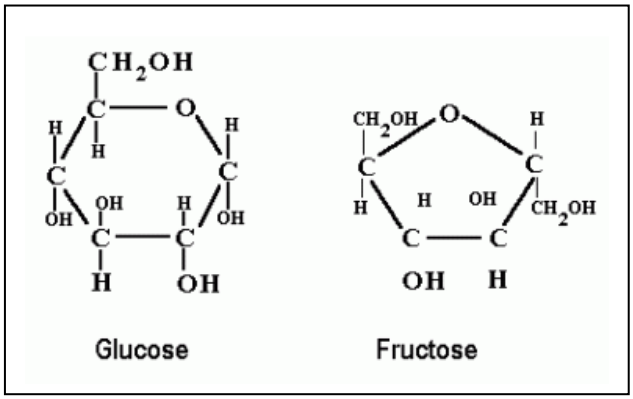
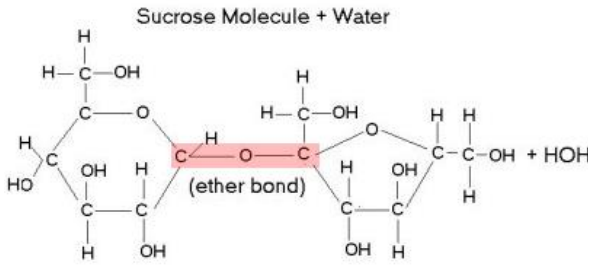
Lesson 1-carbohydrates

Click to revise carbohydrates

Carbohydrates are organic molecules composed of carbon, hydrogen, and oxygen that serve as an energy source for both plants and animals and as a structural material for plant cells.
Glucose is a simple sugar formed by plants during the endothermic process of photosynthesis according to the chemical equation below.
$6CO_2(g) + H_2O(l) \rightarrow C_2H_{12}O_6(aq) + 6O_2(g)$
Monosaccharides are simple carbohydrates composed of a sing molecule such as glucose and fructose, shown on the right.

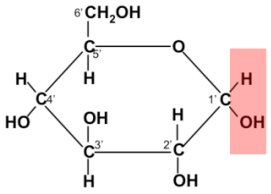


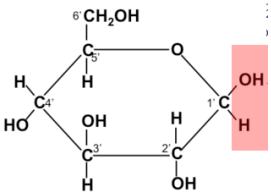
Consider the structure of monosaccharides, they have a number of polar hydroxyl groups which makes them very soluble in water.
Disaccharides, such as sucrose, are formed from two monosaccharides joined by an oxygen atom. This bond between the two monosaccaharides is known as an ***ether link (C-O-C)*** and is formed when two hydroxyl (OH) groups react during a condensation reaction.

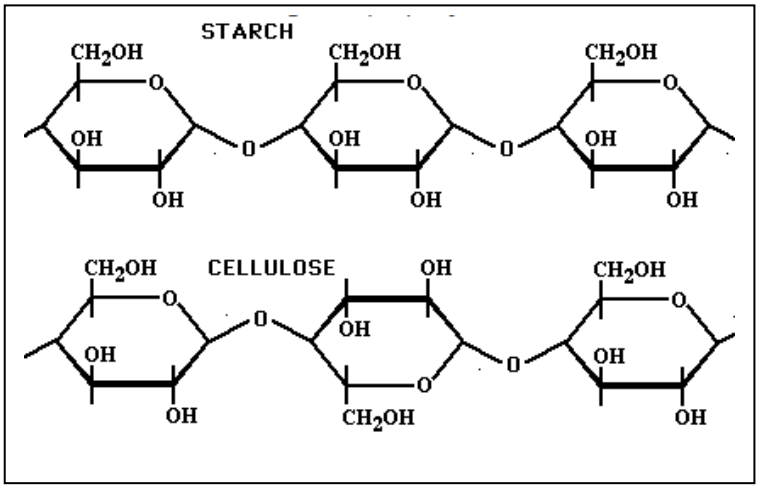


Consider the two isomers of glucose shown on the right.
Each isomer undergoes a condensation polymerisation reaction to form a ***polysaccharide***.
The three polysaccharides that will be covered are:
- starch which is formed by plants and used as a store of glucose. It is formed from alpha glucose molecules.
- glycogen, found in animals and used as a store of glucose in the liver and muscle. It is formed from alpha glucose molecules.
- cellulose, found in plant cell walls and used as a structural material. It is formed from beta glucose molecules.

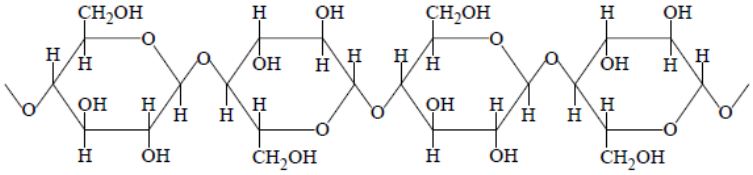
Below are the chemical structural formulae of starch and cellulose.


α-glucose


β-glucose



1) Consider the polymer shown below.

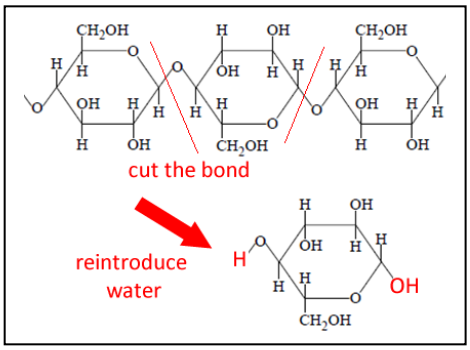


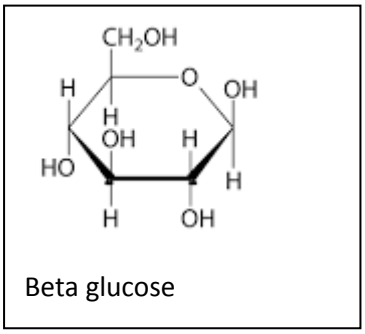
a) What type of reaction formed this polymer. *Condensation polymerisation*

b) What functional group links the monomers of this polymer. *Ether link (C-O-C)*

c) A reaction between what two functional groups produced the link between the monomers in this polymer. *OH and OH*

d) Draw the structural formula of the monomer for this polymer.

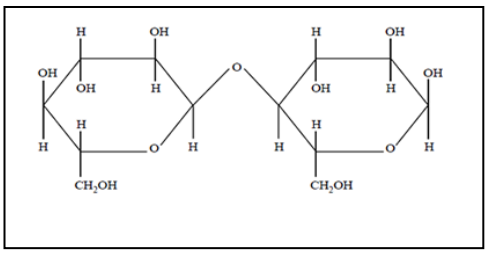




e) Ethanol is produced from the monomer of this polymer in an anaerobic reaction called fermentation. Write a balanced chemical equation for this reaction.

$C_6H_{12}O_6(aq) \rightarrow 2CH_3CH_2OH(aq) + 2CO_2(g)$

2) Consider the disaccharide maltose, shown on the right.



a) Identify the monomers of maltose.
Alpha glucose

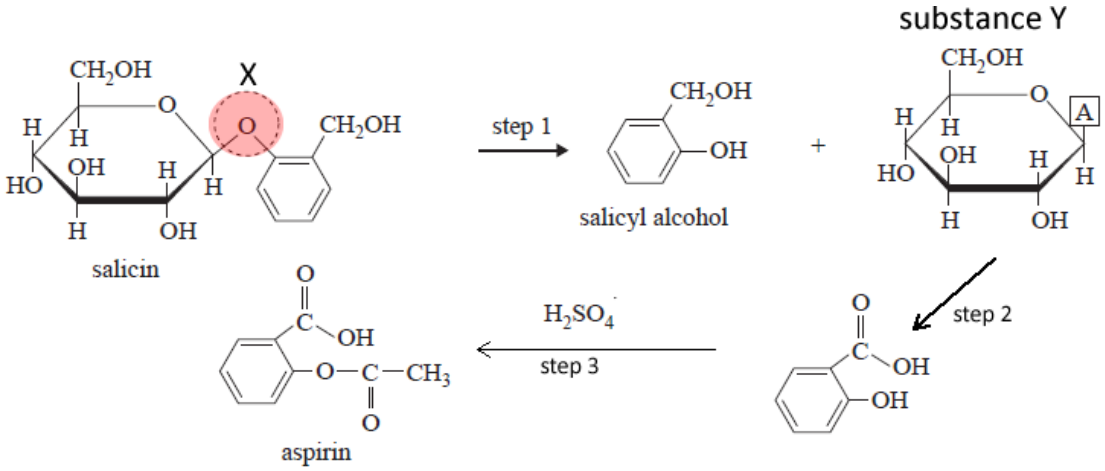
b) What type of bond links the two monomers.
Ether link

c) Write a balanced chemical reaction for the formation of maltose. States not required.
$2C_6H_{12}O_6 \rightarrow C_{12}H_{22}O_{11} + H_2O$

d) Calculate %atom economy for the formation of maltose.
342.4 / (2X 180.2) X 100 = 95.0%

e) Which of the following four carbohydrates has the least available energy to humans when consumed? Sucrose, maltose, starch, cellulose.
Cellulose. It is indigestible and hence unable to be metabolised by the Human body.

3) Salicin was isolated from Willow trees and used to make aspirin.



a) What type of bond is "X" in salicin? *Ether link*
b) What type of reaction is step 1? *hydrolysis*
c) To what group of food molecules does substance Y belong to? *Carbohydrates*
d) What group of atoms are represented by "A" in substance Y? *OH*
e) What type of reaction is step 3? *Esterification (Condensation)*
f) What type of reaction converts salicylic alcohol into salicylic acid, in step 2? *Oxidation*
g) What reagents are needed for step 2 *Cr_2O^{-2} / H^+*

4) The starch of two particular grains is analysed. Grain "A" is found to contain 80% amylopectin and 20% amylose while grain "B" is found to contain 40% amylopectin and 60% amylose. Which grain should be recommended as Low GI?
The grain with the higher proportion of amylose is Low Gi. Since amylose is less soluble than amylopectin it will take longer to be digested and hence the blood sugar level will not rise sharply.