Carbohydrates (Polysaccharides)

- All polysaccharides are polymers
- The monomers making up polysaccharides are glucose molecules
- Starch and glycogen have α glucose as their monomer
- Cellulose has β glucose as its monomer
- The subtle difference in arrangement of atoms in α glucose and β glucose has a large impact on the properties and functions of these polysaccharides

Activity
Use the information above and your knowledge from GCSE to see if you can complete this table

Polysaccharide	Monomer	Where is it found?	Function
Starch	α glucose	In plants in starch granules	Store of glucose and therefore energy in plants
Glycogen	α glucose	In animals, mainly in liver and muscles	Store of glucose and therefore energy in animal tissues
Cellulose	β glucose	In cell walls of plants	Strength

Polymer : large molecules made up of repeating monomers
Eg polysaccharides
Monomer: one of many small molecules that combine together to form a larger molecule (polymer)
Eg glucose is the monomer for polysaccharides

Key Idea: for each polymer there are **REPEATING** monomers ie they are identical to each other

Starch structure
Starch is made up of lots of α glucose molecules joined together

Questions
What sort of reaction would join the α glucose molecules together? Condensation
What sort of bond would form between the glucose molecules? Glycosidic bond
If four glucose molecules joined how many molecules of water would be produced? 3
In the space below draw 4 glucose molecules joined together

Correct drawing using information from the Sugars sheet or textbook

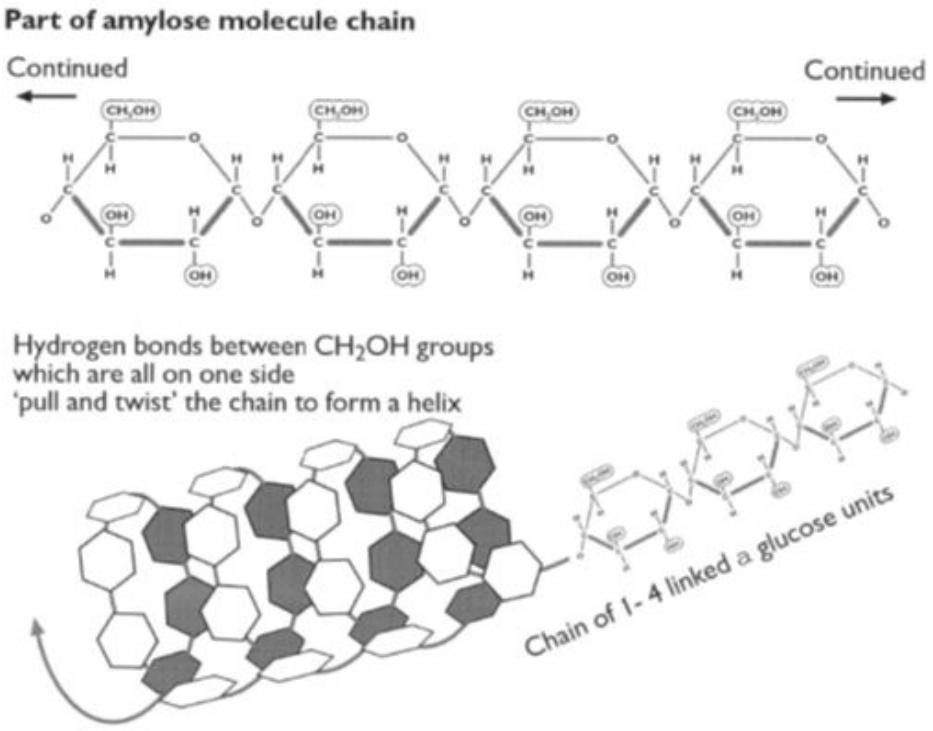
Starch is actually a mixture of two polysaccharides. These are

- Amylose
- Amylopectin

In different species of plant there are different proportions of these two polysaccharides and so there are different possible compositions of starch.

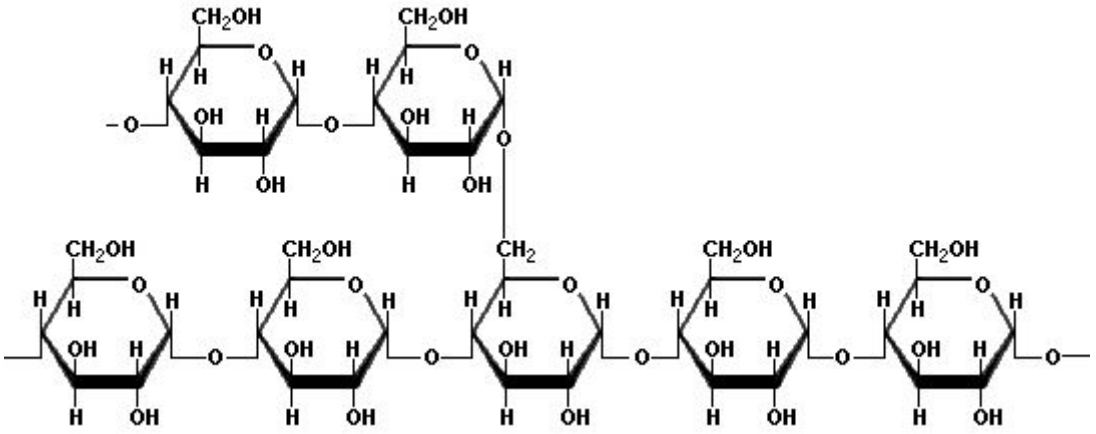
Amylose

Long chains of α glucose form and then coil into a helix. The helix is held in place by hydrogen bonds between the CH_2OH groups. See the diagram below



Amylopectin

In this molecule long chains of α glucose molecules branch. These branches are also made up of α glucose.



The bonds along the long chains are 1-4 Glycosidic bonds since the bond forms between carbon 1 of one glucose and carbon 4 of the next. The branches form through a differnt carbon atom

Look at the diagram

Which carbons are involved in the formation of the branch bonds 1 and 6

Suggest a name for the bonds formed 1-6 Glycosidic bond

Function of starch

- Starch is found in plants not animals
- Its function is to store large numbers of glucose molecules and therefore large amounts of energy

Questions

1. **Which biochemical reaction releases the energy stored in glucose? Respiration**
2. **Where does this biochemical reaction take place? Mitochondria**

How is starch adapted for its function?

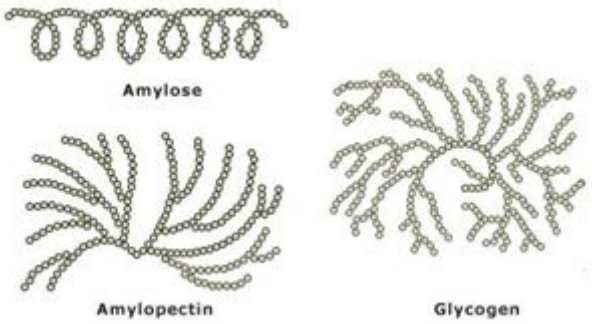
The function of starch is to store glucose and therefore energy in plants. Starch is found in large quantities in storage organs such as carrots and potatoes and is stored within cells in starch granules.

Key features

1. It is composed of amylose which is coiled into a helix and so it is **COMPACT** which means that a lot of starch can be stored in a small space
2. It is also composed of amylopectin which is branched and so provides lots of 'ends' for hydrolytic enzymes to break down the molecule and release glucose **rapidly** when needed
3. It is a large molecule and so won't diffuse out of the cell it is being stored in
4. It is a large molecule and so has no osmotic effect (does not cause water to enter or leave by osmosis)

Glycogen

- Glycogen has a similar structure to amylopectin
- But it has shorter chains and more branches
- It is a storage molecule in animals especially in muscles and liver

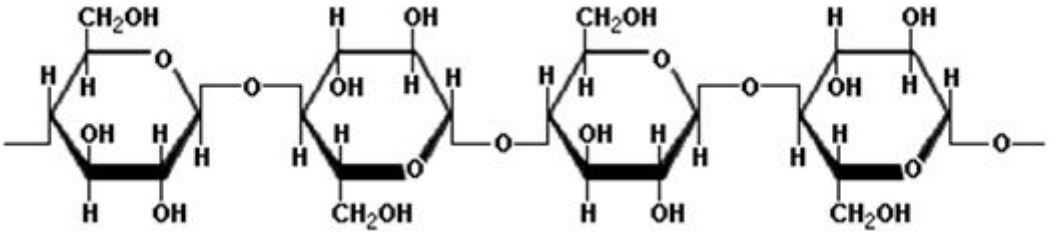


Cellulose

Some revision questions from GCSE

1. **Is cellulose found in plants or animals? Plants**
2. **Where exactly is cellulose found? Cell walls**
3. **What is the function of cellulose? Provide strength**

- Cellulose is formed from □ glucose molecules
- The □ glucose molecules are joined by glycosidic bonds



Questions

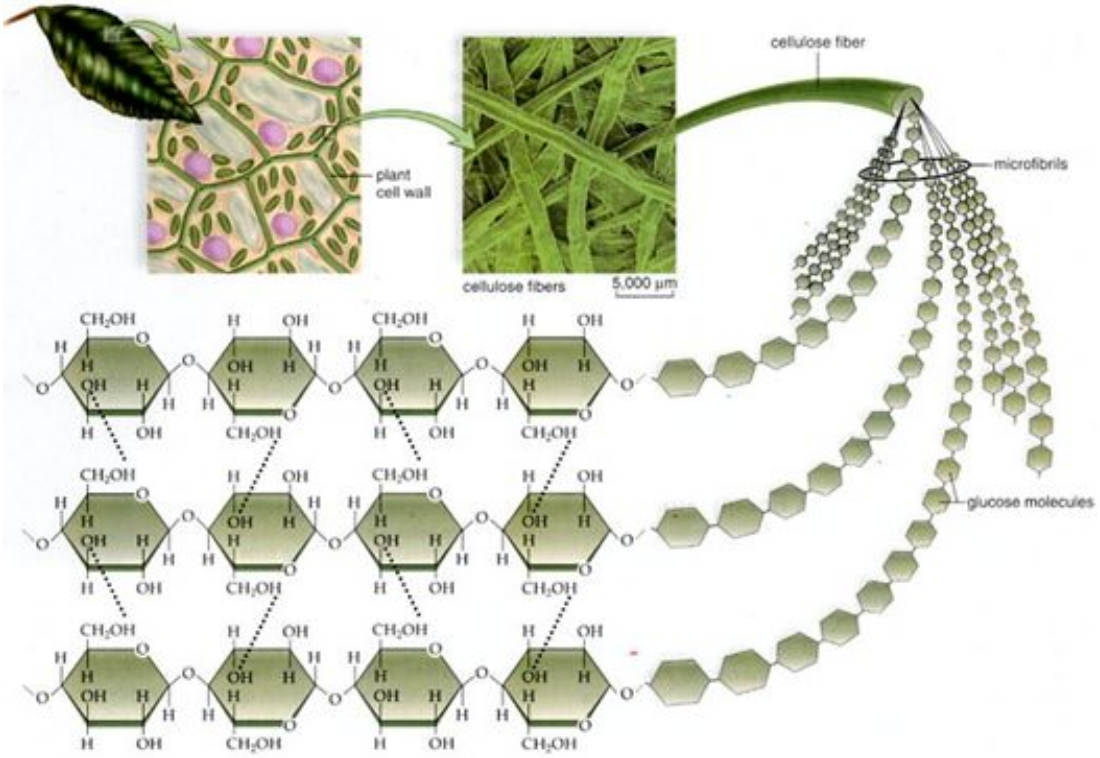
1. **What do you notice about the orientation of the glucose molecules in the chain**

   Alternate glucose molecules are orientated at 180° to those either side

2. **Look at the structure of glucose and suggest why the orientation of the glucose molecules in cellulose is like this**

   The orientation of the hydroxyl group (OH) and H on carbon 1 makes it difficult to form a bond with carbon 4 on the adjacent carbon molecule

- The glucose molecules join together in long chains
- There are no branches
- Lots of these chains lie parallel to one another in bundles
- **Hydrogen bonds** form **between** the chains holding them together
- These bundles are called **MICROFIBRILS**
- Together they have enormous **TENSILE STRENGTH**



Notice that a small change in the glucose molecule had an enormous impact on function

Starch and glycogen are storage molecules whereas cellulose provides strength.

Now try answering these questions from a past paper

1 (a) Give **one** feature of starch and explain how this feature enables it to act as a storage substance.

Feature .....

Explanation .....

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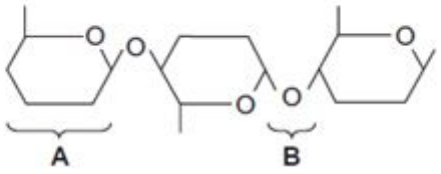
(2 marks)

1 (b) The diagram shows part of a cellulose molecule.



1 (b) (i) Name part **A**.

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(1 mark)

1 (b) (ii) Name bond **B**.

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(1 mark)

1 (c) The structure of cellulose is related to its role in plant cell walls. Explain how.

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(3 marks)

1	(a)		Helical /spiral/coiled; Compact / description e.g. 'tightly packed'; Insoluble; Prevents osmosis/uptake of water / does not affect water potential / (starch) does not leave cell; Large molecule / long chain; Does not leave cell;	1 1 1 1 1 1	2 max Feature = one mark Explanation = one mark These must be related for both marks but can be in reverse order. Allow idea of compact/helical/spiral/coiled due to bonding for two marks.
1	(b)	(i)	β/beta Glucose;	1	Q Reject alpha glucose
1	(b)	(ii)	Glycosidic;	1	
1	(c)		Long/straight/unbranched chains (of glucose); (Joined by) hydrogen bonds; Form (micro)fibrils/(macro)fibrils; Provide rigidity/strength/support;	1 1 1 1	3 max Q Ignore reference to alpha glucose Allow suitable descriptions for last point e.g. 'prevents bursting';