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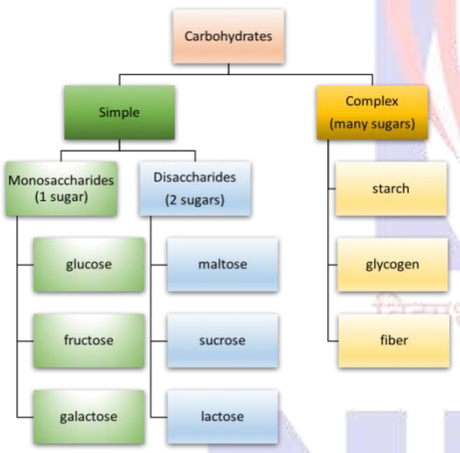
BIOMOLECULES

- Biomolecules are the organic compounds which form the basis of life, i.e., they build up the living system and responsible for their growth and maintenance. The sequence that relates biomolecules to living organism is:
  Biomolecules → Organelles → Cells → Tissues → Organs → Living organism

CARBOHYDRATES

- These are optically active polyhydroxy aldehydes or ketones or the compounds which produce these on hydrolysis.

Classification of Carbohydrates



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

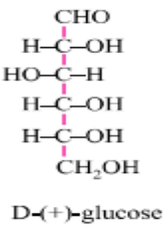
(ii) Disaccharides: Those carbohydrates which produces two monosaccharides on hydrolysis. ***E.g., sucrose, maltose and lactose.***

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

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

Structure of Monosaccharides

- Fischer structure: (+) glucose has 'D' configuration as shown:



D-(+)-glucose

- 'D'- means ñ 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.
- **Sugar:** Carbohydrates which are sweet in taste.

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

(ii) Non-reducing sugars: Those which do not reduce Fehlingís or Tollenís reagent. They do not have free aldehydic group. ***E.g., sucrose.***

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

Preparation:

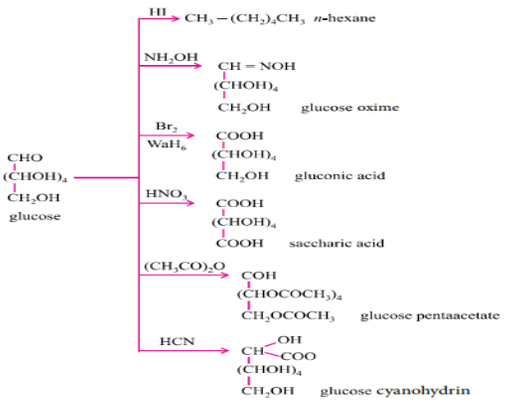
(i) From sucrose:

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

(ii) From starch:

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

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, Schiffís test and does not form the hydrogensulphide product with $NaHSO_3$.

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

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

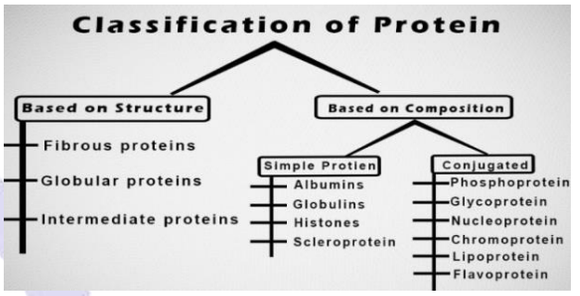
- After which a close chain (cyclic) structure of glucose was proposed by Haworth.
- ***Anomers*** are isomers which have a different configuration at C-1 functional group C-atom
- **Glycosidic linkage:** The linkage between two monosaccharide units through oxygen is called the glycosidic linkage.

PROTEINS

- These are macro molecules made up of amino acids joined by amide linkage $[-(-CONH-)-]$ is here called as peptide linkage. These are required for growth and development of the body.

- **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).

Classification of Proteins



	Description	Example
Globular Proteins	Roughly spherical; chemically active; water soluble	Hormones, enzymes, and antibodies
Fibrous Proteins	Long, regular, repeating shape; chemically stable; insoluble in water	Muscle proteins, cytoskeleton proteins, and collagen fibers
Conjugated Proteins	A protein bonded to a nonprotein molecule	Hemoglobin and glycoproteins

Structure of Proteins

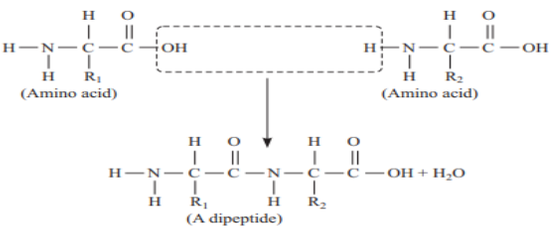


Table: Difference between Primary, Secondary, Tertiary and Quaternary Protein Structure

Primary structure	Secondary structure	Tertiary structure	Quaternary structure
The specific sequence of amino acids in the polypepide chain. Change in amino acids sequence changes the protein completely. They have covalent bonds.	It is the shape in which the long polypeptide chain can exist. It is of two types : α-helix and β-pleated. These structures arise due to regular folding of the backbone of the polypeptide chain due to H-bonding between the C = O and – NH – groups of the peptide bond.	Represents overall folding of the polypeptide chain. It gives rise to the fibrous or globular molecular shapes. Forces stabilizing the 2º and 3º structures are hydrogen bonds, disulphide linkages, van der Waal's and electrostatic forces of attraction.	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.

- **Native state of protein:** The parental state or the natural state in which the protein is found.
- **Denaturation of protein:** Destruction of the native state of protein is denaturation. It can be brought by physical and chemical methods. The 2º and 3º structures are destroyed; only 1º structure is retained.
- **Enzymes:** These are biocatalyst and generally globular proteins e.g., invertase, zymase, phenyl, alaninehydroxylase, urease etc.

Main characteristics of enzymes:

(i) It speeds up the biological reaction upto million times.
(ii) It is highly speci c and work on lock and key theory.
(iii) It is highly sensitive to pH and temperature.

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Vitamins

- They are organic compounds required in the diet in small amounts to perform speci c biological functions for maintenance of optimum growth and health of the organism. They are classified as follows :

(i) Fat soluble vitamins: Vitamin A, D, E and K. They are stored in liver and adipose tissues.

(ii) Water soluble vitamins: B group vitamins and vitamin C. They need to supplied regularly in diet as they are excreted in urine and cannot be stored (except vitamin B_{12}) in our body.

- Their deficiency causes diseases. Biotin (Vit H) is however neither fat nor water soluble. Its deficiency leads to loss of hair.

Vitmains/Minerals	Deficiency Diseases	Symptoms
Vitamin A	Night blindness	Poor vision, loss of vision in darkness
Vitamin B1	Beriberi	Weak muscles, fatigue
Vitamin C	Scurvy	Bleeding gums
Vitmain D	Rickets	Bent bones
Calcium	Osteomalacia	Weak bones, tooth decay
Iodine	Goitre	Swelling in neck
Iron	Anaemia	General weakness, fatigue

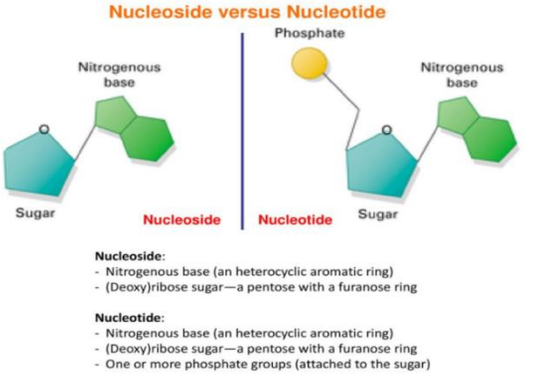
Nucleic acids

- These are biomolecules which are long chain polymers of nucleotides. They are of two types :

(i) Deoxyribonucleic acid (DNA)

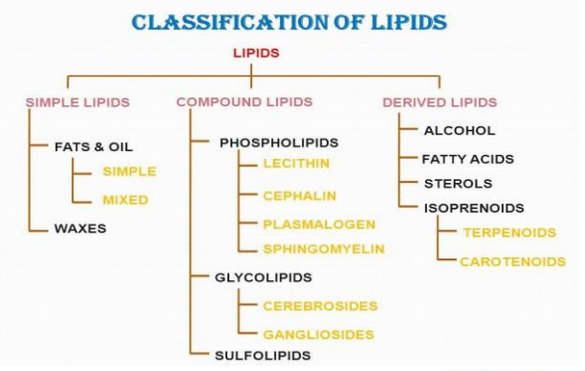
(ii) Ribonucleic acid (RNA)

- **Nuceloside = Base + Sugar**
- **Nucleotide = Base + Sugar + Phosphate**



	DNA	RNA
Acid Name	DeoxyriboNucleic	RiboNucleic
Stability	Very stable (long "life")	Less stable (short "life")
Found in	Nucleus	Nucleus and cytosols
	Mitochondria (most eukaryotes)	
	Plastids (plant cells)	
Function	Static, digital genetic data storage	Dynamic, many varied funvtions
Copier Enzyme	DNA polymerase	RNA polymerase
Structure	Long nucleotide chain	Short nucleotide chain
	Two complementary strands	One strand
	A-, B- or C-form helix	A-form helix only
"Backbone"	Inorganic phosphate	
	Deoxyribose (D in DNA)	Ribose (R in RNA)
Nucleobases	Thymine, Cytosine, Adenine, Guanine	Uracil replaces Thymine
Base Pairing	A↔T (Adenine to Thymine)	A↔U (Adenine to Uracil)
	G↔C (Guanine to Cytosine)	
EM Radiation	Somewhat UV sensitive	Relatively UV resistant

- **LIPIDS:** A **lipid** is any of various organic compounds that are insoluble in water. They include fats, waxes, oils, hormones, and certain components of membranes and **function** as energy-storage molecules and chemical messengers.



HORMONES

- Hormones are chemical messengers which are secreted by endocrine glands. They are carried through the blood stream to the target tissues.
- Majority of the hormones in humans are steroids. The two important classes of steroid hormones are sex hormones and adrenocortical hormones.
- Proteins are very important to us and perform many functions in a cell that are absolutely necessary for our survival.

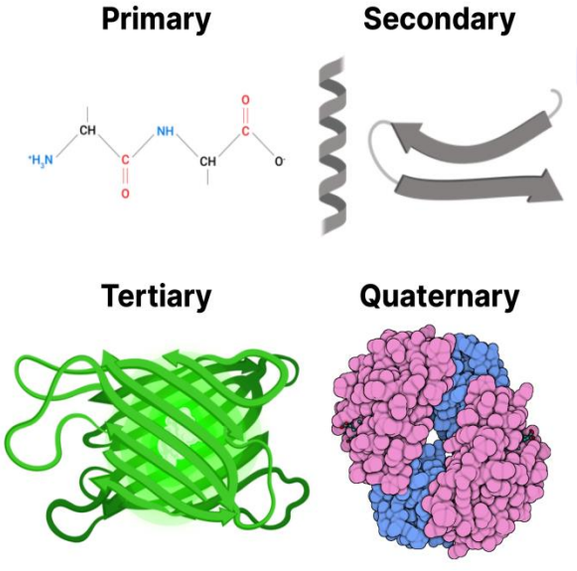


Fig. 29.1: The structure of protein

- Chief sources of proteins are pulses, milk, meat, eggs, etc.
- Enzymes are biocatalysts which speed up the reactions in biosystems. Chemically all enzymes are proteins. They are very specific and selective in their action on substrates.

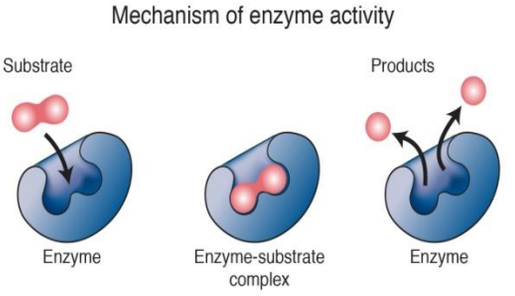


Fig. 29.6: Lock and Key arrangement of enzyme action

- **Biological Importance of Proteins are:**

(i) Proteins are structural components of cells.

(ii) The biochemical catalysts known as enzymes are proteins.

(iii) The proteins known as immunoglobins serve in defence against infections. Compounds

(iv) Many hormones, such as insulin and glucagon are proteins.

Test Yourself

Question: Name a water soluble vitamin which is a powerful antioxidant. Give its one natural source.

Answer: Water soluble vitamin: Vitamin C

Natural source: Amla

Check Yourself

1. During acetylation of glucose it needs, v moles of acetic anhydride. The value of x would be

(A) 3 (B) 5 (C) 4 (D) 1

2. On oxidation with a mild oxidising agent like Br_2/H_2O, the glucose is oxidized to

(A) Saccharic acid (B) Glucaric acid

(C) Gluconic acid (D) Valeric acid

3. Invert sugar is

(A) A type of cane sugar

(B) Optically inactive form of sugar

(C) Mixture of glucose and galactose

(D) Mixture of glucose and fructose in equimolar quantities

4. Which of the following compounds is found abundatly in nature?

(A) Fructose (B) Starch

(C) Glucose (D) Cellulose

5. Glycosidic linkage is an

(A) Amide linkage

(B) Ester linkage

(C) Ether linkage

(D) Acetyl linkage

Stretch Yourself

1. What are the expected products of hydrolysis of lactose?
2. Write a reaction which shows that all the carbon atoms in glucose are linked in a straight chain.
3. What is meant by 'reducing sugars'?
4. Name the only vitamin which can be synthesized in our body. Name the disease caused due to the deficiency of this vitamin.
5. Mention one important function of nucleic acids in our body.

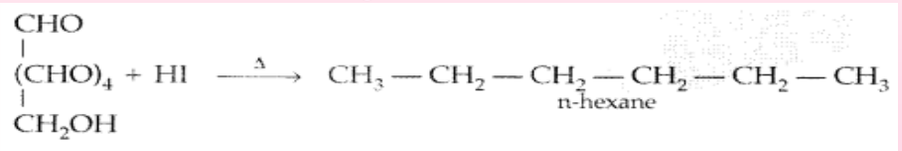
Answers

Check Yourself

Answer: 1(B); 2(C); 3(D); 4(B); 5(C)

Stretch Yourself

1. On hydrolysis, lactose gives P-D-galactose and p-D-glucose.
2. On prolonged heating with HI, it forms n-hexane, shows that all the six carbon atoms are linked in a straight chain:



3. Reducing sugar contains aldehydic or ketonic group in the hemiacetal and hemiketal forms and can reduce Tollen's reagent or Fehlmg's solution.
4. Vitamin which can be synthesized in our body: Vitamin A Its deficiency causes ***Xerophthalmia.***
5. Function of nucleic acid: Nucleic acids control the transmission of hereditary characters from one generation to another.