

Advanced Subsidiary GCE Biology

Unit F215 - Control, Genomes and Environment - High banded Candidate style answer

OCR has produced these candidate style answers to support teachers in interpreting the assessment criteria for the new GCE specifications and to bridge the gap between new specification release and availability of exemplar candidate work.

This content has been produced by senior OCR examiners, with the input of Chairs of Examiners, to illustrate how the sample assessment questions might be answered and provide some commentary on what factors contribute to an overall grading. The candidate style answers are not written in a way that is intended to replicate student work but to demonstrate what a “good” or “excellent” response might include, supported by examiner commentary and conclusions.

As these responses have not been through full moderation and do not replicate student work, they have not been graded and are instead, banded “medium” or “high” to give an indication of the level of each response.

Please note that this resource is provided for advice and guidance only and does not in any way constitute an indication of grade boundaries or endorsed answers.

1(a)(i) A gene controlling coat colour in cats is sex linked. The two alleles of this gene are black and orange. When both are present the coat colour is called tortoiseshell. Define the following terms: [2]	
<i>Candidate style answer</i>	<i>Examiner's commentary</i>
<i>gene</i> <i>This is a length of DNA that is the template for RNA that will then be translated into a particular polypeptide.</i> <i>allele</i> <i>This is one form of a gene. e.g. a gene controlling height could have alternative alleles for tall and dwarf</i>	These definitions are comprehensive, clear and accurate. They provide more information than might be required, but ensures high marks will be awarded regardless of the targeting of the question and therefore the detail that would be expected.

(ii) Explain why there are no male tortoiseshell cats. [2]	
<i>Candidate style answer</i>	<i>Examiner's commentary</i>
<i>The gene controlling coat colour is sex-linked. It is carried on the X chromosome, so males will only have one allele. It is not possible to get tortoiseshell with only one allele as one black and one orange are required.</i>	This answer is a clear and thorough explanation.

The χ^2 statistic is calculated in the following way:

$$\chi^2 = \Sigma \frac{(\text{observed} - \text{expected})^2}{\text{expected}} \quad \Sigma = \text{"sum of ..."}$$

(ii) Calculate the value of χ^2 for the above data. Show your working. [2]

Candidate style answer	Examiner's commentary
$62 - 65 = -3$ $-3^2 = 9$ $9 \div 65 = 0.138$ $131 - 130 = 1 \quad 1^2 = 1$ $1 \div 130 = 0.008$ $67 - 65 = 2$ $2^2 = 4$ $4 \div 65 = \underline{0.062}$ 0.208 $\chi^2 \text{ value} = \dots\dots 0.208 \dots\dots$	Using the values provided in Table 1, the candidate has correctly calculated the value and has done so to a suitable number of decimal places.

(iii) The critical value of χ^2 for this type of investigation with two degrees of freedom is 5.991. Explain whether your answer to (b) (ii) supports the hypothesis. [1]

Candidate style answer	Examiner's commentary
<i>This supports the hypothesis as the critical value for 2 degrees of freedom is 5.991 and 0.208 is below this value.</i>	The candidate has recognised that the mark could be awarded for explaining that the value for χ^2 that has been calculated is below the critical value rather than simply stating whether or not the hypothesis is supported.

(d) Phenotype is influenced by genetic and environmental factors. Describe one example of how the environment influences phenotype. [2]

Candidate style answer	Examiner's commentary
<i>The fur at the extremities (ears, tail, paws) of Siamese cats and Himalayan rabbits are darker in colour than the rest of the body. This is because the allele that controls pigment production can only function at low temperature and the temperature of these parts is lower than the rest of the body, so the fur only grows darker in those places.</i>	A good, clear answer that deals both with the phenotypic change and the mechanism.

(e) The bacterium *Escherichia coli* (*E. coli*) uses glucose as a respiratory substrate. In the absence of glucose, *E. coli* can use lactose. Explain how the use of a different substrate is determined by the interaction between genes and the environment. [5]

<i>Candidate style answer</i>	<i>Examiner's commentary</i>
<p><i>The production of a polypeptide is not simply determined by the length of DNA that actually codes for the polypeptide. In this case, there is a promoter and terminator (which indicate where to start and finish transcription) and the operator (which regulates the activity of three different genes, coding for proteins that are responsible for the uptake of lactose into the cell and its breakdown). All this is collectively known as an operon, in this case the lac operon. When lactose is not present then a repressor molecule binds to the operator. This prevents RNA polymerase from binding to the promoter and so the gene is inactive and the appropriate enzymes are not made. But when lactose is present it binds to the repressor molecule, changing its shape so it cannot bind to the operator. There is nothing now to prevent the RNA polymerase from transcribing the genes and so lactose can be broken down. So the presence or absence of lactose (the environmental factor) will determine whether the lactose (the different substrate) is used for respiration.</i></p>	<p>This answer clearly explains the mechanism of the lac operon. The final statement indicates that the candidate is ensuring that the examiner can see that the question has been addressed. The answer could be improved by mentioning the names of the genes (lacZ, lacY and lacA) and the enzymes concerned.</p>

2(a) Cystic fibrosis (CF) in humans is caused by mutations of a gene coding for transmembrane protein (CFTR) which acts as an ion pump. A large number of different mutations of the gene have been found. Explain what is meant by a gene mutation. [2]

<i>Candidate style answer</i>	<i>Examiner's commentary</i>
<p><i>It is a spontaneous change in the DNA nucleotide sequence. This could be for example a substitution or addition which may or may not affect the production of the protein, depending on whether a new amino acid is coded for.</i></p>	<p>A comprehensive answer.</p>

(b) CFTR regulates the transport of chloride ions (Cl⁻) across the plasma (cell surface) membrane. Tissues that express the normal CFTR allele secrete alkaline fluids, whereas the secretions of tissues expressing some mutant alleles are acidic. The transport of Cl⁻ by epithelial cells expressing the normal CFTR allele was compared with that by epithelial cells expressing one of 10 different mutant CFTR alleles. The results are shown in Table 2.1.

In the table, normal digestive functioning of the pancreas associated with a particular allele is indicated with a tick (✓) and the absence of normal functioning by a cross (×).

Table 2.1

CFTR allele	percentage of Cl ⁻ transported in comparison with normal allele	normal digestive functioning in pancreas
normal	100	✓
mutation 1	6	×
mutation 2	4	×
mutation 3	0	×
mutation 4	3	×
mutation 5	1	×
mutation 6	33	✓
mutation 7	41	✓
mutation 8	46	✓
mutation 9	37	✓
mutation 10	44	✓

With reference to the information given in the table, explain why some mutant CFTR alleles allow normal digestive functioning of the pancreas and others do not. [3]

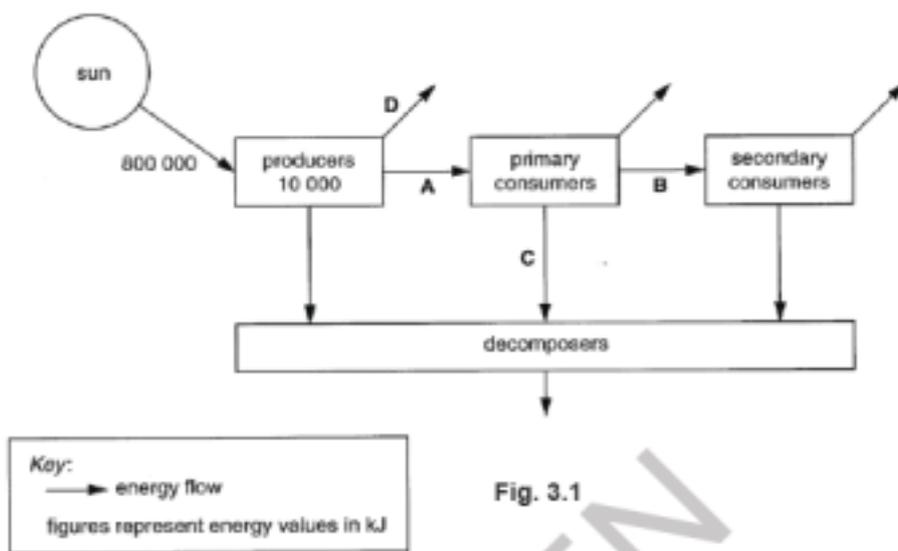
Candidate style answer

It depends on what effect the mutation has on the structure and function of CFTR. Some mutations will have some effect on the shape of the molecule and therefore its function. But others will result in a completely different shape of molecule or will even prevent the formation of the molecule at all. It also depends on the role of CFTR in the particular organ. One role of the pancreas in digestion is to produce an alkaline fluid, composed mainly of HCO₃⁻. The role of CFTR in the pancreas will be probably be involved in a chloride-hydrogencarbonate exchange, by which the hydrogencarbonate ions are released into the secretion. Some mutations prevent the hydrogencarbonate ions from being secreted because the protein is the wrong shape and so the secretions become acidic. The enzymes work at an optimum pH that is alkaline and so the enzymes in the pancreatic juice will not be functioning properly and so digestion will not take place effectively.

Examiner's commentary

This is not an easy question, as the jump has to be made from chloride ion transport to hydrogencarbonate ion transport and the subsequent effect on digestion. Even though this answer is a little long-winded and repetitive, it is a good effort at a complicated sequence of reasoning.

3 Fig 3.1 represents the transfer of energy through a woodland ecosystem.



- (a) Of the 800 000 kJ of energy which reaches the producers, only 10 000 kJ of energy is converted to growth in the producers.
- (i) Calculate the percentage of the energy reaching the producers that is converted to growth in the producers. Show your working. [2]

Candidate style answer	Examiner's commentary
$10\,000 \div 800\,000 = 0.0125$ $0.0125 \times 100 = 1.25$ Answer =1.25..... %	Correct answer with all working shown.

- (ii) Explain what happens to the energy reaching the producers that is not converted to growth. [2]

Candidate style answer	Examiner's commentary
<p>Some of the energy may reach the producer but not be taken in as it is not the correct wavelength for use in photosynthesis. It could be reflected off the cuticle or pass straight through the leaf without being trapped by the chlorophyll in the chloroplasts. Some of the light energy will hit non-photosynthesising parts of the plant, such as a woody stem. Energy that is reflected off the clouds does not count as it has not reached the producer in the first place.</p>	<p>A comprehensive response that has given more detail than is probably necessary for high marks. But the final statement clearly shows that the candidate appreciates the difference between energy reaching the producer and energy that does not even reach the producer.</p>

(iii) Name <u>one</u> decomposer.		[1]
<i>Candidate style answer</i>	<i>Examiner's commentary</i>	
<i>A bacterium such as <u>Nitrobacter</u>.</i>	A correct answer.	

(iv) State two ways in which energy is transferred from primary consumers to decomposers at C.		
<i>Candidate style answer</i>	<i>Examiner's commentary</i>	
<i>1 Egestion of faeces 2 Death</i>	A clear and accurate response.	

(b) Suggest why the percentage energy transfer between producers and primary consumers at A is less than that between the primary consumers and secondary consumers at B.			[3]
<i>Candidate style answer</i>	<i>Examiner's commentary</i>		
<i>Much of the producer is made up of cellulose. Most consumers do not have the necessary enzymes to digest cellulose so have to rely on the mechanical breakdown of the cell walls so that the contents can be digested. Even those consumers who are specialised by having gut bacteria that can digest cellulose cannot extract the maximum amount of energy from their food as the bacteria take some of the energy themselves. Much of the producer may not be eaten because it is inaccessible (e.g. underground) or too tough (e.g. hard seeds or woody stems). On the other hand, the primary consumers are much more digestible than plant material. The enzymes that the secondary consumers have are able to break down the animal tissue far better and so can gain a greater amount of energy from them.</i>	An example of a clear answer that has outlined the problems of accessing or digesting plant material compared to animal material.		

<p>4 One product manufactured using microorganisms is insulin. The process involves genetically engineering bacteria to synthesise human insulin.</p> <p>(a)(i) Describe how the isolated human insulin gene is inserted into a bacteria plasmid. [4]</p>	
<i>Candidate style answer</i>	<i>Examiner's commentary</i>
<p><i>First of all the plasmid is cut in a specific place using a restriction enzyme. The best enzyme to use will be the same one that was used to cut out the insulin gene, as it will then have the right sticky ends to join up with the gene. Then the gene is mixed with the plasmid and they join, using the complementary sticky ends. A bonds with T and C bonds with G. Hydrogen bonds form between the bases and the backbone is sealed using ligase.</i></p>	<p>A clear response that summarises the process. Time and effort was not wasted in outlining how the insulin gene was obtained but the answer could have been improved by indicating that the restriction enzyme cuts in a particular way at a particular base sequence rather than just referring to a 'specific place'.</p>

<p>(ii) Suggest <u>two</u> ways in which the bacteria which take up the modified plasmids can be identified. [2]</p>	
<i>Candidate style answer</i>	<i>Examiner's commentary</i>
<p><i>You can add something else to the insulin gene that you can use to identify whether the gene is present in the plasmid. One way would be to add a fluorescent marker to the insulin gene. The bacteria could then be examined and the ones that glow are the ones that have the plasmid. Or you could add an antibiotic resistance gene to the insulin gene. Then you expose the bacteria to that particular antibiotic and the ones that survive have the antibiotic resistance gene and so also have the insulin gene.</i></p>	<p>A very good response. The candidate has initially outlined the principle and then given two valid ways in which it might be carried out.</p>

<p>(b) Suggest <u>one</u> reason why it is considered preferable to use genetically engineered sources of human insulin rather than insulin obtained from pigs. [1]</p>	
<i>Candidate style answer</i>	<i>Examiner's commentary</i>
<p><i>Some people may have religious reasons for not being able to use insulin obtained from pigs (e.g. jews).</i></p>	<p>A response that sets out the reason rather than simply stating 'ethical' or 'religious'.</p>

<p>(c) Another product manufactured using microorganisms is single cell protein (SCP). Describe how a protein would be synthesised in the cell of a single-celled fungus. In your answer, you should make clear the sequence of the steps in the process.</p> <p style="text-align: right;">[10]</p>	
<i>Candidate style answer</i>	<i>Examiner's commentary</i>
<p><i>Transcription is the first step in the formation of a protein. The appropriate section of the DNA unwinds and the two strands in that section separate. Free RNA nucleotides align, with complementary base pairing, along the sense strand. A aligns with T, U with A, C with G and G with C. Messenger RNA is formed and the mRNA strand leaves the nucleus and moves into the cytoplasm.</i></p> <p><i>Once in the cytoplasm, the mRNA strand attaches to the ribosome where translation takes place. Another type of RNA is found in the cytoplasm. This is transfer RNA. Each tRNA molecule is attached to an amino acid. The amino acid carried is determined by the triplet of bases on the bottom of the molecule. Two mRNA triplets are exposed on the ribosome at a time. One tRNA molecule will bind to the mRNA with complementary base pairing between the codon and anticodon. Then the next tRNA molecule binds in the same way. The neighbouring amino acids at the end of each tRNA molecule will bind together by a condensation reaction forming a peptide bond. The mRNA then moves on one position and the next tRNA molecule binds. This process continues to build the chain of amino acids until a stop codon is reached. Once the chain is produced, the sequence of amino acids will determine the folding into secondary and tertiary structure.</i></p>	<p>This answer is clearly expressed and provides a comprehensive and accurate account.</p>

5 Fig. 5.1 is a drawing of the brain that shows the origin of the cranial nerves.

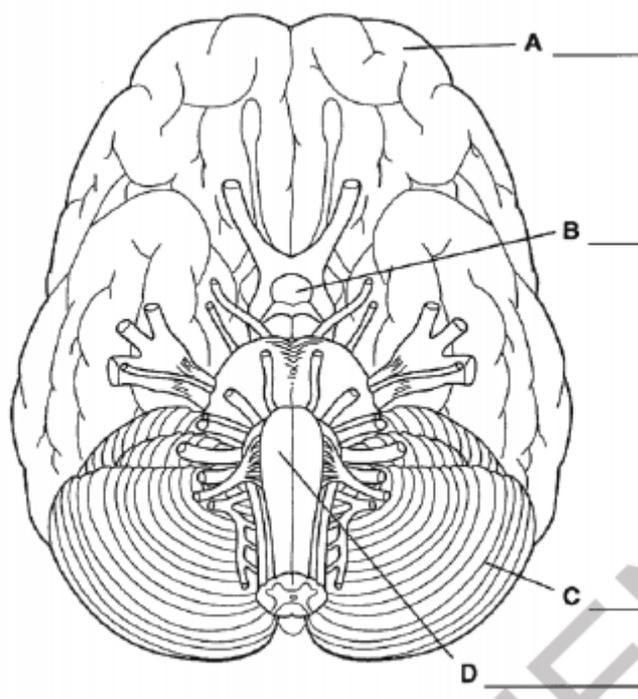


Fig. 5.1

(a) State the direction from which the brain has been drawn. [1]

Candidate style answer	Examiner's commentary
From below.	The correct answer.

(b)(i) Name the structures A, B, C and D shown on Fig. 5.1. [4]

Candidate style answer	Examiner's commentary
<p>A Cerebral hemisphere</p> <p>B Hypothalamus</p> <p>C Cerebellum</p> <p>D Medulla oblongata</p>	This answer is not totally correct, as B is incorrectly named. This was the least obvious structure to name.

(ii) State two roles of structure D. [2]

Candidate style answer	Examiner's commentary
<p>1 Control of heart rate and breathing rate.</p> <p>2 Control of breathing rate.</p>	This answer shows that the candidate only realised after writing the first sentence that two roles were required and that the first sentence had in fact provided two roles. By deleting 'breathing rate' and writing it as the second answer, the candidate has improved their marks. Two answers on the first line might not have been credited, given the format of the answer space provided.

<p>(c) The hypothalamus constantly monitors and regulates the concentration of hormones in the blood. Outline how the hypothalamus regulates the concentration of hormones in the blood. [2]</p>	
<i>Candidate style answer</i>	<i>Examiner's commentary</i>
<p><i>Hormone concentrations are regulated by negative feedback. When there is a decrease in the concentration of hormone in the blood the hypothalamus releases trophic hormones which travel in the blood to the endocrine gland. These stimulate the production of the hormone concerned and the concentration in the blood rises. Once the concentration gets too high, the release of the trophic hormones is inhibited and so hormone production from the endocrine gland decreases.</i></p>	<p>An answer that gives good detail of the mechanism. More than enough information has been supplied for the two available marks, but the candidate has ensured that all aspects of the mechanism have been covered. It would have been all too tempting to answer this question simply in terms of a specific example, but this answer is (as required) in general terms.</p>

6 An investigation was carried out into the effects of two plant growth substances, gibberellins and auxins, on apical dominance. The terminal (apical) buds of a number of pea plants were removed and discarded. The tops of each of the remaining shoots were given one of the following treatments:

- Coated with a paste containing gibberellin.
- Coated with a paste containing auxin (IAA).
- Coated with a paste without any plant growth substance.

In addition, a control group of plants did not have their terminal buds removed and were not coated with paste.

The growth of the side shoots was measured at regular time intervals and a mean value calculated. The results are shown in Fig. 6.1.

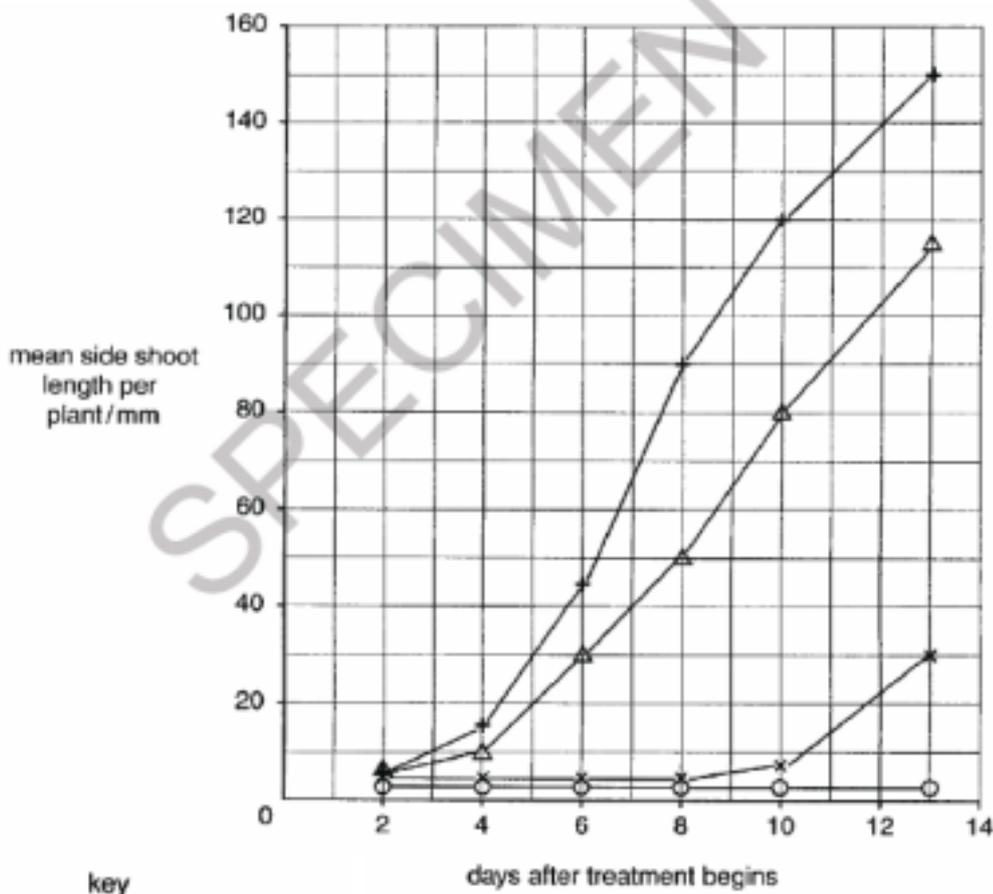


Fig. 6.1

(a) Explain why the side shoots grow when the terminal buds are removed.

[3]

Candidate style answer

The tips of the growing shoots produce auxin. The auxin moves downwards through the shoot. The auxin has the effect of inhibiting the growth of the side shoots. This is known as apical dominance. Once the terminal buds are removed, no auxin is produced. So the inhibition of the side shoots is removed, the cells can divide and the side shoots can grow.

Examiner's commentary

This answer initially explains the principle of apical dominance. For a clear answer this is probably the best approach, as the absence of apical dominance is the key to the answer.

<p>(b) Side shoots show greater growth when paste containing gibberellin is applied than when paste without any plant growth substance is applied. Calculate the percentage increase in growth due to gibberellin in 8 day old seedlings compared to seedlings with paste only. Show your working. [2]</p>	
<i>Candidate style answer</i>	<i>Examiner's commentary</i>
<p>$40 \div 50 \times 100$ Answer =80.....%</p>	<p>This answer is correct and working has been shown.</p>

<p>(c) Using data from Fig. 6.1 describe <u>and</u> explain the effect of auxin (IAA) on the growth of side shoots. [3]</p>	
<i>Candidate style answer</i>	<i>Examiner's commentary</i>
<p><i>The growth of side shoots is inhibited by auxin. There was no growth in the side shoots until after day 8 and until day 8 they behave the same as the control group, only measuring 5mm. The auxin in the paste must be travelling down the shoot just like in the intact plants. After day 8 there is some growth but nothing like the other treatments. As no more auxin paste has been applied, the auxin must be running out but in the control group the tip keeps on producing auxin.</i></p>	<p>This answer shows good understanding and description and analysis of the data. The data quote is accurate and the references to the other treatments clarify the answer.</p>

<p>7(a) Immobilised enzymes can be used in bioreactors that attach to space suits. The bioreactors recover water from the astronauts' urine. The bioreactors use immobilised urease enzyme which catalyses the hydrolysis of urea, forming carbon dioxide and ammonia. These products react to form ions, which are then removed by the bioreactor.</p> <p>(i) State the meaning of the term immobilised enzyme and describe how immobilisation can be achieved. [3]</p>	
<i>Candidate style answer</i>	<i>Examiner's commentary</i>
<p><i>An immobilised enzyme is an enzyme that has been trapped in some kind of insoluble material or mesh. This holds it in place. The method used to immobilise the enzyme will depend on the enzyme itself and the reaction that is being catalysed. It could be encapsulated in alginate beads or gel entrapment or adsorption onto some kind of resin.</i></p>	<p>This is a good response that aims to maximise the marks that can be awarded.</p>

(ii) Suggest <u>three</u> practical advantages of using an immobilised urease bioreactor in a spaceship. [3]	
<i>Candidate style answer</i>	<i>Examiner's commentary</i>
<p>1 The urine produced by the astronauts can be dealt with safely</p> <p>2 The treated urine will produce water that can be used for other purposes and means that less needs to be taken with them</p> <p>3 The enzymes can be reused, which means that there is less to take with them.</p>	This answer demonstrates that the candidate has considered the situation and applies the answers thoughtfully.

(b) An investigation was carried out to compare lipase in soluble and immobilised forms. Palm oil was hydrolysed to produce fatty acids and glycerol.	
<ul style="list-style-type: none"> • The two forms of lipase showed optimal activity at the same pH and temperature (pH 7.5 and 35°C). • At that pH and temperature, 100% of the oil was hydrolysed in two minutes. • If the temperature was increased to 45°C, the immobilised enzyme hydrolysed 100% of the oil but the soluble enzyme hydrolysed only 80% of the oil in two minutes. 	
(i) Define the term <i>hydrolysis</i>. [1]	
<i>Candidate style answer</i>	<i>Examiner's commentary</i>
<i>This is using the chemical addition of water to break a bond, in this case an ester bond.</i>	An accurate answer that has been applied to the question.

(ii) Explain, <u>using the information in the passage</u>, the advantages of using an immobilised enzyme to hydrolyse palm oil. [4]	
<i>Candidate style answer</i>	<i>Examiner's commentary</i>
<p><i>An immobilised enzyme can work at a higher temperature with no reduction in efficiency if the temperature is increased from the optimum of 35°C to 45°C. The reason is that as the enzyme is held in place the bonds are not able to vibrate very much when the temperature is increased and so it is not denatured as easily. A higher temperature may be preferred as the palm oil will be less viscous and can be handled more easily. As the reaction progresses and fatty acids are produced, the pH will fall. Immobilised enzymes are also protected against the effects of pH (denaturing by the breaking of bonds under the influence of H⁺) and can therefore withstand an increase in acidity better than free enzymes can. As with all immobilised enzymes, the enzyme can be reused and will not contaminate the product.</i></p>	<p>This answer has shown consideration of the particular situation and has explained the advantage of using immobilised enzymes in the context of temperature and pH rather than simply describing the effect. The general advantages of immobilised enzymes have been added to complete the picture, even though not directly associated with the passage.</p>

8(a) Explain the meaning of the term *primary succession*. [2]

Candidate style answer	Examiner's commentary
<p>An area of bare ground will be firstly colonised by pioneer plants. Over the years, this area will change through a series of clearly distinct stages, each with its characteristic vegetation. The final stage, after which it does not really change, is the climax.</p>	<p>Sound information that is very well expressed. The only possible criticism is that the terms 'sere' and 'equilibrium' were not used.</p>

Fig. 8.1 shows a primary succession in a temperate climate. X represents an example of deflected succession.

Fig. 8.1

(b) Explain the role of pioneer plants in succession on a bare rock or sand dune. [3]

Candidate style answer	Examiner's commentary
<p>The pioneer plants colonise the bare ground. They grow and when they die they decompose. The decomposing matter forms humus and then soil. The decomposing plants release nutrients into the soil, making the soil more fertile for the next group of plants (that have greater needs than the pioneer plants). The roots of these plants will help to bind the soil particles together and stabilise the soil. This also helps to retain water. But without the pioneer plants in the first place, the nutrient-rich humus and soil would not form.</p>	<p>This answer has clearly established the importance of the pioneer plants, emphasised in the last sentence.</p>

(c) Suggest two ways in which deflected succession at X could be caused. [2]

Candidate style answer	Examiner's commentary
<p>1 Mowing 2 Used for grazing by cows or sheep.</p>	<p>Two suitable suggestions were made.</p>

(d) Explain how biomass changes during a <u>primary</u> succession. [2]	
<i>Candidate style answer</i>	<i>Examiner's commentary</i>
<i>The initial biomass is very low. This is because there are few very small plants at the beginning. As you move through the primary succession, the biomass increases. This is because the plants in the later stages, such as bushes and trees, are larger than the pioneer plants and grasses.</i>	This is a clear and well-reasoned answer.

(e) Using timber production in a temperate country as an example, explain how ecosystems can be managed in a sustainable way. In your answer, you should make clear how the management is sustainable. [7]	
<i>Candidate style answer</i>	<i>Examiner's commentary</i>
<p><i>For the ecosystem to be sustainable, it is important that the timber that is harvested each year can be maintained at a suitable level. A plantation that runs out of timber available to be harvested has not been managed sustainably.</i></p> <p><i>The ecosystem can be managed by the planting and felling of timber. Fast-growing trees, such as conifers, are planted so that they can be harvested quickly and trees that are native to the area or can grow well in the area are chosen for maximum growth. They are not planted too close together so that when they are felled the ones that are being left are not damaged. Young trees are protected from damage by grazing animals. As trees are removed, they are replaced by planting new ones. There is no point in planting huge areas all at the same time because all the trees will be ready at the same time. So it is far better to stagger the planting so that the timber is ready for felling at different times, giving a cycle of planting and harvesting over many years.</i></p> <p><i>There are various ways that the felling regime can help sustainable management. One way is to only fell individual mature trees or small areas, creating passageways or firebreaks. If huge areas are felled at the same time then it can lead to soil erosion and if fire should break out in the unfelled areas then it would be difficult to prevent its spread. Sometimes the complete tree is not cut down, but instead the top of the tree is cut off, leaving part of the trunk. This is known as pollarding and new branches grow up from the trunk, and these can be harvested again and again.</i></p>	<p>This answer shows an appreciation of many of the management policies that are in place in sustainable woodland. The meaning of the term 'sustainable' is made clear, indicating that the candidate appreciates what the term means. The answer is well organised, dealing separately with the definition and appropriate planting and felling strategies.</p>

Overall banding: High

The answers to these questions indicate thorough understanding of many of the principles being tested. There are only a few gaps in knowledge and most of the answers are clear and well organised, although some could be improved.