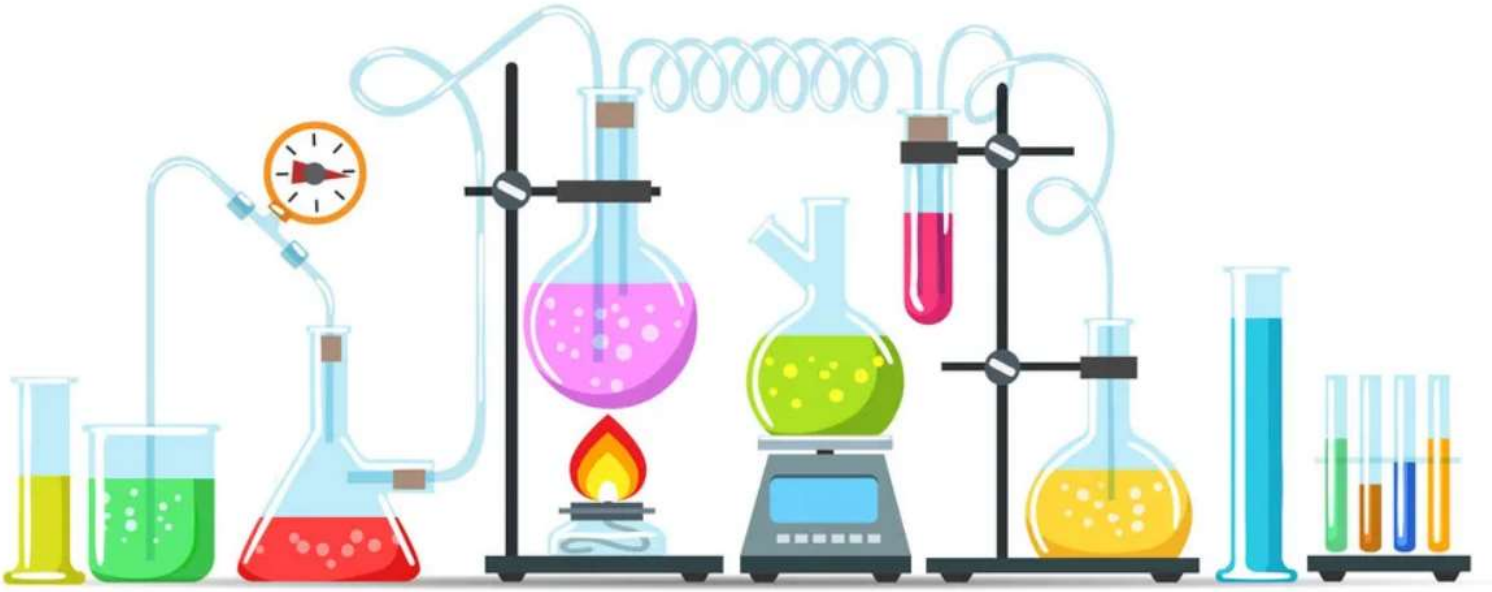
CHEMISTRY



BIOMOLECULES

Introduction:

In this Unit, Structures and functions of some of biomolecules will be discuss. The structure and functions of biomolecules inside the living being is studied in biochemistry. Living systems are made up of various complex biomolecules such as carbohydrates, proteins, enzymes, lipids, vitamins, hormones, nucleic acids and compounds for storage and exchange of energy such as ATP, etc.

Carbohydrates:

Classification of Carbohydrates

On the basis of their behaviour upon hydrolysis, carbohydrates can be divided into three main groups :

i. **Monosaccharides :** A carbohydrate which cannot be hydrolyzed into simpler unit of polyhydroxy aldehyde or ketone is called monosaccharide. About 20 monosaccharides are known to occur in nature. e.g., glucose, fructose, ribose etc.

ii. **Oligosaccharides :** A carbohydrate which upon hydrolysis yields 2–10 unit of monosaccharide is called oligosaccharide. They are further classified as disaccharides, trisaccharides, etc., depending upon the number of monosaccharides, they provide on hydrolysis. For example, sucrose is a disaccharide which on hydrolysis yields two unit of monosaccharides i.e., glucose and fructose whereas raffinose is a trisaccharide which on hydrolysis yields three unit of monosaccharides i.e., glucose, fructose and galactose.

iii. **Polysaccharides:** A high molecular mass carbohydrate which upon hydrolysis yields a large number of monosaccharide units is called polysaccharide e.g., starch, cellulose, glycogen, gums, etc.

$(C_6H_{10}O_5)_n + nH_2O \longrightarrow nC_6H_{12}O_6$

Sugar and non-sugars : In general monosaccharides and oligosaccharides, are crystalline solids, soluble in water and sweet to taste, are collectively known as **sugars**. The polysaccharides, on the other hand, are amorphous insoluble in water and tasteless, are known as **non-sugars**.

Reducing and non-reducing carbohydrates : The carbohydrates containing free aldehydic or ketonic group can reduce Fehling's solution and Tollen's reagent are known as **reducing** carbohydrates. All monosaccharides whether aldose or ketose are reducing in nature. The carbohydrates in which the reducing parts are not free cannot reduce Fehling's solution and

Tollen's reagent are known as **non-reducing** carbohydrates. All polysaccharides like starch, cellulose, glycogen etc. are non-reducing carbohydrates.

i. Monosaccharides

If a monosaccharide contains an aldehyde group, it is known as an aldose and if it contains a keto group, it is known as a ketose.

Carbon atoms	General term	Aldehyde	Ketone
3	Triose	Aldotriose	Ketotriose
4	Tetrose	Aldotetrose	Ketotetrose
5	Pentose	Aldopentose	Ketopentose
6	Hexose	Aldohexose	Ketohexose
7	Heptose	Aldoheptose	Ketoheptose

Glucose

Glucose occurs in nature in free as well as in the combined forms. It is present in sweet fruits and honey. Ripe grapes contain ~20% of glucose.

Preparation of Glucose

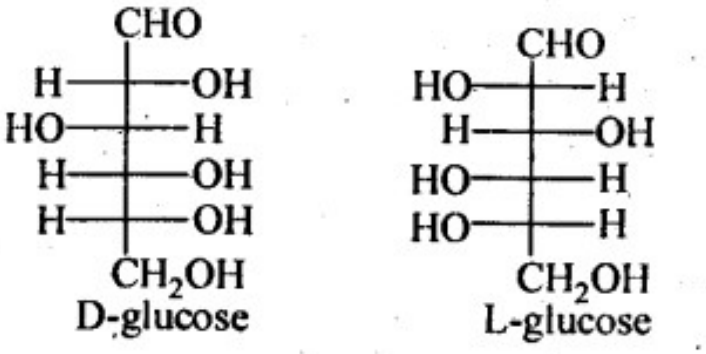
1. **From Sucrose (Cane Sugar)**: When sucrose is boiled with dilute HCl or H_2SO_4 in alcoholic solution, glucose and fructose are obtained in equimolar proportion.

$$C_{12}H_{22}O_{11} + H_2O \longrightarrow C_6H_{12}O_6 + C_6H_{12}O_6$$

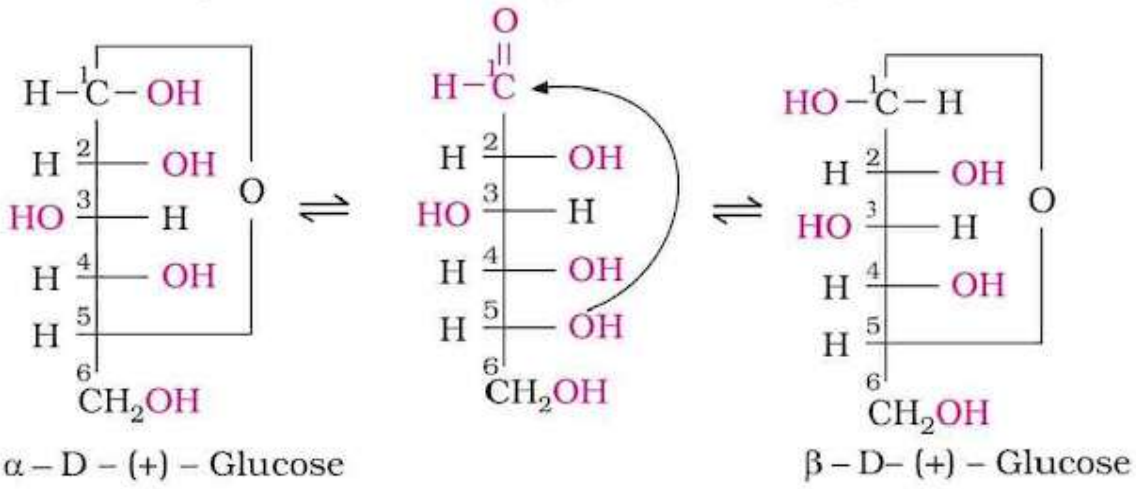
2. **From Starch :** When starch is boiled with dilute H_2SO_4 at 393 K under pressure, glucose is obtained. This is the commercial method for the preparation of glucose.

$$(C_6H_{10}O_5)n + nH_2O \longrightarrow nC_6H_{12}O_6$$

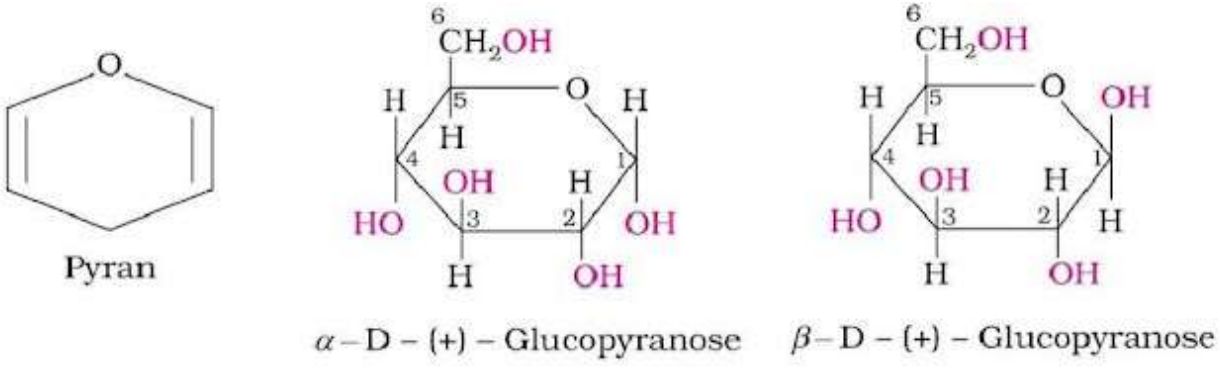
Structure of Glucose: Glucose is an aldohexose and is the monomer of many larger carbohydrates like starch, cellulose etc. It is the most abundant organic compound on the Earth.



Cyclic Structure of Glucose: It was proposed that glucose can form a six-membered ring in which –OH at C-5 can add to the –CHO group and can form a cyclic hemiacetal structure. This explains the absence of –CHO group and also the existence of glucose in α and β-anomeric forms as

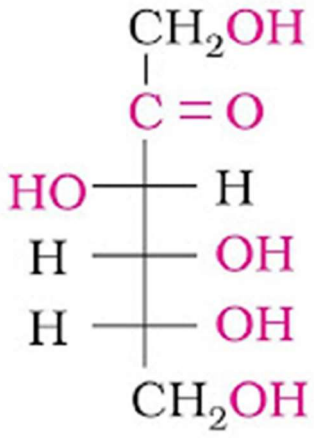


The two cyclic hemiacetal forms of glucose differ only in the configuration of the hydroxyl group at C-1, called anomeric carbon and the corresponding α and β-forms are called anomers. It should be noted that α and β-forms of glucose are not mirror images of each other, hence are not enantiomers.



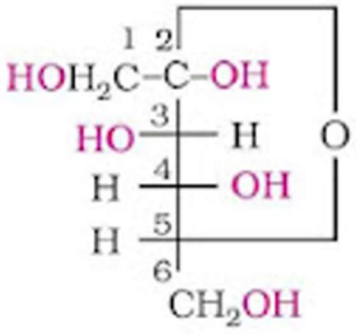
Fructose

Fructose is an important ketohexose. It is obtained by the hydrolysis of sucrose. On the basis of molecular weight determination, elemental analysis and various reaction its molecular formula is found to be $C_6H_{12}O_6$ and open chain structure of it can be written as

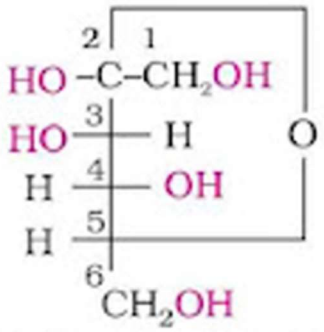


D-(—)-Fructose

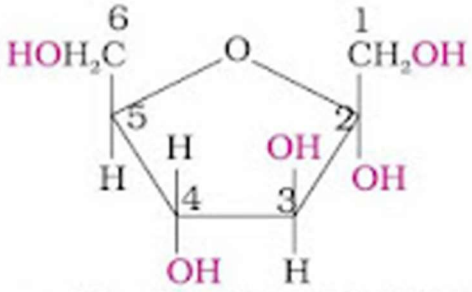
Fructose also exists in two cyclic forms like glucose i.e., α-D-(–) - fructose and β-D- (–) - fructose. The five membered cyclic structure of fructose is formed by the involvement of –OH at C-5 and carbonyl group. The five-membered ring of fructose is named as furanose with analogy to the compound furan.



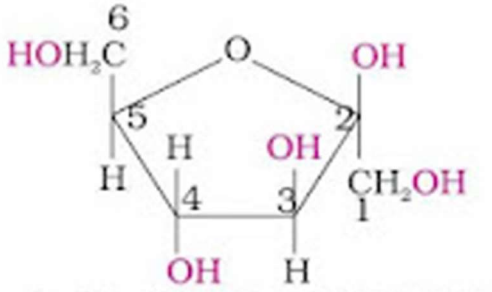
α – D – (–) – Fructofuranose



β – D – (–) – Fructofuranose



α – D – (–) – Fructofuranose



β – D – (–) – Fructofuranose

ii. **Disaccharides**

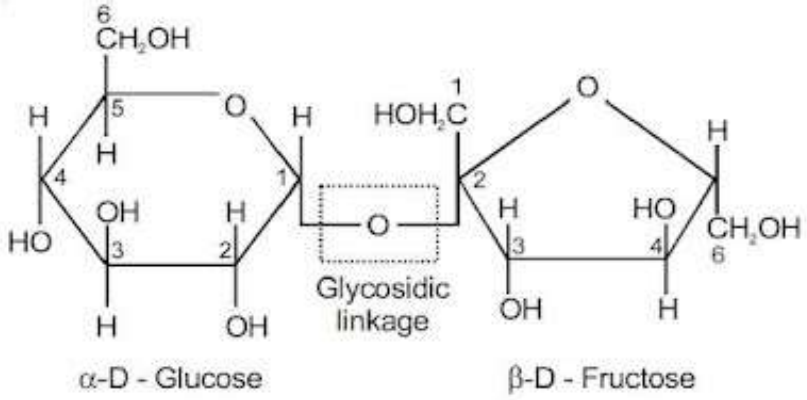
The disaccharides are composed of two units of monosaccharides. On hydrolysis with dilute acids or specific enzymes they give the corresponding monomers.

$$C_{12}H_{22}O_{11} + H_2O \longrightarrow C_6H_{12}O_6 + C_6H_{12}O_6$$

In disaccharides the two monosaccharides units are joined together by an oxide linkage formed by the loss of a water molecule and the linkage is known as glycosidic linkage.

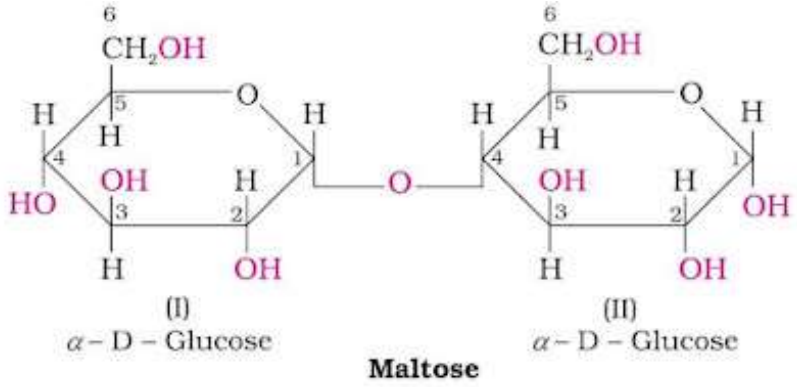
a) Sucrose

Sucrose is formed by the glycosidic linkage between C-1 of α-D-(+)-glucose and C-2 of β-D-(–) fructose:



b) Maltose

Maltose is formed by the glycosidic linkage between C-1 of one glucose unit to the C-4 of another glucose unit.



c) Lactose

Lactose is found in milk so it is also known as milk sugar. It is formed by the glycosidic linkage between C-1 of α-D-galactose unit and C-4 of β-D-glucose unit. Lactose is a reducing sugar.

iii. Polysaccharides

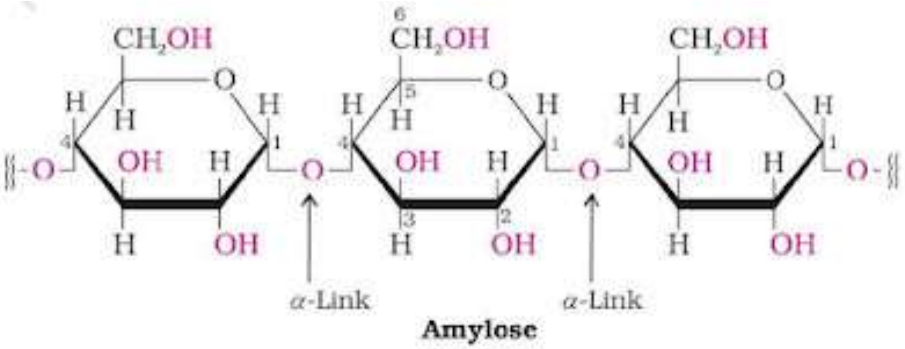
Polysaccharides are long chain polymer of monosaccharides joined together by glycosidic linkages. For example, starch, cellulose, glycogen etc. They mainly act as the food storage or

structural materials.

Starch $(C_6H_{10}O_5)n$

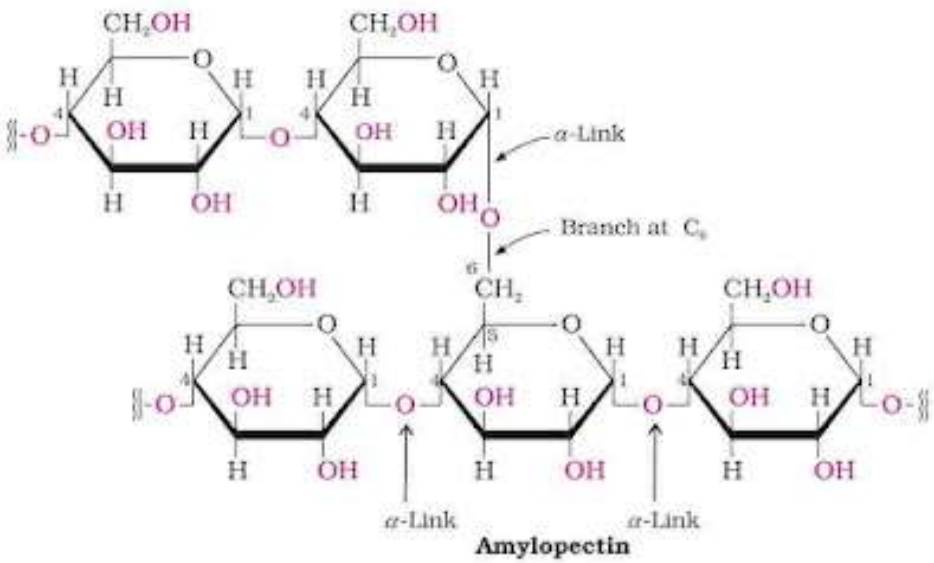
Starch is the main storage polysaccharide of plants. High content of starch is found in cereals, roots, tubers and some vegetables. Starch is a polymer of α-D-(+) Glucose coming of two components namely Amylose and Amylopectin.

Amylose is water soluble component, which constitutes about 15 - 20% of starch. It is a straight chain polysaccharide containing α-D-(+)-glucose units joined together by β-glycosidic linkage involving C-1 of one glucose unit and C-4 of the next.



Amylose

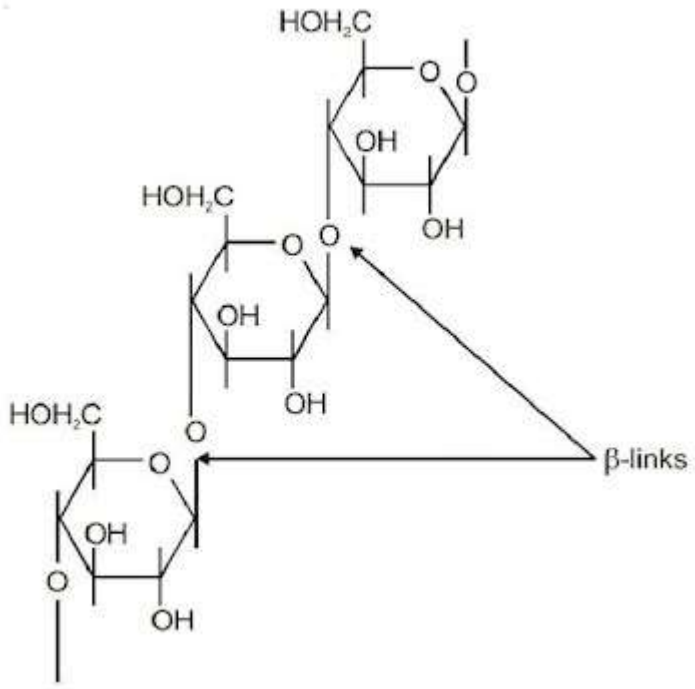
Amylopectin is a branched chain polysaccharide insoluble in water. It constitutes about 80 – 85% starch. It is a branched chain polymer of α-D-glucose units in which chain is formed by C-1 - C-4 glycosidic linkage whereas branching occurs by C-1 – C-6 glycosidic linkage.



Amylopectin

Cellulose

Cellulose is a straight chain polysaccharide composed of only β-D-glucose units. In cellulose there is β-glycosidic linkages between C-1 of one glucose unit and C-4 of the next glucose unit. Cellulose occurs mainly in plants and it is the most abundant organic substance in plant kingdom.



Glycogen

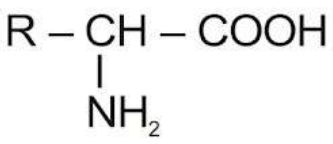
Its structure is similar to amylopectin with more branching than in amylopectin. It is also known as animal starch. In body, carbohydrates are stored as glycogen and when the body needs glucose, enzymes break the glycogen down to glucose. **Glycogen** is present in liver, muscle and brain.

Note : Carbohydrates are essential for life in both plants and animals. Carbohydrates are stored in plant as starch and in animals as glycogen.

Proteins:

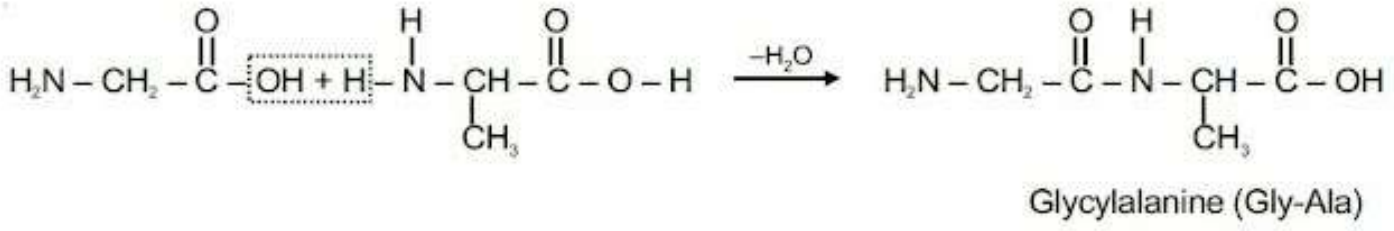
Proteins are high molecular mass complex biopolymer of α-amino acids present in all living cells. They occur in every part of the body and form the fundamental basis of structure and functions of life. The term **protein** is derived from the Greek word "proteios" which means of prime importance. Proteins are the most abundant biomolecules of the living system. Chief sources of proteins are milk, cheese, pulses, peanuts, fish etc.

Amino Acids : The compound containing $-NH_2$ and –COOH functional groups are known as amino acid, depending upon the relative position of $-NH_2$ group with respect to –COOH group, amino acids are classified into α, β, γ, δ and so on amino acid. Hydrolysis of proteins gives only α-amino acids represented as



Essential and non-essential amino acids : The amino acids which cannot be synthesized in the body are known as essential amino acids which must be taken through diet. The amino acids, which can be synthesized in the body are known as non-essential amino acids.

Peptides : When amino acids are joined together by amide bonds, they form larger molecules called **peptides** and **proteins**.



Glycylalanine (Gly-Ala)

Polypeptide : A dipeptide contains two amino acids linked by one peptide linkage, a tripeptide contains three amino acids linked by two peptide linkages and so on. When number of such amino acids is more than ten, then the products are called **polypeptides**.

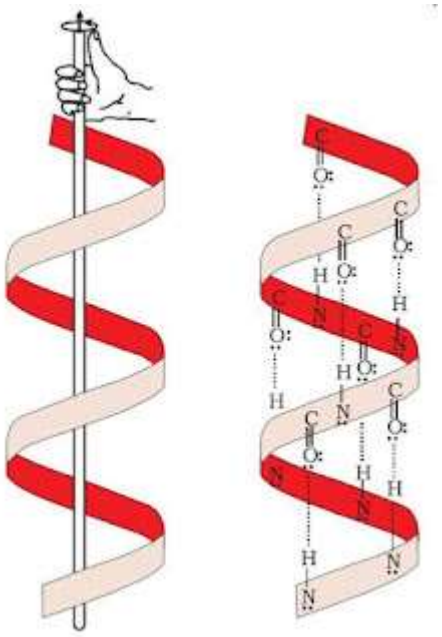
Classification of Protein

On the basis of molecular shape, proteins are classified into two types :

1) **Fibrous Proteins :** When the polypeptide chains run parallel and are held together by hydrogen and disulphide bonds, then fibre-like structure is formed, known as fibrous proteins. Such proteins are insoluble in water. For example: Keratin, Myosin etc.
2) **Globular Proteins :** When the polypeptide chains coil around to give a spherical shape, the formation of globular protein takes place. Such proteins are usually soluble in water. For example : Insulin, Albumins etc.

Primary, Secondary, Tertiary & Quaternary Structures of Proteins :

1) **Primary Structure :** Proteins may have one or more polypeptide chains. Each polypeptide in a protein has amino acids linked with each in a specific sequence and it is this sequence of amino acids that is said to be the primary structure of that protein.
2) **Secondary Structure :** The secondary structure of protein refers to the shape in which a long polypeptide chain can exist. They are found to exist in two different types of structure namely α-helix and β-pleated sheet structure.



3) **Tertiary Structure :** The tertiary structure of proteins represents overall folding of the polypeptide chains i.e., further folding of secondary structure. It gives rise to two major molecular shapes namely fibrous and globular.

4) **Quaternary Structure :** Some of the proteins are composed of two or more polypeptide chains referred to as sub units. The spatial arrangement of these subunits with respect to each other is known as quaternary structure.

Denaturation of Proteins : The loss in biological activity of a protein due to unfolding of globules and uncoiling of helix is called denaturation of protein. During denaturation secondary and tertiary structures are destroyed but primary structure remains intact. The coagulation of egg white on boiling is a common example of denaturation.

Enzymes:

Colloidal solution of protein which works as biological catalyst is known as enzyme. All enzymes are globular proteins. Zymase, Invertase, Maltase, Lactase, Emulsin, Urease, Pepsin, Trypsin, α-Amylase etc are the example of **enzyme**.

Note : The enzymes work best at an optimum temperature range of 298 K to 313 K. Their activity decreases with decrease or increase in temperature and stops at 273 K.

Vitamins:

Vitamins are organic compounds which are essential for normal growth of life for animals, some bacteria and micro organism. Vitamins are not synthesized by animals (except vitamin D). Vitamins are supplied to the organism through food. They are essential dietary factor.

Classification

Vitamins are classified in two categories :

1) **Water Soluble Vitamins :** Vitamin-B-complex and vitamin-C are water soluble.
2) **Fat Soluble Vitamins :** Vitamin-A (Retinol), Vitamin-D (Calciferol), Vitamin-E (Tocopherol), Vitamin-K (Phylloquinone).

Nucleic Acid:

The particles in nucleus of the cell, responsible for heredity are called chromosomes which are made up of proteins and another type of biomolecules called **nucleic acid**. These are natural biopolymers made of nucleotide units i.e., polynucleotides. **Nucleic acid** contain the elements carbon, oxygen, nitrogen and phosphorous.

Hormones:

Hormones are molecules that act as intercellular messengers. These are produced by endocrine glands in the body and are poured directly in the blood stream which transports them to the site of action. Hormones have several functions in the body. They help to maintain the balance of biological activities in the body. **Testosterone** is the major sex hormone produced in males.

MIND MAP : LEARNING MADE SIMPLE

CHAPTER - 14

Biomolecules

Proteins

(Polymers of α–amino acids)
Amino acids contain $–NH_2$ and –COOH group.

Classification:

- On the basis of relative number of $–NH_2$ and –COOH group
  - (I) Neutral–equal number of $–NH_2$ and –COOH group.
  - (ii) Basic – more number of $–NH_2$ than –COOH group.
  - (iii) Acidic – more number of –COOH than $–NH_2$ group.
- On the basis of place of synthesis
  - (i) Essential – cannot be synthesized in the body.
  - (ii) Non-essential – synthesized in the body.
- On the basis of shape
  - (I) Fibrous – fibre –linke structure
  - (ii) Globular – spherical

Structure : $H_2N – CH_2 –$ [CO–NH] (Peptide linkage) $– CH(CH_3) –COOH$

Denaturation of proteins :
When a protein in its native form is subjected to physical change, globules unfold, helix get uncoiled and protein loses its biological activity.

Carbohydrates

Optically active polyhydroxy aldehydes or ketones or compounds which produce such units on hydrolysis.

- **Classification:**

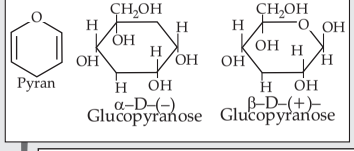
(I) Monosaccharides : (Aldehyde group – aldose, keto group –ketose)
Glucose : Preparation :

(a) From sucrose : $C_{12}H_{22}O_{11} + H_2O \xrightarrow{H^+} C_6H_{12}O_6 + C_6H_{12}O_6$
Sucrose → Glucose + Fructose

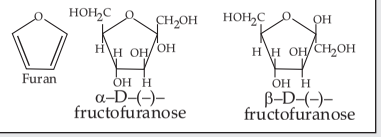
(b) From starch : $(C_6H_{10}O_5)n + nH_2O \xrightarrow[393K;\ 2\text{-}3\ atm]{H^+} nC_6H_{12}O_6$

- **Structure:** CHO–(CHOH)$_4$–CH$_2$OH

Cylcic Structure



Structure of Fructose



CHO–(CHOH)$_4$–CH$_2$OH reacts with:

- HI, Δ → $CH_3CH_2CH_2CH_2CH_3$
- NH_2OH → CH=N–OH, (CHOH)$_4$, CH$_2$OH
- HCN → CH(CN)(OH), (CHOH)$_4$, CH$_2$OH
- Br_2 Water → COOH, (CHOH)$_4$, (CH$_2$OH)
- Acetic Anhydride → CHO, (CH–O–C(=O)–CH$_3$)$_4$, CH$_2$–O–C(=O)–CH$_3$
- Oxidation → COOH, (CHOH)$_4$, COOH

(ii) Disaccharides : Linkage between 2 monosaccharides– Glycosidic linkage (Sucrose, maltose)
(iii) Polysaccharides : Large number of monosaccharides units joined by glycosidic linkages.
(a) Starch : Polymer of α–glucose with two components amylase and amylopectin
(b) Cellulose
(c) Glycogen

Importance:

- Form a major portion of food.
- As storage molecules.
- Cellulose forms cell wall of bacteria and plants.
- Raw materials for industries like textiles, paper, lacquers and breweries.

Vitamins

Organic compounds required in diet in small amounts to perform specific biological functions for maintenance and growth.

Classification:
(i) Fat soluble : Soluble in fats and oils but insoluble in water. (vitamins A,D,E and K)
(ii) Water soluble : B group and vitamin C are soluble in water.

Nucleic Acids

Chromosomes : Particles in nucleus responsible for heredity. Chromosomes are made up of proteins and nucleic acid.
Two types : Deoxyribonucleic acid (DNA), ribonucleic acid (RNA)
Composition : In DNA, sugar is β–D–2–deoxyribose whereas in RNA is β–D–ribose. DNA contains A,G,C,T whereas RNA has A,G,C,U.
Structure : –
Nucleoside : Formed by attachment of a base to 1′ of sugar′
Nucleotide : Formed by link to phosphoric acid at 5′ of sugar.

Base / Base / Base
–Sugar–Phosphate–[Sugar–Phosphate]–Sugar–

Types of RNA : m–RNA, r–RNA, t–RNA

Biological Functions :

- Chemical basis of heredity.
- Responsible for identity of different species of organisms.
- Nucleic acids are responsible for protein synthesis in cell.

DNA Fingerprinting: Unique sequence of bases on DNA.

Enzymes

Globular proteins specific for particular reaction and for particular substrate. Mechanism : Reduces the magnitude of activation energy

Important Questions

Multiple Choice questions-

1.The linkage which holds various amino acid units in primary structure of proteins is

(a) glycosidic linkage
(b) hydrogen bond
(c) peptide linkage
(d) ionic bond

2. Vitamin A is called

(a) Ascorbic acid
(b) Retinol
(c) Calciferol
(d) Tocoferol

3.The deficiency of vitamin B1 causes which disease?

(a) Beriberi
(b) Rickets
(c) Anaemia
(d) Xerosis

4.Deficiency of vitamin C causes

(a) Scurvy
(b) Rickets
(c) Anaemia
(d) None of these

5.An example of non-reducing sugar is

(a) Sucrose
(b) Lactose
(c) Maltose
(d) None

6.Which of the following is not an essential amino acid?

(a) Glycine
(b) Lysine
(c) Phenyl alanine
(d) Valine

7.Which of the following is a water-soluble vitamin?

(a) Vitamin E

(b) Vitamin K
(c) Vitamin B
(d) Vitamin A

8. Vitamin B1 is

(a) Riboflavin
(b) Cobalamin
(c) Thiamine
(d) Pyridoxine

9. Which is sweetest of the following:

(a) Sucrose
(b) Glucose
(c) Fructose
(d) Maltose

10. Rickets may be caused by the deficiency of which vitamin?

(a) Vitamin D
(b) Vitamin C
(c) Vitamin A
(d) Vitamin B

Very Short Question:

1. Give some examples of bimolecules
2. What are carbohydrates?
3. Give one example of each- Monosaccharide, disaccharide and polysaccharide
4. Which disaccharides are non – reducing sugars?
5. Classify the following as monosaccharides disaccharides and polysaccharides Glucose, Sucrose, maltose, ribose, glycogen, lactose, fructose.
6. What is the meaning of statement- Glucose is an aldohexose.
7. Why are polysaccharides considered non- sugars?
8. Give two examples of reducing sugars.
9. Which sugar is present in milk?
10. Name the reagents used to check the reducing nature of carbohydrates.

Short Questions:

1. What are the expected products of hydrolysis of lactose?
2. The melting points and solubility in water of amino acids are generally higher than that of the corresponding halo acids. Explain.

3. 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?
4. What are monosaccharides?
5. What do you understand by the term glycosidic linkage?
6. What are the hydrolysis products of (i)sucrose and (ii)lactose?
7. What happens when D-glucose is treated with the following reagents?
8. Enumerate the reactions of D-glucose which cannot be explained by its open chain structure.
9. Differentiate between globular and fibrous proteins.
10. How do you explain the amphoteric behavior of amino acids?

Long Questions:

1. How do you explain the absence of aldehyde group in the pentaacetate of D-glucose?
2. What is the basic structural difference between starch and cellulose?
3. Define the following as related to proteins
4. What are the common types of secondary structure of proteins?
5. Write the important structural and functional differences between DNA and RNA.

Assertion and Reason Questions:

1. In these questions, a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

a) Assertion and reason both are correct statements and reason is correct explanation for assertion.

b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

c) Assertion is correct statement but reason is wrong statement.

d) Assertion is wrong statement but reason is correct statement.

Assertion: Uracil occurs in DNA.

Reason: DNA undergoes replication.

2. In these questions, a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

a) Assertion and reason both are correct statements and reason is correct explanation for assertion.

b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

c) Assertion is correct statement but reason is wrong statement.

d) Assertion is wrong statement but reason is correct statement.

Assertion: Cysteine can cross link peptide chains.

Reason: Amino acids are classified as essential and non-essential amino acids.

Case Study Questions:

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

When a protein in its native form, is subjected to physical changes like change in temperature or chemical changes 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.

The denaturation causes change in secondary and tertiary structures but primary structures remains intact. Examples of denaturation of protein are coagulation of egg white on boiling, curdling of milk, formation of cheese when an acid is added to milk.

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

(i) Mark the wrong statement about denaturation of proteins.

a) The primary structure of the protein does not change.
b) Globular proteins are converted into fibrous proteins.
c) Fibrous proteins are converted into globular proteins.
d) The biological activity of the protein is destroyed.

(ii) Which structure(s) of proteins remains(s) intact during denaturation process?

a) Both secondary and tertiary structures.
b) Primary structure only.
c) Secondary structure only.
d) Tertiary structure only.

(iii) α-helix and β-pleated structures of proteins are classified as:

a) Primary structure.
b) Secondary structure.
c) Tertiary structure.
d) Quaternary structure.

(iv) Cheese is a:

a) Globular protein.
b) Conjugated protein.
c) Denatured protein.
d) Derived protein.

(v) Secondary structure of protein refers to:

a) Mainly denatured proteins and structure of prosthetic groups.
b) Three-dimensional structure, especially the bond between amino acid residues that are distant from each other in the polypeptide chain.
c) Linear sequence of amino acid residues in the polypeptide chain.

d) Regular folding patterns of continuous portions of the polypeptide chain.

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

Carbohydrates are polyhydroxy aldehydes and ketones and those compounds which on hydrolysis give such compounds are also carbohydrates. The carbohydrates which are not hydrolysed are called monosaccharides. Monosaccharides with aldehydic group are called aldose and those which free ketonic groups are called ketose. Carbohydrates are optically active. Number of optical isomers = 2^n

Where n = number of asymmetric carbons. Carbohydrates are mainly synthesised by plants during photosynthesis. The monosaccharides give the characteristic reactions of alcohols and carbonyl group (aldehydes and ketones). It has been found that these monosaccharides exist in the form of cyclic structures. In cyctization, the -OH groups (generally C_5 or C_4 in aldohexoses and C_5 or C_6 in ketohexoses) combine with the aldehyde or keto group. As a result, cyclic structures of five or six membered rings containing one oxygen atom are formed, e.g., glucose forms a ring structure. Glucose contains one aldehyde group, one IO alcoholic group and four 2° alcoholic groups in its open chain structure.

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

(i) First member of ketos sugar is:

a) Ketotriose.
b) Ketotetrose.
c) Ketopentose.
d) Ketohexose.

(ii) In $CH_2OHCHOHCHOHCHOHCHOHCHO$, the number of optical isomers will be:

a) 16
b) 8
c) 32
d) 4

(iii) Some statements are given below:

1. Glucose is aldohexose.
2. Naturally occurring glucose is dextrorotatory.
3. Glucose contains three chiral centres.
4. Glucose contains one 1° alcoholic group and four 2° alcoholic groups.

Among the above, correct statements are:

a) 1 and 2 only
b) 3 and 4 only
c) 1, 2 and 4 only
d) 1, 2, 3 and 4

(iv) Two hexoses fonn the same osazone, find the correct statement about these hexoses.

a) Both of them must be aldoses.
b) They are epimers at C-3.

c) The carbon atoms I and 2 in both have the same configuration.

d) The carbon atoms 3, 4 and 5 in both have the same configuration.

(v) Which of the following reactions of glucose can be explained only by its cyclic structure?

a) Glucose forms cyanohydrin with HCN.
b) Glucose reacts with hydroxylamine to form an oxime.
c) Pentaacetate of glucose does not react with hydroxylamine.
d) Glucose is oxidised by nitric acid to gluconic acid.

Answers key

MCQ answers:

1. Answer: (c) peptide linkage
2. Answer: (b) Retinol
3. Answer: (a) Beriberi
4. Answer: (a) Scurvy
5. Answer: (a) Sucrose
6. Answer: (a) Glycine
7. Answer: (c) Vitamin B
8. Answer: (c) Thiamine
9. Answer: (c) Fructose
10. Answer: (a) Vitamin D

Very Short Answers:

1. Examples of biomolecules –

   carbohydrates, proteins, Nucleic acids, Lipids, enzymes etc.

2. Carbohydrates are optically active polyhydroxy aldehydes or ketones or the compounds which produce such units on hydrolysis.
3. Answer:
   - Monosaccharide – Glucose, Fructose etc.
   - Disaccharide – Sucrose, maltose etc.
   - Polysaccharide – Cellulose, starch etc.
4. Answer: In disaccharides, if the reducing groups of monosaccharides, i.e. aldehydic or ketonic groups are bonded eg. In sucrose, these are non- reducing.
5. Answer:

Monosaccharide	Disaccharides	Polysaccharides

Glucose	Sucrose	Glycogen
Fructose	Maltose	
Ribose	Lactose	

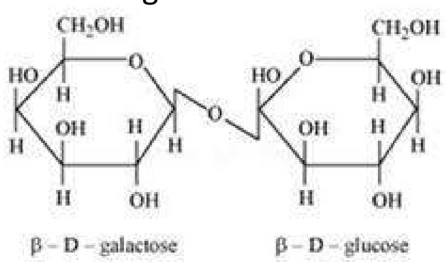
6. Glucose is an aldohexose means that it contains six carbon atoms and aldehyde group.
7. Answer: Polysaccharides are not sweet in taste & hence are called non – sugars.
8. Answer: Examples of reducing sugars: Maltose and Lactose.
9. In milk, lactose is present.
10. Tollen’s reagent and Fehlings solution can be used to check reducing nature of sugars.

Short Answers:

1. **Answer**

Lactose is composed of β-D-galactose and β-D-glucose. Thus, on hydrolysis, it gives β-D-galactose

and β-D-glucose.

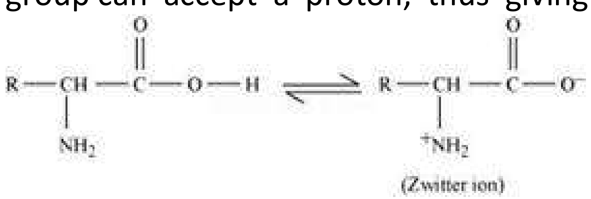


Lactose

$$\underset{\text{Lactose}}{C_{12}H_{22}O_{11}} + H_2O \rightarrow \underset{\text{D-(+)-Glucose}}{C_6H_{12}O_6} + \underset{\text{D-(+)-Galactose}}{C_6H_{12}O_6}$$

2. **Answer:**

Both acidic (carboxyl) as well as basic (amino) groups are present in the same molecule of amino acids. In aqueous solutions, the carboxyl group can lose a proton and the amino group can accept a proton, thus giving rise to a dipolar ion known as a zwitter ion.



Due to this dipolar behaviour, they have strong electrostatic interactions within them and with water. But halo-acids do not exhibit such dipolar behaviour. For this reason, the melting points and the solubility of amino acids in water is higher than those of the corresponding halo-acids.

3. **Answer:**

A DNA molecule is double-stranded in which the pairing of bases occurs. Adenine always pairs with thymine, while cytosine always pairs with guanine. Therefore, on hydrolysis of

DNA, the quantity of adenine produced is equal to that of thymine and similarly, the quantity of cytosine is equal to that of guanine.

But when RNA is hydrolyzed, there is no relationship among the quantities of the different bases obtained. Hence, RNA is single-stranded.

4. Answer :

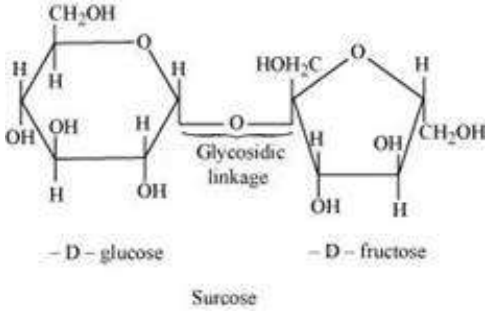
Monosaccharides are carbohydrates that cannot be hydrolysed further to give simpler units of polyhydroxy aldehyde or ketone.

Monosaccharides are classified on the bases of number of carbon atoms and the functional group present in them. Monosaccharides containing an aldehyde group are known as aldoses and those containing a keto group are known as ketoses. Monosaccharides are further classified as trioses, tetroses, pentoses, hexoses, and heptoses according to the number of carbon atomsthey contain. For example, a ketose containing 3 carbon atoms is called ketotriose and an aldose containing 3 carbon atoms is called aldotriose.

5. Answer

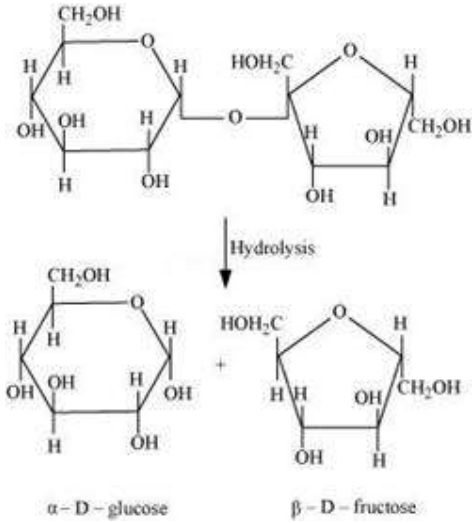
Glycosidic linkage refers to the linkage formed between two monosaccharide units through an oxygen atom by the loss of a water molecule.

For example, in a sucrose molecule, two monosaccharide units, α-glucose and β-fructose, are joined together by a glycosidic linkage.

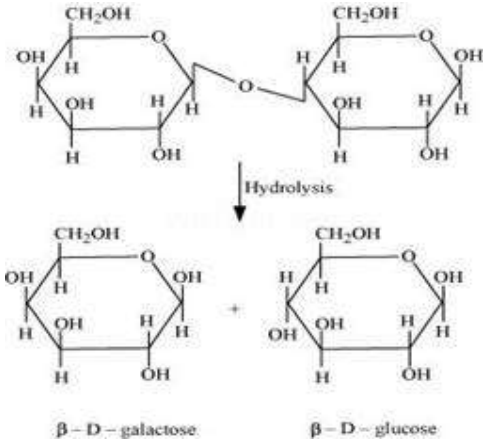


6. Answer:

(i) On hydrolysis, sucrose gives one molecule of α-D glucose and one molecule of β-fructose.

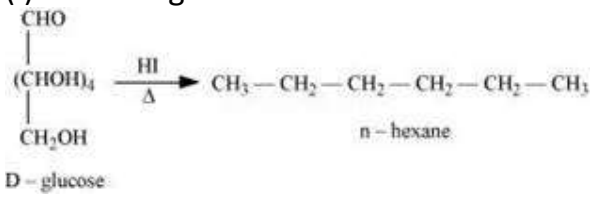


(ii) The hydrolysis of lactose gives β-galactose and β-glucose.

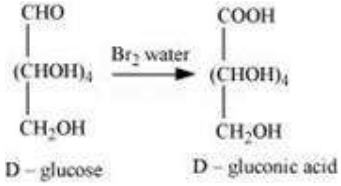


7. Answer:

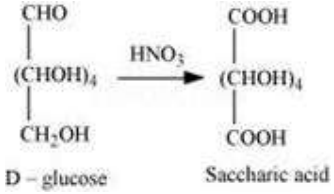
(i) When D-glucose is heated with HI for a long time, n-hexane is formed.



(ii) When D-glucose is treated with Br_2 water, D- gluconic acid is produced.



(iii) On being treated with HNO_3, D-glucose get oxidised to give saccharic acid.



8. Answer :

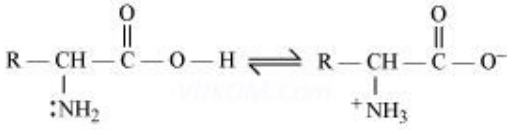
(1) Aldehydes give 2, 4-DNP test, Schiff's test, and react with $NaHSO_4$ to form the hydrogen sulphite addition product. However, glucose does not undergo these reactions.
(2) The pentaacetate of glucose does not react with hydroxylamine. This indicates that a free -CHO group is absent from glucose.
(3) Glucose exists in two crystalline forms – α and β. The α form (m.p. = 419 K) crystallises from a concentrated solution of glucose at 303 K and the β form (m.p = 423 K) crystallises from a hot and saturated aqueous solution at 371 K. This behavior cannot be explained by the open chain structure of glucose.

9. Answer :

	Fibrous protein		Globular protein
1.	It is a fibre-like structure formed by the polypeptide chain. These proteins are held together by strong hydrogen and disulphide bonds.	1.	The polypeptide chain in this protein is folded around itself, giving rise to a spherical structure.
2.	It is usually insoluble in water.	2.	It is usually soluble in water.
3.	Fibrous proteins are usually used for structural purposes. For example, keratin is present in nails and hair; collagen in tendons; and myosin in muscles.	3.	All enzymes are globular proteins. Some hormones such as insulin are also globular proteins.

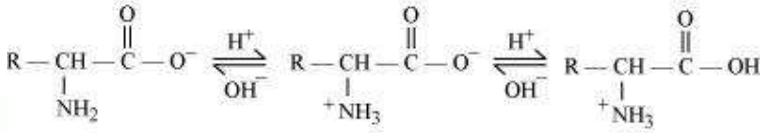
10.Answer:

I n aqueous solution, the carboxyl group of an amino acid can lose a proton and the amino group can accept a proton to give a dipolar ion known as zwitter ion.



Zwitter ion

Therefore, in zwitter ionic form, the amino acid can act both as an acid and as a base.

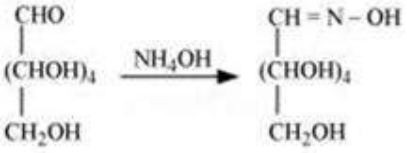


Thus, amino acids show amphoteric behaviour.

Long Answers:

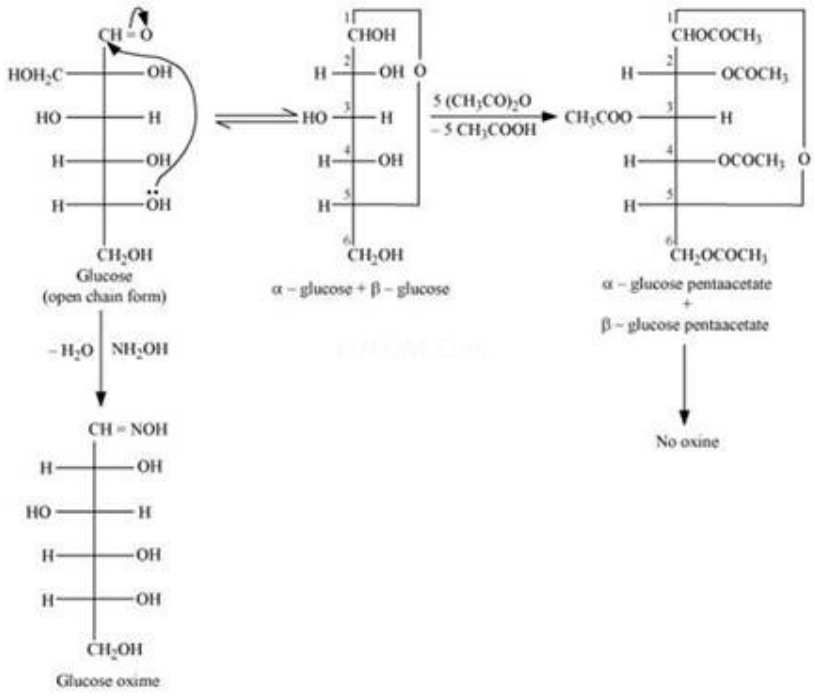
1. **Answer:**

D-glucose reacts with hydroxylamine(NH_2OH) to form an oxime because of the presence of aldehydic (-CHO) group or carbonyl carbon. This happens as the cyclic structure of glucose forms an open chain structure in an aqueous medium, which then reacts with NH_2OH to give an oxime.



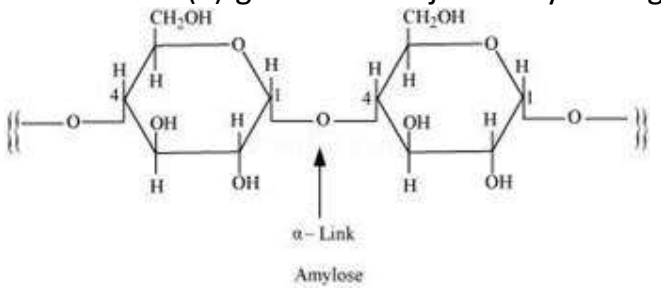
Glucose Oxime

But pentaacetate of D-glucose does not react with NH_2OH. This is because pentaacetate does not form an open chain structure.

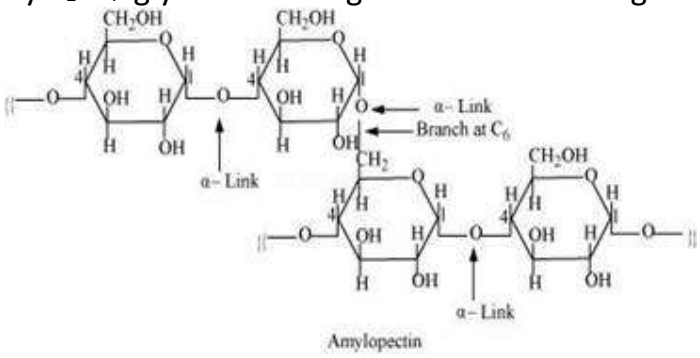


2. Answer:

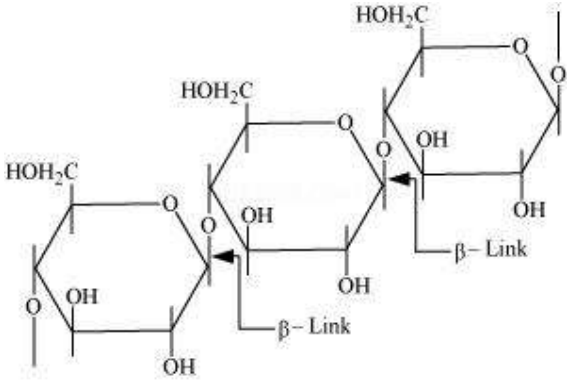
Starch consists of two components – amylose and amylopectin. Amylose is a long linear chain of∝-D-(+)-glucose units joined by C_1-C_4 glycosidic linkage (∝--link).



Amylopectin is a branched-chain polymer of ∝-D-glucose units, in which the chain is formed by C_1-C_4 glycosidic linkage and the branching occurs by C_1-C_6 glycosidic linkage.



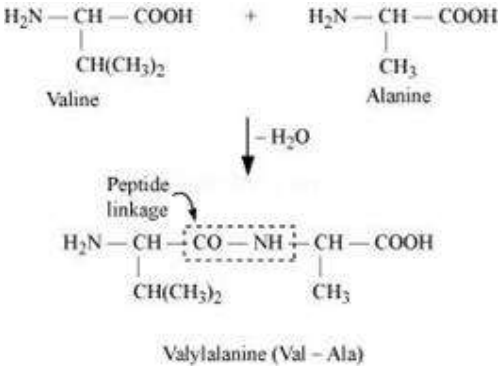
On the other hand, cellulose is a straight-chain polysaccharide of β -D-glucose units joined by C_1-C_4 glycosidic linkage (β -link).



3. Answer:

(i) Peptide linkage:

The amide formed between -COOH group of one molecule of an amino acid and -NH_2 group of another molecule of the amino acid by the elimination of a water molecule is called a peptide linkage.



(ii) Primary structure:

The primary structure of protein refers to the specific sequence in which various amino acids are present in it, i.e., the sequence of linkages between amino acids in a polypeptide chain. The sequence in which amino acids are arranged is different in each protein. A change in the sequence creates a different protein.

(iii) Denaturation:

In a biological system, a protein is found to have a unique 3-dimensional structure and a unique biological activity. In such a situation, the protein is called native protein. However, when the native protein is subjected to physical changes such as change in temperature or chemical changes such as change in pH, its H-bonds are disturbed. This disturbance unfolds the globules and uncoils the helix. As a result, the protein loses its biological activity. This loss of biological activity by the protein is called denaturation. During denaturation, the secondary and the tertiary structures of the protein get destroyed, but the primary structure remains unaltered.

One of the examples of denaturation of proteins is the coagulation of egg white when an egg is boiled.

4. Answer:

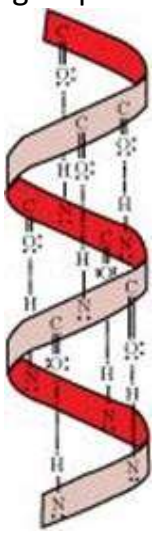
There are two common types of secondary structure of proteins:

(i) α-helix structure

(ii) β pleated sheet structure

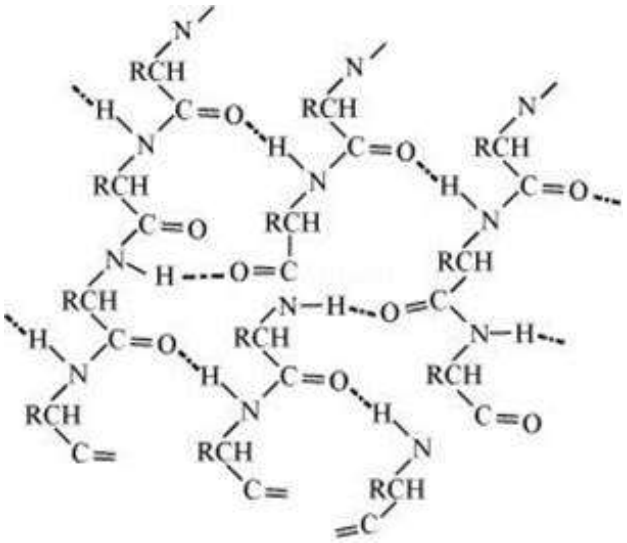
$\propto$– Helix structure:

In this structure, the -NH group of an amino acid residue forms H-bond with the $>C=O$ group of the adjacent turn of the right-handed screw ($\propto$-helix).



β pleated sheet structure:

This structure is called so because it looks like the pleated folds of drapery. In this structure, all the peptide chains are stretched out to nearly the maximum extension and then laid side by side. These peptide chains are held together by intermolecular hydrogen bonds.



5.Answer:

The structural differences between DNA and RNA are as follows:

	DNA		RNA
1.	The sugar moiety in DNA molecules is β -D-2 deoxyribose.	1.	The sugar moiety in RNA molecules is β -D-ribose.
2.	DNA contains thymine (T). It does not contain uracil (U).	2.	RNA contains uracil (U). It does not contain thymine (T).
3.	The helical structure of DNA is double –	3.	The helical structure of RNA is single-

	stranded.		stranded.

The functional differences between DNA and RNA are as follows:

	DNA		RNA
1	DNA is the chemical basis of heredity.	1	RNA is not responsible for heredity.
2	DNA molecules do not synthesise proteins, but transfer coded message for the synthesis of proteins in the cells.	2	Proteins are synthesised by RNA molecules in the cells.

Assertion and Reason Answers:

1. (d) Assertion is wrong statement but reason is correct statement.

Explanation:

Uracil occurs in RNA

2. (b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

Explanation:

Cysteine can cross link peptide chains through disulphide bridge. Cross linking by disulphide bridge can occur either between the distant, properly oriented parts of the same polypeptide chain (as in oxytocin or vasopressin) or between different polypeptide chains.

Case Study Answers:

1. Answer :

(i) (c) Fibrous proteins are converted into globular proteins.

(ii) (b) Primary structure only.

(iii) (b) Secondary structure.

(iv) (c) Denatured protein.

Explanation:

Cheese is a denatured protein.

(v) (d) Regular folding patterns of continuous portions of the polypeptide chain.

2. Answer :

(i) (a) Ketotriose.

(ii) (a) 16

(iii) (c) 1, 2 and 4 only

Explanation:

Glucose contains four chiral centres.

(iv) (d) The carbon atoms 3, 4 and 5 in both have the same configuration.

Explanation:

In the formation of osazone, C-1 and C-2 react with phenylhydrazine to form phenylhydrazone. If C-3, C-4, C-5 have same configuration they will form same osazone even if they differ in configuration at C-1 or C-2.

(v) (c) Pentaacetate of glucose does not react with hydroxylamine.

Explanation:

Pentacetate of glucose does not react with hydroxylamine showing absence of free -CHO group. This cannot be explained by open structure of glucose.