# BIOMOLECULES

## SOLVED SUBJECTIVE EXERCISE

### Very Short Answer Type Questions (1 mark)

**1.** Explain why vitamin C cannot be stored in the body ?
**Ans.** Vitamin C is soluble in water, hence, it is readily excreted in urine and thus cannot be stored in the body.

**2.** What are reducing sugars?
**Ans.** All those carbohydrates which reduce Fehling's solution to red ppt. of $Cu_2O$ or Tollens' reagent to metallic Ag are called reducing sugars. All monosaccharides (both aldoses and ketoses) and disaccharides except sucrose are reducing sugars.

**3.** What are the constituents of starch?
**Ans.** Amylose and Amylopectin.

**4.** Write the constituents of maltose.
**Ans.** Two units of α-D-Glucose.

**5.** What is the structural feature characterising reducing sugars?
**Ans.** The main structural feature of reducing sugars is the presence of an aldehyde group (—CHO) such as in glucose, mannose, galactose, etc. or a-ketol grouping (—CO—$CH_2OH$) as present in fructose.

**6.** What is meant by inversion of sugar?
**Ans.** Sucrose is dextrorotatory but on hydrolysis, it gives an equimolar mixture of D(+)-glucose and D(-)-fructose which is levorotatory. This change of specific rotation from dextrorotation to levorotation is known as inversion of sugar.

**7.** What are zwitter ions?
**Ans.** A zwitter ion is a dipolar ion formed by neutralization of acidic and basic centres present within the molecule.

**8.** What is isoelectric point?
**Ans.** The pH at which there is no net migration of the amino acid under the influence of an applied electric field is called isoelectric point. For example, the isoelectric point of glycine is 6.1.

**9.** What are anomers? Give one example.
**Ans.** Anomers are those isomers which differ in orientation of OH at C1 carbon, e.g., α-glucose β-glucose are anomers.

**10.** What purine and pyrimidine bases are present in DNA and RNA?
**Ans.** ***Purines*** : adenine and guanine; ***pyrimidines*** : cytosine and thymine in DNA and cytosine and uracil in ***RNA***.

**11.** Write biological importance of Nucleic acid.
**Ans.** (i) To transmit genetic material to their offsprings. (ii) Protein synthesis.

**12.** If the fragment of one strand of DNA molecule has the base sequence ATCTCGTAG, what is the base sequence of complementary strand?
**Ans.** TAGAGCATG.

**13.** Give one example of a denaturated protein.
**Ans.** Curdling of milk.

**14.** The deficiency of which vitamin causes the disease 'pernicious anaemia'?
**Ans.** Vitamin $B_{12}$.

**Short Answer Type Questions (2 mark)**

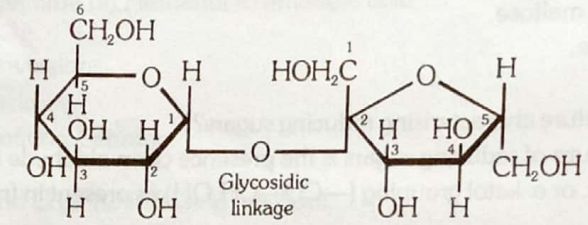
**15.** When RNA is hydrolysed, there is no relationship among the quantities of different bases obtained? What does this fact suggest about the structure of RNA?

**Ans.** A DNA molecule has two strands in which the four complementary bases pair each other, viz. cytosine (C) always pairs with guanine (G) while thymine (T) always pairs with adenine (A). Therefore, when a DNA molecule is hydrolysed, the molar amounts of cytosine is always equal to that of guanine and that of adenine is always equal to that of thymine. RNA also contains four bases, the first three are same as in DNA but the fourth one is uracil (U).

As in RNA there is no relationship between the quantities of four bases (C, G, A and U) obtained, therefore, the base-pairing principle, viz., a pairs with U and C Pairs with G is not followed. So, unlike DNA, RNA has a single strand.

**16.** What do you understand by the glycosidic linkage?

**Ans.** The linkage between two monosaccharide units through oxygen atom is called glycosidic linkage. The glycosidic linkage in sucrose molecule is shown below.




α-D-Glucose **Sucrose** β-D-Fructose

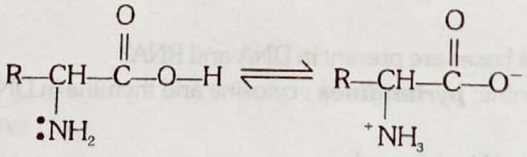
**17.** What are essential and non-essential amino acids? Give two examples of each type.

**Ans.** α-Amino acids which are required for health and growth of human beings but are not synthesized by the human body are known as essential amino acids. Examples: valine, leucine, phenylalanine, etc. On the other hand, α-amino acids which are needed for health and growth of human beings and are synthesized by the human body are called non-essential amino acids. Examples: glycine, alanine, aspartic acid; etc.

**18.** How do you explain the amphoteric nature of amino acids?

**Ans.** Amino acids contain both acidic (carboxyl group) and basic (amino group) groups in the same molecule. In aqueous solution, the carboxyl group can lose a proton and amino group can accept a proton, giving rise to a dipolar ion known as zwitter ion. This is neutral but contains both positive and negative charges.

In zwitter ionic form, amino acids show amphoteric behaviour as they react with both acids and bases.



**19.** What is the effect of denaturation on the structure of protéins?

**Ans.** During denaturation, 2° and 3° structures of proteins are destroyed but 1° structure remains intact. Due to denaturation, the globular proteins (soluble in $H_2O$) are converted into fibrous proteins (insoluble in $H_2O$) and their biological activity is lost. For example, boiled egg which contains coagulated proteins cannot be hatched.

**20.** How are vitamins classified? Name the vitamin responsible for coagulation of blood?

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

(i) ***Water soluble vitamins***: These include vitamin B-complex ($B_1$, $B_7$, $B_5$, i.e., nicotinic acid, $B_6$, $B_{12}$, pantothenic acid, biotin, i.e., vitamin H and folic acid) and vitamin C.

(ii) ***Fat soluble vitamins***: These include vitamin A, D, E and K. These are stored in liver and adipose (fat storing tissues). Vitamin K is responsible for coagulation of blood.

**21.** Why are vitamin A and vitamin C essential to us? Give their important sources.

**Ans.** ***Vitamin A*** is essential for us because its deficiency can cause xerophthalmia (hardening of cornea of eye) and night blindness.

***Sources:*** Carrots, Fish liver oil, butter and milk.

***Vitamin C:*** Vitamin C is essential for us because its deficiency causes scurvy (bleeding gums) and pyorrhea (loosening and bleeding of teeth).

***Sources:*** Amla, Citrus fruits and green leafy vegetables.

**22.** Name the two components of starch. How do they differ from each other structurally?

**Ans.** Starch is a polymer of a-glucose and consist of two components Amylose and Amylopectin. Amylose is a long unbranched chain with 200-1000 α–D–(+)-glucose units held by $C_1$–$C_4$ glycosidic linkage.
Amylopectin is a branched chain polymer of a-D-glucose units in which chain is formed by $C_4$–glycosidic linkage whereas branching occurs by $C_1$–$C_6$ glycosidic linkage.

**23.** Explain the following terms:
(i) Mutarotation.
(ii) Avitaminosis.

**Ans.** ***(i) Mutarotation:*** The spontaneous change in specific rotation of an optically active compound with the passage of time till it acquire equilibrium value is called mutarotation.

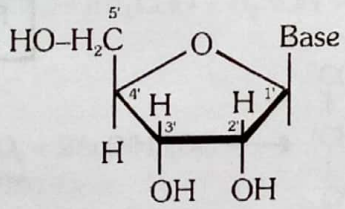
***(ii) Avitaminosis:*** Lack of more than one vitamin causes multiple deficiency diseases called avitaminosis.

## Short Answer Type Questions (3 mark)

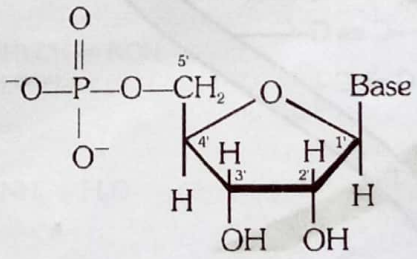
**24.** What is the difference between a nucleoside and a nucleotide?

**Ans.** ***A nucleoside*** is formed when 1–position of pyrimidine (cytosine, thiamine or uracil) or 9–position of purine (guanine or adenine) base is connected to $C_1$ of sugar (ribose or deoxyribose) by a β–linkage. Hence, in general, nucleosides may be represented as: Sugar-Base. For example, structure (A) represents a nucleoside.

***A nucleotide*** contains all the three basic compounds of nucleic acids, i.e., a phosphoric acid group, a pentose sugar and a nitrogenous base. These are obtained by esterification of $C_5'$ — OH group of the pentose sugar by phosphoric acid.




**A**
**Nucleoside**

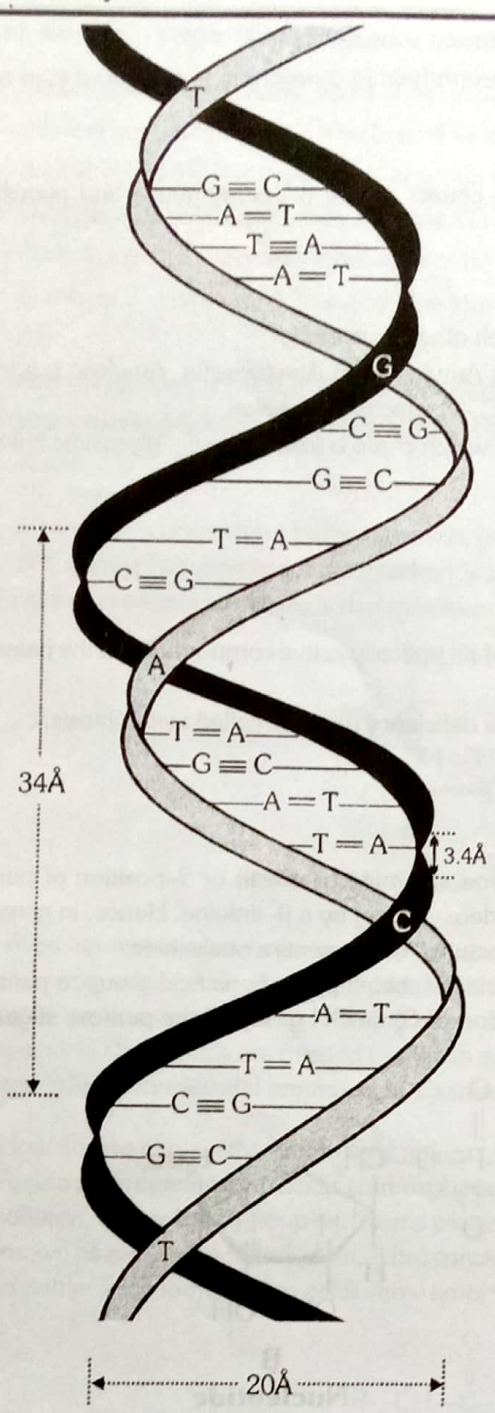



**B**
**Nucleotide**

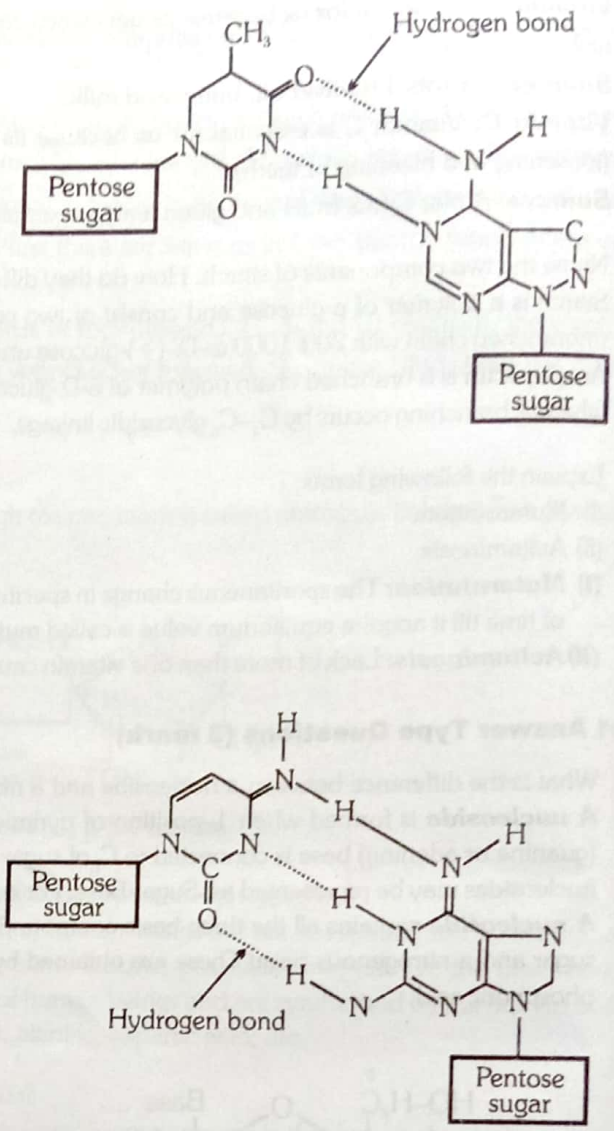
Thus, in general, a nucleotide is represented as sugar—Base—O—P(=O)(—OH)—OH.

**25.** The two strands in DNA are not identical but are complimentary. Explain.

**Ans.** The two strands in DNA molecule are held together through 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 base, the only possible pairing in DNA are G (guanine) and C (cytosine) through three H-bonds, i.e., bases (C ≡ G) and between A (adenine) and T (thymine) through two H-bonds (i.e., A = T) Fig. 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 not identical but are complimentary.




(a) The double strand helix structure for DNA




(b) Base pair in DNA

**26.** Define enzymes. How do enzymes differ from ordinary chemical catalysts?

**Ans.** ***Enzymes:*** Enzymes are naturally occurring simple or conjugate proteins acting as specific catalysts in cell processes. The enzyme facilitates a biochemical reaction by providing alternative lower activation energy pathways thereby increasing the rate of reaction.

Enzymes are different from ordinary chemical catalysts in following ways:

(i) They are highly specific in their action i.e., each enzyme can catalyse only a specific type of reaction.

(ii) Enzymes can speed up reactions to the extent of about ten million times.

(iii) Enzymes function at a moderate temperature (about 310 K) and moderate pH (6-8).

(iv) Even a small quantity of an enzyme can catalyse the reaction of a large quantity of the substrate. This is because as in chemical reactions, the catalyst (enzyme) is regenerated after the reaction.

**27.** Which forces are responsible for the stability of α-helix? Why is it named as $3.6_{13}$ helix?

**Ans.** Hydrogen bonds between —N—H and —C = O groups of peptide bonds give stability to the structure. Thus, a structure having maximum hydrogen bond shall be favoured. α-Helix is one of the most common ways in which a polypeptide chain forms all possible hydrogen bonds by twisting into a right handed screw (helix) with the —NH group of each amino acid residue hydrogen bonded to the —C = O of an adjacent turn of the helix.
The α-helix is also known as $3.6_{13}$ helix, since each turn of the helix has approximately 3.6 amino acid residue and a 13 member ring is formed by hydrogen bonding.

**28.** How will you distinguish between ?
(i) Glucose and Fructose (ii) Glucose and Sucrose (iii) Glucose and Starch.

**Ans.** (i) Glucose decolourises red colour of bromine water. It is oxidised to gluconic acid. Fructose does not react with bromine water. Fructose gives a red colour with resorcinol and conc. HCl while glucose does not give any colour.
(ii) Glucose on heating with Tollen's reagent gives silver mirror while sucrose does not. Glucose gives red ppt. with Fehling's solution while sucrose does not.
(iii) Glucose gives positive tests with Tollen's reagent and Fehling's solution while starch does not. Starch gives blue colour with iodine solution while glucose does not.

**29.** What happens when ?
(a) Glucose is heated with phenyl hydrazine.
(b) Glucose is treated with hydroxylamine.
(c) Glucose is made to react with ammoniacal silver nitrate solution.
(d) Glucose reacts with acetic anhydride.
(e) Glucose is oxidised with nitric acid.

**Ans.** (a) $\underset{\text{Glucose}}{CH_2OH(CHOH)_4CHO} + H_2NNHC_6H_5 \longrightarrow \underset{\text{Glucose phenyl hydrazone}}{CH_2OH(CHOH)_4\,CH{=}NNHC_6H_5}$

With excess of phenyl hydrazine, glucosazone, $CH_2OH(CHOH)_3{-}\underset{\displaystyle CH{=}NNHC_6H_5}{\overset{\displaystyle C{=}NNHC_6H_5}{|}}$ , is formed.

(b) $CH_2OH(CHOH)_4CHO + H_2NOH \longrightarrow \underset{\text{Glucose oxime}}{CH_2OH(CHOH)_4CH{=}NOH}$

(c) $\underset{\text{Glucose}}{C_6H_{12}O_6} + 2Ag(NH_3)_2OH \longrightarrow \underset{\displaystyle CH_2OH}{\overset{\displaystyle COONH_4}{(CHOH)_4}} + \underset{\text{Silver mirror}}{2Ag} + 3NH_3 + H_2O$

(d) $\underset{\displaystyle CH_2OH}{\overset{\displaystyle CHO}{(CHOH)_4}} + 5(CH_3CO)_2O \longrightarrow \underset{\displaystyle CH_2OOCCH_3}{\overset{\displaystyle CHO}{(CHOOCCH_3)_4}} + 5CH_3COOH$

Glucose pentaacetate
(A mixture of α-and β-

(e) $\underset{\text{Glucose}}{CH_2OH(CHOH)_4CHO} + 3[O] \xrightarrow{HNO_3} \underset{\text{Saccharic acid } (C_6) \text{ or Glucaric acid}}{HOOC(CHOH)_4COOH} + H_2O$

**30.** Name the vitamins, deficiencies of which cause :
(i) Night blindness, (ii) Rickets, (iii) Impaired clotting of blood, (iv) Pernicious anaemia,
(v) Impotency (Sterility), (vi) Cheilosis (cracking of lips and corners of the mouth)

**Ans.** (i) Vitamin A, (ii) Vitamin D, (iii) Vitamin K, (iv) Vitamin $B_{12}$,
(v) Vitamin E, (vi) Vitamin $B_2$.

# EXERCISE-1

## PREVIOUS YEARS BOARD PROBLEMS

### CBSE 2016

1. (i) Write one reaction of D-Glucose which cannot be explained by its open chain structure.
   (ii) What type of linkage is present in Nucleic acids ?
   (iii) Give one example each for water-soluble vitamins and fat-soluble vitamins?

### CBSE 2015

1. (i) Which one of the following is a disaccharide :
   starch, maltose, fructose, glucose
   (ii) What is the difference between acidic amino acid and basic amino acid?
   (iii) Write the name of the linkage joining two nucleotides.

### CBSE 2014

1. Define the following terms as related to proteins:
   (i) Peptide linkage
   (ii) Primary structure
   (iii) Denaturation

2. Define the following terms:
   (i) Glycosidic linkage
   (ii) Invert sugar
   (iii) Oligosaccharides

3. Write the products of hydrolysis of lactose.

4. Define the following terms:
   (i) Nucleotide
   (ii) Anomers
   (iii) Essential amino acids

### CBSE 2013

1. What are the products of hydrolysis of sucrose ?

2. What are the products of hydrolysis of lactose?

3. Write the name of linkage joining two amino acids.

### CBSE 2012

1. Write a reaction which shows that all the carbon atoms in glucose are linked in a straight chain.

2. What is essentially the difference between α-glucose and β-glucose? What is meant by pyranose structure of glucose.

## CBSE 2011

1. Explain what is meant by
   (i) pyranose structure of glucose?
   (ii) glycosidic linkage ?
2. Write such reactions and facts about glucose which cannot be explained by its open chain structure.
3. The deficiency of which vitamin causes the disease pernicious anaemia?
4. Write the main structural difference between DNA and RNA. Of the four bases name those which are common to both DNA and RNA.
5. What are vitamins? Deficiency of which vitamins causes convulsions and pernicious anaemia ?
6. Define the following giving one example of each.
   (i) Zwitter ion
   (ii) Glycosidic linkage

## CBSE 2010

1. What are the products of hydrolysis of sucrose ?
2. What are monosaccharides?
3. What is meant by reducing sugars?
4. What is meant by denaturation of proteins?
5. (i) What type of bonding helps in stabilising the α-helix structure of proteins?
   (ii) Differentiate between globular and fibrous proteins.
6. Amino acids may be acidic, alkaline or neutral. How does this happen? What are essential and non-essential amino acids? Name one of each type.

## CBSE 2009

1. Enumerate the reaction of D-glucose which cannot be explained by the open chain structure.
2. What is the biological effect of denaturation of proteins ?
3. Name the four bases present in DNA. Which one of these is not present in RNA?
4. Name two fat soluble vitamins, their sources and the diseases caused due to their deficiency in diet.

# EXERCISE-1

## PREVIOUS YEARS BOARD PROBLEMS

## BIOMOLECULES

### CBSE 2016

**Sol.1** (i) Sodium Hydrogen Sulphite reaction/ Pentaacetate of glucose does not react with Hydroxylamine/Schiff's test (any one)

(ii) Phosphodiester linkage

(iii) Fat soluble - Vitamin A/D /E/ K

Water soluble - Vitamin B /C

### CBSE 2015

**Sol.1** (i) Maltose

(ii) In acidic amino acid more carboxyl groups as compared to amino groups are present & In basic amino acid more number of amino than carboxyl groups are present

(iii) Phosphodiester linkage

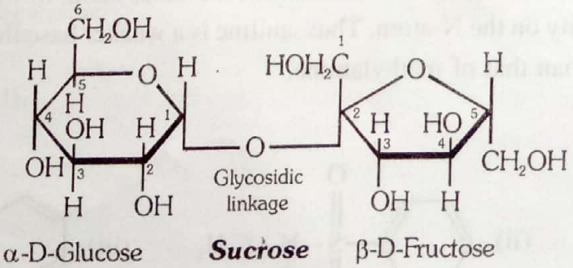
### CBSE 2014

**Sol.1** (i) Proteins are connected to each other by –CO–NH bond which is called the peptiede bond or the peptide linkage. chemically. peptide linkage in an amide (–CO–NH–) bond formed between carboxyl group (–COOH) and amino group ($–NH_2$)

(ii) Each polypeptide chain has a large number of α-amino acids linked to one another in a specific sequence. The specific sequence in which various amino acids are lined with each other to form a polypeptide, is called its primary structure.

(iii) When a native protein is subjected to physical change the hydrgoen bonds are distarbed. As a result globules unfold and helix get uncoiled and protein loses its biological activity. This is known as denaturation of protein.

**Sol.2** (i) The linkage between two monosaccharide units through oxygen atom is called glycosidic linkage. The glycosidic linkage in sucrose molecule is shown below.




α-D-Glucose **Sucrose** β-D-Fructose

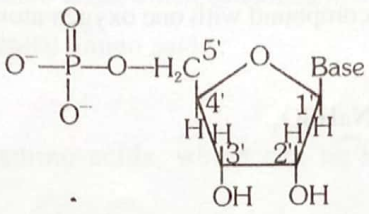
(ii) Sucrose is dextrorotatory but on hydrolysis, it gives an equimolar mixture of D(+)-glucose and D(-)-fructose which is levorotatory. This change of specific rotation from dextrorotation to levorotation is known as inversion of sugar.

(iii) Carbohydrates which gives 2–10 mono saccharide units on hydrolysis are called digosaccharides.

**Sol.3** Lactose is $C_{12}H_{22}O_{11}$ a disaccharide with a glucose and a galactose unit present in pyranose form so on hydrolyzing it we will obtain glucose and galactose.

**Sol.4** (i) All the three basic components of nucleic acids (i.e., pentose sugar, phosphoric acid, and base) are present in a nucleotide.

Nucleotide = Sugar + Base + Phosphoric acid




Structure of a nucleotide

(ii) α-D-glucose and β-D-glucose which have configuration isomer at $C_1$ carbon is known as Anomers

(iii) Essential amino acids are required by the human body, but they cannot be synthesised in the body. They must be taken through food. For example : valine and leucine

## CBSE 2013

**Sol.1** α–D(+) Glucose and B–D(–) fructose

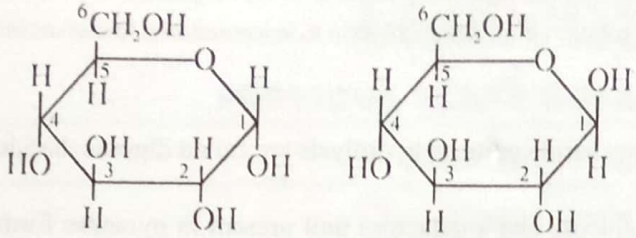
**Sol.2** Lactose is $C_{12}H_{22}O_{11}$ a disaccharide with a glucose and a galactose unit present in pyranose form so on hydrolyzing it we will obtain glucose and galactose.

**Sol.3** Peptide linkage.

## CBSE 2012

**Sol.1** Rxn with HI

**Sol.2** The six membered cyclic structure of glucose is called pyranose structure.



α – D glucose



β – D glucose

## CBSE 2011

**Sol.1** (i) The six membered cyclic structure of glucose is known as pyraxose structure (α–or–B). It is analogous to pyran which is a cyclic organic compound with one oxygen atom and five carbon atoms in the ring.

(ii) same as **Q.2 (i) in 2014**

**Sol.2** Do not react with schiff's base and $NaHSO_3$.

**Sol.3** $B_{12}$

**Sol.4** DNA is double stranded α-helix structure in which two strands are coiled spirally in opposite directions. RNA has single stranded α-helix structure. DNA contains four bases namely, adenine (A), guanine (G), cytosine (C) and thymine (T).

**Sol.5** Organic compounds required in the diet in small amounts to perform specific biological functions for normal maintenance of optimum growth and heath of the orgainsm.

B–6 and B–12

**Sol.6** (i) A zwitter ion is a dipolar ion formed by neutralization of acidic and basic centres present within the molecule.

(ii) same as **Q.2 (i) in 2014**

## CBSE 2010

**Sol.1** α–D(+) Glucose and B–D(–) fructose

**Sol.2** It Cannot be hydrolysed further to give simpler unit of polyhydroxy aldehyde and ketone. e.g glucose, fructose, ribose etc.

**Sol.3** All those carbohydrates which reduce Fehling's solution to red ppt. of $Cu_2O$ or Tollens' reagent to metallic Ag are called reducing sugars. All monosaccharides (both aldoses and ketoses) and disaccharides except sucrose are reducing sugars.

**Sol.4** When a native protein is subjected to physical change the hydrgoen bonds are distarbed. As a result globules unfold and helix get uncoiled and protein loses its biological activity. This is known as denaturation of protein.

**Sol.5** (i) Intra molecular H–bonding.

(ii) (i) **Fibrous protein :-** They have thread or fible like structures in which polypeptide chains run paralled and are hell logether by hydrgoen and disutphide bond. These proteins are insolable in water e.g. Keratin and Myosin.

(ii) **Globular proteins :-** They have spherical shape in which chains of polypeptides coil around. These are soluble in water, e.g. insulin and albumins.

**Sol.6** Amino acids are classified as acidic, basic or neutral depending upon the relative number of amino and carboxyl groups in their molecule.

Equal number of amino and carboxyl groups makes it neutral; more number of amino thatn carboxyl group makes it basic and more carboxyl groups as compared to amino groups makes it acidic.

**Essential amino acids :** The amino acids which cannot be synthesised in the body and must be obtained through diet, are known as essential amino acids.

Example: Valine, Leucine.

**Non-essential acids :** The amino acids, which can be synthesised in the body are known as non-essential amino acids.

**Example :** Alanine, Aspartic acid.

## CBSE 2009

**Sol.1** Do not react with schiff's base and $NaHSO_3$.

**Sol.2** During denaturation, 2° and 3° structures of proteins are destroyed but 1° structure remains intact. Due to denaturation, the globular proteins (soluble in $H_2O$) are converted into fibrous proteins (insoluble in $H_2O$) and their biological activity is lost. For example, boiled egg which contains coagulated proteins cannot be hatched.

**Sol.3** DNA contains four bases viz adenine (A), guanine (G), cytosine (C) and thymine (T). RNA also contains four bases, first three bases are same as in DNA but the fourth one is uracil (U).

**Sol.4**

| ADKE | Source | Diseases |
|---|---|---|
| A | Fish liver oil carrots, butter and milk | Xerophthalmia and night blindness |
| B | Exposure to sunlegth, Fist and egg yolk | Rickets, Osteomalacia |
| C | Vegetable oils like wheat gram oil, sunflower oil, etc | Increased fragility of RBCs and mustular weakness |
| D | Green leafy vegetables | Increased blood clotting time |