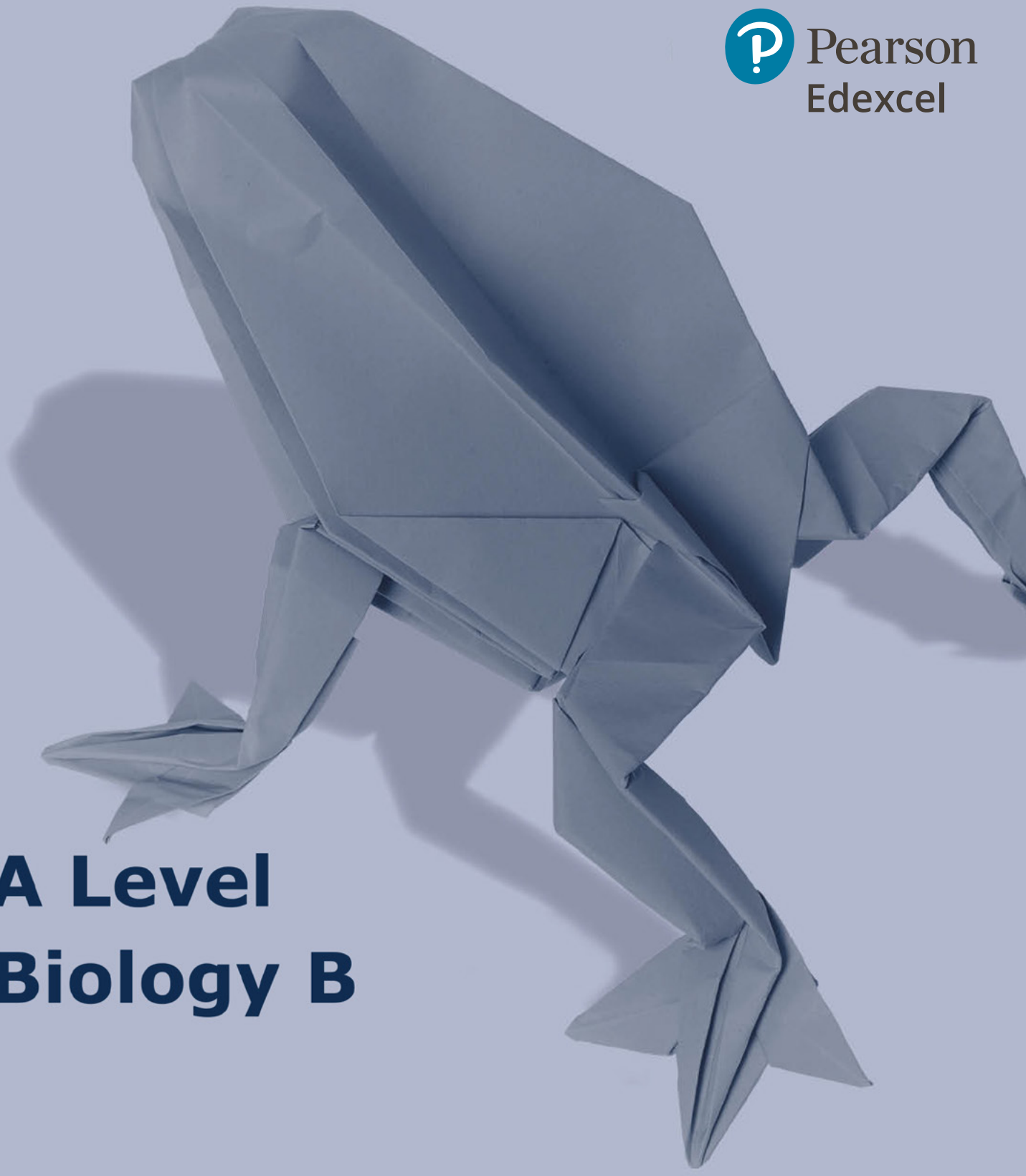
Pearson Edexcel



A Level Biology B

EXEMPLAR WORK WITH COMMENTARIES

Pearson Edexcel GCE A Level Biology B

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Contents

About this booklet

This booklet has been produced to support biology teachers delivering the new GCE A level Biology B specification (first assessment summer 2017).

The booklet looks at questions from the Sample Assessment Materials. It shows real student responses to these questions, and how the examining team follow the mark schemes to demonstrate how the students would be awarded marks on these questions.

How to use this booklet

Our examining team have selected student responses to 6 questions from the trialling of the Sample Assessment Materials. Following each question you will find the mark scheme for that question and then a range of student responses with accompanying examiner comments on how the mark scheme has been applied and the marks awarded, and on common errors for this sort of question.

Paper 1: Advanced Biochemistry, Microbiology and Genetics

Exemplar question 1

7 The order of bases in a section of DNA codes for a sequence of amino acids in a protein.

(a) Draw a diagram to show the structure of an amino acid.

(2)

(b) The diagram below shows the order of bases in a section of DNA that codes for part of a polypeptide chain.

A	A	T	C	G	C	C	G	G	A	T	A	T	G	G	C	A	A

leucine — alanine — alanine — tyrosine — threonine — valine

(i) Give the sequence of bases in the mRNA that codes for the amino acid leucine.

(1)

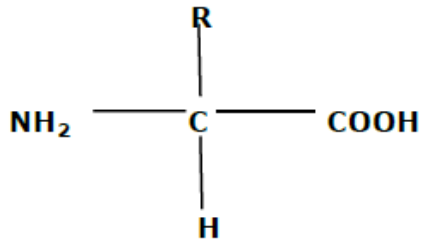
(ii) Explain how this length of DNA will code for this sequence of amino acids.

(3)

*(iii) Discuss the possible consequences for this sequence of amino acids if a point mutation occurred in this section of DNA.

(6)

Mark scheme

Question Number	Acceptable Answer	Additional guidance	Mark
7(a)	 • central carbon atom bonded to NH_2 and COOH group (1) • central carbon atom bonded to R group and H atom (1)	Allow opposite orientation with R group and R may be replaced with appropriate group	**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
7(b)(i)	UUA		**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
7(b)(ii)	An explanation that makes reference to the following: • 18 bases code for six amino acids (1) plus any two from: • because genetic code is made up of triplets of bases (1) • because the code is degenerate, some amino acids can have more than one code (1) • because of non-overlapping code (1)		**(3)**

Question Number	Indicative content	
***7(b)(iii)**	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. • Frame shift effect due to addition / deletion • Replace amino acid due to substitution • No effect on amino acids due to substitution • Degeneracy of code due to substitution • Shorter due to stop codon • Consequence for protein structure explained	
Level	Mark	Descriptor
	0	No awardable content
Level 1	1-2	Demonstrates isolated elements of biological knowledge and understanding to the given context with generalised comments made. Vague statements related to consequences are made with limited linkage to a range of scientific ideas, processes, techniques and procedures. The discussion will contain basic information with some attempt made to link knowledge and understanding to the given context.
Level 2	3-4	Demonstrates adequate knowledge and understanding by selecting and applying some relevant biological facts/concepts.

		Consequences are discussed, which are occasionally supported through linkage to a range of scientific ideas, processes, techniques and procedures. The discussion shows some linkages and lines of scientific reasoning with some structure.

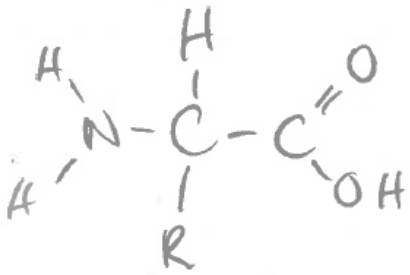
Level 3	5-6	Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of biological facts/concepts. Consequences are discussed, which are supported throughout by sustained linkage to a range of scientific ideas, processes, techniques or procedures. The discussion shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.

Student answers for part a)

Student answer A

(a) Draw a diagram to show the structure of an amino acid.

(2)



Examiner comments

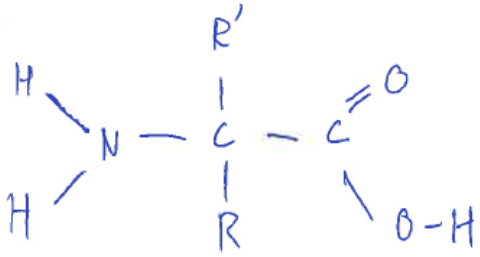
This candidate has drawn a correct structure of an amino acid and gains both marks. The mark scheme shows the carboxylic acid group as COOH, but this candidate has drawn it out correctly.

Mark awarded = 2.

Student answer B

(a) Draw a diagram to show the structure of an amino acid.

(2)



Examiner comments

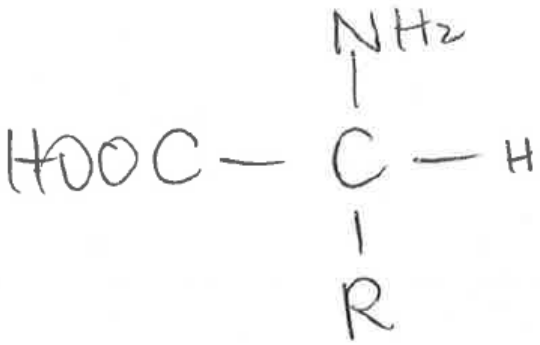
The amino group and the carboxylic acid group are drawn correctly, but this candidate has incorrectly shown two R groups on the central carbon atom. This drawing gains mark point 1, but not mark point 2.

Mark awarded = 1.

Student answer C

(a) Draw a diagram to show the structure of an amino acid.

(2)



R is the side chain.

Examiner comments

This candidate has drawn the molecule in a different view, but the groups attached to the central carbon atom are correct and so gains both mark points 1 and 2.

Mark awarded = 2.

Student answers for part b) i)

Student answer A

(i) Give the sequence of bases in the mRNA that codes for the amino acid leucine.

(1)

~~UUAGGGCCUAUACCGU~~ UU

UUA.

Examiner comments

UUA is the correct sequence.

Mark awarded = 1.

Student answer B

(i) Give the sequence of bases in the mRNA that codes for the amino acid leucine.

(1)

UUAGCGGCCUAUACCGUU

Examiner comments

This candidate has written out the entire mRNA sequence, which does not code for leucine. This answer is, therefore, incorrect.

Mark awarded = 0.

Student answer C

(i) Give the sequence of bases in the mRNA that codes for the amino acid leucine.

(1)

~~AAT~~ TTA

Examiner comments

This candidate has incorrectly given the base sequence of the complementary DNA strand.

Mark awarded = 0.

Student answers for part b) ii)

Student answer A

(ii) Explain how this length of DNA will code for this sequence of amino acids.

(3)

DNA transcribed to mRNA which is translated into amino acids by using tRNA which reads bases in 3's, codons. each codon codes for an amino acid. triplet code, it degenerate so more than one codon can code for an amino acids ie 20 naturally occuring amino acids and 64 codons

Examiner comments

This answer includes appropriate descriptions of the genetic code consisting of triplets of bases and of the degenerate nature of the code. Mark points 2 and 3 are therefore awarded. To gain full marks, candidates are expected to include mark point 1.

Mark awarded = 2.

Student answer B

(ii) Explain how this length of DNA will code for this sequence of amino acids.

(3)

3 bases code for 1 amino acid ⇒ triplet code
RNA polymerase will read the gene and the appropriate amino acids will be assembled.

Examiner comments

This answer refers only to the triplet nature of the genetic code and gains mark point 2.

Mark awarded = 1.

Student answer C

(ii) Explain how this length of DNA will code for this sequence of amino acids.

(3)

DNA transcribed into mRNA by RNA polymerase
mRNA translated. by Complementary tRNA molecules
(anticodon to codon) carrying amino acids are joined
together.

Examiner comments

This answer includes a brief description of transcription and translation, but does not give any relevant information.

Mark awarded = 0.

Student answers for part b) iii)

Student answer A

*(iii) Discuss the possible consequences on this sequence of amino acids if a point mutation occurred in this section of DNA.

(6)

If a point mutation ie a different nucleotide base ~~on~~ replaces another.

As code is degenerate this point mutation could have no effect as new codon ~~base~~ could code for same amino acid.

Missense if code for different amino acid which may alter shape and function of final protein

Nonsense if the new codon now codes for a stop codon which halts translation ∴ smaller ∅, no function polypeptide produced.

Examiner comments

This answer includes relevant information about a substitution mutation and the consequent effect of this on the polypeptide. The content is sufficient for level 2 and a mark of 4 is appropriate. For level 3, candidates are expected to include examples of other types of point mutations and their possible effects on the amino acid sequence.

Mark awarded = 4.

Student answer B

*(iii) Discuss the possible consequences for this sequence of amino acids if a point mutation occurred in this section of DNA.

(6)

A point mutation can happen if a base is deleted, substituted or added. If a base is deleted or added this causes a frameshift and all the codons after it will be different. This means the amino acid sequence will be completely different. If a different base is substituted then that codon will be different. The codon could become a stop codon & the amino acid chain will be shorter. If the third base in the codon is changed then it might cause a new amino acid to be put into the chain or have no effect because the code is degenerate. If a new amino acid is put in then the polypeptide could have different bonds and be a different shape and might not work.

(Total for Question 7 = 12 marks)

Examiner comments

This answer has a logical, clear structure and includes quite comprehensive details of different type of point mutations and their consequences, illustrating a level 3 response. The candidate has included references to frame shift, base substitution, degeneracy of code, stop codon and the consequence for protein structure. A mark of 6 is appropriate.

Mark awarded = 6.

Student answer C

*(iii) Discuss the possible consequences on this sequence of amino acids if a point mutation occurred in this section of DNA.

(6)

A point mutation would result in a frame shift. Possibly altering many amino acids adjacent to the point mutation. i.e an enzyme with a shape not specific to its function may be synthesised, leading to a metabolic block and potentially death.

Examiner comments

This candidate has described the effect of a point mutation in terms of frame shift only, and the possible effect of this on the shape of an enzyme. There is some attempt to select and apply relevant biological facts and concepts with just enough to justify level 2 and a mark of 3 is appropriate.

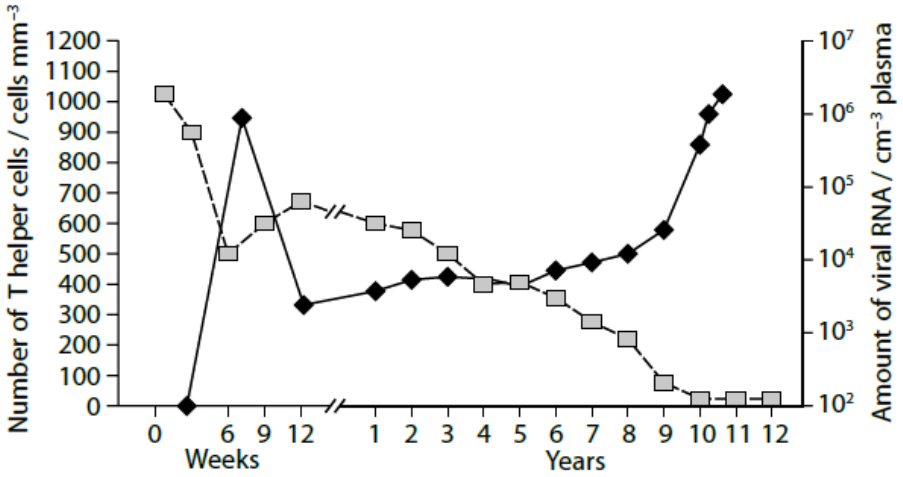
Mark awarded = 3.

Exemplar question 2

9 The Human Immunodeficiency Virus (HIV) causes an infection called Acquired Immune Deficiency Syndrome (AIDS).

The virus attacks T helper cells in the body and eventually leads to death, usually as a result of opportunistic infections.

The graph below shows changes in the T helper cell count and in the amount of viral RNA in a person during a period from initial HIV infection to death.



(a) Calculate the percentage change in viral RNA from week two to week six.

(2)

(b) Analyse the data to explain the changes in the T helper cell count from initial HIV infection until death.

(5)

(c) The HIV virus contains an enzyme called reverse transcriptase. This enzyme uses the viral RNA as a template to synthesise a single strand of complementary DNA in the host cell.

(ii) Describe how other enzymes convert the complementary single strand of DNA into a double strand of DNA in the host cell.

(2)

(d) There are drugs that can be taken to reduce the reproduction of HIV.

Explain why a patient is usually given several different drugs at the same time.

(2)

Markscheme

Question Number	Acceptable Answer	Additional guidance	Mark
9(a)	$(10^6 - 10^2) \div 10^2$ x 100 (1) 999900 % (1)	Correct answer gains full marks with no working	**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
9(b)	An explanation that makes reference to the following: • overall the T helper cell count falls from {week 0 / initial HIV infection} and the amount of viral RNA increases (1) • between week 6 and week 12 the amount of viral RNA falls, therefore the T helper cell count increases (1) plus any three of the following: • virus attaches to (CD4) surface receptors (1) • virus genetic material / RNA enters T helper cell (1) • virus genetic material produces virus proteins / new virus particles (1) • T helper cells lyse (1) • T killer cells attack infected T helper cells / phagocytosis by macrophages (1)		**(5)**

Question Number	Acceptable Answer	Additional guidance	Mark
9(c)(ii)	A description that makes reference to the following: • DNA polymerase to join nucleotides / bases / formation of phosphodiester bonds (1) • ligase to join DNA sections (1)		**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
9(d)	An explanation that makes reference to the following: • HIV mutates (1) • resistance to one drug but not to {all / others} (1)		**(2)**

Student answers for part a)

Student answer A

(a) Calculate the percentage change in viral RNA from week two to week six.

(2)

$$\frac{10^6 - 10^2}{10^2} \times 100 = 9.999 \times 10^5$$

Answer 9.999×10^5 %

Examiner comments

The calculation is carried out correctly and the answer is also correct, gaining both marks.

Mark awarded = 2.

Student answer B

(a) Calculate the percentage change in viral RNA from week two to week six.

(2)

$10^2 - 10^6$

$$\frac{10^6 - 10^2}{10^2} \times 100$$

Answer 9999 %

Examiner comments

This candidate has shown the calculation correctly, although the answer given is incorrect and so gains the first mark point only.

Mark awarded = 1.

Student answer C

(a) Calculate the percentage change in viral RNA from week two to week six.

(2)

Answer 999900

Examiner comments

The correct answer with no working shown, gains two marks. This candidate has not included the % sign with the answer, but the word 'percentage' is included in the stem of this question and is not needed to gain full marks.

Mark awarded = 2.

Student answers for part b)

Student answer A

(b) Analyse the data to explain the changes in the T helper cell count from initial HIV infection until death.

(5)

From 2–6 weeks, the number of T helper cells decreases from around 900 → 500 due to the rapid increase in viral RNA. The viral RNA concentration drops as the number of T helper cells slowly increase. From 12 weeks → 12 years the amount of viral RNA slowly increases, causing the number of T helpers to slowly drop until death.

Examiner comments

This candidate has correctly indicated that (overall) the amount of viral RNA increases and the T helper cell numbers decrease. This gains mark point 1.

For mark point 2, there must be a clear link between the amount of viral RNA and the T helper cell count (note the word 'therefore' in the mark scheme) and a stated time reference, between week 6 and week 12.

Mark awarded = 1.

Student answer B

(b) Analyse the data to explain the changes in the T helper cell count from initial HIV infection until death.

(5)

In the first 6 weeks the number of T helper cells falls & the number of viruses increases. This is because the viruses attach to the CD4 receptors on the T cells and virus RNA is injected into the cell. This causes the cell to make new viruses and the helper cells break open & die releasing viruses which attach to other more T helper cells. In the next 6 weeks the number of viruses decreases so fewer T helper cells are killed & the body makes more of them. In the following years the infected T helper cells are killed by T killer cells and the increasing number of viruses.

Examiner comments

This is a comprehensive, detailed answer which carefully analyses the data to explain the changes in the numbers of T helper cells, gaining full marks.

Mark awarded = 5.

Student answer C

(b) Analyse the data to explain the changes in the T helper cell count from initial HIV infection until death.

(5)

The number of T helper cell decreases as the weeks increases from 1020 cells mm^{-3} in week 0 to 50 cells mm^{-3} in week 12 HIV is a virus and it first infect a host cell (T helper cell) which the virus ~~in fect~~ injects its viral RNA and it is transcribe to cDNA by reverse transcriptase and the viral cDNA is added to the normal T helper cell DNA and cause mutation. More HIV ~~virus~~ is produce and it burst out the T helper cell ~~because~~ and infect other T helper cell and repeat the whole process, therefore the number of T helper cell decreases overtime. As viral RNA increases, more HIV is replicated and the rate of virus replication is higher than that of T helper cell replication, so causing T helper cell count to decrease

Examiner comments

This answer includes mark points 4, 5 and 6. The last sentence just makes mark point 1, 'as the viral RNA increases […] so causing T helper cell count to decrease' as this is within the context of the overall changes.

Mark awarded = 4.

Student answers for part c) ii)

Student answer A

(ii) Describe how other enzymes convert the complementary single strand of DNA into a double strand of DNA in the host cell.

(2)

RNA polymerase produce a short RNA primer and anneal this to the start of the strand. DNA polymerase III add bases to extend the strand by complementary base pairing. DNA polymerase I replace RNA primer to DNA bases. Ligase rejoin the sugar phosphate backbone.

Examiner comments

For full marks, candidates are expected to name both DNA polymerase and ligase, and to outline the function of each enzyme. This answer includes both mark points and gains full marks.

Mark awarded = 2.

Student answer B

(ii) Describe how other enzymes convert the complementary single strand of DNA into a double strand of DNA in the host cell.

(2)

In replication, DNA polymerase causes free nucleotides to be added to the complementary strand.

Examiner comments

This answer refers to the function of DNA polymerase, but does not include ligase and therefore gains mark point 1 only.

Mark awarded = 1.

Student answer C

(ii) Describe how other enzymes convert the complementary single strand of DNA into a double strand of DNA in the host cell.

(2)

Free DNA nucleotides join together by base pairing (hydrogen bonds) to the complimentary strand and the phosphate-sugar backbone is joined together by DNA ligase.

Examiner comments

This answer does not refer to DNA polymerase and the description of the function of ligase is too vague to distinguish it from the function of DNA polymerase.

Mark awarded = 0.

Student answers for part d)

Student answer A

(d) There are drugs that can be taken to reduce the reproduction of HIV. Explain why a patient is usually given several different drugs at the same time.

(2)

The drugs could be resistant to previous drugs used by fighting. The virus may be resistant to one or more of them.

The different drugs attack different enzymes involved in the reproduction of viral DNA

(Total for Question 9 = 12 marks)

Examiner comments

There are two key ideas in the mark scheme for this part. This candidate correctly states that 'the virus may be resistant to one or more of them', but there is no reference to mutation of HIV. The answer therefore gains the second mark point only.

Mark awarded = 1.

Student answer B

(d) There are drugs that can be taken to reduce the reproduction of HIV. Explain why a patient is usually given several different drugs at the same time.

(2)

To maximise the chance of survival since one may be too weak on its own.

Examiner comments

This answer is too vague to be given credit and no specific mark points are included.

Mark awarded = 0.

Student answer C

(d) There are drugs that can be taken to reduce the reproduction of HIV.

Explain why a patient is usually given several different drugs at the same time.

(2)

There are different types of HIV and the drugs affect different steps in the reproduction process.

(Total for Question 9 = 12 marks)

~~HIV~~ This is because the HIV can mutate in a person and some of these might be resistant to one drug.

Examiner comments

Both mark points are included in this answer; there is an indication that HIV mutates and that it may be resistant to one drug.

Mark awarded = 2.

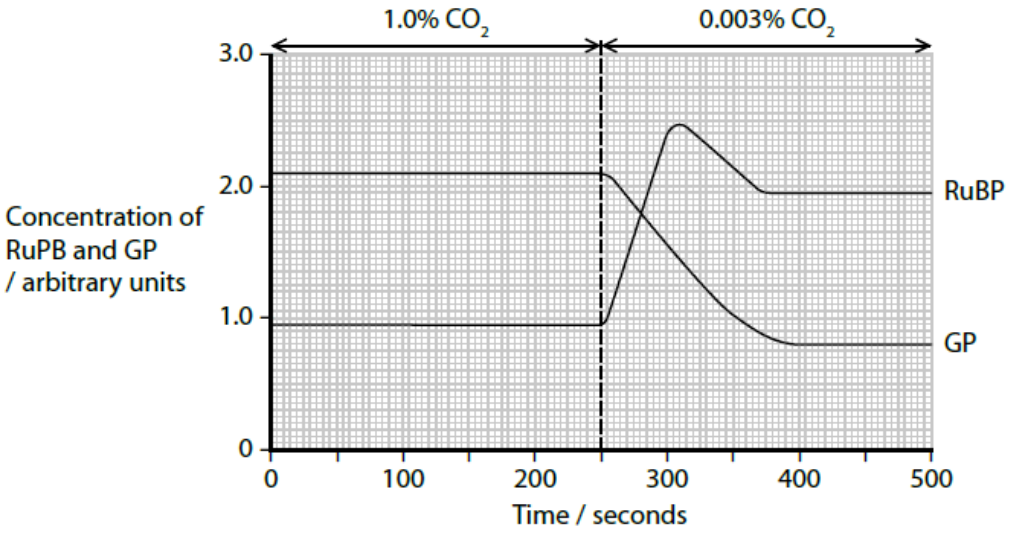
Exemplar question 3

10 An investigation was carried out into the effect of carbon dioxide concentration on photosynthesis.

Cells of a unicellular alga were suspended in a solution containing 1.0% carbon dioxide. After 250 seconds the carbon dioxide was changed to 0.003% CO_2.

The cells were illuminated with a bright light and some were removed at regular time intervals. The concentrations of ribulose bisphosphate (RuBP) and glycerate 3-phosphate (GP) in the cells were measured.

The graph below shows the results of the investigation.



(a) Explain why the cells were illuminated at a high light intensity during this investigation.

(3)

(b) (i) Analyse the data to explain the effect of carbon dioxide concentrations on the production of RuBP.

(4)

(ii) Analyse the data to explain the effect of carbon dioxide concentrations on the rate of production of GP.

(3)

(c) This investigation was carried out at 25 °C.

Explain the effect of lowering the temperature on the concentration of RuBP for the first 250 seconds of this investigation.

(3)

Markscheme

Question Number	Acceptable Answer	Additional guidance	Mark
10(a)	An explanation that makes reference to the following: • light (intensity) will not be a limiting factor (1) • therefore carbon dioxide (concentration) is (only) limiting factor (1) • so the effect of carbon dioxide concentration can be seen (1)	Accept: {ATP / NADPH / eq} produced during light dependent reactions	**(3)**

Question Number	Acceptable Answer	Additional guidance	Mark
10(b)(i)	An explanation that makes reference to four of the following: • reducing the carbon dioxide concentration causes the RuBP to increase (1) • (at higher carbon dioxide concentration) RuBP is low because it is converted to carbohydrate / used to fix carbon dioxide (1) • RuBP rises because being regenerated / eq (1) • RuBP falls as being used to {fix / eq} carbon dioxide (1) • RuBP level remains constant once (new) equilibrium reached (1)	Accept correct manipulation of figures Correct answer gains full marks	**(4)**

Question Number	Acceptable Answer	Additional guidance	Mark
10(b)(ii)	An explanation that makes reference to the following: • the rate of GP production falls for 150 s after carbon dioxide decreased (1) • drops because less carbon dioxide available to convert into GP / less carbon fixation / carbon dioxide is limiting / eq (1) • levels out at a lower level as carbon dioxide still available but at lower level (1)	Accept correct manipulation of figures Accept sophisticated answers based on reduction of photosynthesis	**(3)**

Question Number	Acceptable Answer	Additional guidance	Mark
10(c)	An explanation that makes reference to the following: • RuBP concentration would be lower (1) • because low temperature reduces activity of {RUBISCO / Calvin cycle} (1) • because there is less carbon dioxide fixation / less GP or GALP available to regenerate RuBP (1)	Accept sophisticated answers based on an initial increase in RuBP concentration	**(3)**

Student answers for part a)

Student answer A

(a) Explain why the cells were illuminated at a high light intensity during this investigation.

(3)

The main aim of this experiment is to investigate the effect of carbon dioxide concentration on photosynthesis. So the other factors like light, water ~~and~~ which will affect photosynthesis have to be more than enough to ensure that there is no other limiting factor than concentration of carbon dioxide.

Examiner comments

Although the first sentence is worded in a different way from the wording on the mark scheme, the purpose of the experiment is clear and this gains mark point 3. The second part of this answer makes it clear that light will not be a limiting factor, but carbon dioxide is a limiting factor and therefore gains mark points 1 and 2.

Mark awarded = 3.

Student answer B

(a) Explain why the cells were illuminated at a high light intensity during this investigation.

(3)

A lack of sunlight ~~affects~~ decreases the rate of the light dependent reaction

Bright light ensures that light intensity was not a limiting factor and any results ~~changes~~ were due to the change in CO_2

light intensity was a control factor

Examiner comments

This candidate makes it clear that light is not a limiting factor and that the effect of carbon dioxide can be seen. Therefore mark points 1 and 3 are awarded. The idea that carbon dioxide is a limiting factor is not explicit, so mark point 2 is not gained.

Mark awarded = 2.

Student answer C

(a) Explain why the cells were illuminated at a high light intensity during this investigation.

(3)

This allows light dependent reaction to occur. So ATP and NADPH from this process can be used in light independent reaction, so the Calvin Cycle will not cease.

Examiner comments

In the mark scheme, the additional guidance for this part includes credit for named products of the light-dependent reactions (ATP and reduced NADP). This answer, therefore, gains one mark.

Mark awarded = 1.

Student answers for part b) i)

Student answer A

(b) (i) Analyse the data to explain the effect of carbon dioxide concentrations on the production of RuBP.

(4)

increas [CO_2] results in more RuBP, but the [RuBP] only rises until there is no more GP.

Examiner comments

This answer does not explain the effect of carbon dioxide concentration on the production of RuBP; instead it gives an outline description of the changes in the concentration of RuBP.

Mark awarded = 0.

Student answer B

(b) (i) Analyse the data to explain the effect of carbon dioxide concentrations on the production of RuBP.

At 1% conc. of CO_2 RuBP stays fairly low, as plenty of CO_2 to bind to so saturated. At CO_2 levels ~~becomes~~ an increase of RuBP as less CO_2 ∴ more RuBP produced to bind ~~binding~~ with CO_2, decreases slightly then remains level at higher conc than before as equilibrium set up. higher conc. of less bound to CO_2.

Examiner comments

This answer includes mark points 2, 1 and 5, gaining 3 marks.

Mark awarded = 3.

Student answer C

(b) (i) Analyse the data to explain the effect of carbon dioxide concentrations on the production of RuBP.

(4)

At high concentrations of CO_2, the concentration of GP is high while the concentration of RuBP is low. This is because RuBP is being combined with the readily available CO_2, catalysed by Rubisco, to produce GP. Thus used up the RuBP present and builds up a store of GP. At low concentrations, the amount of RuBP present is increased because there is little CO_2 to react with so the concentration builds up.

Examiner comments

This candidate has included marks points 2 and 1 in the answer. There is also some irrelevant content on the changes in GP, for which there is no additional credit.

Mark awarded = 2.

Student answers for part b) ii)

Student answer A

(ii) Analyse the data to explain the effect of carbon dioxide concentration on the rate of production of GP.

(3)

At a high conc. of CO_2 (1%) the concentration of GP is at 2.1 (relatively high) but when the CO_2 % is decreased to 0.0003% the concentration of GP gradually falls ~~to~~ over 150 seconds to c. 1.8

Examiner comments

This answer gains mark point 1, for a description of the effect of carbon dioxide concentration on the rate of production of GP, but there is no attempt to explain this effect.

Mark awarded = 1.

Student answer B

(ii) Analyse the data to explain the effect of carbon dioxide concentration on the rate of production of GP.

(3)

Lots of GP is produced at high concentrations of CO_2 due to lots of reactions between CO_2 and RuBP. At low concentrations of CO_2 less GP is produced because there are less reactions between CO_2 and RUBP and so GP is getting converted to TP more.

Examiner comments

This answer includes mark point 2 only. For mark point 1, a time reference (or appropriate manipulation of figures) would need to be included.

Mark awarded = 1.

Student answer C

(ii) Analyse the data to explain the effect of carbon dioxide concentrations on the rate of production of GP.

(3)

At high CO_2 concentration lots of GP is produced because the Calvin cycle is going fast. When the carbon dioxide concentration is lowered less CO_2 fixation happens so less GP is produced from 250s to 375s. Then the level ~~is~~ is lower but constant because Calvin cycle is slower.

Examiner comments

This candidate has included mark point 2, and the description of the effect on the Calvin cycle also gains mark point 3 from the additional guidance. Mark point 1 has not been given because the time difference has not been calculated.

Mark awarded = 2.

Student answers for part c)

Student answer A

(c) This investigation was carried out at 25 °C.

Explain the effect of lowering the temperature on the concentration of RuBP for the first 250 seconds of this investigation.

(3)

Conc of RuBP would decrease
lower temp - reaction happens slower.

Examiner comments

This answer includes mark point 1, but for mark point 2, a specific reference to RUBISCO or the Calvin cycle is also expected.

Mark awarded = 1.

Student answer B

(c) This investigation was carried out at 25 °C.

Explain the effect of lowering the temperature on the concentration of RuBP for the first 250 seconds of this investigation.

RUBP concentration would decrease because RUBISCO enzyme ~~would~~ would not ~~be~~ ~~does~~ function as well. (3)

Examiner comments

This candidate has correctly indicated that the RuBP concentration decreases and has related this to the activity of RUBISCO, gaining mark points 1 and 2.

Mark awarded = 2.

Student answer C

(c) This investigation was carried out at 25 °C.

Explain the effect of lowering the temperature on the concentration of RuBP for the first 250 seconds of this investigation.

Rubisco catalyses the Calvin cycle at temperature effects enzyme activity (3)

Examiner comments

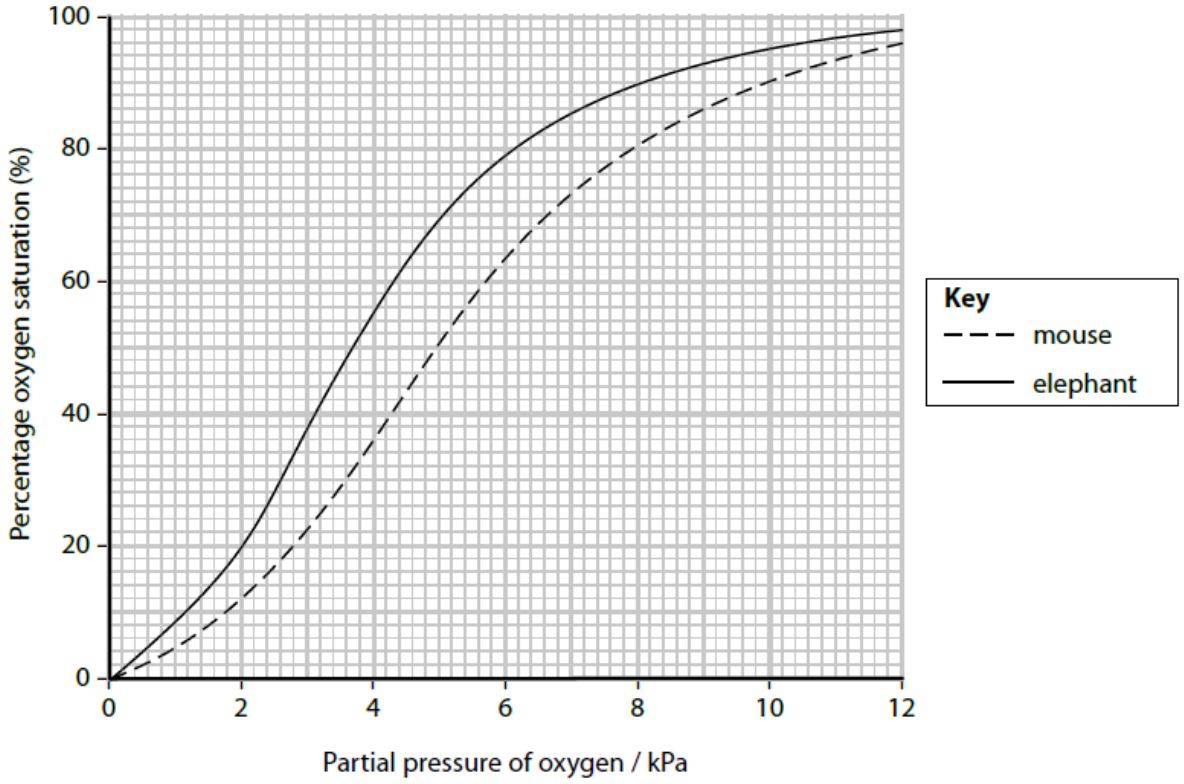
This answer is insufficiently accurate to be given credit, because there is no mention of the effect of temperature on RuBP concentration, or on reduced activity of RUBISCO or the Calvin cycle.

Mark awarded = 0.

Paper 2: Advanced Physiology, Evolution and Ecology

Exemplar question 1

6 The graph below shows the oxygen haemoglobin dissociation curves for a blood sample from an elephant and a mouse.



*(b) Explain the effect that body size has on the metabolic rate of these two mammals.

(6)

Markscheme

Question Number	Indicative content	
6(b)*	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant • Dissociation curve for mouse haemoglobin is to the right of the curve for elephant haemoglobin • Mouse haemoglobin has a lower affinity for oxygen • Mouse haemoglobin allows more dissociation • Mouse has bigger surface area to volume ratio • Mouse loses more heat / needs to regenerate more heat • Maintenance of body temperature • Mouse has higher metabolic rate • Mouse needs more oxygen • Accept converse answers for elephant	
Level	Mark	Descriptor
	0	No awardable content
Level 1	1-2	Demonstrates isolated elements of biological knowledge and understanding to the given context with generalised comments made. The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context.
Level 2	3-4	Demonstrates adequate knowledge and understanding by selecting and applying some relevant biological facts/concepts to provide the explanation being presented. Lines of argument occasionally supported through the application of relevant evidence (scientific ideas,

		processes, techniques and procedures). The explanation shows some linkages and lines of reasoning with some structure.
Level 3	5-6	Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of biological facts/concepts to provide the explanation being presented. Line(s) of argument supported throughout by sustained application of relevant evidence (scientific ideas, processes, techniques and procedures). The explanation shows a well-developed and sustained line of reasoning which is clear, coherent and logically structured.

Student answers for part b)

Student answer A

(b)* Explain the effect that body size has on metabolic rate of these two mammals.

(6)

Aerobic respiration releases heat.

Aerobic respiration also requires oxygen.

Mouse lose heat faster as it has high sa:volume ratio

∴ it has a higher metabolic rate.

(small body size ⇒ high sa:vol ratio)

Examiner comments

This candidate has correctly related body size to surface area : volume ratio, heat loss and metabolic rate, linking ideas with lines of reasoning. This justifies a level 2 response and a mark of 4 (just). For level 3, candidates are expected to relate these principles to the relative demand for oxygen and to apply this to the dissociation curves for the two mammals.

Mark awarded = 4.

Student answer B

(b)* Explain the effect that body size has on metabolic rate of these two mammals.

(6)

Elephant has very large body size ∴ needs more O_2 ,
so at lower partial pressures, it has a greater saturation
of O_2 in blood , as needs more O_2 to travel around the
body as larger. Less dissociation needed as small SA to Volume ratio so lower metabolic rate
Mice are a lot smaller therefore use less energy to move, so
at lower pressures don't need as high a saturation of O_2 in
the blood , so dissociates quicker as have higher metabolic rate
as need to generate more body heat as have a larger SA
to volume ratio.

Examiner comments

This answer is not well expressed and lacks overall coherence. It does, however, include some relevant information on the relative surface area and volume ratios and metabolic rate. This is a level 1 answer, with some basic information and some attempt to link knowledge and understanding.

Mark awarded = 2.

Student answer C

*(b) Explain the effect that body size has on the metabolic rate of these two mammals.

(6)

A smaller mammal like a mouse has a higher metabolic rate than an elephant. This is because it has a larger surface area to volume ratio. This means that it will lose heat faster and need to have a higher rate to release produce heat energy. This heat comes from the breakdown of glucose in respiration. So the mouse will need to get oxygen more efficiently.

Examiner comments

This is a well-developed answer with a sustained line of reasoning, putting it into level 3. If the answer had included an explanation of how the mouse obtains oxygen 'more efficiently', with reference to the dissociation curves, a mark of 6 would be justified.

Mark awarded = 5.

Paper 3: General and Practical Principles in Biology

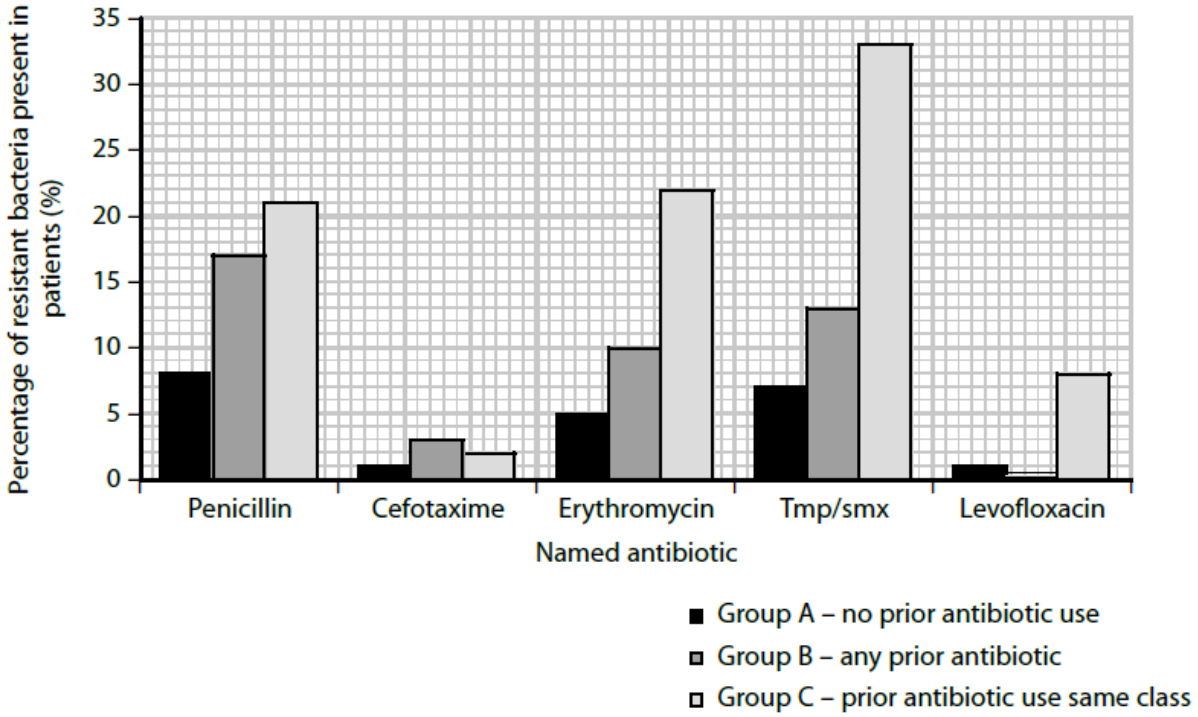
Exemplar question 1

9 Antibiotics have been developed to control bacterial infections.

*(c) Bacterial resistance to common antibiotics is an increasingly serious problem facing doctors treating a wide range of infections.

The graph below shows the percentage of resistant bacteria in patients being treated with antibiotics for *Streptococcus pneumoniae* infections.

Group A had never been given antibiotics.
Group B had been previously treated with other antibiotics.
Group C had been previously treated with the named antibiotic.



Analyse the data and use your knowledge of antibiotic resistance to evaluate the claim that soon doctors will be unable to treat most common bacterial infections with antibiotics.

(9)

Markscheme

Question Number	Indicative content
***9(c)**	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. Candidates are expected to reach a decision/conclusion on whether the development of bacterial resistance is so serious and rapid that antibiotics will become ineffective in the treatment of the majority of bacterial infections. • Prior use of antibiotics increases the percentage of resistant bacteria, supported by quantitative data • Prior use of the named antibiotic has the greatest effect, supported by quantitative data • Increasing use of antibiotics increases selection pressures so more resistant strains • Shows understanding that resistance mechanisms are inherited by sexual means and lateral gene transfer, e.g. via plasmids and this means they can spread rapidly and in some cases across species • Bacteria have high reproduction rates and mutations more likely within a short time • Understands current methods used to limit increase in resistant strains such as strict controls on antibiotic prescribing, problems of ensuring patients complete course of treatment when symptoms disappear, limit use of antibiotics in animal husbandry etc. • Comments on difficulties of developing new drugs • Methods of preventing spread of resistant strains especially hospital infection • Movement of humans means that transfer of resistant strains will spread to new hosts more easily

Level	Mark	Descriptor
	0	No awardable material
Level 1	1-3	Provides little or no reference to a range of scientific ideas, processes, techniques and procedures. Scientific argument may be attempted, but fails to link biological concepts and/or ideas in order to support decision/conclusion. Limited attempt to address the question.
Level 2	4-6	Scientific reasoning occasionally supported through the linkage of a range of scientific ideas, processes, techniques and procedures. Scientific argument is partially developed. Attempts to synthesise and integrate relevant knowledge with linkages to biological concepts and/or ideas, leading to a notional scientific argument or decision/conclusion based on evidence.
Level 3	7-9	Scientific reasoning supported throughout by sustained linkage of a range of scientific ideas, processes, techniques or procedures. Scientific argument is well developed and logical. Demonstrating throughout the skills of synthesising and integrating relevant knowledge with consistent linkages to biological concepts and/or ideas, leading to nuanced and balanced scientific argument or decision/conclusion based on evidence.

Student answers for part c)

Student answer A

Analyse the data and use your knowledge of antibiotic resistance to evaluate the claim that soon doctors will be unable to treat most common bacterial infections with antibiotics.

(9)

In general, patients have higher resistant bacteria if they have used same class antibodies before, the most obvious one is Tmp which 36 % of resistance bacteria is in the patients. ~~There are still~~. Patients ~~not~~ still have resistance bacteria even if they did not use antibiotic before, the highest percentage in result will b Tmp again with 16%.

The results shows the bacteria mutate easily ~~th~~ and with antibodies, bacterias mutate by natrual selection. ~~B~~ ~~Muto~~Random mutation occurs in some bacteria ~~that~~ survive ~~did not die~~ ~~&~~ but those did not die ~~but survive~~. They multiply themselves by binary fission and replicate rapidly. ~~This is~~ After several generation, all bacteria is replaced by the mutated one which is resist to that antibody so there is a high possibility that ~~be~~ common bacterial infection soon cannot be treat by antibodies.

Examiner comments

There is some relevant information in this answer, but it is generally inaccurate, with references to, for example, antibodies instead of antibiotics and the statement that 'bacteria mutate by natural selection'. The account lacks overall coherence, as the ideas are not carefully linked together. This is a level 1 answer and a mark of 3 (just) is appropriate as there is some use of quantitative data.

Mark awarded = 3.

Student answer B

Analyse the data and use your knowledge of antibiotic resistance to evaluate the claim that soon doctors will be unable to treat most common bacterial infections with antibiotics.

(9)

(9)

There are still resistant bacteria present ~~even~~ after the treatment of antibiotics. The bacteria can always ~~must~~ mutate of (developing resistance) ~~it~~. They can exchange genetic information with other bacteria with ~~it~~ (antibiotic resistance).

Examiner comments

This answer is very limited in its content, with only one theme of mutation and exchange of genetic information. The account lacks breadth and detail, showing a limited attempt to address the question and to link biological concepts to support a conclusion. This is a level 1 answer and a mark of 1 is appropriate.

Mark awarded = 1.

Student answer C

Analyse the data and use your knowledge of antibiotic resistance to evaluate the claim that soon doctors will be unable to treat most common bacterial infections with antibiotics.

(9)

The data shows that even those patients that haven't used ~~bacd~~ antibiotics have resistant bacteria. This must be because they are present in the environment due to mutations. In bacteria mutations can occur on ~~plastids~~ plasmids which are made up of nucleic acids. These ~~plastids~~ plasmids can be exchanged between bacteria in a type of sexual reproduction. So more bacteria can have the resistance genes and bacteria reproduce very quickly. TMP has ~~be~~ the greatest % at 53% in total and Cefotaxime has the lowest at 7% in total.

The data shows that there are higher percentages of resistant bacteria for all the antibiotics if the patient has used the antibiotic before.

So from this graph it seems that eventually none of these antibiotics will be used to treat bacterial infections. But new antibiotics are being produced and any six of them are shown here so it might be possible. Other methods of treatment and hygiene procedures could be developed.

Examiner comments

This is a level 3 answer, which includes most of the indicative content. Comments are supported with references to quantitative data. The answer has an overall coherence, with a clear, sustained argument leading to a judgement related to the stated claim. A mark of 9 is appropriate for this answer.

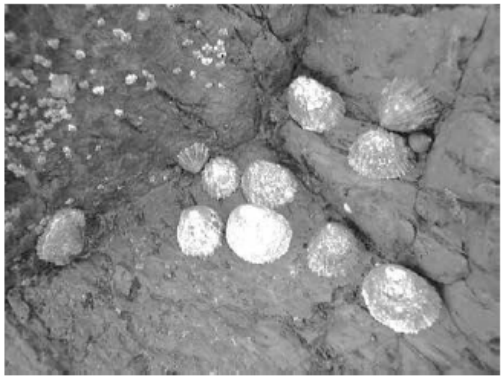
Mark awarded = 9.

Exemplar question 2

13 The photograph below shows limpets *Patella vulgata* living on a rocky seashore.

Limpets are snail-like animals with a conical shell. The limpets live on a part of the shore which is covered by the sea twice each day. They feed on algae when the rocks are covered with sea water.

When they are uncovered at low tide they clamp against the rock to prevent desiccation.



A student investigated the relationship between the size of the limpets and their location on the shore.

A 40 m transect was used, beginning at the low water mark and extending up a sloping rocky shore. A 1 m^2 quadrat was placed every 5 m along this transect and the diameter of 10 randomly selected limpets was measured.
The table below shows data collected from this investigation.

Distance from low water mark / m	Rank of distance	Mean diameter of limpets / mm	Rank of diameters	Difference in the two ranks (D)	D^2
0	9	19.8	3	6	36
5	8	20.2	1	7	49
10	7	19.6	4	3	9
15	6	18.8	5	1	1
20	5	20.1	2	3	9
25	4	17.4	6	−2	4
30	3	16.1			
35	2	16.9	8	−6	36
40	1	17.2			

(a) Complete the table on the previous page to show the missing data.

(2)

(c) The student carrying out the investigation wrote a further hypothesis:

'The limpets lower on the shore have a longer time to feed and will grow bigger.'

Design a laboratory experiment to test this hypothesis.

(5)

Markscheme

<table>
<tr><th>Question Number</th><th>Correct Answer</th><th>Additional guidance</th><th>Mark</th></tr>
<tr><td>13(a)</td><td>
<table>
<tr><th>Distance from low water mark / m</th><th>Rank of distance</th><th>Mean diameter of limpets / mm</th><th>Rank of diameters</th><th>Difference in the two ranks (D)</th><th>D^2</th></tr>
<tr><td>0</td><td>9</td><td>19.8</td><td>3</td><td>6</td><td>36</td></tr>
<tr><td>5</td><td>8</td><td>20.2</td><td>1</td><td>7</td><td>49</td></tr>
<tr><td>10</td><td>7</td><td>19.6</td><td>4</td><td>3</td><td>9</td></tr>
<tr><td>15</td><td>6</td><td>18.8</td><td>5</td><td>1</td><td>1</td></tr>
<tr><td>20</td><td>5</td><td>20.1</td><td>2</td><td>3</td><td>9</td></tr>
<tr><td>25</td><td>4</td><td>17.4</td><td>6</td><td>-2</td><td>4</td></tr>
<tr><td>30</td><td>3</td><td>16.1</td><td>9</td><td>-6</td><td>36</td></tr>
<tr><td>35</td><td>2</td><td>16.9</td><td>8</td><td>-6</td><td>36</td></tr>
<tr><td>40</td><td>1</td><td>17.2</td><td>7</td><td>-6</td><td>36</td></tr>
<tr><td colspan="5">ΣD^2 =</td><td>216</td></tr>
</table>

differences in ranks of distance and diameter (1)
D^2 values correct (1)

</td><td></td><td>(2)</td></tr>
</table>

Question Number	Correct Answer	Additional guidance	Mark
13(c)	An answer that makes reference to five of the following: • limpets kept in sea-water in tanks at the same {temperature / salinity} as they affect growth (1) • suitable number of {limpets in each tank / tanks containing limpets} to ensure reliability (1) • size of limpets in each tank selected to be within (narrow) range to start / or same distribution of sizes to ensure same potential for growth (1) • provision of food for limpets in equal amounts in each tank as food affects growth (1) • withdrawal of water from tanks for different periods of time (1) • size measured {mass / diameter / area of foot} because dependent variable must be quantitative to allow for statistical testing (1)		**(5)**

Student answers for part a)

Student answer A

Distance from low water mark / m	Rank of distance	Mean diameter of limpets / mm	Rank of diameters	Difference in the two ranks (D)	D^2
0	9	19.8	3	6	36
5	8	20.2	1	7	49
10	7	19.6	4	3	9
15	6	18.8	5	1	1
20	5	20.1	2	3	9
25	4	17.4	6	-2	4
30	3	16.1	9	- 6	36
35	2	16.9	8	-6	36
40	1	17.2	7	- 6	36

Examiner comments

The table has been completed correctly, gaining both mark points.

Mark awarded = 2.

Student answer B

Distance from low water mark / m	Rank of distance	Mean diameter of limpets / mm	Rank of diameters	Difference in the two ranks (D)	D^2
0	9	19.8	3	6	36
5	8	20.2	1	7	49
10	7	19.6	4	3	9
15	6	18.8	5	1	1
20	5	20.1	2	3	9
25	4	17.4	6	-2	4
30	3	16.1	9	- 6	36
35	2	16.9	8	-6	36
40	1	17.2	7	6	36

Examiner comments

Mark point 1 has not been awarded, because one of the values for D is shown as 6, rather than -6. This answer does, however, gain mark point 2.

Mark awarded = 1.

Student answers for part c)

Student answer A

(c) The student carrying out the investigation wrote a further hypothesis:

'The limpets lower on the shore have a longer time to feed and will grow bigger.'

Design a laboratory experiment to test this hypothesis.

(5)

Set up five sea water tanks containing the young same number of limpets and rocks with enough algae. The limpets should be the same size or measure their area or mass. Each tank will have the seawater in it for a different length of time each day e.g. 24 hours, 12 hours, 6 hours, 3 hours, 1 hour. The tanks will be kept going in the same conditions of temperature and oxygen concentration for a number of weeks and then the limpets will be measured again. The change in area or mass is then plotted against time of feeding and the correlation coefficient calculated.

(Total for Question 13 = 13 marks)

Examiner comments

This answer includes several points relating to experimental design. However, it is important to note that most of the points on the mark scheme need to be qualified with a justification to gain credit. To illustrate this, the first sentence of this answer refers to setting up five tanks of sea water. This is the first part of mark point 2, but it is expected that candidates will justify this in terms of ensuring reliability. There are also references to supplying algae, using limpets of the same size and maintaining the same temperature for the experiment. All of these points need to be qualified, to be given credit.

The answer states that 'each tank will have the sea water in it for a different length of time each day, e.g. 24 hours, 12 hours, 6 hours, 3 hours, 1 hour.' This is acceptable for mark point 5 (withdrawal of water from tanks for different periods of time). The last sentence includes a reference to calculating a correlation coefficient, but this needs to be clearly related to the collection of quantitative data for the dependent variable.

Mark awarded = 1.

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