

Biological molecules

IGCSE Biology

The chemical elements in food



Bread is rich in carbohydrates, one of the main food groups.

Image: FranHogan, CC BY-SA 4.0 (commons.wikimedia.org)

carbohydrates
and fats
C H O

proteins
C H O N

Carbohydrates and fats contain C, H and O; proteins also contain nitrogen

Living things are built from a few kinds of **molecule** 分子. The most important are carbohydrates, fats and proteins. Each is made from a small number of chemical **elements** 元素.

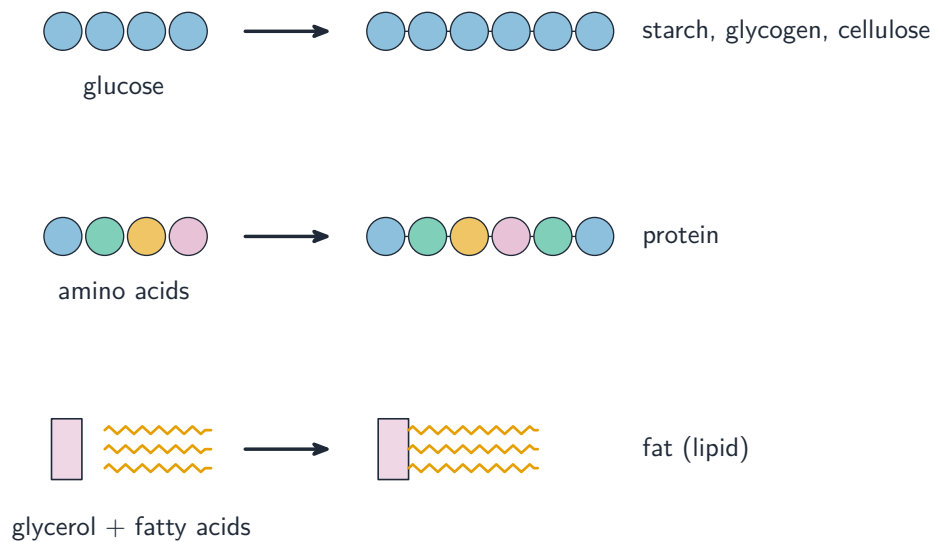
- **Carbohydrates** 碳水化合物 and **fats** 脂肪 contain three elements: **carbon** 碳 (C), **hydrogen** 氢 (H) and oxygen (O).
- **Proteins** 蛋白质 contain carbon, hydrogen and oxygen too, plus **nitrogen** 氮 (N). (Some proteins also contain sulfur, S.)

Building large molecules from small ones

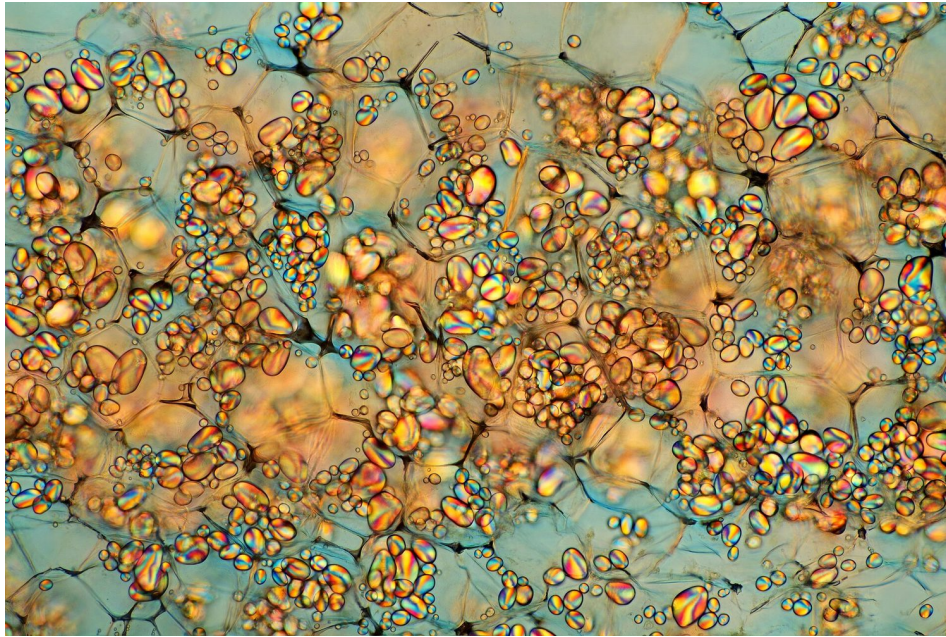
Large molecules are made by joining many small molecules together, like beads on a string.

Large molecule	Built from
starch 淀粉, glycogen 糖原 and cellulose 纤维素	many glucose 葡萄糖 units
proteins	amino acids 氨基酸
fats and oils	fatty acids 脂肪酸 and glycerol 甘油

Starch and glycogen are energy stores; cellulose makes plant cell walls. Proteins are built from about 20 different kinds of amino acid joined in a chain. One fat molecule is made from three fatty acids joined to one glycerol.



Large molecules are built by joining many small units, like beads on a string



Starch grains from a potato, seen under a microscope —each grain is built from many glucose units

Image: MarekMiś, CC BY 4.0 (commons.wikimedia.org)

Food tests

You can test a piece of food to find out which substances it contains. Add the test chemical and watch for a colour change.

Food substance	Test	Positive result
starch	add iodine solution 碘液	orange-brown → blue-black
reducing sugars 还原糖 (such as glucose)	add Benedict's solution 本尼迪特试剂 and heat	blue → brick-red / orange
protein	add biuret 双缩脲 solution	blue → purple
fats and oils	ethanol 乙醇 emulsion 乳浊液 test	a cloudy white layer forms
vitamin 维生素 C	add to blue DCPIP	blue → colourless

Two things to remember: only the Benedict's test needs **heat**; and DCPIP loses its colour (goes colourless), while the other tests gain a new colour.

Food substance (test)	start	positive result
Starch (iodine)		 blue-black
Reducing sugar (Benedict's, heat)		 brick-red
Protein (biuret)		 purple
Fat (ethanol emulsion)		 cloudy white
Vitamin C (DCPIP)		 colourless

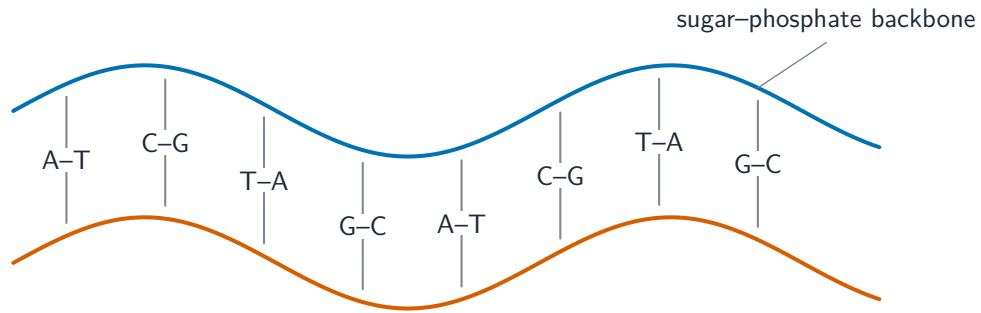
Each food test gives its own colour change for a positive result

Worked example. A student tests an unknown food. Iodine solution stays orange-brown. Benedict's solution, after heating, turns brick-red. Biuret solution turns purple. What does the food contain? Iodine staying orange-brown is a **negative** result, so there is no starch. Brick-red is a **positive** Benedict's result, so reducing sugar is present. Purple is a **positive** biuret result, so protein is present. The food contains reducing sugar and protein, but no starch. "No colour change" is a real result - it tells you the substance is **absent**.

The structure of DNA (Supplement)

DNA is the **genetic material** 遗传物质—it carries the instructions for building and running an organism. Its structure has four key points:

- two **strands** 链 are coiled together to form a **double helix** 双螺旋 (like a twisted ladder).
- each strand carries chemicals called **bases** 碱基.
- **bonds** 化学键 between pairs of bases hold the two strands together.
- the bases always pair in the same way: **A with T**, and **C with G**.



two strands form a double helix; bases pair A-T and C-G

DNA is a double helix; the bases always pair A-T and C-G

Exam tips

- Carbohydrates and fats are made of C, H and O. Proteins also contain N (nitrogen).
- Learn each food test and its colour change. For reducing sugars you must **heat** the Benedict's solution.
- DCPIP goes from blue to **colourless**; the other four tests each give a **new** colour.
- In DNA, the bases pair only A-T and C-G. So if you know the bases on one strand, you can work out the other.