

Biological molecules revision notes

Living things are built from a small set of large molecules: carbohydrates, fats and proteins. This topic covers the elements they contain, how they are built from smaller units, and the chemical tests used to identify them in food.

For Cambridge IGCSE Combined Science 0653, **Supplement** is Extended content, only examined on Papers 2 and 4.

1 Biological molecules Spec B4.1

Carbohydrates, fats and proteins Spec B4.1.1, B4.1.2

Carbohydrates, fats and proteins are made from just a few chemical elements. Each is a **large molecule** built from many smaller molecules joined together.

Elements in the three main food molecules

Molecule	Elements present
Carbohydrates	carbon, hydrogen, oxygen
Fats (and oils)	carbon, hydrogen, oxygen
Proteins	carbon, hydrogen, oxygen, nitrogen

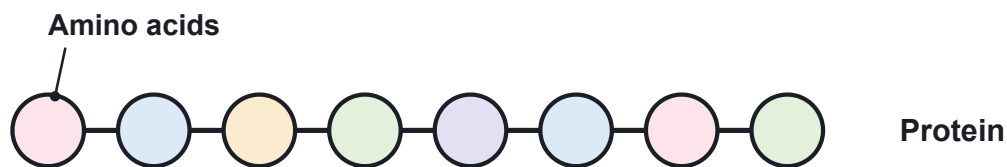
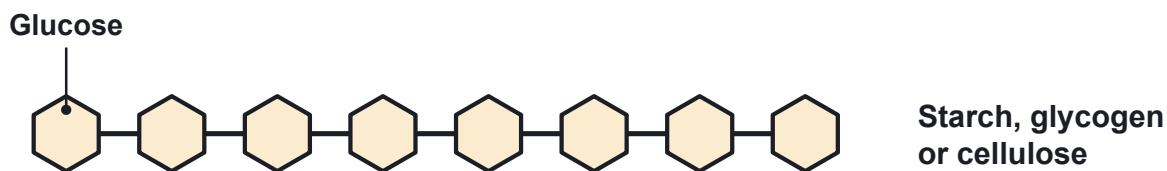
Common mistake: Carbohydrates and fats contain the same three elements. Proteins contain these three plus nitrogen. Write the element names in full, or use the symbols C, H, O and N correctly.

Large molecules are made from smaller molecules

Building blocks

Large molecule	Made from
Starch	many glucose molecules joined together
Glycogen	many glucose molecules joined together
Cellulose	many glucose molecules joined together
Proteins	many amino acids joined together
Fats and oils	three fatty acids joined to one glycerol

Starch is the **energy store** in plants. Glycogen is the energy store in animals and fungi. Cellulose is a **structural** carbohydrate that makes up plant cell walls. All three are built from the same unit, glucose, but the glucose molecules are joined in different arrangements.



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Large molecules are built from **smaller molecules** joined together.

Exam tip: Learn the three pairings exactly: glucose makes starch, glycogen and cellulose; amino acids make proteins; fatty acids and glycerol make fats and oils.

Food tests Spec B4.1.3

Chemical tests show which biological molecules are in a food. Most foods must first be ground up with a little water and filtered or allowed to settle, so the test is done on the liquid.

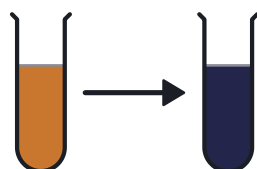
Food tests and results			
Test	Food molecule	Method	Positive result
Iodine solution	starch	Add a few drops of iodine solution (orange-brown) to the sample.	turns blue-black (negative: stays orange-brown)
Benedict's solution	reducing sugars	Add Benedict's solution (blue) to the sample, then heat in a hot water bath.	blue turns green, yellow, orange or brick-red as the amount of reducing sugar increases (negative: stays blue)
Biuret test	proteins	Add biuret solution (blue) to the sample and mix.	turns purple / lilac (negative: stays blue)
Ethanol emulsion test	fats and oils	Mix the sample with ethanol, then pour the mixture into water.	a cloudy white emulsion forms (negative: stays clear)
DCPIP test	vitamin C	Add the sample drop by drop to DCPIP solution (blue).	DCPIP changes from blue to colourless

Practical skill: Benedict's solution must be heated to work. Use a water bath at about 80 °C, not a Bunsen flame directly on the tube, and wear eye protection. Compare colours against a set of known samples to judge the amount of sugar.

The DCPIP test works the other way round from the others: the colour is lost (blue to colourless) when vitamin C is present. The more drops of food sample needed to decolourise a fixed volume of DCPIP, the less vitamin C the sample contains.

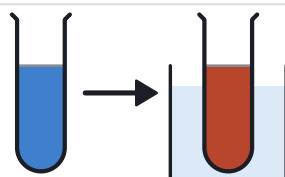
Exam tip: Always give the start colour and the end colour, for example 'blue to brick-red'. 'It changes colour' gets no mark.

Iodine solution
test for starch



start: orange-brown
positive: blue-black

Benedict's solution
test for reducing sugars



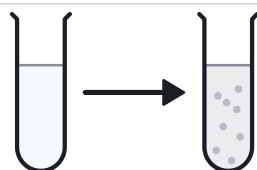
start: blue
positive: brick-red
(heat in a hot water bath)

Biuret test
test for proteins



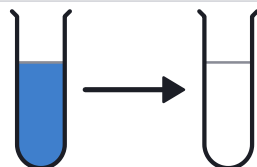
start: blue
positive: purple

Ethanol emulsion test
test for fats and oils



start: clear
positive: cloudy white emulsion

DCPIP test
test for vitamin C



start: blue
positive: colourless

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Learn the start colour and the positive colour for each test.

Quick check

1. Which element is found in proteins but not in carbohydrates or fats?
2. What small molecules join to make a protein?
3. What is the positive result for the iodine test?
4. Which test uses DCPIP, and what is the positive result?

Quick check answers

Biological molecules

1. Nitrogen.
2. Amino acids.
3. Orange-brown turns blue-black, showing starch.
4. Test for vitamin C; blue DCPIP becomes colourless.