

1.2 Lipids and ester bonds

Name: _____ Class: _____ Date: _____

Total: 20 marks

KEY WORDS triglyceride • ester bond • saturated • unsaturated
• emulsion

Objective

Practise statement 1.5: triglyceride synthesis, ester bonds, and the saturated/unsaturated distinction that links lipid chemistry to diet and cardiovascular risk.

1 Key knowledge and worked examples

■ One glycerol, three fatty acids, three ester bonds

A **triglyceride** forms when glycerol's three hydroxyl groups each condense with the carboxyl group of a fatty acid, releasing three water molecules and forming three **ester bonds**.

■ Saturation decides packing

A **saturated** fatty acid has no C=C: the chain is straight, chains pack closely, and the fat is solid at room temperature (butter). An **unsaturated** acid has one or more C=C, each forcing a kink: packing is loose and the oil is liquid (olive oil). More energy per gram than carbohydrate because the molecule is more reduced – that is why seeds and adipose tissue store lipid.

■ Worked example: designing the emulsion test comparison

To compare the lipid content of two milks: equal volumes of each + equal ethanol, shake, decant the ethanol into equal volumes of cold water. A cloudy white **emulsion** means lipid present. Compare turbidity between the two tubes – the milk giving the denser emulsion carries more lipid. Controls: same volumes, same temperature, same water volume; repeat with three samples each.

2 Practice

2.1 Describe how a triglyceride is synthesised, naming the reactants, the type of reaction and the bond formed. [3]

2.2 Oleic acid contains one C=C bond per chain and stearic acid contains none. Explain which fat solidifies at the lower temperature. [2]

2.3 State one advantage of storing energy as triglyceride rather than glycogen. [1]

3 Exam-style questions

3.1 The table shows the percentage of fatty acids in three dietary fats.

Fat	Saturated / %	Monounsaturated / %	Polyunsaturated / %
Butter	51	21	3
Olive oil	14	73	8
Sunflower oil	10	20	66

Use your knowledge of fatty-acid structure to explain why butter is solid at room temperature while sunflower oil is liquid, and suggest which fat a doctor might recommend to a patient with high blood LDL-cholesterol. Justify your answer. [5]

3.2 A triglyceride contains the fatty acids $\text{C}_{17}\text{H}_{33}\text{COOH}$, $\text{C}_{17}\text{H}_{35}\text{COOH}$ and $\text{C}_{17}\text{H}_{35}\text{COOH}$. Determine how many of the three fatty-acid chains are unsaturated, state the total number of water molecules released when this triglyceride forms, and name the bonds that link the fatty acids to glycerol. [4]

3.3 Adipose tissue stores triglyceride but muscle stores glycogen. Explain this difference by comparing energy per gram and the effect on cell water potential, and state one situation in which the body preferentially mobilises lipid rather than glycogen. [5]
