

Chapter #13

Biochemistry

Q1. Explain the source and uses of carbohydrates?**Ans: 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. Plants synthesize carbohydrates through photosynthesis.



Plants convert glucose into starch and cellulose.

Composition of carbohydrates:

Carbohydrates are monomers and polymers of aldehydes and ketones that have numerous hydroxyl groups attached.

Society, Technology and Science**Protein Deficiency:**

Protein deficiency leads to physical and mental retardation. Excess lipids or fats may lead to heart disease or a stroke, cancer, diabetes and other health problems. The nutritional chemists recommend that no more than 30% of your daily caloric intake comes 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.

Q2. List of classification of carbohydrates?

Ans: Classification of carbohydrates:

Carbohydrates are classified as:

i) Monosacchride ii) Oligosacchrides iii) Polysacchrides

Q3. What is the chemical nature of monosacchrides? Discuss their structure.

Ans: Monosacchrides:

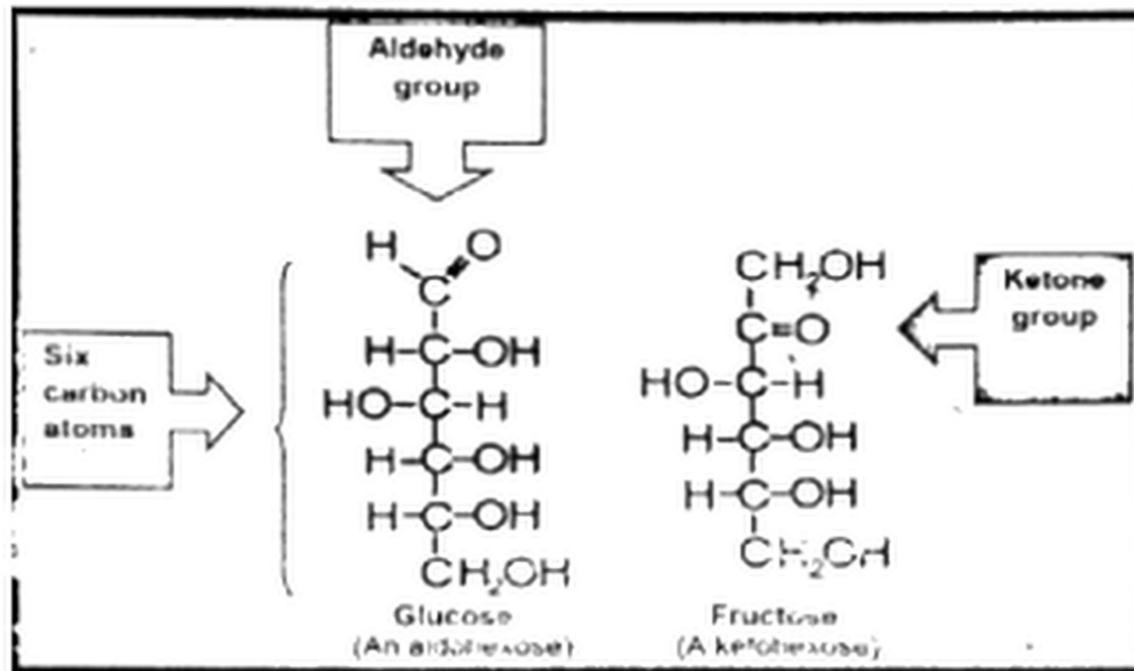
Monosacchrides are the simplest carbohydrates. They cannot be hydrolyzed.

General formula of Monosacchrides:

They have general formula $(\text{CH}_2\text{O})_n$ where n is 3 to 6 carbon atoms. So, monosacchrides contain 3 to 6 carbon atoms.

Classification of Monosacchrides:

Monosacchrides are further classified as trioses, tetroses, pentoses, hexoses etc. This classification is based on the number of carbon atoms they contain.



Glucose and Fructose:

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

Dextrorotatory or Dextrose sugars:

Some Monosaccharide molecules can rotate the plane of plane polarized light to right (clockwise). They are called dextrorotatory or dextrose sugars.

Glucose, manose, Galactose are dextrose sugars.

Characteristics of monosaccharides:

Monosaccharides are white crystalline solids. They are soluble in water and have sweet taste. They are reducing in nature.

Q4. Is glucose a pentose?

Ans: No, glucose is a hexose ($C_6H_{12}O_6$).

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Use of dextrose in drips:

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

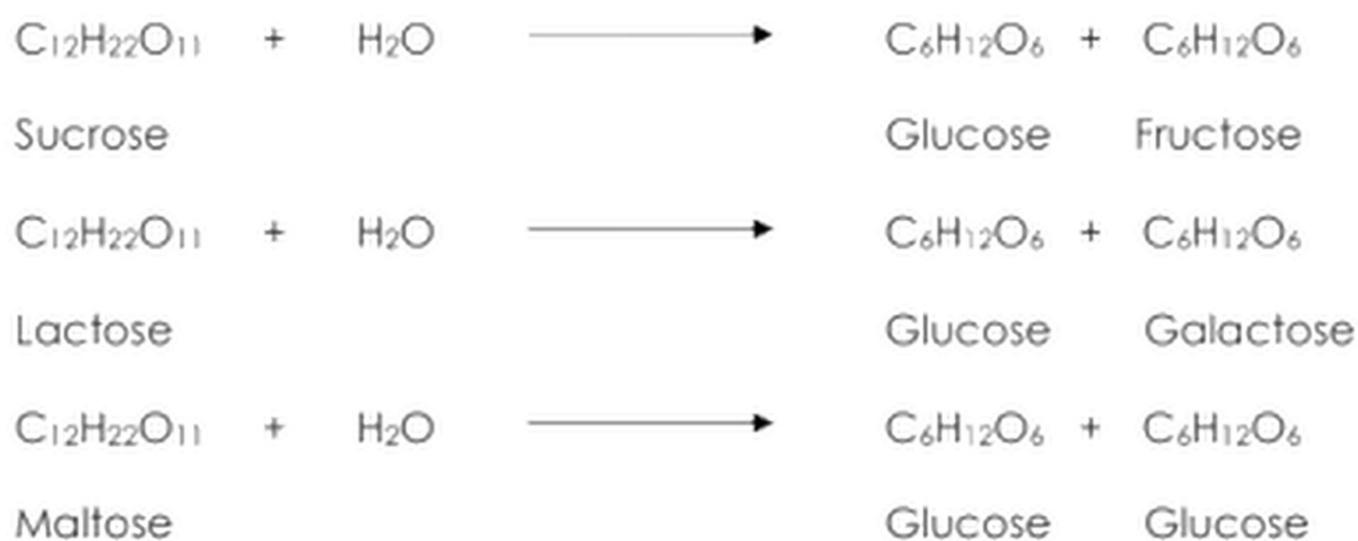
Q5. What is the chemical nature of Oligosacchrides? Discuss their structure.

Ans: Oligosacchrides:

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

Classification of Oligosacchrides:

They are further classified as disacchrides, trisacchrides etc. Prefixes di, Tri, tetra, penta etc. indicate the number of monosachride units, they produce on hydrolysis. They are white crystalline solids. They have sweet taste and are soluble in water.



Self-Assessment Exercise 13.1

1. **Classify sucrose, lactose and maltose as mono, di and tri- sacchrides . Give reason.**

Ans: Since sucrose consists of two monomers, therefore sucrose is a disacchahride. (which we call table sugar, cane sugar, or "sugar" itself).

Sucrose is a disacchahride of glucose and fructose.

Maltose is a disacchahride of glucose and glucose.

Maltose = Glucose + Glucose

Lactose is a disacchahride of glucose and galactose.

Lactose = Glucose + Galactose

2. **Is galactose, a monosacchride?**

Ans: Galactose is a monosacchride because it cannot be hydrolyzed and consist of only one unit.

3. **Raffinose, (C₁₈H₃₂O₁₆) hydolyzes as follows. Is raffinose a disacchahride?**



Ans: Examples:

Raffinose, found in molasses contain the three hexoses. Therefore, raffinose is a trisacchride.

Self-Assessment Exercise 13.2

1. List
- a) Three examples of Monosacchrides
 - b) Three examples of disacchahrides
 - a) One Example of trisacchride

b) Two examples of Polysacchrides**2. List sources of****(a) Sucrose****(b) Maltose****(c) Lactose****Solution:****1. List****a) Three examples of Monosacchrides**

Glucose, Manose, Galactose, Fructose

b) Three examples of disacchrides

Maltose, lactose, Sucrose

c) One Example of trisacchride

Isomaltotriose, Igerotriose, Maltotriose, maltotriulose, Raffinose

d) Two examples of Polysacchrides

Cellulose, Glycogen, Starch

2. List sources of**(a) Sucrose**

Sucrose is obtained in sugarcane, sugarbeet, honey and fruits.

(b) Maltose

Maltose is found in cereals. It is also found in beverages, beer, cereal, pasta, potatoes.

(c) Lactose

Lactose is main sugar in milk and dairy products.

Q6. Activity 13.1: To check the relative solubility in water of starch and sugar.

- **Mix a teaspoon full of starch in a beaker, half-filled with water. Stir well. What happens?**
- **Mix a teaspoon full of sugar in another beaker, half-filled with water. Stir well. What happens?**

Which is soluble in water, starch or sugar?

Sugar is soluble in water whereas, starch is insoluble in water.

Q7. What are Proteins? Write their function.

Ans: Proteins:

Proteins are complex nitrogenous substances that produce amino acids on complete hydrolysis.

Functions of Protein:

Proteins have many functions in body.

- i. Protein transport and store oxygen and nutrients.
- ii. Proteins acts as catalysts for the thousands of reactions that make life possible.
- iii. Proteins regulate many important systems in our body.

Characteristics of Proteins:

Proteins are high molecular weight polymers. The building blocks of all proteins are amino acids therefore, all proteins produce amino acids on hydrolysis.

Q8. An amino acid has two functional groups. What are those?

Ans: An amino acid has two functional groups. All amino acids have a carboxyl and amino group in order for them to form long continuous chains of proteins.

DO YOU KNOW?

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

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Enzymes:

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 stain, 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 cloths.
- (d) Lactase is used in infant foods.

DO YOU KNOW?

Kwashiorkor:

An extreme lack of proteins and vitamins causes a deficiency disease called kwashiorkor. The symptoms include retarded growth, discoloration 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) Proteins (b) Amino Acids
3. Draw peptide linkage.
4. Define:
(a) Essential Amino acids
(b) Non-essential amino acids

Solution:

1. What two functional groups are found in Amino acids?

Ans: carboxyl and Amino group.

2. Define

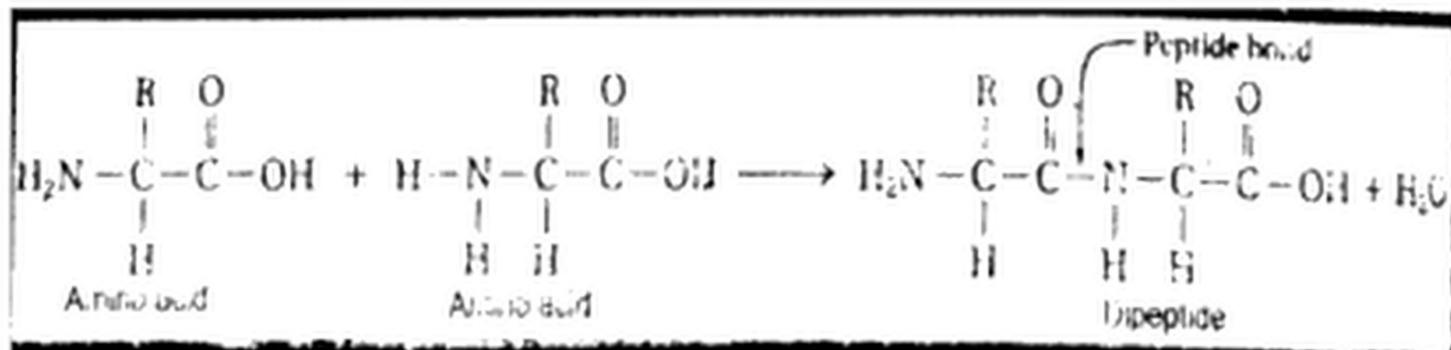
(a) Protein:

Proteins are complex nitrogenous substances that produce amino acids on complete hydrolysis.

(b) Amino Acids:

Amino acids are biologically important organic compounds made from amine (-NH₂) and carboxyl group (-COOH) functional groups, along with a side chain specific to each amino acid.

3. Draw peptide linkage



4. Define

(a) Essential amino acids

Essential amino acids cannot be made by the body. As a result, they must come from food.

The essential amino acids are: Histidine, Isoleucine, leucine, lysine, Methionine, Phenylalanine, Threonine, Tryptophan and Valine.

(b) Non-essential amino acids:

“Non-essential” means that our bodies produce an amino acid, even if we don't get it from food we eat.

They include alanine, asparagine, aspartic acid and glutamic acid.

Q9. Activity 13.2: To observe and explain the denaturing of Proteins.

Carry out the following:

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

White viscous fluid or albumin present in egg is protein. When egg is boiled, this protein is solidified or coagulates. This change of protein is called **Denaturing of Protein**. The denaturing may also occur during change in pH.

Q10. Which compounds are included in Lipids?

Ans: 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:

- (a) Fats and oils
- (b) Cholesterol
- (c) Sex Hormones
- (d) Components of cell membrane called phospholipids
- (e) Some vitamins (A, D, E and K)

Q11. Write down role of fatty acids?

Ans: Fatty acids:

Fats and oils are referred as simple lipids. They are esters of fatty acid with trihydroxy alcohol, glycerol. For this reason they are called glyceryl Esters or glycosides.

Fatty acids are long chain carboxylic acids. They are building blocks of lipids. For Example, stearic acid, $C_{17}H_{35}COOH$ is one such acid that occurs in animal fats.

Q12. Give some common fatty acids in natural fats?

Ans: Some common fatty acids in natural fats:

No. of Carbon atoms	Condense 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

Self-Assessment Exercise 13.4

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

Solution:

1. Define

(a) Lipids

A fatty or organic waxy compound that is readily soluble in non-polar solvent (e.g. Ether) but not in polar solvent (e.g. Water). Its major biological functions involve energy storage structural component of cell membrane, and cell signaling.

Examples of lipids are waxes, oils, sterols, cholesterol, fat-soluble vitamins, monoglycerides, diglycerides, Triglycerides (fats) and phospholipids.

(b) Fats

Any of a large number of oily compounds that are widely found in plant and animal tissues and serves mainly as a reserve source of energy.

Some examples of foods that contain fats and butter are butter, oil, nuts, meat, fish and some dairy products.

(c) Oils

A lipid is called oil if it is liquid at room temperature. Oils contain larger proportion of unsaturated fatty acid units.

2. Consult table 13.1 and write

No. of Carbon atoms	Condense Structure	Name	Source
4	$\text{CH}_3\text{—CH}_2\text{—CH}_2\text{—COOH}$	Butyric acid	Butter
6	$\text{CH}_3\text{—(CH}_2\text{)}_4\text{—COOH}$	Caproic acid	Butter
16	$\text{CH}_3\text{—(CH}_2\text{)}_{14}\text{—COOH}$	Palmitic acid	Palm oil
18	$\text{CH}_3\text{—(CH}_2\text{)}_{16}\text{—COOH}$	Stearic acid	Beef fat

18	$\text{CH}_3-(\text{CH}_2)_7-\text{CH}=\text{CH}-$ $\text{CH}_2)_7-\text{COOH}$	Oleic acid	Olive oil
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i) **The names two fatty acids that are components of fats**

Stearic acid $\text{CH}_3-(\text{CH}_2)_{16}-\text{COOH}$

Butyric acid $\text{CH}_3-\text{CH}_2-\text{CH}_2-\text{COOH}$

ii) **The name of one fatty acid that is a component of an oil**

Oleic acid $\text{CH}_3-(\text{CH}_2)_7-\text{CH}=\text{CH}-(\text{CH}_2)_7-\text{COOH}$

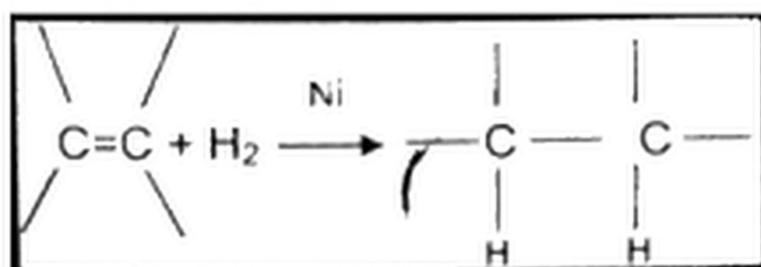
Science Titbits

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

Society, Technology and Science

Hydrogenation:

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



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.

Important information

Flax seeds:

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

DO YOU KNOW?

Insulin:

Insulin is a protein coded by DNA. It is required for the proper use of glucose with 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 human digestive tract. The bacterial cell multiply rapidly making billions of cells and each new E.coli cell carries in its DNA, a gene for human insulin.

Q13. Describe the importance of Nucleic acids.

Ans: Nucleic acids:

Nucleic acids are large known molecules essential for all known forms of life. They include DNA(Deoxyribonucleic acid) and RNA (Ribonucleic acid).

More than 1000 years ago a Swiss biochemist discovered a class of nitrogen-containing compounds in the nuclei of cells. These nitrogen-containing compounds in the nuclei of cells, these nitrogen-containing compounds which were first observed from the pus infected wounds are called nucleic acids.

Importance of 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 cell.

Structure of nucleic acids:

They are long chain of 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

Kinds of Nucleic acids:

There are two kinds of nucleic acids, Deoxyribonucleic acid (DNA) and ribonucleic acid (RNA).

Function of DNA:

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

Q14. Who discovered the structure of DNA?

Ans: 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.

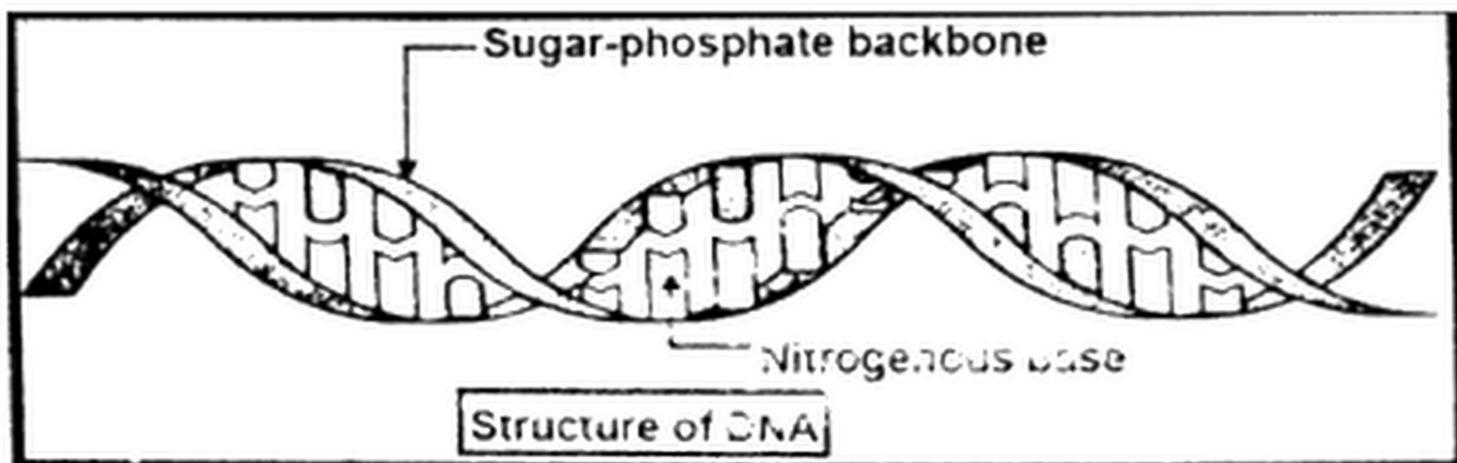
Q15. What is the structure and function of DNA?

Ans: Deoxyribonucleic acid (DNA):

DNA exists in the form of two strands twisted around each other in a spiral formation called a double helix. Each chain or strand is made up of deoxyribose sugar, phosphate unit and a nitrogen base. The strands are held together by hydrogen bonds. The order of these base pairs in a strand is a code which stores information which is used to produce proteins.

Function of DNA:

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.



Q16. What is the structure and function of RNA?

Ans: 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 responsible for directing synthesis of new proteins.

Function of RNA:

RNA receives, reads, decodes and uses genetic information from DNA to synthesize new proteins.

Science Titbits
(Chemistry in action)

DNA fingerprinting:

The variation in DNA of individuals forms the basis of a method for identifying a person from sample of their hair, skin cells or body fluid because DNA like fingerprints are unique for each individual this method is called DNA fingerprinting. Only a tiny sample is needed. The pattern is compared with DNA of a sample from 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 a individual.

Self-Assessment Exercise 13.5

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

Solution:**1. How do DNA and RNA differ in structure?****Ans: Deoxyribonucleic acid (DNA):**

DNA exist in the form of two strands twisted around each other in a spiral formation called a double helix. . Each chain or strand is made up of deoxyribose sugar, phosphate unit and a nitrogen base. The strands are held together by hydrogen bonds. The order of these base pairs in a strand is a code which stores information which is used to produce proteins.

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 responsible for directing synthesis of new proteins.

2. Name two kinds of nucleic acid?

There are two kinds of nucleic acids, Deoxyribonucleic acid (DNA) and Ribonucleic acid (RNA).

3. Write the differences in DNA and RNA.

- i. DNA has the bases Adenine, Thymine, Guanine, Cytosine.
RNA has the bases Adenine, Uracil, Guanine, Cytosine.
- ii. DNA has the sugar deoxyribose.
RNA has the sugar ribose.

- iii. DNA is double stranded.
RNA is single stranded.

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?

Ribonucleic acid (RNA)

Q17. Give the introduction of Vitamins?

Ans: Introduction of vitamins:

In 1897 the Dutch scientist C. Eijkman discovered that polished rice lacked something found in the hull. Lack of something caused the disease beri beri. A British scientist F. G Hopkins experimentally proved that in addition to carbohydrate, fats, proteins and minerals certain missing factors were also needed to sustain healthy growth. In 1912, Casimir 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 are not amine. So the generic name these compounds became Vitamin. Vitamins are accessory growth factors.

Q18. Describe different types of vitamins

Ans: Types of Vitamins: There are two types of vitamins

(a) Fat soluble vitamins:

A vitamin that dissolves in fat is called fat soluble vitamin.

Examples: Vitamin A,D,E and K.

Harmful effects to use excess amount of Vitamins:

Taking excess amounts of fat soluble vitamins may be harmful. For instance, large excess of vitamin A can cause dry skin, irritability and feeling of pressure inside 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.

Example: For example, Vitamin B (complex) and C.

Note: Our body has limited capacity to store these vitamins. If taken in excess they are readily excreted from the body. Water soluble vitamins are not toxic even if taken in excess.

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Color, Flavour and Fragrance:

Some natural products are added in prepared foods to enhance color, flavour 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, pineapple 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 of diseases.

Function of vitamin C:

Vitamin C is frequently added to fruit juices and flavoured drinks to prevent scurvy and elimination of Rickets.

Function of Vitamin A:

Vitamin A is added to margarine to prevent night blindness.

Self-Assessment Exercise 13.6

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

Solution:**1. Define vitamins.**

Vitamins are specific organic compounds which are required by our bodies to prevent specific diseases but cannot be produced by our bodies.

2. Is vitamin C soluble in fat or water?

Vitamin C is soluble in water.

3. Give examples of fat soluble vitamins.

Vitamin A, D, E and K.

Q19. Give the sources and uses of vitamin A, B, C, D, E and K

Ans: Sources, Uses of vitamins and diseases due to their deficiency:

Vitamin	Sources	Nessecary for	Deficiency symptoms
A	Milk, butter, fish, oils, eggs, fresh green vegetables	Eyes and skin	Night blindness, Dry skin
B (a group of several vitamins)	Whole meal bread, rice, yeast, liver, soy beans, fresh green vegetables	Energy production in cells, nerves and skin	Skin diseases, Tounge, inflammation, aneamia, 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	Hemolysis of red blood cells, streility
K	Fresh green vegetables, Liver	Clotting blood	Hemorrhage delayed blood clotting

Science Titbits

Loss of vitamins:

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 Examples, rice, pulses, beans, grams, peas etc.

Q20. What three elements are important in both proteins and carbohydrates?

Ans: Carbon, Hydrogen and Oxygen.

Q21. What five elements are primarily responsible for the makeup of DNA and RNA?

Ans: The five "elements" are Carbon, Oxygen, Hydrogen, Nitrogen and Phosphorus.

Q22. Write structural formula of an amino acid containing four carbon atoms.

Ans:

