Cambridge Assessment International Education

Example Responses – Paper 2

Cambridge International AS & A Level Biology 9700

For examination from 2022

Cambridge Pathway

Contents

Introduction

The main aim of this booklet is to exemplify standards for those teaching Cambridge International AS & A Level Biology 9700.

This booklet contains responses to all questions from June 2022 Paper 22, which have been written by a Cambridge examiner. Responses are accompanied by a brief commentary highlighting common errors and misconceptions where they are relevant.

The question papers and mark schemes are available to download from the School Support Hub.

9700 June 2022 Question Paper 22

9700 June 2022 Mark Scheme 22

Past exam resources and other teaching and learning resources are available from the School Support Hub.

Question 1

1 Epithelial cells in the small intestine have cell structures known as microvilli. The microvilli of these cells are found only on the surface that borders the gut lumen.

Fig. 1.1 shows images of microvilli of intestinal epithelial cells. These images have been obtained using a scanning electron microscope and a transmission electron microscope.

Fig. 1.1**A** is at a different magnification to Fig. 1.1**B**.

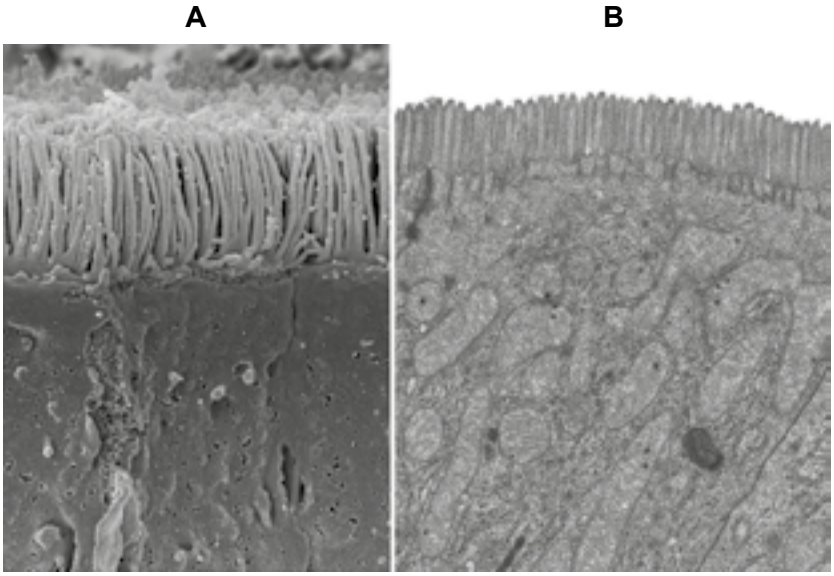

Fig. 1.1

(a) With reference to Fig. 1.1, state how it is possible to distinguish between a scanning electron micrograph and a transmission electron micrograph.

Fig. 1.1A is a scanning electron micrograph as it shows the surface contours of the microvilli and is a 3D image. Fig. 1.1B is a transmission electron micrograph as it shows a section through microvilli and is a 2D image. [1]

Examiner comment

- The question asked candidates to refer to Fig. 1.1, so required at least one of the images to be identified correctly.
- Knowledgeable responses gave clear comparisons of Fig. 1.1**A** and Fig. 1.1**B**. Comparative sentences were used, but separate descriptions were acceptable.
- Candidates were not given marks for a general description of a scanning electron micrograph that had no reference to Fig. 1.1, or no clear comparative contrast to a transmission electron micrograph.

(b) The approximate length of a microvillus is 1 μm.

Outline the method you would use to estimate the magnifications of the images shown in Fig. 1.1.

For each image I would measure the length of 5 microvilli in mm using a ruler and calculate the mean. Then to find the magnification I would multiply the length by 1000 to convert it to μm and divide it by the actual length, which is 1μm.

..... [2]

Examiner comment

- The strongest responses remembered that there were numerous microvilli in each image, so that the most accurate estimate of magnification would be obtained by using mean length.
- Most candidates showed knowledge of the formula to use, but many forgot to state or to show that the same units needed to be used to obtain the correct calculated value of magnification.

(c) One role of an intestinal epithelial cell is the absorption of glucose from the gut lumen into the circulatory system. This involves different membrane transport proteins.

The events occurring in an intestinal epithelial cell during the absorption of glucose are summarised in Fig. 1.2.

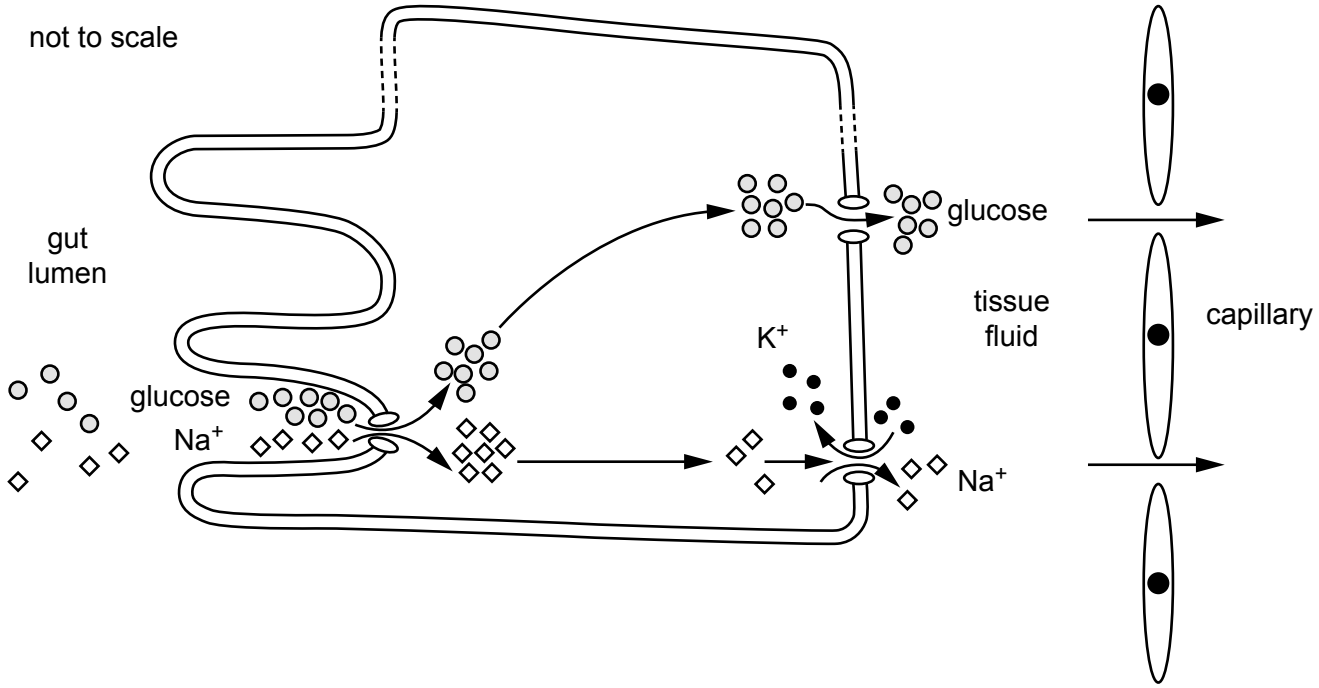

Fig. 1.2

- Sodium ions (Na^+) are removed from the cell by active transport through a transport protein known as a sodium-potassium (Na^+/K^+) pump.
- This decreases the concentration of Na^+ in the cell compared to the gut lumen.
- Glucose molecules are cotransported with Na^+ into the cell from the gut lumen.
- Glucose molecules are transported out of the cell into the tissue fluid down a concentration gradient.

(i) Active transport involves water-soluble substances, such as Na^+ and K^+, and the use of ATP to provide the energy needed for their transport through carrier proteins.

Outline **other** features of active transport.

Active transport moves substances across a membrane against a concentration gradient. The substance binds to a specific binding site in the protein. Binding causes a conformational change.

..... [2]

Examiner comment

- The use of ATP or energy for active transport did not need to be repeated because this information was given in the question, which asked for other features of the process.
- Most candidates knew that substances were moved across the cell surface membrane against their concentration gradient.
- It is correct to state that substances move from a low concentration to a high concentration, but it is an incorrect concept to state that substances move from a low concentration gradient to a high concentration gradient.
- To be awarded the two marks available for this question, more than one correct feature needed to be given. Fewer candidates gave a statement about specificity or noted that conformational change occurred to allow movement from one side of the membrane to the other.

(ii) Glucose molecules enter the cell through a membrane protein.

Suggest why glucose molecules need to be cotransported with Na^+ when it enters the cell through the membrane protein.

Glucose needs to be cotransported with Na^+ when its concentration in the lumen is lower than in the cell. The movement of Na^+ by facilitated diffusion into the cell provides the power to move glucose against the concentration gradient.

..... [2]

Examiner comment

- A good approach to this question would have come at the beginning of Question 1. The temptation to jump straight to the part-questions should have been avoided. Time was needed to read the main question introduction and to understand the events occurring in Fig. 1.1. This would have allowed candidates to note the active pumping of sodium ions out of the cell to the tissue fluid and hence understand why sodium ions could enter cells passively from the gut lumen.
- Some candidates needed to spend more time reading and understanding the focus of this question. These candidates saw ‘glucose’ and ‘membrane protein’ and gave reasons about why a substance such as glucose needed to cross the cell surface membrane into the intestinal cell using a transport protein. Others correctly concentrated on the need to be cotransported with sodium ions.
- Candidates could apply understanding of sucrose cotransport into phloem companion cells to see that this was not a case of direct active transport, an error that was made by some candidates.

(iii) Explain how microvilli increase the uptake of glucose into an intestinal epithelial cell.

Many microvilli provide a very large surface area for the uptake of glucose. This also allows the cell surface membrane to contain more transport proteins, including cotransport proteins.

..... [2]

Examiner comment

- Almost all candidates noted an increase in surface area (than without microvilli) or realised that the presence of the microvilli gave a large surface area. Some incorrectly thought that the second point should be to re-state the point given in the question**:** that this allowed an increase in glucose uptake. Only some candidates explained further that there would be more transport proteins available.
- A common error was to produce an answer implying that microvilli were cells rather than cell structures.
- Some candidates incorrectly wrote 'microtubules' and should have checked their response to spot this error.

(d) Stem cells are also located in the wall of the small intestine. These cells divide by mitosis continuously.

Suggest **and** explain the importance of mitosis by stem cells in the small intestine.

Mitosis by stem cells produces genetically identical cells. These cells can differentiate into specific intestinal cells for tissue repair or to replace dead or damaged cells. The new cells have the same function as the cells they replace, such as absorption of glucose. Stem cells can divide to form more stem cells so that there is always a supply to be able to produce intestinal cells when needed. Mitosis by stem cells is important to produce more cells for growth of the intestine when infants are developing. ..... [4]

Examiner comment

- Four marks were allocated for this question. There were many correct ideas that could be given and the example response reflects most of the main points that could be suggested by applying syllabus knowledge and understanding.
- Although many knew that stem cells divided to form stem cells, far fewer explained the importance of stem cell renewal in terms of always being available to replace intestinal cells when needed.
- A common error was to state that stem cells divide into intestinal cells, rather than to explain that they formed cells that could go on to differentiate.
- Stem cells were incorrectly described as differentiating into microvilli rather than into intestinal cells with microvilli.
- It was common for candidates to move away from the subject matter and give long answers based on stem cells in the bone marrow, production of cells of the immune system or uncontrolled mitosis leading to tumour formation.

Question 2

2 Cholera is a life-threatening and infectious disease caused by the bacterium *Vibrio cholerae*. One of the symptoms of the disease is severe diarrhoea.

V. cholerae O1 and *V. cholerae* O139 are the two forms of the pathogen that are associated with cholera epidemics (large outbreaks). These two forms have different antigens that can be detected.

(a) If an outbreak of cholera is suspected but not confirmed, a standard home treatment for diarrhoeal diseases can be used immediately to help prevent severe illness as a result of dehydration. If cholera is the cause of the disease, this standard treatment also helps to prevent a larger outbreak of the disease.

(i) Outline the standard treatment that can be used for suspected cholera cases.

The treatment is oral rehydration therapy. It is a solution of glucose and mineral salts that is given to the person to drink. Sometimes antibiotics are given as well as ORT.

..... [2]

Examiner comment

- The text accompanying the question explained that a standard home treatment for diarrhoeal diseases could be used immediately for suspected cholera cases. This was the cue to outline oral rehydration therapy, rather than to write about prevention measures.
- Some candidates incorrectly used the term dehydration to mean rehydration and should have checked their answer to spot this error.
- Many candidates erroneously gave a long list of good hygiene practice for cholera or wrote about contaminated water and problems with sewage infrastructure. 'Treatment' was mistaken by these candidates as 'prevention.' Some candidates wrote about vaccination programmes, even though the question asked for a standard home treatment for diarrhoeal diseases.

(ii) Suggest **and** explain why this treatment can help to prevent a larger outbreak of cholera.

The person will recover more quickly and this reduces the time when the person passes contaminated diarrhoea into the sewage system. There is less chance of drinking water becoming contaminated, so helps to prevent the pathogen from being transmitted to many other people. [2]

Examiner comment

- Candidates needed to consider how ORT treatment helped to protect others. The recovery of the person with cholera needed to be qualified with a shorter time for recovery, meaning less time when the person had the potential to transmit the pathogen to others in contaminated faeces.
- Many candidates mistakenly listed preventive measures for the general public to take, which included personal hygiene, vaccination, and improvements to water and sewage infrastructure.

(b) Rapid diagnostic testing (RDT) can be used to diagnose cholera by detecting the presence of *V. cholerae*. One type of RDT involves using a dipstick that contains mobile and immobilised monoclonal antibodies.

Monoclonal antibodies (mAbs) are specific in their action.

Fig. 2.1 shows a simplified diagram of an RDT dipstick that can be used to distinguish between *V. cholerae* O1 and *V. cholerae* O139. A faecal sample from a person with suspected cholera is collected and added to a reagent solution to form the test mixture.

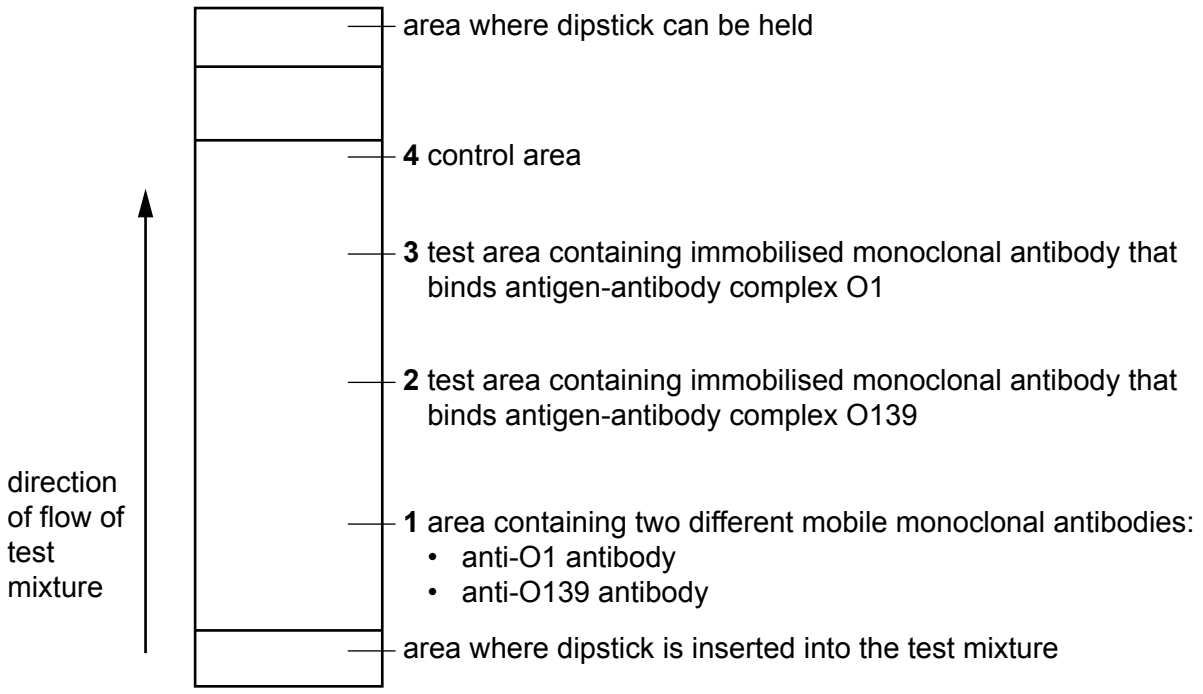

Fig. 2.1

The test mixture moves up the dipstick through area **1**. The mobile monoclonal antibodies are attached to tiny gold particles. If these antibodies collect in test area **2** or **3**, a coloured band becomes visible.

A coloured band that becomes visible in area **4** confirms that the test strip is working and that the results are valid.

(i) Explain how the structure of the monoclonal antibodies in the dipstick allows them to be specific in their action.

Different monoclonal antibodies have different variable regions which make up their antigen binding sites. They bind only to their specific antigen. The variable region has a specific amino acid sequence and tertiary structure, so the shape of the binding site is complementary to the shape of that particular antigen. [2]

Examiner comment

- This was a straightforward question for those who realised they needed to apply their knowledge of how the structure of an antibody is related to its function.
- Some wasted time and wrote about how each main feature of antibody structure was related to its function, rather than concentrating on specificity.
- Many candidates became confused with cell signalling and introduced the term ‘receptor’, either referring to a receptor on an antigen or a receptor on the antibody.
- Some did not concentrate on antibody structure and gave general answers about events that could occur within the dipstick.

(ii) Fig. 2.2 shows the results for samples taken from two different people, **A** and **B**, who are suspected of having cholera.

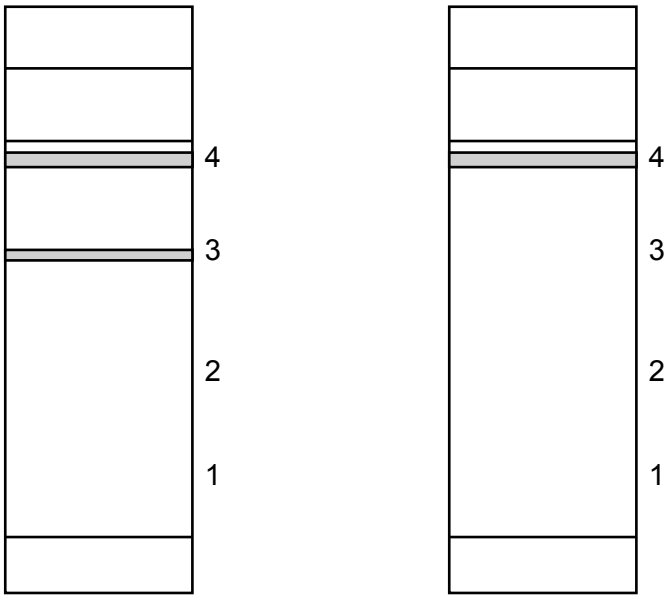

Fig. 2.2

With reference to Fig. 2.2, state **and** explain the conclusions that can be drawn from the results of the RDT dipsticks for each person.

Person A is infected with Vibrio cholerae O1 and person B does not have cholera O1 or O139. The coloured band at area 4 shows these are valid results. Person A only has antigens for Vibrio cholerae O1 in the faecal sample, so these formed a complex with anti-O1 mobile antibodies. The band in area 3 shows that the immobilised antibodies have bound to this complex. In person B, no antigen-antibody complexes have formed because there is no band at area 2 or 3. [3]

Examiner comment

- Well-organised answers firstly stated the conclusions that could be made from the dipstick and then gave supporting evidence and explanations.
- The results shown in Fig. 2.2 needed to be 'translated' into the written answer. It was not enough, for example, to write that 'area 2 and 3 show that Person B …..' A better answer would be to state that 'no coloured bands at 2 and 3 are shown, so Person B ….'
- Some candidates had not spent enough time reading through the introduction to **(b)** and studying Fig. 2.1. It was common for candidates to mistakenly think that the strip was testing for the presence of antibody, or antigen-antibody complex, in the actual faecal sample.

(c) Table 2.1 shows the results of an investigation to evaluate the effectiveness of an RDT dipstick in diagnosing cholera.

Samples taken from 156 people were tested using a dipstick and compared to the results obtained by culturing the pathogen in a laboratory for accurate identification.

Table 2.1

	number of test results		
	using culture techniques (to obtain accurate identification)	**using dipstick**	
		correct diagnosis	**incorrect diagnosis**
positive results for cholera	102	97	5
negative results for cholera	54	32	22

(i) With reference to Table 2.1, calculate the percentage chance of an RDT dipstick correctly confirming that a person with cholera has the disease.

95.1%

[1]

Examiner comment

- The calculation required for this needed to use the row for positive results for cholera. Candidates then needed to take the correct diagnosis value using the dipstick and divide it by the value obtained for the culture techniques: (97 / 102) x 100 = 95.09%. Candidates who gave this answer, or to additional decimal places, were only given the mark if their rounded-up value came to 95.1%. Those that gave 95.0% had not rounded up correctly.
- The most common errors were to calculate the percentage based on dividing 97 by 156, to get 62.2% or on dividing 129 by 156, to get 82 7%
- Even in questions that do not ask candidates to show their working, it is good practice to write down the values used and the calculation performed, because it often saves time during a final check of answers.

(ii) Using an RDT dipstick to diagnose cholera is much cheaper than culturing the pathogen and requires less technical skill.

Suggest **one** additional advantage of using an RDT dipstick, rather than culture techniques, to diagnose cholera.

It takes much less time to get a diagnosis, so treatment can begin earlier.

..... [1]

[Total: 11]

Examiner comment

- There were many valid suggestions that were acceptable for this question, but those related to a cheaper cost or less need for technical skill were ignored because these were in the information given and the question asked for an additional advantage.
- One-word answers should have been avoided. ‘Quick’ or ‘quicker’ needed to be accompanied by further qualification.
- The suggestion that the dipstick was more accurate was incorrect. Earlier in Question 2, information was provided so that it could be deduced that culture techniques gave a more accurate diagnosis.

Question 3

3 Hummingbirds are the smallest of birds and are found in the Americas. Some species migrate hundreds of kilometres between warmer overwintering areas and summer breeding grounds. Like mammals, birds maintain a constant body temperature.

Hummingbirds have a high requirement for sugars because they have a very high metabolic rate. Fig. 3.1 shows a hummingbird feeding on nectar, one of their main food sources.

Fig. 3.1

(a) Nectar is a sugary liquid containing mainly sucrose, fructose and glucose.
Sucrose has the molecular formula $C_{12}H_{22}O_{11}$. Fructose and glucose each have the molecular formula $C_6H_{12}O_6$.

State **two** differences between sucrose and fructose, other than the number of carbon, hydrogen and oxygen atoms present.

Sucrose is a disaccharide, while fructose is a monosaccharide. Sucrose

is a non-reducing sugar, while fructose is a reducing sugar.

.....

.....

..... [2]

Examiner comment

- Two short statements contrasting the two sugars produced a good response for this type of question.
- As the answer was restricted to two comparisons, it was important to use differences that were as precise as possible and could not be challenged. For example, stating that 'sucrose is composed of two monomers and fructose is not' is far less precise than stating that 'sucrose is a disaccharide and fructose is a monosaccharide.'
- A common error was to make a correct point but then qualify it with incorrect detail. For example, 'Sucrose is a disaccharide composed of two glucose molecules, but fructose is a monosaccharide.'
- Reading a question twice can often help. Some candidates incorrectly compared sucrose with glucose.

(b) In preparation for migration, sugars need to be converted to triglycerides to function as energy reserves. Hummingbirds can double their body mass during this time.

(i) Fig. 3.2 shows the structural formula of one type of storage triglyceride. The triglyceride has two types of fatty acid residue, palmitate and oleate.

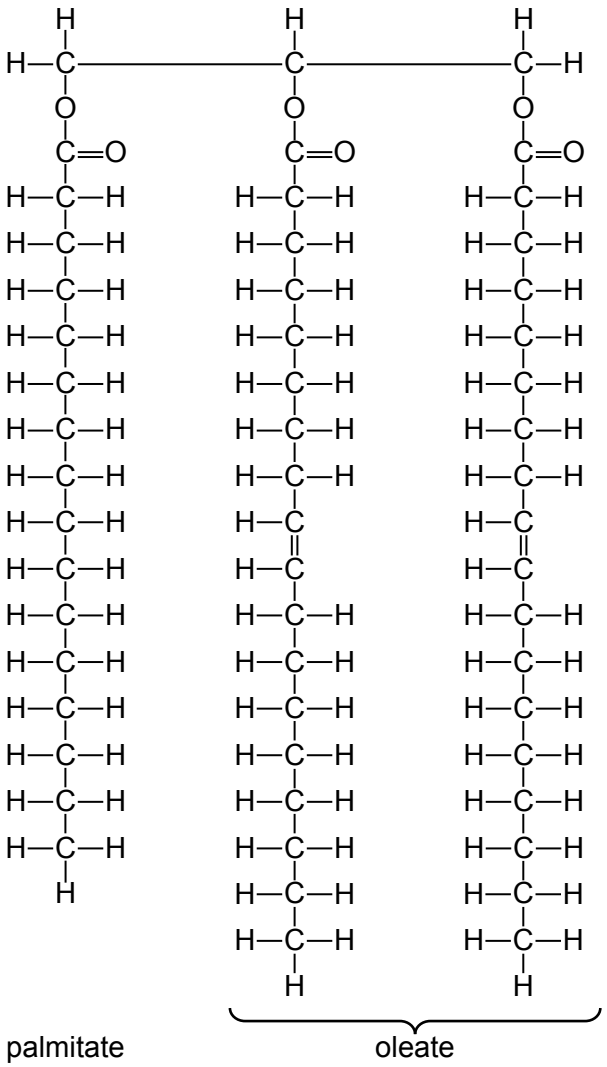

Fig. 3.2

Outline the features of the molecular structure of the triglyceride shown in Fig. 3.2.

The triglyceride is composed of a glycerol joined to each of three fatty residues by an ester bond. The two oleates are unsaturated. Each one has a carbon-carbon double bond in the hydrocarbon chain. The palmitate is a saturated fatty acid and has no carbon-carbon double bonds.

..... [3]

Examiner comment

- Some used terms related to phospholipids, for example, describing the glycerol as ‘a hydrophilic head portion’ while others used the term ‘fats’ to mean fatty acids, or ‘glyceride’ to mean glycerol.
- Many candidates did not mention glycerol at all in their response.
- Many candidates were not precise when referring to the ester bonds and stated that there was ‘an ester bond’, or that the fatty acids contained ester bonds, or that there were three esters.
- Some missed the instruction to give molecular features and gave answers suggesting the functions of the triglyceride in Fig. 3.2.

(ii) In hummingbirds, glycogen is the long-term carbohydrate energy store.

Suggest **one** reason why hummingbirds build up a greater energy store in the form of triglyceride, rather than a greater energy store of glycogen, in preparation for migration.

For the same mass, triglycerides release more energy than glycogen to use for migration.

..... [1]

Examiner comment

- There were many correct ways to answer this question, and a common suggestion related to the proportionately greater number of C–H bonds present in triglycerides.
- Some candidates simply repeated the information in the question and stated that more energy could be stored in triglycerides, without trying to explain the advantage of this in terms of energy release for migration.

(c) In birds such as hummingbirds:

- blood is kept within vessels
- for each complete circuit of the body, blood passes through the heart twice.

State the term used to describe this type of circulatory system.

Closed, double circulation. ..... [1]

Examiner comment

Almost all candidates knew that double circulation or double circulatory system was the term to describe the statement in the second bullet point, but only some remembered to give the term ‘closed’ to describe the fact that blood is kept in vessels.

(d) The heart of birds has the same structure as the heart of mammals. Compared with the heart of mammals, the heart of birds is larger in proportion to their body size.

Suggest why the heart of birds is larger in proportion to their body size.

Birds are more active. They have a high energy requirement because they fly. A larger heart pumps more blood at a higher pressure to deliver more oxygen and glucose to their body tissues for aerobic respiration and remove the greater quantity of waste carbon dioxide.

..... [2]

Examiner comment

- This question used an unfamiliar example and expected candidates to recall the role of the heart and consider why the heart of a bird would be proportionately larger than that of a mammal.
- Some candidates did not address the fact that birds have a proportionately large heart and only stated that the heart could pump blood at high pressure to reach all the body tissues, which would be the same situation for mammals.
- A fairly common error was to assume all birds fly at high altitudes, where there is a lack of oxygen.

(e) Complete Table 3.1 to show the names and functions of the main blood vessels associated with the heart of mammals.

Table 3.1

function of blood vessel	name of blood vessel
carries blood from the heart to the lungs	pulmonary artery
carries blood to the heart from the lungs	pulmonary vein
carries blood from the heart to the rest of the body	aorta
carries blood to the heart from the rest of the body	vena cava

[3]

[Total: 12]

Examiner comment

- Most candidates knew the correct names of these blood vessels, but where there were gaps or where ‘artery’ or ‘vein’ was given, it tended to be for the aorta and / or the vena cava.
- Candidates should always aim to learn the correct spellings of scientific terms, particularly as some misspellings become close to other terms that have a different meaning. Here, the correct spelling of aorta was required. Quite a number gave ‘arota’. Many candidates had problems spelling ‘pulmonary’ correctly.
- Some candidates are visual learners and several drew little sketches of the heart and blood vessels to help remind them of the correct answers. Approaches such as this can be helpful to candidates.

Question 4

4 The enzyme carbonic anhydrase has been found in a wide range of organisms and acts as a catalyst in many tissues.

Studies have shown that there are differences in the protein structure of the enzyme and differences in the number and organisation of introns and exons of the gene coding for the enzyme.

All carbonic anhydrase enzymes catalyse the same reversible reaction, shown in Fig. 4.1.

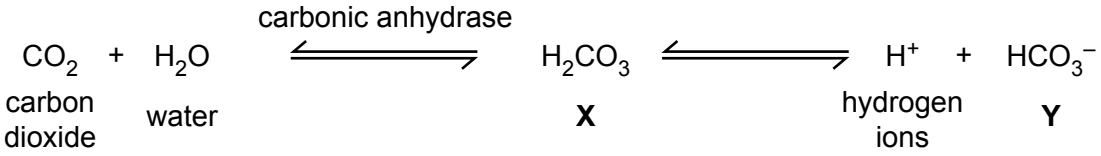

Fig. 4.1

(a) With reference to Fig. 4.1, name **X** and **Y**.

X carbonic acid

Y hydrogen carbonate ions

[2]

Examiner comment

- Substance **X** was sometimes given as hydrogen carbonate, particularly when **Y** was correctly named as hydrogencarbonate ions.
- In questions such as this, when a candidate is not sure of the correct substance, at some stage a choice must be made and only one must be named. Giving different possibilities in the hope that one will be marked as correct is not a feasible strategy and would not be given marks.

(b) Carbonic anhydrase enzymes can have different primary structures.

Suggest how all carbonic anhydrase enzymes can catalyse the same reaction, even though they have different primary structures.

They could form tertiary structures that have the same shape of active site.

[1]

Examiner comment

- Some suggested that the enzymes would have different substrates that fit into the active site, which would not be the case because they were catalysing the same reaction.
- Some made the assumption that the active sites of the different carbonic anhydrase enzymes would be similar but did not state this, and instead described the induced fit mechanism.

(c) Genes coding for proteins in eukaryotes consist of introns and exons.

Outline the similarities and differences between the introns and the exons of genes coding for proteins such as carbonic anhydrase.

Exons and introns are both part of the primary transcript. Introns are non-coding and are removed during RNA splicing. The exons are coding sequences and during splicing they are joined to form mRNA. The introns stay in the nucleus but mRNA leaves the nucleus to go to the ribosomes for translation.

..... [3]

Examiner comment

- To help them answer this question, it was important that candidates had a good grasp of the sequential steps in protein synthesis that involve post transcriptional modification.
- Many candidates who did very well overall in the exam found this extended response very challenging. The subject matter, introns and exons, is new to the current syllabus and so candidates could not rely on knowledge of past paper questions and mark schemes.
- Well-expressed answers adopted a sequential approach, often similar to the order of the mark points in the mark scheme, by writing about the primary transcript before giving points about post-transcriptional modification and finishing with notes about translation.
- Clear answers kept comparison points close together so these could be easily awarded marks without having to match these up from different areas of the response.
- It was particularly important in this question to be very precise in the use of scientific terminology and to check that contradictions were not made. Examples included:
  - Using the term ‘genes’ instead of ‘nucleotide sequences’. Statements such as ‘exons are coding genes’ or ‘introns are genes that are non-coding’, could not be given marks. Candidates had already been given the information that genes consist of introns **and** exons.
  - Describing the RNA molecule formed as a direct result of transcription as messenger RNA or mRNA, rather than using the correct term, primary transcript.
  - Explaining that mRNA only contained exons in one part of the response but contradicting this in another part of the response by stating that introns were removed from mRNA.
- A common misconception was to think that introns were the same as STOP codons.
- A common error was to state that introns and exons were amino acid sequences.
- References to introns being ‘genetic junk’ were ignored. With the recent discoveries about the roles that introns have in the cell, this term tended to be avoided. A few candidates knew that introns can have regulatory roles in the cell, however, these tended to be those candidates who had already been awarded full marks.

All mammals have the same type of carbonic anhydrase, known as α-carbonic anhydrase. Many different forms, or isoforms, of α-carbonic anhydrase have been identified in mammals.

There are 15 isoforms of α-carbonic anhydrase (CA) in humans. Cells of different tissues have one or more isoforms. Within cells the isoforms may be in different locations.

(d) Red blood cells contain two isoforms, CA1 and CA2.

Suggest the location of CA1 and CA2 in red blood cells **and** give a reason for your answer.

They are located throughout the cell cytoplasm, close to all the haemoglobin molecules. When the carbonic acid dissociates, the hydrogen ions can rapidly bind to haemoglobin to form haemoglobinic acid.

[2]

Examiner comment

- There were a number of different ways to answer this question and it was acceptable to suggest that the enzymes are located in the cytoplasm and in the cell surface membrane.
- For the reason, many just described the reaction shown in Fig. 4.1 rather than thinking about the efficiency of being in the location, such as close proximity to the haemoglobin molecules.
- The question says that the enzymes are in red blood cells and a very common error was to describe a location in the body, frequently given as the lungs, or to state that the enzyme was dissolved in blood plasma.

(e) Isoform CA6 forms part of human breast milk. Mammary gland cells package CA6 in Golgi vesicles for release from the cells.

Name the transport mechanism associated with CA6 secretion.

Exocytosis [1]

Examiner comment

- 'Bulk transport' as an answer was ignored as it was not precise enough to show that movement occurs from the cell to the external surroundings.
- Although the sequence of events leading to the final release of the product from the Golgi vesicles is an active process, a common error was to write 'exocytosis (active transport)'. This could not be awarded marks because these are two different transport mechanisms.

(f) Human CA isoforms in some epithelial cells in the eye have a role in the formation of the clear fluid of the eye known as aqueous humour. Overactivity of the enzyme may lead to a harmful increase of pressure within the eye and cause a condition known as glaucoma.

Acetazolamide is a therapeutic drug that can be used in the treatment of glaucoma. It acts as a reversible non-competitive inhibitor.

Describe the mechanism of action of acetazolamide as a reversible non-competitive inhibitor of carbonic anhydrase.

Acetazolamide binds to a site on the enzyme other than the active site. This causes a change in the shape of the active site so that the substrate cannot enter and bind to the active site. No product is made until the acetazolamide detaches from the enzyme.

..... [3]

[Total: 12]

Examiner comment

- Some candidates described the mechanism of action of a competitive inhibitor, as well as that of a non-competitive inhibitor. This prevented them being awarded full marks as there were some marking points that could not be awarded because a choice had been given.
- Detail was important when describing enzyme action, for example the substrate should have been described as not being able to bind to the active site, rather than not being able to bind to the enzyme.
- Close attention needed to be paid to the wording of the question. Some saw the term 'reversible non-competitive inhibitor' and wrote a response in terms of the effect on enzyme rate of reaction, rather than on the mechanism of action of the inhibitor. So, stating that less substrate binds to react and less product is produced is not at the level of mechanism of action. If a molecule of acetazolamide binds to an enzyme molecule, the substrate cannot bind and no product is formed.
- A common incorrect spelling of active site was 'active side.'

Question 5

5 Fig. 5.1 is a photomicrograph of a transverse section through part of the bronchus of the human gas exchange system. The image is of a good resolution for a light microscope.

The bronchial epithelium is a single layer of cells lining the lumen of the bronchus.

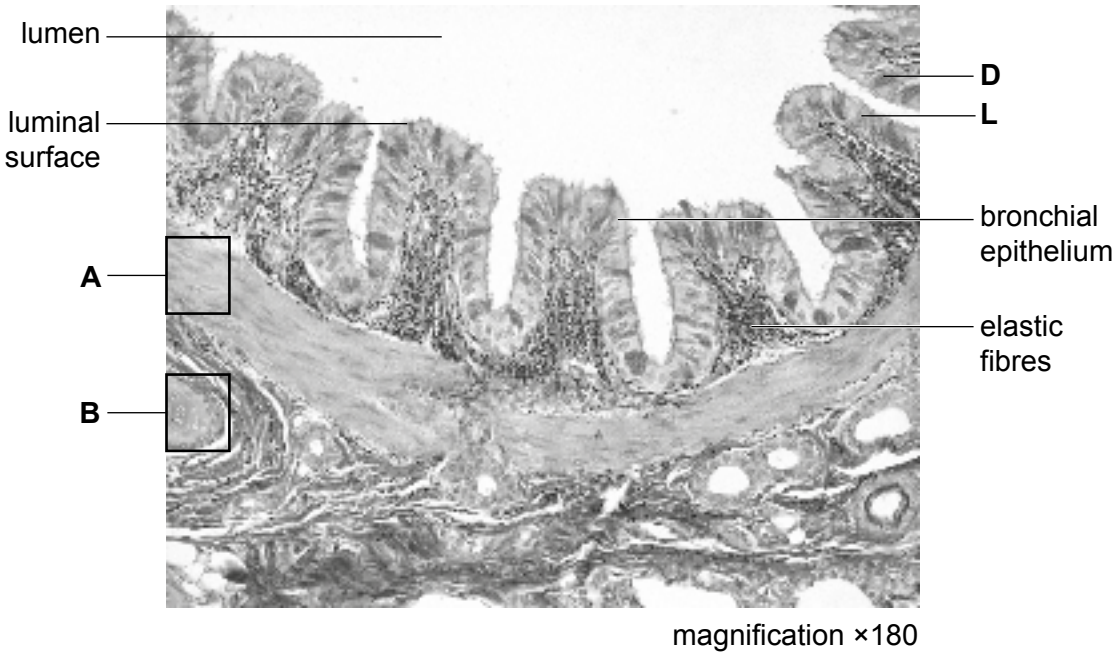

Fig. 5.1

(a) The luminal surface shown in Fig. 5.1 is not clearly defined and appears slightly blurred.

State why the luminal surface of the bronchial epithelium appears slightly blurred, even though the resolution of the image is good.

There are cilia on the luminal surface and these are so small that they cannot be seen clearly on the image.

..... [1]

Examiner comment

- The resolution of the image in Fig. 5.1 was described as good, but the most common error was to state that the resolution was poor. Some realised cilia were on the luminal surface but stated they were too small to be seen, which contradicted with the idea of seeing a slightly blurred surface.
- Some candidates use the term microvilli as another meaning of cilia, which is incorrect.

(b) Some cells of the bronchial epithelium shown in Fig. 5.1 appear darker than others. For example, cell **D** appears darker than cell **L**.

With reference to the bronchial epithelium shown in Fig. 5.1, explain why some cells, such as cell **D**, appear darker and other cells, such as cell **L**, appear lighter.

The bronchial epithelium contains ciliated epithelial cells and goblet cells. During staining, cell D had more structures that took up the stain than cell L, so D looks darker. Another explanation is that less light was passing through cell D because it had more structures in it that absorbed light, compared to cell L. [2]

Examiner comment

- If the question does not limit the response to a particular number of explanations, then it is acceptable to give one or two additional points to go beyond the mark allocated to the question, to be sure of achieving full marks.
- It was not necessary to state whether cell D was a goblet cell or a ciliated epithelial cell, and full marks were available for candidates who gave valid explanations for the differences seen, other than that there are two cell types present.
- It was common for a response to identify either the darker cell or the lighter cell as the goblet cell and to state that the cell was darker (or lighter) because it was full of mucus. This statement needed to be qualified with an explanation, for example related to staining or light penetration.
- There were many answers indicating that candidates had not read carefully the information provided. For example, some referred to darker areas and lighter areas on the image or to light shining at different angles casting shadows. Neither of these would be valid ideas to explain one dark cell next to one light cell.
- One of the most common errors was to state or imply that goblet cells or ciliated epithelial cells were in other cells. For example, 'The dark cells contain goblet cells.'
- Another common error was to write about differences owing to the presence of cilia or mucus on the surface of the cells, despite being told that the image was a transverse section.
- As the subject of the image was a structure in the gas exchange system, some responses tried to give explanations based on whether the cell had taken up oxygen or not.

(c) In Fig. 5.1 the tissue in box **B** is cartilage.

The tissue shown in box **A** is different from the tissue in box **B**.

Outline the differences in the structure **and** function of tissue **A** compared with tissue **B**.

Tissue A is smooth muscle. The muscle cells are spindle shaped and are close together whereas the chondrocyte cells of cartilage are rounded and more spread out. Smooth muscle contracts and relaxes. When air is forced out the muscle contracts to constrict the bronchus. Cartilage supports the bronchus and keeps the airway open for air to flow.

..... [3]

[Total: 6]

Examiner comment

- To achieve full marks, candidates needed to write about differences in function, as well as in structure, between tissue A and tissue B. In this question, a clear statement about one of the tissues did imply a difference and so detail for the other tissue did not have to be stated for the mark to be awarded.
- Although there were differences that could be readily observed in Fig. 6.1, many candidates did not write about differences in the shape and distribution of cells, and generally only correctly identified tissue A as smooth muscle or being composed of smooth muscle cells.
- It was common to see A identified as goblet cells and/or mucous glands, or for A to be composed of muscle and elastic tissues, even though the question referred in the singular to tissue A.
- Candidates were told that tissue B was cartilage but it was quite common for this fact to be missed or forgotten. A number identified B as smooth muscle and A as cartilage and where this occurred, attempts were made to see if a mark could be given for an error, carried forward. When contradictory points appeared further in the response, this was often not possible to do. It is very important for candidates to re-read their answers and check back to information accompanying a question to see if they have made any avoidable errors.

Question 6

6 The transport tissues of plants are phloem and xylem.

The role of xylem is the transport of water and mineral ions from the soil solution to the different parts of the plant body.

The role of phloem is the translocation of assimilates and other substances from sources to sinks.

(a) The source of mineral ions for the plant is the soil solution. These mineral ions are transported from the roots in the xylem. Mineral ions are also found in the phloem sap within phloem sieve tubes.

Suggest why mineral ions are found within phloem sieve tubes **and** state how they are transported within phloem sieve tubes.

The mineral ions move up the xylem dissolved in water to the source. They can enter phloem sieve tubes when water moves in by osmosis. This increases hydrostatic pressure in the sieve tubes so the phloem sap with the mineral ions moves by mass flow to the sink down a pressure gradient. Mineral ions stored in the source also enter sieve tubes from companion cells through plasmodesmata.

..... [3]

Examiner comment

- There were two parts to this question, and the best responses addressed the entry of mineral ions into the phloem sieve tubes and the mechanism of movement within the sieve tubes. Most candidates were able to be given some marks, usually either for mass flow and/or for the movement down a pressure gradient.
- Mineral ions present in an organism are dissolved in water. Many forgot to explain this concept, either by stating that they are dissolved in the water moving up the xylem or that they are dissolved in phloem sap.
- A common error was to give details of sucrose transport into the companion cell and phloem sieve tube, without any mention of mineral ions.
- Some candidates incorrectly replaced sucrose with mineral ions in an account of proton-sucrose cotransport.
- A number of candidates knew that mass flow was the mechanism of transport, then contradicted this by also stating that mineral ions move by diffusion or active transport.

(b) Phloem tissue consists of different cell types.

Complete the passage using the most appropriate terms to summarise some of the features of phloem tissue.

The end walls of sieve tube elements are modified to allow efficient flow of phloem sap by the formation of sieve plates . These structures also prevent the cells from bursting under pressure. The cytoplasm of sieve tube elements is very much reduced and is found at the periphery of the cells. Most of the organelles in the cell are absent. Adjacent to sieve tube elements are companion cells that carry out the metabolic processes of the missing organelles, allowing the sieve tube elements to function. [3]

[Total: 6]

Examiner comment

- Sieve pores was an example of another acceptable answer instead of sieve plates, but 'pores' was not considered to be a full answer to complete the first sentence in this cloze passage.
- Apart from 'edge', 'sides' was accepted as an alternative to 'periphery' but descriptions such as 'ends' or 'corners' were not suitable.

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