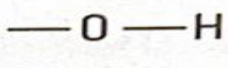
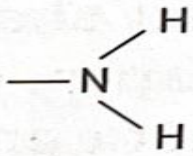
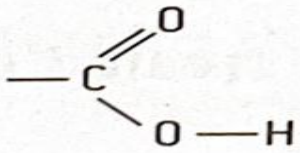
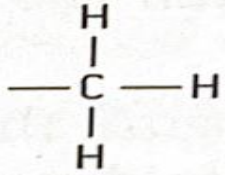
Biological molecules

Carbohydrates

Carbohydrates

Names of some chemical groups that are needed during this chapter/ please memorize

Table 6. Names and structures of some chemical groups found in biological molecules

Name of chemical group	Structure	Simplified notation
Hydroxyl group		—OH
Amine group (also named amino group)		—NH_2
Carboxyl group (also named acid group)		—COOH
Methyl group		—CH_3

Objectives :

- Study the structures and functions of monosaccharides (glucose, galactose, fructose, ribose and deoxyribose), disaccharides (Maltose, lactose and sucrose) and polysaccharides (Starch (including amylose and amylopectin) glycogen and cellulose).
- Learn how to draw glucose .
- Monosaccharide monomers are linked together by condensation reactions to form disaccharides and polysaccharide polymers.
- State that the bond that forms between monosaccharides is called glyosidic bond.
- Sucrose, lactose and maltose should be included as examples of disaccharides produced by combining monosaccharides.
- Practical Skill: Describe the test for reducing sugars using Benedict's reagent and be able to use it to compare the reducing sugar content in different foods.
- Know that sucrose is not considered a reducing sugar
- Describe the test for starch using Iodine solution and be able to use it to compare the starch contents in different foods.

Resources :

Book pages 27 , 28

https://www.youtube.com/watch?v=rQyWJIn1HYE introduction

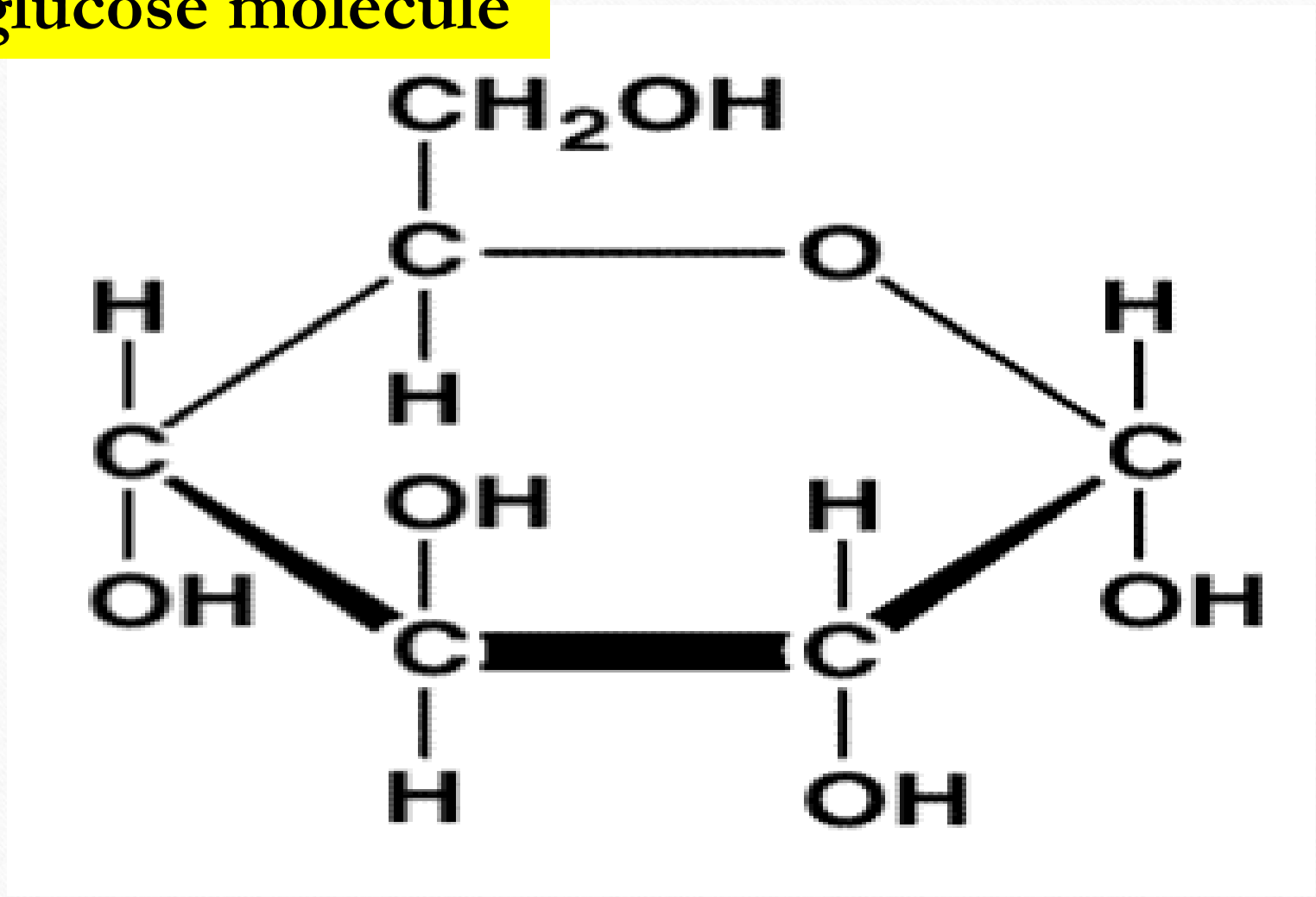
Carbohydrates are the body's main source of energy. They contain carbon, hydrogen and oxygen, and they can be represented by the formula (CHO)n where n indicates the number of carbon atoms in the molecule. The ratio of carbon to hydrogen to oxygen is always 1:2:1. Carbohydrates can be classified into three main groups:
monosaccharides, disaccharides and polysaccharides.

Monosaccharides : (also called simple sugars) are the simplest forms of sugar and the most basic units from which all carbohydrates are built. *(monomers of carbohydrates)*

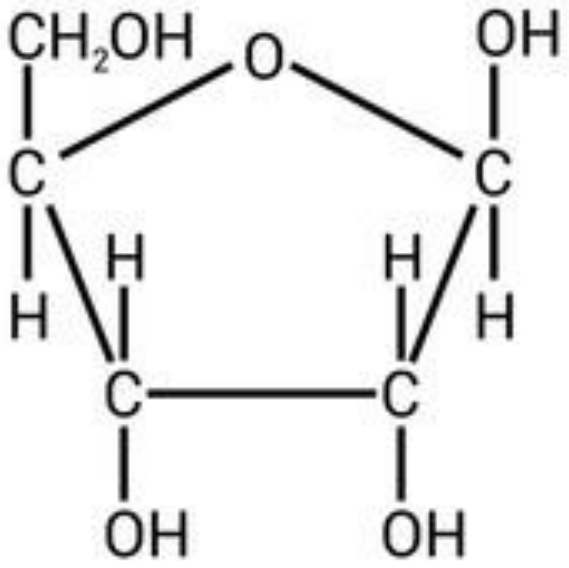
Disaccharide : is the sugar formed when two monosaccharides are joined by glycosidic linkage.

Polysaccharide : a carbohydrate (e.g. starch, cellulose, or glycogen) whose molecules consist of a number of sugar molecules bonded together.

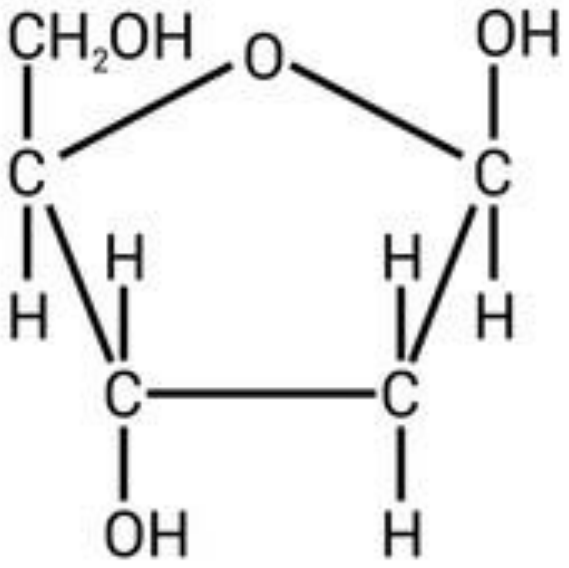
Draw a glucose molecule



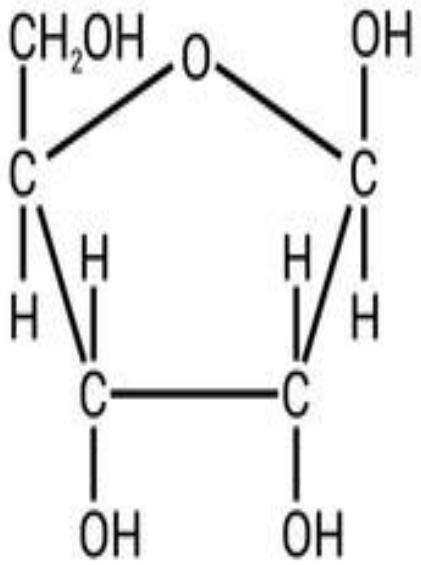
Ribose



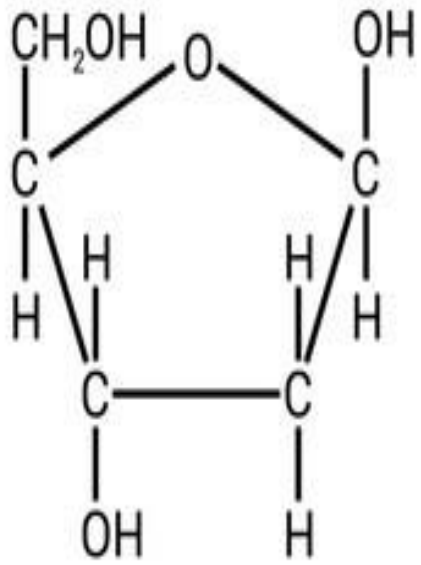
Deoxyribose



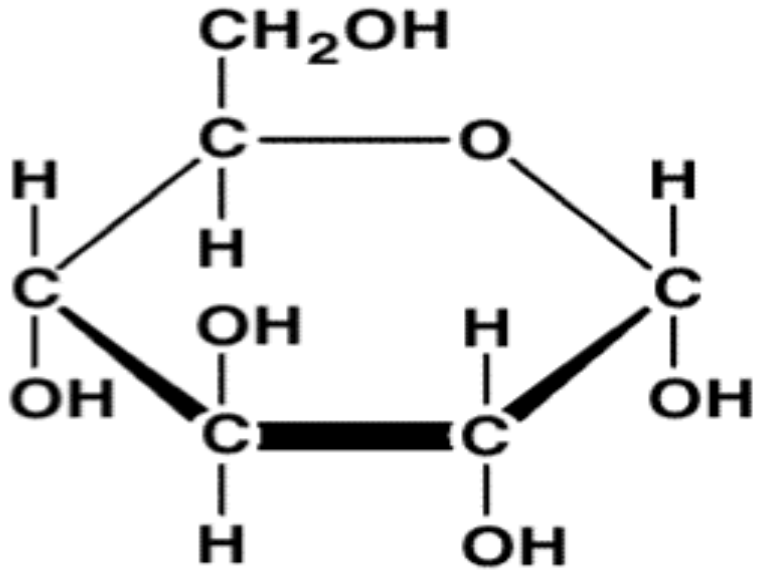
Ribose



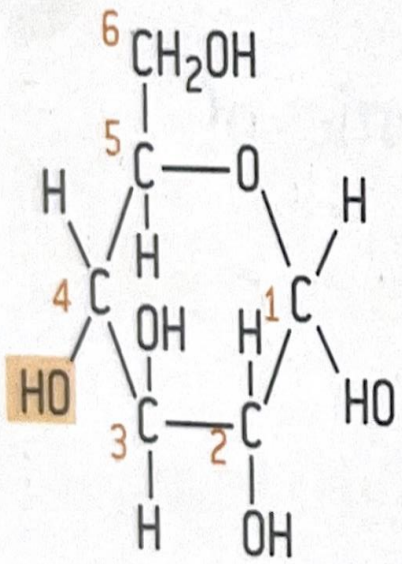
Deoxyribose



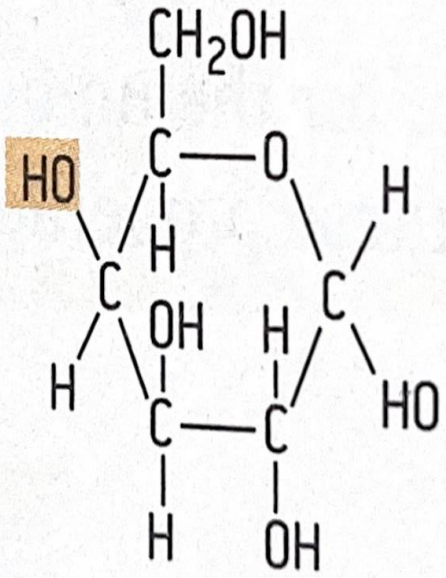
Glucose



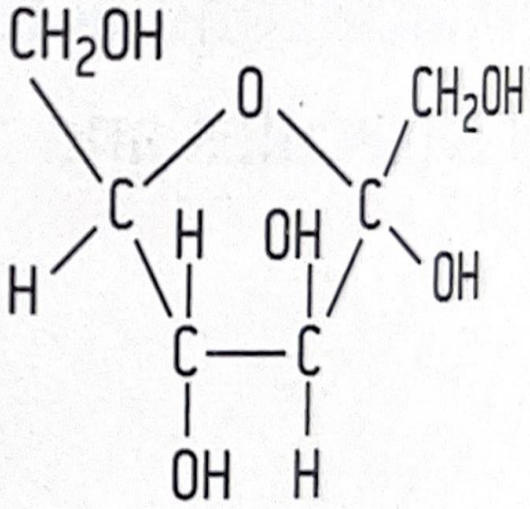
Monosaccharides



glucose

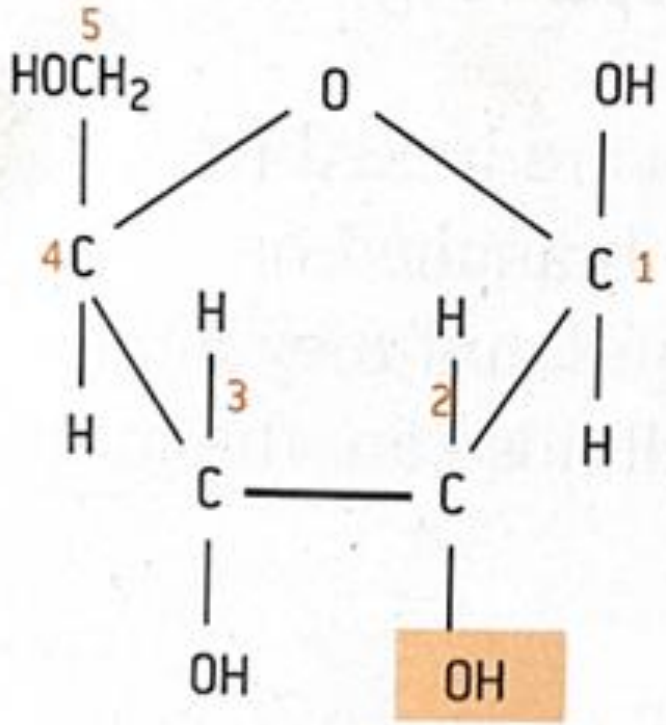


galactose

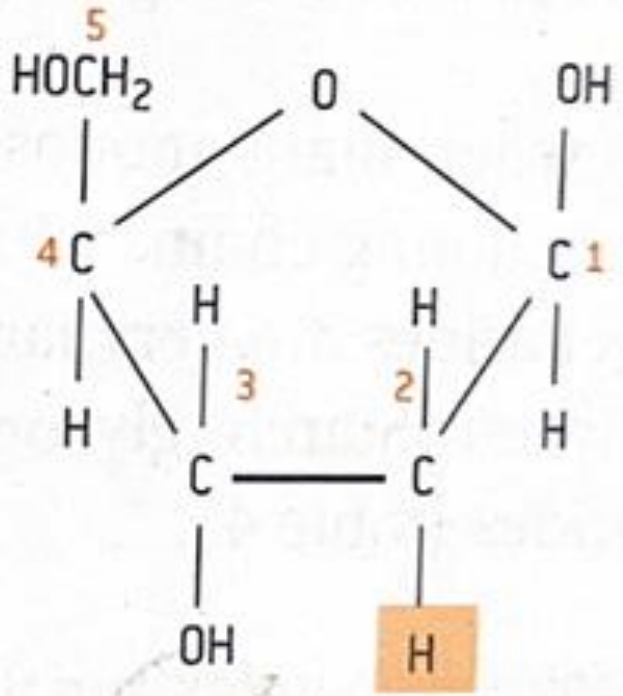


fructose

Figure 7. Glucose, galactose and fructose (monosaccharides)



ribose



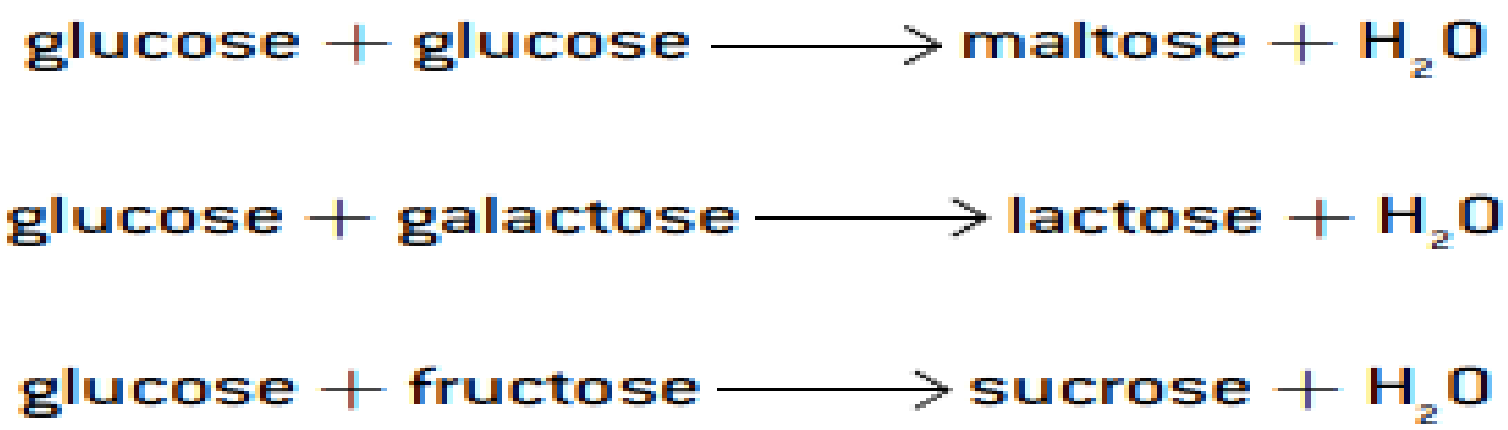
deoxyribose

Figure 6. Ribose and deoxyribose (pentose sugars)

Table 2. Examples of monosaccharides and their function

Monosaccharide	Function
Glucose	An important source of energy. It is used in aerobic respiration to help make ATP
Galactose	Nutritive sweetener in foods
Fructose	Fruit sugar
Ribose	It is part of ribonucleic acid (RNA)
Deoxyribose	It is part of deoxyribonucleic acid (DNA)

Disaccharides

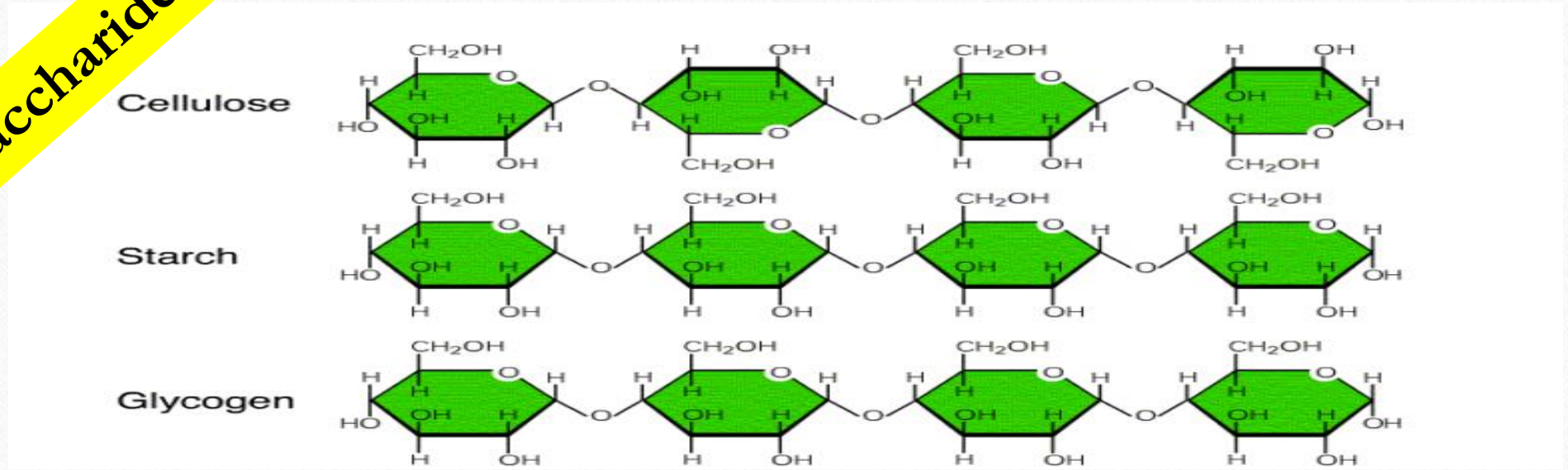


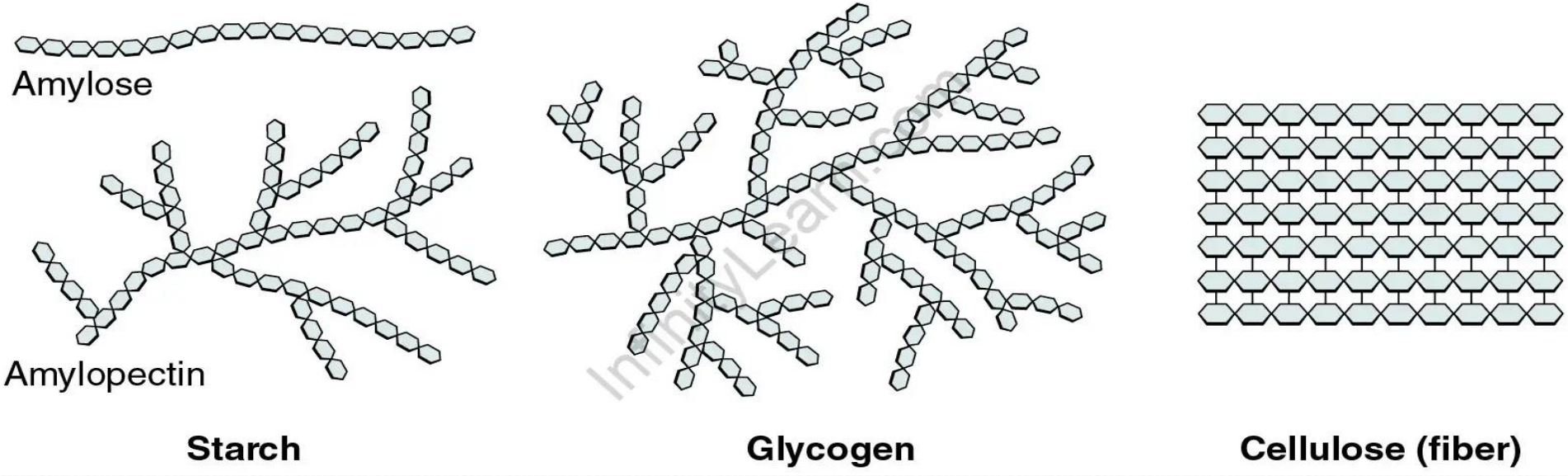
Disaccharides form when **two monosaccharides** are linked together via a **covalent bond or (glycosidic bond)**. This reaction is called **condensation because it involves the release of water.** The most common disaccharides include maltose, lactose and sucrose. **Lactose** consists of the monosaccharides, **glucose and galactose**. **Sucrose** consists of the monosaccharides **glucose and fructose.**

Table 3. Examples of disaccharides and their function

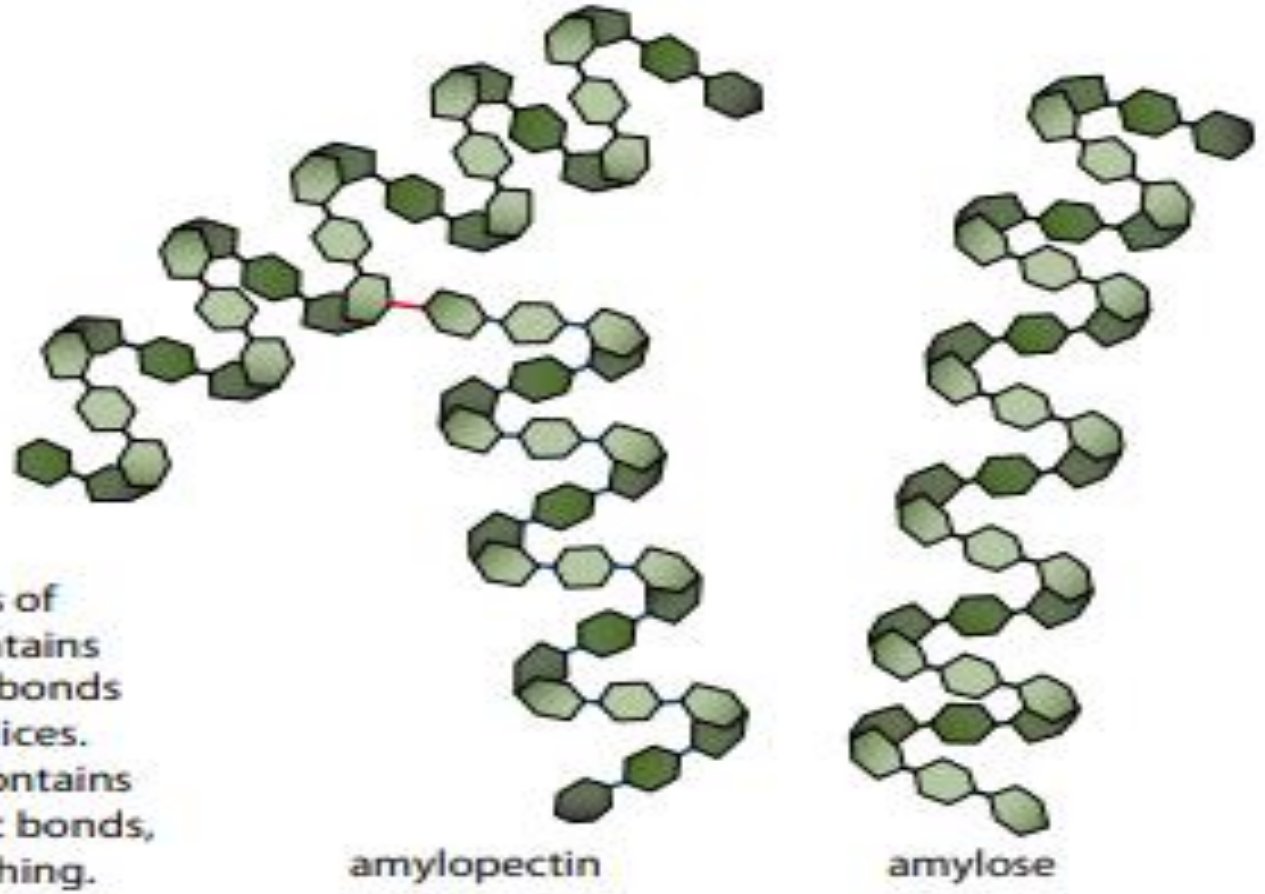
Disaccharide	Function
Maltose	Also called malt sugar. It is found in barley.
Lactose	The sugar found naturally in milk.
Sucrose	Also called table sugar. It is the transport sugar in plants.

Polysaccharides





Amylose and amylopectin are two forms of starch



There are two forms of starch. Amylose contains only 1–4 glycosidic bonds and forms linear helices. Amylopectin also contains some 1–6 glycosidic bonds, which causes branching.

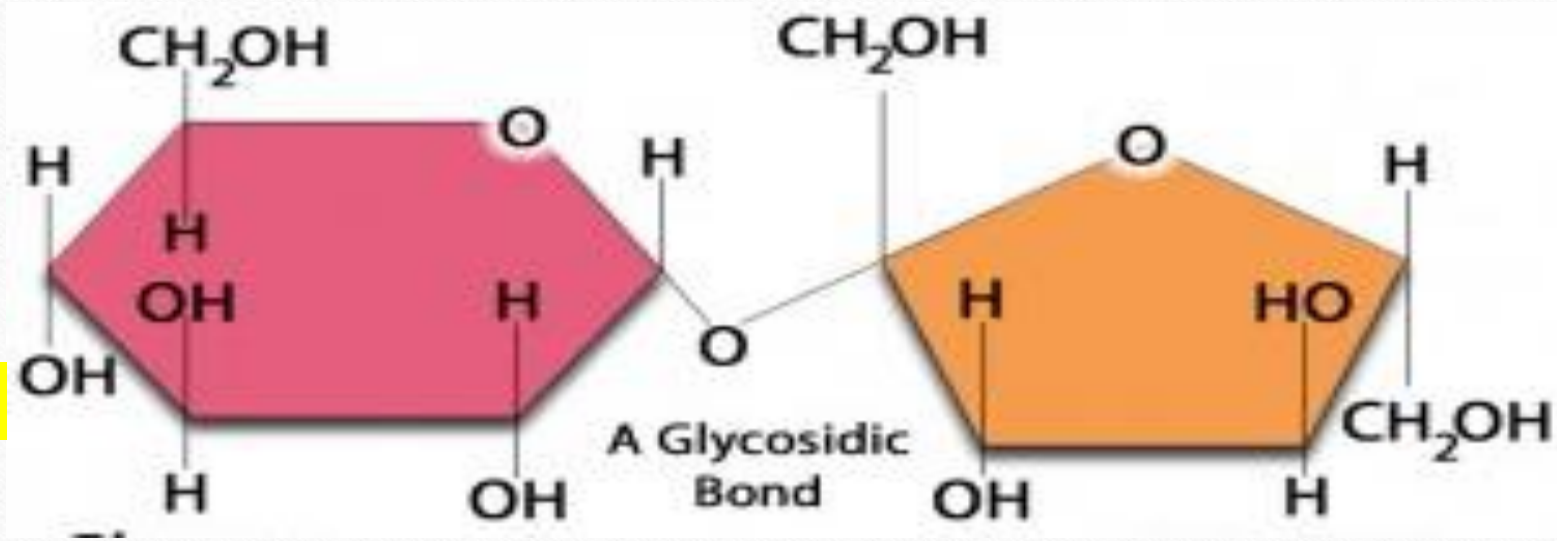
Polysaccharides form when many monosaccharides are linked by covalent bonds to form a long chain .Polysaccharides are very large molecules and they are usually insoluble in water. Starch, glycogen and cellulose are the most common polysaccharides.

Table 4. Examples of polysaccharides and their function

Polysaccharide	Function
Starch	Storage of carbohydrates in plants
Glycogen	Storage of carbohydrates in animals
Cellulose	Main component in plant cell walls

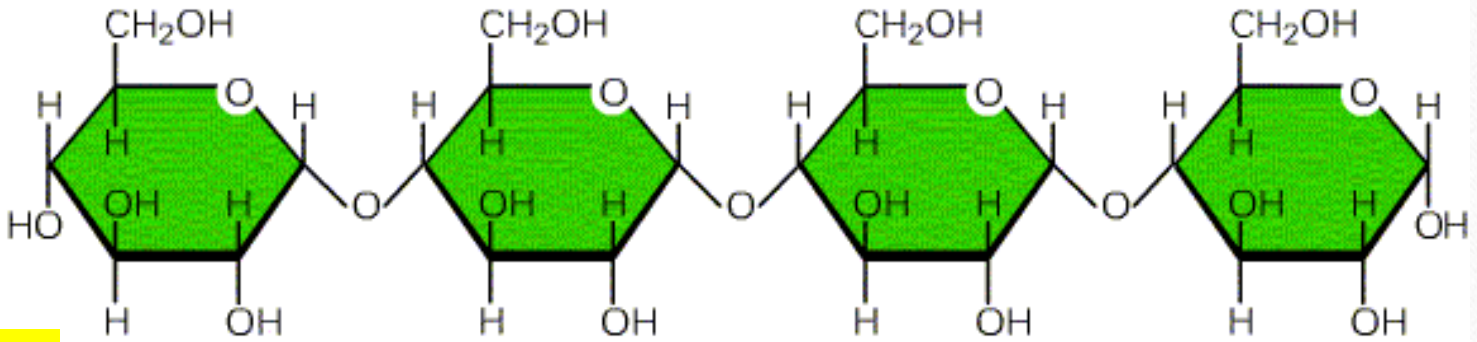
A

disaccharide



B

Polysaccharides



Form of carbohydrate	Examples	Example of use in plants	Example of use in animals
monosaccharide	glucose, galactose, fructose	fructose is a component of fruits, making them taste sweet and attracting animals to eat them, thereby dispersing the seeds inside	glucose is the source of energy for cell respiration – it is obtained from the digestion of carbohydrate foods
disaccharide	maltose, lactose, sucrose	sucrose is transported from leaves to storage tissues and other parts of the plant to provide an energy source	lactose is found in milk and provides energy for young mammals
polysaccharide	starch, glycogen, cellulose	cellulose is a structural component of plant cell walls starch is used as a food store	glycogen is the storage carbohydrate of animals, found in the liver and muscles

Lab visit / Test for starch

https://www.sciencebuddies.org/stem-activities/starch-food-test

To test the presence of starch in potatoes and rice, **Iodine test is performed in which Iodine solution is used**. It is done by adding a few drops of iodine solution to the food sample. If starch is present in the rice or potatoes, it will turn blue-black colour, if absent then it will remain brown in colour.

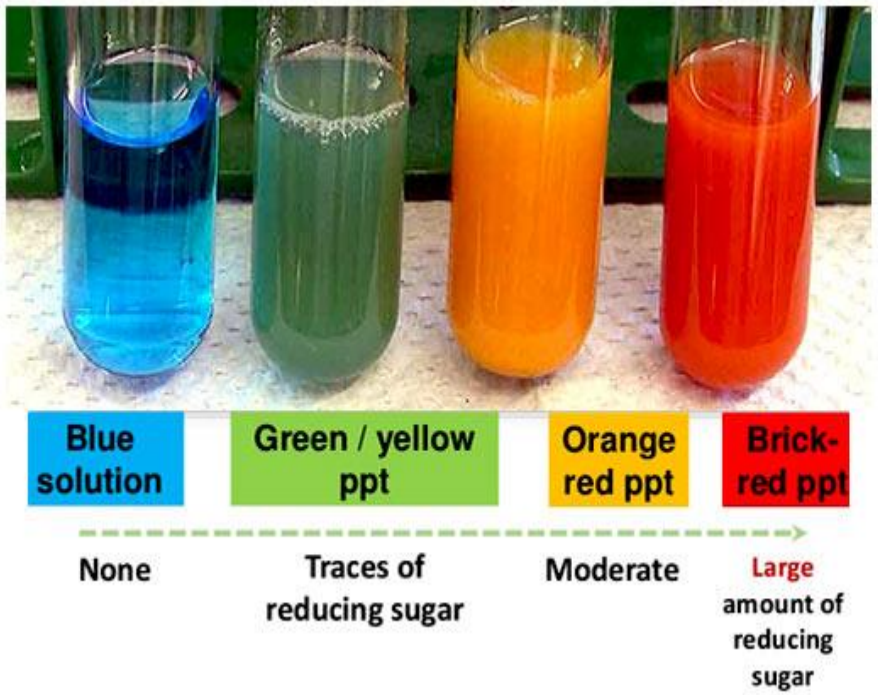
Lab visit / Test for reducing sugar

https://www.youtube.com/watch?v=uY98fzHu4M4

To test for reducing sugars:

1. Add a sample of the food you are testing to a test tube.
2. Add Benedict's solution (blue)
3. Place in a water bath (around 80°C)
4. After a few minutes, the solution will turn green and then red/orange.

A positive test gives the "brick red" colour and means there is sugar in the food.



Check your understanding :

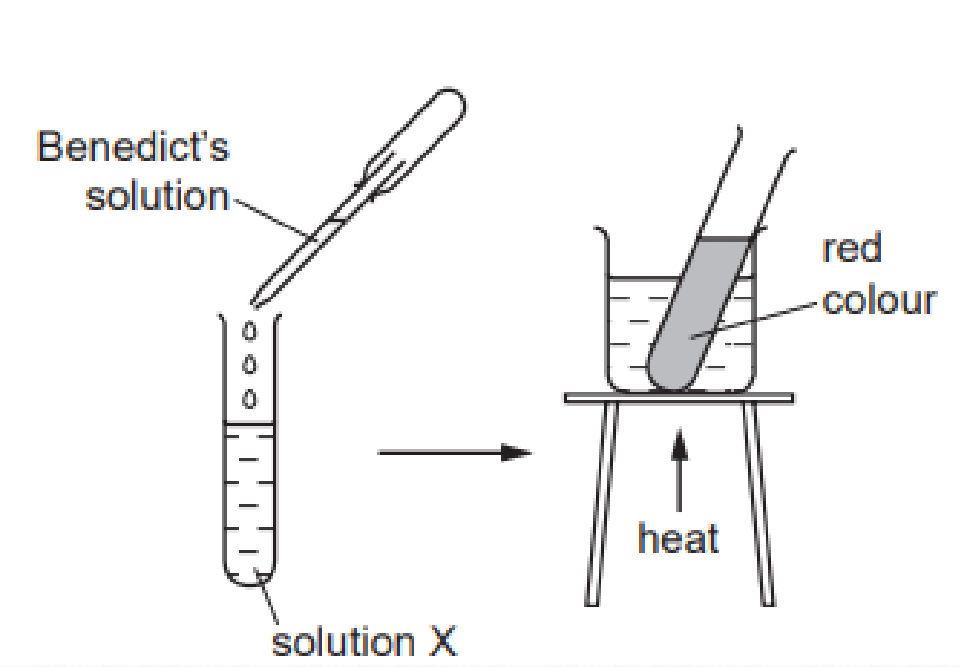
Q1. What are the smaller basic units of starch and glycogen molecules?

	starch	glycogen
A	amino acids	fatty acids and glycerol
B	amino acids	simple sugars
C	simple sugars	fatty acids and glycerol
D	simple sugars	simple sugars

Q2. The diagram shows a food test carried out on solution X.

Which nutrient is present in solution X?

a reducing sugar



Q3. The data show the concentrations of sugar and starch in an onion.

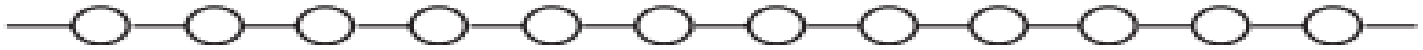
total sugar including reducing sugar /g per 100g	starch /g per 100g
3.7	0.

The onion is tested with Benedict's solution and iodine solution.

Which set of results is correct?

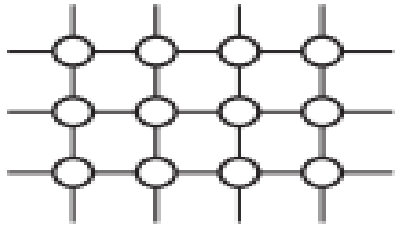
	Benedict's solution	iodine solution
A	blue	blue-black
B	blue	brown
C	brick red	blue-black
D	brick red	brown

Q4. The diagram shows part of a starch molecule.

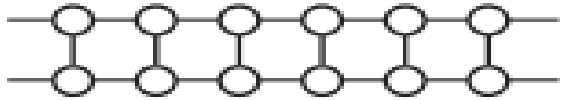


Which diagram shows this molecule after it has been **completely** digested?

A



B



C

D

Q5. Which elements do carbohydrates contain?

A carbon, hydrogen and oxygen

B carbon, hydrogen and sulphur

C carbon, nitrogen and oxygen

D carbon, nitrogen and sulphur