

2.2 Carbohydrates and lipids

Name: _____ Class: _____ Date: _____

Total: 18 marks

KEY WORDS polysaccharide 多糖 • glucose 葡萄糖 • monomer 单体 • triglyceride 甘油三酯 • glycosidic bond 糖苷键

Objective

Build the skills to answer exam questions on **carbohydrates and lipids** — the structure of sugars and **polysaccharides** 多糖, the bonds that join them, and how **triglycerides** 甘油三酯 and **phospholipids** 磷脂 are built and used.

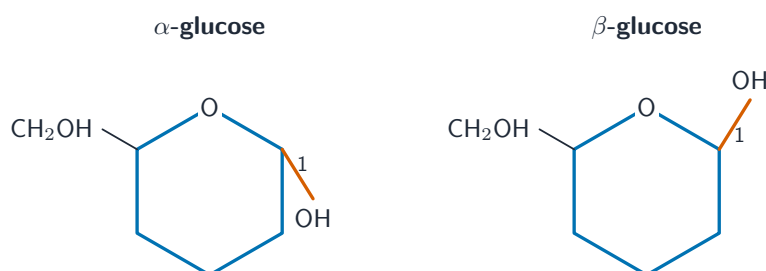
You must be able to:

- describe α -glucose and β -glucose and the **glycosidic bond** 糖苷键 formed by condensation
- relate the structures of starch, glycogen and **cellulose** 纤维素 to their functions
- describe a triglyceride (glycerol + three fatty acids, **ester bonds** 酯键) and relate it to its function
- describe a phospholipid and its hydrophilic head and hydrophobic tails

1 Worked examples

■ Glucose and the glycosidic bond

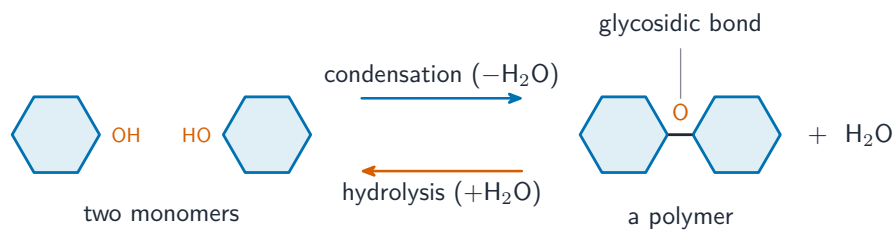
Glucose forms a ring with six carbons. The two ring forms differ only at carbon 1: in α -glucose the -OH points **down**; in β -glucose it points **up**. This small difference decides which polysaccharide can be built.



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

The two ring forms differ only at carbon 1

Two sugars join by **condensation** 缩合 — a glycosidic bond forms and **one water molecule is removed**. The reverse, **hydrolysis** 水解, adds water to break the bond.

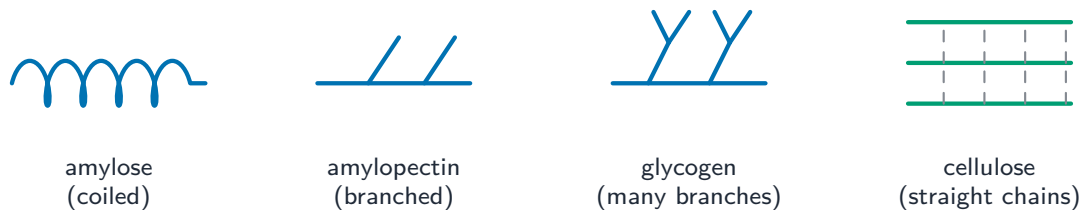


Condensation removes water to join monomers; hydrolysis adds water to split them

■ Polysaccharides: shape fits function

- **starch** 淀粉 (plant store) = **amylose** (unbranched, coils) + **amylopectin** (branched).
- **glycogen** 糖原 (animal store) = like amylopectin but more branched → broken down fast.
- **cellulose** = β -glucose, so chains are straight and pack into strong fibres for the cell wall.

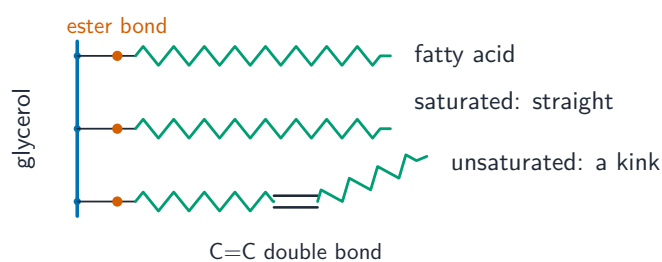
Storage polysaccharides are compact, **insoluble** 不溶 (stay in the cell) and do not change the **water potential** 水势.



Branched, coiled stores (starch, glycogen) vs straight, strong cellulose fibres

■ Triglycerides and phospholipids

A **triglyceride** is one **glycerol** 甘油 + three **fatty acids** 脂肪酸, joined by three ester bonds (three water molecules removed). **Saturated** 饱和 fatty acids have no C=C double bonds; **unsaturated** 不饱和 have one or more. Triglycerides are a good energy store: they release about twice the energy per gram of carbohydrate, and are insoluble.



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

One glycerol plus three fatty-acid tails, joined by ester bonds

A **phospholipid** has one fatty acid replaced by a **phosphate** 磷酸 group, giving a **hydrophilic** 亲水 head and two **hydrophobic** 疏水 tails — why phospholipids form membranes.

2 Practice

2.1 Name the bond formed when (a) two monosaccharides join, and (b) a fatty acid joins glycerol. [2]

2.2 State **two** ways the structure of starch suits its function as an energy store. [2]

2.3 Explain why cellulose is strong enough to support a plant cell wall. [3]

3 Exam-style questions

3.1 Which statement about α -glucose and β -glucose is correct? [1]

- **A** they are different elements
 - **B** they differ in the position of an -OH group on carbon 1
 - **C** β -glucose cannot form a ring
 - **D** only α -glucose is a reducing sugar
-

3.2 How many water molecules are released when one glycerol joins three fatty acids to form a triglyceride? [1]

- **A** 1
 - **B** 2
 - **C** 3
 - **D** 6
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3.3 Which polysaccharide is made of β -glucose and forms straight chains? [1]

- **A** amylopectin
 - **B** amylose
 - **C** cellulose
 - **D** glycogen
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3.4 (a) Describe how a glycosidic bond is formed between two glucose molecules. [2]

(b) Glycogen and cellulose are both polymers of glucose, but have very different functions. Explain how their structures relate to their functions. [4]

3.5 Explain why a triglyceride is a good long-term energy store.

[2]

Solutions

2.1 (a) glycosidic bond; (b) ester bond.

2.2 Any two: compact / insoluble (does not leave the cell or affect water potential) / branched so many ends for fast hydrolysis / large molecule.

2.3 β -glucose means every other glucose is flipped, so chains are long and straight; many straight chains lie side by side, held by hydrogen bonds into strong microfibrils.

3.1 B. They differ only in the position of the -OH on carbon 1.

3.2 C. Three ester bonds form, so three water molecules are released.

3.3 C. Cellulose is made of β -glucose and forms straight chains.

3.4 (a) a glycosidic bond forms by condensation, removing one water molecule.

(b) glycogen is highly branched, giving many ends for fast hydrolysis to release glucose for respiration; cellulose is straight β -glucose chains held side by side by hydrogen bonds into strong fibres that support the cell wall.

3.5 insoluble / does not affect water potential; releases about twice the energy per gram of carbohydrate.