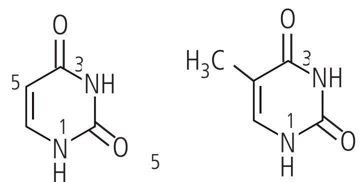
CHAPTER 14

Biomolecules

ANSWERS

1. **(a) :** Thymine, also known as 5-methyluracil, is a pyrimidine base. As the name implies, thymine may be derived by methylation of uracil at the 5th carbon.



Uracil   Thymine

2. **(b) :** RNA contains uracil as pyrimidine base instead of thymine which is present in DNA.

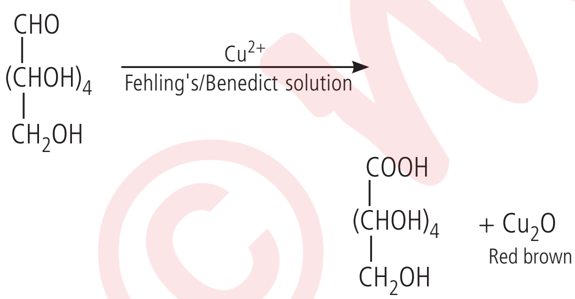
3. **(d)**   **4.** **(b)**

5. **(c) :** Peptide linkage is present in proteins.

6. **(b) :** Sucrose is dextrorotatory while an equimolecular mixture of glucose and fructose which it gives on hydrolysis is laevorotatory. Inversion of sign of optical rotation has occurred during hydrolysis. Thus this hydrolysis is called inversion.

7. **(b) :** Cysteine can cross link peptide chains through disulphide bridge.

8. **(c) :**



OR

(c) : '*D*' corresponds to the position of –OH group on the right side on the farthest asymmetric C-atom.

9. **(a)**   **10.** **(b)**

11. Hormones are produced by endocrine glands and are transported to the target tissues through the circulation of blood.

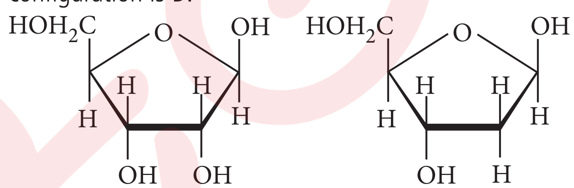
12. Isoelectric point is the pH at which the amino acid has net zero charge and exists as dipolar ion ($H_3N^+CHRCOO^-$). When pH is below the isoelectric point, the cation ($H_3N^+CHRCOOH$) predominates and it migrates to the cathode while at pH higher than isoelectric point the anion ($H_2NCHRCOO^-$) predominates and it migrates to anode.

13. (i) They occur in every part of our body and form the fundamental basis of structure and functions of life.

(ii) They are also required for growth and maintenance of our body.

14. Deoxyribose sugar, phosphoric acid and nitrogen containing heterocyclic bases are the hydrolysis products of DNA.

15. Ribose and 2- deoxyribose are found in nucleic acids. Their configuration is D.



β–*D* – ribose   β–*D* – 2 deoxyribose .

16. The sugars which reduce Fehling's solution and Tollens' reagent are called reducing sugars. For example, all monosaccharides containing free —CHO or $-\overset{|}{C}=O$ group are reducing sugars.

OR

(i) Most of the chemical reactions which occur in living systems process at very slow rates under mild condition of temperature and pH. These reactions are catalysed by a group of biomolecules called enzymes. Examples are zymase, maltase, lactase etc.

(ii) They are organic compounds, which are required in the diet in small amount to perform biological functions and growth of the body.

17. (i) These are the carbohydrates which on hydrolysis give 2 - 10 unit monosaccharides. For example, sucrose, lactose, maltose, etc.

(ii) Sucrose is dextrorotatory but after hydrolysis gives dextrorotatory glucose and laevorotatory fructose. Since laevoratatory fructose is more than dextrorotatory of glucose, the mixture is laevorotatory. Thus, hydrolysis of sucrose brings about a change in sign of rotation, from dextro to laevo and the product name as invert sugar.

18. The following reactions of *D*-glucose cannot be explained on the basis of its open chain structure :

(i) *D*-Glucose does not react with sodium bisulphite ($NaHSO_3$).

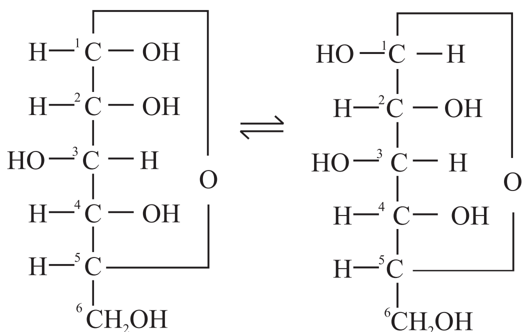
(ii) It does not give 2, 4-DNP test and Schiff's test.

(iii) The pentaacetate of *D*-glucose does not react with hydroxylamine.

(iv) *D*-Glucose shows the phenomenon of mutarotation *i.e.*, when its aqueous solution is kept for sometime its optical activity changes.

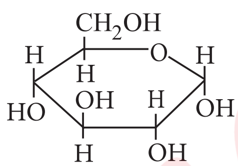
(v) On reaction with 1 mole of methanol, it yield two monomethyl derivatives which are known as methyl α-*D*-glucoside and methyl-β-*D*-glucoside.

19. In α-*D* Glucose, the –OH group at C_1 is towards right whereas in β-glucose, the –OH group at C_1 is towards left. Such a pair of stereoisomers which differ in the configuration only at C_1 are called anomers.



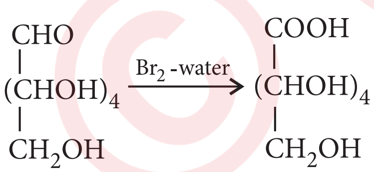
α-*D*-(+) – Glucose β-*D*-(+)-Glucose

The six membered cyclic structure of glucose is called pyranose structure (α– or β –), in analogy with heterocyclic compound pyran.



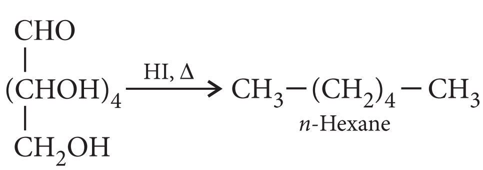
α-*D*-(+)-Glucopyranose

20. (i) *D*-Glucose gets oxidised to carboxylic acid (gluconic acid) on reaction with bromine water.



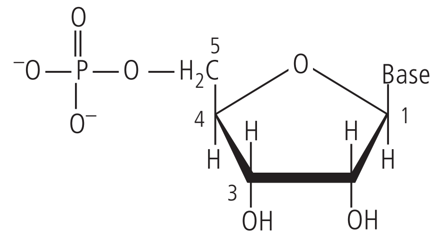
D-Glucose Gluconic acid

(ii) On prolonged heating with HI, *D*-glucose forms *n*-hexane.



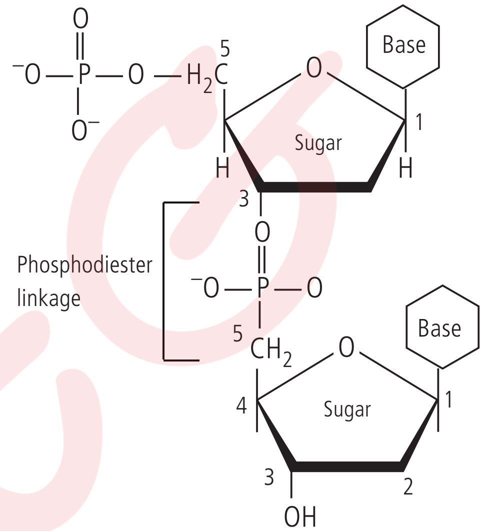
D-Glucose

21. A unit formed by the attachment of a base to 1′ position of sugar is known as nucleoside, when nucleoside is linked to phosphoric acid at 5′ position of sugar moiety, a nucleotide is formed.



A nucleotide

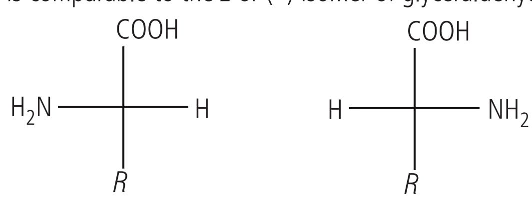
Nucleotides are joined together by phosphodiester linkage between 5′ And 3′ carbon atoms of pentose sugar.



Dinucleotide

The linkage is resemble with two ester groups joined together. The acid involved is phosphoric acid (H_3PO_4).

22. Except glycine all naturally occurring α-amino acids are optically active since the α-carbon atom is asymmetric. These exist in *D* and *L* form. Most naturally occurring amino acids have *L*-configurations in which $-NH_2$ group is written on the left hand side. It is comparable to the *L* or (–) isomer of glyceraldehyde.



L-amino acid *D*-amino acid

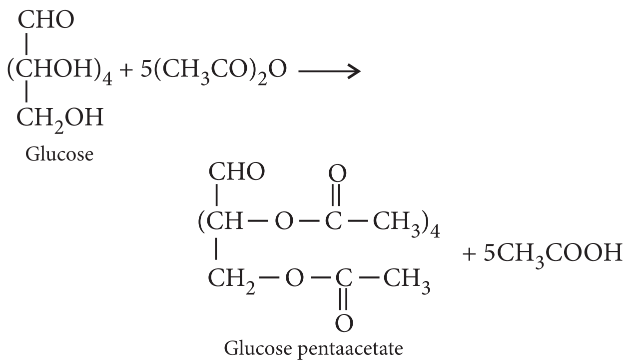
OR

(a) As amino acids have both acidic (carboxyl group) and basic groups (amino group) in the same molecule, they react with both acids and bases. Hence, they show amphoteric behaviour..

(b) In α-helix structure, intramolecular H-bonding takes place whereas in β-pleated structure, intermolecular H-bonding takes place.

23. (i) Glucose reacts with hydroxylamine to form monoxime and adds one molecule of hydrogen cyanide to give cyanohydrin so it contains a carbonyl group which can be an aldehyde or a ketone.

(ii) On acetylation with acetic anhydride, glucose gives a pentaacetate. This confirms that glucose contains five – OH groups.



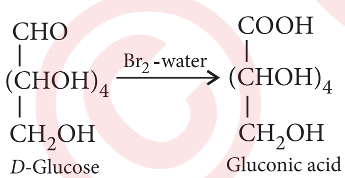
24. Carbohydrates are stored in animal body as glycogen. It is also known as animal starch. Carbohydrates are stored in plants as starch.

Cellulose is present in wood and in the fibre of cotton cloth.

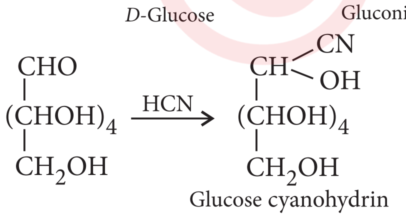
25. (a) When a protein in its native form, is subjected to physical change like change in temperature or chemical change like change in pH, the hydrogen bonds are disturbed. Due to this, globules unfold and helix get uncoiled and protein loses its biological activity. This is called denaturation of protein. During denaturation 2° and 3° structure are destroyed but 1° structure remains intact.

(b) In starch glycosidic α-linkage is present and in cellulose, glycosidic β-linkage is present between glucose units. Glucose is itself a monosaccharide.

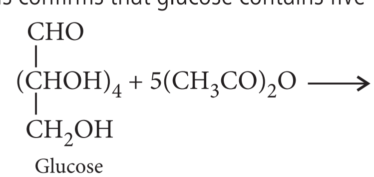
26. (a) *D*-Glucose gets oxidised to carboxylic acid (gluconic acid) on reaction with bromine water.

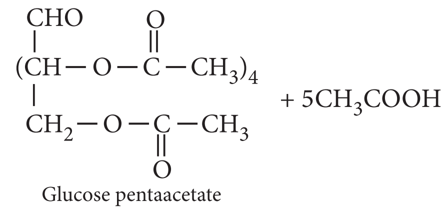


(b)



(c) On acetylation with acetic anhydride, glucose gives a pentaacetate. This confirms that glucose contains five – OH groups.





27. Glucose was assigned the structure on the basis of following evidences

(a) On prolonged heating with HI, it forms *n*-hexane suggesting that all the six carbon atoms are linked in a straight chain.

(b) Glucose reacts with hydroxylamine to form an oxime and adds a molecule of hydrogen cyanide to give cyanohydrin. It confirms the presence of a $>C=O$ group in glucose.

(c) Glucose gets oxidised to six carbon carboxylic acid (gluconic acid) on reaction with a mild oxidising agent which shows it has aldehyde group.

(d) Formation of pentaacetate confirms presence of five –OH groups on different carbon atoms.

28. RNA are of three types :

(i) Messenger RNA (*m*-RNA) : Functions as messenger carrying the information in a gene to the protein synthesizing machinery.

(ii) Transfer RNA (*t*-RNA) : They transfer the amino acids from cytoplasm to the protein synthesizing machinery.

(iii) Ribosomal RNA (*r*-RNA) : They associate with a set of proteins to form ribosomes. These complex structures, which physically move among an *m*-RNA molecule, catalyze the assembly of amino acids into protein chains. They also bind *t*-RNAs and various molecules necessary for protein synthesis.

OR

Following reactions can not be explained on the basis of open chain structure of *D*-glucose.

1. Despite having aldehyde group glucose does not give 2,4–DNP test, Schiff's test and addition product with $NaHSO_3$.

2. Pentaacetate of glucose does not react with hydroxylamine indicating absence of free –CHO group.

3. Glucose exits as an equilibrium between open-structure and closed cyclic structure. In cyclic structure, (–OH) group of C_5 reacts with (–CHO) group to form hemiacetal group. Thus, in this form there is no free aldehyde group is present due to which the above reactions are not shown by glucose.

29. (a) Actually, glucose exists in the cyclic hemiacetal form with only a small amount (< 0.05%) of the open chain form. Since, the concentration of the open chain form is low and its reaction with 2,4-DNP is reversible, therefore, formation of 2,4-DNP derivative cannot disturb the equilibrium to regenerate more of the open chain form from the cyclic hemiacetal form and hence, does not give this test.

(b) The two strands in DNA molecule are held together by the hydrogen bonds between purine base of one strand and pyrimidine base of the other and *vice versa*. Because of different sizes and geometries of the bases, the only possible pairing in DNA are G (guanine) and C (cytosine) through three H-bonds, *i.e.*, (C ≡ G) and between A (adenine) and T (thymine) through two H-bonds (*i.e.*, A = T) . Due to this base-pairing principle, the sequence of bases in one strand automatically fixes the sequence of bases in the other strand. Thus, the two strands are complementary and not identical.

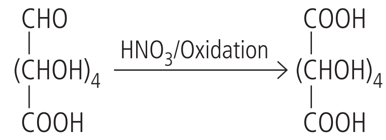
(c) The basic structural difference between starch and cellulose is of linkage between the glucose units. In starch, there is α-*D*-glycosidic linkage. Both the components of starch-amylose and amylopectin are polymers of α-*D*-glucose. On the other hand, cellulose is a linear polymer of β-*D*-glucose in which C1 of one glucose unit is connected to C4 of the other through β-*D*-glycosidic linkage.

30. (i) : The sugar present in milk is lactose.

(ii) Lactose is a disaccharide and two monosaccharides units are present.

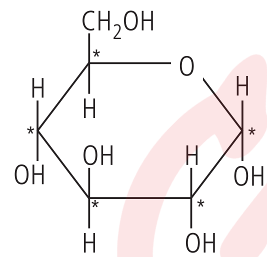
(iii) It is made up of *D*(+) glucose and *D*(+) galactose.

(iv) Glucose is oxidised with conc. HNO_3 to give Glucaric acid or Saccharic acid.



Glucose   Glucaric acid or Saccharic acid

(v)



There are 5-assymetric carbon in glucopyranose.

So, no. of stereoisomer = $2^n = 2^5 = 32$.