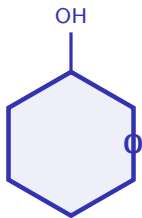


Biological Molecules

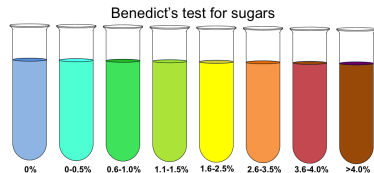
A-Level Biology ■ Topic 2

A-Level Biology



What we will cover

- 1 Food tests
- 2 Carbohydrates
- 3 Polysaccharides
- 4 Lipids
- 5 Proteins
- 6 Water



Benedict's colour scale

Food tests

Benedict's

reducing sugar 还原糖 → brick-red

emulsion

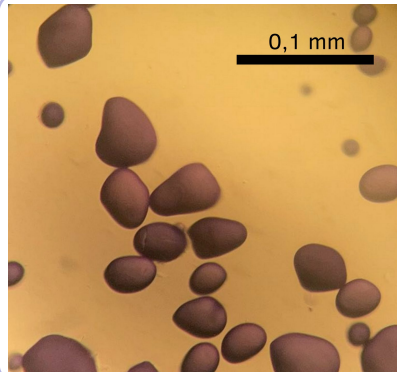
lipid 脂质 → white emulsion

iodine

starch 淀粉

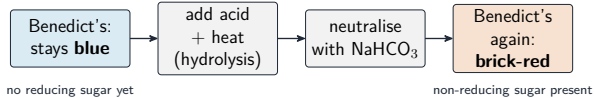
biuret

protein 蛋白质



starch grains

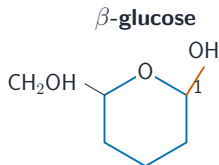
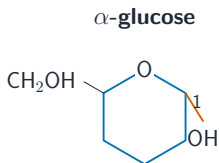
Testing for a non-reducing sugar



A **non-reducing sugar** 非还原糖 (sucrose) gives a negative Benedict's.

Hydrolyse 水解 it first with acid & heat, neutralise, then re-test – a brick-red shows it was present.

Carbohydrates and the two glucose forms

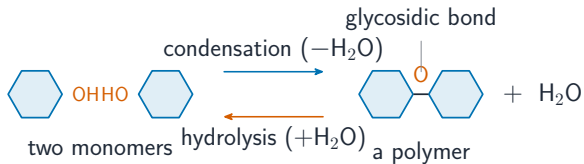


only carbon 1 differs: the OH points **down** in α , **up** in β

Monosaccharide 单糖 (glucose) →
disaccharide 二糖 →
polysaccharide 多糖.

The two ring forms differ only at carbon 1: -OH points **down** in α -glucose α -葡萄糖, **up** in β -glucose β -葡萄糖 – deciding which polymer it builds.

Condensation and hydrolysis



Two sugars join by a **glycosidic bond** 糖苷键.

- **condensation** 缩合 – removes water to join
- **hydrolysis** 水解 – adds water to split

Polysaccharides – shape fits the job



amylose
(coiled)



amylopectin
(branched)



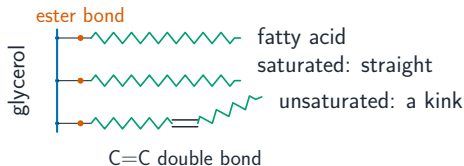
glycogen
(many branches)



cellulose
(straight chains)

- **starch** 淀粉
(**amylose** 直链淀粉 coil + **amylopectin** 支链淀粉 branched) – plant store
- **glycogen** 糖原 – animal store, more branched
- **cellulose** 纤维素 – straight β chains → strong cell wall

Triglycerides



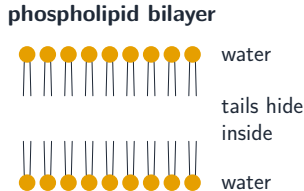
3 ester bonds form $\rightarrow$ 3 H_2O removed (condensation)

A **triglyceride** 甘油三酯: one **glycerol** 甘油 + three **fatty acids** 脂肪酸 by **ester bonds** 酯键.

- **saturated** 饱和 – no double bonds (solid)
- **unsaturated** 不饱和 – kinked (liquid)

A rich energy store – twice the energy per gram.

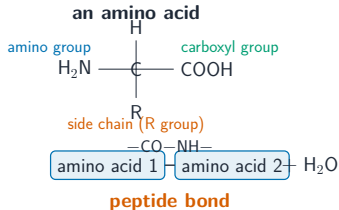
Phospholipids



A **phospholipid** 磷脂 has a **hydrophilic** 亲水 **phosphate** 磷酸 head and two **hydrophobic** 疏水 tails.

Heads face the water, tails hide inside – forming the **bi-layer** of every cell membrane.

Amino acids and the peptide bond



condensation removes one water for each peptide bond

Every **amino acid** 氨基酸 has an **amino group** 氨基, a **carboxyl group** 羧基, an H and a variable **R group** 侧链. Two join by a **peptide bond** 肽键 (condensation) into a **polypeptide** 多肽.

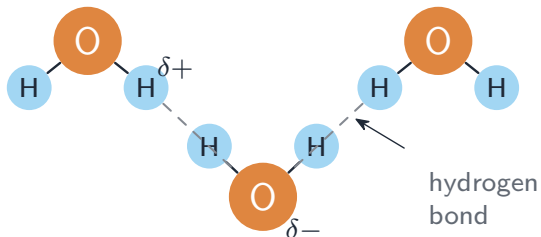
The four levels of protein structure



- **primary** 一级结构 – the amino-acid order
- **secondary** 二级结构 – α -helix 螺旋 & β -sheet 折叠片
- **tertiary** 三级结构 – the folded 3-D shape
- **quaternary** 四级结构 – several chains

Globular 球状蛋白质 (haemoglobin)
vs **fibrous** 纤维状蛋白质 (collagen).

Water



Water is **polar** 极性, so molecules attract by **hydrogen bonds** 氢键. This explains:

- a good **solvent** 溶剂
- high **specific heat capacity** 比热容 – steady temperature
- high **latent heat** 汽化潜热 – cooling by evaporation

Worked example – identifying a molecule

A sample gives a purple biuret result and stays blue with Benedict's. After boiling with acid it now gives brick-red. Explain.

- Purple biuret $\Rightarrow$ **protein present** (peptide bonds).
- Benedict's blue at first $\Rightarrow$ **no reducing sugar**.
- Boiling with acid **hydrolyses glycosidic bonds**, splitting a non-reducing sugar into its monomers.
- Brick-red after $\Rightarrow$ a **non-reducing sugar** (e.g. sucrose) was there all along.

Neutralise before the second Benedict's, or the acid stops it working.
Blue $\rightarrow$ red only after hydrolysis = **non-reducing sugar**.

Topic 2 – key takeaways

1

Carbohydrates

α vs β glucose; condensation joins them

2

Polysaccharides

starch & glycogen store; cellulose supports

3

Lipids

triglycerides store energy;
phospholipids form membranes

4

Proteins

four structure levels; shape fits function

Check yourself

1

Which test detects protein, and its colour?

2

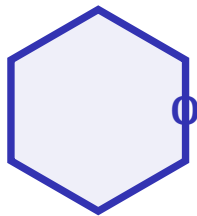
Which bond joins two monosaccharides?

3

Cellulose is made of which glucose form?

4

Which part of a phospholipid is hydrophilic?

**Answers**

1. biuret → purple 2. a glycosidic bond 3. β -glucose 4. the phosphate head