UNIT 14

BIOMOLECULES

Points to Remember

Biomolecules

These are the macromolecules essential for survival of life, e.g. carbohydrotes, proteins, etc.

Carbohydrates

These are polyhydroxy aldehydes or ketones or their derivatives, e.g. glucose.

Sugars

These are the carbothydrates having sweet taste.
They may be reducing or non-reducing.

Glucose

•It is obtained by hydrolysing starch or cane sugar.
•its reactions are as:

Glucose $\xrightarrow[\Delta]{HI}$ n-hexane:

$\xrightarrow[3\ mol]{NH_2OH}$ Oxime

$\xrightarrow{Br_2\ Water}$ Gluconic acid

$\xrightarrow[CH_3COCl]{Acelylation}$ Pentaacetate

$\xrightarrow{HNO_3}$ Saccharic Acid

Sucrose

•It contains D-(+)glucose and D(-) fructose joined together by β -1,2-glycosidic linkage.
•It is also called invert sugar.

Proteins

These are polymers of α-amino acids.

Amino Acids

These contain amino as well as carboxyl functional group.
They may be essential or non-essential,

Zwitter Ion

Ion containing positive as well as negative charge is called zwitter ion.

e.g. $R-\underset{\overset{|}{{}^{+}NH_3}}{CH}-\overset{\overset{O}{\|}}{C}-O^-$

Denaturation

• It is the process of destroying 2^0 or 3^0 structure of protein by heating and by changing pH.
•Due to this, protein losts its biological activity.
•e.g. coagulation of egg white on boiling.

Vitamins, Nucleic Acids and Hormones

Vitamins

These are essential but in very small amounts.
Vitamins A, D, E and K are fat soluble while rest are water soluble.

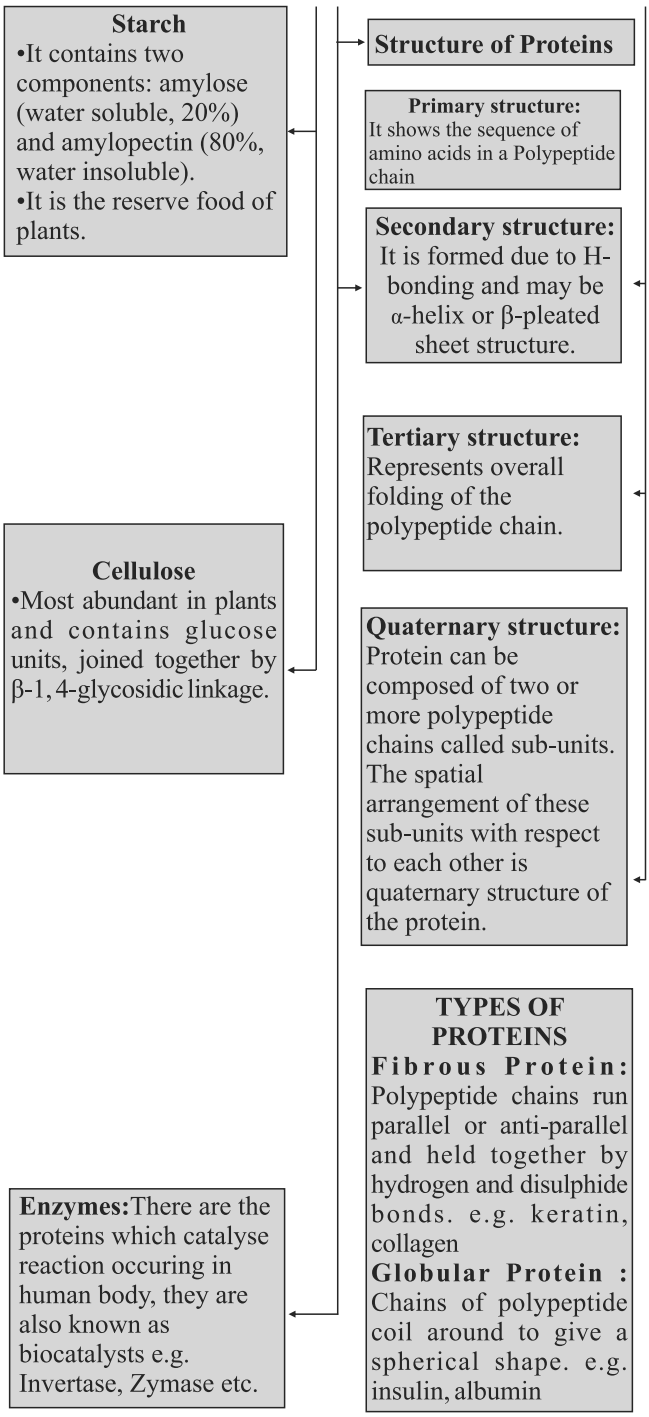
Deficiency Diseases

Vitamin	Deficiency Disease
A	Xerophithalmia
B_1	Beri-beri
B_{12}	Pernicious anaemia
C	Scurvy
D	Rickets
E	Infertility
K	Icreased blood clotting time
H	Loss of hair

Nucleic acid: These are the polymer of nucleotides(Sugar + base+ Phosphoric acid)

DNA	RNA
i) Double helical.	i) Single stranded.
ii) Sugar is 2-deoxyribose.	ii) Sugar is ribose.
iii)Bases : A, T, G, C.	iii)Bases : A,U,G,C
iv)Property of replication.	iv)Do not replicate.
v) It is responsible for transmission of heredity Character	v) Helps in protein biosynthesis.

Hormones: These are the chemicals secreted by Endocrine glands.


Starch
•It contains two components: amylose (water soluble, 20%) and amylopectin (80%, water insoluble).
•It is the reserve food of plants.
Cellulose
•Most abundant in plants and contains glucose units, joined together by β-1, 4-glycosidic linkage.
Enzymes: There are the proteins which catalyse reaction occuring in human body, they are also known as biocatalysts e.g. Invertase, Zymase etc.
Structure of Proteins
Primary structure: It shows the sequence of amino acids in a Polypeptide chain
Secondary structure: It is formed due to H-bonding and may be α-helix or β-pleated sheet structure.
Tertiary structure: Represents overall folding of the polypeptide chain.
Quaternary structure: Protein can be composed of two or more polypeptide chains called sub-units. The spatial arrangement of these sub-units with respect to each other is quaternary structure of the protein.
TYPES OF PROTEINS
Fibrous Protein: Polypeptide chains run parallel or anti-parallel and held together by hydrogen and disulphide bonds. e.g. keratin, collagen
Globular Protein : Chains of polypeptide coil around to give a spherical shape. e.g. insulin, albumin

1. **Carbohydrates :** These are optically active polyhydroxy aldehydes or ketones or the compounds which produce these on hydrolysis.

2. **Classification :**

   (i) **Monosaccharides :** Those carbohydrates which cannot be hydrolysed into further simpler carbohydrates. e.g, glucose, fructose, galactose etc.

   (ii) **Disaccharides :** Those carbohydrates which produces two monosaccharides on hydrolysis. e.g, sucrose, maltose and lactose.

   (iii) **Oligosaccharides :** Those carbohydrates which give two to ten monosaccharides on hydrolysis.

   (iv) **Polysaccharides :** Those carbohydrates which on hydrolysis gives large number of monosaccharides on hydrolysis. e.g, starch, cellulose, glycogen.

3. **Sugar :** Carbohydrates which are sweet in taste.

   (i) **Reducing sugars :** Those which reduce Fehling's or Tollens' reagent due to availability of free aldehydic groups. e.g, glucose, fructose, galactose.

   (ii) **Non-reducing sugars :** Those which do not reduce Fehling's or Tollens' reagent. They do not have free aldehydic group. e.g, sucrose.

4. **Glucose :** It is a monosaccharide with molecular formula $C_6H_{12}O_6$.

5. **Preparation of Glucose:**

   (i) **From sucrose :**

   $$C_{12}H_{22}O_{11} + H_2O \xrightarrow{H^+} \underset{\text{glucose}}{C_6H_{12}O_6} + \underset{\text{Fructose}}{C_6H_{12}O_6}$$ (only from sucrose)

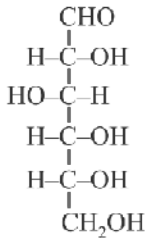
   (ii) **From starch :**

   $$(C_6H_{10}O_5)_n + nH_2O \rightarrow C_{12}H_{22}O_{11} + H_2O \rightarrow \underset{\text{glucose}}{2C_6H_{12}O_6}$$

6. **Structure:**

   Fischer structure :

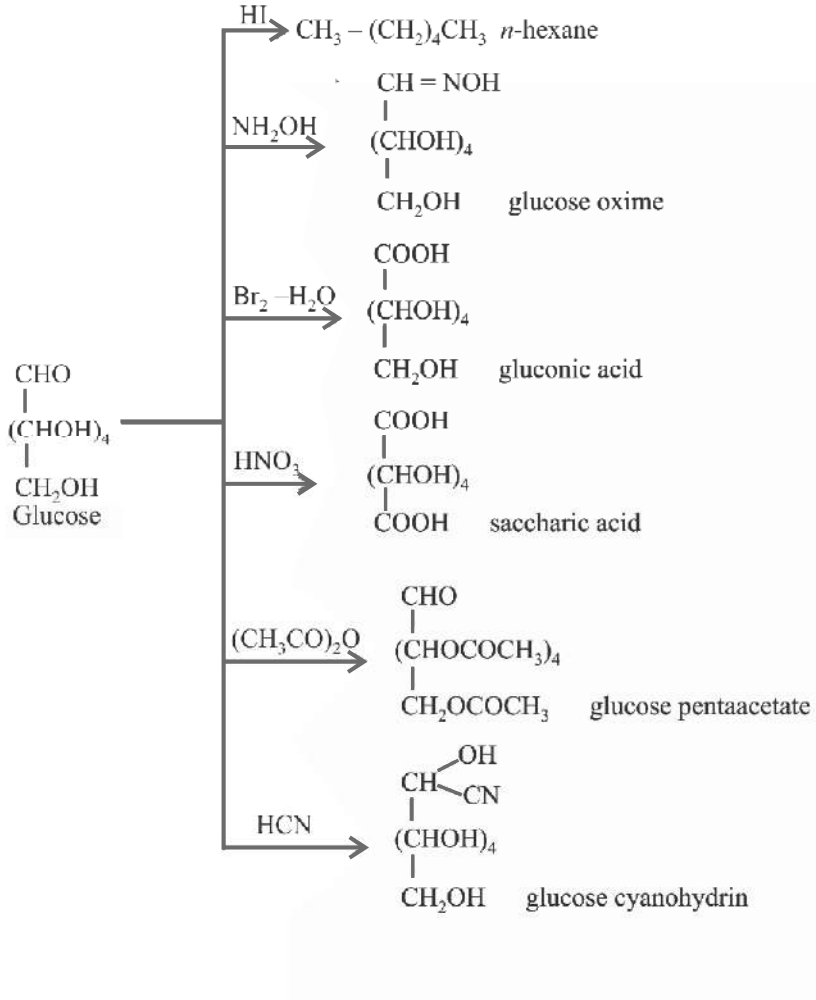
   (+) glucose has 'D' configuration as shown :



D-(+)-glucose

'D'- means – OH group on first chiral 'C' from the bottom is on right hand and (+) means it is dextrorotatory *i.e.*, it rotates plane polarized light towards right.

Reactions of glucose :



Objections against open chain structure of glucose

The open chain structure was unable to explain the following reactions :

(a) It does not give the 2, 4-DNP test, Schiff's test and does not form the hydrogensulphite addition product with $NaHSO_3$

(b) The pentacetate of glucose does not react with NH_2OH, indicating the absence of free aldehydic group.

(c) Glucose exist in 2 different crystalline forms α and β forms. These are called anomers. They differ in optical rotation, they also differ in melting point.

After which a close chain (cyclic) structure of glucose was proposed by Haworth.

* Anomers are isomers which have a different configuration at C-1 functional group

7. **Glycosidic linkage :** The linkage between two monosaccharide units through oxygen is called the glycosidic linkage.

8. **Proteins :** These are macro molecules made up of amino acids joined by amide linkage (– CONH –) is called as peptide linkage. These are required for growth and development of the body.

9. **Amino acids :** These contain an amino (- NH_2) and an acidic (- COOH) group and are therefore amphoteric in nature. In solution, they exist in the form of zwitter ion (a dipolar ion).

10. **Native state of protein :** The parental state or the natural state in which the protein is found.

11. **Denaturation of protein :** Destruction of the native state of protein is denaturation. It can be brought by physical and chemical methods. The 2° and 3° structures are destroyed, only 1° structure is retained.

Enzymes : These are biocatalyst and generally globular proteins *e.g.,* invertase, zymase, phenylalanine hydroxylase, urease etc.

Main characteristics of enzymes :

(i) It speed up the biological reaction upto million times.

(ii) It is highly specific and work on lock and key theory.

(iii) It is highly sensitive to pH and temperature.

12. **Nucleic acids :** These are biomolecules which are long chain polymers of nucleotides. They are of two types :

(i) Deoxyribonucleic acid (DNA)

(ii) Ribonucleic acid (RNA)

13. Nuceloside = Base + Sugar

Nucleotide = Base + Sugar + Phosphoric acid

OBJECTIVE TYPE QUESTIONS

I MULTIPLE CHOICE QUESTIONS

1. Which of the following acids is a vitamin?

(a) aspartic acid (b) ascorbic acid

(c) oxalic acid (d) saccharic acid

2. Non-reducing sugar out of following is -

(a) Glucose (b) Sucrose

(c) Maltose (d) Lactose

3. In a protein molecule amino acids are linked together by:

(a) Peptide linkage (b) Coordinate bond

(c) Glycosidic linkage (d) Phospodiester linkage

4. One strand of DNA has the sequence. ATGCTT, the sequence of complementary strand would be:

(a) TCCGAA (b) TACGTA

(c) TACGAA (d) TAGCTA

5. Which of the following vitamin is water soluble?

(a) Vitamin C (b) Vitamin D

(c) Vitamin K (d) Vitamin E

6. In both DNA and RNA, base and phosphate ester linkage are at -

(a) C'_5 and C'_2 respectively of sugar molecule

(b) C'_2 and C'_5 respectively of sugar molecule

(c) C'_3 and C'_5 respectively of sugar molecule

(d) C'_5 and C'_1 respectively of sugar molecule

7. The two functional groups present in a typical carbohydrates are:
   (a) -OH and -COOH (b) -CHO and -COOH
   (c) >C=O and -OH (d) -CHO and -COCl
8. The presence or absence of hydroxyl group on which carbon atom of sugar differentiates RNA and DNA.
   (a) 1st (b) 2nd
   (c) 3rd (d) 4th
9. The carbohydrate known as invert sugar is -
   (a) Lactose (b) Sucrose
   (c) Maltose (d) Glucose
10. Pick the disaccharide from following:
   (a) Maltose (b) Cellulose
   (c) Maltase (d) Starch
11. Which one of the following is not an aldose?
   (a) Glucose (b) Ribose
   (c) Fructose (d) Galactose
12. Biomolecule containing transition metal is-
   (a) Vitamin C (b) Chlorophyll
   (c) Haemoglobin (d) RNA
13. Which of the following does not have glycosidic linkage?
   (a) Maltose (b) Amylose
   (c) Galactose (d) Sucrose
14. Fibrous proteins are present in:
   (a) Haemoglobin (b) Albumin
   (c) Collagen (d) Insulin
15. Hydrolysis of lactose with dilute acid yields
   (a) equimolar mixture of D-glucose and D-fructose
   (b) equimolar mixture of D-glucose and D-galactose
   (c) equimolar mixture of D-galactose and D-fructose
   (d) equimolar mixture of D-galactose and D-sucrose

16. Match the carbohydrate in Column I with its characteristic given in Column II

Column-I	Column-II
(A) Lactose	(p) Ketohexose
(B) Starch	(q) Disaccharide
(C) Sucrose	(r) Polysaccharide
(D) Fructose	(s) on hydrolysis gives β-D-glucose and β-D-galactose

(a) A - s, B - r, C - p, D - q
(b) A - p, B - q, C - r, D - s
(c) A - r, B - s, C - p, D - q
(d) A - s, B - r, C - q, D - p

17. Match the carbohydrate in Column I with its characteristic given in Column II

Column-I	Column-II
(A) Keratin	(p) protein
(B) Haemoglobin	(q) β-pleated protein
(C) Riboflavin	(r) α-amino acid
(D) Glycine	(s) Water soluble vitamin

(a) A-p. B-q. C-s, D-r
(b) A-q, B-p, C-s, D-r
(c) A-q, B-p. C-r, D-s
(d) A-s, B-r, C-q, D-p

18. The number of chiral carbon present in β-D-(+)-glucose is:
(a) 2 (b) 4 (c) 5 (d) 1

19. Which of the following nitrogenous base is not present in RNA?
(a) Adenine (b) Uracil (c) Cytosine (d) Thymine

20. Hormone produced under stress which stimulates glycogenolysis in the liver of human being ?
(a) Thyroxin (b) Insulin (c) Adrenaline (d) Estradiol

II FILL IN THE BLANKS

1. The disease beri-beri is caused due to lack of .....
2. Scurvy is caused due to deficiency of .....
3. .....(carbohydrate) is not digested by human beings but digested by herbivorous animals.
4. .....on hydrolysis gives D-glucose and D-galactose.

5. Amylose and amylopectin are the two components of.....
6. Carbohydrates which yields a large number of monosaccharide units on hydrolysis are called .....
7. Carbohydrates which reduce Tollens' reagent are called .....
8. Deficiency of ..... leads to xerophthalmia and night blindness.
9. .....contains pentose sugar, and base whereas.....contains pentose sugar, base as well as phosphate group.
10. The pair of stereoisomers which differ only in the configuration of the hydroxyl group at C-1 are called .....

III ASSERTION-REASON TYPE QUESTIONS

In each of the following questions, a statement of Assertion (A) is given followed by a corresponding statement of Reason (R) just below it. Of the statements, mark the correct answer as

(a) Both assertion and reason are correct, and reason is the correct explanation of the assertion.

(b) Both assertion and reason are correct, but reason is not the correct explanation of the assertion.

(c) Assertion is correct, but reason is incorrect.

(d) Assertion is incorrect but reason is correct.

1. **ASSERTION :** A solution of sucrose in water is dextrorotatory but on hydrolysis in presence of little HCl it becomes laevorotatory.
   REASON : Sucrose on hydrolysis gives unequal amount of glucose and fructose as a result sign of rotation changes.
2. **ASSERTION** : Fructose does not contain aldehyde group but still reduce Tollens' reagent.
   REASON : In the presence of base, fructose undergoes rearrangement to form glucose and mannose.
3. **ASSERTION :** D-(+)-Glucose is dextrorotatory in nature.
   REASON : 'D' represents its dextrorotatory nature.
4. **ASSERTION :** Vitamin D can be stored in our body.
   REASON : Vitamin D is fat soluble vitamin.

5. **ASSERTION :** All naturally occurring α-amino acids except glycine are optically active.
   REASON : Most naturally occurring amino acids have D-configuration.
6. **ASSERTION :** In presence of enzyme, substrate molecule can be attacked by the reagent effectively.
   REASON : Active sites of enzymes hold the substrate, molecule in a suitable position.
7. **ASSERTION:** Sucrose is a non-reducing sugar.
   REASON : It has glycosidic linkage.
8. **ASSERTION:** Vitamin C has to be continuously supplied through diet.
   REASON: Vitamin C is a water soluble vitamin, excreted by urine
9. **ASSERTION :** Cellulose is not digested by human beings.
   REASON : Cellulose is a polymer of β-D-glucose.
10. **ASSERTION:** Non-essential amino acids are not necessary for protein synthesis.
    REASON: Non-essential amino acids are produced in the human body.

IV ONE WORD ANSWER TYPE QUESTIONS

1. Name the component of starch which is water soluble.
2. Write the product formed when glucose is treated with HI.
3. What are the products of hydrolysis of maltose?
4. Name the purines present in DNA.
5. Write the name of linkage joining two amino acids.
6. The deficiency of which vitamin causes the disease pernicious anaemia.
7. Name the nitrogenous base that is found in nucleotide of RNA only.
8. Name the vitamin whose deficiency is responsible for poor coagulation of blood.
9. Write the product formed on reaction of D-glucose with Br_2 water.
10. Name the polysaccharide which is stored in the liver of animals.

VERY SHORT ANSWER TYPE QUESTIONS (1Marks)

Q. 1. What structural feature is required for a carbohydrate to behave as reducing sugar ?

Ans. The carbonyl group of any one monosaccharide present in carbohydrate must be free.

Q. 2. Give the significance of (+) sign in the name D-(+)-glucose.

Ans. (+) sign indicates dextro-rotatory nature of glucose.

Q. 3. Glucose is an aldose sugar but it does not react with sodium hydrogen sulphite. Give reason.

Ans. The – CHO group reacts with – OH group at C-5 to form a cyclic hemiacetal.

Q. 4. Why is sucrose called invert sugar ?

Ans. When sucrose is hydrolysed by water, the optical rotation of solution changes from positive to negative.

Q. 5. Name the amino acid which is optically inactive.

Ans. Glycine.

Q. 6. Give reason : Amylase present in the saliva becomes inactive in the stomach.

Ans. HCl present in stomach decreases the pH.

Q. 7. Name the interactions responsible for the stability of α-helical structure of proteins

Ans. Hydrogen bonding.

Q. 8. Which nucleic acid is responsible for carrying out protein synthesis in the cell ?

Ans. RNA (Ribonucleic acid)

Q. 9. When RNA is hydrolysed, there is no relationship among quantities of different bases obtained. What does this fact suggest about structures of RNA ?

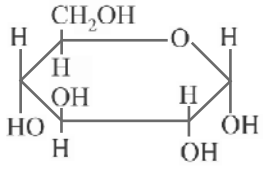
Ans. RNA is single stranded.

Q. 10. What type of linkage holds together the monomers of DNA and RNA ?

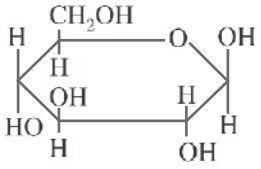
Ans. Phosphodiester linkage.

Q. 11. Give the Haworth projection of D-glucopyranose.

Ans.



α-D(+) Glucopyranose



β-D(+) Glucopyranose

Q. 12. Where does the water present in the egg go after boiling the egg ?

Ans. On boiling, during denaturation process water gets absorbed in denaturated proteins.

Q. 13. Name two protein which is insoluble in water.

Ans. Keratin. Myosin

Q. 14. Mention two important functions of carbohydrates in plants.

Ans. Major energy source, storage molecules like starch in plants.

Q. 15. Name the different types of RNA molecules found in cells of organisms.

Ans. tRNA, mRNA, rRNA.

Q. 16. Why are carbohydrates generally optically active ?

Ans. Because they contain one or more chiral carbon.

Q. 17. During curdling of milk, what happens to sugar present in it ?

Ans. Lactose changes to lactic acid.

Q. 18. The two strands in DNA are not identical but complementary. Explain.

Ans. Base pairing rule is followed; A = T and G ≡ C. (Hydrogen bonding between complementary bases)

Q. 19. If one strand of DNA has the sequence 5'-G-G-A-C-T-A-C-T-3', what is the sequence of bases in the complementary strand ?

Ans. 3'-C-C-T-G-A-T-G-A-5'

Q. 20. What are monosaccharides ?

Ans. Sugars which cannot be hydrolysed to give simpler units or compounds.

Q. 21. What is the difference between native protein and denatured protein ?

Ans. Proteins found in a biological system with unique 3D-structure and biological activity is called native protein. When native protein is subjected to physical and chemical change, protein loses its biological activity and is called denatured protein.

SHORT ANSWER TYPE QUESTIONS (2 or 3 Questions)

Q. 1. Define the following terms in relation to proteins :

(i) Peptide linkage (ii) Denaturation

Ans. (i) Peptide linkage : A link between two amino acids with loss of water – CO – NH – peptide linkage.

(ii) A process that changes the three dimensional structure of native protein is called denaturation of protein. It results into breaking of hydrogen bonds and disulphide linkages. Thus, a completely denatured protein has a shape of random coil.

Q. 2. List the reactions of glucose which cannot be explained by its open chain structure.

Ans. (i) Despite having the aldehyde group, glucose does not give 2, 4 DNP test or Schiff's test.

(ii) It does not form hydrogensulphite addition product with $NaHSO_3$.

(iii) The penta acetate of glucose does not react with hydroxylamine indicating the absence of free – CHO group.

Q. 3. Explain what is meant by :

(i) Biocatalyst (ii) Glycosidic linkage

Ans. (i) Biocatalysts are the catalysts which increases the rate of metabolism biochemical reactions.

(ii) The linkage between the monosaccharide units through oxygen is called glycosidic linkage.

Q. 4. Explain the following terms :

(i) Invert sugar **(ii) Polypeptides**

Ans. (i) An equimolar mixture of glucose and fructose produced on hydrolysis of sucrose is called invert sugar. It is called so because sucrose is dextrorotatory whereas its hydrolysis product is laevorotatory.

(ii) Polypeptides are polymers of amino acids containing less than 100 amino acids. For example, oxytocin, vasopressin, etc.

Q. 5. Name the product of hydrolysis of sucrose. Why is sucrose not a reducing sugar ?

Ans. On hydrolysis, sucrose gives equimolar mixture of D-(+)-glucose and D-(−)-fructose. Sucrose is not a reducing sugar as glucose and fructose are linked through their reducing centres in structure of sucrose.

Q. 6. Explain nucleotides and nucleosides.

Ans. A nucleoside contain only two basic components of nucleic acids *i.e.*, pentose sugar and nitrogenous base.

A nucleotide contains all the three basic components of nucleic acids *i.e.*, a phosphoric acid group, pentose sugar and nitrogenous base.

Q. 7. Describe primary structure and secondary structure of proteins.

Ans. Primary structure of proteins : The protein in which amino acids linked with each other in a specific sequence is said to be the primary structure of that protein.

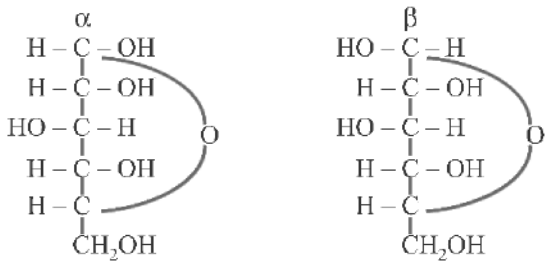
Secondary structure of proteins : It refers to the shape in which a long polypeptide chain can exist *i.e.*, α-helix and β-pleated structure.

Q. 8. What is essentially the difference between α-form of glucose and β-form of glucose ? Explain.

Ans. α-form of glucose and β-form of glucose differ only in the configuration of the hydroxyl group at C_1 in cyclic structure of glucose/hemiacetal form of glucose.

Q. 9. What are anomers ? Give the structures of two anomers of glucose.

Ans. Monosaccharides which differs in configuration at C_1 e.g., α-glucose and β-glucose.



α-Glucose β-Glucose

Q. 10. Write the obtained by hydrolysis of:

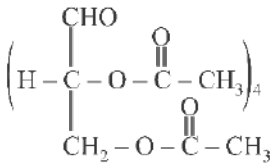
(i) Maltose **(ii) Cellulose**

Ans. (i) α-D-glucose (ii) β-D-glucose

Q. 11. (i) Acetylation of glucose with acetic anhydride gives glucose penta-acetate. Write the structure of penta acetate.

(ii) Explain why glucose penta acetate does not react with hydroxylamine ?

Ans. (i)



Glucose pentaacetate

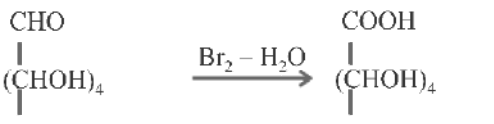
(ii) The molecule of glucose penta acetate has a cyclic structure in which – CHO is involved in ring formation.

Q. 12. Write the products of oxidation of glucose with :

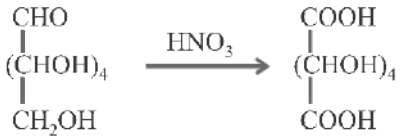
(i) Bromine water

(ii) Nitric acid

Ans. (i)



Glucose Gluconic acid

(ii) 

Glucose Saccharic acid

Q. 13. State two main differences between globular and fibrous proteins.

Ans.

	Globular protein		**Fibrous protein**
(i)	They form a α-helix structure.	(i)	They have β-pleated structure.
(ii)	They are water soluble.	(ii)	They are water insoluble.

Q. 14. What are essential and non-essential amino acid ? Give two examples of each type.

Ans. Essential amino acids are those which are not produced in our body and required to be supplied from outside, *e.g.,* valine, leucine.

Non-essential amino acids are those which are produced by our body, *e.g.,* glycine, alanine.

Q. 15. Coagulation of egg white on boiling is an example of denaturation of protein. Explain it in terms of structural changes.

Ans. Protein albumin present in egg white gets denatured *i.e.,* 2° & 3° structures are destroyed and 1° structure is retained.

Q. 16. Describe two important functions of nucleic acids.

Ans. (i) DNA is responsible for transfer of heredity information from one generation to another.

(ii) RNA is responsible for protein synthesis.

Q.17. (i) What type of linkage is responsible for the formation of proteins ?

(ii) Write the product formed when glucose is treated with HI.

Ans. (ii) Peptide linkage.

(iii) n-hexane.

Q.18. Differentiate between the following :

(i) Secondary and tertiary structure of protein

(ii) α-helix and β-pleated sheet structure of protein

Ans. (i) **Secondary structure** is responsible for the shape of protein α-helix and β-pleated sheets in which polypeptide chains have peptide bonds.

Tertiary structure represents overall folding of polypeptide chain and give rise to the fibrous or globular molecular shape.

(ii) **α-helix structure :** The peptide chains coiled up to form right handed helix involving H-bonding (Intramolecular).

β-pleated sheets : The peptide chains lie side by side together by intermolecular hydrogen bonding.

Q.19. (i) Name the four bases present in DNA.

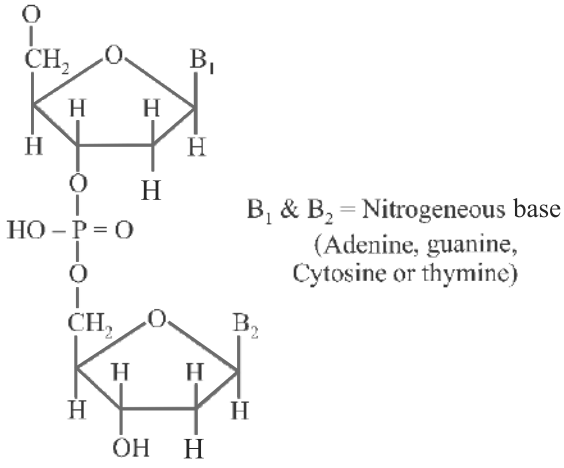
(ii) Which of them is not present in RNA ?

(iii) Give the structure of a nucleotide of DNA.

Ans. (i) Adenine, Guanine, Thymine, Cytosine.

(ii) Thymine.

(iii)



B_1 & B_2 = Nitrogeneous base (Adenine, guanine, Cytosine or thymine)

Q.20. Glucose or sucrose are soluble in water but cyclohexane and benzene are insoluble in water. Explain.

Ans. Glucose contain 5 – OH groups and sucrose contain eight – OH groups, because of this they form intermolecular hydrogen bonding, so they are soluble in water. But benzene and cyclohexane doesn't contain – OH groups hence doesn't form intermolecular hydrogen bonding, so they are not soluble in water.

CASE STUDY BASED QUESTIONS

1. Read the passage given below and answer the following questions:

Living systems are made up of various complex biomolecules like carbohydrates, proteins, nucleic acids, lipids, etc. Proteins and carbohydrates are essential constituents of our food. Carbohydrates are the main source of energy that is ingested by the human body . Brain mainly utilizes the glucose. Red blood cells also use glucose only. Fiber in the diet is not digested by human body due to lack of cellulase enzyme. Glucose is the major enegy source in the body. Glycogen is the storage form of glucose and glycogen is stored in skeletal muscles and liver. If glucose intake exceeds than it is utilized in the body it is converted into fat. Riboses are utilized in formation of deoxyribonucleic acid . Carbohydrates are polyhydroxy alcohol with potentially active carbonyl group which may be aldehyde or keto group. Carbohydrates can be classified on the basis of carbon atom present in the carbohydrates. Carbohydrates are classified into four types monosaccharides, disaccharides, oligosaccharides, polysaccharides. Monosaccharides cannot be hydrolyzed further into simpler form. They may contain 3-7 carbon atoms but monosaccharides containing 5-6 carbon atoms are more abundant in nature. All monosaccharides reduce Tollens' reagent as well as Fehling's solution and hence are called reducing sugars. Pentoses and hexoses have cyclic structures, furanose and pyranose. Disaccharides give two monosaccharides on hydrolysis. Polysaccharides may be homopolysaccharides and heteropolysaccharides. Plants produce carbohydrates by photosynthesis. In most animals, carbohydrates are the quickly accessible reservoir of energy. The main function of carbohydrates is to provide energy, but they also play an important role in the structure and function of the body organs and nerve cells.

The following questions are multiple choice questions. Choose the most appropriate answer:

(A) Which of the following statements is **not** true about glucose?

(a) It is an aldohexose.

(b) On heating with HI it forms n-hexane.

(c) It is present in furanose form.

(d) It does not give 2, 4-DNP test.

(B) The α- and β-forms of glucose are

(a) isomers of D(+) glucose and L(–) glucose respectively

(b) anomers of glucose

(c) isomers which differ in the configuration of C-2

(d) isomers which differ in the configuration of C-5

(C) The monosaccharide constituents of lactose are:

(a) α-D-glucose and β-D-fructose

(b) α-D-glucose only

(c) β-D-glucose only

(d) β-D-glucose and β-D-galactose

(D) Glycogen is a branched chain polymer of α-D-glucose units in which chain is formed by C1-C4 glycosidic linkage whereas branching occurs by the formation of C1–C6 glycosidic linkage. Structure of glycogen is similar to_____.

(a) Amylose (b) Amylopectin

(c) Cellulose (d) Glucose

2. Read the passage given below and answer the following questions:

Proteins are very important biomolecules of living systems. α-Amino acids are the building blocks of proteins. About 20 α-amino acids have been isolated by the hydrolysis of proteins. Ten amino acids which the body cannot synthesize are called essential amino acids. The remaining ten are called non-essential amino acids. Proteins are complex nitrogeneous polymers of amino acids connected through peptide bonds. Protein is very important in sports performance as it can boost glycogen storage , reduce muscle soreness and promote muscle repair. For those who are active regularly , there may be benefit from consuming a portion of protein at each mealtime and spreading protein intake throughout the day. Protein intake that exceeds the recommended daily allowance is widely accepted

for both endurance and power athletes. The various techniques utilized to rate protein will be discussed. Traditionally, sources of dietary protein are seen as either being of animal or vegetable origin. Animal sources provide a complete source of protein (i.e. containing all essential amino acids), whereas vegetable sources generally lack one or more of the essential amino acids. Animal sources of dietary protein, despite providing a complete protein and numerous vitamins and minerals, have some health professionals concerned about the amount of saturated fat common in these foods compared to vegetable sources. The advent of processing techniques has shifted some of this attention and ignited the sports supplement marketplace with derivative products such as whey, casein and soy. Individually, these products vary in quality and applicability to certain populations.

The following questions are multiple choice questions. Choose the most appropriate answer:

(A) Correct statement about amino acids is-
  (a) All amino acids are optically active
  (b) All amino acids except glycine are optically active.
  (c) All amino acids except glutamic acid are optically active.
  (d) All amino acids except lysine are optically active.

(B) Proteins are found to have two different types of secondary structures viz. α-helix and β-pleated sheet structure. α-helix structure of protein is stabilised by:
  (a) Peptide bonds
  (b) van der Waals forces
  (c) Hydrogen bonds
  (d) Dipole-dipole interactions

(C) Example of Globular proteins is -
  (a) Myosin
  (b) Albumin
  (c) Collagen
  (d) Fibroin

(D) Which of the statements about denaturation given below are correct?
  (1) Denaturation of proteins causes loss of secondary and tertiary structures of the protein.
  (2) Denaturation leads to the conversion of double strand of DNA into single strand.
  (3) Denaturation affects primary structure which gets distorted.
  (a) (2) and (3) (b) (1) and (3)
  (c) (1) and (2) (d) (1), (2) and (3)

3. Read the passage given below and answer the following questions:

The particles in the nucleus of cell, responsible for heredity, are called chromosomes which are made up of proteins and another type of biomolecules called nucleic acids. Nucleic acids are long chain polymers of nucleotides. Nucleotides are low molecular weight intracellular compounds that play major roles in physiological and biological functions, They act as precursors for nucleic acid synthesis and are also fundamental for intermediary metabolism. The two types of nucleic acids found in the chromosomes of cells of mammals are called 'deoxyribonucleic acid' and 'ribonucleic acid'. They are usually abbreviated as DNA and RNA respectively. As they are found in the nuclus of cells , they are called nucleic acids.Nucleotides and nucleic acids turn over rapidly, especially in growing tissues or those undergoing constant cell renewal. Tissues that grow have a net formation of new DNA and a rapid turnover of RNA . Nucleotides consists of a nitrogenous base (purine or pyrimidine), a pentose (ribose or deoxyribose), and one or more phosphate groups. The nitrogenous bases are derived from two parent heterocyclic molecules. The major purines found in living organisms are adenine and guanine, while cytosine, thymine, and uracil are the major pyrimidine bases. Nitrogenous bases can be formed from amino acid precursors or reutilized after their release from nucleic acid breakdown via the salvage pathway. The purine ring carbon atoms formed from the dispensable amino acids glycine, glutamic acid, and aspartame. The carbon atoms pyrimidines are derived from carbamoyl phosphate and aspartame. It has been concluded that there are about six billion base pairs in the DNA of a single human cell.

The following questions are multiple choice questions. Choose the most appropriate answer:

(A) Dinucleotide is obtained by joining two nucleotides together by phosphodiester linkage. Between which carbon atoms of pentose sugars of nucleotides are these linkages present?

(a) 5' and 3' (b) 1' and 5'

(c) 5' and 5' (d) 3' and 3'

(B) In DNA, the complementary bases are:

(a) Uracil and adenine; cytosine and guanine

(b) Adenine and thymine; guanine and cytosine.

(c) Adenine and thymine; guanine and uracil

(d) Adenine and guanine; thymine and cytosine.

(C). The correct statement regarding RNA and DNA is:

(a) The sugar component RNA is arabinose and sugar in DNA is ribose

(b) The sugar component in RNA is 2-deoxyribose and the sugar component in DNA is arabinose.

(c) The sugar component in RNA is arabinose and the sugar component in DNA is 2'-deoxyribose.

(d) The sugar component in RNA is ribose and sugar component in DNA is 2' deoxyribose

(D). Which one of the following is not present in RNA ?

(a) Uracil (b) Ribose

(c) Thymine (d) Phosphate

4. Read the passage given below and answer the following questions:

Adenosine triphosphate (ATP) is the energy-carrying molecule found in the cells of all living things. ATP captures chemical energy obtained from the breakdown of food molecules and releases it to fuel other cellular processes. ATP is a nucleotide that consists of three main structures:the nitrogenous base, adenine; the sugar, ribose; and a chain of three phosphate groups bound to ribose. The phosphate tail of ATP is the actual power source which the cell taps. Available energy is contained in the bonds between the phosphates and is released when they are broken, which occurs through the addition of a water molecule (aprocess called hydrolysis). Usually only the outer phosphate is removed from ATP to yield energy; when this occurs ATP is converted to adenosine diphosphate (ADP), the form of the nucleotide having only two phosphates. The importance of ATP (adenosine triphosphate) as the main source of chemical energy in living matter and its involvement in cellular processes has long been recognized. The primary mechanism whereby higher organisms, including h u m a n s , generate ATP is through mitochondrial oxidative phosphorylation. For the majority of organs, the main metabolic fuel is glucose, which in the presence of oxygen undergoes complete combustion to CO_2 and H_2O:

$C_6H_{12}O_6 + 6O_2 \rightarrow 6O_2 + 6H_2O + \text{energy}$

The free energy (ΔG) liberated in this exergonic (ΔG is negative) reaction is partially trapped as ATP in two consecutive processes: glycolysis (cytosol) and oxidative phosphorylation (mitochondria). The first produces 2 mol of ATP per mol of glucose, and the second 36 mol of ATP per mol of glucose. Thus, oxidative phosphorylation yields 17-18 times as much useful energy in the form of ATP as can be obtained from the same amount of glucose by glycolysis alone. The efficiency of glucose metabolism is the ratio of amount of energy produced when 1 mol of glucose oxidised in cell to the enthalpy of combustion of glucose. The energy lost in the process is in the form of heat. This heat is responsible for keeping warm.

Reference : Erecinska', M., & Silvet, I. k..(1989). TP and Brain Function Journal of Cerebral Blood Flow & Metabolism, 9(1), 2-19.
https://doi.org/10.10381jcbfm.1989, 2 and
https://www,britannica.com/science/adenosine-triphosp hate)

(A) Cellular oxidation of glucose is a:

(a) spontaneous and endothermic process
(b) non spontaneous and exothermic process
(c) non spontaneous and endothermic process
(d) spontaneous and exothermic process

(B) What is the efficiency of glucose metabolism if 1 mole of glucose gives, 38ATP energy?(Given: The enthalpy of combustion of glucose is 686 kcal, 1ATP= 7.3kcal)

(a) 100%
(b) 38%
(c) 62%
(d) 80%

(C) Which of the following statement is true?

(a) ATP is a nucleoside made up of nitrogenous base adenine and ribose sugar.
(b) ATP consists the nitrogenous base, adenine and the sugar, deoxyribose.
(c) ATP is a nucleotide which contains a chain of three phosphate groups bound to ribose sugar.
(d) The nitrogenous base of ATP is the actual power source.

(D) Nearly 95% of the energy released during cellular respiration is due to:

(a) glycolysis occurring in cytosol
(b) oxidative phosphorylation.
(c) glycolysis occuring in mitochondria
(d) oxidative phosphorylation occurring in mitochondria

(E) Which of the following statements is correct?

(a) ATP is a nucleotide which has three phosphate groups while ADP is a nucleoside which has three phosphate groups.
(b) ADP contains a nitrogenous bases adenine, ribose sugar and two phosphate groups bound to rihose.
(c) ADP is the main source of chemical energy in living matter.
(d) ATP and ADP are nucleosides which differ in number of phosphate groups.

5. **Read the passage and answer the following questions:**

EVIDENCE FOR THE FIBROUS NATURE OF DNA

The basic chemical formula of DNA is now well established. it consists of a very long chain, the backbone of which is made up of alternate sugar and phosphate groups, joined together in regular 3' 5' phosphate di-ester linkages. To each sugar is attached a nitrogenous base, only four different kinds of which are commonly found in DNA. Two of these---adenine and guanine--- are purines, and the other two thymine and cytosine-are pyrimidines. A fifth base, 5-methyl cytosine, occurs in smaller amounts in certain organisms, and a sixth, 5-hydroxy-methyl-cytosine, is found instead of cytosine in the T even phages. It should be noted that the chain is unbranched, a consequence of the regular intemucleotide linkage. On the other hand the sequence of the different nucleotides is, as far as can be ascertained, completely irregular. Thus, DNA has some features which are regular, and some which are irregular. A similar conception of the DNA molecule as a long thin fiber is obtained from physicochemical analysis involving sedimentation, diffusion, light scattering, and viscosity measurements. These techniques indicate that DNA is a very asymmetrical structure approximately 20 Å wide and many thousands of angstroms long. Estimates of its molecular weight currently center between 5×10^6 and 10^7 (approximately 3×10^4 nucleotides). Surprisingly each of these measurements tend to suggest that the DNA is relatively rigid, a puzzling finding in iew of e large number of single bonds (5 per nucleotide) in the phosphate-sugar back bone. Recently these indirect inferences have been confirmed by electron microscopy.

Reference: Watson, J. D., & Crick, F. H. (1953, January). The structure of DNA In Cold spring Harbor symposia on quantitative biology (Vol. 18, pp. 123-131) old Spring Harbor Laboratory Press.

(A) Purines present in DNA are:
   (a) adenine and thymine
   (b) guanine and thymine
   (c) cytosine and thymine
   (d) adenine and guanine

(B) DNA molecule has_____ internucleotide linkage and__purines sequence of the different nucleotides
   (a) regular, regular
   (b) regular, irregular
   (c) irregular, regular
   (d) irregular, irregular

(C) DNA has a_____backbone.
(a) phosphate -purine
(b) pyrimidines- sugar
(c) phosphate- sugar
(d) purine- pyrimidine

(D) Out of the four different kinds of nitrogenous bases which are commonly found in DNA, _____has been replaced in some organisms.
(a) adenine
(b) guanine
(c) cytosine
(d) thymine

ANSWERS

I MULTIPLE CHOICE QUESTIONS

I 1. (b) 2. (b) 3. (a) 4. (c) 5. (a) 6. (c) 7. (c) 8. (b) 9. (b) 10. (a) 11. (c) 12. (c) 13. (c) 14. (c) 15. (b) 16. (d) 17. (b) 18. (b) 19.(d) 20.(c)

II FILL IN THE BLANKS

1. Amylose 2. n-Hexane 3. α-D-glucose 4. Adenine and guanine
5. Peptide linkage. 6. Vitamin B_{12} 7. Uracil 8. Vitamin K. 9. Gluconic acid
10. Glycogen.

III ASSERTION REASON TYPE QUESTIONS

1. (c) 2. (a) 3. (c) 4. (a) 5. (c) 6. (a) 7. (b) 8. (a) 9. (b) 10. (d)

IV ONE WORD ANSWER TYPE QUESTIONS

1. Vitamin B 2. Vitamin C 3. Cellulose 4. Lactose 5. Starch 6. Polysaccharides
7. Reducing sugars 8. vitamin A 9. Nucleoside, nucleotide 10. Anomers

CASE STUDY BASED QUESTIONS

1. A. (c) B. (b) C. (d) D. (b)
2. A. (b) B. (c) C. (b) D. (c)
3. A. (b) B. (b) C. (d) D. (c)
4. A. (d) B. (b) C. (c) D. (d) E.(b)
5. A. (d) B. (b) C. (c) D. (c)

UNIT TEST-1

Biomolecules

Maximum Marks : 20 **Time Allowed : 1 Hours**

1. Name polysaccharide which is stored in the liver of animals. (1)
2. Name the enantiomer of D-glucose. (1)
3. Why is sucrose called invert sugar? (1)
4. Name the building blocks of proteins. (1)
5. Give the structure of simplest optically active amino acid. (1)
6. What are anomers? Give the structures of two anomers of glucose. (2)
7. Write the products obtained by hdydrolysis of (2)
   (i) maltose (ii) cellulose
8. What are vitamins? Give two examples of water soluble vitamin. (2)
9. What do you understand by following: (3)
   (i) denaturation of protein
   (ii) reducing sugar
10. Differentiate between the following (3)
    (i) secondary and tertiary structure of protein.
    (ii) α-helix and β-pleated sheet structure of protein.
    (iii) nucleoside and nucleotide
11. (i) Name four bases present in DNA. (3)
    (ii) Which of them is not present in RNA?
    (iii) Name the linkage responsible for stability of strands of DNA.

UNIT TEST-2

Biomolecules

Maximum Marks : 20 **Time Allowed : 1 Hours**

1. Name the following: (1)
   (i) Nitrogenous base present in RNA but not in DNA.
   (ii) Optically inactive amino acid
2. Explain- Amino acids shows amphoteric behaviour. (1)
3. Mention two examples of disachharides. (1)
4. The linkage responsible for stability of primary structure of protein is (1)
5. Name the diseases associated with the deficiency of vitamin A and vitamin B_{12}. (1)
6. Write any three reactions which cannot be explained by linear structure of D-glucose. Write cyclic structure of glucose. (2)
7. Discuss the tertiary and quaternary structure of proteins. Name the intermolecular forces responsible for stability of these structures. (2)
8. Explain- denaturation of proteins. Discuss its effect on the primary, secondary, tertiary and quaternary structures of proteins. (2)
9. Differentiate following pairs giving examples: (3)
   (i) Reducing and non-reducing sugars
   (ii) Essential and non-essential amino acids
   (iii) Fibrous and globular proteins
10. Write the reactions of D-glucose with following: (3)
    (i) HI/Δ
    (ii) Bromine water
    (iii) Acetic anhydride
11. Give reasons for following: (3)
    (i) Amino acids are soluble in water.
    (ii) Tryptophan is required in diet regularly but glutamic acid does not.
    (iii) DNA is more stable than RNA.