2.2 Carbohydrates and lipids

Name: _____ Class: _____ Date: _____ **Total: 18 marks**

KEY WORDS polysaccharide • glucose • triglyceride • monomer • polymer

Objective

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

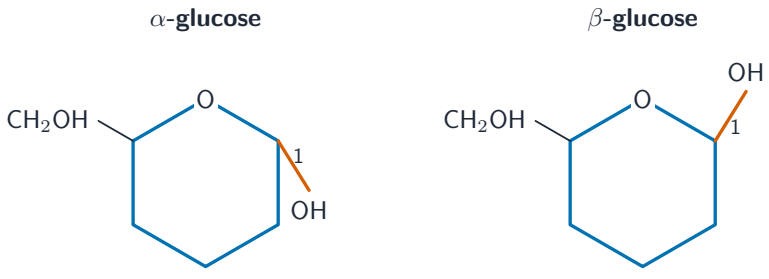
You must be able to:

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

1 Key knowledge and 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.

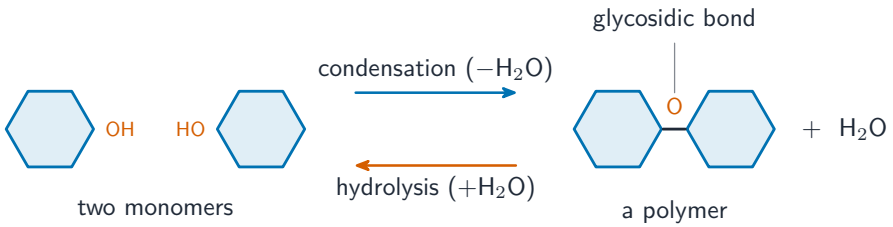


only carbon 1 differs: the OH points **down** in α, **up** in β

The two ring forms differ only at carbon 1

Two sugars join by **condensation** – a glycosidic bond forms and **one water**

molecule is removed. The reverse, **hydrolysis** , adds water to break the bond.



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

Polysaccharides: shape fits function

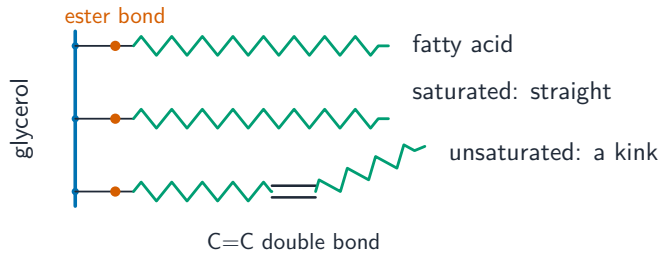
- **starch** (plant store) = **amylose** (unbranched, coils) + **amylopectin** (branched).
- **glycogen** (animal store) = like amylopectin but more branched → broken down fast.
- **cellulose** = β-glucose, so chains are straight and pack into strong fibres for the cell wall.

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

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

Triglycerides and phospholipids

A **triglyceride** is one **glycerol** + three **fatty acids** , joined by three ester bonds (three water molecules removed). **Saturated** fatty acids have no C=C double bonds; **unsaturated** 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 → 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** group, giving a **hydrophilic** head and two **hydrophobic** 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

3.3 Which polysaccharide is made of β-glucose and forms straight chains? [1]

- **A** amylopectin
- **B** amylose
- **C** cellulose
- **D** glycogen

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

Each answer shows the steps, then the **result**.

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