



13

BIOCHEMISTRY



After completing this lesson, you will be able to:

This is 11 days lesson
(period including homework)

- Distinguish between mono-, di- and trisaccharides.
- Describe the bonding in a protein molecule.
- Explain the sources and uses of carbohydrates, proteins, and lipids.
- Differentiate between fats and oils.
- Describe the importance of nucleic acids.
- Define and explain vitamins and their importance.
- Check the relative solubility in water of starch and sugar.
- Observe and explain the denaturing of proteins.
- Explain why agricultural and nutritional sciences are vital.
- Explain the use of natural products in the preparation of flavors, fragrances, resins and pharmaceuticals.
- List and describe the commercial uses of enzymes.
- Explain hydrogenation of vegetable oil.
- Explain the use of dextrose in drips.



Reading

INTRODUCTION

Life requires energy. Where this energy comes from? Can you use the energy of sun light directly to perform all life activities? Plants trap this energy and convert it into chemical energy.



How? They store this energy in substances such as carbohydrates, proteins and lipids. We need these compounds for existence. For proper nutrition, our diet should include balanced proportions of carbohydrates, proteins and lipids. We also need adequate amount of vitamins, minerals and fibre.

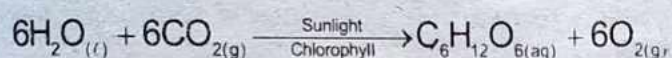
Some compounds found in every living cell, serve as the information and control centers of the cell. They have ability to reproduce, store and transmit genetic



information. What are these compounds? This chapter will enable you to recognize these important compounds.

13.1 CARBOHYDRATES

Carbohydrates are the most abundant class of organic compounds. Carbohydrates have the general formula $C_x(H_2O)_y$. This formula suggests that they are hydrates of carbon with few exceptions. Recall that plants synthesize carbohydrates through photosynthesis.



Plants convert glucose into starch and cellulose. Carbohydrates are monomers and polymers of aldehydes and ketones that have numerous hydroxyl groups attached.

Society Technology and Science

As the world population is increasing, the demand for food is also increasing. To grow more crops, new methods and techniques are used.

Protein deficiency leads to physical and mental retardation. Excess lipids or fats may lead to heart diseases or a stroke, cancer, diabetes and other health problems. The nutritional chemists recommend that no more than 30 % of your daily caloric intake come from fat. Healthy crops, fruits and vegetables are necessary for our proper growth and health. So both agricultural and nutritional sciences are vital for us.

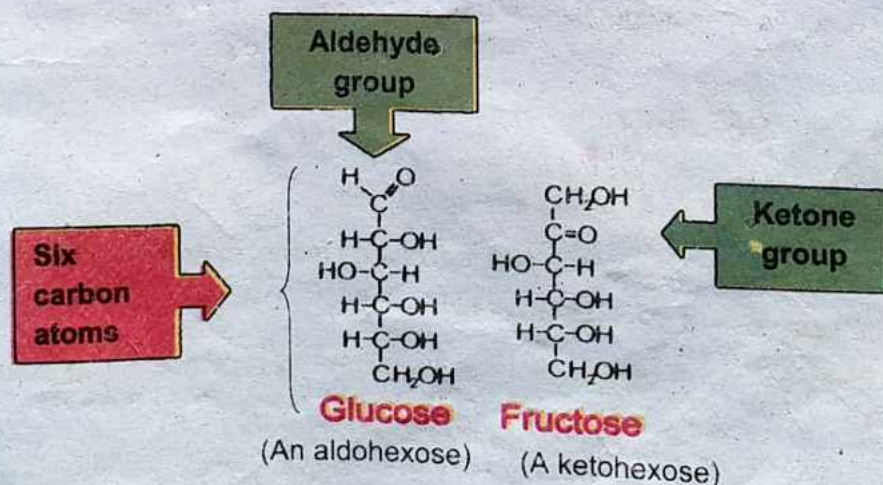
13.1.1 Classification of Carbohydrates

Carbohydrates are classified as

- i) Monosaccharide
- ii) Oligosaccharides
- iii) Polysaccharides

Monosaccharides

Monosaccharides are the simplest carbohydrates. They cannot be hydrolyzed. They have general formula $(CH_2O)_n$ where n is 3 to 6 carbon atoms. So monosaccharides contain 3 to 6 carbon atoms. They are further classified as trioses, tetroses, pentoses, hexoses etc. This classification is based on the number of carbon atoms they contain. The two most familiar





monosaccharides
monosaccharides are glucose and fructose. Both have molecular formula $C_6H_{12}O_6$. Is glucose a pentose? Glucose is a pentahydroxy aldehyde, whereas fructose is a pentahydroxy ketone. Their open chain structures are as follows. They are called simple sugars.

Some monosaccharide molecules can rotate the plane of plane polarized light to right (clockwise). They are called dextro-rotatory or dextrose sugars.

monosaccharides
Glucose, manose, galactose are dextrose sugars. Monosaccharides are white crystalline solid. They are soluble in water and have sweet taste. They cannot be hydrolyzed. They are reducing in nature.

Oligosaccharides

Carbohydrates which upon hydrolysis form 2 to 9 molecules of monosaccharides or simple sugars are called oligosaccharides.

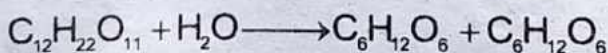
Therefore, depending upon the number of monosaccharide units they produce on hydrolysis, they are further clarified as disaccharides, trisaccharides etc. Prefixes di, tri, tetra, penta etc. indicate the number of monosaccharide units, they produce on hydrolysis. They are white crystalline solids. They have sweet taste and are soluble in water.

Society, technology and Science

5% m/v aqueous solution of dextrose is used in drips. 5% m/v aqueous solution means 5 grams of dextrose dissolved in water to form 100 cm³ of solution. It is intravenously given to patient who is severely dehydrated or is unable to eat or is not allowed to eat.



Sucrose Glucose Fructose



Lactose Glucose Galactose

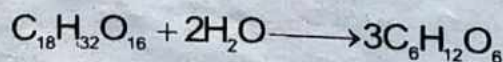


Maltose Glucose Glucose



Self-Assessment Exercise 13.1

1. Classify sucrose, lactose and maltose as mono, di or tri-saccharides. Give reason.
2. Is galactose, a monosaccharide? *Yes*
3. Raffinose, $C_{18}H_{32}O_{16}$ hydrolyses as follows. Is raffinose a disaccharide? *No, trisaccharide*





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Polysaccharides

Carbohydrates which upon hydrolysis form 100 to 1000 units of simple sugars are called polysaccharides. Starch and cellulose are polysaccharides. They are amorphous solids. They are tasteless and insoluble in water. They are non-reducing in nature.

13.1.2 Sources and Uses of Carbohydrates

Carbohydrates are the most abundant class of carbon containing compounds. They have varied sources. (Figure 13.1)

- Monosaccharides such as glucose, fructose and galactose are obtained from fruits, vegetables and cereals. They are also present in honey.
- Disaccharide such as sucrose is obtained in sugarcane, sugar beet and fruits. Maltose is found in cereals. Lactose is main sugar in milk and dairy products.
- Cellulose is obtained from plants e.g. Cotton is pure cellulose.
- Starch is present in cereals, wheat, barley, rice, maize, potato, sweet potato etc.

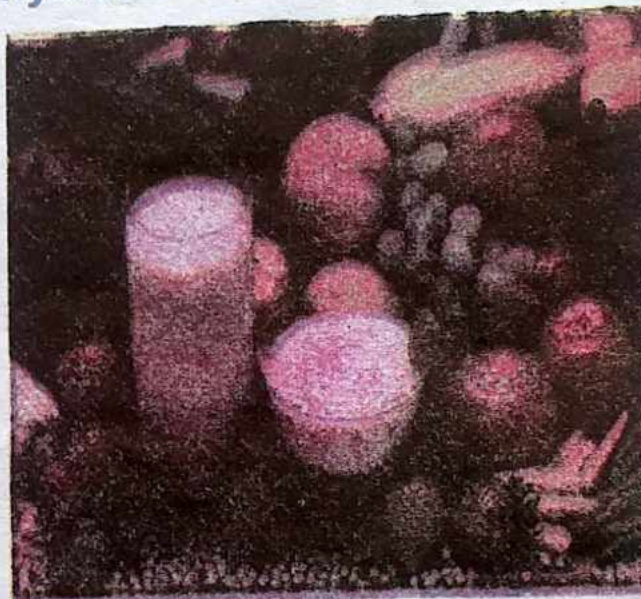


Figure 13.1: Some sources of carbohydrates

Uses

- Carbohydrates store and transport energy in both plants and animals. 1g of glucose provides us 15.6 KJ of energy.
- They serve as food source for most organisms.
- Carbohydrates serve as structural material for plants. Cellulose in the human diet is referred as fibre. It is found in bran, whole meal bread, fruit and vegetables. We cannot digest it but it is very important for us. It helps the muscles of our intestines to move food efficiently through the digestive track. It absorbs and carries away toxic chemicals in food that would otherwise harm us. It also helps in lowering cholesterol and regulates blood pressure.
- Sucrose is used as common table sugar.
- Glucose is stored in animal muscles and liver cells in the form of glycogen. Glycogen serves as long term energy reservoir. It can be converted back to glucose when needed for energy. Plants store excess energy as starch.
- Starch is used to make rectified spirit by fermentation process.
- Starch is converted to dextrin which is used as an adhesive for stamps and as wallpaper glue.
- Cows, cattle, goats, deer, sheep and termites derive nutrition from cellulose.



- We use cellulose in the form of wood for heat, housing and furniture.
- Wood is also used to make paper and wood pulp.
- Cellulose fibre of cotton is used to make rayon and cellulose acetate, which are used in textile industry for making cloth.



Self-Assessment Exercise 13.2

- List a) Three examples of monosaccharides.
b) Three examples of disaccharides
c) One example of trisaccharide
d) Two examples of polysaccharides

fructose, glucose, mannose, galactose, dextrose, sucrose, lactose, maltose, raffinose, cellulose, starch

2. List sources of

- Sucrose
- Maltose
- Lactose

sugar cane, sugar beet, fruits, cereals, milk & dairy products



Activity 13.1

To check the relative solubility in water of starch and sugar.

Carry out the following

- Mix a tea spoon full of starch in a beaker, half filled with water. Stir well. What happens?
 - Mix a tea spoon full of sugar in another beaker, half filled with water. Stir well. What happens?
- Which is soluble in water, starch or sugar?

13.2 PROTEINS

Animals require protein as one of the three major classes of food. What are two other major classes of food? The human body contains tens of thousands of different proteins. Proteins have many functions in the human body.

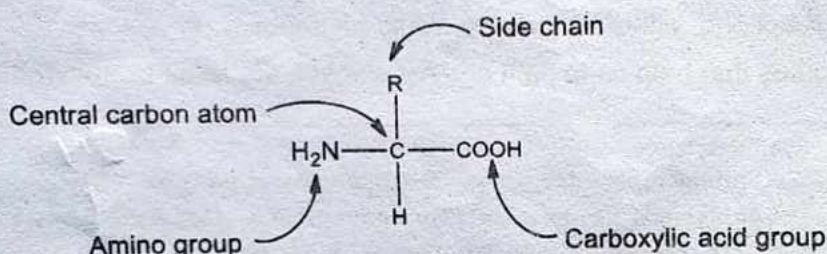
- They transport and store oxygen and nutrients.
- They act as catalysts for the thousands of reactions that make life possible.
- They regulate many important systems in our bodies.



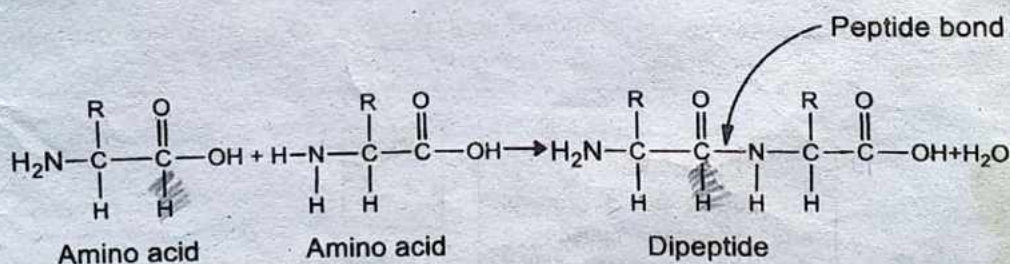
Proteins are high molecular weight polymers. The building blocks of all proteins are the amino acids therefore, all proteins produce amino acids on hydrolysis. **Proteins are complex nitrogenous substances that produce amino acids on complete hydrolysis.**

13.2.1 Amino Acids as Building Block

An amino acid has two functional groups. What are those? Amino acids are building blocks of protein synthesis. Twenty different amino acids are involved in protein synthesis. Out of twenty amino acids, our bodies can synthesize only ten amino acids. Such amino acids are called **non-essential amino acids**. The remaining ten are called **essential amino acids**. Essential amino acids must be present in our diet. Why?



Molecules of amino acids join together through amino ($-NH_2$) group of one molecule and carboxyl ($-COOH$) group of another molecule by eliminating a molecule of water.



The linkage $\text{—}\overset{\text{O}}{\parallel}\text{C—NH—}$ which joins two amino acid units is called a **peptide bond**.

The resulting molecule is called a dipeptide. There is still an amino group on the left and a carboxyl group on the right. Each of these groups can react further to join more amino acid units. In this way thousands of amino acid units join to form a giant molecule of protein.

13.2.2 Sources and Uses of Proteins

Most proteins obtained from animal sources contain all the essential amino acids in adequate amounts. Meat, fish, eggs, milk and cheese are important sources of proteins. Plants also provide us proteins. For example, pulses, beans, meat, egg, fish etc. are rich in proteins. (Figure 13.2)

Do you know?

Most of the growth occurs in the first 2 years of life. The human brain reaches nearly full size by this age. Protein deficiency leads to both physical and mental retardation.



Figure 13.2: Some sources of proteins

- We require proteins in our diet, to provide amino acids to make muscles, hair, enzymes and repair of body tissues.
- Proteins are essential for the formation of protoplasm and components of cells.
- Proteins are essential for both physical and mental growth especially in children.
- A protein called gelatin is obtained by heating bones and tendons in water. It is used in bakery goods.
- Enzymes are proteins that catalyze specific biological reactions, without which life would be impossible.
- The antibodies that help us to fight against disease are large protein molecules.

Society, Technology and Science

Enzymes are large protein molecules. They are biological catalysts. They catalyze chemical reactions in living organisms. Enzymes are also commercially important. They are used in the production of sweeteners, chocolate syrup, bakery products, infant foods, detergents to remove food stains, in cheese making, in paper and pulp industries to remove sticky matter, to prepare fabrics for clothes, furniture and other household items. For example (a) enzymes like diastase, invertase and zymase are used in the fermentation of molasses and starch to produce ethanol. (b) Amylase is used in bread making. (c) Proteases and amylase are used in detergents to remove food stains on the cloths. (d) Lactase is used in infant foods.



Do you know?

An extreme lack of proteins and vitamins causes a deficiency disease called kwashiorkor. The symptoms include retarded growth, discolouration of skin and hair, bloating, a swollen belly and mental apathy.



Self-Assessment Exercise 13.3

1. What two functional groups are found in amino acids?
2. Define
 - (a) protein
 - (b) Amino acids
3. Draw peptide linkage
4. Define
 - a) Essential amino acids
 - b) Non-essential amino acids



Activity 13.2

To observe and explain the denaturing of proteins.

Reading

Carry out the following:

- Carefully break an egg and pour its contents in a bowl. Observe its contents.
- Boil another egg for few minutes, remove covering shell and cut it into two pieces and observe.

White viscous fluid or albumin present in an egg is protein. When egg is boiled, this protein solidifies or coagulates. This change of protein is called denaturing of protein. The denaturing may also occur due to change in pH.

13.3 LIPIDS

A lipid is any component of plant or animal tissue that is insoluble in water, but soluble in solvents of low polarity such as ether, hexane, benzene and carbon tetrachloride. Lipids include:

- Fats and oils
- Cholesterol
- Sex hormones
- Components of cell membrane called phospholipids
- Some vitamins (A,D,E and K)

3.3.1 Fatty Acids

Fats and oils are referred as simple lipids. They are esters of fatty acids with a trihydroxy alcohol, glycerol. For this reason they are called glyceryl esters or glycerides. Fatty acids are long chain carboxylic acids. They are the building blocks of lipids. For example, stearic acid, $C_{17}H_{35}COOH$ is one such acid that occurs in animal fat. Some common fatty acids are given in table 13.1

Table 13.1 Some Common Fatty Acids in Natural fats

No. of carbon atoms	Condensed structure	Name	Source
4	$CH_3 - CH_2 - CH_2 - COOH$	Butyric acid	Butter
6	$CH_3 - (CH_2)_4 - COOH$	Caproic acid	Butter
16	$CH_3 - (CH_2)_{14} - COOH$	Palmitic acid	Palm oil
18	$CH_3 - (CH_2)_{16} - COOH$	Stearic acid	Beef fat
18	$CH_3 - (CH_2)_7 - CH=CH - (CH_2)_7 - COOH$	Oleic acid	Olive oil

Which of these fatty acids form oil?

Palm oil



A lipid is called fat if it is solid at room temperature.

A lipid is called oil if it is liquid at room temperature.

The differences in melting points are due to the degree of unsaturation of constituent fatty acids. Fats contain larger proportion of saturated fatty acid units. Oils contain larger proportion of unsaturated fatty acid units.



Review Exercise 13.4

1. Define (a) Lipids (b) Fats (c) Oils
2. Consult table 13.1 and write
 - i) the names two fatty acids that are components of fats.
 - ii) the name of one fatty acid that is component of an oil.

SCIENCE TITBITS

All the cholesterol in human diet comes from animal products such as milk, meat, cheese and eggs. No vegetable product contains cholesterol.



Reading



Figure 13.3: Some sources of lipids

13.3.2 Sources and Uses of Lipids

Animals, plants and marine organisms such as salmon and whales are rich source of lipids. Milk is an important source of animal fats from which butter, ghee, cheese etc. are obtained. Seeds of many plants such as sunflower, corn, cotton, ground nut, coconut, olive etc. are good source of vegetable oils. Cod liver oil is obtained from salmon and whales. Some sources of lipids are shown in figure 13.3.

Fats and oils have several important functions in living organisms.

- Butter, ghee and vegetable oils are used for cooking and frying of food, preparing bakery products and sweets.
- In mammals a layer of fat is present under the skin. This layer acts as a thermal insulator.
- Fats protect delicate organs from shocks. A layer of fat around our heart and kidneys protect these organs from injury.
- Lipids provide some vitamins such as A, D and E which are essential for health. These vitamins are insoluble in water and soluble in lipids.

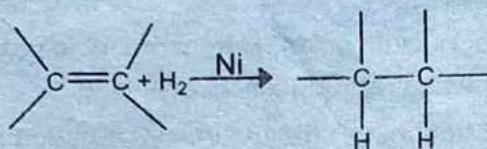


- Fats and oils are important food stores in living organisms. They provide about twice, as much energy per gram as do carbohydrates.
- Vegetable oils are converted into vegetable ghee or margarine by catalytic hydrogenation.
- Fats and oils are also used for the manufacture of materials like soaps and detergents, cosmetic, polishes, paints and varnishes.
- In our bodies cholesterol is essential for the synthesis of several hormones, vitamin D and bile acids.

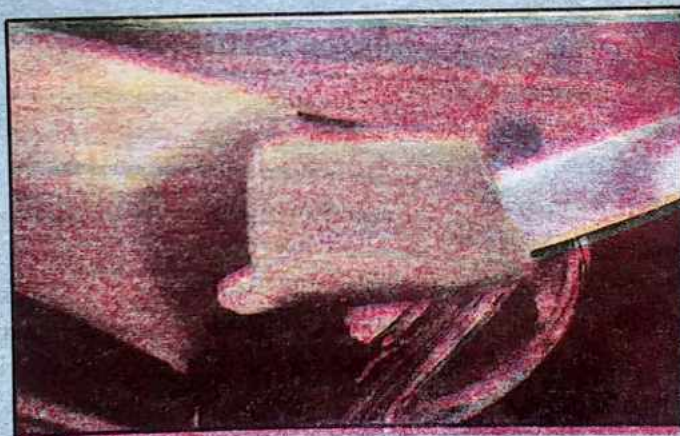
Society, Technology and Science

Addition of hydrogen to an alkene is called hydrogenation. This reaction takes place in the presence of Ni, Pd or Pt as catalyst.

Q13



This reaction is used to make margarine or vegetable ghee. Fatty acid component of vegetable oil contains carbon-carbon double bonds. When hydrogen is added to these oils, they become saturated and harder.



Do you know?

Insulin is a protein coded by DNA. It is required for the proper use of glucose by cells. People with diabetes formerly had to use insulin from cattle. Now human insulin is made using recombinant DNA technology. Scientists take the human gene for insulin production and paste it into the DNA of E coli, a bacterium commonly found in the human digestive track. The bacterial cell multiply rapidly, making billions of copies of themselves and each new E. Coli cell carries in its DNA, a gene for human insulin.

Important Information

It has recently been shown that feeding hens, a diet containing a lot of flax seeds lowers the amount of cholesterol in eggs.

13.4 NUCLEIC ACIDS

More than 100 years ago, a Swiss biochemist discovered a class of nitrogen-containing compounds in the nuclei of cells. These nitrogen-containing compounds which were first obtained from the pus of infected wounds are called nucleic acids.

Nucleic acids are vital components of all life. They are found in every living cell. They serve as the information and control centers of the cell. They are long chain molecules made up of nucleotides. Each nucleotide consists of three components.

- (i) Nitrogenous base.
- (ii) A pentose sugar or five carbon sugar.
- (iii) Phosphate group.

There are two kinds of nucleic acids, Deoxyribonucleic acid (DNA) and ribonucleic acid (RNA). How is it that each species reproduces its own kind?

DNA can store and transmit all the genetic information needed to build organisms. For instance, in human beings, the single fertilized egg cell carry the information for making legs, hands, head, liver, heart, kidneys etc. DNA is found primarily in the cell nucleus.

Structure of DNA was discovered by J. Watson and Francis Crick in 1953. They were awarded the 1962 Nobel Prize for their work. This discovery initiated the field of molecular biology. Cancer research involves an extensive study of nucleic acids.

13.4.1 Deoxyribonucleic Acid (DNA)

DNA exists in the form of two strands twisted around each other in a spiral formation called a double helix (Figure 13.4). Each chain or strand is made up of a deoxyribose sugar, phosphate unit and a nitrogen base. The strands are held together by hydrogen bonds. The order of the base pairs in a strand is a code that stores information which is used to produce proteins. The key to the ability of DNA to store genetic information and to pass it on from generation to generation is its double stranded structure.



Figure 13.4 Structure of DNA

13.4.2 Ribonucleic Acid (RNA)

RNA exists in the form of single strand. It is made of a ribose sugar, phosphate unit and nitrogen base. RNA is synthesized by DNA to transmit the genetic information. RNA is

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responsible for directing synthesis of new proteins. RNA receives, reads, decodes and uses genetic information from DNA to synthesize new proteins.

Science Titbits (Chemistry in action)

The variation in DNA of individuals forms the basis of a method for identifying a person from samples of their hair, skin cells or body fluid. Because DNA sequences like fingerprints are unique for each individual, this method is called DNA fingerprinting. Only a tiny sample is needed. The pattern is compared with the DNA of a sample from a known individual. If the DNA fingerprints are identical, it can be stated with a high degree of chemistry that the DNA in the known sample is from individual.

**Review Exercise 13.5**

1. How do DNA and RNA differ in structure?
2. Name the two kinds of nucleic acid?
3. Write differences between DNA and RNA.
4. What is the sugar unit in DNA? *Deoxyribose*
5. What sugar is found in RNA? *Ribose*
6. Which nucleic acid is involved in protein synthesis? *RNA*

- i) Nitrogenous Base
- ii) Phosphate Unit
- iii) A pentose sugar
- iv) Ribose sugar
- ✓ Deoxyribose sugar

13.5 VITAMINS

In 1897 the Dutch scientist C. Eijkman discovered that polished rice lacked something found in the hull. Lack of something caused the disease beriberi. A British scientist F.G Hopkins experimentally proved that in addition to carbohydrates, fats, proteins, and minerals, certain

missing factors were also needed to sustain healthy growth. In 1912 Casmir Funk, Polish biochemist used the word 'vitamine' (from Latin word vita meaning life) for these missing factors. He thought all these factors contained the amino group. However, the final 'e' was dropped after it was found that all these factors were not amines. So the generic name of these compounds became Vitamin. Vitamins are accessory growth factors.



(a)



(b)

Figure 13.5 (a) Vitamin D deficiency causes softening of bones (b) vitamin B₃ deficiency causes inflammation and abnormal pigmentation.



9 (Vitamins are specific organic compounds which are required by our bodies to prevent specific diseases but cannot be produced by our bodies. They must be present in our diet in addition to proteins, fats, carbohydrates and minerals. 10

Vitamins are substances that are essential for our bodies. Vitamin A is important in vision. It helps in the chemical transmission of images from the eye to the brain. It also keeps the cornea moist. Vitamin C is required for the formation of blood and boosting the immune system that protects against illnesses ranging from common cold to cancer.

Vitamin B helps to regulate nerve impulse transmissions, in the formation of haemoglobin and activates more than 100 different enzymes. Vitamin D regulates blood calcium. It is necessary for proper bone and tooth growth. (See figure 13.5)

13.5.1 Types of Vitamins

There are two types of vitamins

(a) Fat soluble vitamins

A vitamin that dissolves in fat is called fat soluble vitamin. For example, vitamin A, D, E and K. Taking excess amount of fat soluble vitamins may be harmful. For instance large excess of vitamin A can cause irritability, dry skin and feeling of pressure inside the head. Too much vitamin D can cause pain in bones, hard deposits in joints and kidneys, and weight loss.

(b) Water soluble vitamins

A vitamin that dissolves in water is called water soluble vitamin. For example, vitamins B (complex) and C. Our body has limited capacity to store these vitamins. If taken in excess, these are readily excreted from the body. Water soluble vitamins are not toxic even if taken in excess.

Society, technology and Science

A natural product is a compound or substance produced by living organism (plants, animals and microorganism). The term natural products for commercial purposes also refer to cosmetics, flavours, fragrance, dietary supplements, foods, resins and pharmaceuticals.

Some natural products are added in the prepared food to enhance colour, flavor and fragrance. Many of such substances are extracted from fruits and other plant materials. For instance vanilla, banana oil, grape flavouring, almond flavouring, strawberry flavouring, pine apple flavouring etc., corn syrup is used in greatest amounts as resins in many food preparations.

A number of natural products are also added to the food to prevent deficiency diseases. (Vitamin C is frequently added to fruit juices and flavoured drinks to prevent scurvy and elimination of rickets. Vitamin A is added to margarine to prevent night blindness)

Plants have always been a rich sources of pharmacologically active natural products e.g alkaloids, morphine, cocaine, digitalis, quinone, nicotine etc. Many of these are useful drugs in themselves and others are starting materials for synthetic drugs. Most of the compounds derived from microorganism are used in antibiotics e.g., penicillin, cephalosporin, tetracycline etc. Many natural compounds are used as drugs against diseases such as cancer, viral or bacterial infections, malaria etc.

**Self-Assessment Exercise 13.6**

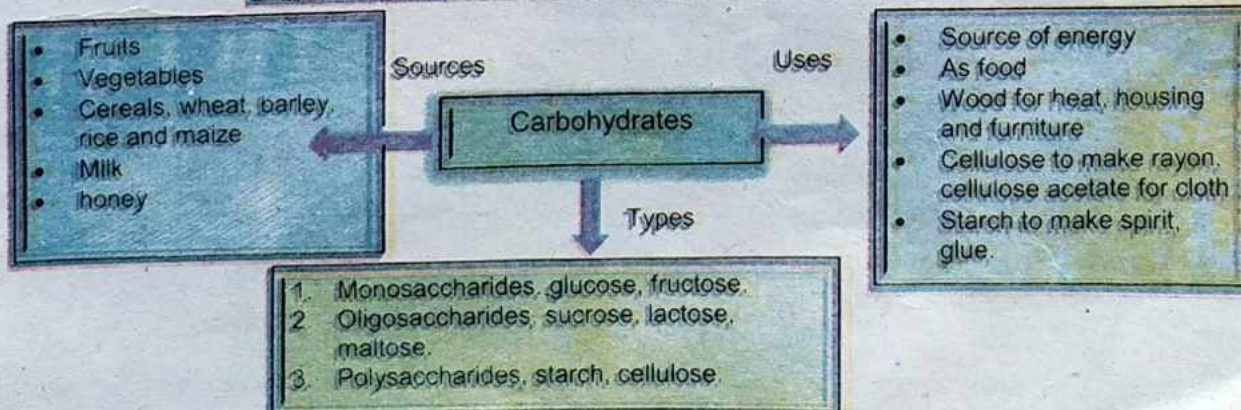
1. Define vitamins
2. Is vitamin C soluble in fat or in water?
3. Give examples of fat soluble vitamins.

Sources and uses of vitamins are given in table 13.2.

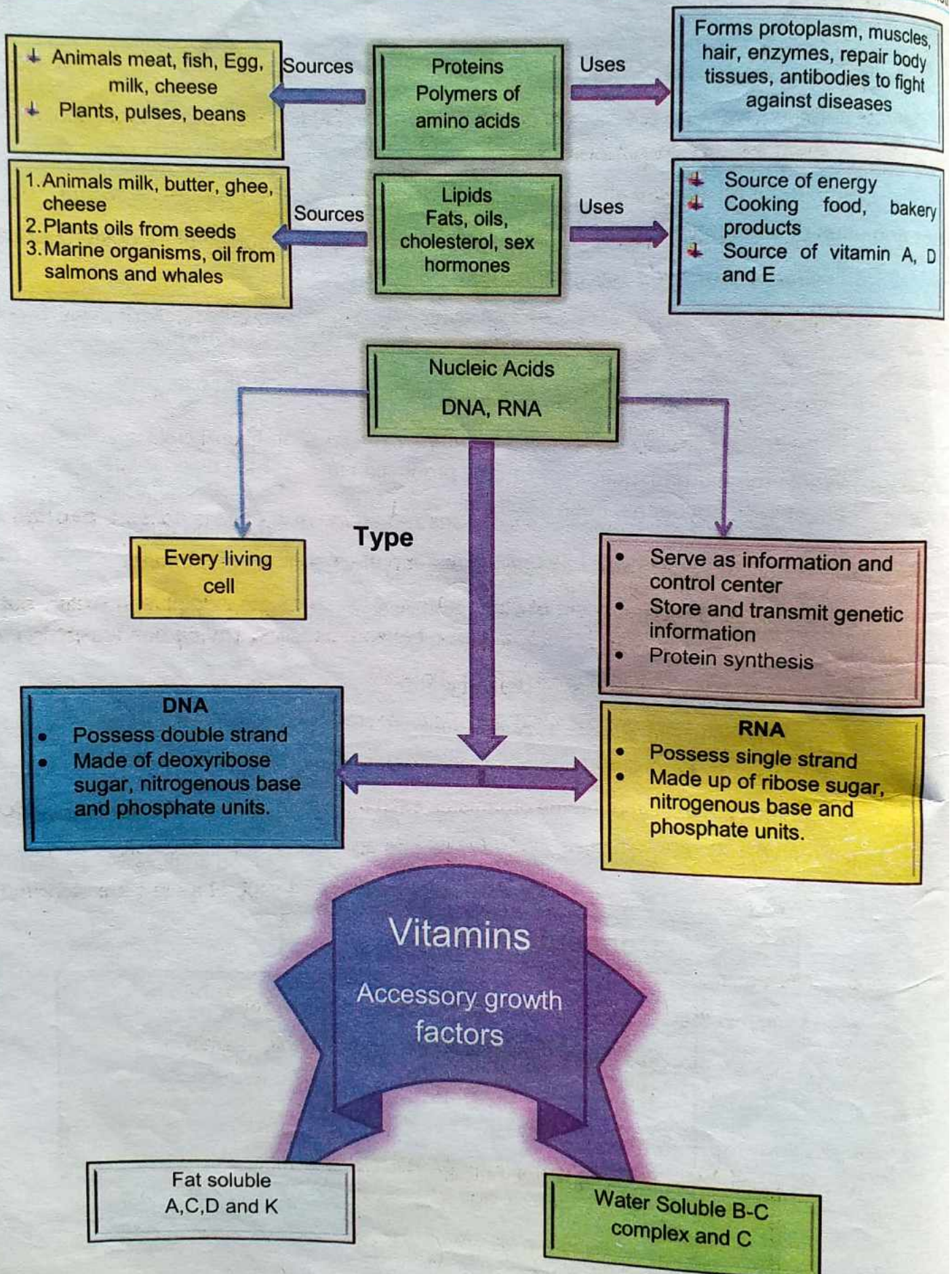
Table 13.2 Sources, uses of vitamins and diseases due to their deficiency

Just 2

Vitamin	Sources	Necessary for	Deficiency symptoms
A	Milk, butter, fish oils eggs, fresh green vegetable	Eyes and skin	Night blindness, dry skin
B (a group of several vitamins)	Whole meal bread, rice, yeast liver, soybeans, fresh green vegetables	Energy production in cells, nerves, skin	Skin diseases, tongue inflammation, anemia, bleeding gums
C	Oranges, lemons tomatoes fresh green vegetables.	Blood vessels, gums, healing wounds, preventing colds	Scurvy
D	Milk, butter, eggs, fish oils	Bones, teeth	Rickets, osteomalacia
E	Whole meal bread, rice eggs, butter, fresh green vegetables	Antioxidant	Haemolysis of red blood cells, sterility
K	Fresh green vegetables liver	Clotting blood	Haemorrhage delayed blood clotting

Concepts in brief**Science Titbits**

Some foods lose their vitamin contents when they are cooked in water and then drained. The water soluble vitamins go down the drain with water. For example rice, pulses, beans, gram, peas etc.



Key Points

- ❖ Carbohydrates are monomers and polymers of aldehydes and ketones that have numerous hydroxyl groups attached.
- ❖ Monosaccharides are the simplest carbohydrates. They cannot be hydrolyzed.
- ❖ Carbohydrates which upon hydrolysis form 2 to 9 molecules of monosaccharides or simple sugars are called oligosaccharides.
- ❖ Starch and cellulose are polysaccharides. They on complete hydrolysis produce 100 to 1000 units of simple sugars.
- ❖ 1g of glucose provides us 15.6 KJ of energy.
- ❖ Proteins are substances that produce amino acids on hydrolysis.
- ❖ The linkage $\text{—}\overset{\text{O}}{\parallel}{\text{C}}\text{—NH—}$ which joins two amino acid units is called a **peptide bond**.
- ❖ Meat, fish, eggs, milk and cheese are important sources of proteins.
- ❖ A lipid is any component of plant or animal tissue that is insoluble in water, but soluble in solvents of low polarity such as ether, hexane, benzene and carbon tetrachloride.
- ❖ . Fatty acids are long chain carboxylic acids.
- ❖ A lipid is called fat if it is solid at room temperature.
- ❖ A lipid is called oil if it is liquid at room temperature.
- ❖ Animals, plants and marine organisms such as salmon and whales are rich source of lipids.
- ❖ Nucleic acids serve as the information and control centers of the cell.
- ❖ DNA exists in the form of two strands twisted around each other in a spiral formation called a double helix
- ❖ RNA exists in the form of single strand.
- ❖ A vitamin that dissolves in fat is called fat soluble vitamin.
- ❖ A vitamin that dissolves in water is called water soluble vitamin.

References for additional informations.

- ❖ Chemistry, Addison - Wesley.
- ❖ Chemistry for changing times John W. Hill, Doris K. Kolb.



Review Questions

1. Select the correct answer.

- i) Which compound found in every living cell, serves as the information and control center?
(a) amino acid (b) protein (c) lipid (d) DNA
- ii) Plants convert glucose into
(a) starch (b) lipids (c) proteins (d) amino acids
- iii) Glucose is a
(a) tetrose (b) pentose (c) disaccharide (d) hexose
- iv) Which is not a dextrose sugar
(a) glucose (b) mannose (c) galactose (d) fructose
- v) Raffinose, $C_{18}H_{32}O_{16}$ on hydrolysis forms ____ simple sugars.
(a) 1 (b) 2 (c) 3 (d) 3 to 9
- vi) Which is not a source of starch?
(a) wheat (b) rice (c) cotton (d) potato
- vii) Which is not a protein?
(a) gelatin (b) antibodies (c) enzymes (d) cholesterol
- viii) Soaps and detergents are made from
(a) proteins (b) carbohydrates (c) fats and oils (d) all of these.
- ix) Which is not present in DNA
(a) deoxyribose sugar (b) ribose sugar (c) phosphate unit (d) nitrogen base
- x) Raffinose $C_{18}H_{32}O_{16}$ is a
(a) monosaccharide (b) disaccharide (c) oligosaccharide (d) polysaccharide

2. Give short answers.

- i) Decide, whether sucrose is a disaccharide or monosaccharide. Give reason
- i) What is a dextrose sugar?
- ii) Write the formula of an amino acid and identify functional groups in it.
- iv) What is a peptide bond?



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- v) Which compounds are included in lipids?
- vi) What is the function of DNA?
- 3. Distinguish between mono, di-, and tri-saccharides. Give examples.
- 4. Describe bonding in a protein molecule.
- 5. Explain sources and uses of lipids.
- 6. Give sources and uses of proteins.
- 7. Give sources and uses of carbohydrates.
- 8. Differentiate between fats and oils.
- 9. Define and explain vitamins.
- 10. Why are vitamins important for us?
- 11. Describe the importance of nucleic acids.
- 12. Explain why agricultural and nutritional sciences are vital.
- • 13. Explain hydrogenation of vegetable oil.
- 14. List commercial uses of enzymes.
- 15. Explain the use of dextrose in drips.
- 16. Separate water soluble vitamins from the following.

Vitamin A, Vitamin C, Vitamin E, Vitamin B



Think-Tank

- 17. Compare components in both proteins and carbohydrates?
- 18. What is the name of the bond that forms between two amino acids in building a protein?
- 19. How many molecules of water are needed to allow a disaccharide to form monosaccharides? Illustrate with a chemical equation.
- 20. Draw the structure of each of the following molecules.
 - a) An amino acid having $-\text{CH}_3$ as R group.
 - b) A protein containing two amino acids.
- 21. Distinguish between DNA and RNA?
- 22. Hydrogenation is an important reaction in food industry. Interpret this statement.