Chapter - 5

Notes

Biomolecules

Biomolecules: The hydrocarbon derivatives with covalently linked carbon skeleton and functional group which plays a vital role in the living organism.

Major Biomolecules with their monomers & functions.

Biomolecule	Monomer	Function	Constituent elements
① Proteins	Amino acids	Fundamental constituent of structure and function of cell	C, H, O, N, S
② Polysaccharides (carbohydrates)	Monosaccharides	Energy storage	C, H, O
③ Nucleic acids	Nucleotides	Transfer of genetic information (DNA) & metabolic activities (RNA)	C, H, O, N, P
④ Lipids	Fatty acids and Glycerol	structural comp. & long term energy storage	C, H, O

Macromolecules: (Biopolymers) large molecules, composed of thousands of covalently bonded atoms (such as protein).

* functional groups on one end of the monomer (headgroup)

Carbohydrates Notes

Properties:

Carbohydrates :- hydrates of carbon

Basic elements includes :- carbon, hydrogen & oxygen in a ratio of 1:2:1.
Hence the Empirical formula is $(CH_2O)_n$

Types of carbohydrates

1) Monosaccharides / single sugar
2) oligosaccharides
3) polysaccharides.

Monosaccharides :- simplest sugar having a single ketone unit.
empirical formula is $C_n(H_2O)_n$ and cannot be further hydrolysed.

Notes

Carbohydrates

Monosaccharides (Single saccharide Units)

- Trioses → contain 3 carbon atom → sweet, colorless crystalline solid that is an intermediate comp. of carbohydrate Metabolism
  - $C_3H_6O_3$ eg: Glyceraldehyde (3C)
- Tetrose
  - $C_4H_8O_4$ eg. Erythrose (4C)
- Pentose
  - $C_5H_{10}O_5$ eg. Ribose (5C) → simple sugar & carbohydrate with molecular formula
- Hexose
  - eg. Glucose (6C)
- Heptose
  - eg. sedoheptulose

Oligosaccharides (2-10 saccharide units)

- Disaccharides
  - eg: Sucrose, (2 saccharide Unit)
- Trisaccharides
  - eg. Raffinose (3 saccharide unit)
- Tetrasaccharides
  - eg: stachyose (4 Saccharide Units)
- Pentasaccharides
  - eg: Verbascose (5 Saccharide Units)

Polysaccharides

- 10+ more
- Homopolysaccharides
  - eg: Starch,
- Heteropolysaccharides
  - eg: mucopolysaccharides

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Monosaccharides are classified by

① Location of the carbonyl/functional group - eg: Aldose
② number of carbons in carbon skeleton - no. of carbon atoms they possess.

Location of carbonyl group -

1) Aldose -: Carbonyl carbon is the last one in the chain
eg - glucose.

2) Ketose -: Carbonyl carbon is internal to the chain so that there are other carbons on both its sides.

Isomeric forms of Monosaccharides -:

* One or more asymmetric carbon (carbon atom bonded with four different atoms or groups). atoms due to which they exist a number of isomeric forms.

* The number of isomeric forms can be found for a compound, it is equal to 2^n where n = no. of asymmetric carbon atoms in the compound.

a) Optical isomers -:
have capacity to rotate the plane polarized light either to left or right. when passed through their solution.

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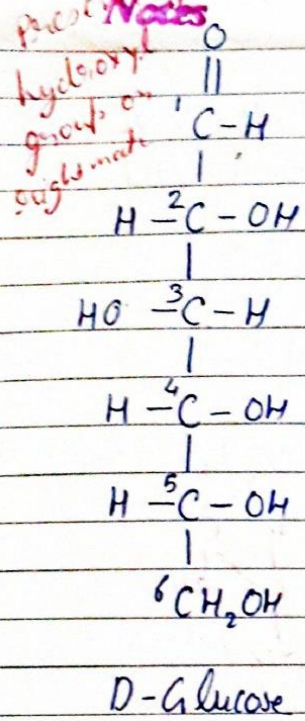
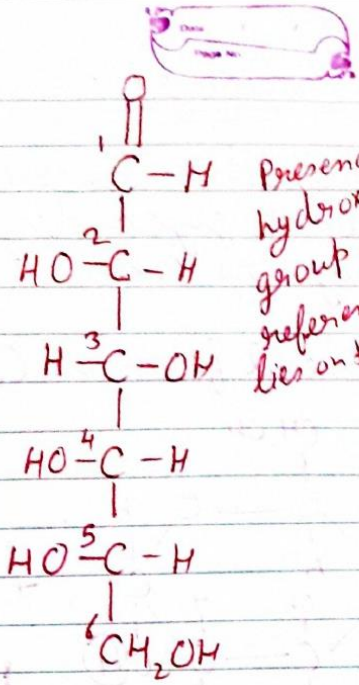
Notes

Presence of hydroxyl group on asymmetric carbon



D-Glucose

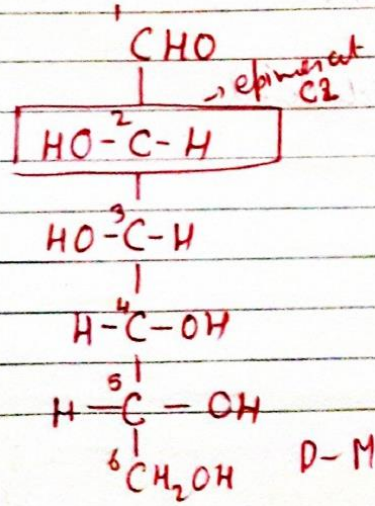


Presence of hydroxyl group on the reference carbon lies on the left.

L-Glucose.

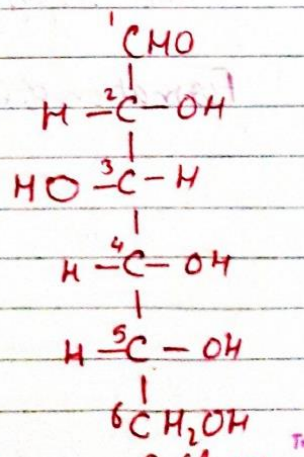
Glucose

b) Epimers :- molecules differ in configuration only at one chiral centre. ie shows variation in configuration of -OH & -H on a particular carbon atom.
eg :- Glucose, galactose & mannose.

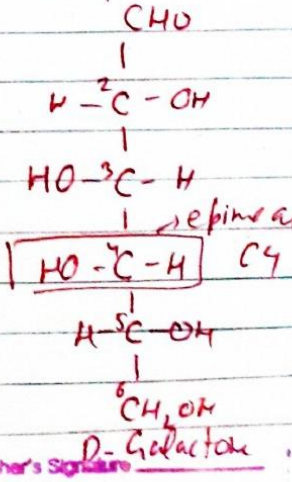


epimer at C2

D-Mannose



D-Glucose.



epimer at C4

D-Galactose

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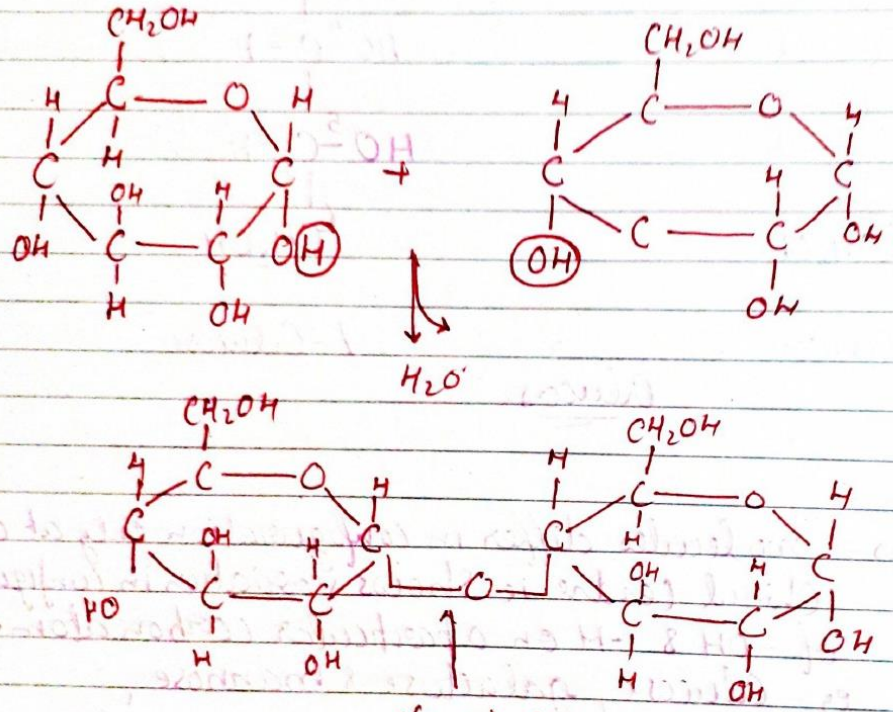
Oligosaccharides:

* Monosaccharides which link with each other with the help of glycosidic linkage and form complex polymers called

* General form is $C_n(H_2O)_{n-1}$.



$\alpha(1\rightarrow4)$ glycosidic bond.

Formation of Glycoside Bond.

Notes

Polysaccharides

* Long chain polymers of carbohydrates with more than ten monosaccharide unit bonded together with glycoside bond.

eg :- Starch, glycogen, cellulose etc.

can be classified into two categories:-

1) Homopolysaccharides :- They are stored in the body as reserved food materials and may serve as energy sources.

Homo = Same.

eg :- Starch, glycogen.

2) Heteropolysaccharides :- provide protection, shape & support to the tissues and organs.

Lipids :- heterogenous group of compounds that are insoluble in water but soluble in organic solvents like alcohol

* Produced on linkage of two chemically different types of organic molecules.

Notes

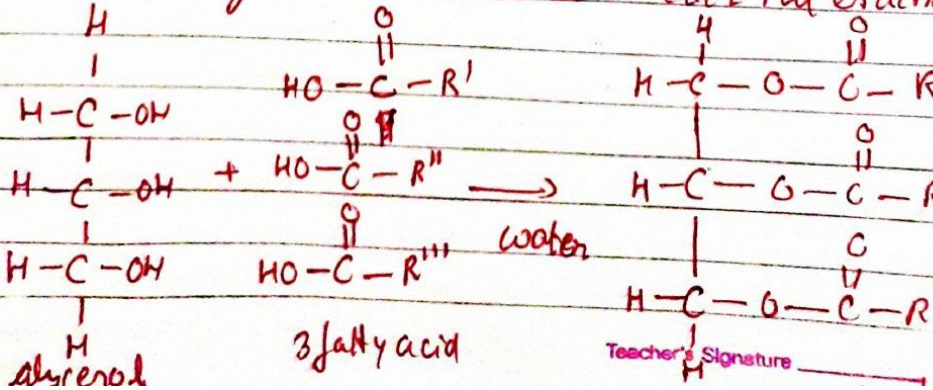
Lipids

- **Simple Lipids** → Esters of fatty acids
  - **Fats** → esters of fatty acids and glycerol
  - **Waxes** → esters of long chain fatty acids and long chain alcohols
- **Compound Lipids** → Esters of fatty acids and alcohol contain other groups also
- **Derived Lipids** → composed of hydrocarbon rings and a long hydrocarbon side chain.

Types of Lipids :- 3 classes as follows on the basis of their chemical composition.

1) Simple lipids :-

esters of fatty acids with alcohols where the two types of subunits combine as a result of condensation reaction liberating a water molecule in each interaction



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ester :- chemical compound derived from an acid (organic, inorganic) in which at least one -OH (hydroxyl) group is replaced by an -O- alkyl group.

Simple lipids can be subdivided into two main types

a) Fats and oils :-
esters of fatty acids with glycerol.

b) Waxes :- formed as a result of long chain fatty acids with an alcohol other than glycerol

2) Compound Lipids :- Ester of fatty acids that involve alcohols containing additional group like phosphate, carbohydrates.
classified as

a) Phospholipids :- lipids containing phosphate groups.
1) Glycerophospholipids :- contain glycerol as a alcohol.
2) Sphingophospholipids :-

b) Glycolipids :- contain fatty acid attached to the alcohol containing one or more carbohydrate
- Cerebrosides

c) Lipoproteins :- complex lipids with proteins attached to them eg :- LDL (Low density lipoproteins)
HDL (High density lipoproteins).

3) Derived Lipids :- Simple or compound lipids on hydrolysis produce compounds like fatty acids, steriods. etc.
It is so called as it is derived from lipids.

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Structural Components of Lipid Molecules :-

* Comprises of two types of carbon units :
  1) alcoholic moiety 2) fatty acids

Fatty acid :- Carboxylic acids with a hydrocarbon side chain

On the basis of length of ~~Carbon~~
1) Short chain :- less than 6 carbon atom.
2) Medium chain :- carbon chain 8-16
3) Long chain :- 16-24 carbon atoms.

Alcohol moiety :- a half of ~~cmod~~ → a molecule.
A functional groups characterized by C-O-H morety.

Proteins - * Most abundant macromolecules found in living organism.
- They are structurally chains of amino acids where as the subunits link mutually by covalent bonds are called Peptides bonds.

* Linear chains thus formed are named on the basis of number of subunits that participate in chain formation.

* Each single alteration in the amino acid sequence may affect the functioning of the protein resulting in disorder like Sickle cell anaemia.

polypeptides - short chain of amino acid

Notes

* Due to variation on the sixth amino acid on the β chain of hemoglobin where glutmate is replaced by valine amino acid.

* Hemoglobin molecule aggregates into long fibres on deoxygenation giving sickle like shape to the RBC. Life span of sickle shaped RBC is small, so hemoglobin level in blood declines and disorder is called sickle cell anemia.

Amino Acids - (Basic unit of proteins)

* Basic constituents of all the proteins
First Amino acid discovered was Aspargine (discovered by Asparagus).
* Subunits undergo condensation polymerization to form linear polypeptide chains.

~~Polypeptides~~ :-

* A single alteration in the amino acid sequence effects the functioning of proteins resulting in disorder like Sickle cell anaemia.
* Due to variation in

* All amino acids except glycine where two bonds are satisfied by (hydrogen atom) possess a central asymmetric carbon (α carbon) atom bonded to 4 diff group.

The central asymmetric carbon of the amino acids has two has two functional group - Amino ($-NH_2$) & carboxyl ($-COOH$) group.

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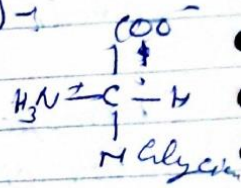
amino group → basic in nature

carboxyl group → acidic in nature.

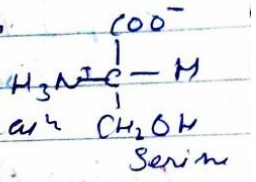
Notes

Types of amino acid :-

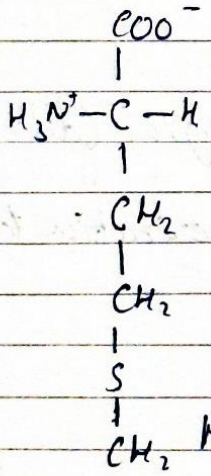
1) Amino acids with aliphatic side chain (R group) :- have more amino mono-carboxylic acids



2) Amino acids with -OH group in the side chain

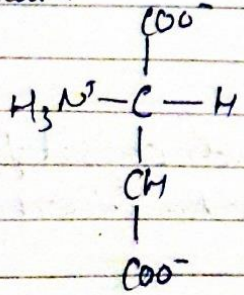


3) Amino acids with sulphur containing side chain



Methionine.

4) Amino acids with (carboxyl group containing) acidic side chain



Notes

Protein: Primary Structure:-

* Linear polymers of amino acids are called peptides.

Types of proteins:-

1) Classification of Proteins on the basis of their functions:-

a) Structural Proteins:- Basic components of various structures
eg. Keratin (component of hairs & epidermis),
collagen (component of bone matrix & cartilage).

b) Functional Proteins:-

1) Storage Proteins:- Proteins ~~participate in~~ provide nutrition and are involved in storage

2) Transport proteins:- Proteins basically provide nutrition and are involved in
Proteins bind with specific molecules and help in their transport from one part to other. eg:- Hemoglobin.

3) Defense Proteins:-

Nucleotide :- one of the structural component or building block of DNA & RNA.

Ribose → simple sugar and carbohydrate with molecular formula $C_5H_{10}O_5$.

Notes

Nucleic Acid are biopolymers, or small biomolecules essential to all known forms of life.

* The term nucleic acid is the overall name for DNA and RNA. They are composed of nucleotides, which are monomers made of 3-components: a 5-carbon sugar, a phosphate group and a nitrogenous base.

* These complex biomolecules are positioned in the nucleus of living cell.

* Plays vital role as molecules responsible for storage & transfer of genetic information and also as energy rich compounds participating in metabolic processes.

Type of Nucleic Acid :-

Two type of nucleic Acid.

1) DNA (Deoxy - ribonucleic acid)
2) RNA (Ribonucleic acid)

DNA	RNA
1) Double stranded molecule	Single stranded molecule
2) Sugar present in DNA is Deoxy ribose sugar which is 5 membered carbon ring.	Sugar present in 5 carbon Ribose sugar.

codons - seq. of DNA or RNA nucleotides that corresponds with specific amino

repository → a place where things are or may be stored.

Pyrimidine → two classes of heterocyclic nitrogenous base found in nucleic acids DNA & RNA

Notes

DNA	RNA
3) Four nitrogenous bases present are Thymine, Cytosine, Adenine & Guanine.	Uracil base instead of Thymine. All the other bases are same.
4) Sum total of purine base is always equal to pyrimidine base ie. A+G = C+T	Purine and pyrimidine bases is not equal.
5) Exist in one form or type in an organism.	Exist in 3 main type – mRNA, rRNA & tRNA.
6) Not degraded in cell	Degraded in cell by nucleus.
7) Transfer of genetic information from one generation to other.	Transfer and expression of genetic information. Also helps in DNA replication by acting as a primer and also in protein synthesis.

Adenine (A) → is a nucleobase (a Purine derivative) Organic base of Purine. role in biochemistry, cellular respiration

Guanine (G) → most easily oxidized DNA base, and its oxidant product used in providing shimmery lustre to eyeshadow & nail gloss, used as additives.

Cytosine (C) → a pyrimidine & one of the nitrogenous bases found. Cytosine forms nucleoside.

Thymine (T) → binds to adenine via two hydrogen bond to assist in stabilizing nucleic acid structure

→ bonds to cytosine because they both share 3 hydrogen bond

Purine → an aromatic heterocycle composed of carbon & nitrogen.

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Notes

Enzymes

Metabolic activities:-

it is a part of metabolism which take place in the body of an organism.

Metabolism is the phenomenon which includes set of chemical reaction which are essential for a living organism to maintain its life.

* Significant amount of energy which may be released during reaction or may be stored in form of energy

3 Main purpose of metabolism:-

1) Conversion of food to energy to run cellular processes.

2) Conversion of food/fuel to building blocks for proteins, lipids, nucleic acids & carbohydrates

3) elimination of nitrogenous wastes.

Classification of Metabolic reactions:-

① Catabolic :- Breaking down of compounds
eg :- ~~breaking down of compounds~~

② eg :- breaking down of glucose.

③ Anabolic :- the building up of compounds
eg :- proteins, carbohydrates etc.

Notes

Catalysis :- increasing the rate of chemical reaction by introducing a catalyst.

- Catalyst :- is a substance that is not consumed by the chemical reaction, but acts to lower its activation energy to speed up chemical reaction.
- Catalyst can be recovered chemically unchanged at the end of reaction.

Enzymes :-

it is considered as bio - catalysts which increase the velocity of biological reaction and remain unchanged at the end of the reaction.

5 enzymes :-

1) Amylase :- produced in mouth (break down large starch molecule into smaller sugar molecu
2) Pepsin :- produced in stomach (breaks down protein in amino acids)
3) Trypsin :- produced in pancreas (breakdown prote
4) Pancreatic lipase :- produced in pancreas (used to bre up fats)
5) Deoxyribonuclease and ribonuclease :- produced in pancreas. (break bond in nucleic like DNA & RNA)

Notes

Chemical nature of enzymes:-

- enzymes are reaction specific.

Some enzymes may be specific for particular type of substrate or a functional group or a chemical bond.
The same substrate may undergo diff. reactions like transamination, the enzymes that catalyse the same substrate molecule for diff. reaction

Classification

On Basis of chemical nature it is divided into two types

1) Simple enzymes:- enzymes are composed of amino acids only ie. protein

2) Conjugated/cofactor enzymes:- Possess a non protein group called cofactor along with the protein part of the enzyme.
The proteineous part is called apoenzyme.
a protein that forms an inactive enzyme

Holoenzyme = Cofactor + Apoenzyme

Apoenzyme:- An enzyme with its co-factor removed

Holoenzyme:- Complete complex of a protein with all necessary small organic molecules metal ions and other components

Notes

Cofactors can be classified as

1) Coenzyme :- non protein part which remains loosely bound or attached to the enzyme.

* Thermostable organic compound with low

Mechanism of Enzyme Action

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