Exercise walk-through

Carbohydrates and lipids ▪ 2.2

eXercise

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

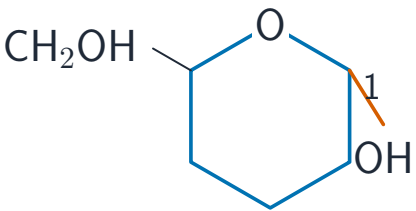
Method — Glucose and the glycosidic bond

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.

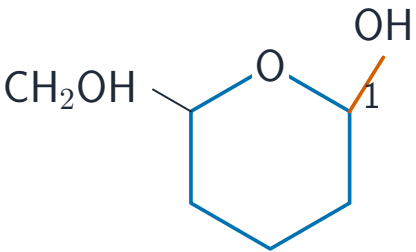
Two sugars join by **condensation** 缩合 — a glycosidic bond forms and **one water molecule is removed**. The reverse, **hydrolysis** 水解, adds water to break the bond.

Method — Glucose and the glycosidic bond

α-glucose

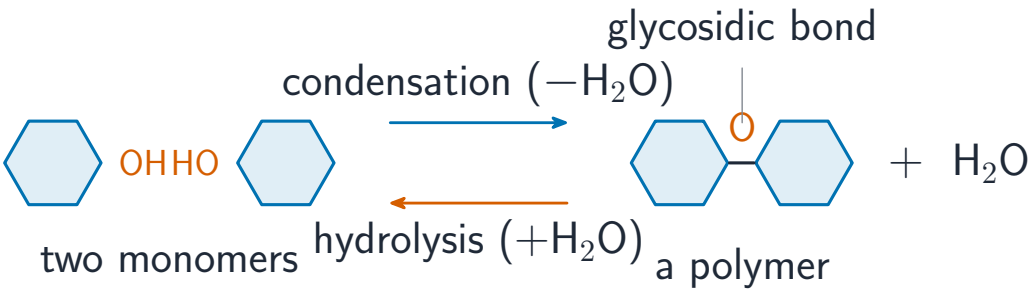


β-glucose



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

Method — Glucose and the glycosidic bond



Method — 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.

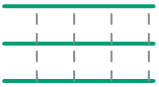
Storage polysaccharides are compact, **insoluble** 不溶 (stay in the cell) and do not change the **water potential** 水势.

Method — Polysaccharides: shape fits function

amylose
(coiled)

amylopectin
(branched)

glycogen
(many branches)

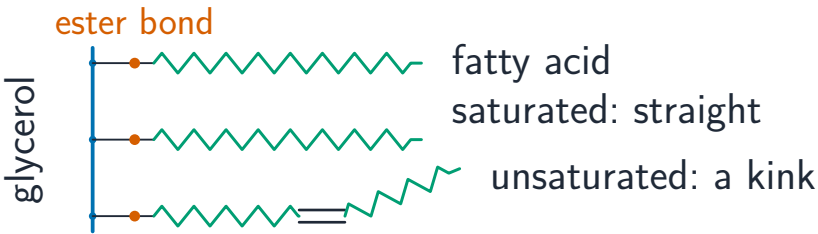


cellulose
(straight chains)

Method — 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. 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.

Method — Triglycerides and phospholipids



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

A triglyceride: a glycerol backbone joined to three fatty acid chains by ester bonds

Practice 2.1 ▪ 2 marks

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

Solution 2.1

Method: Triglycerides and phospholipids

Worked steps

(a) glycosidic bond B1; (b) ester bond B1.

Practice 2.2 ▪ 2 marks

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

Solution 2.2

Method: Polysaccharides: shape fits function

Worked steps

Any two: compact / insoluble (does not leave the cell or affect water potential) / branched so many ends for fast hydrolysis / large molecule B1 *each, max 2.*

Practice 2.3 ▪ 3 marks

Explain why cellulose is strong enough to support a plant cell wall.

Solution 2.3

Method: Polysaccharides: shape fits function

Worked steps

β-glucose means every other glucose is flipped **M1**, so chains are long and straight **A1**; many straight chains lie side by side, held by hydrogen bonds into strong microfibrils **A1**.

Exam-style 3.1 ▪ 1 mark

Which statement about α-glucose and β-glucose is correct?

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

Solution 3.1

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

Worked steps

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

Exam-style 3.2 ▪ 1 mark

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

A 1

B 2

C 3

D 6

Solution 3.2

Method: Triglycerides and phospholipids

A 1

B 2

C 3 ✓

D 6

Worked steps

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

Exam-style 3.3 ▪ 1 mark

Which polysaccharide is made of β-glucose and forms straight chains?

A amylopectin

B amylose

C cellulose

D glycogen

Solution 3.3

A amylopectin

B amylose

C cellulose ✓

D glycogen

Worked steps

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

Exam-style 3.4 ▪ 2 marks

(a) Describe how a glycosidic bond is formed between two glucose molecules.
(b) Glycogen and cellulose are both polymers of glucose, but have very different functions. Explain how their structures relate to their functions.

Solution 3.4

Worked steps

(a) a glycosidic bond forms B1 by condensation, removing one water molecule B1.

(b) glycogen is highly branched, giving many ends for fast hydrolysis to release glucose for respiration M1 A1; cellulose is straight β-glucose chains held side by side by hydrogen bonds into strong fibres that support the cell wall M1 A1.

Exam-style 3.5 ▪ 2 marks

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

Solution 3.5

Method: Triglycerides and phospholipids

Worked steps

insoluble / does not affect water potential B1; releases about twice the energy per gram of carbohydrate B1.