



Class XI Academic Program-2020

# BIOLOGY

Lecture : B-06

Chapter 03 : Cell Chemistry

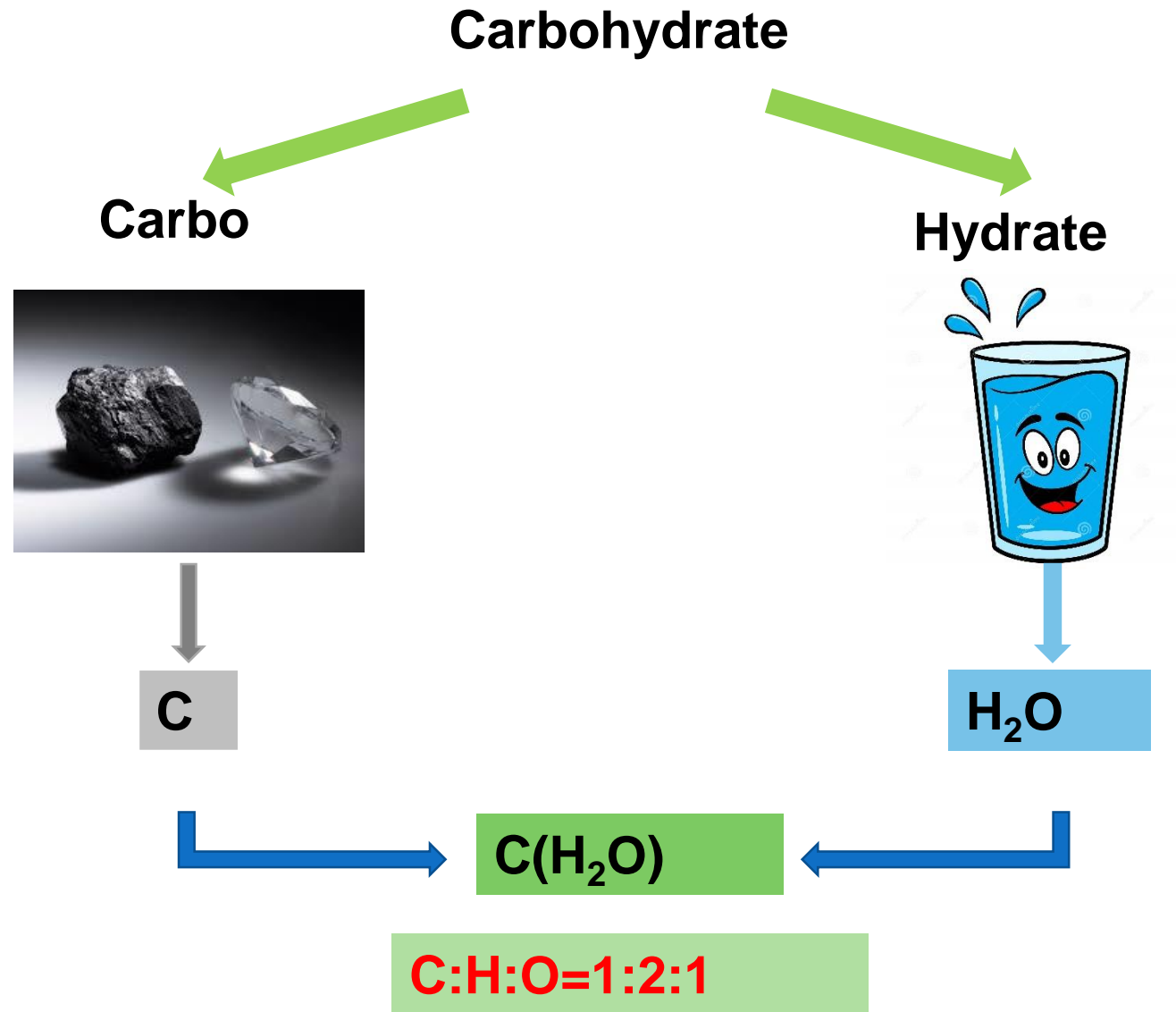


উদ্ভাস

একাডেমিক এন্ড এডমিশন কেয়ার

[www.udvash.com](http://www.udvash.com)

# Hydrates of Carbon



## Do all the Carbohydrates have a 1:2:1 ratio ?

Sometimes two or more small carbohydrate molecules combine to form a new bigger carbohydrate molecule. At this time, one molecule of water comes out of every two adjacent carbohydrate molecules. Therefore C:H:O=1:2:1 ratio is not always maintained.



C:H:O  
ratio

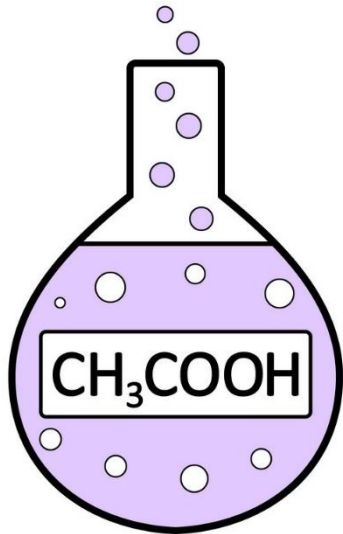
1:2:1

1:2:1

~~1:2:1~~

## All that glitters isn't gold

Despite the  $C:H:O = 1:2:1$  ratio, many compounds are not carbohydrates. e.g.,



### Acetic acid

Formula:  $CH_3COOH$

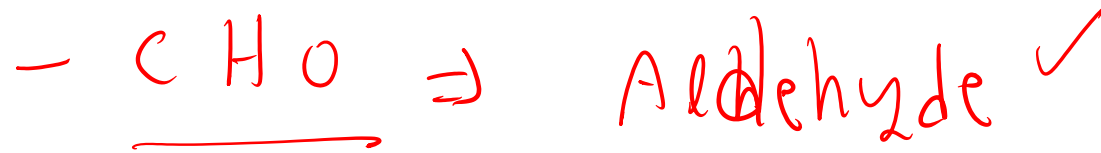
$C:H:O$  ratio= $1:2:1$

Nature: Organic acid

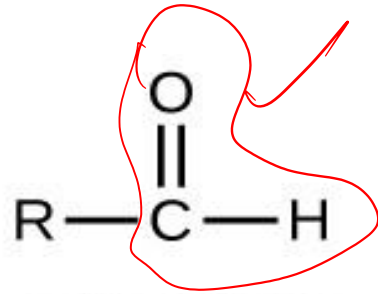
## Then what's the proper definition of Carbohydrate?

From the above discussion it is understood that  $C:H:O = 1:2:1$  is a preliminary rule. So what is the proper definition of carbohydrate?

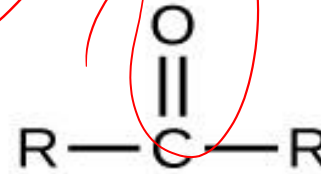
Carbohydrates are poly hydroxy aldehyde or poly hydroxy ketone or their derivatives.



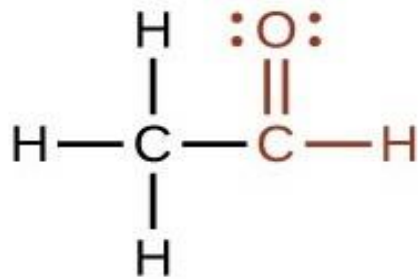
# Aldehyde and Ketone



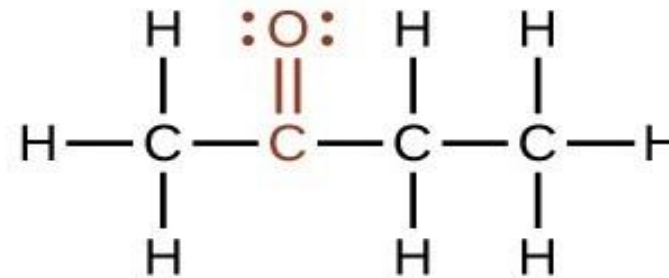
Functional group  
of an aldehyde



Functional group  
of a ketone



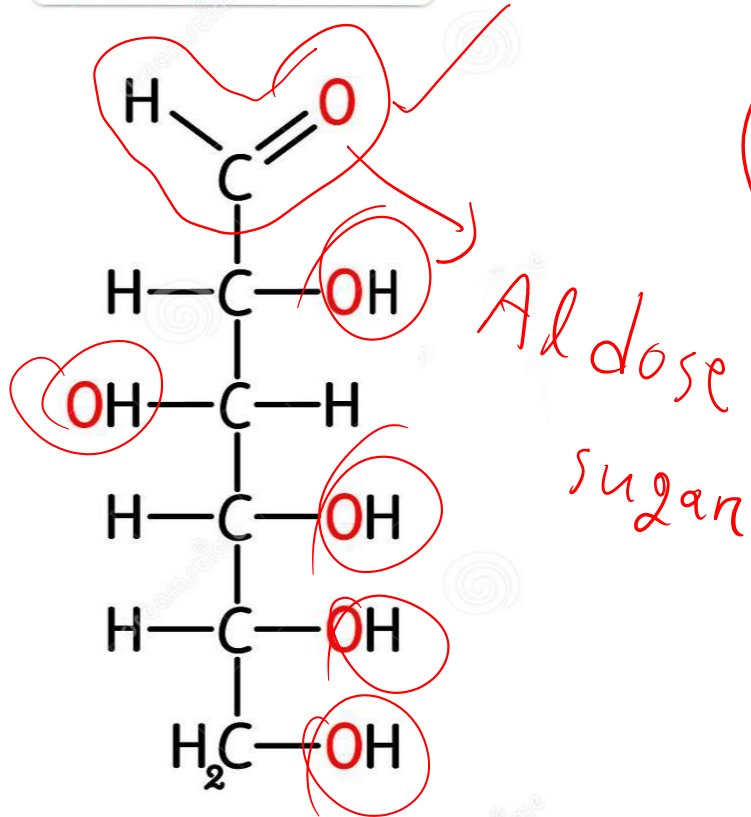
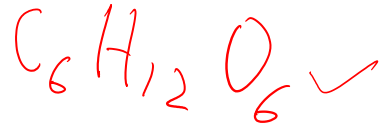
CH<sub>3</sub>CHO  
An aldehyde  
ethanal (acetaldehyde)



CH<sub>3</sub>COCH<sub>2</sub>CH<sub>3</sub>  
A ketone  
butanone

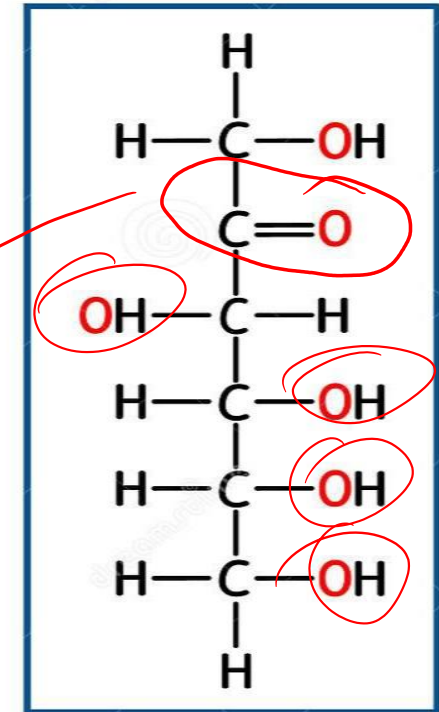
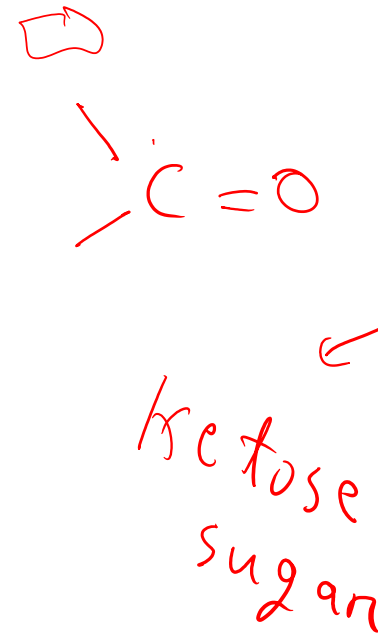
# Poly Hydroxy Aldehyde & Poly Hydroxy Ketone

## Glucose



isomane

## Fructose



# Types

## Carbohydrate

2 types on the basis of taste ✓



1. Sugar ✓
2. Non-sugar ✓

2 types on the basis of reducing ability ✓



1. Reducing sugar ✓
2. Non-reducing sugar ✓

\* \* 4 types on the basis of chemical structure ✓



1. Monosaccharide ✓
2. Disaccharide ✓
3. Oligosaccharide (3, 4, 6) ✓
4. Polysaccharide ✓



# Sugar and non-sugar

## Sugar

- It's sweet in taste
- Granular
- Soluble in water
- Example- glucose, fructose, sucrose



## Non-sugar

- It's not sweet in taste
- Agranular
- Insoluble in water
- Example- starch, cellulose, glycogen



# Monosaccharide

↓  
simplest form of  
carbohydrate

➤ General formula:  $C_nH_{2n}O_n$

➤ Number of carbon atoms: 3-10

➤ Types on the basis of carbon no.

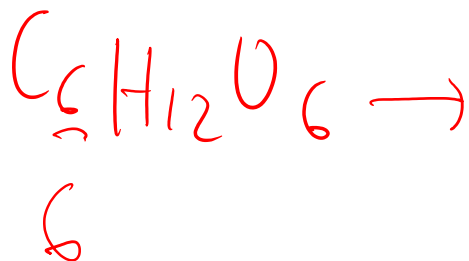
③ ➤ **Triose**: **Aldose**- glyceraldehyde; **Ketose**- dihydroxyacetone

④ ➤ **Tetrose**: **Aldose**- erythrose, **Ketose**- erythrulose

⑤ ➤ **Pentose**: **Aldose**- xylose, ribose, deoxyribose, arabinose, **Ketose**- ribulose, xylulose  
→ RNA → DNA

⑥ ➤ **Hexose**: **Aldose**- glucose, manose, galactose, **Ketose**- fructose

⑦ ➤ **Heptose**: **Aldose**- sedoheptulose



# DNA, RNA contains Carbohydrates!

DNA is composed of-

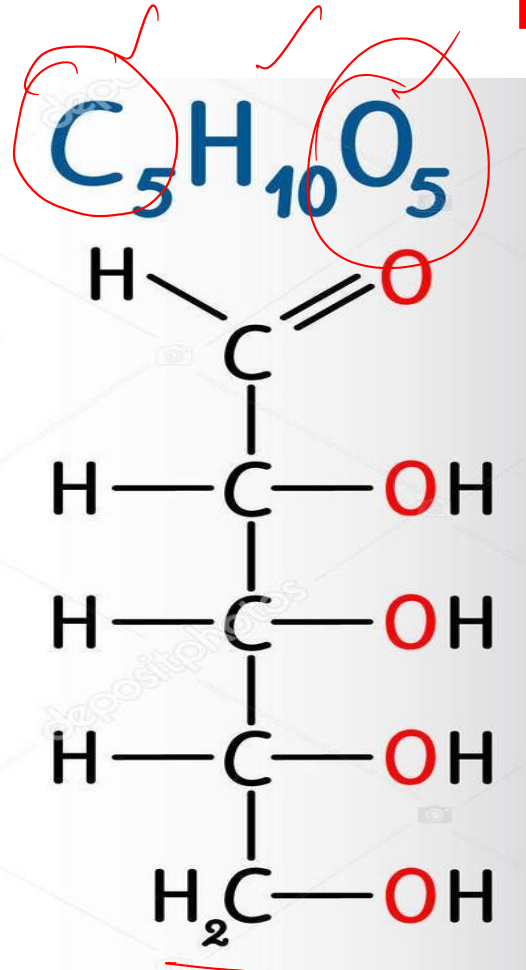
- **Deoxyribose** sugar
- N base
- Phosphate group

RNA is composed of-

- **Ribose** sugar
- N base
- Phosphate group

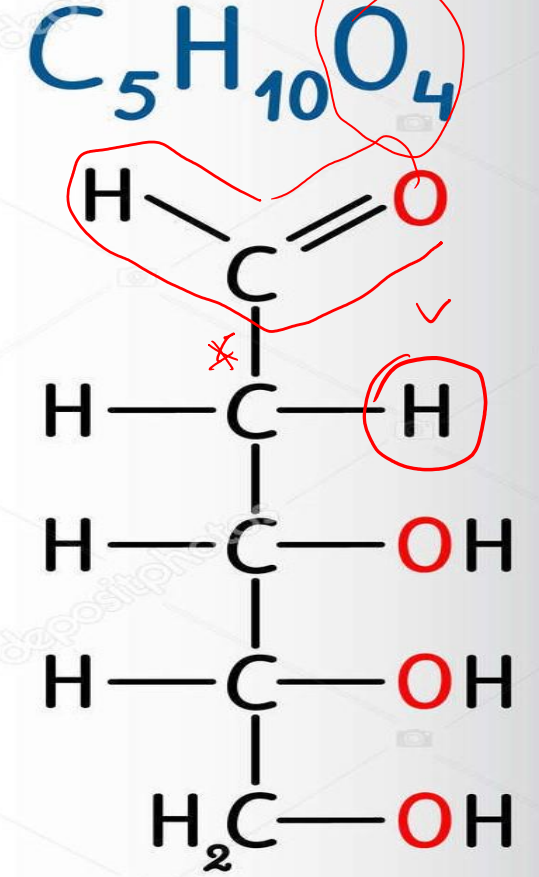
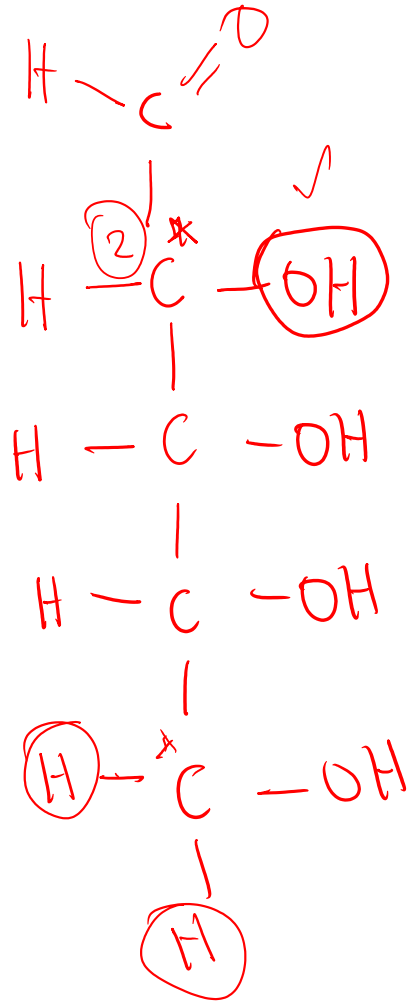


# Pentose: Deoxyribose & Ribose



**Ribose**

RNA



**Deoxyribose**

DNA

## Hexose: Glucose(Grape sugar)

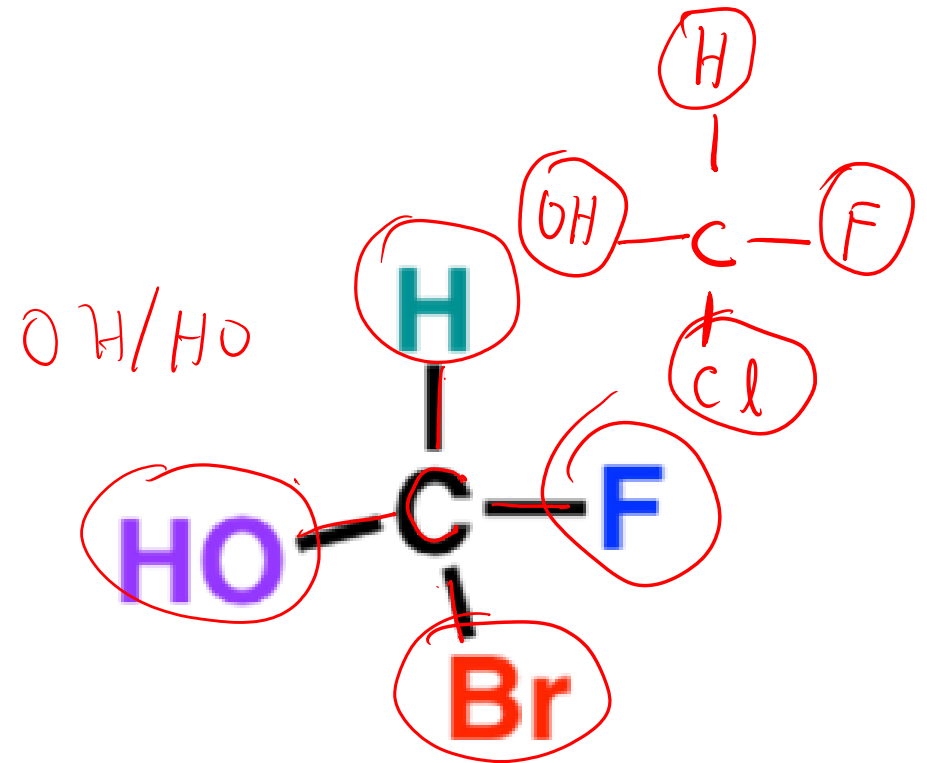
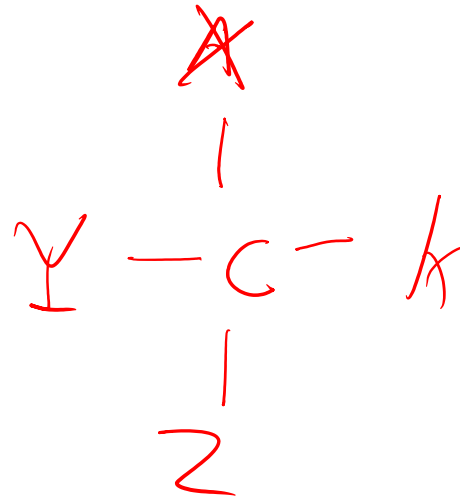
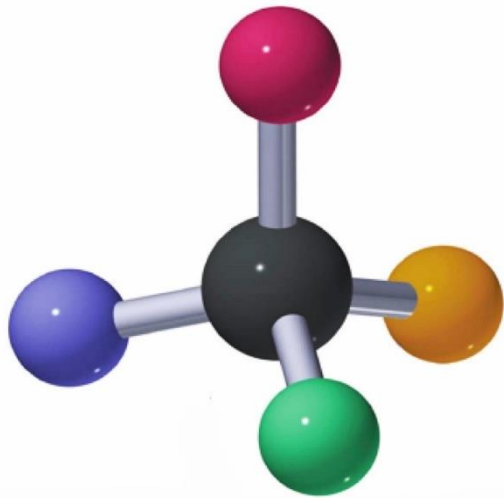
- ❖ Another name is dextrose
- ❖ Formula:  $C_6H_{12}O_6$
- ❖ Aldohexose
- ❖ Different types of ripe fruits and honey contain a profuse amount of glucose. The amount of glucose in ripe grapes is 12-30 percent. So it's called grape sugar.



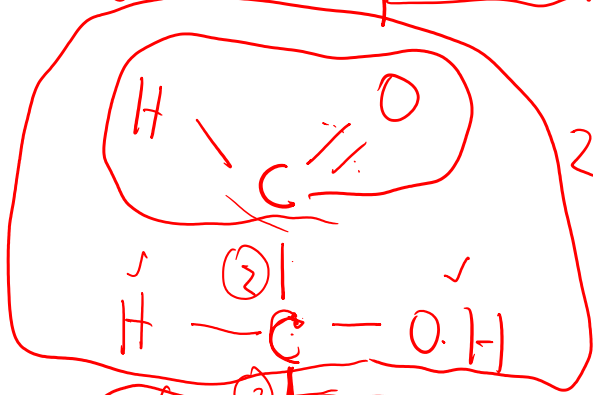
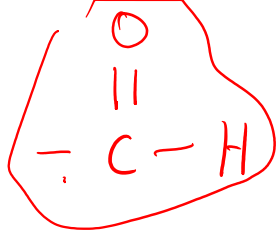
# Glucose: Structure

Before we know the structure of glucose, let us know what is asymmetric carbon or chiral carbon.

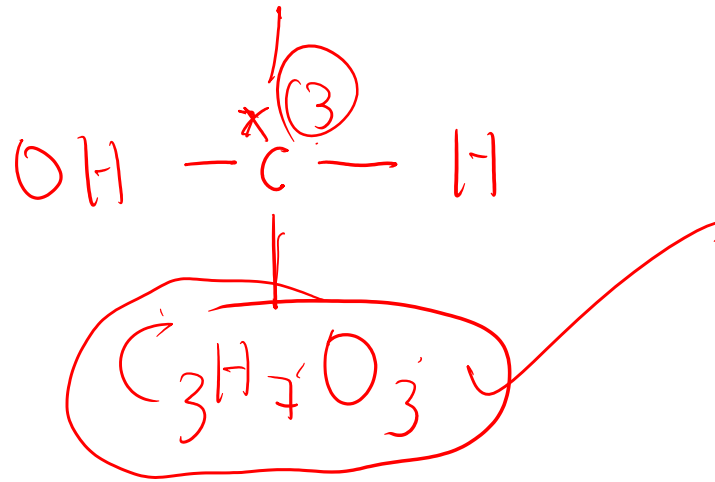
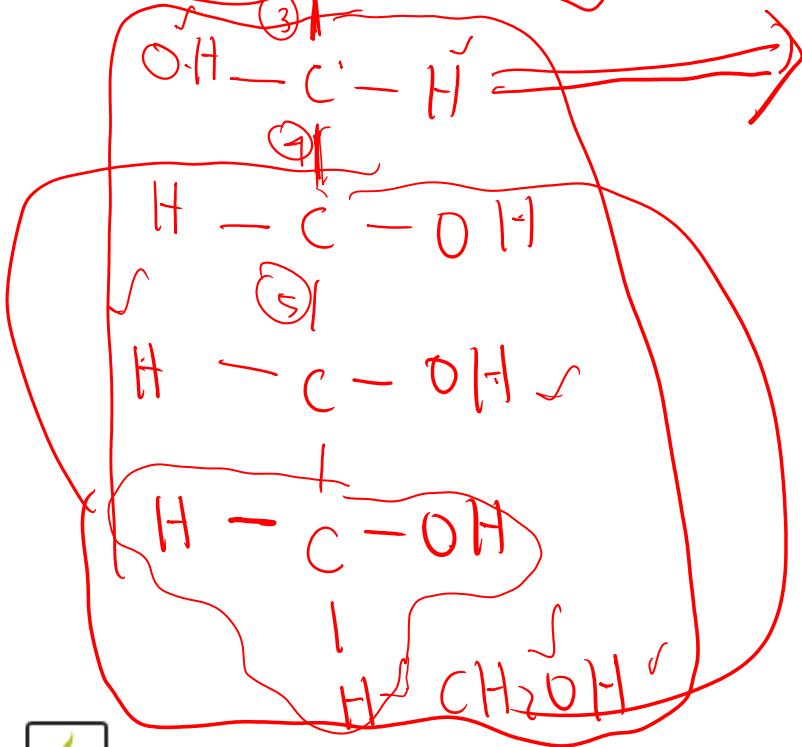
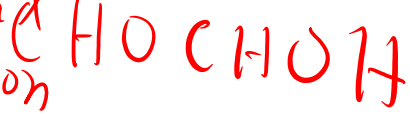
An asymmetric carbon atom (<sup>✓</sup>chiral carbon) is a carbon atom that is attached to **four different** types of atoms or groups of atoms.







2, 3, 4, 5 → chiral carbon



উদ্ভাস

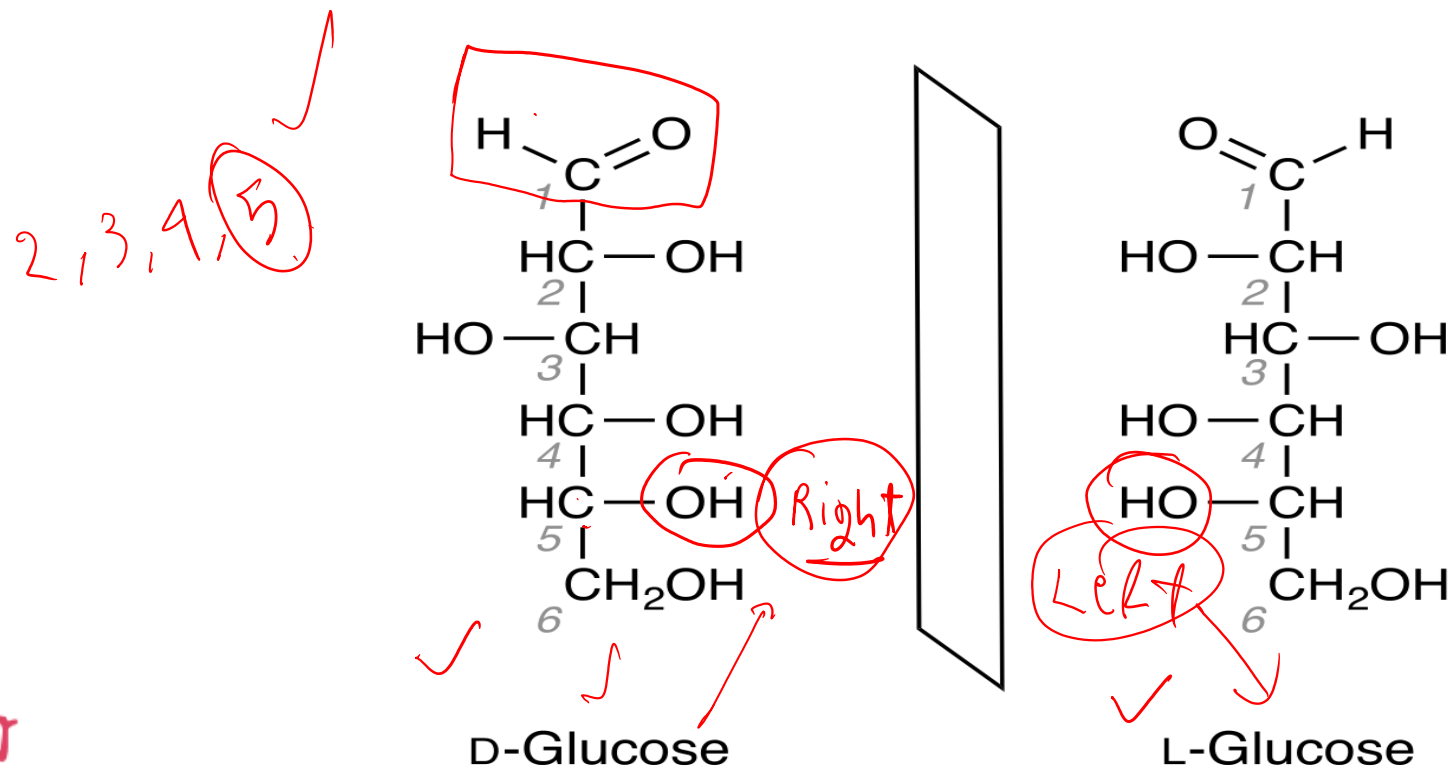
একাডেমিক এন্ড এডমিশন কন্ট্রোল

Biology 1<sup>st</sup> Paper

Chapter 03 : Cell Chemistry

## D & L form

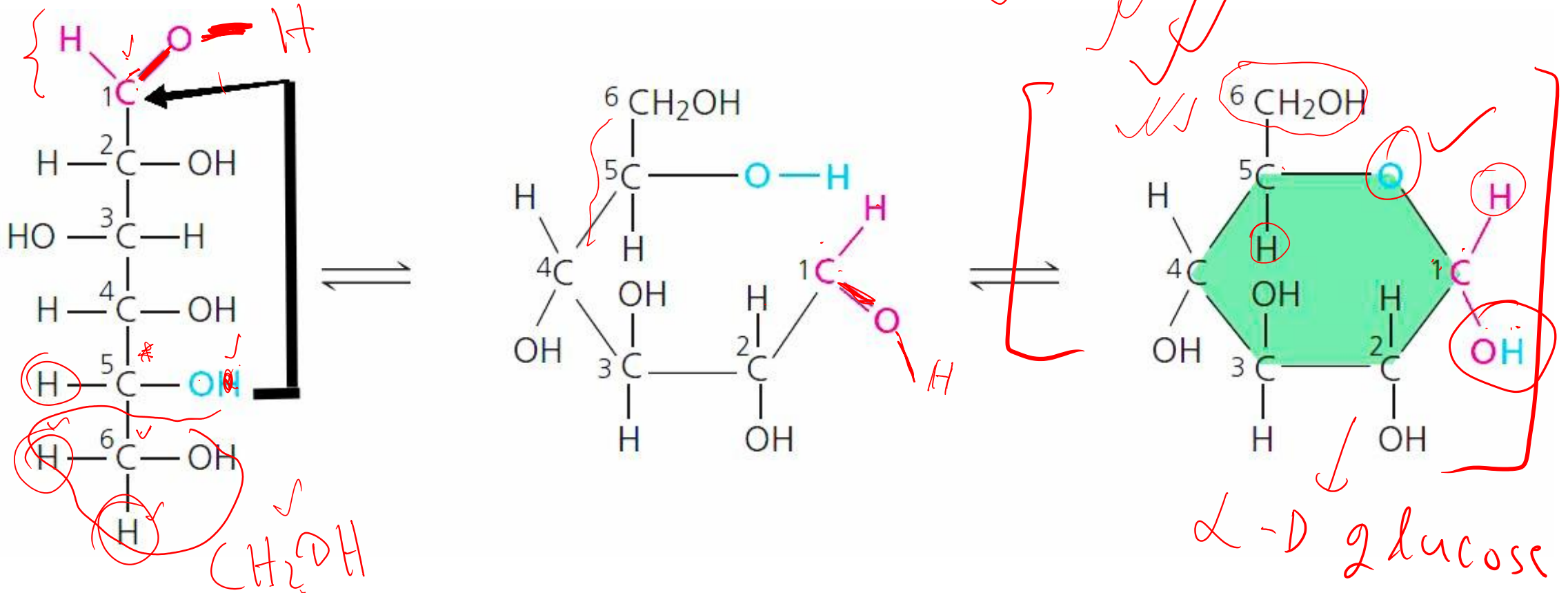
D and L forms are two types of stereo isomer of a monosaccharide. L isomers have the hydroxy group attached to the left side of the asymmetric carbon farthest from the carbonyl, while D isomers have the hydroxy group on the right side. The C5 in glucose is the farthest asymmetric carbon. So if OH group in C5 is on the right side it is called D glucose and if the OH group is on the left side it is called L glucose.



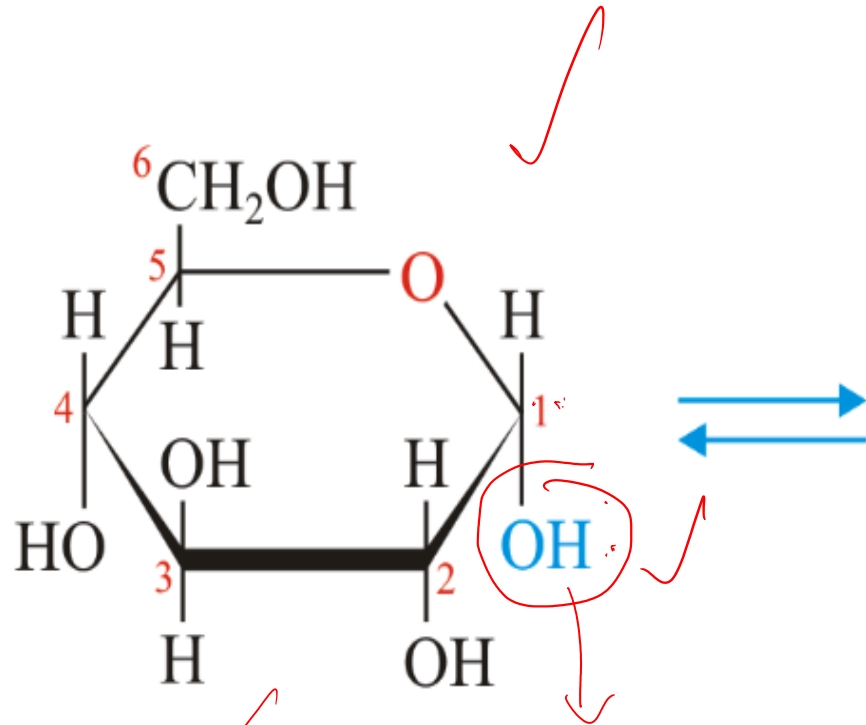


# Ring structure of glucose

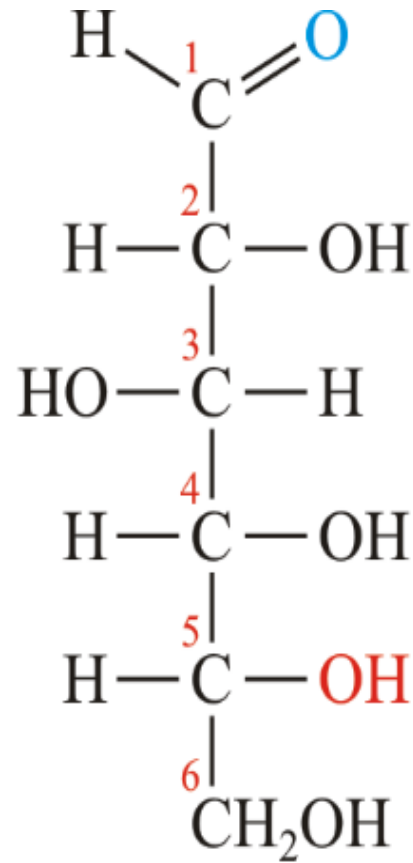
In solution, C1 of glucose usually comes closer to C5. Then the ring structure of glucose is formed.



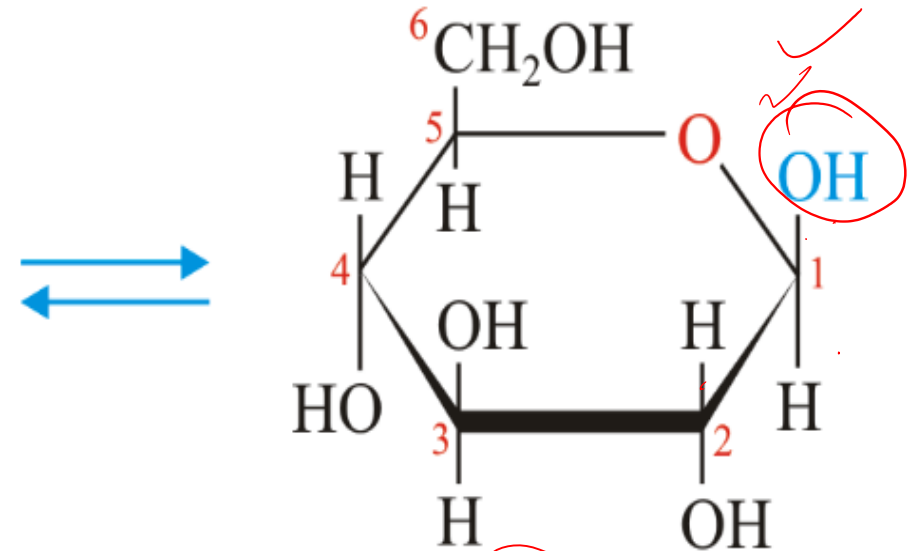
## $\alpha$ - D & $\beta$ - D Glucose



$\alpha$ -D-glucose



D-glucose



$\beta$ -D-glucose

## Poll Question:01

Which of the following is called dextrose ?

(a) Sucrose

(b) Fructose

(c) Glucose

(d) Cellulose

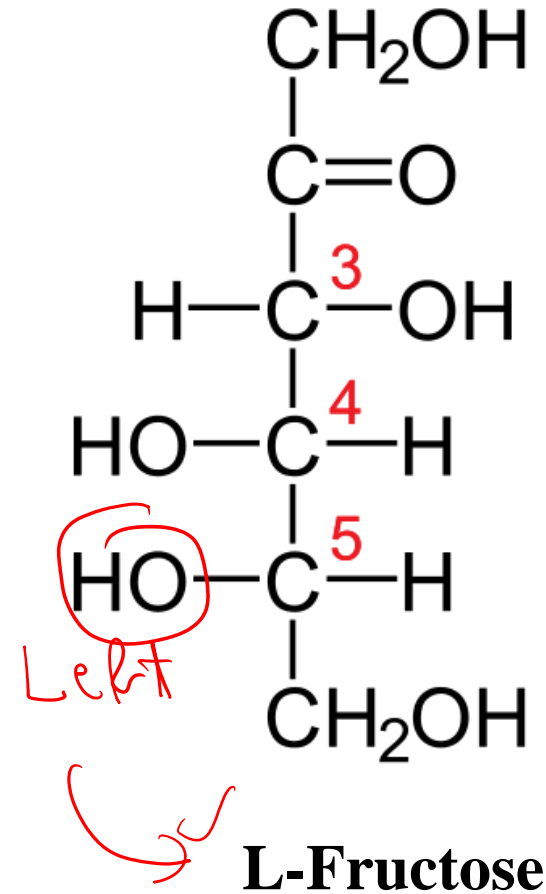
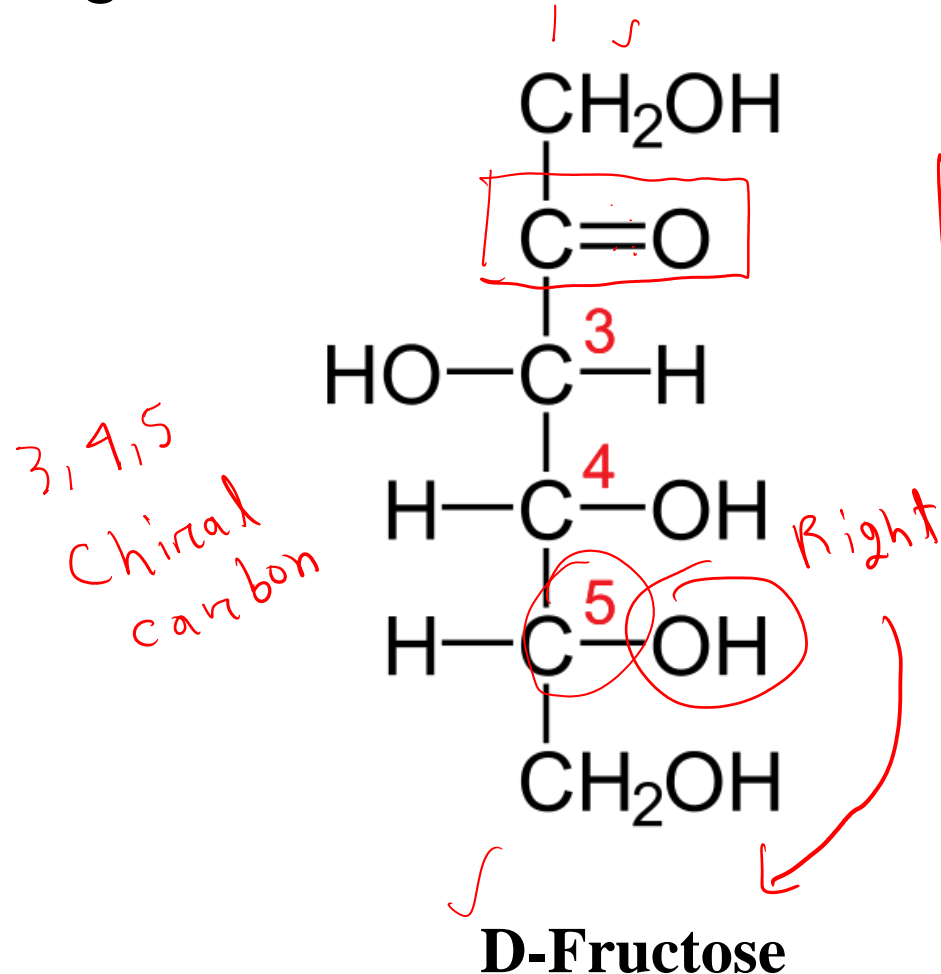
# Hexose: Fructose

- ❖ Formula:  $C_6H_{12}O_6$
- ❖ It's a ketohexose
- ❖ Most ripe sweet fruits and honey contain fructose. So it's called fruit sugar.
- ❖ It was first identified from fruit. So it was named fructose.
- ❖ Fructose combines with glucose to form sugar.

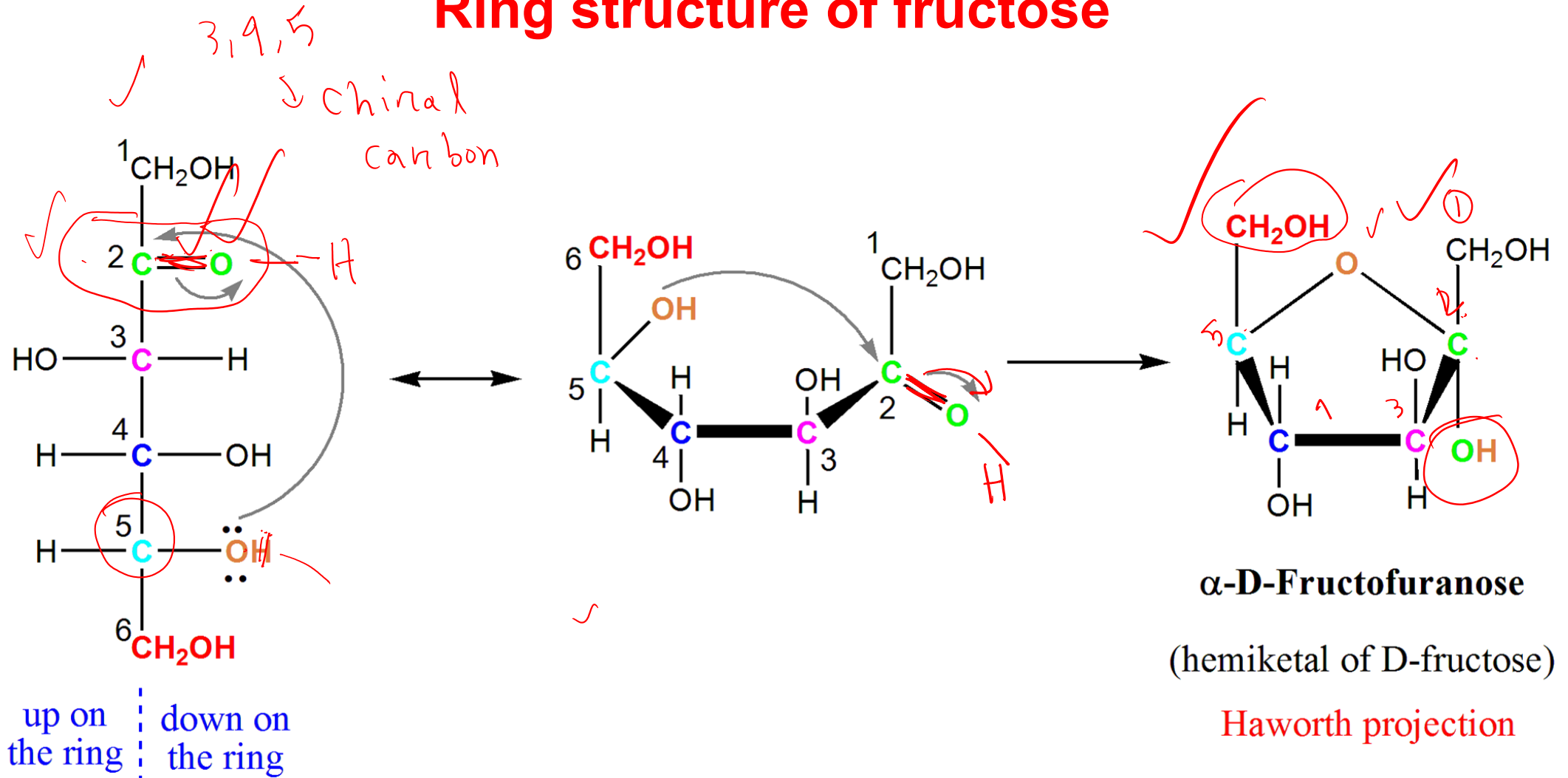


# D & L Fructose

Like glucose, fructose also has D & L form



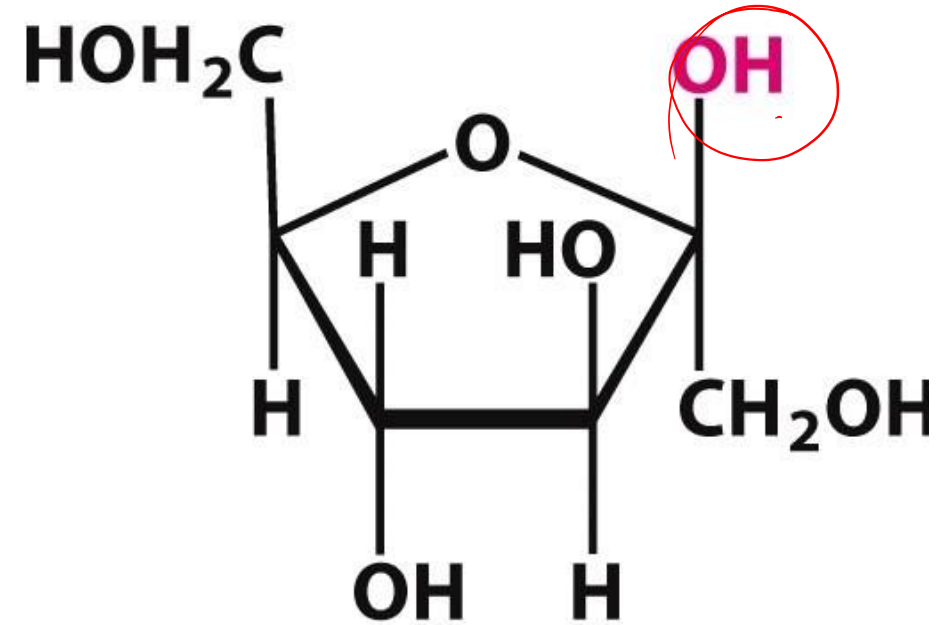
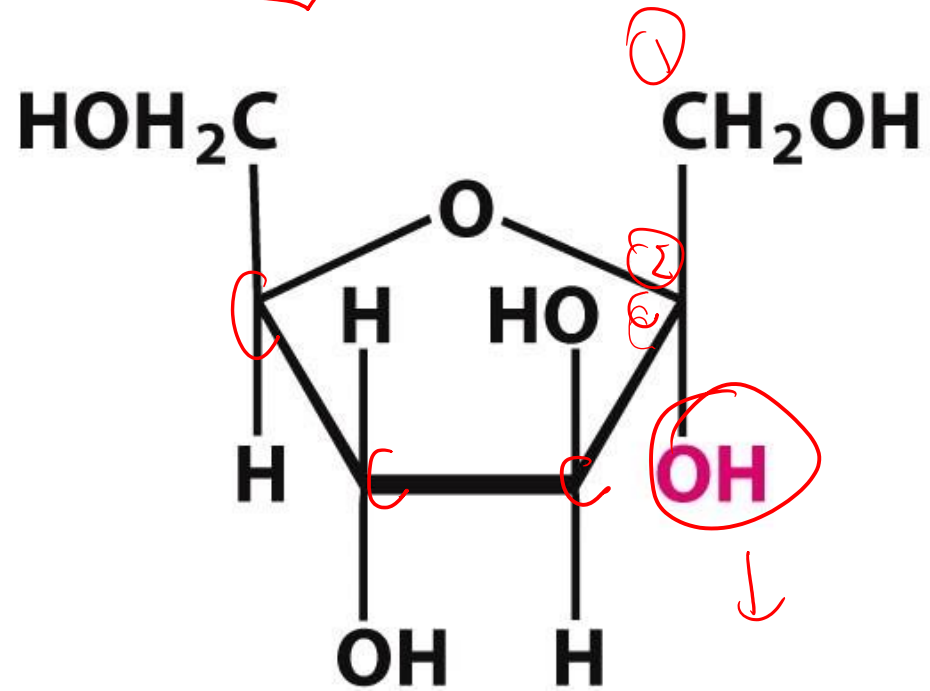
# Ring structure of fructose



উদ্ভাস

একাডেমিক এন্ড এডমিশন কেয়ার

## $\alpha$ - D & $\beta$ - D Fructose





# Diasaccharide



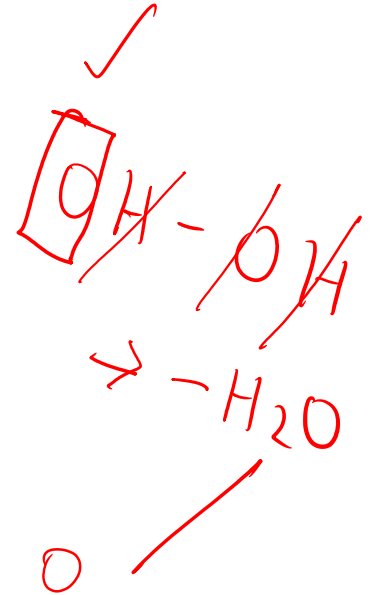
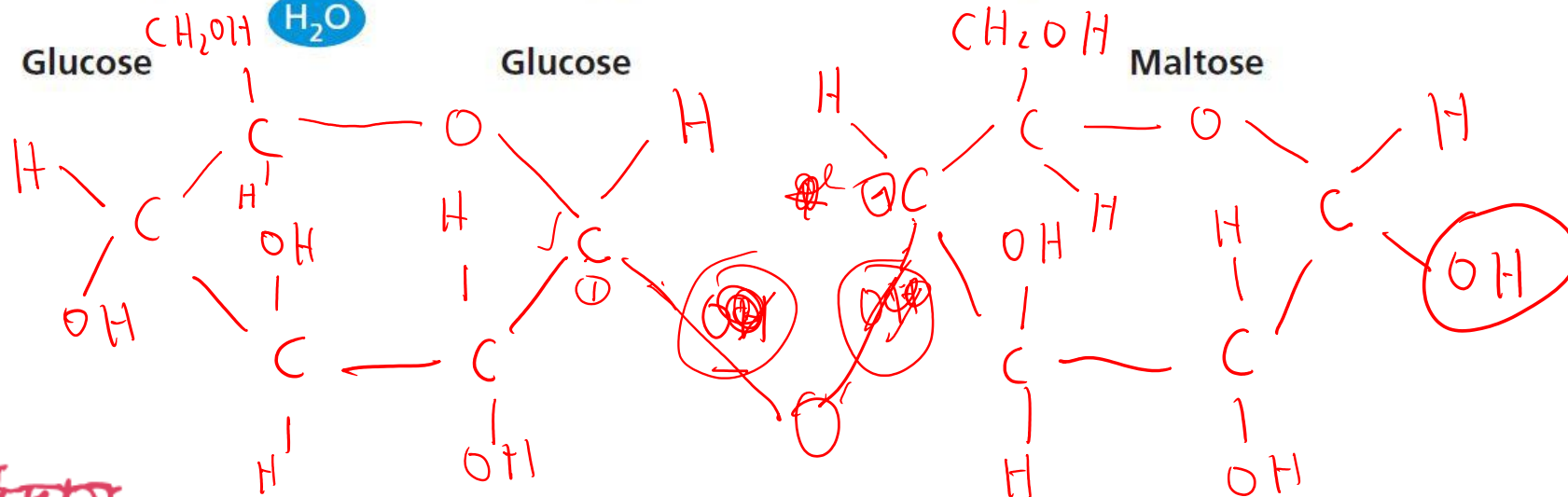
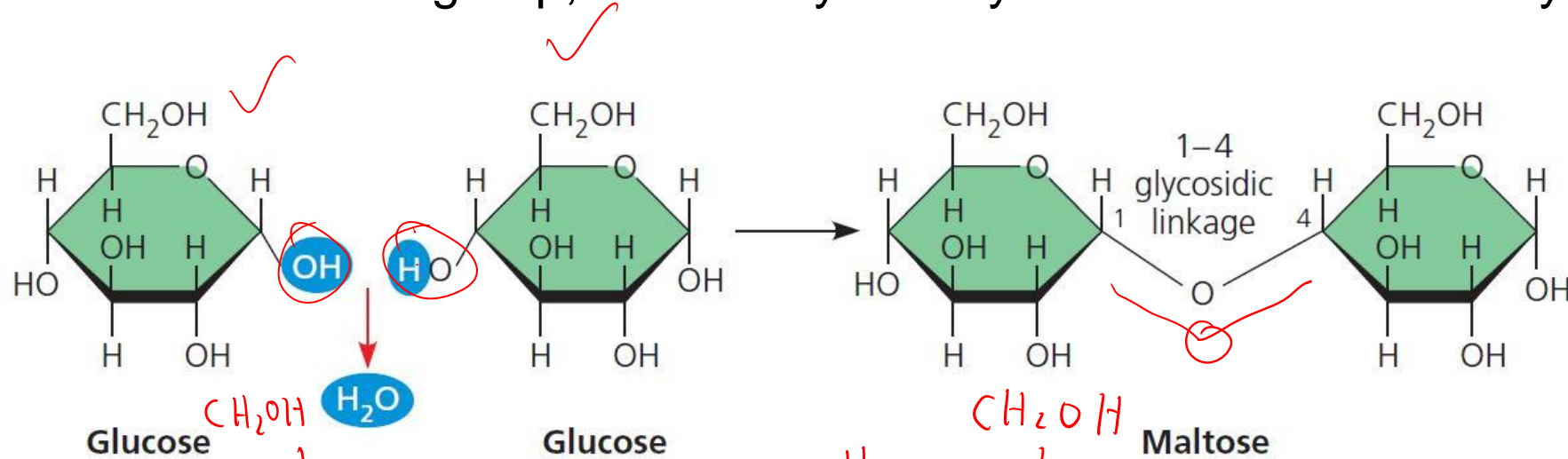


# Diasaccharide

- ❖ A disaccharide is the carbohydrate formed when two molecules monosaccharide are joined by glycosidic linkage.
- ❖ Example: sucrose, cellobiose, maltose, lactose
  - sucrose  $\rightarrow$   $\alpha$ -D glucose +  $\beta$ -D fructose
  - cellobiose  $\rightarrow$   $\beta$ -D glucose +  $\beta$ -D glucose
  - maltose  $\rightarrow$   $\alpha$ -D glucose +  $\alpha$ -D glucose
  - lactose  $\rightarrow$  glucose + galactose
- ❖ The condensation reaction between two molecules of monosaccharide results in the removal of one molecule of water from the two -OH radicals.

# Glycosidic bond

A glycosidic bond or glycosidic linkage is a type of covalent bond that joins a carbohydrate molecule to another group, which may or may not be another carbohydrate.



উদ্ভাস

একাডেমিক এন্ড এডমিশন কন্ট্রোল

Biology 1<sup>st</sup> Paper

Chapter 03 : Cell Chemistry

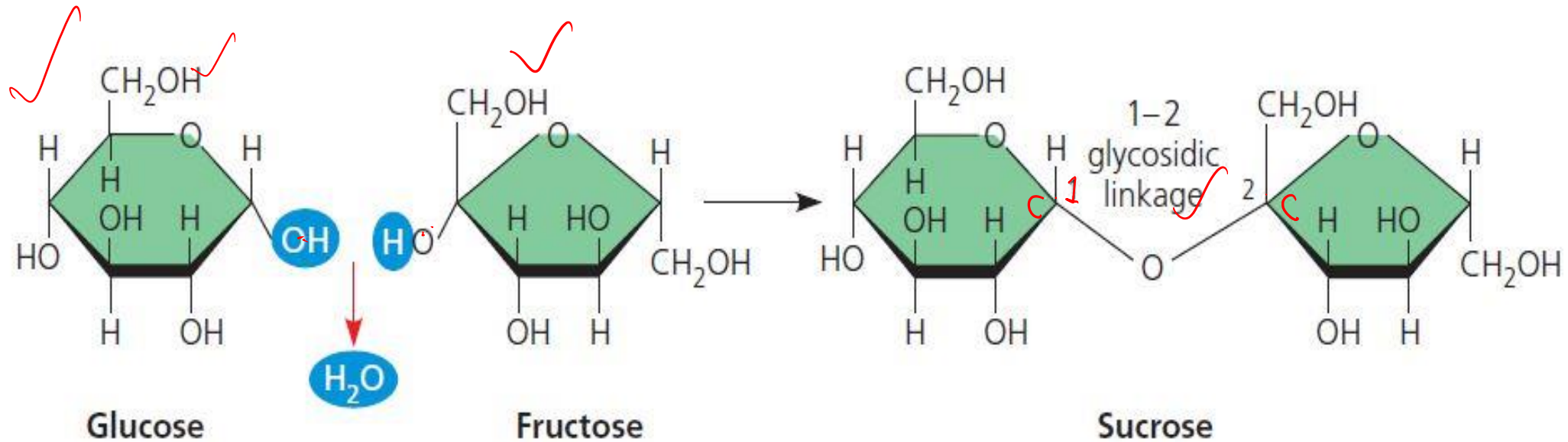
# Diasaccharide: Sucrose

- ❖ Formula:  $C_{12}H_{22}O_{11}$
- ❖ One molecule  $\alpha$ -D glucose combines with one molecule  $\beta$ -D fructose to form one molecule "sucrose". During this, one molecule of water is formed.
- ❖ Both glucose and fructose are reducing sugars, but sucrose is not a reducing sugar.
- ❖ The principal disaccharide of plants.
- ❖ Carbohydrates synthesized in the leaves of green plants are transported to other parts of the plant as sucrose.

sugar = sucrose



# Sucrose



Reducing sugar: Free aldehyde/ketone group present:  
 Non " " : All monosaccharide,  
 " " / " " absent, disaccharide (except sucrose)  
 Example: Sucrose

# Oligosaccharide

- ❖ 3 to 10 molecules of monosaccharide combine to form one oligosaccharide.
- Trisaccharide : Composed of three molecules monosaccharides.
  - Raffinose → Glucose + Fructose + Galactose
- Tetrasaccharide : Composed of four molecules monosaccharides.
  - stachyose → Glucose + Fructose + (2)Galactose

## Poll Question:02

Oligosaccharides are composed of\_\_\_\_

(a) 2-10 monosaccharides

(b) 3-10 monosaccharides

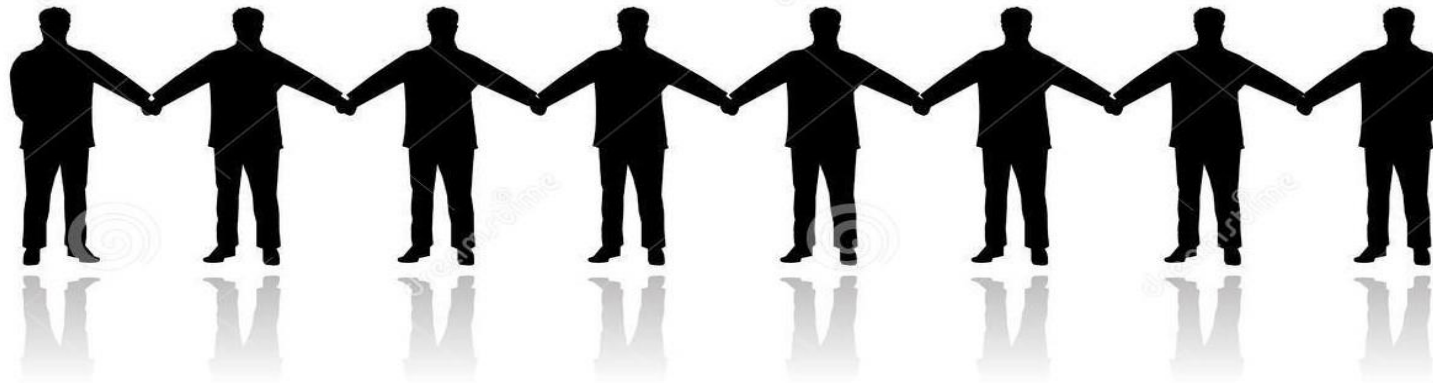
(c) 4-10 monosaccharides

(d) 5-10 monosaccharides



# Polysaccharide

- Consists of more than ten monosaccharide molecules.
- Usually insoluble in water and not sweet.
- Examples: starch, cellulose, glycogen
- Cellulose is most commonly found in nature.



# Polysaccharide: Starch

"Polymer of  
D-D glucose"

- ❖ Formula :  $(C_6H_{10}O_5)_n$
- ❖ Consists of amylose and amylopectin.
- ❖ Exists as a stored substance of plants.
- ❖ Paddy, wheat, potato are the main sources of starch.
- ❖ Round potato starch particles are the largest and rice starch particles are the smallest.





# Amylose and Amylopectin.

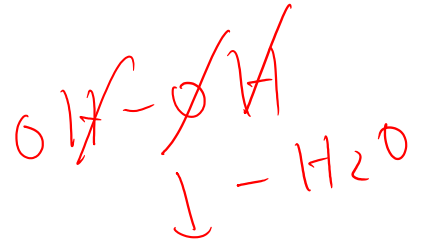
## Amylose ✓

- $\alpha$ -1-4 glycosidic bonds are present.
- Consists of 200 to 1000 glucose molecules.
- Unbranched
- 22% of the starch found in potato, rice, wheat, maize barley is amylose.
- Changes its color to black(black-blue) in presence of iodine.

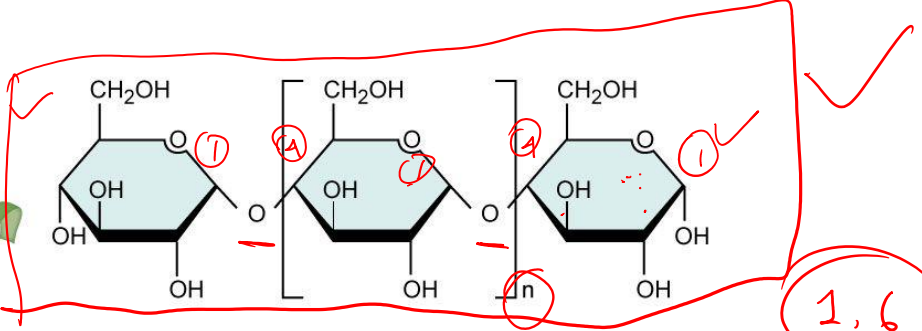
## Amylopectin ✓

- In addition to the  $\alpha$ -1-4 glycosidic bonds,  $\alpha$ -1-6 glycosidic bonds are also present.
- Consists of 2000 to 200,000 glucose molecules.
- Branched
- 78% of the starch found in potato, rice, wheat, maize barley is amylopectin.
- Changes its color to red or purple in presence of iodine.

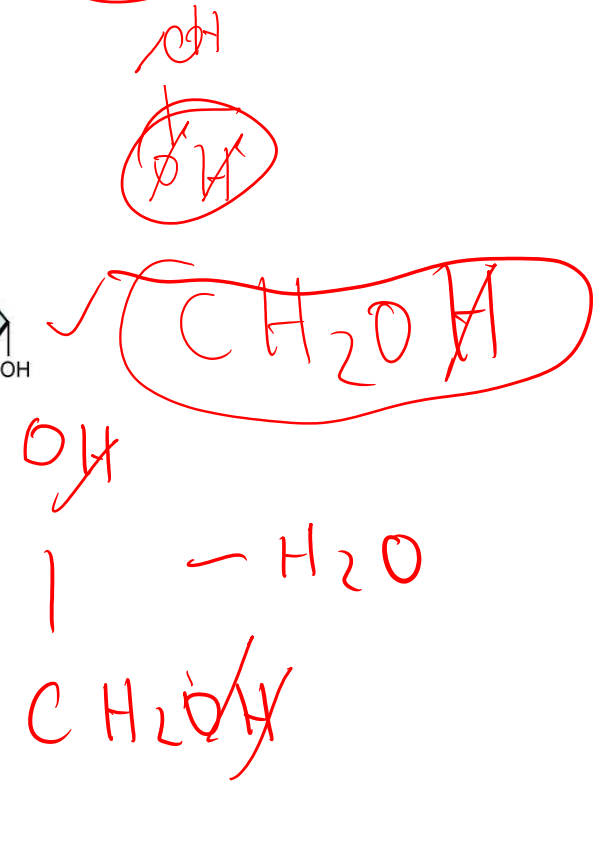
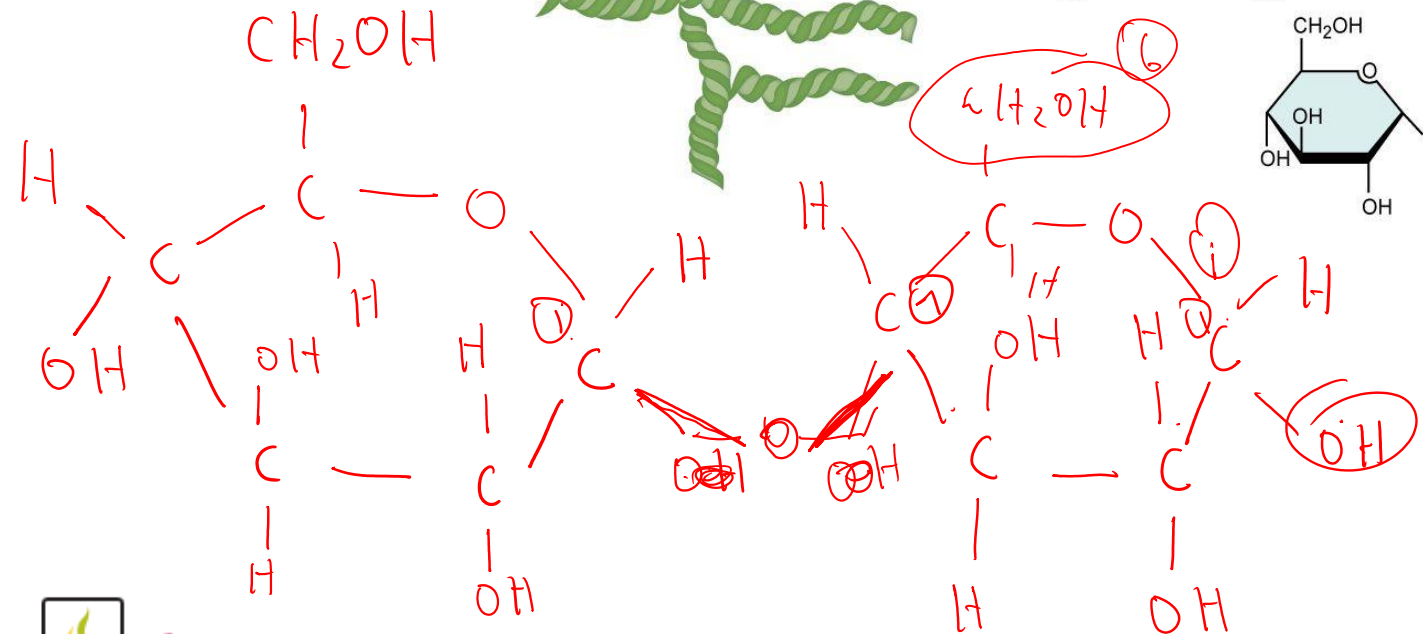
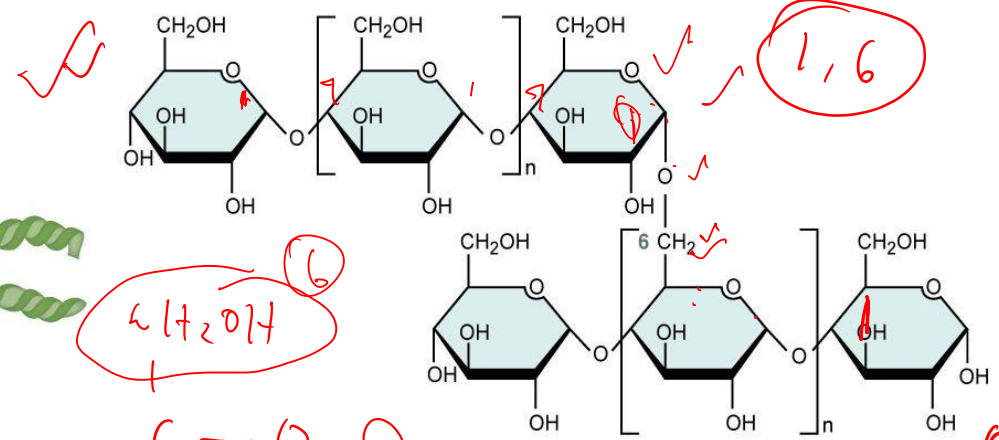
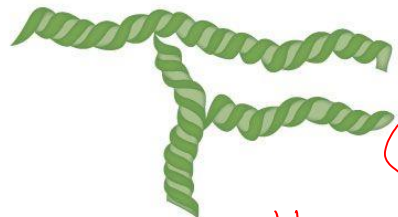
# Amylose and Amylopectin.



Amylose



Amylopectin



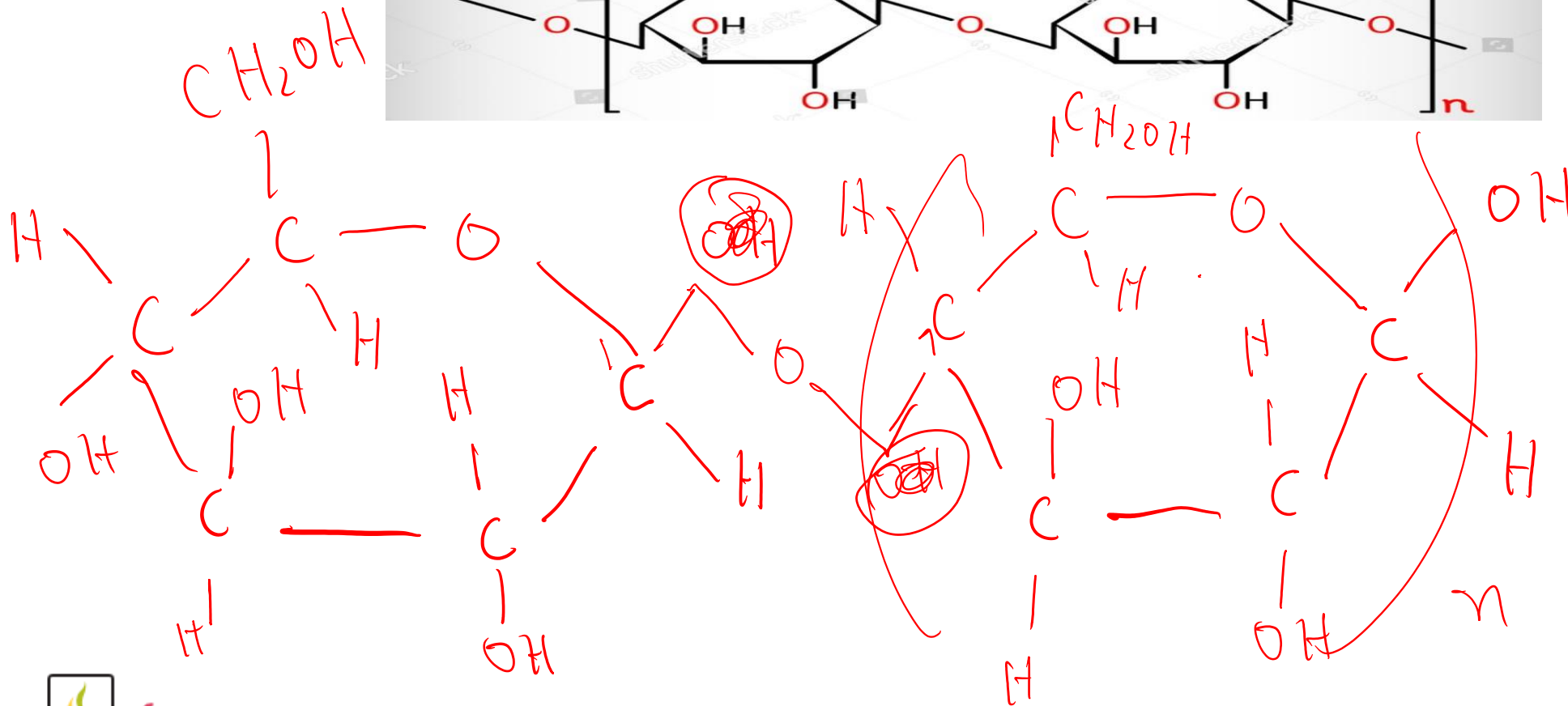
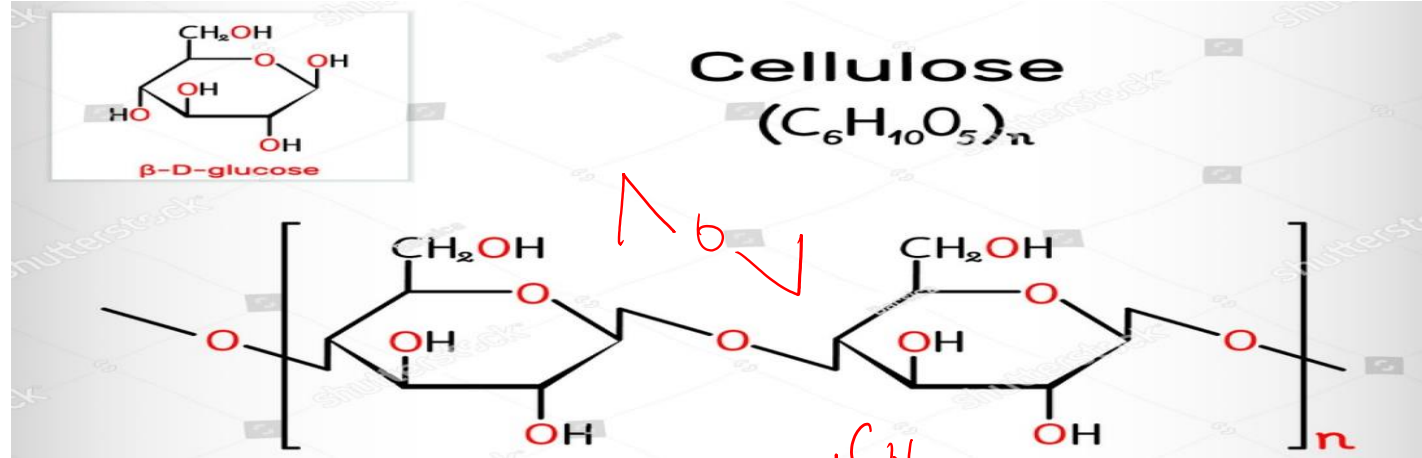
# Cellulose

- ❖ 300 to 3000  $\beta$ -D glucose molecules bind to each other in  $\beta$ -1-4 glycosidic linkage to form cellulose.
- ❖ The cell wall of plants is made up of cellulose.
- ❖ cellulose molecules are not branched.
- ❖ Doesn't change color in presence of iodine
- ❖ Human cannot digest cellulose

Polymer of  
 $\beta$ -D glucose



# Cellulose



উদ্ভাস

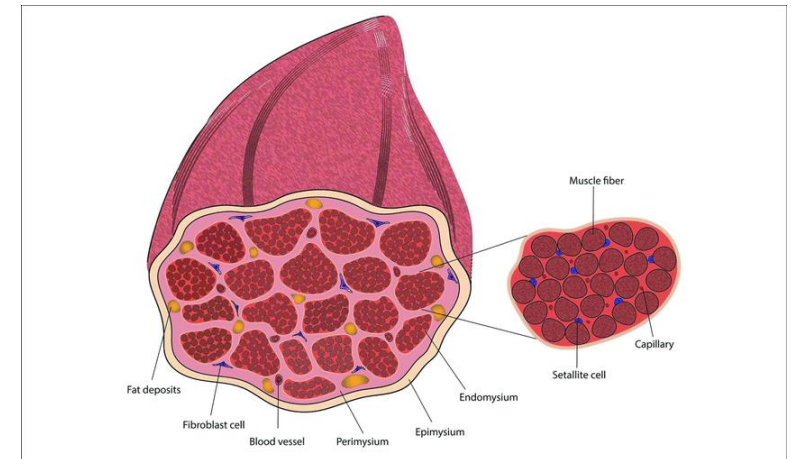
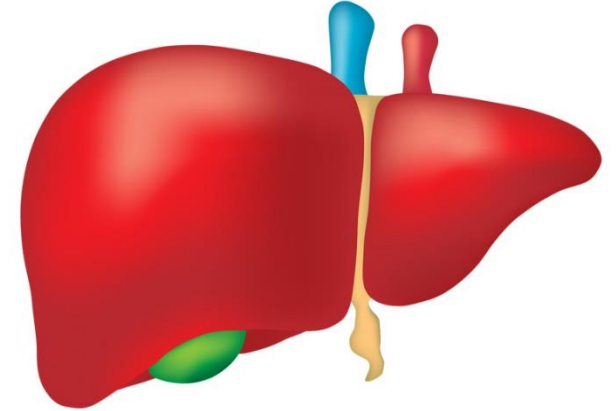
একাডেমিক এন্ড এডমিশন কন্ট্রোল

Biology 1<sup>st</sup> Paper

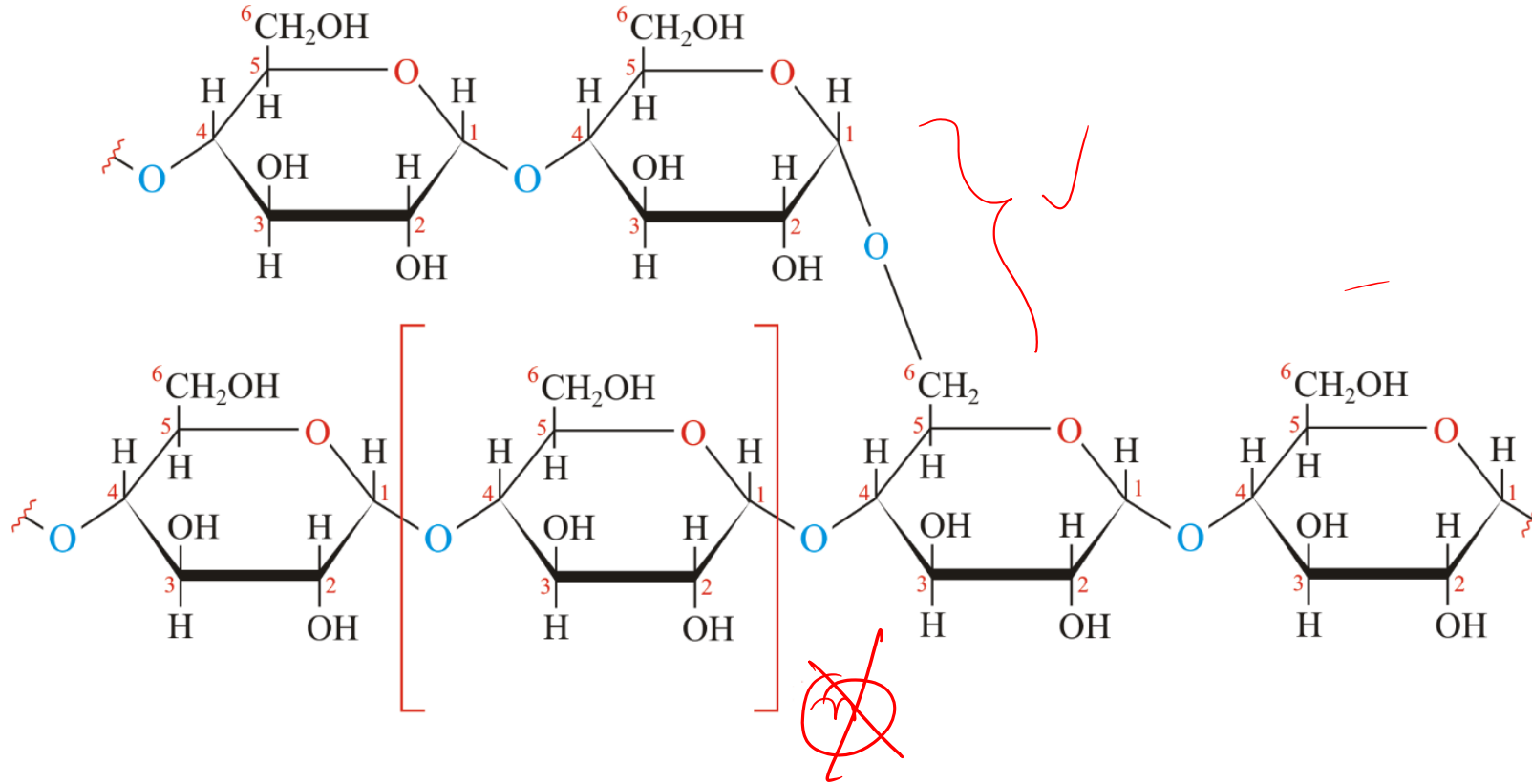
Chapter 03 : Cell Chemistry

# Glycogen

- ❖ Formula  $(C_6H_{10}O_5)_n$
- ❖ Made up of  $\alpha$ -D glucose
- ❖ Molecules are branched like amylopectin
- ❖ Branches are formed through  $\alpha$ -1, 6 linkages. Each branch usually contains 10 to 20 glucose molecules.
- ❖ Although it is the main stored food component of the animal body, it is also the stored food of cyanobacteria (bluish green algae) and some fungi (yeast).
- ❖ Glycogen is stored in the liver and muscles of animals.
- ❖ Takes a reddish purple color in presence of iodine



# Glycogen



## Poll Question:03

Which of the following information about glycogen is incorrect ?

(a) Made up of  $\alpha$ -D glucose

(b) Branching is not present

(c) Stored food of animal

(d) Present in muscle cell



# Amino acid: Building Block of Protein

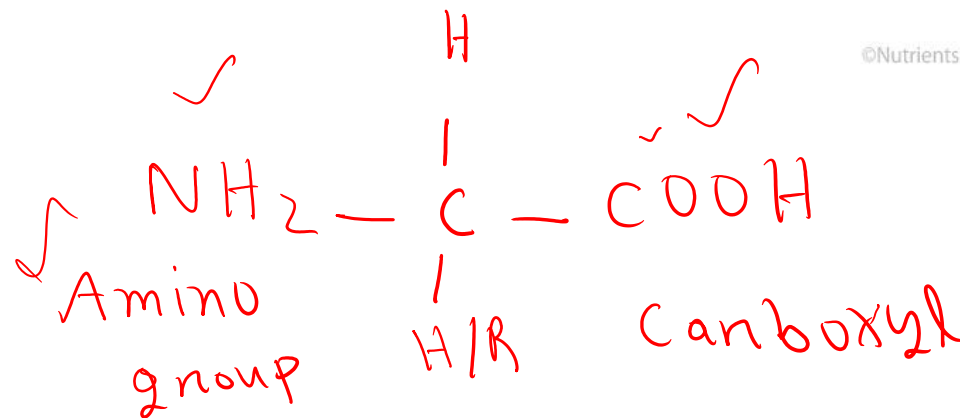
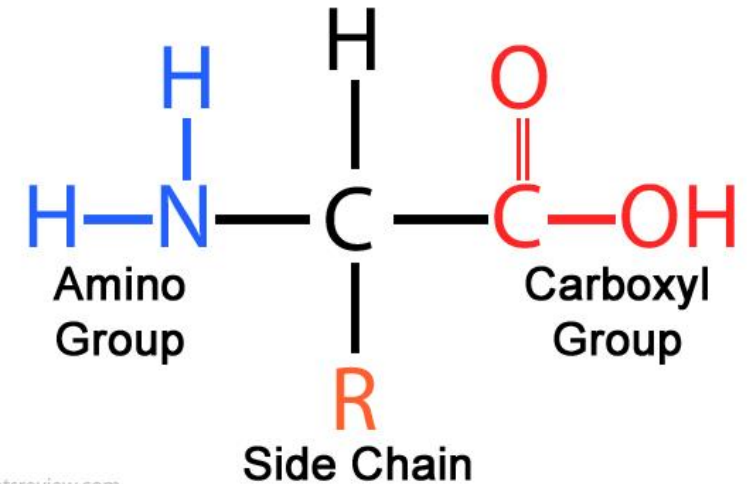




# Amino acid *(Monomer of protein)*

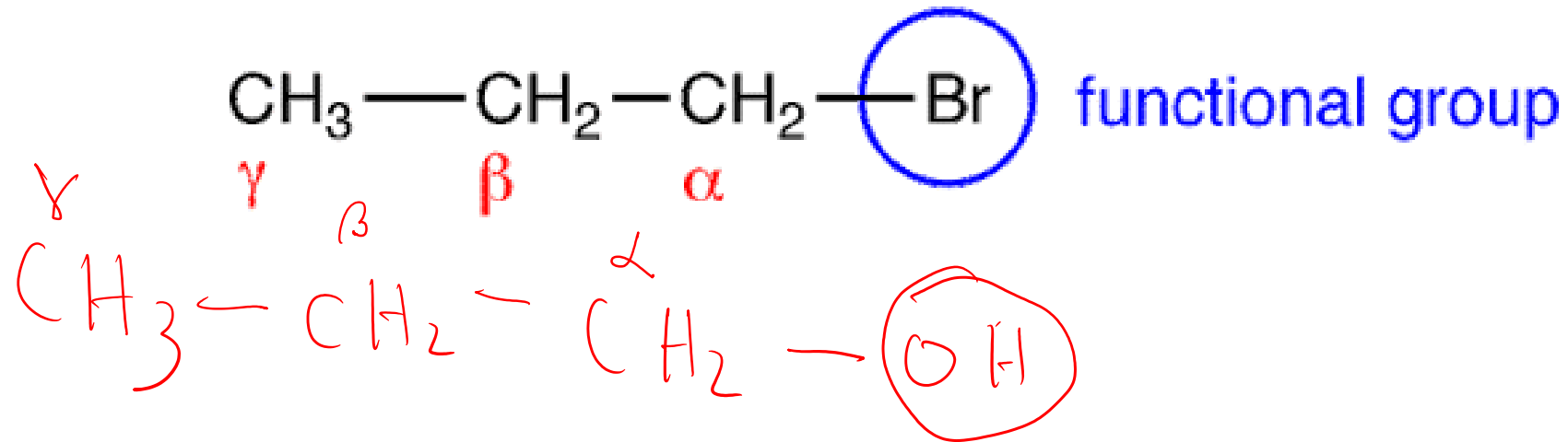
- ❖ The organic acid that is produced when one or more hydrogen atoms of an organic acid are replaced by an amino group ( $-\text{NH}_2$ ) is called an amino acid.
- ❖ General formula:  $\text{R}-\text{CH}(\text{NH}_2)\text{COOH}$ .
- ❖ Amino acids consist of an amino group ( $-\text{NH}_2$ ), a carboxyl group ( $-\text{COOH}$ ) and a side chain group (R). However, some amino acids may contain 2 amino groups or 2 carboxyl groups or sulfur.

## Amino Acid Structure



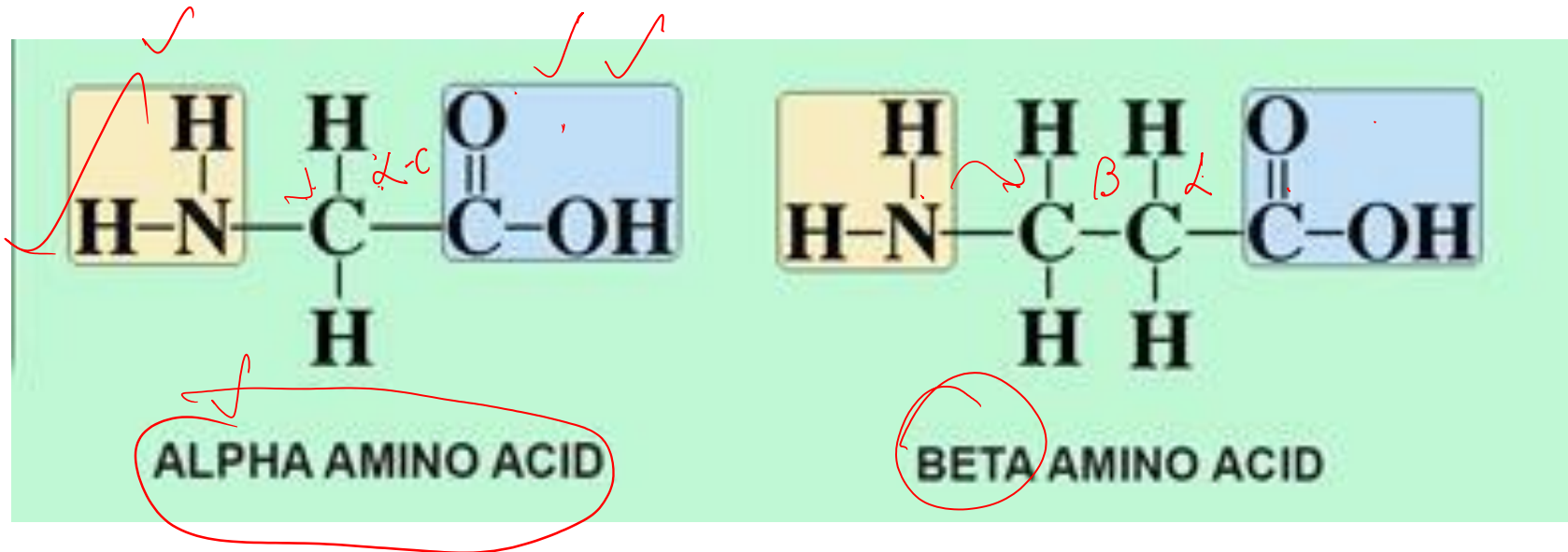
## $\alpha$ & $\beta$ Carbon

The alpha carbon in organic molecules refers to the first carbon atom that attaches to a functional group. The second carbon atom is called the beta carbon, and the system continues naming in alphabetical order with Greek letters



## $\alpha$ Amino acid

The carbon atom closest to the carboxyl ( $-\text{COOH}$ ) group of amino acids is called the  $\alpha$  carbon. If the amino ( $-\text{NH}_2$ ) group is attached to the  $\alpha$  carbon, it is called an "  $\alpha$  amino acid ". Almost all the amino acids in the human body are  $\alpha$  amino acids.



# Types of Amino acid

Based on the structure, amino acids are divided into 3 types.

1. Aliphatic amino acids : Glycine, alanine, valine
2. Aromatic amino acids : Phenyl alanine, tyrosine
3. Heterocyclic amino acids: tryptophan, proline, histidine

- Protein Amino Acids: Usually 20 amino acids participate in the formation of different proteins. These are called protein amino acids.
- Non-protein amino acids: Does not participate in protein formation.

Amino acids are divided into two types based on the need for presence in the diet.

1. Essential amino acids: 8. But 10 for children.
2. Non-essential amino acids

## Poll Question:04

How many protein amino acids are available in nature ?

(a) 8

(b) 10

(c) 12

(d) 20

Using the following mnemonic we can easily memorize the names of 10 essential amino acids.



Phenylalanine

Valine

Threonine

Tryptophan

Isoleucine

Methionine

Histidine

Arginine

Leucine

Lysine



## Poll Question:05

Which of the following is not a protein amino acid ?

(a) Valine

(b) Glycine

(c) Isoleucine

(d) Tryptophan

লেগে থাকো সৎ ভাবে,  
স্বপ্ন জয় তোমারই হবে।



উদ্ভাস

একাডেমিক এন্ড এডমিশন কেয়ার

[www.udvash.com](http://www.udvash.com)