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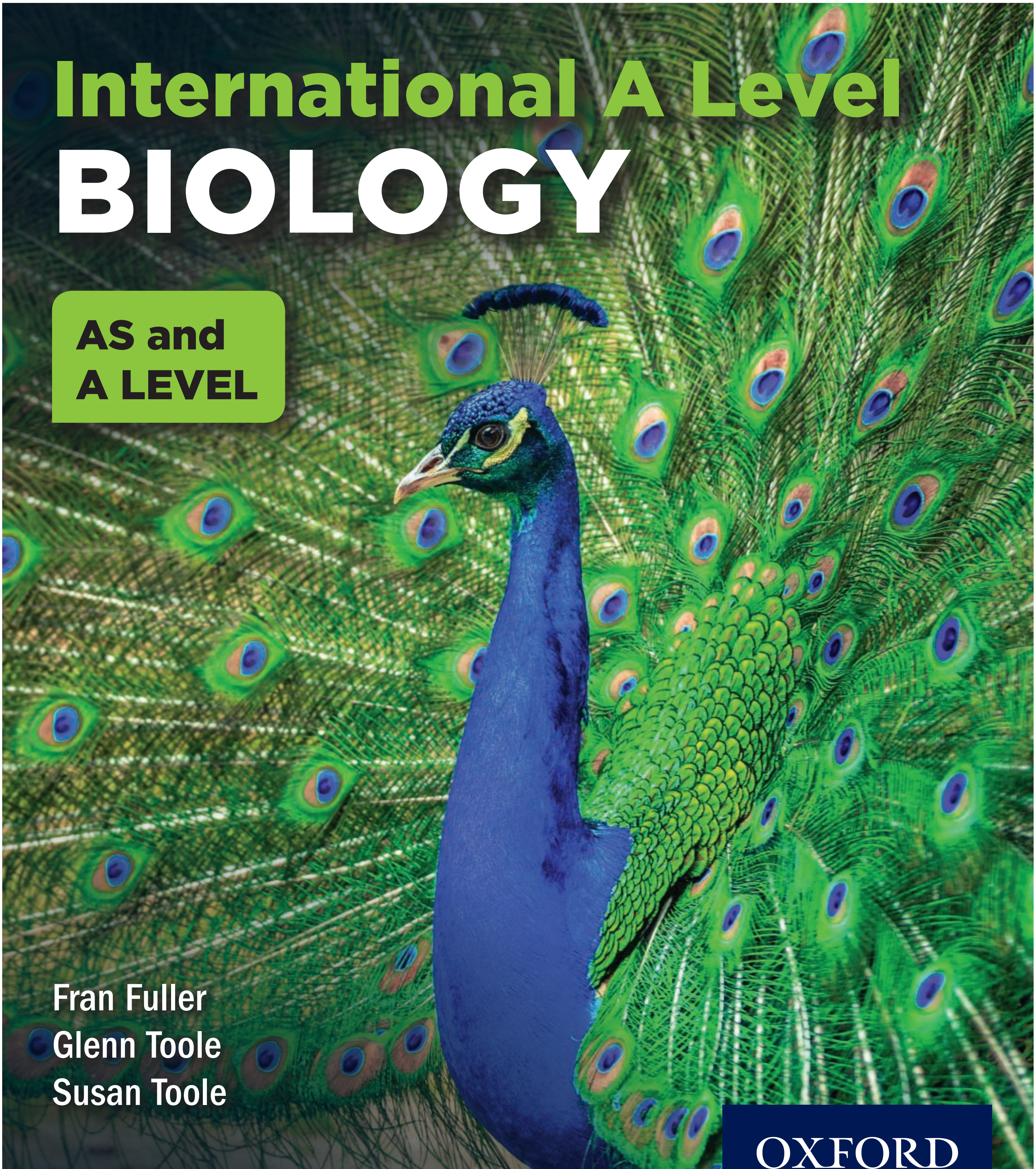

International A Level
BIOLOGY

AS and A LEVEL

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OXFORD

Contents

Answers to the Practice Questions are available at www.oxfordsecondary.com/oxfordaqaexams-alevel-biology

How to use this book

Learning objectives

- At the beginning of each topic, there is a list of learning objectives.
- These are matched to the specification and allow you to monitor your progress.
- A specification reference is also included.
  Specification reference: 3.1.1

This book contains many different features. Each feature is designed to support and develop the skills you will need for your exams, as well as foster and stimulate your interest in biology.

Terms that you will need to be able to define and understand are shown in **bold type** within the text.

Where terms are not explained within the same topic, they are highlighted in **bold orange text**. You can look these words up in the glossary.

Application features

These features contain important and interesting applications of biology in order to emphasise how scientists and engineers have used their scientific knowledge and understanding to develop new applications and technologies. There are also application features to develop your maths skills, and to develop your practical skills. In addition, there is a feature on each of the ten Required Practicals clearly sign-posted within each relevant chapter.

Synoptic link

These highlight how the sections relate to each other. Linking different areas of biology together becomes increasingly important, as many exam questions (particularly at A Level) will require you to bring together your knowledge from different areas.

Study tip

Study tips contain prompts to help you with your revision.

Extension features

These features contain material that is beyond the specification, which is designed to stretch you and provide you with a broader knowledge and understanding and lead the way into the types of thinking and areas you might study in further education. As such, neither the detail nor the depth of questioning will be required for the exams. But this book is about more than getting through the exams.

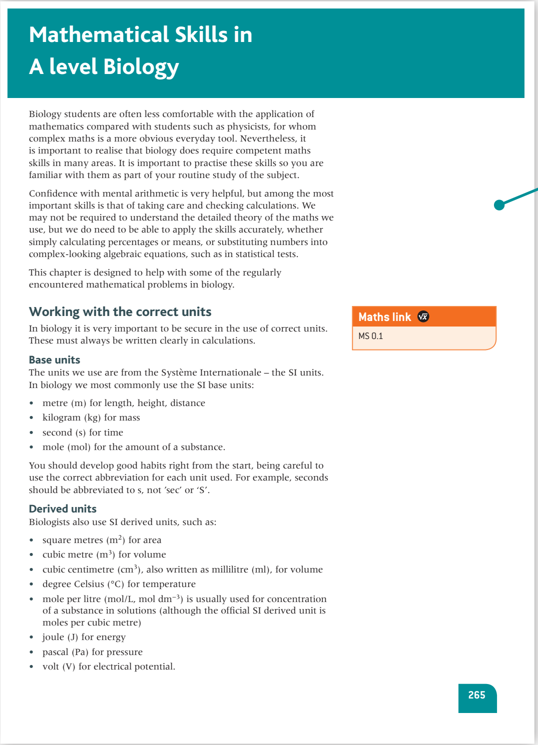
1 Extension and application features have questions that link the material with concepts that are covered in the specification. There are also extension features to develop your maths skills, and to develop your practical skills.

Hint

Hint features give other information or ways of thinking about a concept to support your understanding.

Summary questions

1 These are short questions that test your understanding of the topic and allow you to apply the knowledge and skills you have acquired. The questions are ramped in order of difficulty.



Mathematical Skills in A level Biology

Biology students are often less comfortable with the application of mathematics compared with students such as physicists, for whom complex maths is a more obvious everyday tool. Nevertheless, it is important to realise that biology does require competent maths skills in many areas. It is important to practise these skills so you are familiar with them as part of your routine study of the subject.

Confidence with mental arithmetic is very helpful, but among the most important skills is that of taking care and checking calculations. We may not be required to understand the detailed theory of the maths we use, but we do need to be able to apply the skills accurately, whether simply calculating percentages or means, or substituting numbers into complex-looking algebraic equations, such as in statistical tests.

This chapter is designed to help with some of the regularly encountered mathematical problems in biology.

Working with the correct units

In biology it is very important to be secure in the use of correct units. These must always be written clearly in calculations.

Maths link
MS 0.1

Base units

The units we use are from the Système Internationale – the SI units. In biology we most commonly use the SI base units:

- metre (m) for length, height, distance
- kilogram (kg) for mass
- second (s) for time
- mole (mol) for the amount of a substance.

You should develop good habits right from the start, being careful to use the correct abbreviation for each unit used. For example, seconds should be abbreviated to s, not 'sec' or 'S'.

Derived units

Biologists also use SI derived units, such as:

- square metres (m^2) for area
- cubic metre (m^3) for volume
- cubic centimetre (cm^3), also written as millilitre (ml), for volume
- degree Celsius (°C) for temperature
- mole per litre (mol/L, mol dm^{-3}) is usually used for concentration of a substance in solutions (although the official SI derived unit is moles per cubic metre)
- joule (J) for energy
- pascal (Pa) for pressure
- volt (V) for electrical potential.

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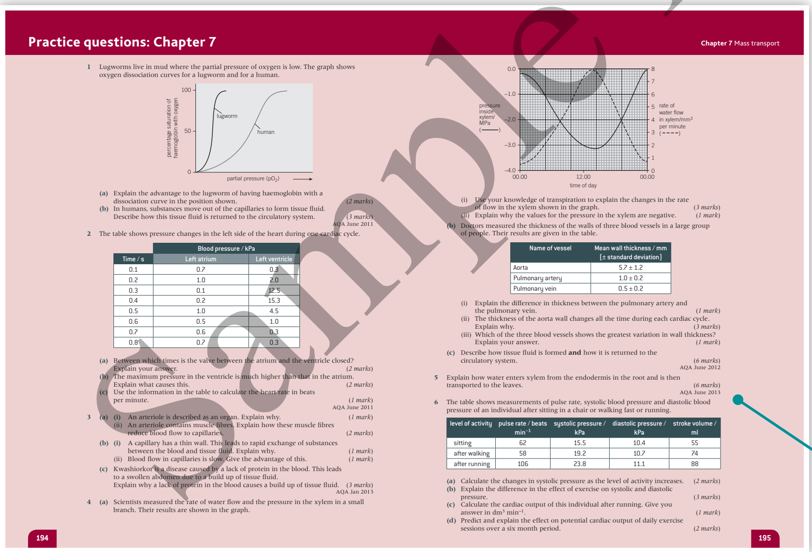
Mathematical section to support and develop your mathematical skills required for your course. Remember, at least 10% of your exam will involve mathematical skills.



Practice questions: Chapter 7

Chapter 7 Mass transport

1 Lugworms live in mud where the partial pressure of oxygen is low. The graph shows oxygen dissociation curves for a lugworm and for a human.

(a) Explain the advantage to the lugworm of having haemoglobin with a dissociation curve in the position shown. *(2 marks)*
(b) In humans, substances move out of the capillaries to form tissue fluid. Describe how this tissue fluid is returned to the circulatory system. *(3 marks)*
AQA June 2011

2 The table shows pressure changes in the left side of the heart during one cardiac cycle.

Time / s	Blood pressure / kPa	
	Left atrium	Left ventricle
0.1	0.7	0.3
0.2	1.0	2.0
0.3	0.1	12.5
0.4	0.2	15.3
0.5	1.0	4.5
0.6	0.5	1.0
0.7	0.6	0.3
0.8	0.7	0.3

(a) Between which times is the valve between the atrium and the ventricle closed? Explain your answer. *(2 marks)*
(b) The maximum pressure in the ventricle is much higher than that in the atrium. Explain what causes this. *(2 marks)*
(c) Use the information in the table to calculate the heart rate in beats per minute. *(1 mark)*
AQA June 2011

3 (a) (i) An arteriole is described as an organ. Explain why. *(1 mark)*
(ii) An arteriole contains muscle fibres. Explain how these muscle fibres reduce blood flow to capillaries. *(2 marks)*
(b) (i) A capillary has a thin wall. This leads to rapid exchange of substances between the blood and tissue fluid. Explain why. *(1 mark)*
(ii) Blood flow in capillaries is slow. Give the advantage of this. *(1 mark)*
(c) Kwashiorkor is a disease caused by a lack of protein in the blood. This leads to a swollen abdomen due to a build up of tissue fluid. Explain why a lack of protein in the blood causes a build up of tissue fluid. *(3 marks)*
AQA Jan 2013

4 (a) Scientists measured the rate of water flow and the pressure in the xylem in a small branch. Their results are shown in the graph.

(i) Use your knowledge of transpiration to explain the changes in the rate of flow in the xylem shown in the graph. *(3 marks)*
(ii) Explain why the values for the pressure in the xylem are negative. *(1 mark)*
(b) Doctors measured the thickness of the walls of three blood vessels in a large group of people. Their results are given in the table.

Name of vessel	Mean wall thickness / mm (± standard deviation)
Aorta	5.7 ± 1.2
Pulmonary artery	1.0 ± 0.2
Pulmonary vein	0.5 ± 0.2

(i) Explain the difference in thickness between the pulmonary artery and the pulmonary vein. *(1 mark)*
(ii) The thickness of the aorta wall changes all the time during each cardiac cycle. Explain why. *(3 marks)*
(iii) Which of the three blood vessels shows the greatest variation in wall thickness? Explain your answer. *(1 mark)*
(c) Describe how tissue fluid is formed **and** how it is returned to the circulatory system. *(6 marks)*
AQA June 2012

5 Explain how water enters xylem from the endodermis in the root and is then transported to the leaves. *(6 marks)*
AQA June 2013

6 The table shows measurements of pulse rate, systolic blood pressure and diastolic blood pressure of an individual after sitting in a chair or walking fast or running.

level of activity	pulse rate / beats min^{-1}	systolic pressure / kPa	diastolic pressure / kPa	stroke volume / ml
sitting	62	15.5	10.4	55
after walking	58	19.2	10.7	74
after running	106	23.8	11.1	88

(a) Calculate the changes in systolic pressure as the level of activity increases. *(2 marks)*
(b) Explain the difference in the effect of exercise on systolic and diastolic pressure. *(3 marks)*
(c) Calculate the cardiac output of this individual after running. Give you answer in $dm^3\ min^{-1}$. *(1 mark)*
(d) Predict and explain the effect on potential cardiac output of daily exercise sessions over a six month period. *(2 marks)*

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Practice questions at the end of each chapter including questions that cover practical and maths skills.

1 Biological molecules

1.1 Carbohydrates

Learning objectives:

- → Describe how large molecules like carbohydrates are constructed.
- → Describe the structure of a monosaccharide.
- → Describe how to carry out the Benedict's test for reducing sugars.

Specification reference: 3.1.1.1 and 3.1.1.2

As the word suggests, carbohydrates are carbon molecules (carbo) combined with water (hydrate). Some carbohydrate molecules are small whilst others are large.

Life based on carbon

Carbon atoms have an unusual feature. They very readily form bonds with other carbon atoms. This allows a sequence of carbon atoms of various lengths to be built up. These form a backbone along which other atoms can be attached. This permits an immense number of different types and sizes of molecule, all based on carbon. The variety of life that exists on Earth is a consequence of living organisms being based on the versatile carbon atom. As a result, carbon-containing molecules are known as organic molecules. In living organisms, there are relatively few other atoms that attach to carbon. Life is therefore based on a small number of chemical elements.

Hint

In biology certain prefixes are commonly used to indicate numbers. There are two systems, one based on Latin and the other on Greek. The Greek terms that are used when referring to chemicals are:

- mono – one
- di – two
- tri – three
- tetra – four
- penta – five
- hexa – six
- poly – many

The making of large molecules

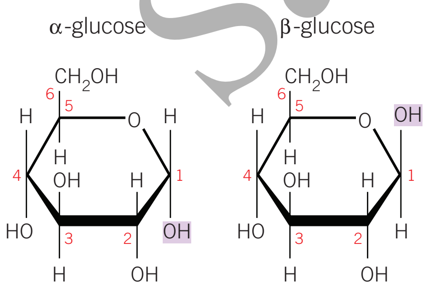
Many organic molecules, including carbohydrates, are made up of a chain of individual molecules. Each of the individual molecules that make up these chains is given the general name **monomer**. The carbon atoms of these monomers join to form longer chains. These longer chains of repeating monomer units are called **polymers**. How this happens is explained in Topic 1.2. Biological molecules such as carbohydrates and proteins are often polymers. These polymers are based on a surprisingly small number of chemical elements. Most are made up of just four elements: carbon, hydrogen, oxygen, and nitrogen.

In carbohydrates, the basic monomer unit is a sugar, otherwise known as a saccharide. A single monomer is therefore called a **monosaccharide**. A pair of monosaccharides can be combined to form a **disaccharide**. Monosaccharides can also be combined in much larger numbers to form **polysaccharides**.

Monosaccharides

Monosaccharides are sweet-tasting, soluble substances that have the general formula $(CH_2O)_n$, where n can be any number from 3 to 7.

Perhaps the best-known monosaccharide is glucose. This molecule is a hexose (6-carbon) sugar and has the formula $C_6H_{12}O_6$. However, the atoms of carbon, hydrogen, and oxygen can be arranged in many different ways, forming **isomers**. Although the molecular structure is often shown as a straight chain for convenience, the atoms actually form a ring, as in Figure 1, which can take a number of forms.

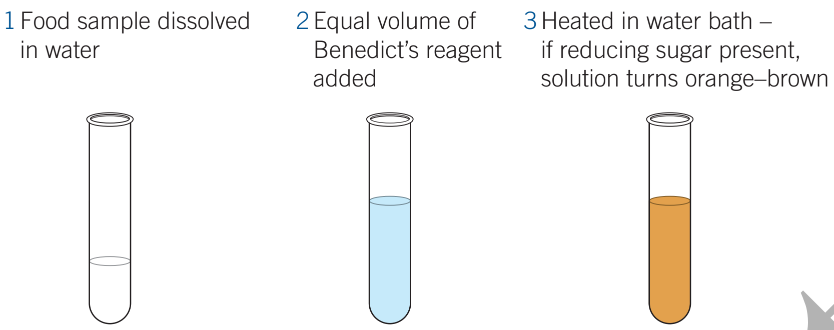


▲ **Figure 1** *Molecular arrangements of α- and β-glucose (five carbon atoms at the intersection of the lines have been omitted for simplicity. Each line represents a covalent bond).*

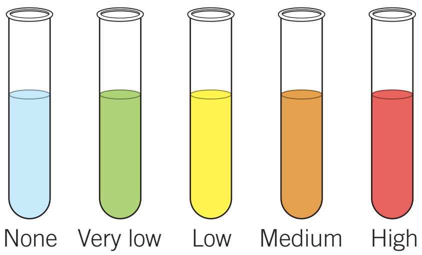
Test for reducing sugars

All monosaccharides and some disaccharides (e.g., maltose) are reducing sugars. Reduction is a chemical reaction involving the gain of electrons. A reducing sugar is therefore a sugar that can donate electrons to (or reduce) another chemical, in this case Benedict's reagent. The test for a reducing sugar is therefore known as the Benedict's test. Benedict's reagent is an alkaline solution of copper(II) sulfate. When a reducing sugar is heated with Benedict's reagent it forms an insoluble orange-brown to red precipitate of copper(I) oxide. The test is carried out as follows:

- Add 2 cm^3 of the food sample to be tested to a test tube. If the sample is not already in liquid form, first grind it up in water.
- Add an equal volume of Benedict's reagent.
- Heat the mixture in a gently boiling water bath for 5 minutes.



▲ **Figure 2** *The Benedict's test*



▲ **Figure 3** *Results of Benedict's test according to the concentration of reducing sugar present*

▲ **Figure 4** *If a reducing sugar is present, an orange-brown colour is formed*

Study tip

The Benedict's test may be a practical exercise but make sure that you have a detailed knowledge of the procedure.

Summary questions

1 Large molecules often contain carbon. Why is this?
2 What is the general name for a molecule that is made up of many similar repeating units?
3 Why does Benedict's reagent turn red when heated with a reducing sugar?

▼ **Table 1** *The Benedict's test*

Concentration of reducing sugar	Colour of solution and precipitate
None	Blue
Very low	Green
Low	Yellow
Medium	Brown
High	Red

Semi-quantitative nature of the Benedict's test

Table 1 shows the relationship between the concentration of reducing sugar and the colour of the solution and precipitate formed during the Benedict's test. The differences in colour mean that the Benedict's test is semi-quantitative, that is it can be used to estimate the approximate amount of reducing sugar in a sample.

The Benedict's test was carried out on five food samples. The results are shown in Table 2.

1 Place the letters in sequence of the increasing amount of reducing sugar in each sample.
2 Suggest a way, other than comparing colour changes, in which different concentrations of reducing sugar could be estimated.
3 Explain why it is not possible to distinguish between very concentrated samples, even though their concentrations are different.

▼ **Table 2**

Sample	Colour of solution
A	Yellowish brown
B	Green
C	Red
D	Dark brown
E	Yellowish green

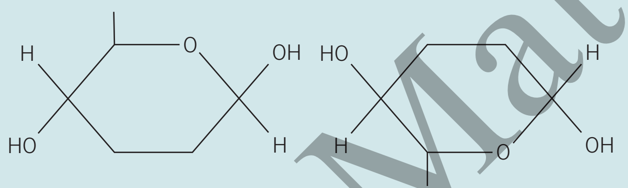
Practice questions: Chapter 1

1 **(a)** The table shows some substances found in cells. Complete the table to show the properties of these substances. Put a tick in the box if the statement is correct.

Statement	Substance			
	Starch	Glycogen	Deoxyribose	DNA helicase
Substance contains only the elements carbon, hydrogen, and oxygen				
Substance is made from amino acid monomers				
Substance is found in both animal cells and plant cells				

(*4 marks*)

(b) The diagram shows two molecules of β-glucose.



On the diagram, draw a box around the atoms that are removed when the two β-glucose molecules are joined by condensation. (*2 marks*)

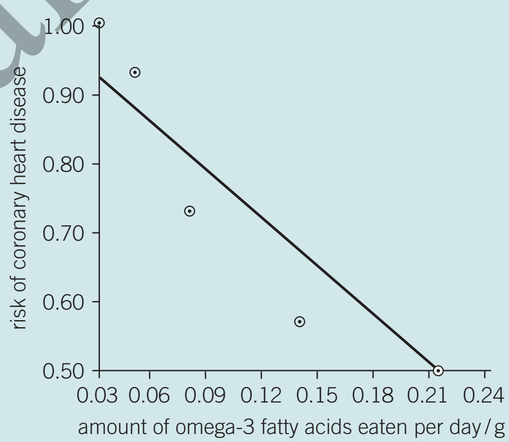
(c) (i) Hydrogen bonds are important in cellulose molecules. Explain why. (*2 marks*)

(ii) A starch molecule has a spiral shape. Explain why this shape is important to its function in cells. (*1 mark*)

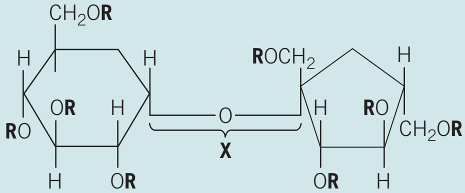
AQA Jan 2011

2 **(a)** Omega-3 fatty acids are unsaturated. What is an *unsaturated* fatty acid? (*2 marks*)

(b) Scientists investigated the relationship between the amount of omega-3 fatty acids eaten per day and the risk of coronary heart disease. The graph shows their results. Do the data show that eating omega-3 fatty acids prevents coronary heart disease? Explain your answer. (*3 marks*)



(c) Olestra is an artificial lipid. It is made by attaching fatty acids, by condensation, to a sucrose molecule. The diagram below shows the structure of olestra. The letter R shows where a fatty acid molecule has attached.



(i) Name bond **X**. *(1 mark)*

(ii) A triglyceride does *not* contain sucrose or bond **X**. Give **one** other way in which the structure of a triglyceride is different to olestra. *(1 mark)*

(iii) Starting with separate molecules of glucose, fructose, and fatty acids, how many molecules of water would be produced when one molecule of olestra is formed? *(1 mark)*

AQA Jan 2011

3 **(a)** (i) The equation shows the reaction catalysed by the enzyme lactase. Complete this equation.

Lactase + ………………… ⟶ Glucose + ……………………………… *(2 marks)*

(b) (ii) Name the type of chemical reaction shown in this equation. *(1 mark)*

(c) Lactase is an enzyme. Lactose is a reducing sugar.

(i) Describe how you could use the biuret test to distinguish a solution of the enzyme lactase from a solution of lactose. *(1 mark)*

(ii) Explain the result you would expect with the enzyme. *(1 mark)*

AQA Jan 2010

4 Some seeds contain lipids. Describe how you could use the emulsion test to show that a seed contains lipids. *(3 marks)*

AQA Jan 2012

Answers to the Practice Questions are available at
www.oxfordsecondary.com/oxfordaqaexams-alevel-biology