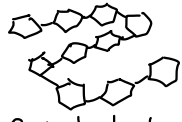
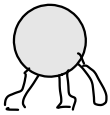
There are four main types of biological molecule which are found in all organisms:


Carbohydrates


Lipids


Proteins


Nucleic acids

Monomers and polymers

- Most carbohydrates, proteins and nucleic acids are polymers.
- Examples of monomers include monosaccharides, amino acids and nucleotides.
- GCSE Chemistry: Condensation polymerisation reactions are used to make polymers. Polymers can be broken down into monomers by hydrolysis reactions.

Carbohydrates

Monosaccharides

- All carbohydrates contain the elements Carbon, Hydrogen and Oxygen.
- Carbohydrate is a polymer made from monomers called monosaccharides, like glucose, fructose and galactose. (Call of them are hexose monosaccharides)

- General formula for monosaccharides: $(CH_2O)_n$

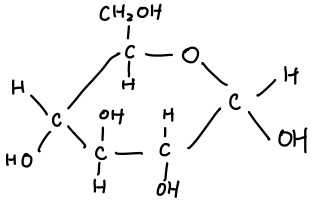
Carbohydrates (made of)
- Monosaccharides (General Term: Sugars) → Glucose, Fructose, Galactose ... (Simple carbs/ Sugars)
- Disaccharides (Sugars)
- Polysaccharides ← complex carbs

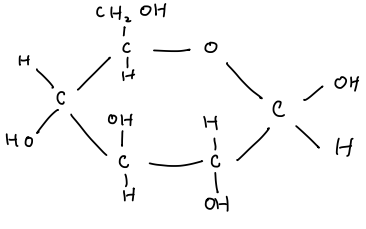
Amount of carbon atoms	Type of sugar (monosaccharide)	$(CH_2O)_n$	Example	
3	Triose	$C_3H_6O_3$	Glyceraldehyde	
4	Tetrose	$C_4H_8O_4$	Threose	
5	Pentose	$C_5H_{10}O_5$	Ribose	
6	Hexose	$C_6H_{12}O_6$	Glucose	

Glucose

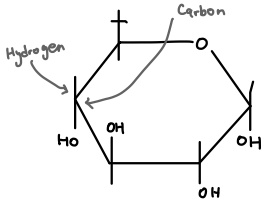
- A hexose sugar – a monosaccharide with 6 carbon atoms
- There are two types of glucose: α-glucose and β-glucose.

$C_6H_{12}O_6$

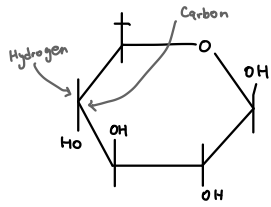

α-glucose


β-glucose

Isomers for glucose (different structural form)



alpha - Glucose

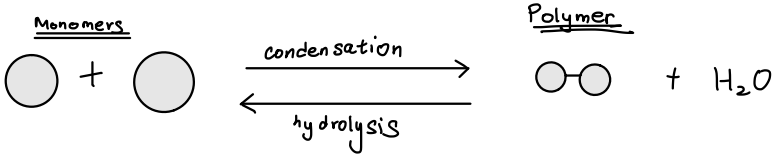


beta - Glucose

Lactose intolerance

- Person lacks the lactase enzyme to break down lactose hence allergic to lactose in milk etc.

Making and breaking polysacharrides



Synanym to remember biomolecules elements

- CHO → Carbon, Hydrogen, Oxygen
- CHO → Carbon, Hydrogen, Oxygen
- CHON → Carbon, Hydrogen, Oxygen, Nitrogen
- CHONP → Carbon, Hydrogen, Oxygen, Nitrogen, Phosphorus

Reducing Sugars — what are they?

- The H (Hydrogen) could dissociate from the carbon ring if it IS a reducing sugar. → hence could form glycosidic bond
- Maltose ✓ Reducing Sugar
- Lactose ✓ Reducing Sugar
- Sucrose X Non-reducing sugar → Sucrose and sucrose cannot form a polysaccharide as the hydrogen could not dissociate and could not form a glycosidic bond.
- Reducing Sugar turns Benedict's Solution red (positive test)

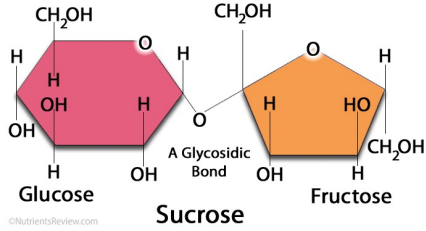
Disaccharide

- A disaccharide is formed when two monosaccharides join together.
- Monosaccharides are joined together by condensation reactions
  ↳ a glycosidic bond forms

Disaccharide formation

Monosaccharides			Disaccharide
α-glucose	+	α-glucose	→ Maltose
glucose	+	fructose	→ Sucrose
glucose	+	galactose	→ Lactose

A Disaccharide Example



Polysaccharides

- A polysaccharide is formed when more than two monosaccharides are joined together by condensation reactions.
- Polysaccharides can be broken down into their monosaccharides by hydrolysis reactions.

There are three polysaccharides we need to know:

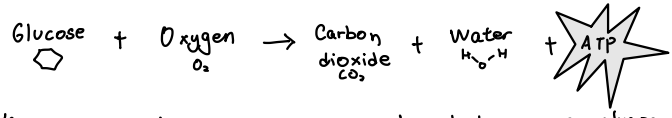
- Starch
- Glycogen
- Cellulose

! smaller chains of polysaccharides are called oligosaccharides

Unlike monosaccharides and disaccharides, polysaccharides are not sweet-tasting nor easily soluble they are not sugars.

Different polysaccharides function can be altered by changing their respective monosaccharides as well as changing how the monosaccharides are bonded together.
e.g 1,4 Glycosidic vs 1,6 Glycosidic Bonds

Respiration takes in alpha glucose to produce energy for plants and animals. It is the main source of energy.



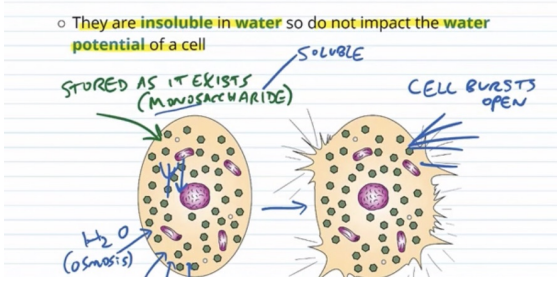
Let's say a person has a very sugary meal and has excess glucose not needed to be converted to energy in respiration:

- Excess chemical energy is stored in cells by forming polysaccharides of alpha glucose.
- α-glucose polysaccharides are well-suited for energy storage, this is because:

  ◇ They are compact (lots of energy in small space)
  ◇ They are insoluble hence cells would not burst due to osmosis leading to cytolysis
  ◇ They are large so they do not diffuse in and out of the cell

- They are are easily hydrolysed (broken down) to form energy

Properties of polysaccharides	Importance for Energy Storage
Large molecule	Cannot diffuse out of cell
Insoluble molecule	Does not affect the water potential of cell
Compact	Lots of energy stored in little space
Easily broken down	Readily accessible energy

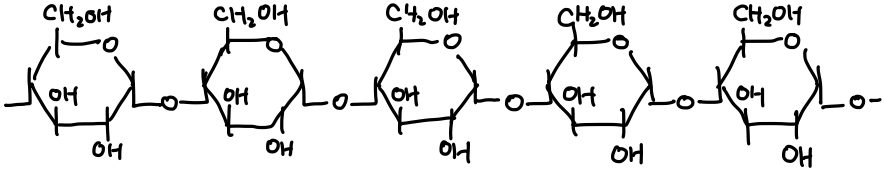


Starch

- An example of a polysaccharide that stores energy is starch. (glycogen as well)
  - Found in leaves and storage organs
  - It is compacted into dense, insoluble grains stored in amyloplasts.
  - Since amyloplasts store starch, storage organs contain cells with numerous amyloplasts to ensure the plant always have a sufficient amount of energy
  - Starch consists of two polysaccharides: amylose & amylopectin

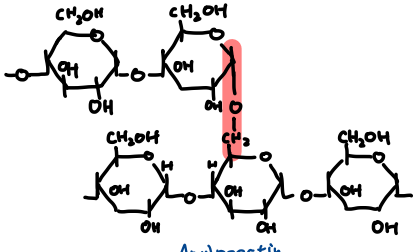
Amylose

→ Amylose is a long chain of alpha glucose molecules joined together by 1, 4 glycosidic bonds.



GCSE Biology Recap: Carbohydrases help break down carbohydrates into simple sugars. The enzyme amylase breaks down starch.

Amylase helps break down amylose.



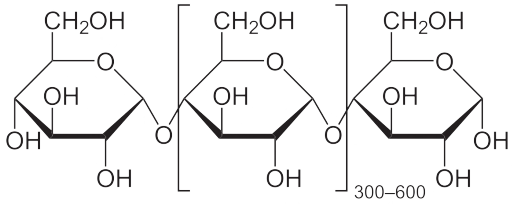
Amylopectin

- Amylopectin is also found in starch.
- This causes more accessible sites for amylase to break down, hence energy can be broken down faster from respiration.

(Starch) Amylose/ Amylopectin —Amylase→ Maltose (Disaccharide of 2 glucose) —Maltase→ Glucose

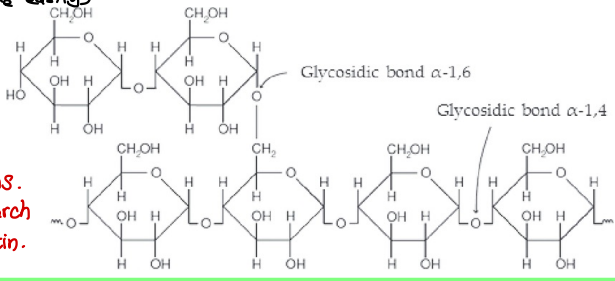
Amylose

- A long, unbranched chain of α-glucose
- Compact - good for storage of energy



Amylopectin

- A long, branched chain of α-glucose.
- Glucose can be released quickly (as enzymes can break down glycosidic bond more easily)



Summary

- There are many polysaccharides: e.g. Starch, Glycogen, Cellulose.
- Polysaccharides are formed from many monosaccharides under condensation reactions.
- The two components that make up starch are polysaccharides: amylose and amylopectin.

Glycogen

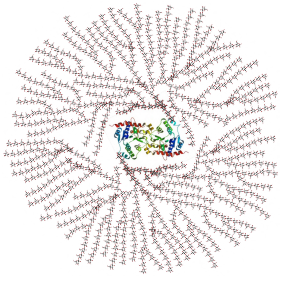
- Glycogen is the equivalent of starch but for animals.
- They are used to store excess glucose.
- Glycogen is another polysaccharide of α-glucose, besides amylose and amylopectin.

Structure of Glycogen

- Structure similar to amylopectin (a component of starch) (both with side branches)
- Glycogen has more side branches though

↓ Hence

- Stored glucose can be released quickly.
- Glycogen is also a compact molecule. so good for storage. (as with other alpha-glucose polypeptides)



Cellulose

- Cellulose provides structural support for cells (found in cell walls)

- Made of long, unbranched chains of beta-glucose (joined by hydrogen bonds)
- The cellulose chains (to right) are linked together by hydrogen bonds to form strong fibres called microfibrils.

↓ Hence

- Strong fibres provide strength for cell walls.