

Carbohydrates, lipids and proteins

5 questions · 51 marks

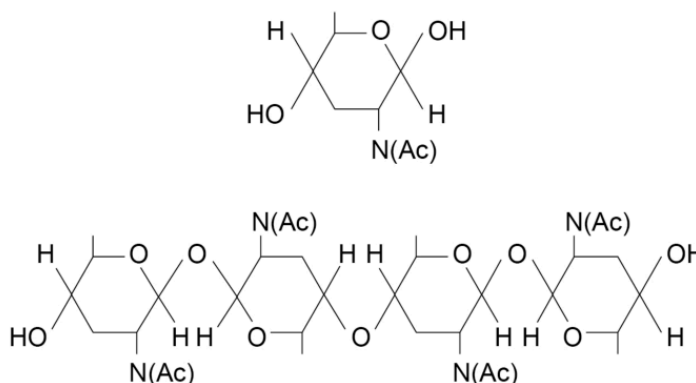
Answer all questions. The marks available are shown against each part. Every question is taken unaltered from a past paper; the source is noted beneath it.

1. 1 Chitin is a polysaccharide. The chitin monomer is a β -glucose molecule with one OH group replaced by an NHCOCH_3 group. NHCOCH_3 can be represented by $\text{N}(\text{Ac})$.

8 marks

Figure 1 shows the monomer that forms chitin and the chitin polymer.

Figure 1



Chitin has a similar structure to cellulose.

Use **Figure 1** to describe **three** ways the structure of chitin is similar to the structure of cellulose.

[3 marks]

1

—

2

—

3

- 2 Chitin keeps the tracheae open in the tracheal system of gas exchange in an insect. Gas exchange does **not** occur in the tracheae.

Explain the importance of **one** adaptation of the gas exchange surface in the tracheal system of an insect.

[2 marks]

3

Lignin is a polymer found in the walls of xylem vessels in plants. Lignin keeps the xylem vessel open as a continuous tube.

Explain the importance of the xylem being kept open as a continuous tube.

[3 marks]

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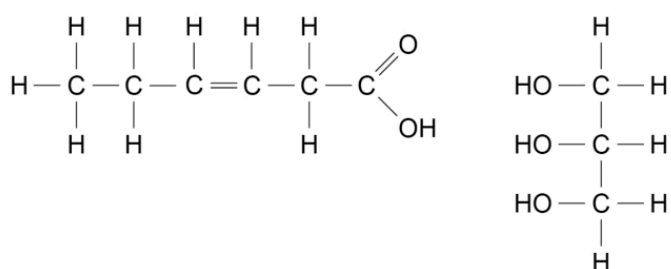
2.

1

Figure 1 shows the structure of a fatty acid molecule and the structure of a glycerol molecule.

8 marks

Figure 1



On **Figure 1**, draw a circle around the part of the fatty acid molecule **and** the part of the glycerol molecule that is removed to form a bond in a triglyceride molecule.

Name the bond formed between a fatty acid and glycerol in a triglyceride molecule.

Name the reaction involved in forming a bond between a fatty acid and glycerol in a triglyceride molecule.

[3 marks]

Bond ____

Reaction ____

Table 1 shows information about three fatty acids.

Table 1

Name of fatty acid	Diagram of fatty acid structure	Fatty acid melting point / °C
Stearic acid	$ \begin{array}{cccccccccccccccccccc} \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} \\ & & & & & & & & & & & & & & & & & \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C} & \text{C}=\text{O} \\ & & & & & & & & & & & & & & & & & \\ \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} \end{array} $	70
Oleic acid	$ \begin{array}{cccccccccccccccccccc} \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} \\ & & & & & & & & & & & & & & & & & \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C} & =\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C} & \text{C}=\text{O} \\ & & & & & & & & & & & & & & & & & \\ \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} \end{array} $	14
Linoleic acid	$ \begin{array}{cccccccccccccccccccc} \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} \\ & & & & & & & & & & & & & & & & & \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C} & =\text{C}-\text{C}-\text{C} & =\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C} & \text{C}=\text{O} \\ & & & & & & & & & & & & & & & & & \\ \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} \end{array} $	-5

2

Name the fatty acid shown in **Table 1** that is a saturated fatty acid.

[1 mark]

3

The melting point is the temperature at which a solid changes state to be a liquid.

Use **Table 1** to describe the relationship between fatty acid structure and fatty acid melting point.

[1 mark]

4

The ratio of saturated to unsaturated fatty acids in a cell-surface membrane determines the extent of the membrane's fluidity.

Scientists provided a cell culture of mouse phagocytes with liquid broth rich in unsaturated fatty acids.

The scientists observed:

- an increase in the proportion of phospholipids in the phagocytes containing unsaturated fatty acids
- more phagocytosis.

Suggest and explain why there was more phagocytosis.

[3 marks]

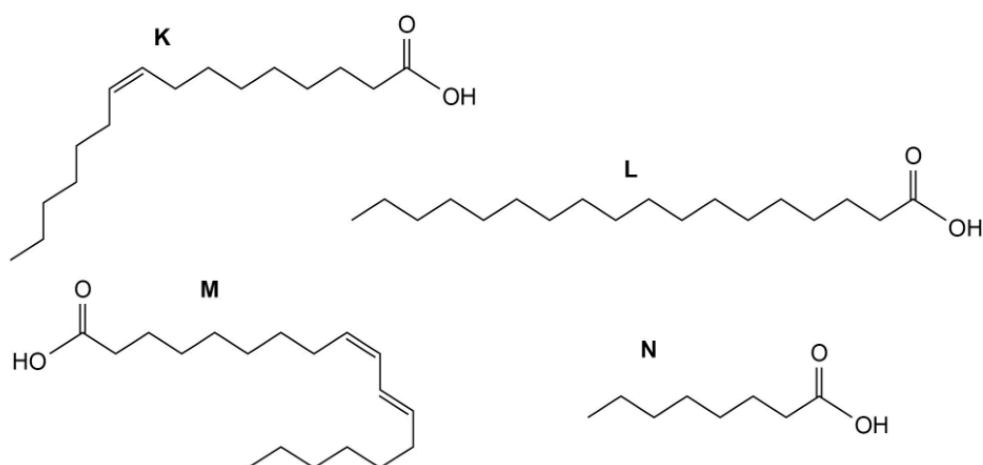
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3. 1 Describe how a triglyceride molecule is formed.

10 marks

[3 marks]2 **Table 5** shows some properties of four fatty acids.**Table 5**

Fatty acid	Number of carbon atoms in the R group	Number of double bonds in the R group
Caprylic acid	8	0
Palmitoleic acid	16	1
Stearic acid	18	0
Linoleic acid	18	2

Figure 10 shows diagrams of these fatty acids.**Figure 10**Put a tick (✓) in **one** box that contains correct information about one of these fatty acids.**[1 mark]**

Caprylic acid is an unsaturated fatty acid represented by diagram **L**.

☐

Linoleic acid is a saturated fatty acid represented by diagram **N**.

☐

Palmitoleic acid is an unsaturated fatty acid represented by diagram **K**.

☐

Stearic acid is a saturated fatty acid represented by diagram **M**.

☐

The percentage of saturated fatty acids compared with unsaturated fatty acids found in lipid stores in seeds differs in different populations.

Scientists investigated two populations of the plant, *Helianthus annuus*.

The scientists grew young plants from seeds collected from each population. They placed the seeds on wet tissue paper so that the root growth was visible.

They grew seeds from each population at two temperatures:

- warm temperature of 24 °C
- cool temperature of 10 °C

After 10 days, the scientists measured the length of each root.

Table 6 shows some of the properties of the two populations and the scientists' results.

Table 6

Population	Temperature in natural environment	In the seed – Mean percentage of fatty acids that are saturated	Mean length of root after 10 days at 24 °C / mm ($\pm 2 \times$ standard deviation)	Mean length of root after 10 days at 10 °C / mm ($\pm 2 \times$ standard deviation)
1	Warm	10.9	8.2 (± 1.0)	3.1 (± 0.3)
2	Cool	6.1	5.5 (± 0.9)	4.3 (± 0.2)

The mean $\pm 2 \times$ standard deviation includes 95% of the data.

3

The scientists used a data logger to measure the length of the root rather than a ruler.

Suggest **one** reason why they used a data logger **and** explain why this was important in this investigation.

[1 mark]

4

It is known that:

- during respiration saturated fatty acids yield more energy than unsaturated fatty acids
- saturated fatty acids have higher melting points than unsaturated fatty acids
- lipases in seeds act more rapidly on liquid substrates.

Use this information and **Table 6** to show how each population is better adapted for its natural environment when compared with the other population.

[4 marks]

Explanation of expected result

3

'Free sugar' is the sugar in food and drinks released when food is crushed or when sugar is added to food at home or by manufacturers.

Scientists recommend that no more than 5% of the energy consumed per day should come from 'free sugar'.

The mean daily energy requirement for a 10-year-old child is 8100 kJ

The 'free sugar' in one tablespoon of molasses contains 250 kJ of energy.

Calculate the number of tablespoons of molasses required for a 10-year-old child to reach the recommendation for energy consumed in 'free sugar' per day.

[1 mark]

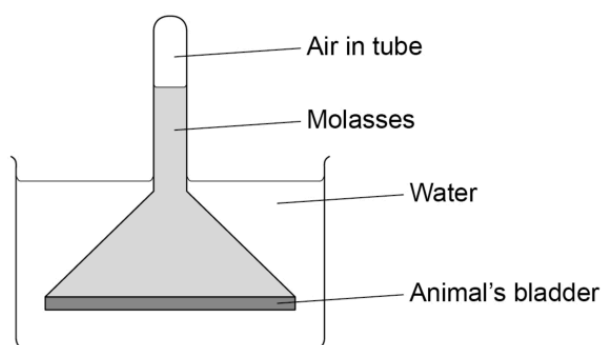
Number of tablespoons

per day

4

A scientist used the apparatus in **Figure 3** to investigate osmosis.

Figure 3



Use your understanding of osmosis to explain why the air pressure in the tube increased.

[3 marks]

5

The scientist repeated the investigation, but made **one** change to the molasses. The scientist did **not** change the volume of molasses at the start of the investigation.

The scientist observed that the air pressure inside the tube increased by 160 kPa compared with 800 kPa in the first investigation.

Suggest the change the scientist made to the molasses to cause this smaller increase in air pressure.

Use the air pressure figures in a calculation to support your answer.

[2 marks]

Suggested change

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5.**1**

Describe the transport of carbohydrate in plants.

[5 marks]**2**

Compare and contrast the structure of starch and the structure of cellulose.

[6 marks]**3**

Describe the complete digestion of starch by a mammal.

[4 marks]

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15 marks