

BIOMOLECULES

Preface

Biochemistry is the branch of chemistry which deals with the composition and behaviour of living systems. In this chapter you will learn about carbohydrates, their types, lipids, proteins, amino acids & their functions, nucleic acids, types of DNA & RNA and their functions.

After successful completion of the topic, you will be able to know about.

- (i) Mono, di & polysaccharides
- (ii) Simple, compound & derived lipids
- (iii) Protein structures & configurations
- (iv) Nucleic acids (DNA & RNA)

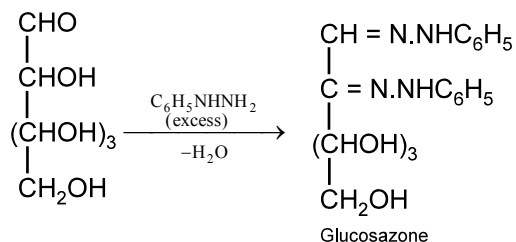
This book consists of theoretical & practical explanations of all the concepts involved in the chapter. Each article followed by a ladder of illustration. At the end of the theory part, there are miscellaneous solved examples which involve the application of multiple concepts of this chapter.

Students are advised to go through all these solved examples in order to develop better understanding of the chapter and to have better grasping level in the class.

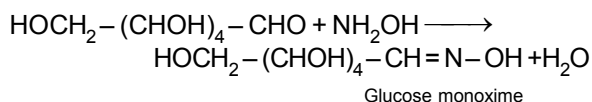
Total No. of questions in Biomolecules are-

In Chapter Examples	08
Solved Examples	12
Total No. of questions	20

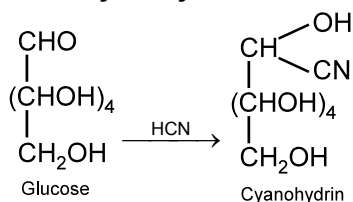
5. Formation of Osazone



6. Reaction with Hydroxylamine



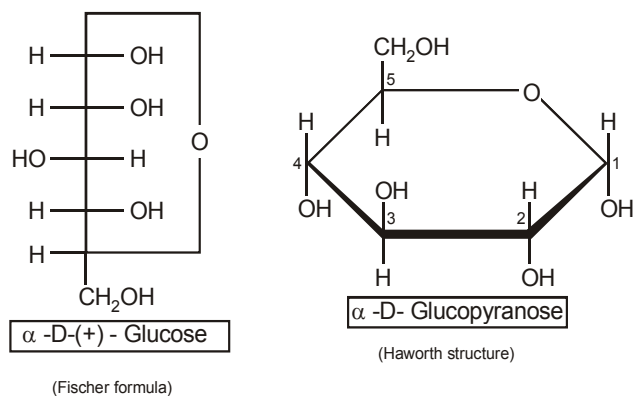
7. Formation of Cyanohydrin



Objection to linear structure :

Glucose pentaacetate does not react with hydroxylamine thus indicating the absence of free $-\text{CHO}$ group.

Cyclic Structure of Glucose



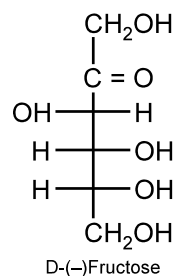
FRUCTOSE (LAEVULOSE), $\text{C}_6\text{H}_{12}\text{O}_6$

Fructose is a ketohexose. It is obtained along with glucose by the hydrolysis of sucrose..

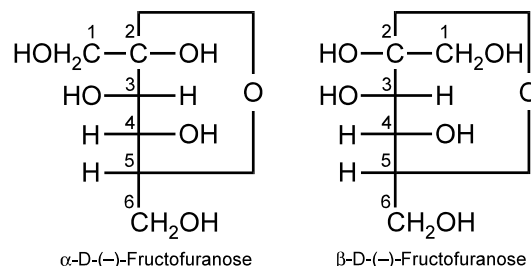
Structure of Fructose

Fructose has the molecular formula $\text{C}_6\text{H}_{12}\text{O}_6$ and on the basis of its reactions it was found to contain a ketonic functional group at C—2 and six carbon atoms in straight chain as in case of glucose. It belongs to D-series and is a laevorotatory compound. Therefore, fructose is correctly named as D-(–)-fructose. Its open chain structure may be

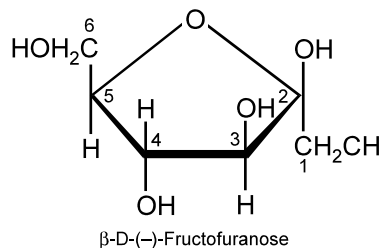
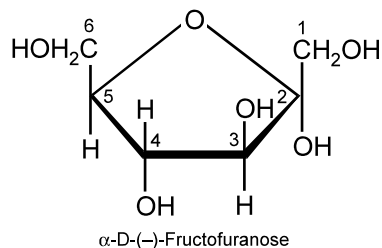
written as:



Fructose also exists in two cyclic forms which are obtained by the addition of $-\text{OH}$ at C–5 to the $(>\text{C} = \text{O})$ group. The ring thus formed is a five membered ring and is named as furanose with analogy to the compound furan.



The cyclic structures of two anomers of fructose are represented by Haworth structures as given



Isomerism

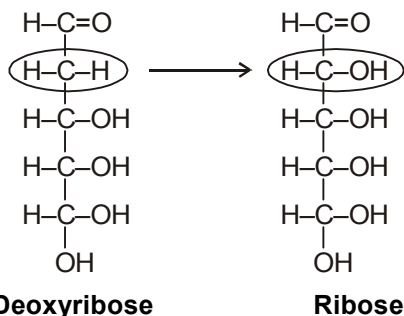
Carbohydrates which differ in configuration at the glycosidic carbon (i.e. C_1 in aldoses and C_2 in ketoses) are called **anomers**. For example, α -D-glucose and β -D-glucose are anomers since they differ in configuration at C_1 (glycosidic carbon).

Carbohydrates which differ in configuration at any carbon other than glycosidic carbon are called **epimers**. For example glucose and mannose are called epimers since they differ in configuration at C_2 (glycosidic carbon) while glucose and galactose are called **epimers** since they differ in configuration at C_4 (other than the glycosidic carbon).

2.1.1 Derivatives of monosaccharides

Following are derivatives of monosaccharides.

- (a) **Deoxysugar** : If 1 hydrogen occupies the position of one $-OH$ than deoxysugar is formed.



- (b) **Amino sugar** - $-OH$ group of Aldose is replaced by $-NH_2$ group than it is called as amino sugar.
Eg. D-glucosamine, D-galactosamine

2.2 Oligosaccharides

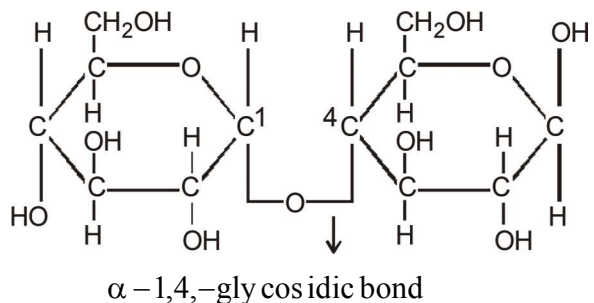
It is formed by combination of 2 to 10 monosaccharide units.

2.2.1 Disaccharides

- (a) The disaccharides are sugars composed of two molecule of same or different monosaccharides.
- (b) Generally one molecule of water is reduced in forming disaccharides reaction is called as dehydration .
- (c) General Formula = $C_n(H_2O)_{n-1}$
- (d) Bond present in between them is called as **glycosidic bond**.

Some Important Disaccharides

- (i) **Maltose** = Glucose + Glucose



- (ii) **Lactose** = Galactose + Glucose

- (iii) **Sucrose** = Glucose + Fructose

⇒ It is a commercial or kitchen sugar.

2.3 Polysaccharides

- (a) Polysaccharides yield more than 6 molecules of monosaccharides on hydrolysis.
- (b) General formula = $(C_6H_{10}O_5)_n$.
- (c) These are linear polymers and also highly branched
- (d) **These are not called as sugar because are not sweet in taste.**

Excep. - Insulin is sweet.

- (i) **Starch**

⇒ **Stored food of plant**

⇒ It is insoluble in water.

⇒ It gives blue colour with iodine.

⇒ Its monomer is a α -D glucose.

⇒ It is formed of two compounds viz.



- (a) **Amylose** :

⇒ It has 250-300 monomers.

⇒ These are combined with α 1, 4-linkage

⇒ It is **unbranched** helical structure.

⇒ They give blue colour with I_2 .

⇒ It is 15% to 20% in starch.

- (b) **Amylopectin** :

⇒ Branch of 24-30 glucose monomers.

⇒ Many branches are present.

⇒ In straight chain it is attached by α 1, 4 glycosidic bond while in **branched** chain it is linked by α -1,6 linkage.

⇒ Give red colour with I_2 .

⇒ It is 80 - 85% in starch.

(ii) Glycogen (animal starch) :

⇒ Found in form of reserved food in animals

⇒ It is found in more amount in Liver and muscles.

⇒ It is a multibranched polysaccharide.

⇒ Its monomer unit is α D glucose.

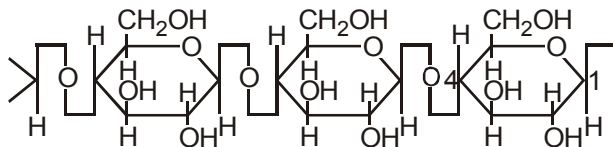
⇒ In straight chain α 1,4 linkage and in branched chain α 1, 6 linkage is present.

⇒ Give red colour with I_2 .

(iii) Cellulose

⇒ It is mainly found in plant cells .

⇒ It is main constituent of cell wall.



Structure of Cellulose

⇒ It does not give colour with I_2 .

⇒ It is monomers of **D-glucose**

⇒ β - 1,4 glycosidic bond is present

⇒ It is insoluble in water .

⇒ Water hydrolysis is done by cellulase enzyme.

2.4 Biological Importance of Carbohydrate :

(i) It is main source of energy.

(ii) It is called fuel of the body.

(iii) Cell wall of plant cell is made up of cellulose.

(iv) Exoskeleton of insect is formed of chitin.

(v) Sugar is structural component of DNA and RNA.

(vi) 1gm Carbohydrate give 4.1 kcal of energy.

2.5 Test of Carbohydrates

(a) Carbohydrate with Tollen's reagent (ammonical silver nitrate) give silver mirror test.

(b) Carbohydrate with Fehling solution (alkaline $CuSO_4$) give a red ppt.

Examples based on Carbohydrates

Ex.1 To classified as carbohydrate a compound must contain at least-

(A) 2 Carbons (B) 3 Carbons

(C) 4 Carbons (D) 6 Carbons

Ans. (B)

Sol. Since carbohydrates are optically active polyhydroxy aldehydes/ketones, it must contain at least three carbon atoms. Hydroxy aldehyde with 2 carbon atoms, viz. CH_2OH . CHO is not carbohydrate as it optically inactive.

Ex.2 Glucose can't be classified as-

(A) Hexose

(B) Carbohydrates

(C) Aldose

(D) Oligosaccharide

Ans. (D)

Sol. Glucose is a monosaccharide, while oligosaccharides contain 2 to 10 monosaccharide units.

3. LIPIDS ::

(a) Lipids words is derived from greek word lipos which means fat.

(b) Lipids are heterogeneous group of substances which have common property of being relatively insoluble in water and soluble in non-polar solvents such as ether, Chloroform etc.

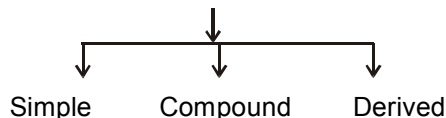
(c) Form 3-5% part of protoplasm.

(d) $H_2O \neq 2 : 1$ (different from water)

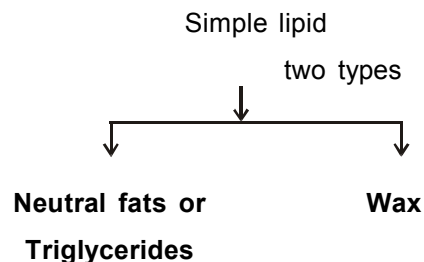
(e) Ratio of oxygen is less.

(f) Specific gravity < 1

Three types



3.1 Simple lipid :

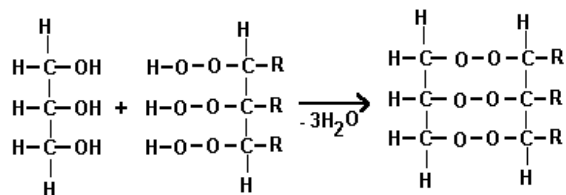


3.1.1 Triglycerides

(a) These are esters of fatty acids with glycerol.

Ester bond is present

(b) Synthesis is of following type-



(c) Fatty acids which occur in natural fats usually contain an even number of carbon atoms (4 to 30) in straight chains.

(d) Simplest fatty acid HCOOH .

(e) More complex fatty acid are formed by successive addition of $-\text{CH}_2$ groups.

↓ Fatty acids are of 2 types



(i) **Saturated :**

⇒ Only single bond is present in them.

⇒ First member is CH_3COOH .

Other examples :

⇒ Palmitic acid - $\text{C}_{15}\text{H}_{31}\text{COOH}$

→ $\text{CH}_3(\text{CH}_2)_{14}\text{COOH}$

⇒ Stearic acid - $\text{C}_{17}\text{H}_{35}\text{COOH}$

→ $\text{CH}_3(\text{CH}_2)_{16}\text{COOH}$

⇒ Palmitic and stearic acid is found in fats of animals in less amount.

⇒ These are solid and are found in fats.

(ii) **Unsaturated :**

⇒ Double bond is present in these fatty acid chain.

⇒ These are liquids at room temperature. Found in Oils.

⇒ These are of two types

Monounsaturated - 1 Double bond is present
Eg. Oleic acid.

⇒ Oleic acid is present in more amount in nature.

Polyunsaturated - More than two double bond

Eg. Linoleic acid with two double bonds

Linoleic acid with three double bonds

Arachidonic acid with four double bonds (Groundnut)

3.1.2 Wax :

⇒ These are esters of other alcohols of high molecular weight instead of glycerols.

⇒ These are insoluble in water.

⇒ These are monohydric alcohols.

⇒ Some examples of waxes -

Myricye palmitate (Honeybee wax)

Cetyl palmitate (Dolphin and whale wax)

Cerumen (ear wax)

3.2 Compound Lipid- Are of 4 types :

(a) Phospholipids.

(b) Glycolipids.

3.2.1 Phospholipids :

Phosphorous is present.

ex. cell wall

3.2.2 Glycolipids

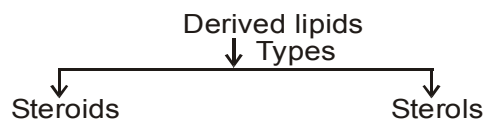
⇒ Lipid + Sugar = Glycolipids

⇒ Present in brain, Adrenal glands, kidney, WBC liver, thymus, Spleen, Lungs, egg yolk

⇒ Glycolipids = 2 Fatty acid + 1 sphinocine + 1 galactose.

3.3 Derived lipids

⇒ By hydrolysis of fats they are obtained



3.3.1 Steroids :

⇒ These are different from other fats.

⇒ It is insoluble in water.

(i) **Bile acids :**

⇒ Present in secretion of liver.

(ii) **Sex hormones :**

⇒ These are androsterones.

(iii) **Adrenal hormone-** Eg : Aldosterone

3.3.2 Sterols :

- ⇒ They have -OH groups.
- ⇒ They are complex monohydroxy alcohols.

(i) **Cholesterol** - It is widely distributed in all cells of body.

3.4 Biological importance of Fat :

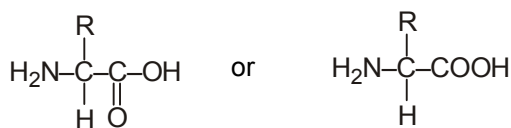
- ⇒ It is source of energy.
- ⇒ It is important for absorption of vitamin A, D, E and K.
- ⇒ It is important component of plasma membrane.
- ⇒ It act as shock absorber of body.
- ⇒ Calorific value 9.3 kcal.

4. PROTEINS ::

- (a) Proteins are polymers of amino acids.
- (b) Protein is 3/4 part of dry weight of tissues.
- (c) Protein forms structure of body.
- (d) C, H, O, N are necessary present in proteins.
- (e) In some proteins P, S, Fe, Cu, I, also may be present. They are called trace elements.
- (f) 70 types of Amino acids are known. But in proteins about 20 types of amino acids are used. other amino acids are called non-proteinous amino acid for e.g. citruline, ornithine

4.1 Chemical Structure :

(a) Amino acids can be given by the general formula.



R = Alkyl group.

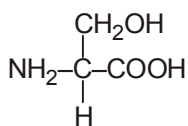
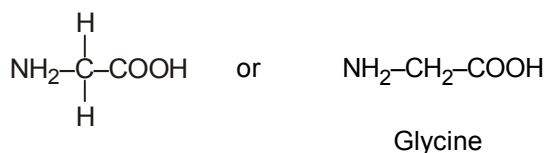
(b) If 'R' Changes amino acids formed also changes.

e.g. If R = H → Glycine (Simplest A. Acid)

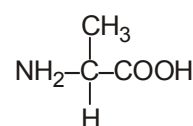
If R = CH₃ → Alanine

If R = CH₂OH → Serine.

'R' group attach with the carbon than that carbon is called α - carbon.

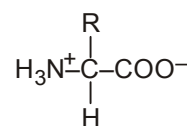


Serine



Alanine

- (c) Amino acids have also NH₂ group. Which is basic and also COOH group. Which is acidic. So Nature of Aminoacid is Acidic + Basic
- (d) Amino Acids are amphoteric in nature. So for it a special term is coined called **Zwitter ion**.
- (e) They have following structure in solution



[Zwitter Ion]

[Net charge on it is zero]

4.2 Classification of Amino Acids :

(A) According to synthesis amino acid is of two types-

(i) Essential amino Acids :

⇒ These are taken by food. Not synthesized in the body.

⇒ These are as follows

- | | |
|--------------------|----------------|
| (1) Leucine | (2) Isoleucine |
| (3) Lysine | (4) Methionine |
| (5) Phenyl alanine | (6) Threonine |
| (7) Tryptophan | (8) Valine |

Arginine and Histidine are **semiesential** amino acids ie. they are partly synthesized in tissues.

(ii) Non - Essential Amino Acid :

(a) These are synthesized in body.

(b) These are not required in food.

(c) These are as follows

- | | |
|---------------------|----------------|
| (1) Alanine | (2) Asparagine |
| (3) Aspartic acid | (4) Cistine |
| (5) Glutamic acid | (6) Glutamine |
| (7) Hydroxy proline | (8) Glycine |

The denaturation may be reversible or irreversible. The coagulation of egg on boiling is an example of irreversible protein denaturation.

However, it has been shown now that in some cases, the process is actually reversible. The reverse process is called **renaturation**.

4.6 Test of Protein :

- (a) With conc. HNO_3 on heating give yellow ppt. Which on more heating give solution On adding NH_4OH Red colour appears. It is **Xanthoprotic test**.
- (b) $(\text{NH}_4\text{OH}) + \text{dil. CuSO}_4$ protein give Blue violet colour. It is a **biurete test**.

4.7. Biological Importance of protein :

- (a) Component of plasma membrane.
 (b) All enzymes are protein.
 (c) Many hormones are protien.
 (d) Antigen and antibody are protein.
 (e) Actin and myosin protein are important in muscle contraction.
 (f) Proteins are important in growth, regeneration and repairing.
 (g) Calorific value 4.0 kcal.

Examples based on Proteins

- Ex.3** Relation between amino acids and proteins is smililar to the one present between-
- (A) Glucose and fructose
 (B) Thyamine and uracil
 (C) Glucose and Glycogen
 (D) Glucose and lactose **Ans.(C)**

Sol. Proteins are formed of amino acids so the same relation as in glucose and glycogen.

- Ex.4** Which of the following is proteins-
- (A) Nylon (B) Terry cotton
 (C) Natural silk (D) Rayon **Ans.(C)**

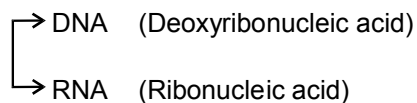
Sol. Silk has β pleated structure.

5. NUCLEIC ACID ::

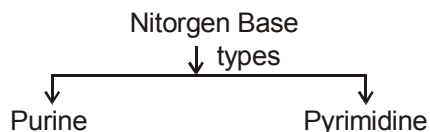
- (a) These are special type of acids which are present in nucleus & cytoplasm.
 (b) Control the metabolic activities of cell.

- (c) They are also found in Mitochondria, centriole and chloroplast.

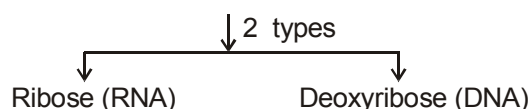
Types → These are of 2 types



- (d) **Fischer** discovered Nitrogen bases in 1888

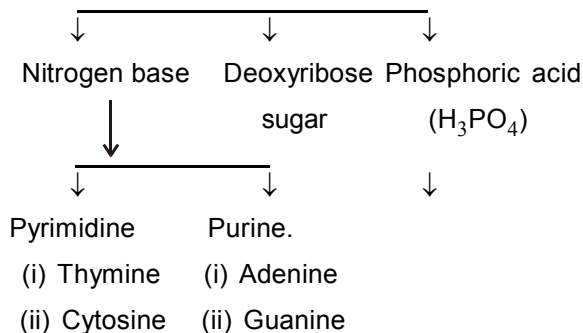


- (e) **Levan** found sugar



5.1 Deoxyribosenuclie Acid (D.N.A.):

- (a) It is found in Nucleus.
 (b) They on pneumococcus bacteria.
 (c) DNA made up of 3 units-



- (d) **Nucleoside**

When nitrogen base combined with deoxyribose sugar it constitute a nucleoside.

S.No. Deoxyribonucleoside

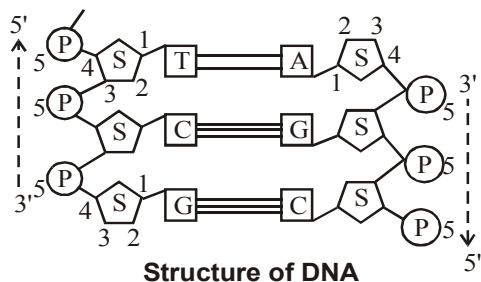
- Adenine + Deoxyribose → Deoxyadenosine
- Guanine + Deoxyribose → Deoxyguanosine
- Cytosine + Deoxyribose → Deoxycytidine
- Thymine + Deoxyribose → Deoxythymidine

- (i) **Nucleotide**

- (a) Nitrogen base+Sugar+Phosphate → Nucleotide
 (b) Nucleotide is a unit of DNA.
 (c) All nucleotides combined and form a chain called polynucleotides by which RNA and DNA formed.

5.1.1 Structure of DNA

- (a) Double Helical model of DNA was proposed by biochemist **J.D. Watson**, British chemist **FHC Crick** in 1953.



- (b) DNA in double stranded structure is made up of two chains of polynucleotides.
- (c) DNA is a polymer of Nucleotide.
- (d) Nucleotide are joined by 3' → 5' phosphodiester bonds.
- (e) Sugar and phosphorous are alternately arranged.
- (f) In both chains, in between A and T, 2 Hydrogen bonds are present while in C and G 3H bonds are present. (A = T) (C ≡ G)
- (g) A always attach with T while C always attaches with G.
- (h) Purine and pyrimidine are found in ratio 1 : 1. cells.
- (i) DNA is attached with histone protein.
- (j) In prokaryotic cell and mitochondria circular DNA is present.

5.1.2 Function of DNA

(i) Self - Replication or self -Duplication

DNA has the property of self - replication . It is therefore a reproducing molecule. This unique property of DNA is at the root of all reproduction. Through its replication, **DNA is acts as the key to heredity**. In the replication of DNA, the two strands of a double helix unwind and separate as a template for the formation of a new complementary strand.

(ii) Protein Synthesis

The specific sequence of base pair in DNA represents coded information for the manufacture of specific proteins. These code instructions first are transcribed into the matching nitrogen- base sequences within mRNA and the instructions in

such RNA subsequently are translated into particular sequence of amino acid units within the polypeptide chains and proteins.

The major steps in the utilization of the genetic information can be represented as :



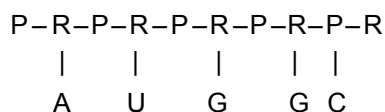
5.2 Ribonucleic Acid (RNA) :

- ⇒ Found in cytoplasm as well as in nucleus.
Cytoplasm → In the ribosome (heigher amount)

5.2.1 Chemical Nature :

- ⇒ Ribonucleic acid is a polymer of purine and pyrimidine ribonucleotides linked by 3' → 5' phosphodiester bridges. The number of nucleotides in RNA ranges from as **few as 75 to many thousands**. Although sharing many features with DNA, RNA possesses several specific difference.
- ⇒ As indicated by its name, sugar in RNA to which the phosphate and nitrogen- bases are attached is ribose rather than the deoxyribose of DNA.
- ⇒ Although RNA contains the ribonucleotides of adenine, guanine, and cytosine, it does not posses thymine. Instead of thymine, RNA contains the ribonucleotides of uracil. Thus the pyrimidine components of RNA differs from those of DNA.
- ⇒ RNA exists basically **as a single-stranded molecule** rather than as a double -stranded helical molecule, as does DNA. However the single strand of RNA is capable of folding back on itself like a hairpin and thus acquiring double-stranded characteristics. In these regions. A pairs with U and G pairs with C.

Thus a given segment of a long RNA molecule might, for example, be represented as follows.



- ⇒ where R stands for ribose ; A, U, G, and C for Adenine, Uracil, Guanine and Cytosine respectively.

5.2.2 Types of RNA and their Functions :

There are 3 main types of RNA molecules

- (i) Messenger RNA (mRNA)
- (ii) Transfer RNA (tRNA)
- (iii) Ribosomal RNA (rRNA)

(i) Messenger RNA (mRNA)

- ⇒ This type of RNA consists of **single strand** of variable length and serves as a template for protein synthesis. Codon in the chromosomes.
- ⇒ mRNA forms complementary copy of DNA as it carries **chemical messages in the form of nitrogen-base sequence from the nucleus to the ribosomes**, i.e. from **DNA to cytoplasm where proteins are synthesized**. Therefore, it is called messenger RNA or mRNA
- ⇒ mRNA is synthesised from DNA in the nucleus. It is called **transcription**.

(ii) Ribosomal RNA

- ⇒ A ribosome is a cytoplasmic nucleoprotein structure which serves as the organellar machinery for protein synthesis from mRNA templates.
- ⇒ On the ribosome, the mRNA and tRNA molecules interact to translate into a specific protein molecule the information transcribed from the DNA.
- ⇒ rRNA constitutes the largest part of total RNA (Highest) - 80%

(iii) Transfer RNA (tRNA) :

- ⇒ These are also called **Soluble RNA**.
- ⇒ Single stranded.
- ⇒ 10-15% of the total RNA.
- ⇒ **Size - Smallest** → 75 - 80 nucleotides only.
- ⇒ **Synthesis** - Within **nucleus** from **DNA**.
- Function**- It transport amino acid from cytoplasm to the site of protein synthesis.

Examples based on

Nucleic acid

Ex.5 Which of the following sugar is present in R.N.A.-

- (A) Ribose (B) Deoxyribose
(C) Both (D) None **Ans. (A)**

Sol. Ribose $C_5H_{10}O_5$

Ex.6 Which one of the following is not present in RNA-

- (A) Uracil (B) Thymine
(C) Ribose (D) Phosphate

Ans. (B)

Sol. Except thymine all Uracil, Ribose & phosphate are present in R.N.A.

6. ENZYMES ::

Proteins which are used as a catalyst in biochemical reaction is known as biocatalysts.

6.1 Specific characteristics

Enzymes have following two specific characteristics :

- (i) Specificity (ii) Efficiency

6.1.1 Specificity of enzymes

- (a) Generally one enzyme can catalyze only one biochemical reaction.
- (b) It can increase rate of reaction upto 10^{20} times.
- (c) In some cases one enzyme can catalyze more than one reaction and one reaction can be catalyzed by more than one enzyme.

eg. Enzyme present in Yeast (Zymase) can ferment both glucose and fructose into alcohol and also cane-sugar can be hydrolysed by invertase and sucrase enzymes.

6.1.2 Efficiency of enzymes

- (a) One molecule of enzyme can convert millions of substrate molecules into product per second.
- eg. Carbonic anhydrase enzyme present in red blood cells has a highest turn over number.
- (b) With having tertiary structure it can be collected as crystals.
- Enzymes are denatured at higher temperature.
- (c) Enzyme can be stored at low temperature as they are inactivated.

6.2 Importance of enzymes

In the thousands of enzymes presents in body if even a single enzyme would be absent or damaged than complex disease in results.

eg. Scarcity of **Phenylalanine** hydroxylase enzyme in human body is result in **Phenylketonuria** disease.

6.3 Factors affecting enzyme action :

- (i) **Optimum temperature and pH.** Enzyme catalysed reactions have maximum rate at physiological pH of around 7.4 and human body temperature of 37°C (310 K) under one atmosphere pressure.

In fact, as the temperature or pH is increased, the rate rises to a maximum (at 37°C or $\text{pH} = 7.4$) and then falls off.

(ii) **Enzyme activators (co-enzymes).** The activity of certain enzymes is increased in the presence of certain substances, called co-enzymes. It has been observed that if a protein contains a small amount of vitamin as the non-protein part, its activity is enhanced considerably. The activators are generally metal ions such as Na^+ , Mn^{2+} , Cu^{2+} , Co^{2+} etc. These metal ions are weakly bonded to the enzyme molecules and increase their catalytic activity. For example, the enzyme, amylase, in presence of NaCl , which provides Na^+ ion, shows a very high catalytic activity.

(iii) **Enzyme inhibitors and poisons.** Just as in the case of catalysts, the activity of enzyme is slowed down in the presence of certain substance. Such substances are called inhibitors or poisons. They act by combining with the active functional group thereby reducing or completely destroying the catalytic activity of the enzymes. The use of many drugs is on account of their action as enzyme inhibitors in our body.

Examples based on

Enzyme

Ex.7 Enzyme is made up of -

- (A) Proteins (B) Minerals
(C) Oil (D) Fatty acids

Ans(A)

Sol. All enzymes are proteins

Ex .8 The enzyme which catalyses hydrolysis of sucrose is-

- (A) Maltase (B) Zymase
(C) Invertase (D) Proteinase

Ans(C)

Sol. Hydrolysis of sucrose is called inversion.

7. NUTRIENTS ::

Sodium, Potassium and Chlorine

- (i) Na^+ is the principal mineral cation in the extracellular fluid.
(ii) K^+ is the principal cation inside the cell.
(iii) Cl^- is the principal mineral anion in the ECF.

(iv) Na^+ and K^+ are essential to the maintenance of water balance and acid-base balance.

(v) Na^+ and K^+ are important in nerve impulse transmission.

Calcium and Phosphorus

(i) Calcium and phosphorus are deposited in bones and teeth to give them strength and rigidity.

(ii) Ca^{2+} is also essential for blood coagulation, neuromuscular function, cardiac function and actions of many enzymes and hormones.

(iii) Phosphorus enters into many compounds such as nucleic acids and phospholipids, many coenzymes and high energy compounds like ATP.

(iv) Calcium plays an essential role in sustaining intestinal peristalsis and growth of body tissues.

Iron

(i) Iron is required for haemoglobin synthesis.

(ii) Iron is essential both for transportation of oxygen to tissues and for operation of oxidative systems within the tissue cells.

Magnesium

(i) Magnesium is required as a catalyst for many intracellular enzymatic reactions, particularly those relating to carbohydrate metabolism.

(ii) Mg is the central metal atom in chlorophyll

Iodine

Iodine is used in the synthesis of thyroid hormones.

Zinc

(i) Zinc is a constituent of carbonic anhydrase, present in RBCs helping in CO_2 transport.

(ii) Zinc is a component to lactic dehydrogenase, important for the interconversion between pyruvic acid and lactic acid

(iii) Zinc is a component part of some peptidases and therefore is important for digestion of proteins in the alimentary canal

Cobalt

- (i) Cobalt helps in erythropoiesis and in the activities of some enzymes.
- (ii) It is present in vitamin B₁₂.

Copper

- (i) Copper helps in the utilisation of iron.
- (ii) Copper deficiency may produce anaemia because of failure in iron utilisation.

Molybdenum

- (i) Molybdenum is a constituent of oxidase enzymes (**xanthine oxidase**)
- (ii) Molybdenum plays an important role in biological **nitrogen** fixation

Fluorine

- (i) Fluorine maintains normal dental enamel and prevents dental caries.
- (ii) Excessive intake of fluorine cause fluorosis characterized by mottled teeth and enlarged bones.

8. VITAMINS ::

It has been observed that certain organic compounds are required in small amounts in our diet but their deficiency causes specific diseases. These compounds are called vitamins.

Classification of Vitamins

Vitamins are classified into two groups depending upon their solubility in water or fat.

(i) Fat soluble vitamins:

Vitamins which are soluble in fat and oils. But insoluble in water are kept in this group. These are vitamins A, D, E and K. They are stored in liver and adipose (fat storing) tissues.

(ii) Water soluble vitamins:

B group vitamins and vitamin C are soluble in water so they are grouped together. Water soluble vitamins must be supplied regularly in diet because they are readily excreted in urine and can not be stored (except vitamin B₁₂) in our body.

Some important vitamins, their sources and diseases caused by their deficiency are listed in table.

Sr. No	Name of Vitamins	Source	Deficiency Diseases
1	Vitamin A (Retinol)	Fish liver oil, carrots, butter and milk	Xerophthalmia (hardening of cornea of eye) Night blindness
2	Vitamin B ₁ (Thiamine)	Yeast, milk, Green vegetables and cereals and grams	Beri beri (loss of appetite, retarded growth)
3	Vitamin B ₂ (Riboflavin)	Milk, eggwhite, liver, Kidney	Cheilosis (fissuring at corners of mouth and lips), digestive disorders and burning sensation of the skin
4	Vitamin B ₆ (Pyridoxine)	Yeast, milk, egg yolk, cereals and grams	Convulsions
5	Vitamin B ₁₂ (Cyanocobal-amine)	Meat, fish, egg and curd	Pernicious anaemia (RBC deficient in haemoglobin)
6	Vitamin C (Ascorbic acid)	Citrus fruits, amla and green leafy vegetables	scurvy (bleeding gums)
7	Vitamin D (Calciferol)	Exposure to sunlight, fish and egg yolk	Rickets (bone deformities in children) and osteo-malacia (soft bones and joint pain in adults)

SOLVED EXAMPLES

Ex.1 Which of the following is not a reducing sugar-
 (A) Glucose (B) Sucrose
 (C) Mannose (D) Fructose **Ans. (B)**

Sol. Sucrose is not a reducing sugar because it does not reduce fehling's solution.

Ex.2 Which one of the following is the reagent used to identify glucose-
 (A) Neutral ferric chloride
 (B) Chloroform and alcoholic KOH
 (C) Ammonical silver nitrate
 (D) Sodium ethoxide **Ans. (C)**

Sol. Ammonical silver nitrate (Tollen's reagent) oxidises glucose to gluconic acid and itself reduced to metallic silver.

Ex.3 Following is/are the oligosaccharides-
 (A) Glucose (B) Sucrose
 (C) Lactose (D) Cellulose
Ans. (B,C)

Sol. Oligosaccharides are the compounds which give 2 to 10 monosaccharides on hydrolysis. For example - sucrose, lactose, maltose etc

Ex.4 $\begin{matrix} -N-C- \\ | \quad || \\ H \quad O \end{matrix}$ group is characteristic of-
 (A) Cellulose (B) Nucleic acid
 (C) Proteins (D) Phospholipids
Ans. (C)

Sol. Peptide bond $\left(\begin{matrix} -N-C- \\ | \quad || \\ H \quad O \end{matrix} \right)$ is characteristic of proteins.

Ex.5 The pH value of a solution in which a polar amino acid does not migrate under the influence of electric field is called-
 (A) Isoelectric point
 (B) Isoelectric point
 (C) Neutralisation point
 (D) None **Ans. (B)**

Sol. Isoelectric point is the pH at which structure of amino acid has no charge.

Ex.6 The simplest amino acid is-
 (A) Glycine (B) Alanine
 (C) Guanine (D) All the above

Ans. (A)

Sol. Simplest amino acid is glycine (α -amino acetic acid H_2N-CH_2-COOH).

Ex.7 The main structural feature of protein is-
 (A) Ester linkage (B) Ether linkage
 (C) Peptide linkage (D) All of these

Ans. (C)

Sol. The main structural feature of proteins is the presence of peptide linkage.

Ex.8 The primary structure of a polypeptide is determined by-
 (A) The number of disulphite bonds in the polypeptide
 (B) The number of amino acids in the polypeptide
 (C) The order of amino acids in the polypeptide
 (D) The length of the polypeptide

Ans. (C)

Sol. The primary structure of a polypeptide is the information of order of different amino acids in that polypeptide.

Ex.9 DNA molecule consists of units of-
 (A) Base-sugar
 (B) Base - sugar - phosphate
 (C) Base - phosphate
 (D) None of these

Ans. (B)

Sol. DNA has nucleotide unit, i.e., Sugar + base + H_3PO_4 .

Ex.10 The process of formation of RNA from DNA is known as-
 (A) Translation (B) Transcription
 (C) Replication (D) Mutation

Ans. (B)

Sol. The process of formation of RNA from DNA is called transcription.

Ex.11 The organic compound which will answer Fehling's solution test is-

- (A) Ethanol (B) Acetone
(C) Maltose (D) Benzaldehyde

Ans. (C)

Sol. Maltose, being reducing sugar, reduces Fehling solution.

Q.12 The main point of difference between DNA and RNA is-

- (A) Presence of thymine in DNA and RNA
(B) Presence of deoxyribose and thymine in DNA, ribose and uracil in RNA
(C) Presence of ribose and thymine in DNA, deoxyribribose and uracil in RNA
(D) Presence of deoxyribose in DNA and ribose in RNA

Ans. (B)

Sol. DNA has deoxyribose sugar, RNA has ribose sugar with three bases common as adenine, guanine and cytosine. DNA has fourth base thymine ; RNA has uracil.

