

Question 37

(22 marks)

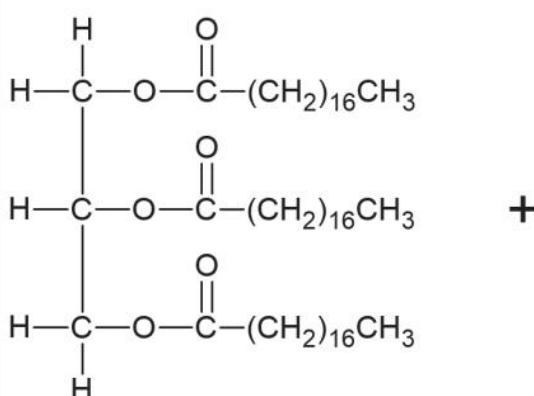
Triglycerides may be used in chemical synthesis processes to manufacture both soaps and biodiesel.

- (a) Write balanced equations to show the reagents required and all products formed in the synthesis of soap in saponification of tristearin, and the synthesis of biodiesel in base-catalysed transesterification of tristearin. The structural formula of the reactant tristearin, a common triglyceride, and the product glycerol are given. There are separate boxes for reactants and products to help structure your answers.

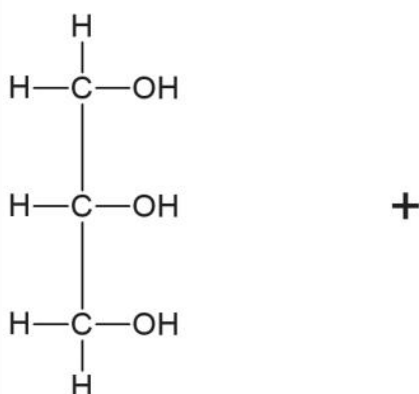
- (i) Balanced equation for the formation of soap from tristearin.

(3 marks)

Reactants

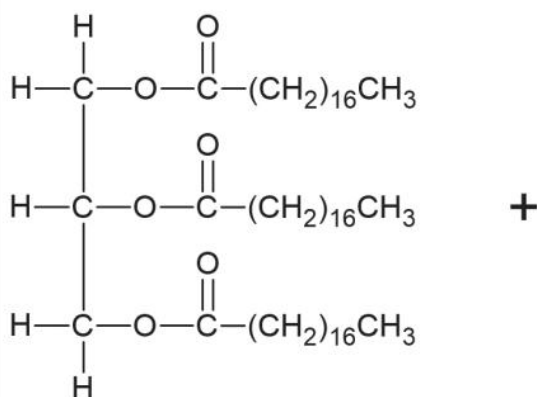


Products

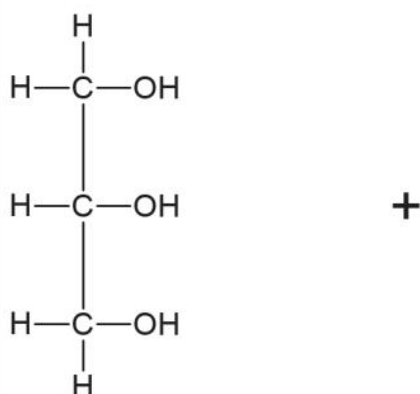


- (ii) Write the balanced equation for the formation of biodiesel from tristearin. (4 marks)

Reactants



Products



An alternative method for biodiesel synthesis is lipase-catalysed transesterification of triglycerides. Lipases are enzymes that may be isolated from many biological sources.

- (b) Biodiesel production would not be viable in the absence of a base or lipase catalyst. Use collision theory to explain how the presence of catalysts makes the production of biodiesel viable in these processes. (3 marks)

- (c) Lipase-catalysed transesterification occurs under milder conditions of temperature and pH compared to the base-catalysed process. Explain why these conditions are a requirement and state **one** advantage for biodiesel production. (3 marks)

Requirement for mild temperature and pH

Advantage for biodiesel production

Information about the structure of a lipase B enzyme (Chain A) from the yeast species *Candida antarctica* is freely available through the Protein Data Bank (PDB). Use this information to answer part (d).



- (d) A portion of this lipase B structure is highlighted in a box on the image above. Identify this structural feature of the protein and state the level of protein structure. (2 marks)

Structural feature: _____

Level of protein structure: _____

- (c) Lipase-catalysed transesterification occurs under milder conditions of temperature and pH compared to the base-catalysed process. Explain why these conditions are a requirement and state **one** advantage for biodiesel production. (3 marks)

Requirement for mild temperature and pH

Advantage for biodiesel production

Information about the structure of a lipase B enzyme (Chain A) from the yeast species *Candida antarctica* is freely available through the Protein Data Bank (PDB). Use this information to answer part (d).



- (d) A portion of this lipase B structure is highlighted in a box on the image above. Identify this structural feature of the protein and state the level of protein structure. (2 marks)

Structural feature: _____

Level of protein structure: _____

Another example of this level of protein structure visible in the image are β -pleated sheets.

- (e) The formation of β -pleated sheets and the structure identified in part (d), on page 26, form through the same type of intermolecular force. Name and describe this intermolecular force, including a diagram that shows which atoms of the protein structure are involved. (4 marks)

Name: _____

Description: _____

Intermolecular force diagram:



The sequence of 317 amino acids of this lipase B protein chain is given in the PDB. The presence of three disulfide bridges is clearly represented in the data.

- (f) Identify the amino acid where disulfide bridges can form. (1 mark)

- (g) Disulfide bridges are an example of a protein tertiary structure. Define 'tertiary structure' and outline how it forms. (2 marks)
