon molecules and hydrogen molecules.

(a) **Saturated fatty acid—** A saturated fat is a type of fat, in which the fatty acids have single bonds. For example, butyric acid, palmitic acid, etc.

(b) **Unsaturated fatty acid—**An unsaturated fat is a fat or fatty acid in which there is at least one double bond within the fatty acid chain.

Thus, carbon and hydrogen are bonded by double bonds. Examples: folic acid, linoleic acid, etc.

(ii) Glycerol— Glycerol obtained by hydrolysis of fat performs the function of energy production.

(iii) Sterol— Chemically sterol is not related to fat but fatty acid and alcohol are present in it. These are the organic compounds which are made up of mixed cyclic conformations.

Sterols can be divided into following categories on the basis of source—

(a) Cholesterol— It is found in the animal world. It is found in blood, liver, adrenal glands, pituitary gland, brain and peripheral nerves of humans and animals. Cholesterol is present in yellow part of eggs, butter, ghee, cottage cheese, meat, liver, etc.

(b) Ergosterol— This fat is mainly found in yeast. It is also present in the human body under the skin where it gets converted into vitamin D in the presence of ultraviolet rays of the sun.

Functions—

1. **Providing energy—** Fat is a condensed form of energy. 1 gram fat gives 9 kilocalories energy. Therefore fat provides twice the energy than carbohydrates and protein. Because of high density and low solubility fat remains stored in fatty tissues and they get oxygenated to provide energy whenever need arises.
2. **Providing protection to soft organs of the body—** Fat remains stored in fatty tissues under the skin and acts as a thick layer. There is a double layer of fat on all soft organs of the body such as heart, liver, lungs, kidneys, and pancreas. This double layer acts as a protective layer.
3. **Controlling body temperature—** The fat layer under our skin acts as a thermal barrier. Thus, fat is helpful in controlling and regulating body temperature.
4. **As a source of soluble vitamin—** Fat is the best source of obtaining fat soluble vitamins 'A', 'D', 'E', 'K'. These vitamins are easily absorbed in the presence of fats.
5. **Procurement of essential fatty acids—** Some essential fatty acids are not formed in the body but they are important for the health of body and protection of skin and fat-rich food makes it possible.

Other functions— Fat is digested slowly. The stomach does not get rid of it and one does not feel hungry. In fact, fat reduces the secretion of gastric juice in stomach. Fat helps in keeping skin smooth and healthy. It acts as a lubricant of alimentary canal and it helps in keeping the passage of stomach and intestines smooth. In addition to this, it helps in production of other important products.

Source— fats and oils are obtained from both animal and plant sources.

Plant source— cereals, lentils, groundnuts, sesame, coconut, mustard, dry fruits such as cashew, almonds and vegetable oil obtained from them.

Animal source— ghee, butter, cream, milk, milk products, fish oil, animal fat, etc.

Effects of deficiency—

Following are the effects of deficiency of fat in food—

1. Decrease in availability of energy to the body
2. Normal growth stops
3. Dryness, roughness, dullness of skin
4. Phrynoderma
5. Decrease in working capacity of cells
6. Lack of essential fatty acids such as linoleic acid, linolenic acid, arachidonic acid and fat soluble vitamins A, D, E, K.

Effects of excess of fat—

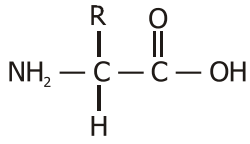
1. **Obesity—** Obesity is a condition where a person has accumulated more body fat which increase weight of the body.
2. **Diabetes—** Excess consumption of fat and carbohydrates leads to excess formation of glucose. Glucose can be stored to a limited extent in the blood. Diabetes is a disorder of the metabolism causing excessive thirst and the production of large quantity of urine.
3. **Heart-related diseases—** Excess of fat in blood causes an increase in cholesterol. Excess of cholesterol gets accumulated in the inner walls of arteries. It is called Atherosclerosis. As a result, blood pressure increases and this has a direct effect on the heart which increases the chances of heart attacks.

Protein— Protein is essential for survival, therefore, it is the most important element of all. That is why protein is called as 'body-building unit'. Protein is derived from Greek word *'proteios'*, meaning "primary", "in the lead", or "standing in front '. A Dutch chemist Gerrit Mulder is credited with coining the term "protein" in 1838. The 1/5th part of human body's weight or 20% of it is made up of protein.

Chemical Formaton — protein is an organic compound. Carbon, hydrogen, oxygen, nitrogen elements are present in it. The main part of protein, about 16%, is made up of nitrogen. Amino acid is the smallest unit of protein. Many amino acids together make a protein, so an amino acid is called as base unit.

Amino group (-NH_2) is basic in nature and provides the basic character to the protein. Carboxyl group (-COOH) is acidic in nature and provides acidic character to the protein. Therefore, presence of both these groups makes amino acid neutral in nature.

The chemical formula of amino acid is—



Amino acid

Emil Fischer and Hoff Mischer in 1920 reported the linking of amino acids through peptide bonds.

The quality of protein depends on types of amino acids present, their quantity and their way of linking. We know about 22 types of amino acids present in our body and food. Out of these, 10 amino acids are very important for the growth and development of our body. These are known as essential amino acids.

Essential and non-essential amino acids— Essential amino acids are drawn from the food that we eat because in the absence of essential amino acids growth and development of our body is disrupted. Following are the essential amino acids—

1. Histidine
2. Leucine
3. Isoleucine
4. Lysine
5. Arginine
6. Methionine

7. Threonine
8. Phenyl alanine
9. Valine
10. Tryptophan

Non-essential amino acids are formed in the body itself in the presence of nitrogen. Following are the major non-essential amino acids—

1. Alanine
2. Hydroxyproline
3. Proline
4. Aspartic acid

Classification of protein— Protein is classified as given in the table— 13.3

Table : 13.3

Protein		
On the basis of quality	**On the basis of source**	**On the basis of chemical structure**
Complete	From Animal source	Simple
Partially complete	From plant source	Conjugated
incomplete		Derivative

1. On the basis of quality— Protein is classified on the basis of amino acids present in them because quality of any protein depends on the presence of quantity, type and quality of amino acids.

(i) Superior or complete protein— In these high biological valued proteins all the essential acids are present in adequate quantity and proper ratio. These carry out the function of overall growth and development of the body and perform formative functions. This type of protein is obtained from animal sources such as milk, curd, meat, fish, eggs, liver and from plat sources like dry fruits, soya bean, etc.

(ii) Medium or partially complete protein— In these some essential amino acids are present but one or two essential amino acids are absent. These proteins maintain life but are not useful for physical growth and development. These proteins do not form new nerves and cells. The protein obtained from plant sources such as lentils, cereals, soya bean are medium quality proteins. Cereals lack lysine while lentils lack methionine.

(iii) Inferior or incomplete protein— In these proteins, essential amino acids are totally absent. And so these types of protein are useless in physical growth and development. Incomplete protein is present in stem-root vegetables, fruits and maize. Gelatin in fruits is also an incomplete protein.

2. On the basis of source—

(i) Plant protein— Protein obtained from plant sources is of medium or of inferior quality. Such protein is present in lentils, soya bean, cashew, almonds, groundnuts, dry fruits, etc. This protein can be used as a complete protein in mixed form. For example, lentils lack methionine while in wheat lysine is absent. Lentils and wheat together make a complete protein. Similarly lentils and wheat can be combined with milk or milk products to make complete proteins, for example in *dahi bada*, *kheer*, kedgeree, khichari etc.

(ii) Animal protein— Protein obtained from animal sources is of superior quality. These are complete proteins because the essential amino acids important for body's growth and development are present in it. For example, milk, curd, eggs, meat, fish, liver, cottage cheese, buttermilk, etc.

3. **On the basis of chemical structure—** proteins are divided into 3 categories on the basis of physical characters and solubility.

1. **Simple protein—** These proteins are made up only amino acids. On hydrolysis they give simple units of amino acids. For example—

The protein in yellow part of egg— albumin

Protein in wheat— glutenins, gliadins

Protein in milk— lactoglobulin

Protein in maize— zein

2. **Conjugated protein—** A conjugated protein is a protein that functions in interaction with other chemical groups.

Simple protein + other chemical groups = conjugated protein

These proteins are named on the basis of chemical groups present—

Glycoprotein— simple protein + carbohydrate

Nucleoprotein— simple protein + nucleic acid

Lipoprotein— simple protein + lipid

Haemoglobin — simple protein (globin) + heme (iron)

Phosphoprotein — simple protein + phosphorous

3. **Derived protein—** Derived proteins are formed by partial fragmentation of protein because of physical activities, temperature, somatic stress, digestion. For example-

In milk— casein

In blood clot— fibrin

In boiled eggs— albumin

In digestive juices— peptones, proteoses, peptides

Functions of proteins—

1. **Growth and development of body—** Protein is essential for growth and development. Cells are made up of protein. The repair of damaged cells is also carried out by cells. During infancy, childhood and adolescence protein is important because these stages are of rapid development. Other than this for repair work protein is needed till old age.

2. **For formation and repair of tissues—** Tissues get damaged due to continuous working and different physical activities. Their regeneration and repair becomes important and this is done by protein. The envelope of alimentary canal, production of red blood cells, blood clotting requires protein.

3. **Regulation of different activities of body—**

(i) Protein regulates acids and bases in our body, acts as buffer.

(ii) **For production of hormones—** Different hormones are made up protein molecules and these hormones regulate and control different activities. In the absence of protein, proper production and secretion of hormones does not take place.

(iii) **Contraction of muscles—** Myosin and actin are important for contraction and relaxation of muscles. Myosin and actin are made up proteins.

(iv) **Production of enzymes—** Proteins make enzymes. Enzymes carry out various activities in the body such as digestion of food, oxygenation, metabolism, etc.

(v) **Formation of vitamins—** Some amino acids act as precursors for vitamin formation. For

example, Colin of vitamin B group needs methionine, tryptophan for niacin, etc.

6. **Helpful in normal vision—** cones and rods, present in retina of eyes, form special products in the presence of protein and helps in seeing colours and dyes in dim light.
7. **Providing energy—** in the absence of carbohydrates and fat, protein performs the function of providing energy. One gram of protein gives 4 kilocalories of energy.
8. **Maintaining water balance—** protein present in plasma generates osmotic pressure in the body which maintains the water balance of the body.

Effects of protein deficiency—

The reason for deficiency of protein in the body is lack of protein-rich food items in diet or consumption of incomplete or partially incomplete protein-rich foods for long time. When protein is not present in adequate quantities in the food, it disrupts growth and development of the body. The effect of protein deficiency is known as protein energy malnutrition because protein deficiency leads to deficiency of protein as well as energy. Deficiency of proteins leads to following diseases— (1) Kwashiorkor (2) Marasmus (3) Marasmic Kwashiorkor

(1) Kwashiorkor— it occurs in children of 1-4 years of age. It is caused by lack of protein in diet. This occurs in children whose diet includes carbohydrates but lack protein. Cicely Williams in 1935 reported first about Kwashiorkor. It is an African word which means "disease of a baby deposed from the breast when the next one is born".

1. Growth failure— both growth and development of children get arrested. Also weight and height get stunted.
2. Edema—body swells due to deficiency of protein. Water gets into the cells and tissues of the body. Because of swelling child appears to be healthy.
3. Muscles begin to degenerate. Arms and legs weaken and grow thin.
4. Behavior of child becomes irritating and disinterested. Child feels lethargic, lazy and tired.
5. Hemoglobin cannot be produced due to lack of protein. This results in anemia.
6. Mental development is arrested.
7. Disease resistance capacity reduces and incidence of other diseases increase.

(2) Marasmus— Marasmus occurs in children of 6-12 months of age due to undernourishment. Protein as well as energy deficiency are the main cause. Marasmus is a Greek word meaning "to waste". The main reason for Marasmus is weaning at a very young age and lack of proper and nutritious food. The symptoms of Marasmus are—

Figure : 13.1 Marasmus

1. Physical growth and development stops, height does not increase, drop in body weight.
2. Inflammation and absence of fat from under the skin.
3. Frequent urination due to infection of alimentary canal.
4. Skin becomes dry, rough, dull, and lifeless.
5. Muscle deformation.
6. Limbs become thin and weak.

3. **Marasmic Kwashiorkor—** In under-developed and developing countries where protein- energy deficiency is prevalent, symptoms of both Marasmus and Kwashiorkor appear together. Proper treatment, nutritious food can result in better health of children suffering from Kwashiorkor. But treatment of Marasmus takes time to show tangible results.

Deficiency of protein in pregnant mothers leads to improper development of the foetus. The baby born is slightly built and weak. Sometimes there is scarcity of milk in feeding mothers. Symptoms of deficiency of protein in adults are — loss of body weight, aanemia, loss of disease resistance capacity, presence of illness, etc.

Figure : 13.2 (Kwashiorkor)

Energy— Carbohydrate, protein and fat are main energy producing food substances. Oxygenation of these provides energy. This energy is used for various functions and processes of the body. Energy is required for voluntary activities like running, walking, sleeping, cooking etc. and for involuntary activities like breathing, blood circulation, heart beating, etc. Calorie is the unit of heat energy.

Kilocalorie is the energy needed to raise the temperature of 1 kilogram of water through 1 °C, equal to one thousand small calories.

Oxygenation of 1 gram carbohydrate and protein gives 4 kilocalories of energy and that of 1 gram fat gives 9 kilocalories of energy.

The excess of energy in food causes obesity, increase in weight, other diseases such as diabetes, high blood pressure, heart diseases, etc. Working capacity is also adversery affected.

Deficiency of energy causes weight loss, loss of activity, effect on physical growth, etc.

Water— Water is very important for life**.** After oxygen, water is an essential requirement for survival of life. Water is formed by the chemical combination of hydrogen and oxygen. The chemical formula of water is H_2O. It is an inorganic compound.

Physical organization— Water makes up 60-70% part of our body's weight. Quantity of water is 60-70% in tissues. Bones and teeth also have about 20% of water.

Table : 13.4 Distribution of water in body : At a glance

	% of body weight	Total water present
Total body weight	70 kg	—
Total water quantity	70	49 kg
(1) intra cellular water	50	35 kg
(2) extra cellular water	20	14 kg
(a) interstitial fluid	9	6 l
(b) lymphatic duct	7	5 l
(c) blood vessel	4	3 l

Water is present in all the cells of body but the percentage of water differs in different organs. Water distribution in the body can be divided into 3 categories:

1. **Extra cellular fluid—** this includes 20% of water.
2. **Intra cellular fluid —** this includes 50% of water.
3. **Interstitial fluid—** this includes 9% water, 7% water is present in lymphatic ducts and 4% in blood vessels.

70-75% water is present in the body of children. Slightly built people have more quantity of water in their bodies than people with heavely built bodies. Bodies of men have more water than that of women. With the increasing age water in the body decreases while fat gets stored.

Organs like liver, brain, stomach, small intestines which perform more active functions such as digestion, absorption, and metabolism have more water quantity than other tissues. In contrast, bones and teeth which are inactive for metabolism functions have less quantity of water (20%).

Functions of water—

1. **As a solvent—** Water is an important solvent. All the nutrients in the body are carried by water to different cells. Water is essential for digestion. It also helps in absorption of food and metabolism.
2. **For controlling body temperature—** Water has specific heat. This is the reason why water is capable of maintaining a constant body temperature. Water distributes the body's entire internal heat to all the parts of body. When the body temperature increases water removes excess of heat as sweat which keeps the temperature constant.
3. **As a lubricant—** Water acts as a lubricant in internal organs, joints, and between organs. It keeps the cells moist. Presence of saliva in mouth makes swallowing of food easy. Mucous is present in respiratory system, digestive system, excretion system, etc, presence of water between joints reduces friction. Lack of water in joints at old age causes joint pain.
4. **As a structural unit of body cell—** Cell is the smallest unit of body. Water plays an important role in formation of new cells.
5. **For formative functions—** Water is present in every cell, fiber, tissue of the body. But the amount of water is more in some fibers and less in others. Water is more in active organs where metabolic activities are rapid while less in others.
6. **Protection of soft organs—** Water is present around all the soft organs of the body and protects them from external shocks. Presence of cerebrospinal fluid around the brain is one such example.
7. **Removal of waste products—** It is necessary to remove the waste, harmful substances from our body or produce and accumalate poison in the body. Water removes these waste products with sweat, urine, etc, by dissolving them in itself.
8. **Transportation of nutritive substances—** Water dissolves all the nutrients in itself. Dissolved nutrients get mixed with blood and reach different body organs through blood vessels and lymphatic ducts.

Sources— body takes water from three main sources—

1. **From fluid-rich food items—** Tea, milk, buttermilk, vegetable soup, rice water, fruit