19/1/24

CHAPTER - 10

BIO MOLECULES

★ BIOMOLECULES

Biomolecules are naturally occuring organic compounds present as an essential constituent of living organism present in different cells.
Examples: Cellulose, Starch, Nucleic acids, etc.

★ CARBOHYDRATES

The carbohydrates may be defined as optically ~~opt~~ active polyhydroxy aldehydes or ketones or the compounds which produce such units on hydrolysis.
Example: Glucose, Fructose, Sucrose

- $C_6H_{12}O_6$ (Polyhydroxy aldehyde)
- $C_6H_{12}O_6$ (Polyhydroxy Ketone)
- $C_{12}H_{22}O_{11}$

Hydrolysis

$C_6H_{12}O_{6} + C_6H_{12}O_6$
Glucose Fructose

- CLASSIFICATION OF CARBOHYDRATES

* MONOSACCHARIDES

These cannot be hydrolysed further. Soluble in water.
Example: Glucose ($C_6H_{12}O_6$)
Fructose ($C_6H_{12}O_6$)
Galactose
Ribose

If monosaccharide contains an aldehyde group → Aldose
If monosaccharide contains a keto group → Ketose

* DISACCHARIDES

Two units of Monosaccharides are given on hydrolysis. Soluble in water.

Example: Sucrose $\xrightarrow{\text{Hydrolysis}}$ Glucose + Fructose

* **OLIGOSACCHARIDES**

Carbohydrates that yield two to ten monosaccharide units on hydrolysis are called oligosaccharides. They are further classified as disaccharides, trisaccharides, tetrasaccharides, etc. depending upon the number of monosaccharides, they provide on hydrolysis.

The two monosaccharides units obtained on hydrolysis of a disaccharide may be same or different. For example,

Sucrose $\xrightarrow{\text{hydrolysis}}$ Glucose + Fructose

Maltose $\xrightarrow{\text{hydrolysis}}$ Glucose + Glucose

* **POLYSACCHARIDES**

Carbohydrates which yield a large number of monosaccharides units on hydrolysis are called polysaccharides. Some common examples are starch, cellulose, glycogen, gums, etc. Polysaccharides are not sweet in taste, hence they are also called non-sugars.

* **SUGARS**

Sugars → Monosaccharides and oligosaccharides are crystalline solid. They are soluble in water. Examples: Glucose, Fructose.

Non-sugars → Polysaccharides

• **TYPES OF SUGAR**

* **REDUCING SUGAR**

This contains free aldehyde or ketonic group which reduces Fehling's solution or Tollen's reagent are referred as Reducing sugar.

* **NON-REDUCING SUGAR**

Sugars which do not have free aldehyde or ketonic group, hence do not

reduce Fehling's solution or Tollen's reagent.

★ GLUCOSE

They are found in free or combined form.

- METHODS OF PEPARATION

* FROM SUCROSE

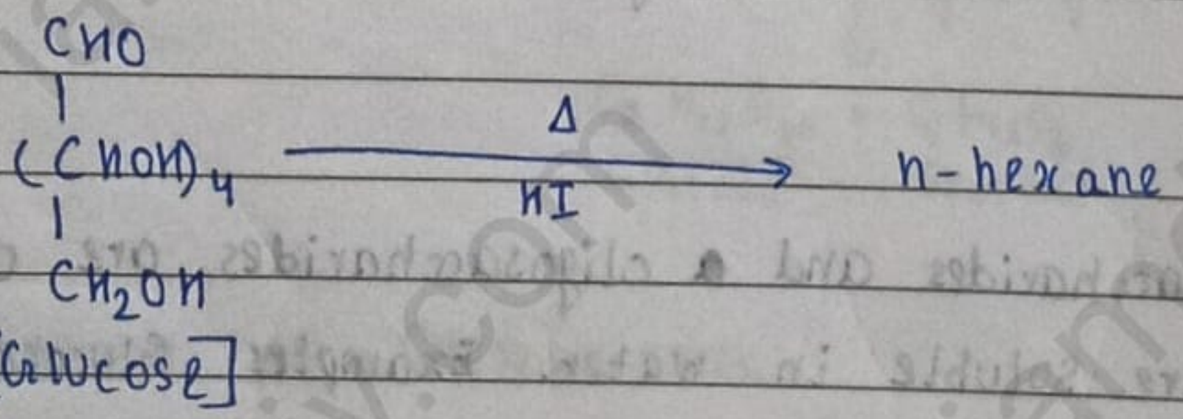
$$C_{12}H_{22}O_{11} \xrightarrow{\text{Hydrolysis}} \underset{\text{Glucose}}{C_6H_{12}O_6} + \underset{\text{Fructose}}{C_6H_{12}O_6}$$

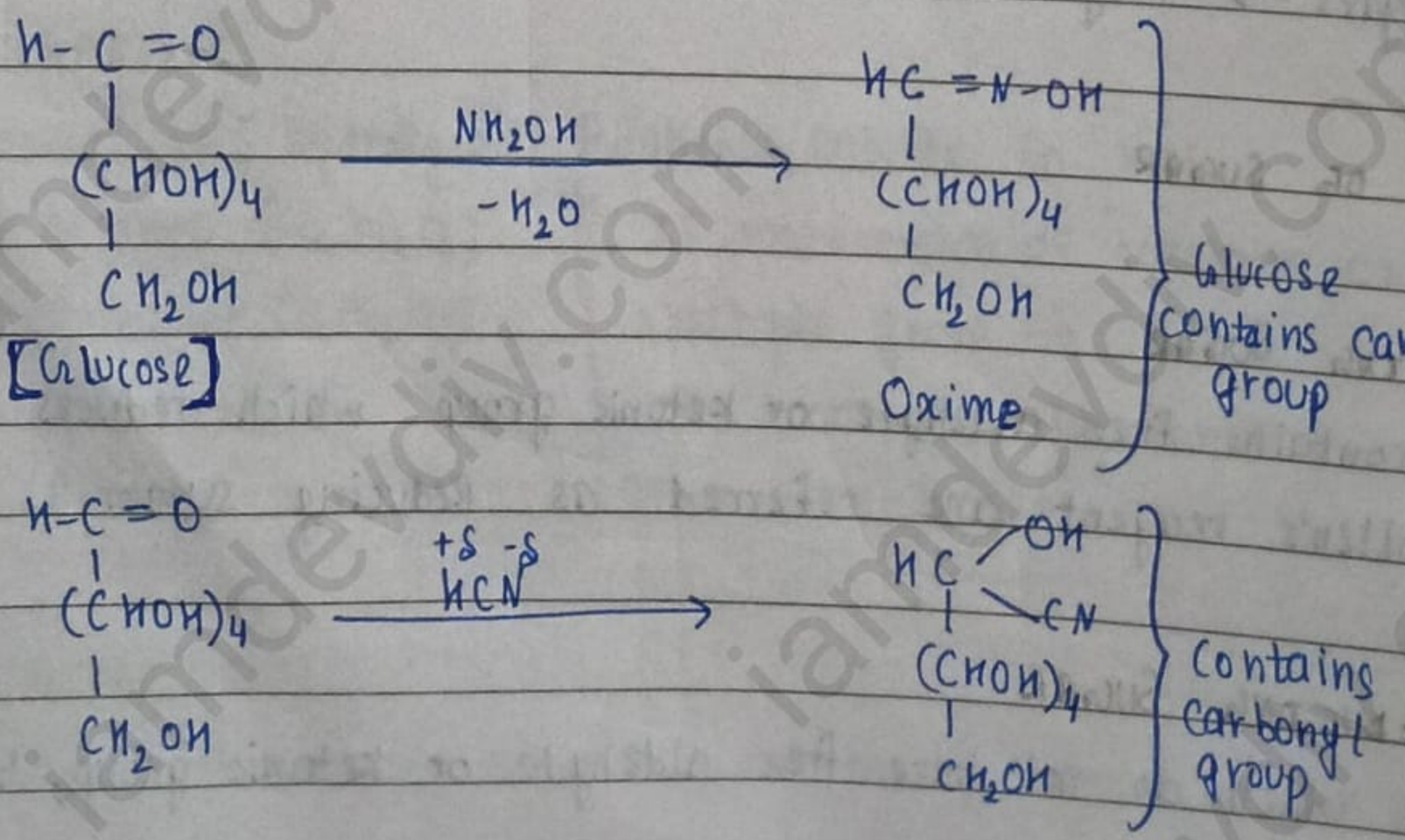
* FROM STARCH

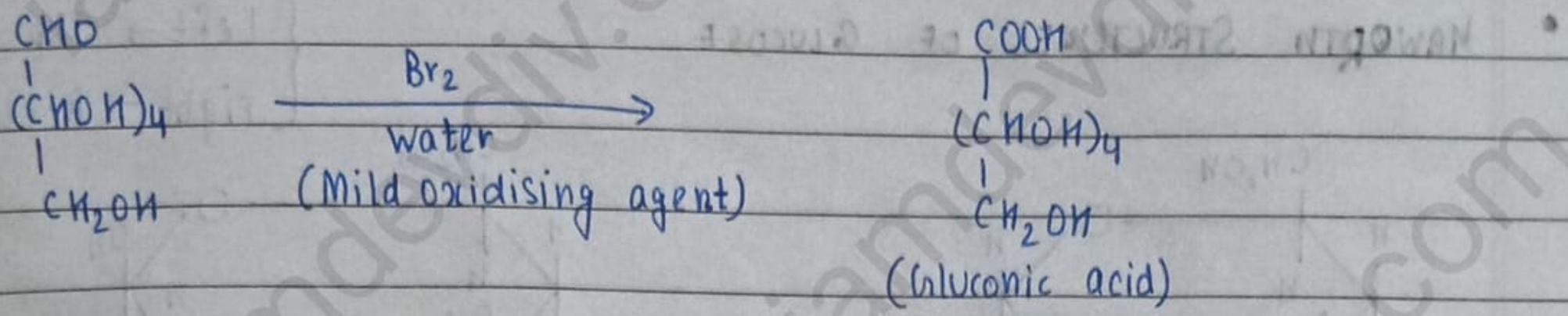
$$\underset{\text{Starch}}{(C_6H_{12}O_5)_n} \xrightarrow[393\,K,\ 2-3\ atm]{H^+} n\,C_6H_{12}O_6 \quad \text{Glucose}$$

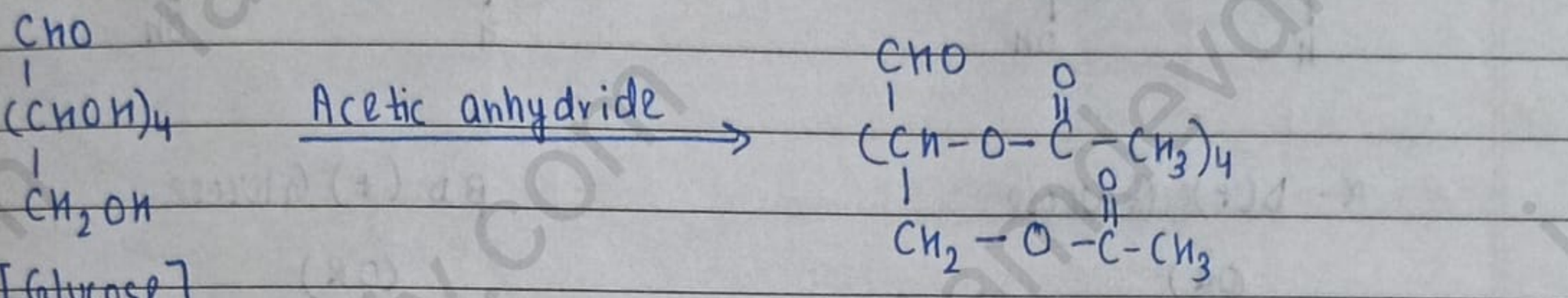
- STRUCTURE OF GLUCOSE

Glucose is called Aldohexose / dextose.

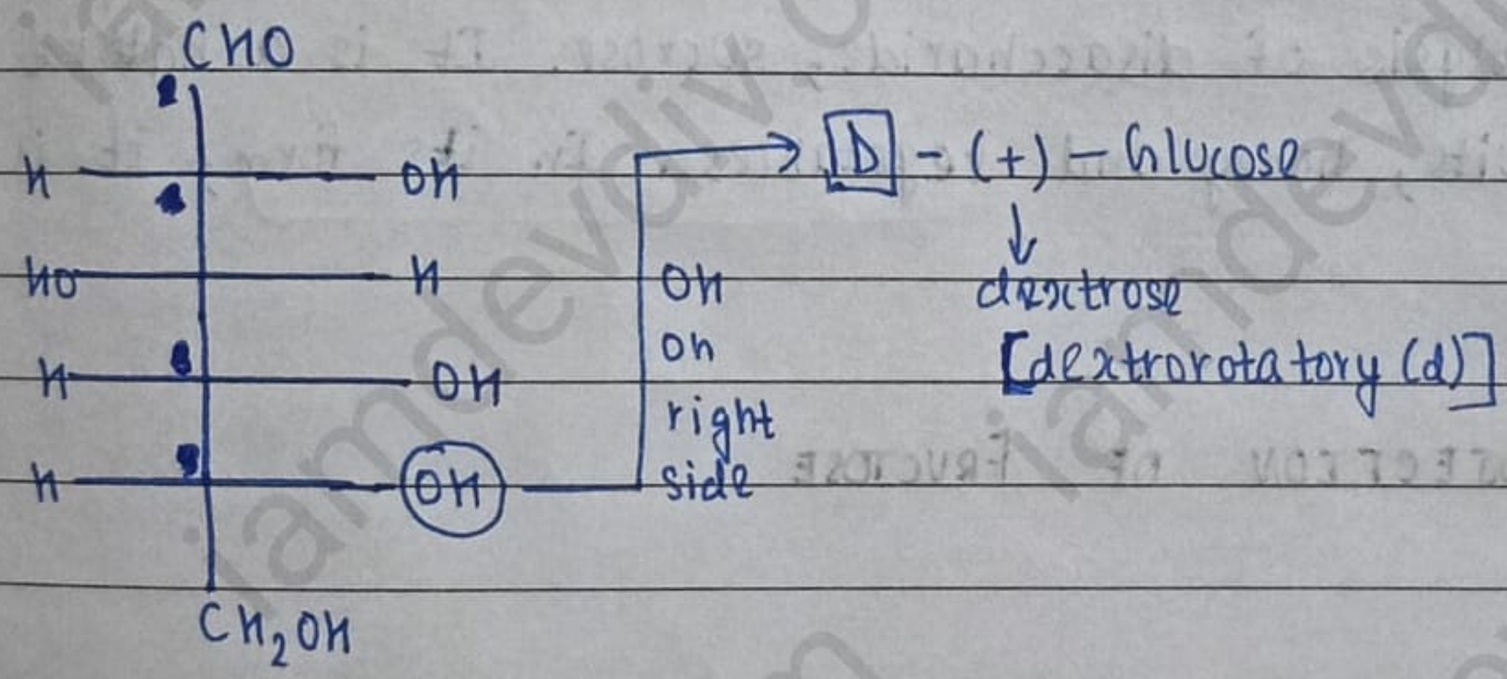


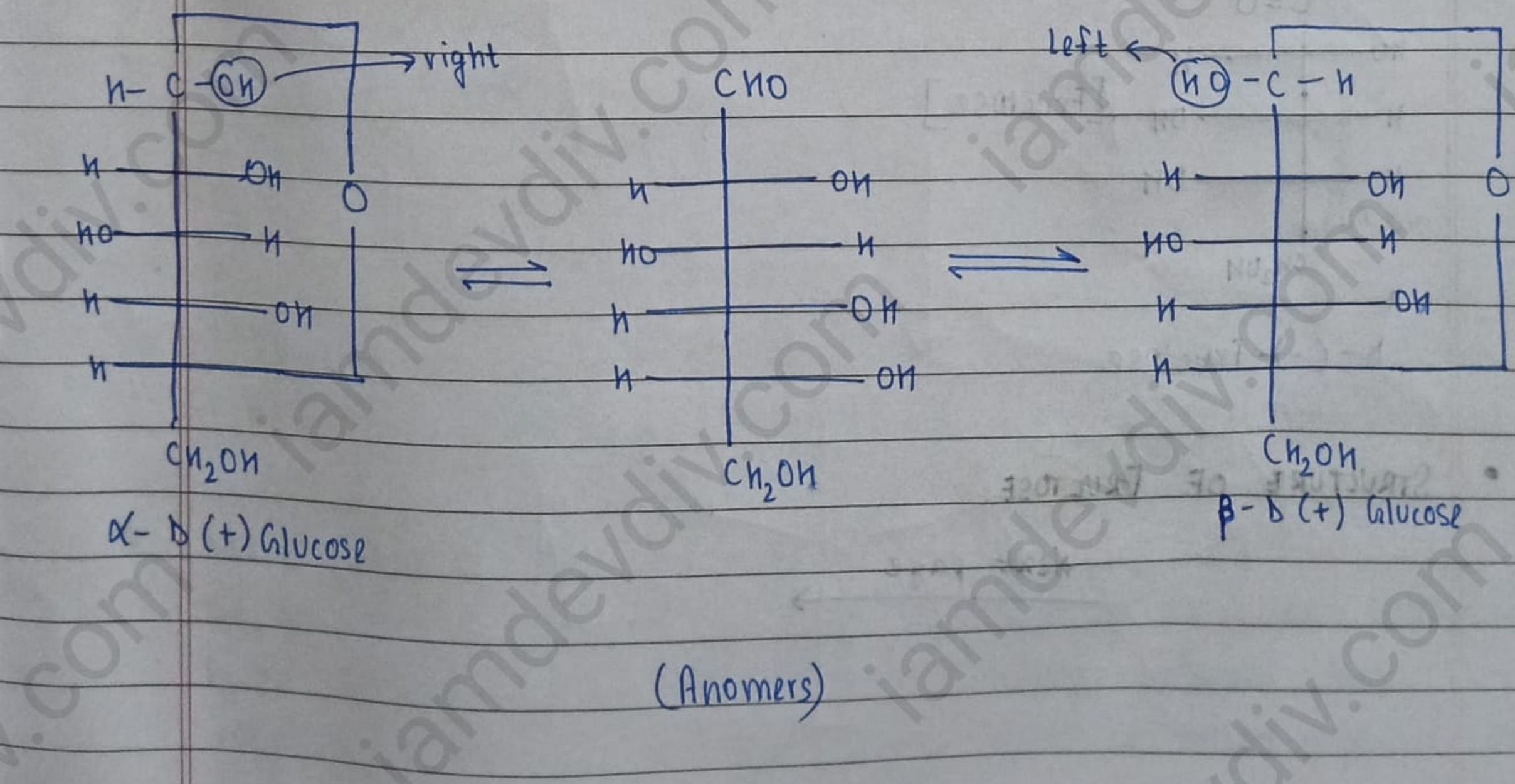






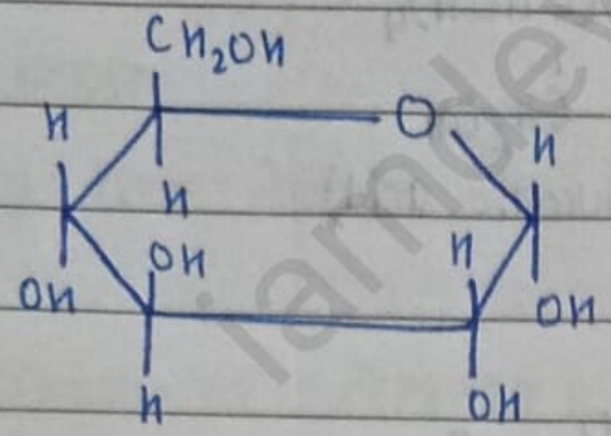
- FISCHER PROJECTION OF GLUCOSE
(Open Structure)



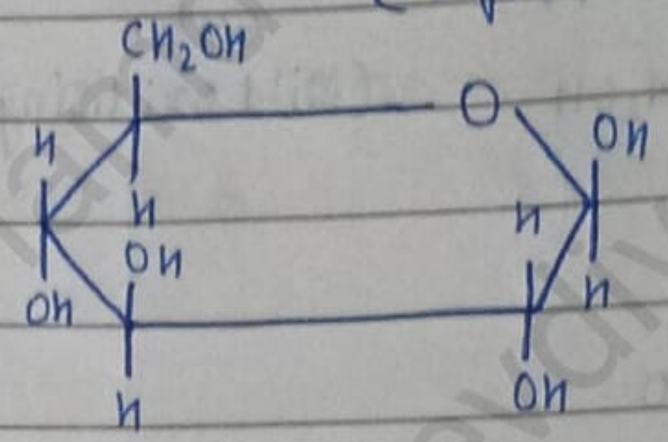


- HAWORTH STRUCTURES OF GLUCOSE

{ Left → Top
right → Bottom }



α- D(+) Glucose
(OR)
α D(+) Glycopyranose

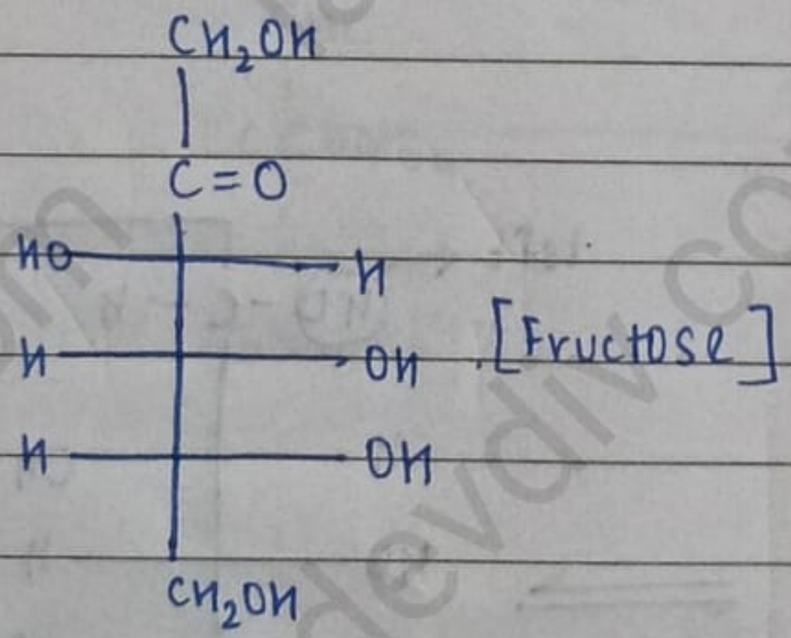


β D (+) Glucose
(OR)
β- D(+) Glycopyranose

★ FRUCTOSE

Fructose is an important ketohexose. It is obtained along with glucose by the hydrolysis of disoccharide, sucrose. It is a natural monosaccharide found in fruits, honey and vegetables. In its form, it is used as a sweetner.

- FISCHER PROJECTION OF FRUCTOSE



[Fructose]

D-(-)- Fructose

- STRUCTURE OF FRUCTOSE

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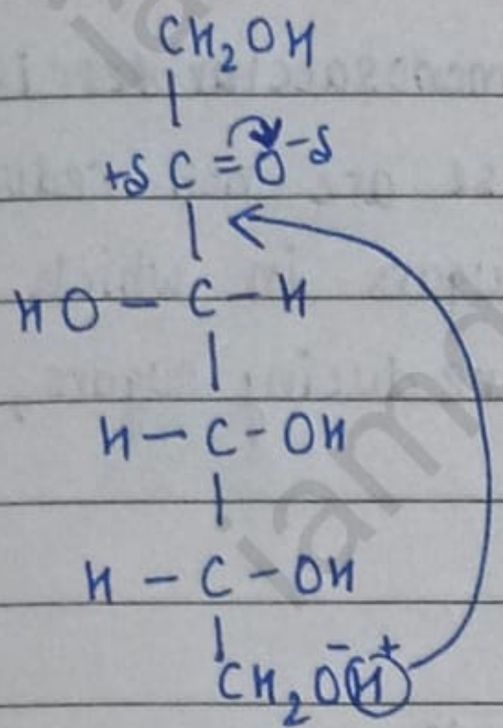
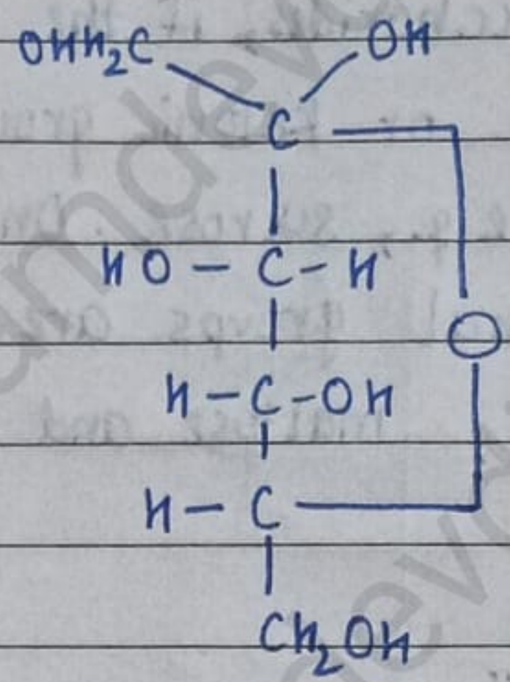
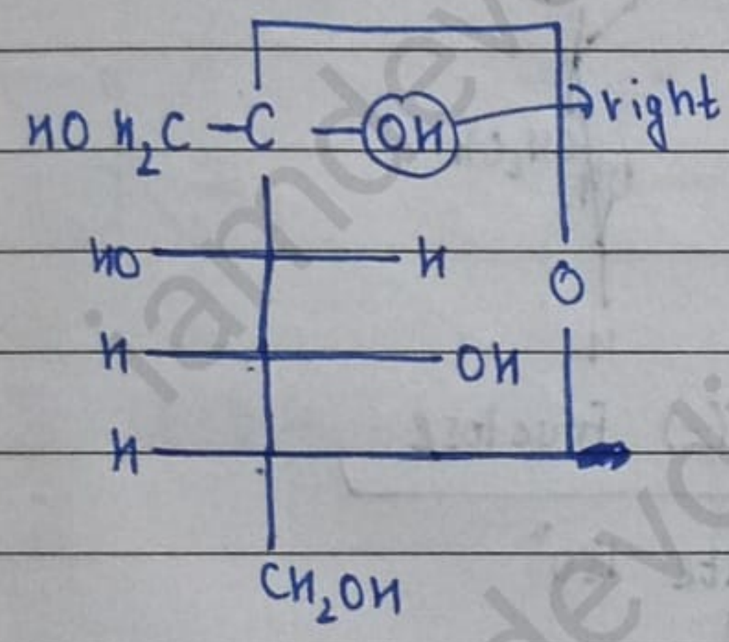
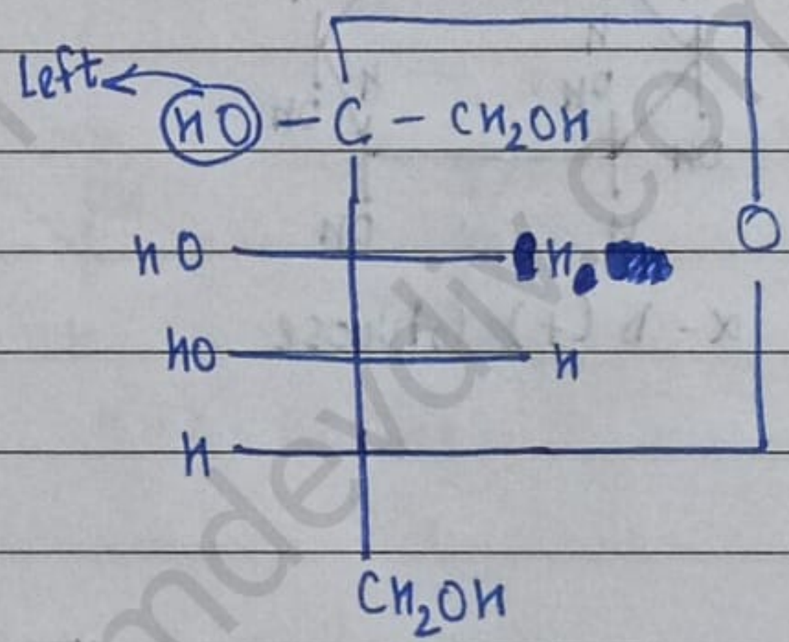




Closed structure of fructose

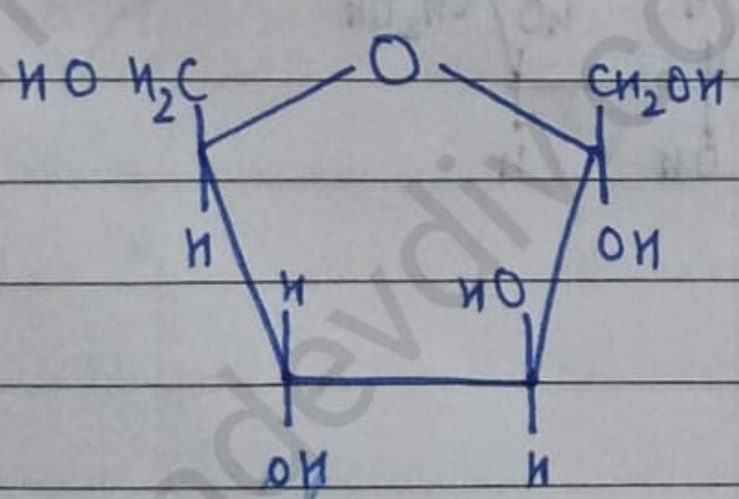


α-D-(-)-Fructofuranose

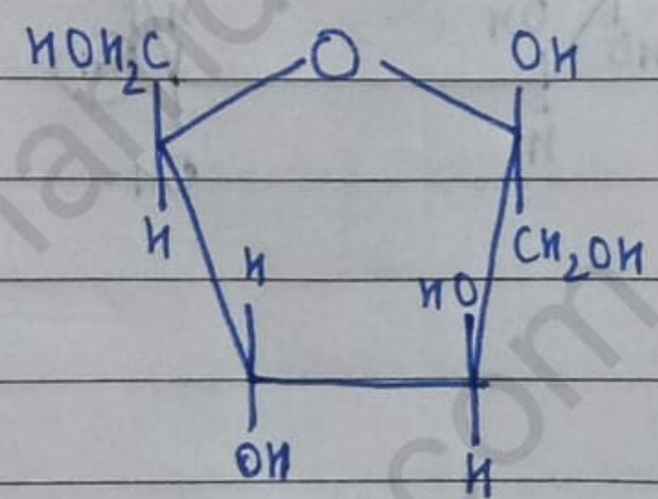


β-D-(-)-Fructofuranose

- HAWORTH STRUCTURES OF FRUCTOSE



α-D-(-)-Fructofurnanose



β-D-(-)-Fructofuranose

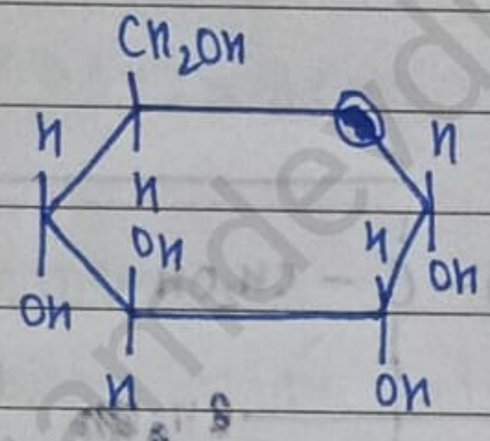
★ DISACCHARIDES

The two, monosaccharides are joined together by an oxide linkage formed by the loss of a water molecule. Such a linkage between two monosaccharide units through oxygen atom is called glycosidic linkage.

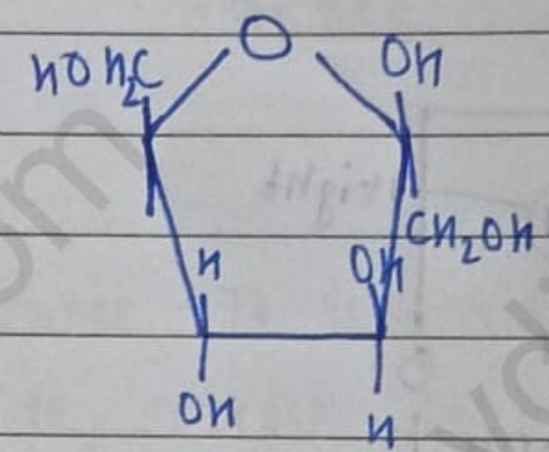
In disaccharides, if the reducing groups of monosaccharides i.e, aldehydic or ketonic groups are bonded. These are non-reducing sugars, e.g., sucrose. On the other hand, sugars in which these functional groups are free, are called reducing sugars, for example, maltose and lactose.

- **SUCROSE**

"C_1 (α-D glucose) — C_2 (β-D glucose)"

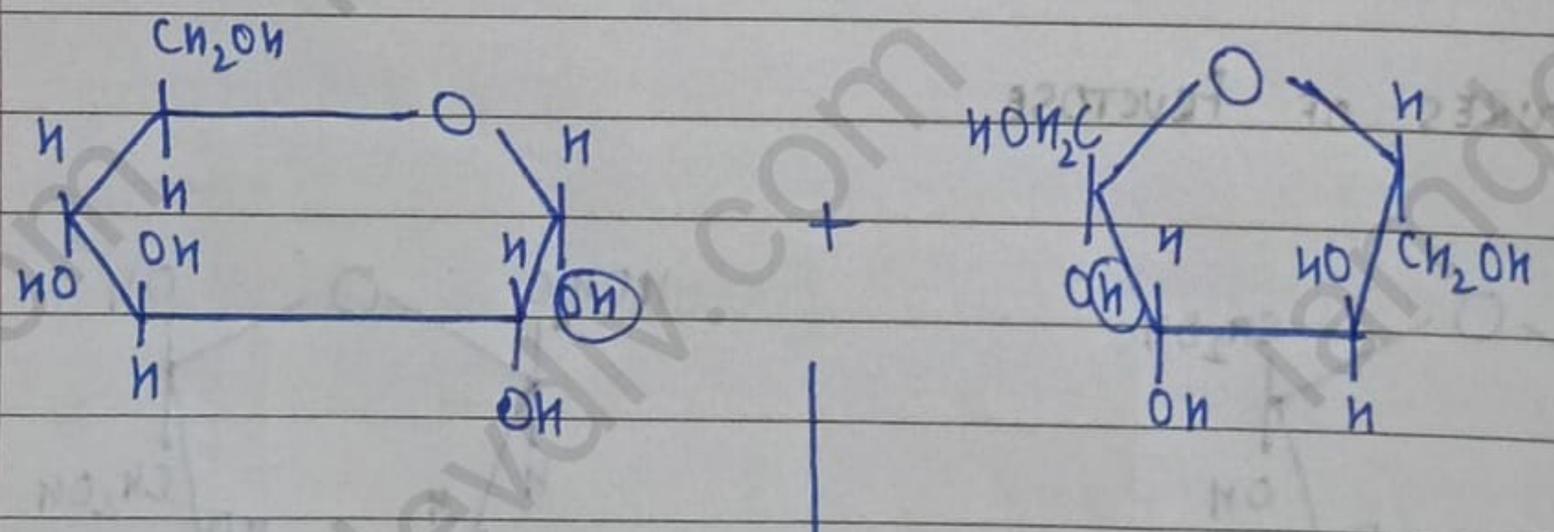


α-D (+) Glucose

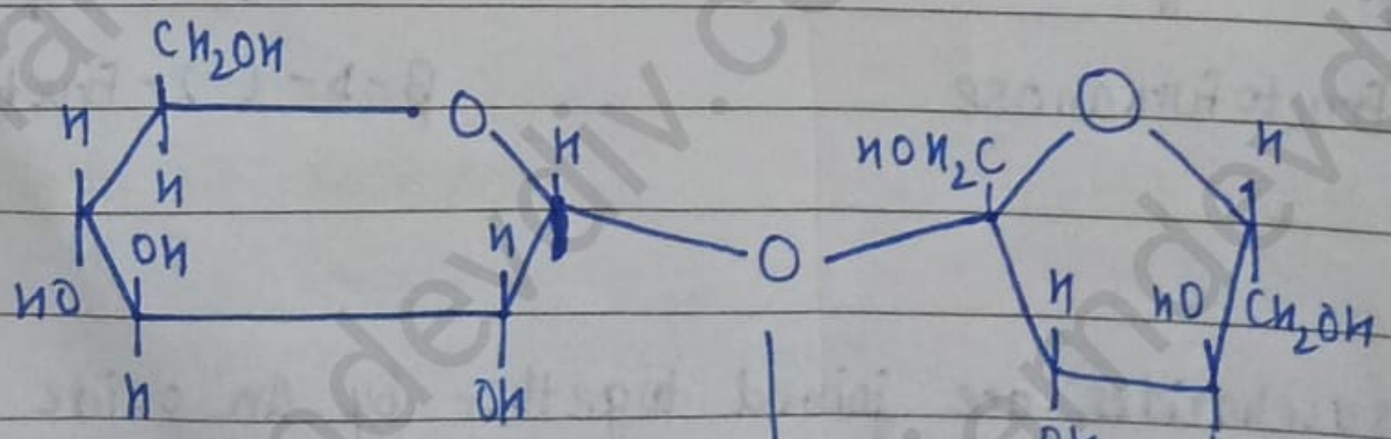


β-D (-) fructose

rotate 180°



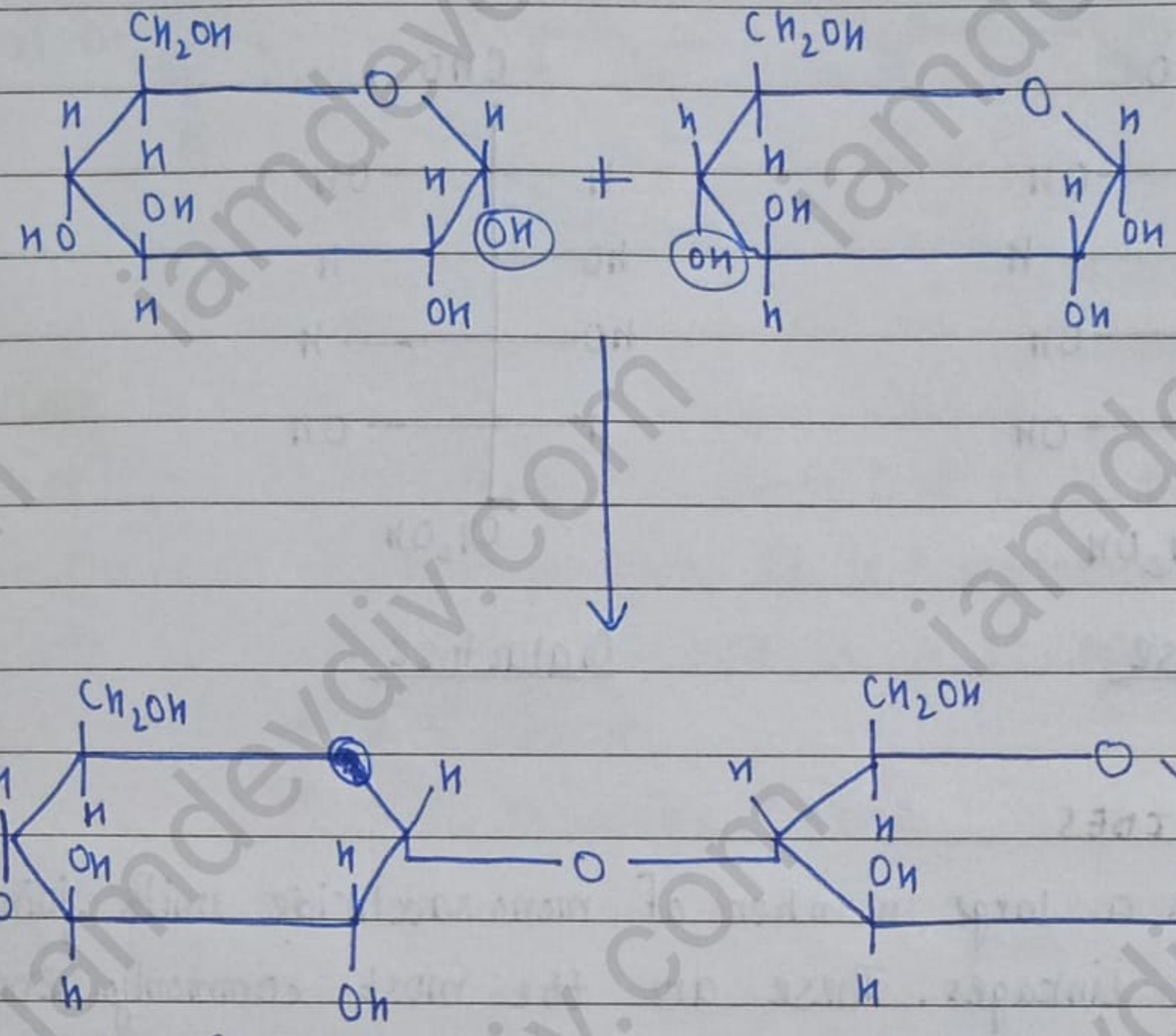
$-H_2O$



Sucrose

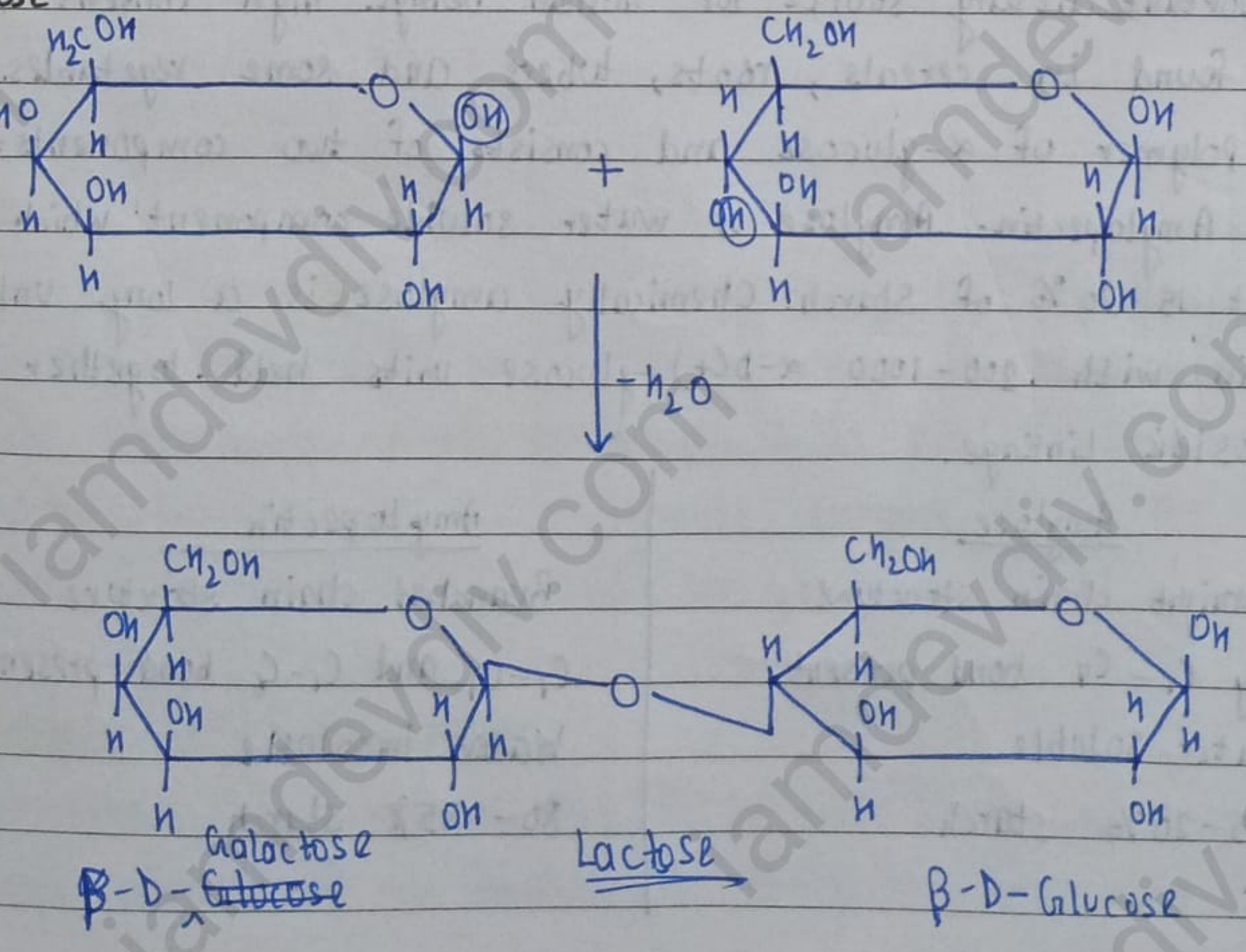
glycosidic linkage

- MALTOSE

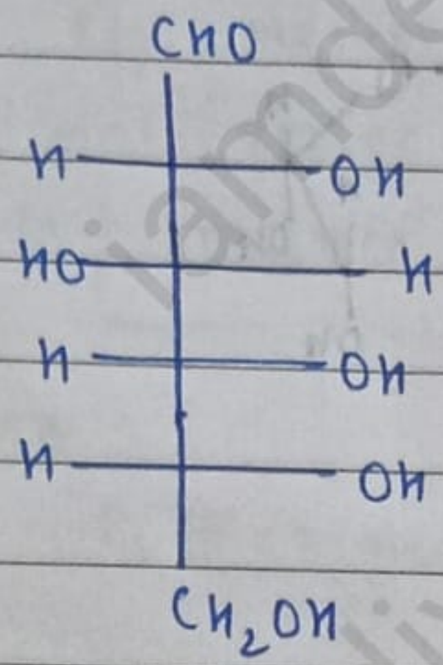


Maltose → α-D-Glucose

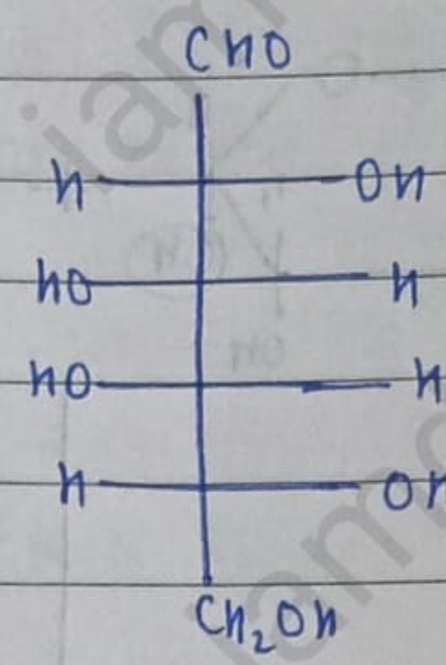
- LACTOSE



* Galactose and Glucose are C_4 epimers of each other



Glucose



Galactose

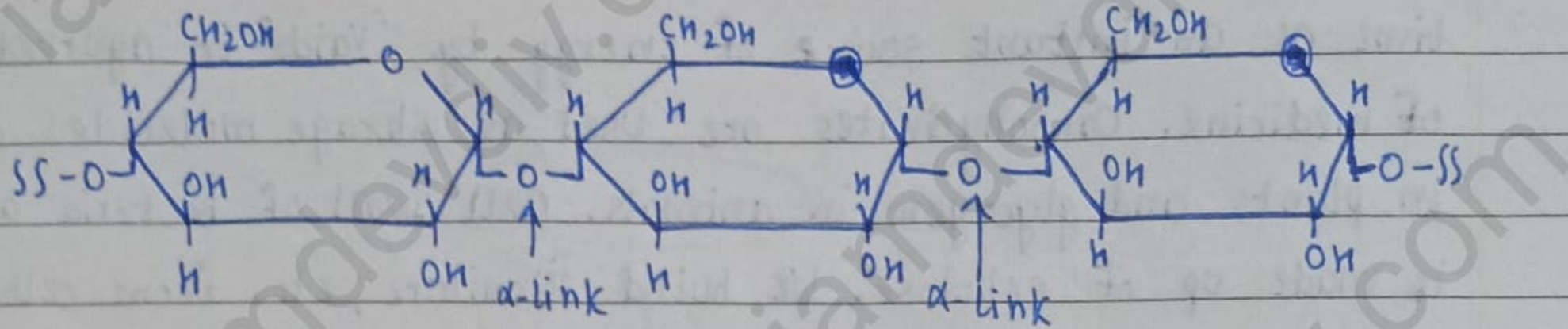
* POLY SACCHARIDES

These contain a large number of monosaccharide units joined together by glycosidic linkages. These are the most commonly encountered carbohydrates in nature. They mainly act as the food storage or structural materials.

- STARCH

Starch is the main storage polysaccharide of plants. It is the most important dietary source for human beings. High content of starch is found in cereals, roots, tubers and some vegetables. It is a polymer of α-glucose and consists of two components- Amylose and Amylopectin. Amylose is water soluble component which constitutes about 15-20% of starch. Chemically amylose is a long unbranched chain with 200-1000 α-D(+)-glucose units held together by C_1-C_4 glycosidic linkage.

Amylose	Amylopectin
Straight chain structure	Branched chain structure
Only C_1-C_4 bond present	C_1-C_4 and C_1-C_6 bond present
Water soluble	Water insoluble
15-20% starch	80-85% starch

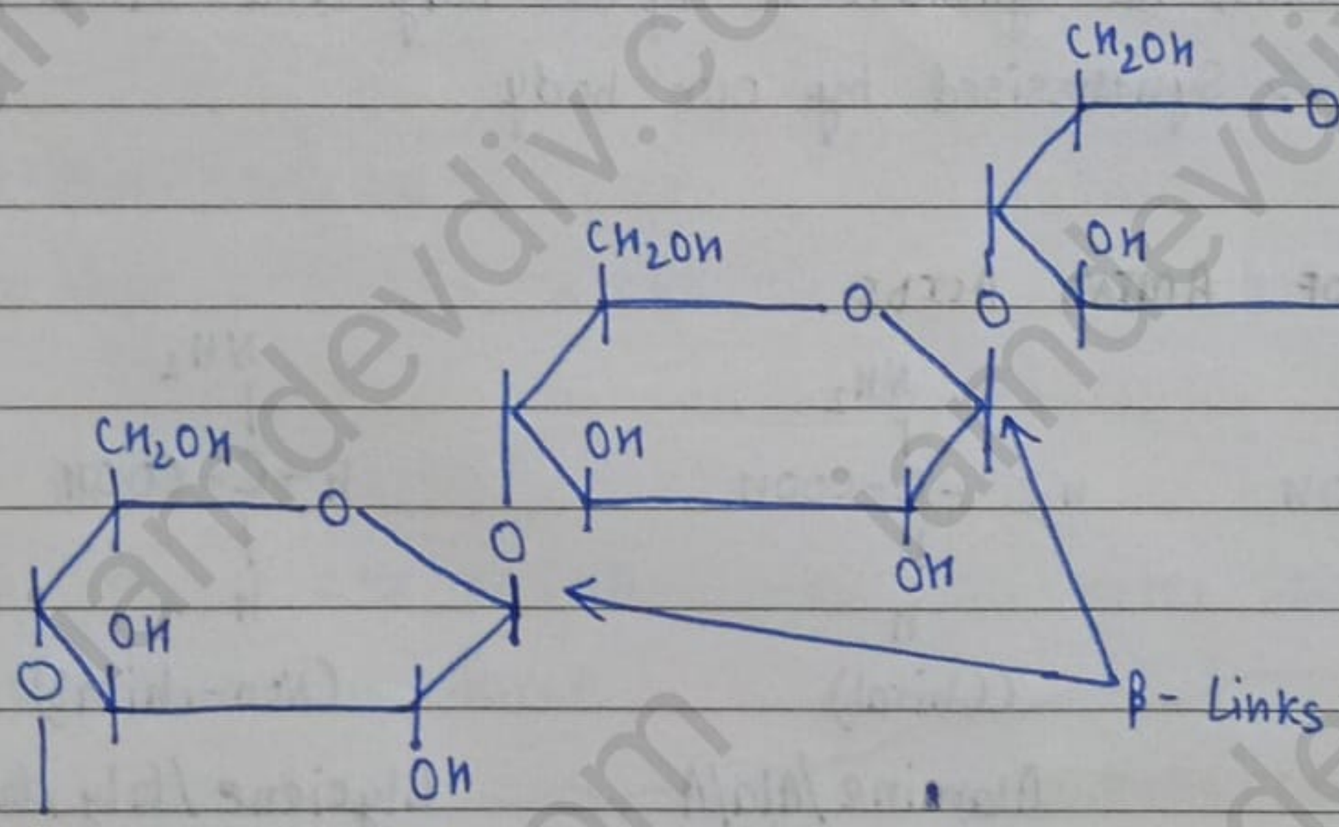


Amylose

- CELLULOSE

Cellulose occurs exclusively in plants and it is the most abundant organic substance in plant kingdom. It is a predominant constituent of cell wall of plant cells. Cellulose is a straight chain.

* β-D Glucose
* C_1-C_4 Glycosidic linkage



- GLYCOGEN

The carbohydrates are stored in animal body as glycogen. It is also known as animal starch because its structure is similar to amylopectin and is rather more highly branched. It is present in liver, muscles and brain. When the body needs glucose, enzymes break the glycogen down to glucose. Glycogen is also found in yeast and fungi.

☆ IMPORTANCE OF CARBOHYDRATES

Carbohydrates are essential for life in both plants and animals. They form a major portion of our ~~snail~~ food. Honey has been used for a long

time as an instant source of energy by 'vaids' in ayurvedic system of medicine. Carbohydrates are used as storage molecules as starch in plants and glycogen in animals. Cell wall of bacteria and plants is made up of cellulose. We build furniture, etc. from cellulose in the form of wood and clothes ourselves with cellulose in the form of cotton fibre. They provide raw materials for many important industries like textiles, paper, lacquers and breweries.

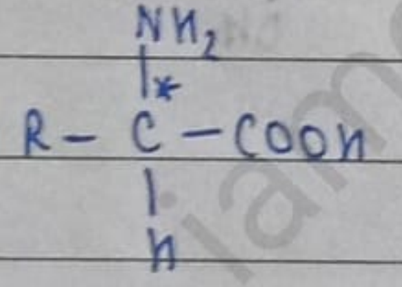
★ PROTEINS

- **AMINO ACIDS**

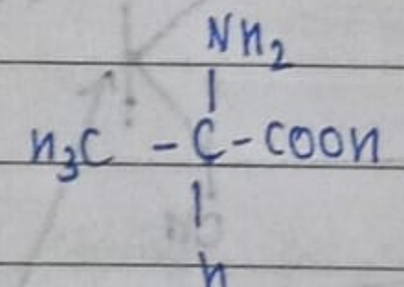
  On the basis of character

1) Essential → cannot be synthesised by our body and taken by diet.
2) Non-essential → Synthesised by our body

* STRUCTURE OF AMINO ACIDS

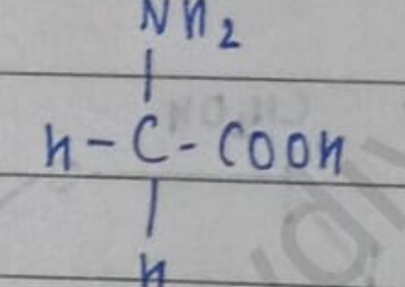


(Chiral)



(Chiral)

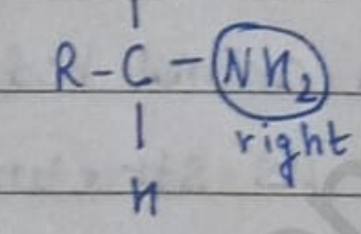
Alanine / Ala / A



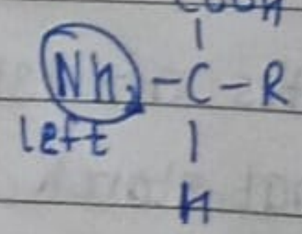
(Non-chiral)

Glyciene / Gly / G

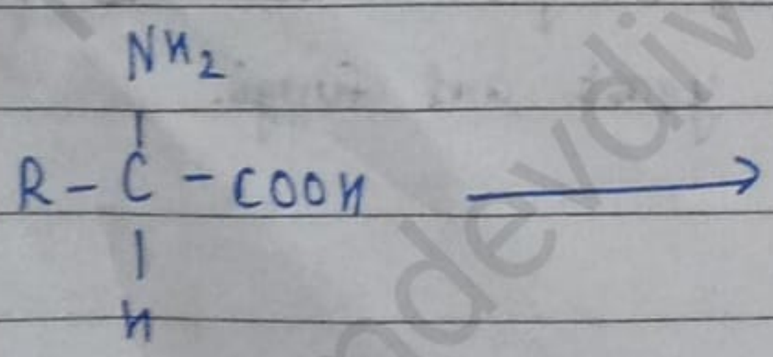
→ Colourless
→ Crystalline
→ Water soluble



D-amino acid

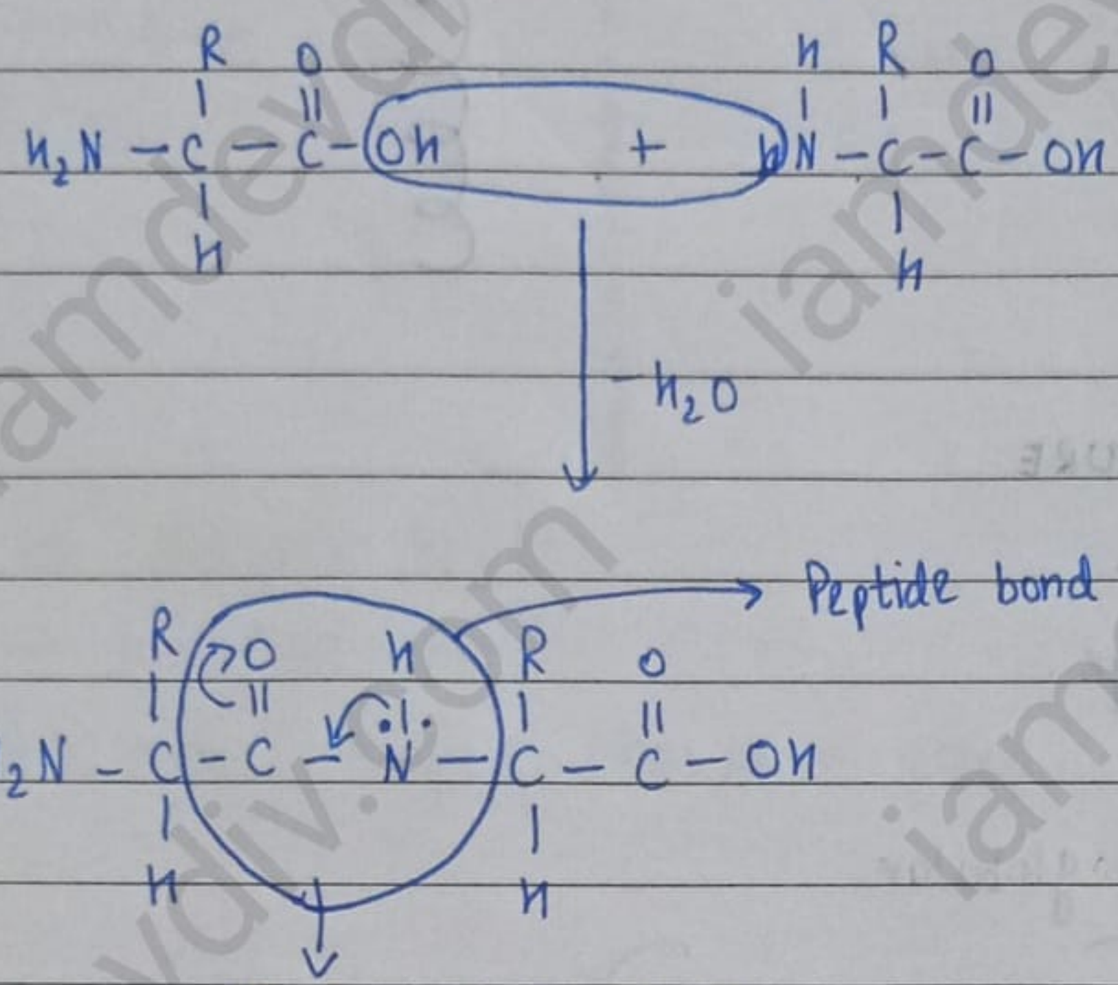


L-amino acid



Zwitter ion

- STRUCTURE OF PROTEINS



✓ Planar

Dipeptide bond → 2 amino acids

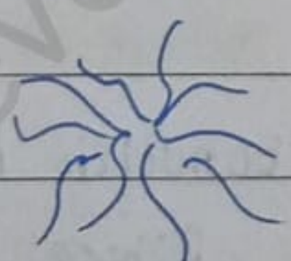
Tripeptide bond → 3 amino acids

* FIBROUS PROTEINS

Thin, long thread like structure which are water soluble. They have high intermolecular forces.

* GLOBULAR PROTEINS

Water soluble, folded



* PRIMARY STRUCTURE

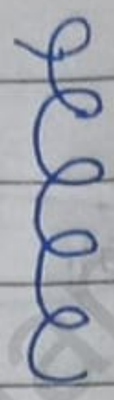
$AA_1 - AA_2 - AA_3 - AA_4$

→ peptide bond

DENATURATION OF PROTEIN

When a protein is subjected to physical change like change in temperature and change in pH. Example: boiling of egg, Curding of milk. Secondary and tertiary structures of protein destroyed while primary structure of protein remain intact. during denaturation (property of a protein change)

* SECONDARY STRUCTURE



H-bond

α-helix

β-sheets

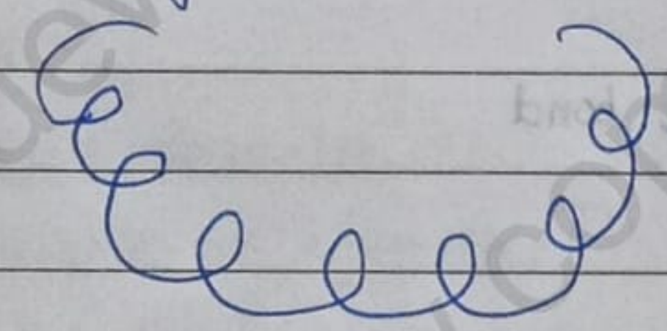
* TERTIARY STRUCTURE

H-bond

Disulphide linkage

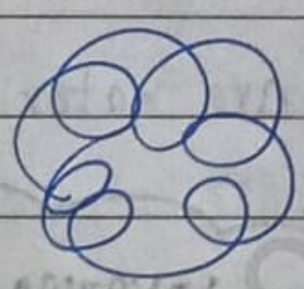
Vander waals

Fibrous proteins globular



* QUATERNARY STRUCTURE

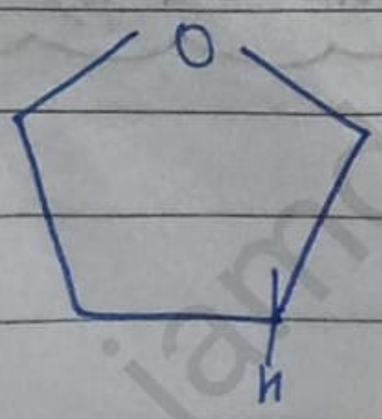
Two or more polypeptide chain linkage



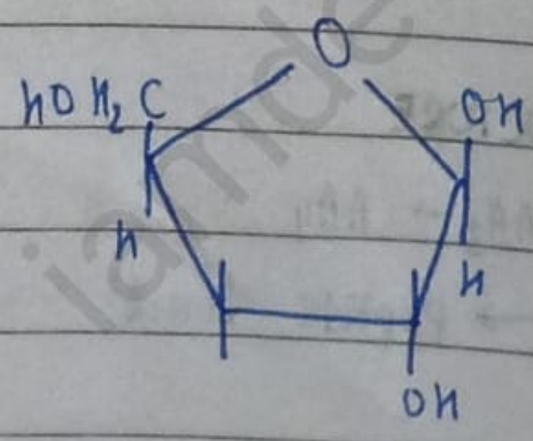
* NUCLEIC ACID

• DNA AND RNA

Deoxyribonucleic Acid (DNA)/
Deoxyribose



Ribonucleic Acid (RNA)/
Ribose



ATGC

A = T G ≡ C

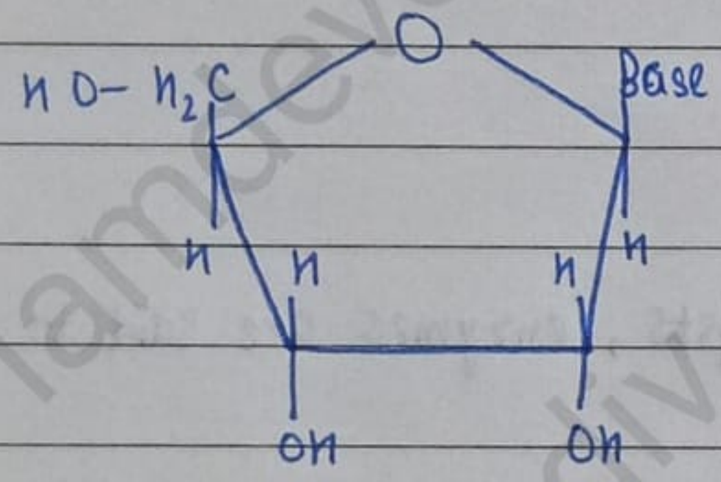
AUGC

A = U G ≡ C

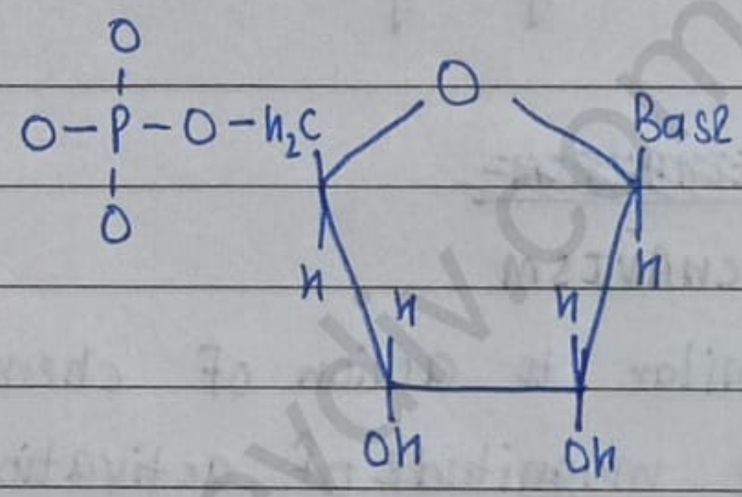
• STRUCTURE OF NUCLEIC ACID

Nucleoside → Sugar + Base

Nucleotide → Sugar + base + phosphate group



(a)



(b)

★ VITAMINS

There are complex ~~structure~~ organic molecule doesn't produce by our body so must be supplied through diet to perform specific biological action, for normal growth and maintenance.

Water soluble → B, C

Fat soluble → A, D, E, K

• DEFICIENCY OF VITAMINS

Deficiency of a vitamin causes deficiency disease.

Deficiency of more than one vitamin causes Avitaminoses.

Excess of vitamins causes Hypervitaminoses.

A → Xerophthalmia, night blindness

B_1 → Beri-Beri

B_2 → Cheilosis

B_6 → Convulsions

B_{12} → Pernicious Anaemia

C → Scurvy

D → Rickets

E → Muscular weakness

K → increase blood clotting time

★ ENZYMES

These are biocatalysts used to catalyse biochemical reaction occuring in living organisms.

~~MECHANISM~~

• MECHANISM

Similar to action of chemical catalysts, enzymes are said to reduce the magnitude of activation energy.

★ HORMONES

Hormones are biomolecules that are produced in the ductless (endocrine) glands and transported by the bloodstream to various parts of the body where they control various metabolic processes. These are required in minute amounts, and unlike fats and carbohydrates, are not stored in the body but are constantly produced.