

Biological Molecules

Model Answers 1

Level	A Level
Subject	Biology
Exam Board	OCR
Module	Foundations in Biology
Topic	Biological Molecules
Booklet	Model Answers 1

Time allowed: 95 minutes

Score: /70

Percentage: /100

Grade Boundaries:

A*	A	B	C	D	E
>69%	56%	50%	42%	34%	26%

Question 1

Fig. 22 shows a triglyceride molecule found in sunflower oil.

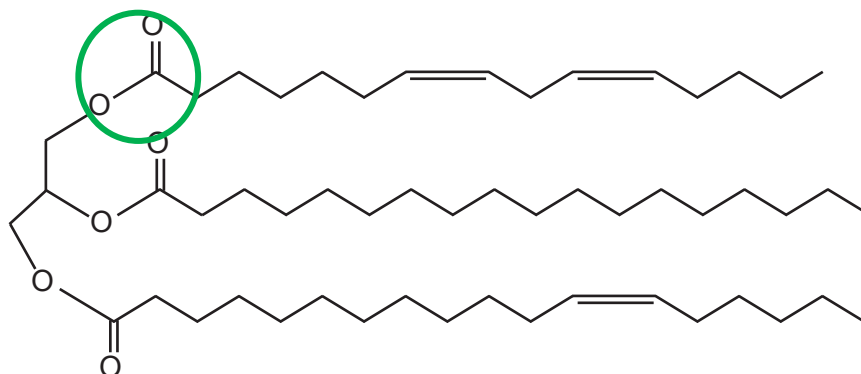


Fig. 22

(a) On Fig. 22 circle an ester bond.

[1]

[Answer on Fig. 22]

The circle can be around any of the 3 ester bonds but must include 2 carbon atoms

(b) Sunflower oil is used to make biodiesel, which contains methyl esters. The fatty acids in the triglyceride molecule are reacted with methanol in a process called transesterification.

After the reaction, two liquid products form which naturally separate from each other. The methyl esters float on top of a more dense liquid.

[1]

Name the part of the molecule seen in Fig. 22 that forms this more dense liquid.

glycerol

Note the question refers to one of the components of oil as fatty acids, so what is the other component of lipids and oils that you are aware of? Seemingly difficult questions are often the easiest so look for clues.

(c) Living organisms have many uses for triglycerides, one of which is the production of phospholipids.

(i) Name three **other** functions of triglycerides in living organisms.

[3]

- As an energy source in respiration / respiratory substrate
- Energy storage
- Thermal insulation
- Electrical insulation
- Buoyancy

Triglycerides have lots of hydrogen atoms so they are 'highly reduced'. When you study respiration you will appreciate that it is the hydrogen atoms in the respiratory substrate that determine how much energy can be released.

- (ii) Table 22 shows the melting points of some of the methyl esters made from the transesterification of sunflower oil fatty acids.

Methyl ester	Formula	Melting point (°C)
Methyl stearate	$C_{19}H_{38}O_2$	39.1
Methyl oleate	$C_{19}H_{36}O_2$	-19.9
Methyl linoleate	$C_{19}H_{34}O_2$	-35.0

Table 22

Describe and explain the pattern of the melting points of these three methyl esters.

[2]

- As the number of hydrogen atoms decreases the melting point decreases
- If the ester has more carbon=carbon double bonds or it's less saturated then its melting point decreases

Fatty acids with fewer hydrogen atoms have more carbon=carbon double bonds. This makes them 'kinked' so that they don't pack as tightly together so they melt at lower temperatures. For this reason unsaturated fats are liquids at room temperature

- (d) Phospholipid molecules also contain fatty acids.

Explain how the fatty acids in phospholipids allow the formation of membranes.

[2]

- Fatty acids are hydrophobic (repel water)
- They form a phospholipid bilayer
- The tails point inwards together

Exam tip: A diagram here would be good, providing it's labelled. If you're not sure about timing then make a note by your answer, if you finish and have time go back to all these references and complete them.

[Total: 9]

Question 2

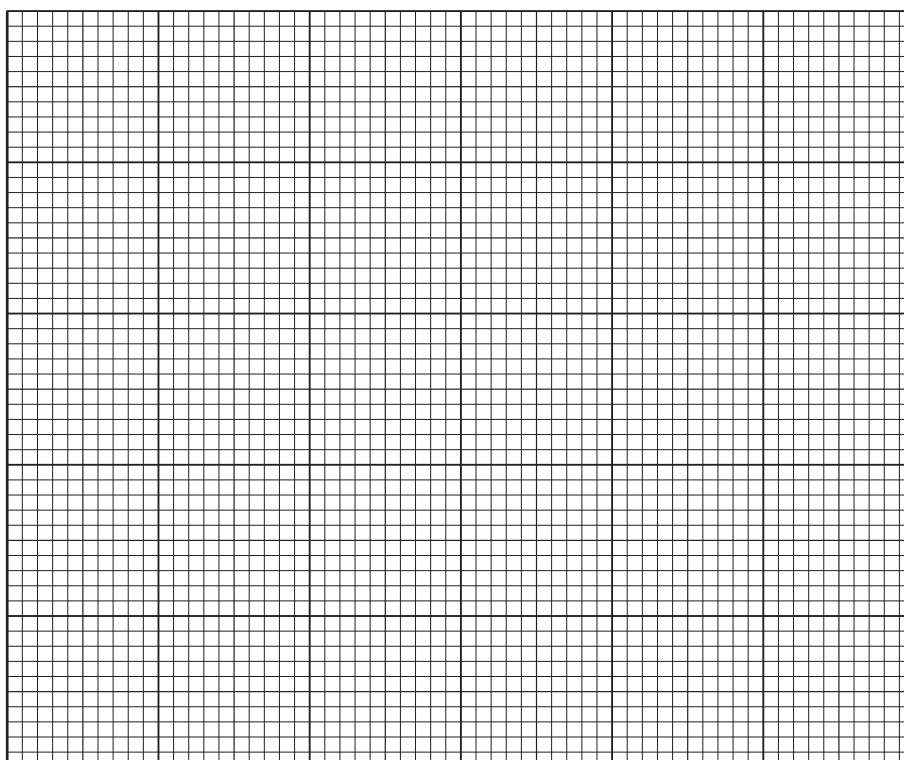
A group of students decided to investigate the glucose content of three types of fruit juice. They carried out the Benedict's test on known concentrations of glucose solutions and used these to calibrate a colorimeter.

The results of their calibration are shown in Table 6.

glucose concentration (mmol dm ⁻³)	% absorbance			
	Trial 1	Trial 2	Trial 3	Mean
1.0	67	68	65	67
2.0	54	52	55	54
3.0	47	46	48	47
4.0	41	41	40	41
5.0	27	25	25	26
6.0	16	16	17	16

Table 6

(a) (i) Plot a graph of the mean % absorbance at each glucose concentration.



[3]

- X axis labelled with glucose concentration mmdm⁻³ y axis labelled mean % absorbance
- Points plotted correctly
- Straight line of best fit which must not extend beyond the points

- (ii) The students were provided with three different fruit juices labelled A, B and C. The Benedict's test was carried out on each fruit juice and samples were prepared for the colorimeter.

Explain how the students would use the calibration curve to estimate the glucose concentration of the fruit juices. [2]

- Find the absorbance of the fruit juice using the colorimeter
- Find the concentration that corresponds to this absorbance
- Follow the line from the absorbance down the graph to the x axis and read off the concn

- (b) The students wrote the following hypothesis:

'The higher the concentration of glucose in the fruit juice, the sweeter it will be.'

- (i) Describe how you would carry out a controlled experiment to test this hypothesis **without** using a colorimeter. [4]

- Taste the fruit juices to see how sweet they are
- Measure the glucose concentration of each juice by viewing the intensity of the red ppt
- Rank them in order of glucose concentration of sweetness
- Compare the ranks using a statistical test (Spearman's) if sweetness is numerical
- Any control variable such as same volumes of fruit juices, cleanse palate in between.
blind testing

Measuring glucose concentration, otherwise known as semi-quantitative Benedict's.

Add same volume of fruit juice solution.

Excess Benedict's, so you know that all the reducing sugar will react

Heat to produce a brick red ppt

Filter off the ppt and you are left with a blue solution, which is the remaining Benedict's

More sugar will use up more Benedict's so the blue will be very pale

Less sugar leaves more Benedict's so it will be more blue

Place the filtrate (left over Benedict's) in a colorimeter to measure absorbance

(ii) Suggest one reason why the results for this experiment might **not** support the students' hypothesis. [1]

- Tasting sweetness is subjective or hard to quantify
- Juices may contain other sugars which are non reducing such as sucrose
- Different people may have different opinions about what is sweet
- Judging colour by eye is subjective and qualitative

(c) Glucose and cholesterol are both molecules transported in the bloodstream that may need monitoring in people with different medical conditions.

Fig. 6 represents the structure of a cholesterol molecule.

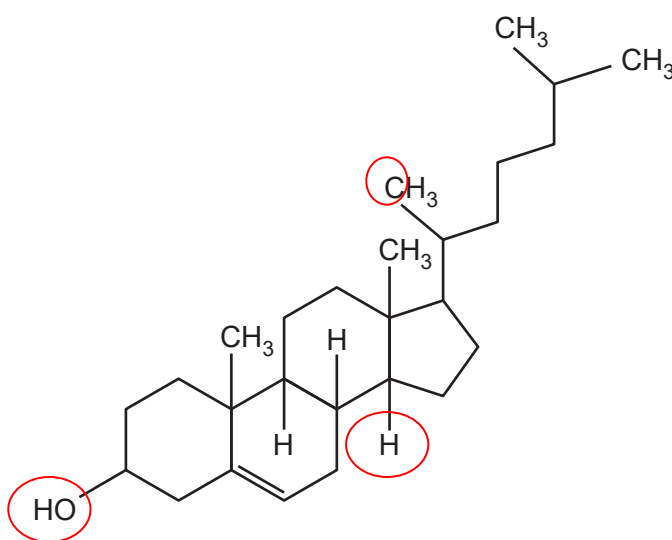


Fig. 6

(i) State **two** ways in which the molecular structure of cholesterol is similar to the molecular structure of glucose. [2]

- Both have oxygen
- Both have carbon and hydrogen
- Both have hydroxyl (–OH) groups

(ii) Glucose is an important biological molecule required by cells for cellular respiration.

State the physical property of glucose that allows it to be easily transported in the bloodstream. [1]

- Glucose is soluble in water

[Total: 13]

Question 3

(a) A student wanted to observe some red blood cells under the microscope. The student placed a small sample of blood onto a microscope slide and added a drop of distilled water. When viewed at high power, the student observed that the red blood cells had burst.

In a similar procedure using plant epidermis, the student observed that the plant cells did not burst.

(i) Explain these observations.



In your answer you should use appropriate technical terms, spelt correctly.

[5]

- The cell cytoplasm has a **lower water** potential than distilled water
- Therefore water moves into cells down a water **potential gradient**
 - Water enters the cell by **osmosis**
- The plasma membrane is weak so the cell bursts (haemolysis)
- A plant cell has a cell wall which is strong so the cell does not burst
- The plant cell becomes **turgid** which reduces water uptake

Water moves by osmosis from an area of high water potential to an area of lower water potential. When a cell is placed in solution, water will either move in or out of the cell, depending on the relative concentrations. If an animal cell fills with water, it will swell and burst, as there is no cell wall to support it.

Exam tip: you must use key terminology here to gain your QWC mark. The key words are shown here in bold.

(ii) Suggest how the student could modify the procedure to observe red blood cells without them bursting.

[1]

To see the cells without them bursting, the student could

- Use a **salt or sugar solution** instead of distilled water
- Use a solution with the same (or lower) water potential as the blood cells

By adding a solute such as salt or sugar to distilled water, the water potential will be lowered. Therefore water will either leave the cell, or there will be no net gain/loss if the water potential is the same as inside the cell.

(b) Oxygen enters red blood cells as they pass through the capillaries in the lungs.

Name the mechanism by which oxygen enters the red blood cells.

[1]

Oxygen enters cells by **Diffusion**

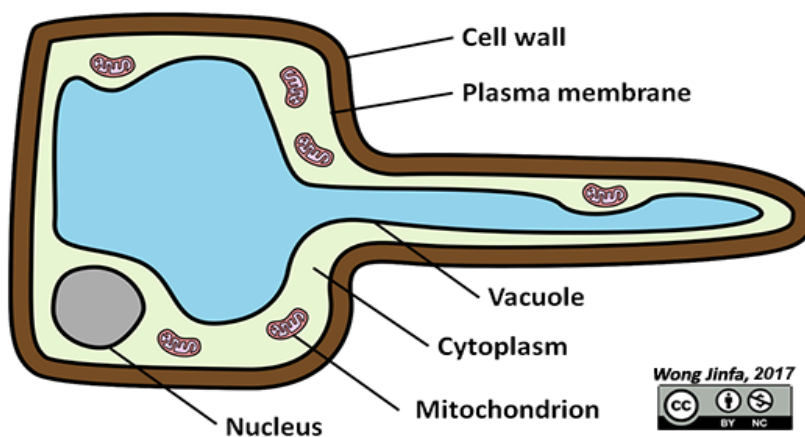
(c) The cells in the epidermis of a plant root are specialised to absorb minerals from the surrounding soil.

State the process by which root epidermal cells absorb minerals from the soil **and** describe how these cells are specialised to achieve absorption.

[3]

- Root epidermal cells take up minerals from the soil by **active transport**
- Cells have hairs
- With a thin cell wall
- To increase the surface area
- They also have many mitochondria
- And many carrier proteins in plasma membrane

Diagram to show structure of a root hair cell:



[Total: 10]

Question 4

(a) Polymers are important molecules that have structural and functional roles in organisms.

Chitin is a polymer that is found in insects, where it forms a major part of the structure of the exoskeleton.

- Chitin is a macromolecule that is similar to a polysaccharide.
- Chitin is composed of molecules of N-acetylglucosamine, the structure of which is shown in Fig. 3.1 below.
- The monomers of N-acetylglucosamine join by 1–4 glycosidic bonds to form the chitin molecule.

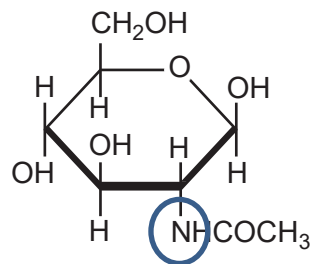


Fig. 3.1

(i) How does the composition of N-acetylglucosamine differ from the composition of a monosaccharide sugar? [1]

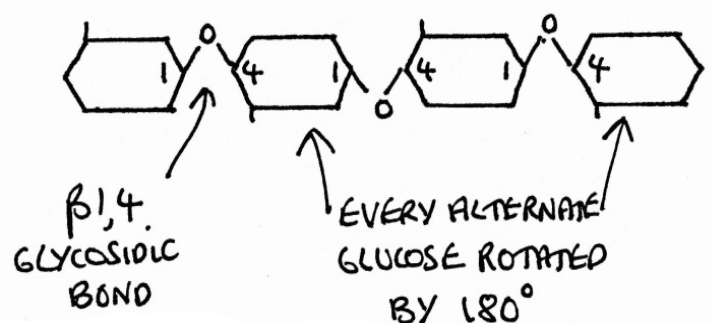
It contains nitrogen

(ii) Which monosaccharide sugar does N-acetylglucosamine most closely resemble? [2]

- Beta The –OH group at carbon 1 is the
- glucose other way up to alpha glucose

(iii) Using your knowledge of the formation of structural polysaccharides, describe the formation of the chitin molecule from its monomer and predict its structure. [4]

- The monomers are joined by condensation reactions
- Involving the removal of water
- Every alternate monomer is rotated through 180° / flipped
- It's flipped because the –OH at carbon 1 is in the wrong position
- The chain is straight
- It is similar to cellulose in many ways



(b) Fig. 3.2 is a photomicrograph of the trachea of a honeybee, *Apis mellifera*.

The trachea of this honeybee is infected with honeybee tracheal mites, *Acarapis woodi*. Some of these mites are labelled **M** on Fig. 3.2.

The trachea and tracheoles of insects have circular bands of chitin. One of these bands is labelled **C** on Fig. 3.2.

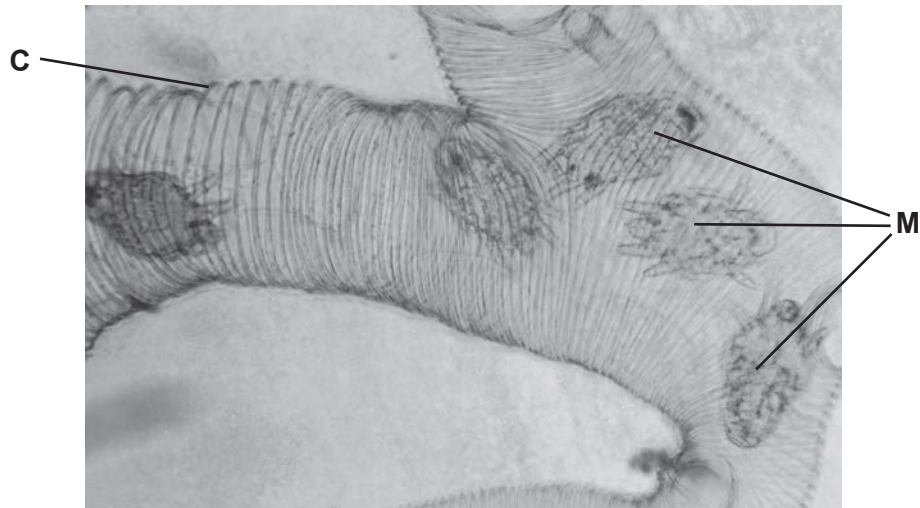


Fig. 3.2

- (i) What is the function of the circular bands of chitin labelled **C**? [1]

The chitin prevents the trachea from collapsing

Ask virtually every Biology student what the pressure is like inside the trachea when you breathe in, and they'll say 'high'. What's the pressure like inside the xylem? They will reply 'High'!!

No!! The answer is low, that's why structures tend to collapse unless they are strengthened

- (ii) The mites use their mouthparts to bite through the walls of the trachea. They then feed off the haemolymph, the blood-like liquid that bathes the cells and organs of the honeybee.

Suggest **one** other way in which the presence of the mites might affect the honeybee.

- The mites might block the airways or restrict air flow [1]
- Lack of haemolymph may deprive the cells of oxygen
- The mites might use up the oxygen
- The mites may transmit disease

A suggest question so, if it follows on from the question and it's biologically correct, you should be OK. The haemolymph has a similar role to tissue fluid.

[Total: 9]

Question 5

In cells, glucose can exist as α -glucose or as β -glucose.

(a) Fig. 1.1 represents the structural formula of a molecule of α -glucose.

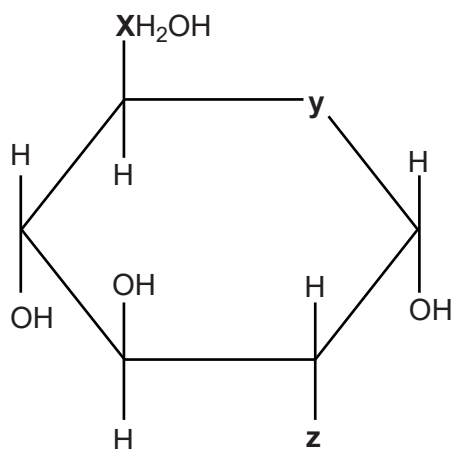


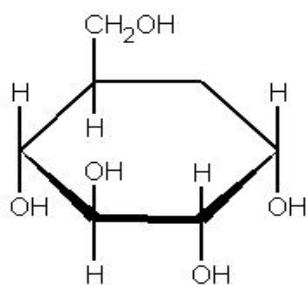
Fig. 1.1

(i) In Fig. 1.1 some atoms or groups have been replaced by the letters **X**, **Y** and **Z**.

Identify the correct atom or group that has been replaced by each letter. [3]

- X** Carbon
- Y** Oxygen
- Z** Hydroxyl group (OH)

This is the structure of α -glucose:

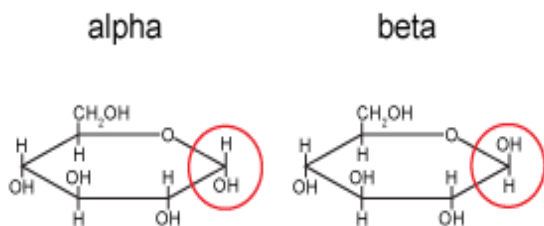


(ii) Describe how the structure drawn in Fig. 1.1 above would be different if it represented a molecule of β -glucose. [2]

β -glucose would be different in that:

- The OH and H groups reversed
- On the right hand C atom (C1)

Note: you can also gain marks by drawing this out, as it can sometimes be difficult to describe!



A Dash of Science.com

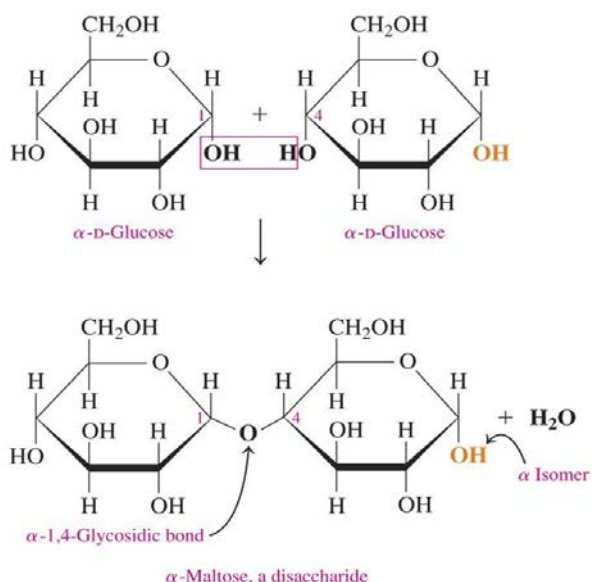
(iii) Two α -glucose molecules can be joined to form a disaccharide molecule.

State the **precise** name of the covalent bond that forms between the two glucose molecules and the name of the disaccharide that is formed. [2]

To join two glucose molecules together:

- Bond = α 1-4 glycosidic
- Disaccharide = maltose

Diagram to show the formation of maltose:



Exam tip: when you are writing the name of the bond, you need to be extremely specific. Alpha refers to the fact that the bond is between two α -glucose molecules. '1-4' refers to the bond joining the 1 carbon from one molecule to the 4 Carbon on the other

(b) Glucose, glycogen and amylose are carbohydrates.

- Glycogen and amylose are used for energy storage.
- Glycogen is found in animals.
- Amylose is found in plants.

Describe how the structure of glycogen allows it to perform its function **and** explain the advantage to animals of using glycogen as an energy store.



In your answer you should make clear the links between structure and function.

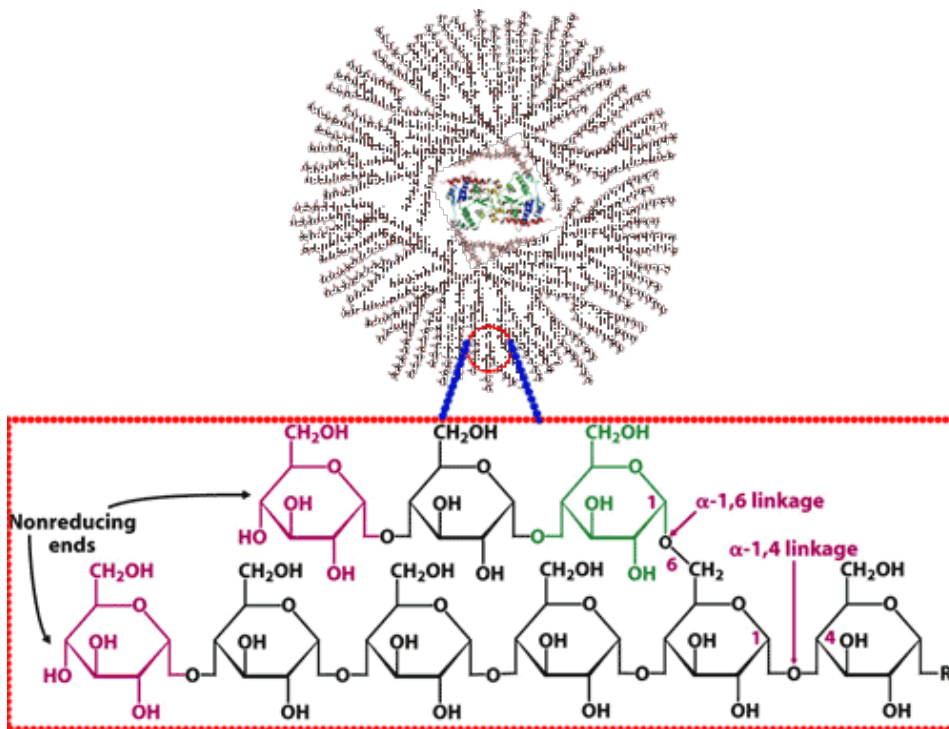
[7]

The structure of glycogen allows it to perform its function:

- It contains α -glucose which is used in respiration
- Glycogen can be broken down by enzymes
- It is a polysaccharide (macromolecule)
- It is insoluble
- So does not affect the water potential
- It is compact so produces large amount of energy in small volume
- It also has 1-6 glycosidic bonds
- Giving a branched structure
- This means it will have a greater surface area for enzyme activity
- So glucose can be removed quickly
- Animals require rapid energy release
- As they have a high metabolic rate

Exam tip: in order to gain your QWC mark here, you need to link how the structure relates to function, by including at least one point from each of the bottom two sets of mark points above.

Diagram to show the structure of glycogen:



- (c) Alpha (α) and beta (β) are prefixes that are frequently used to describe a range of biological molecules, such as α -glucose and β -glucose.

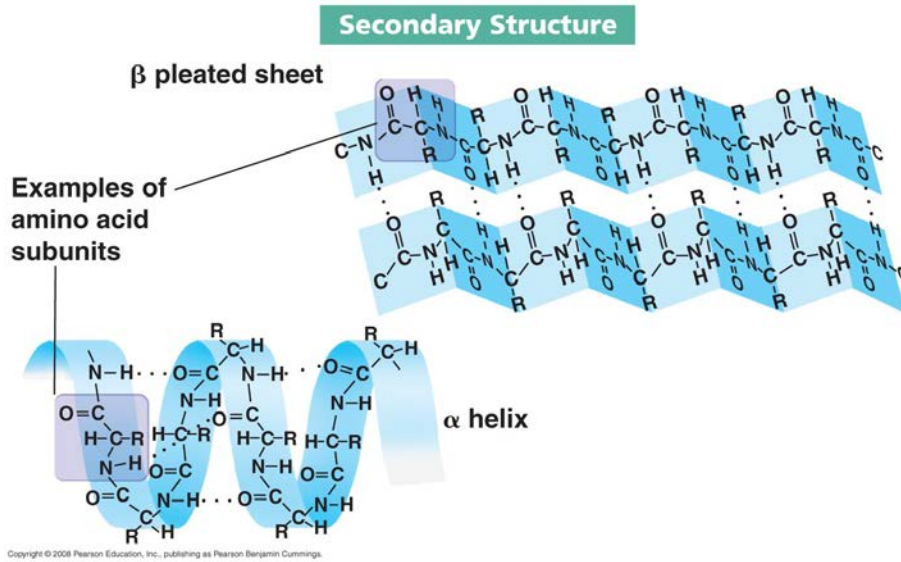
The prefixes α and β can also be used when describing protein structure.

Complete the following statements about proteins using the most appropriate terms.

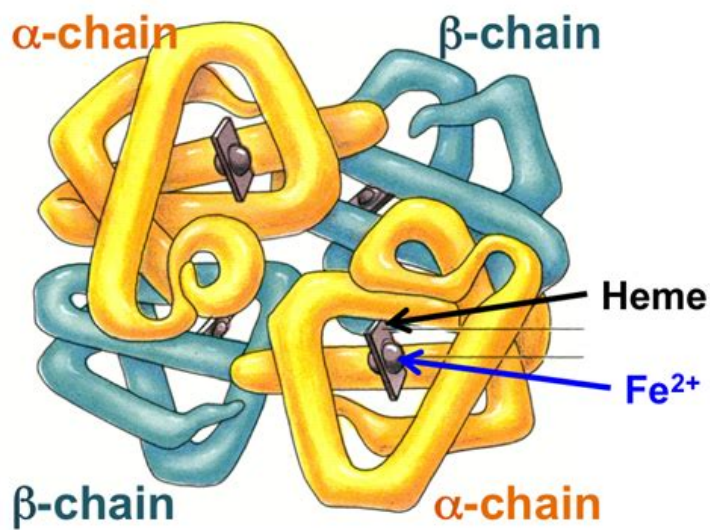
- The secondary structure of a protein may contain many regions folded in zig-zag patterns known as β pleated sheets
- The secondary structure of a protein is determined by the arrangement of Hydrogen bonds, which stabilise the structure.
- The Secondary structure of collagen is described as a left-handed helix because of the direction in which the polypeptide twists.
- Polypeptides known as alpha (α) and beta (β) Subunits/ chains form part of the Quaternary structure of haemoglobin.

[5]

Diagram to show the secondary structure of a protein:



The quaternary structure is formed when several chains come together. For example haemoglobin:



[Total: 19]

Question 6

Lipids are a group of fatty or waxy compounds.

Triglyceride, phospholipid and cholesterol are examples of lipid compounds that are important in living organisms.

(a) Table 7.1 lists a number of statements that could apply to these compounds.

Complete the table by indicating with a tick (✓) which of the compounds applies to each statement.

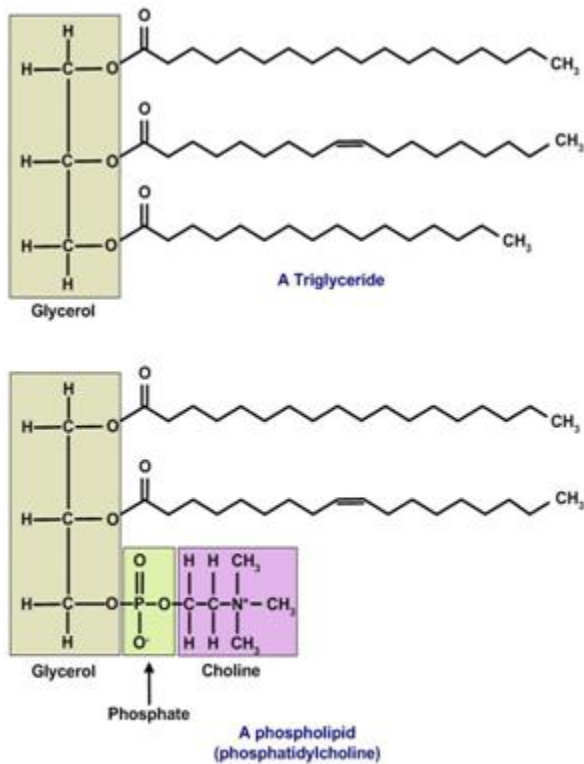
You may use more than one tick in a row.

Statement	Triglyceride	Phospholipid	Cholesterol
Contains only the elements carbon, hydrogen and oxygen	✓		✓
Insoluble in water	✓	✓	✓
Contains glycerol	✓	✓	
Contains ester bonds	✓	✓	
Important in membrane structure		✓	✓
Contains fatty acids	✓	✓	

Table 7.1

[6]

[Diagram to show the structure of triglycerides and phospholipids:](#)



Triglycerides and phospholipids are similar

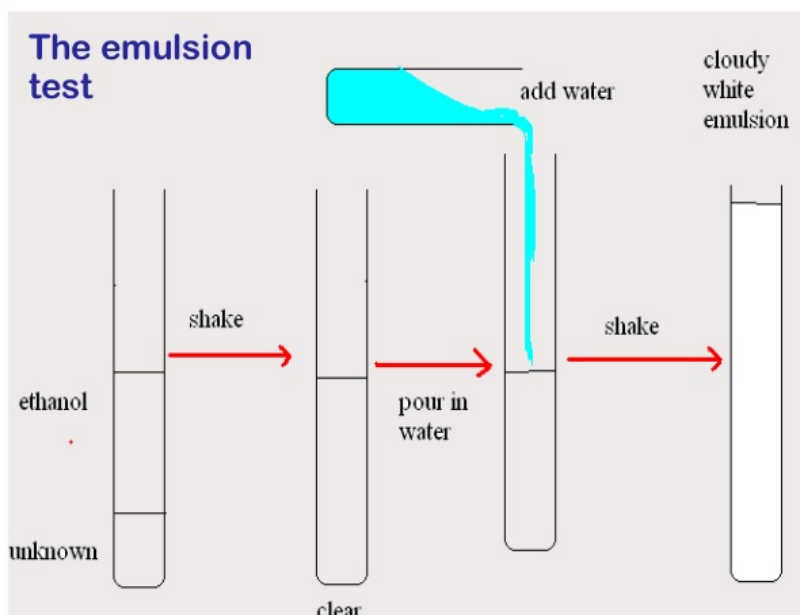
This figure copyright 2009, Steve Blake

(b) Describe how to do the emulsion test for lipids and how a positive result would be identified.

[2]

- mix with / add , ethanol / alcohol , and water
- goes cloudy

[Diagram to show the emulsion test for fats:](#)



(c) Lipids form an essential part of a balanced diet. Some food, such as mycoprotein, is produced by microorganisms.

How might the **lipid** content of mycoprotein differ from food that comes from animals? **[2]**

- less overall lipid
- less saturated fat
- more unsaturated fat

This is because mycoprotein is formed from a fungus and will therefore be much lower in fat.

[Total: 10]