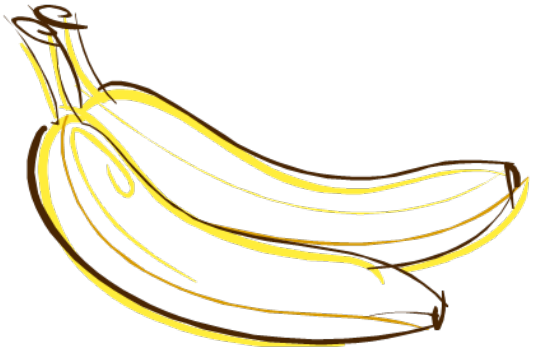
IDENTIFYING MACROMOLECULES IN Nutrient LAB

In this lab, with the use of indicators as chemical detection tools, you will analyze a variety of foods for the presence of nutrients.

Detection is based upon observing a chemical change that takes place most often a change in color.

Lab Objective

Identify the presence of major nutrients such as simple carbohydrates (glucose), complex carbohydrates (starch), protein and fat in common foods.



What is an indicator?

- Indicators are chemical compounds used to detect the presence of other compounds.

Background Information

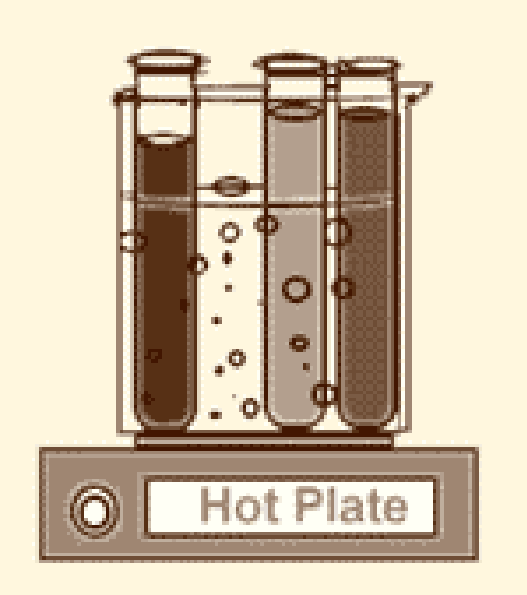
INDICATOR	MACRO-MOLECULE	NEGATIVE TEST	POSITIVE TEST
Benedict's solution	simple carbohydrate	blue	orange
Iodine solution	complex carbohydrate	dark red	black
Biuret solution	protein	blue	violet, black
Sudan IV	lipid	dark red	reddish-orange

Test for Simple Carbohydrates
Benedict's solution

- Benedict's solution is a chemical indicator for simple sugars such as glucose: $C_6H_{12}O_6$.
- Aqua blue: negative test; yellow/green/brick red, etc.: positive test

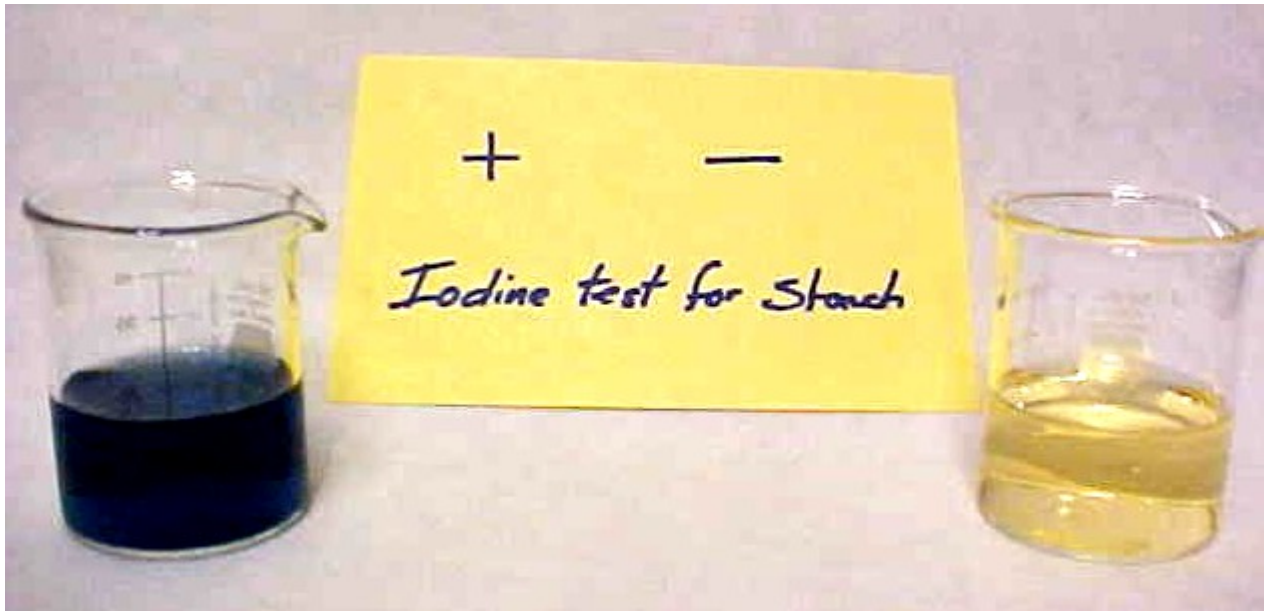
Test for Simple Carbohydrates
Benedict's solution

- Unlike some other indicators, Benedict's solution does not work at room temperature - *it must be heated first*.



Test for Complex Carbohydrates
Iodine Solution

- Iodine solution → color change = blue to black



Test for Complex Carbohydrates
Iodine solution

- Iodine solution is an indicator for a molecule called starch.
- Starch is a huge molecule made up of hundreds of simple sugar molecules (such as glucose) connected to each other.

Test for Protein (amino acids)
Biuret solution

- Biuret solution → dark violet blue to pinkish purple

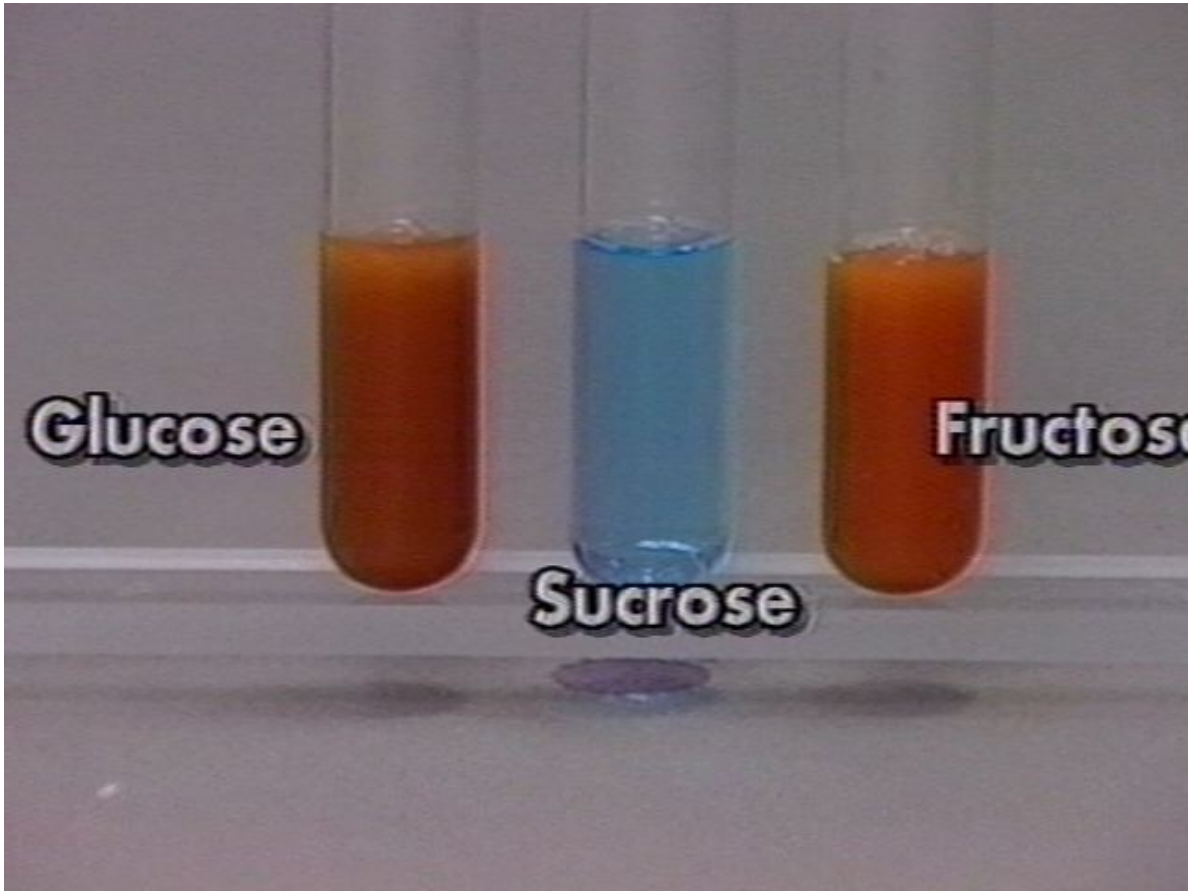
Test for Fats (lipids)

Sudan IV

- If lipids are present the Sudan IV will stain them reddish-orange (positive test).

Question

Why didn’t the test tube containing sucrose change colors?



Question

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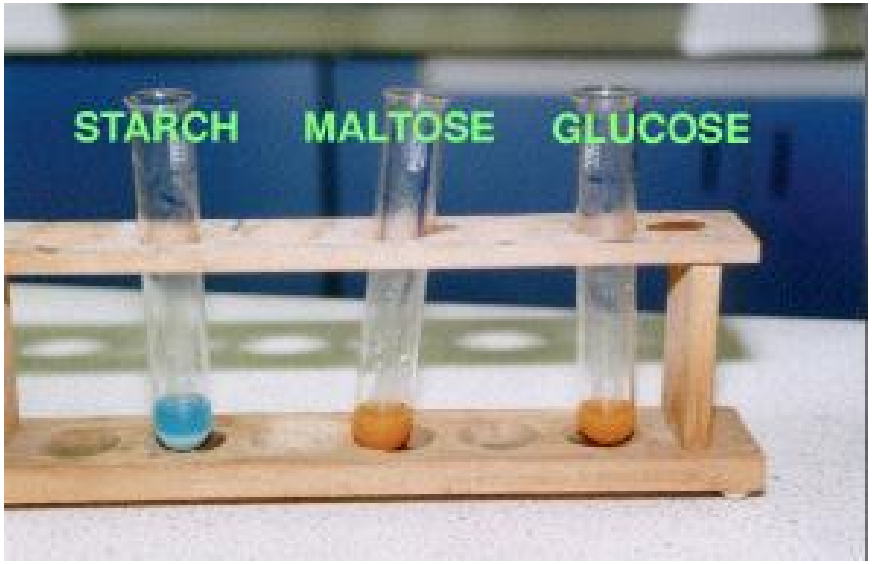
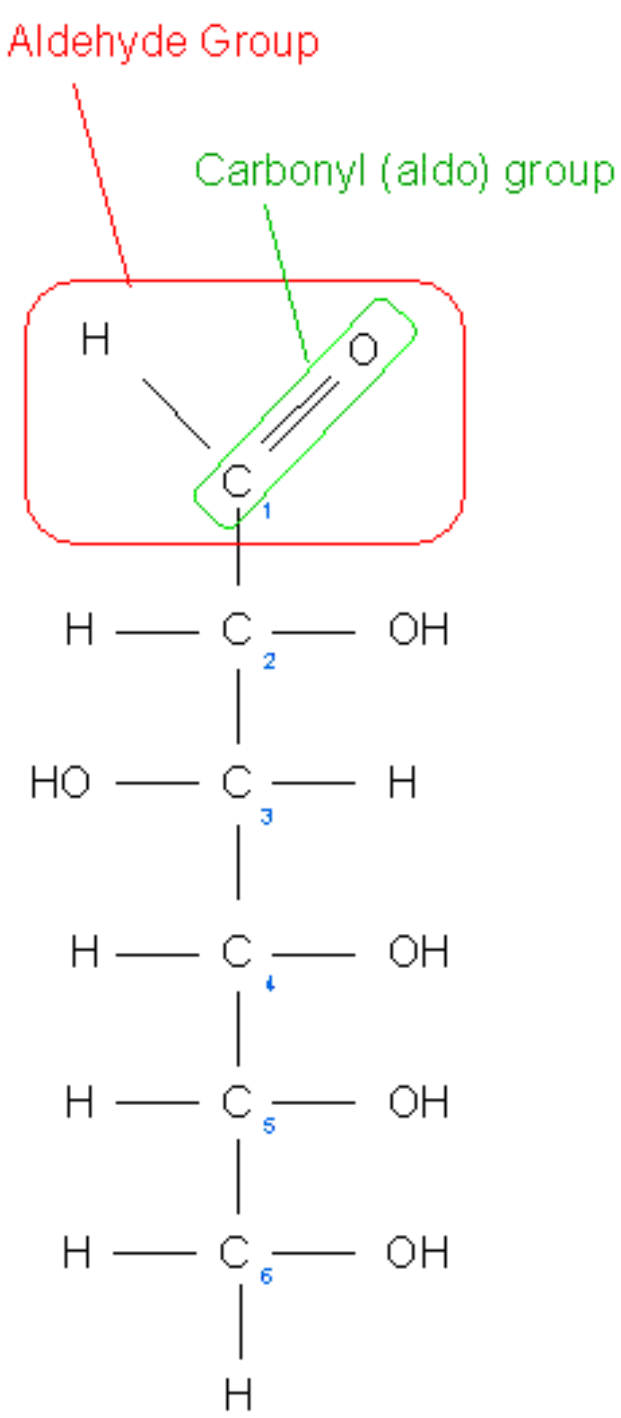


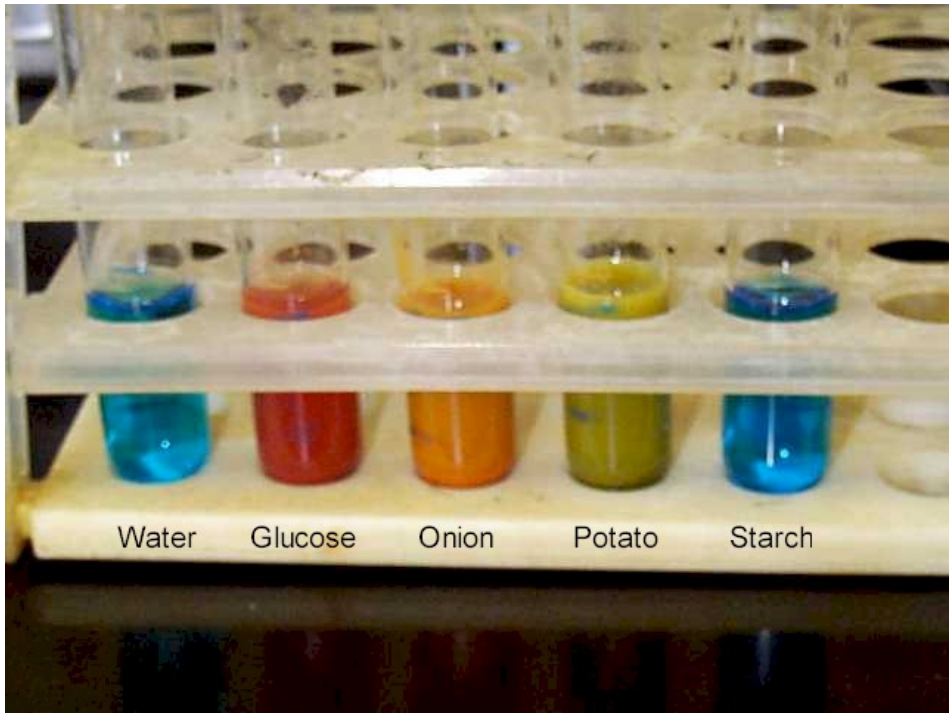
Reducing and Non-Reducing Sugars

- Reduction is the chemist's term for electron gain
- A molecule that gains an electron is thus……
  - "reduced"
- A molecule that donates electrons is called a……
  - "reducing agent"
- A sugar that donates electrons is called a……
  - "reducing sugar"
- The electron is donated by the **carbonyl group**
- **Benedict's reagent** changes colour when exposed to a reducing agent


Aldehyde Group
Carbonyl (aldo) group
H
O
C
1
H — C — OH
2
HO — C — H
3
H — C — OH
4
H — C — OH
5
H — C — OH
6
H

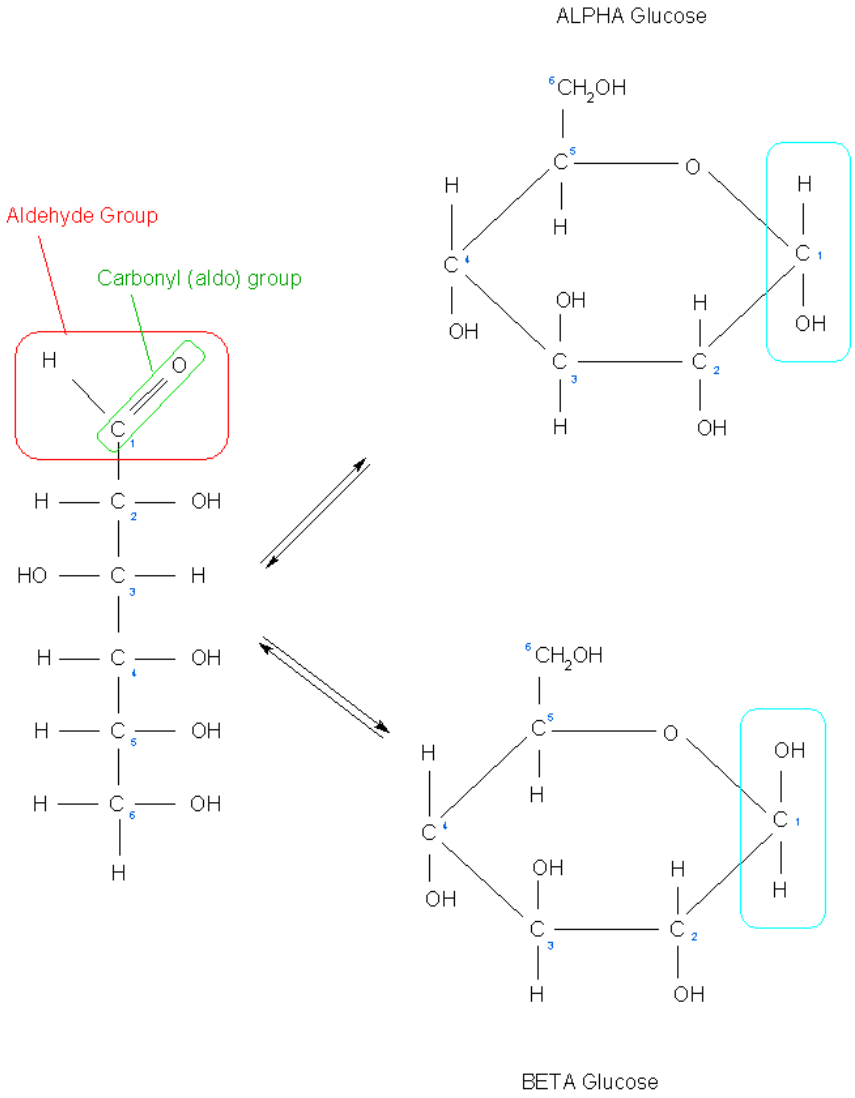
Benedict's Test

- Benedict's reagent undergoes a complex colour change when it is reduced
- The intensity of the colour change is proportional to the concentration of reducing sugar present
- The colour change sequence is:
  - Blue…
  - green…
  - yellow…
  - orange…
  - brick red



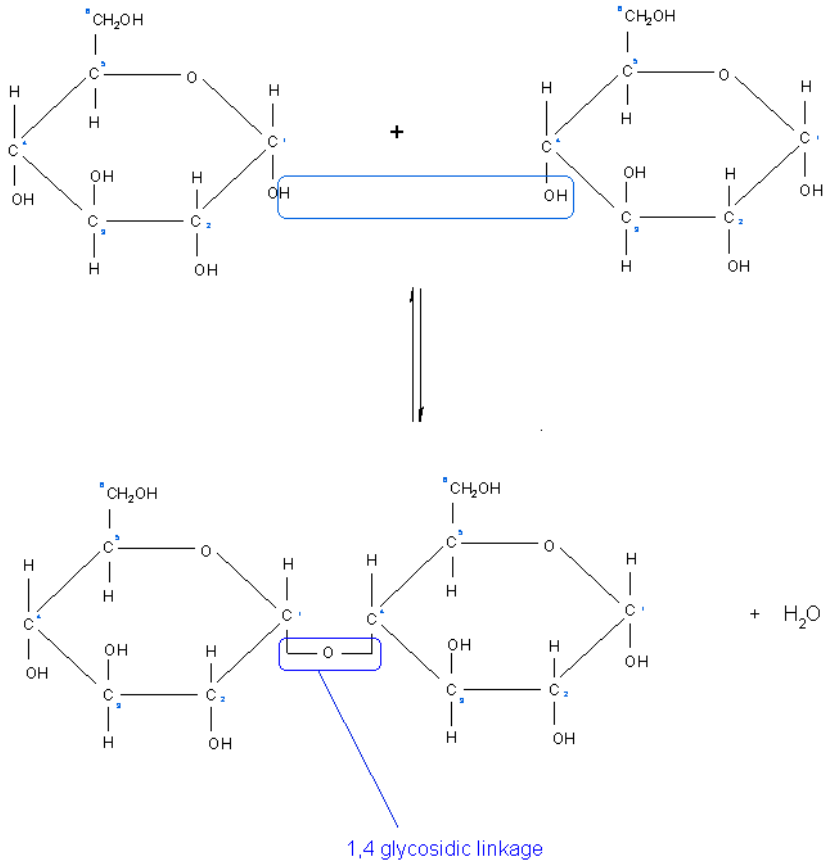
The carbonyl group - monosaccharides

- The carbonyl group is “free” in the straight chain form
- But not free in the ring form
- BUT remember – the ring form and the straight chain form are interchangeable
- So **all** monosaccharides are reducing sugars
- All monosaccharides reduce Benedict’s reagent



The carbonyl group – disaccharides - maltose

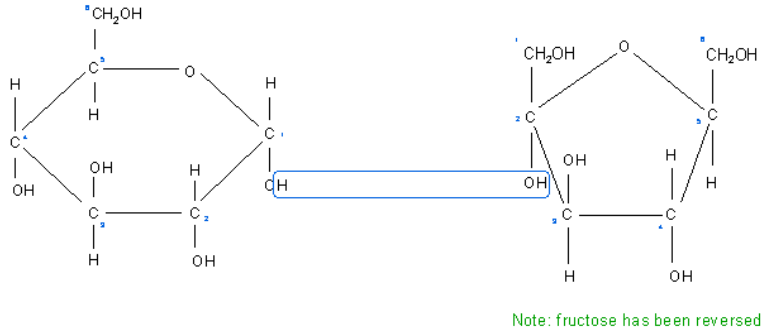
- In some disaccharides e.g. maltose one of the carbonyl groups is still "free"
- Such disaccharides are reducing sugars
- They reduce Benedict's reagent

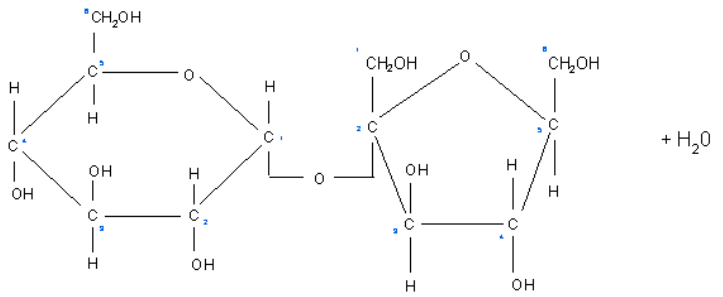


alpha-glucose + alpha-glucose ⇌ maltose + H_2O

The carbonyl group – disaccharides - sucrose

- In some disaccharides e.g. sucrose **both** of the carbonyl groups are involved in the glycosidic bond
- So there are **no** free carbonyl groups
- Such sugars are called **non-reducing sugars**
- They **do NOT** reduce Benedict's reagent

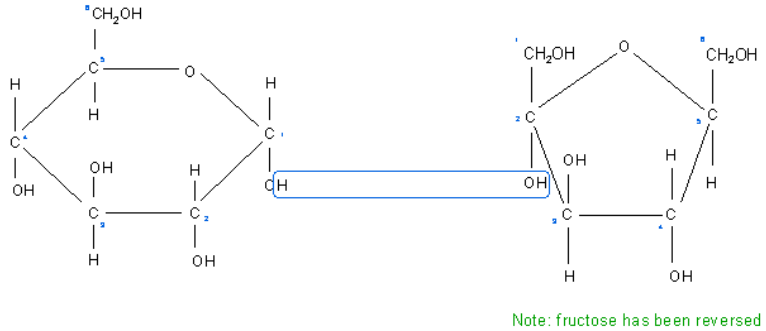


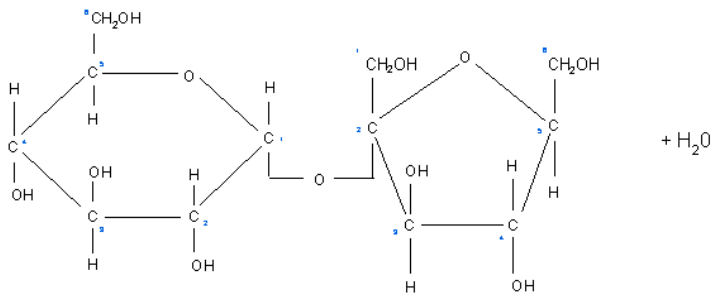


alpha-glucose + fructose ⇌ sucrose + H_2O

The carbonyl group – disaccharides - sucrose

- The subunits of sucrose (glucose and fructose) are reducing sugars
- If sucrose is hydrolysed the subunit can then act as reducing sugars
- This is done in the lab by **acid hydrolysis**
- After acid hydrolysis sucrose **will** reduce Benedict's reagent





alpha-glucose + fructose ⇌ sucrose + H_2O

REDUCING AND NONREDUCING SUGARS: MALTOSE AND FRUCTOSE