Example Candidate Responses

Cambridge International AS & A Level

Cambridge International AS & A Level Biology

9700

Cambridge Advanced

Version 2.0
Updated: 16.02.16

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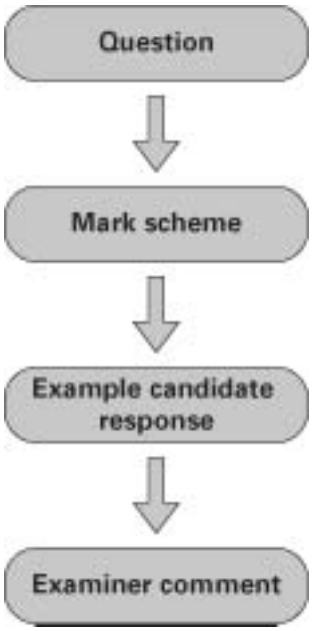
Introduction

The main aim of this booklet is to exemplify standards for those teaching Cambridge International AS and A Level Biology (9700), and to show how different levels of candidates' performance relate to the subject's curriculum and assessment objectives.

In this booklet a range of candidate responses has been chosen as far as possible to exemplify grades A, C and E. Each response is accompanied by a brief commentary explaining the strengths and weaknesses of the answers.

For ease of reference the following format for each component has been adopted:



Each question is followed by an extract of the mark scheme used by examiners. This, in turn, is followed by examples of marked candidate responses, each with an examiner comment on performance. Comments are given to indicate where and why marks were awarded, and how additional marks could have been obtained. In this way, it is possible to understand what candidates have done to gain their marks and what they still have to do to improve their grades.

Past papers, Principal Examiner Reports for Teachers and other teacher support materials are available on http://teachers.cie.org.uk

Assessment at a glance

Paper	Type of Paper	Duration	Marks	Weighting	
				AS Level	A Level
1	Multiple Choice	1 hour	40	31%	15%
2	AS Structured Questions	1 hour 15 min	60	46%	23%
3	Advanced Practical Skills 1/2	2 hours	40	23%	12%
4	A2 Structured Questions	2 hours	100		38%
5	Planning, Analysis and Evaluation	1 hour 15 min	30		12%

Teachers are reminded that a full syllabus is available on www.cie.org.uk

Paper 2 – AS Structured Questions

Question 1(a)

1 Protein production involves a complex sequence of events and a number of cell structures.

(a) The first column in Table 1.1 shows some of the events that occur in the production of a protein in a cell and its eventual release from the cell.

Table 1.1

event	sequence of events (numbers)	cell location (letters)
exocytosis		
protein modification		
secretory vesicle formation		
transcription		
translation		

(i) In Table 1.1, write the sequence in which the events occur, using **1** as the **first** process in the sequence. [2]

(ii) From the list **A** to **F** below, choose **one** cell location for each event and write the letter in Table 1.1. Each letter may be used once, more than once, or not at all.

A Golgi apparatus
B lysosome
C nucleus
D rough endoplasmic reticulum
E smooth endoplasmic reticulum
F plasma (cell surface) membrane [3]

Mark scheme

1 (a) (i) transcription first process and exocytosis final process ;
correct order for remaining three processes (3, 4, 2) ;
accept words and mixture of words and letters [2]

(ii)

F ;
A / D
A ;
C
D ;

events	order of events	cell location (letter)	
exocytosis	**5**	**F**	cell membrane ;
protein modification	**3**	**A / D** **A+D**	Golgi and/or RER ,
secretory vesicle formation	**4**	**A**	Golgi ;
transcription	**1**	**C**	nucleus ,
translation	**2**	**D**	RER ;

[3]

Example candidate response – grade A

event	sequence of events (numbers)	cell location (letters)
exocytosis	5	F
protein modification	3	A
secretory vesicle formation	4	A
transcription	1	C
translation	2	D

Examiner comment – grade A

This candidate has shown a good understanding of the meaning of the various terms in the 'event' column and has then applied this to work out the sequence of events that would occur. The terms were from sections A (Cell Structure), D (Cell membranes and Transport) and G (Transport) of the syllabus. The correct cell location of the different events shows a good knowledge of the functions of the various cell structures (from section A of the syllabus). This candidate has been able to think sequentially about the whole process.

Example candidate response – grade C

event	sequence of events (numbers)	cell location (letters)
exocytosis	5	F ✓
protein modification	3	A
secretory vesicle formation	4	B ✗
transcription	1	C
translation	2 ✓	D ✓

Examiner comment – grade C

This candidate has correctly worked out the sequence of events, demonstrating a good understanding of the meaning of the terms, but has mistakenly thought that secretory vesicles were formed by the lysosome. Knowledge of the various roles of the Golgi apparatus is only partial.

Example candidate response – grade E

event	sequence of events (numbers)	cell location (letters)
exocytosis	5	F
protein modification	3	E
secretory vesicle formation	4	A
transcription	2	D
translation	1	C

Examiner comment – grade E

This candidate is not clear about the difference between transcription and translation, which may also have led to the incorrect identification of the cell structures in **(ii)**. There are gaps in knowledge of the functions of the various cell structures (syllabus section A), with the mark gained for the location of exocytosis, which is a link to section D.

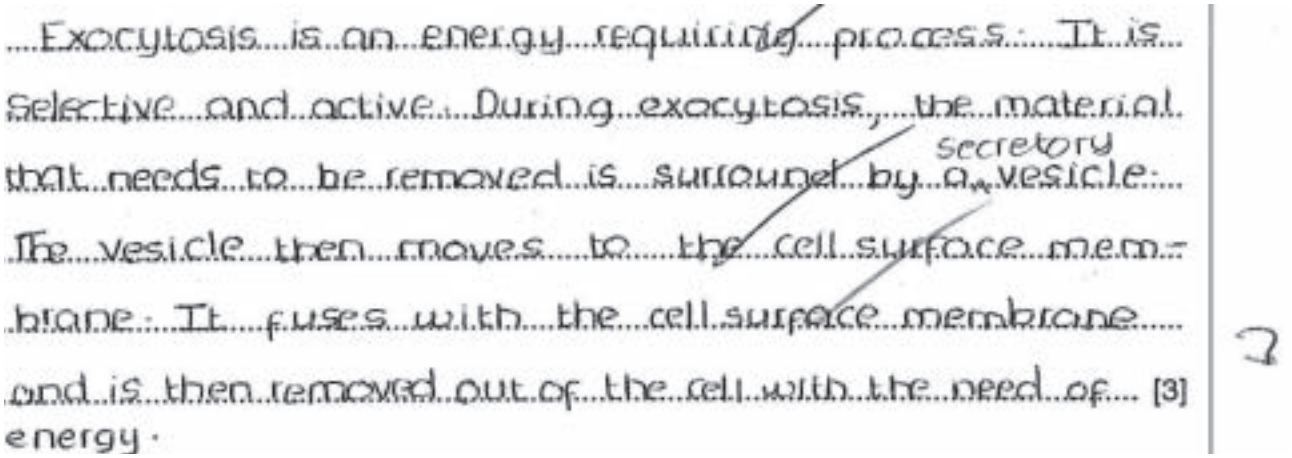
Question 1(b)

(b) Describe the process of *exocytosis*.

Mark scheme

(b) **1** vesicle / vacuole, moves towards, cell, surface / membrane ;
A plasma membrane **R** if lysosome
2 fusion / described, of vesicle with membrane ; **R** attach / bind / combine
3 ref. to (fluid nature of) phospholipids ;
4 contents / AW, secreted / released / exported / removed / emptied / excreted ;
A waste material / digested material
5 active process / energy-requiring / ATP used / AW ;
R 'active transport' **R** endocytosis [max 3]

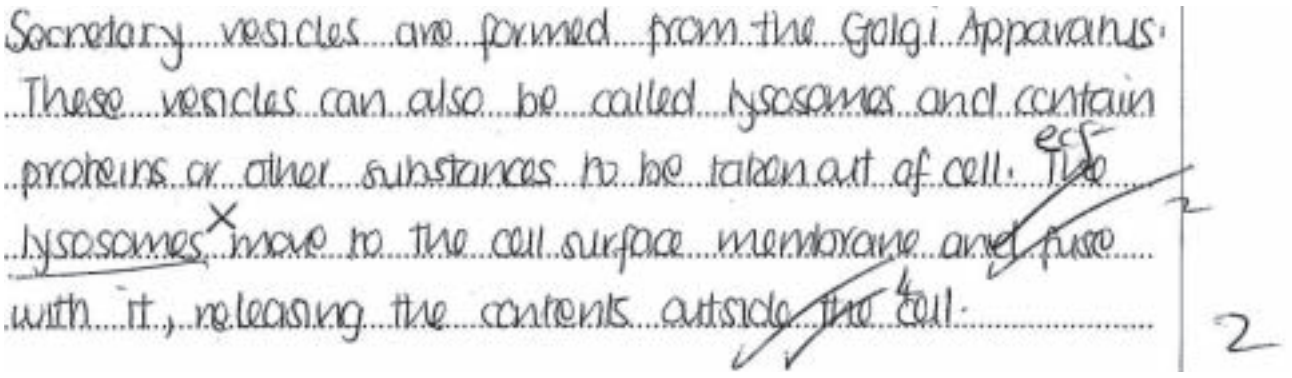
Example candidate response – grade A


Exocytosis is an energy requiring process. It is selective and active. During exocytosis, the material that needs to be removed is surrounded by a secretory vesicle. The vesicle then moves to the cell surface membrane. It fuses with the cell surface membrane and is then removed out of the cell with the need of energy. [3]

Examiner comment – grade A

This candidate has gained maximum marks by giving three of the five available mark points. There are no contradictory statements and a sequential account is clearly given. To have improved this response, the candidate should have avoided the vague nature of the final part of the response, where it was not obvious what was 'removed out of the cell'.

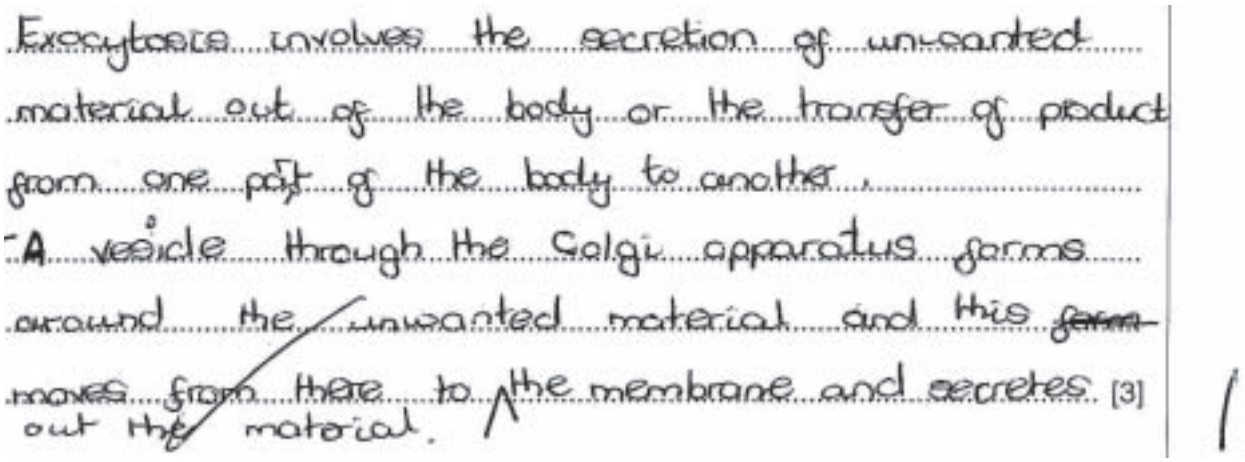
Example candidate response – grade C


Secretary vesicles are formed from the Golgi Apparatus. These vesicles can also be called lysosomes and contain proteins or other substances to be taken out of cell. The lysosomes move to the cell surface membrane and fuse with it, releasing the contents outside the cell.

Examiner comment – grade C

This candidate has shown a good understanding of the process of exocytosis. However, knowledge of the difference between secretory vesicles and lysosomes has not been demonstrated, by mistakenly thinking that lysosomes move to the cell surface membrane, and so the third mark was not awarded.

Example candidate response – grade E


Exocytosis involves the secretion of unwanted material out of the body or the transfer of product from one part of the body to another.
A vesicle through the Golgi apparatus forms around the unwanted material and this forms moves from there to the membrane and secretes out the material. [3]

Examiner comment – grade E

The second paragraph of this response demonstrates some knowledge of the process of exocytosis. The candidate knew that the vesicle moved, but needed to state which membrane was involved and hence did not give sufficient detail. A mark was given, to the benefit of the candidate who used the term 'unwanted', for the idea that waste material was released. The first paragraph contains no correct information, with the candidate stating that material was secreted 'out of the body' instead of 'out of the cell'. This mistake probably would have been spotted and corrected by the candidate if they had checked their response.

Question 1(c)

(c) One example of protein modification is the removal of the first amino acid, methionine, from a newly formed polypeptide chain to make a functioning protein.

(i) The DNA nucleotide sequence that specifies the amino acid methionine is TAC.

State the mRNA nucleotide sequence that is complementary to the DNA sequence for methionine.

..... [1]

(ii) Suggest **two** other ways in which the polypeptide chain is modified to produce the functioning protein.

.....

.....

.....

..... [2]

Mark scheme

(c) (i) AUG ; [1]

(ii)
1 secondary structure / α-helix / β-(pleated) sheet ;
2 tertiary structure / description / folding / complex 3D shape ;
3 formation of named bond(s) ; **R** if peptide bond in list
4 quaternary structure / description (e.g. assembly of polypeptides) ;
5 glycosylation / formation of glycoproteins / addition of carbohydrate(s) *or* sugar(s) ;
R hydrocarbon chain
6 addition of, non-protein portion(s) / prosthetic group(s) / named example ;
A haem / iron / Fe / copper / Cu / magnesium / Mg / AW
7 removal of some amino acids ; **R** one amino acid
8 polypeptide(s) cut into two or more pieces ;
9 AVP ; e.g. ref. to exposure to water molecules and folding
R ref. to amino acids coded for by stop codons [max 2]

Example candidate response – grade A

(i) The DNA nucleotide sequence that specifies the amino acid methionine is TAC.

State the mRNA nucleotide sequence that is complementary to the DNA sequence for methionine.

AUG ✓ [1]

(ii) Suggest **two** other ways in which the polypeptide chain is modified to produce the functioning protein.

→ The polypeptide chain folds to give the tertiary structure of the protein.

→ A carbohydrate portion can be added to the polypeptide chain ✓ [2]

Examiner comment – grade A

In **(i)** the candidate has correctly applied knowledge of the complementary base pairing rules and has remembered that thymine is replaced with uracil in RNA nucleotides. In **(ii)**, the candidate has used arrows to indicate the two different suggestions. Each of these suggests an acceptable modification to the transcribed polypeptide chain that would enable function. The first suggestion comes from the candidate's knowledge of levels of protein structure. The second suggestion could have come from knowledge of glycoproteins that occur as components of the cell surface membrane.

Example candidate response – grade C

(i) The DNA nucleotide sequence that specifies the amino acid methionine is TAC.

State the mRNA nucleotide sequence that is complementary to the DNA sequence for methionine.

AUG [1]

(ii) Suggest **two** other ways in which the polypeptide chain is modified to produce the functioning protein.

Addition of carbohydrates to the peptide chain. Further genetic code is degenerative. A stop codon is reached on the peptide chain shortening the chain and therefore producing a functional protein. [2]

Base substitution can also occur. tRNA synthetase will read the codon on mRNA and accordingly attach an amino acid at the tRNA's amino acid binding site. [Total: 11]

Examiner comment – grade C

In **(i)**, the candidate shows knowledge and understanding of base-pairing during transcription. A good start has been made in **(ii)** to gain a mark, but this is followed by the suggestion (given in the next two sentences that follow) that the chain is shortened, which does not correspond to the idea of a functioning protein. The remaining information does not answer the question. Note that even if there is a correct suggestion within this additional information, no credit can be given as the first two suggestions only will be marked.

Example candidate response – grade E

(c) One example of protein modification is the removal of the first amino acid, methionine, from a newly formed polypeptide chain to make a functioning protein.

(i) The DNA nucleotide sequence that specifies the amino acid methionine is TAC.

State the mRNA nucleotide sequence that is complementary to the DNA sequence for methionine.

AUG [1]

(ii) Suggest **two** other ways in which the polypeptide chain is modified to produce the functioning protein.

During semi-conservative replication, okazaki fragments may change the intended structure of DNA so the mRNA translates a different codon producing a variant amino acid.

Examiner comment – grade E

This candidate has correctly applied knowledge from section F (Genetic Control) of the syllabus to give the correct codon for methionine. The candidate has not understood what was required for **(ii)** or may have not fully read the question, which wanted suggestions for modification to produce the *functioning* protein. Here the candidate answers from the point of view of mutation and gains no marks.

Question 2(a)

2 Malaria is an infectious disease that is considered by the World Health Organization to be a disease of worldwide importance.

(a) Explain what is meant by the term *infectious*.

.....

.....

.....

..... [2]

Mark scheme

2 (a) communicable / transmissible / contagious / transferable / AW ;
A passed from one (infected), host / organism / one person, to another
A 'passed on'

caused by, a pathogen / microorganism / *at least* **two** named types of pathogen ;
A virus, bacterium, fungus, protoctist, worm ;
R parasite unqualified by two types [max 2]

Example candidate response – grade A

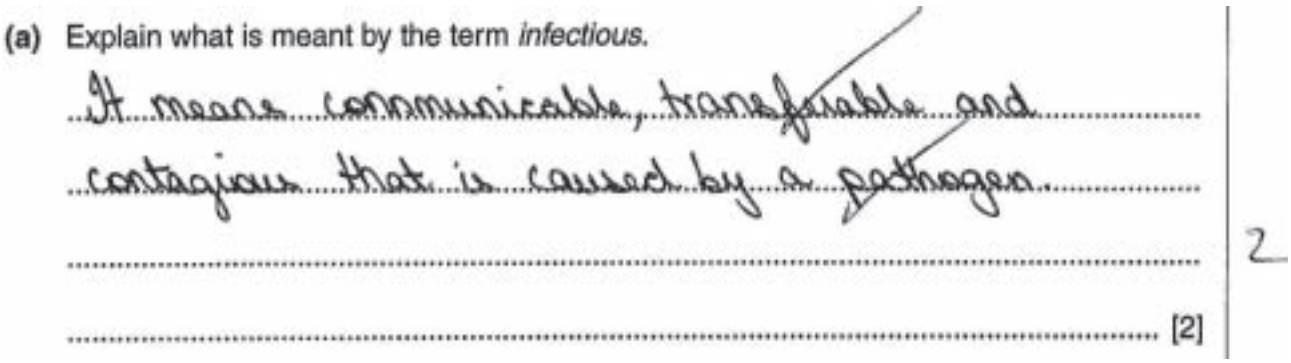
(a) Explain what is meant by the term *infectious*.

Infectious means that a disease caused by a pathogen which is communicable or transmittable from an infected person to an uninfected person [2]

Examiner comment – grade A

This candidate has an excellent understanding of the term *infectious*, including knowledge of pathogens and qualifying the terms communicable and transmissible to be assured of maximum marks.

Example candidate response – grade C


(a) Explain what is meant by the term *infectious*.

It means communicable, transferable and contagious that is caused by a pathogen

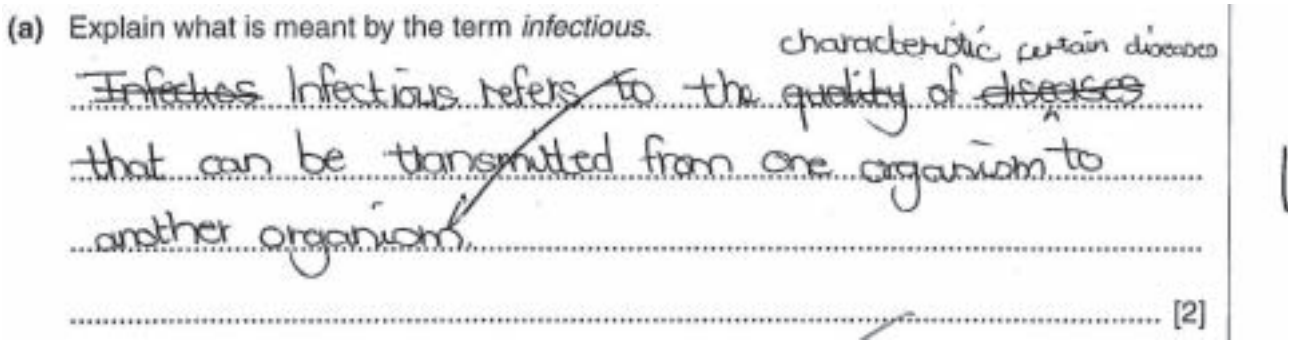
2

[2]

Examiner comment – grade C

This candidate uses the correct scientific terminology and shows a good understanding of the term *infectious*.

Example candidate response – grade E


(a) Explain what is meant by the term *infectious*.

Infectious Infectious refers to the quality of characteristic certain diseases that can be transmitted from one organism to another organism

[2]

Examiner comment – grade E

The candidate gained one mark for understanding and explaining that infectious diseases are transmissible. To gain the additional mark, knowledge of pathogens was expected.

Question 2(b)

(b) Name **one** species of organism that causes malaria.

..... [1]

Mark scheme

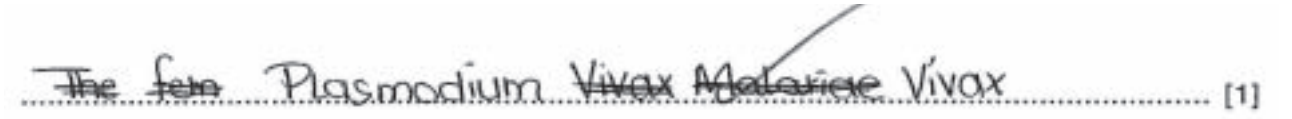
(b) *Plasmodium*, *falciparum / ovale / vivax / malariae* ;
A phonetic spellings for specific name, **A** plasmodium
R if specific name first, [1]

Example candidate response – grade A

Examiner comment – grade A

The candidate has given a species name, correctly spelt and with an upper case for the first letter of the generic name and a lower case first letter for the epithet. As the candidate has used their normal handwriting, they have underlined the species name (usually seen in print in italics).

Example candidate response – grade C



Examiner comment – grade C

The candidate has given a species name, correctly spelt, the right way round, and with an upper case for the first letter of the generic name. To improve, the specific epithet should have had a lower case first letter rather than upper case. Any one of the four species of *Plasmodium* could have been given, so *Plasmodium malariae*, which the candidate crossed out, would also have been acceptable.

Example candidate response – grade E

Examiner comment – grade E

The candidate has correctly avoided naming the vector of the parasite, *Anopheles*, which is a common mistake, but has not answered the question fully as only the genus name for the causative organism has been given, and so no mark awarded.

Question 2(c)

(c) Explain the significance of the following statements in the control of malaria.

(i) The female *Anopheles* mosquito has been more closely studied with regard to malaria than the male *Anopheles* mosquito.

.....

..... [1]

(ii) The infective stages of the malarial organism are present in anti-coagulant produced by the mosquito.

.....

..... [1]

(iii) After circulating in the blood for a short time, the pathogen enters liver cells of the newly infected person and then enters red blood cells.

.....

.....

.....

..... [2]

Mark scheme

(c) (i) (only) female feeds on blood / male does not feed on blood ;
female requires blood (protein) for (development of) eggs ;
(only) female carries, pathogen / disease-causing organism / *Plasmodium* / parasite ;
A (only) female transmits the disease
(only) female is vector ; ***ora*** ***ignore*** female carries, the disease / malaria [max 1]

(ii) anti-coagulant (in saliva) is passed when mosquito, sucks blood / feeds / bites / takes a blood meal ;
anti-coagulant prevents blood clotting when mosquito, sucks blood / feeds / bites / takes a blood meal ; [max 1]

(iii) *in marking accept*
Plasmodium / pathogen / causative organism / malarial organism *where parasite is given below*

short time (in blood plasma)
for exposure to cells of the immune system / AW ;

next stage(s) of life cycle inside cells ;
A sporozoites into merozoites in liver /
merozoites into schizonts in red blood cells

parasite gains, food / energy, from cells ;
parasite, reproduces / multiplies, inside (liver / red blood) cells ;
damage to / bursting of / lysis of / impaired function of, cells ;

(antimalarial) drugs cannot penetrate (liver / red blood) cells ;
parasite, concealed / 'hides', from host immune system ;
A antigen concealment ;

no symptoms, until parasite leaves cells / while parasite is in cells ;
idea that people incubating disease are symptomless ;
A symptomless carriers
idea that treatment unlikely to prevent spread from infected person ;

AVP ; *examples*
different stages provide problems with drug / vaccine development
AVP ; mode of action of potential drugs – block attachment sites on cells
parasite in blood cells allows testing by taking blood samples
further development of any idea given above [max 2]

Example candidate response – grade A

(c) Explain the significance of the following statements in the control of malaria.

(i) The female *Anopheles* mosquito has been more closely studied with regard to malaria than the male *Anopheles* mosquito.

The female Anopheles is a vector for malaria and not the male [1]

(ii) The infective stages of the malarial organism are present in anti-coagulant produced by the mosquito.

The anti-coagulant prevents the blood from clotting when the mosquito sucks blood [1]
So the organism passes into the blood.

(iii) After circulating in the blood for a short time, the pathogen enters liver cells of the newly infected person and then enters red blood cells.

The pathogen matures in the liver cells and then enters red blood cells where they stay, reproduce and hide from phagocytes [2]

2

Examiner comment – grade A

The candidate gave a considered response for part **(c)**, skilfully relating the statements given to the mode of transmission of malaria in **(i)** and **(ii)**, and problems with control of the disease in **(iii)**. This response used the correct scientific terminology and explained well the significance of each statement, providing good evidence of knowledge of the transmission cycle of the disease.

Example candidate response – grade C

(c) Explain the significance of the following statements in the control of malaria.

(i) The female *Anopheles* mosquito has been more closely studied with regard to malaria than the male *Anopheles* mosquito.

Take blood protein to produce her eggs

[1]

1

(ii) The infective stages of the malarial organism are present in anti-coagulant produced by the mosquito.

Plasmodium gameles ~~diffuse~~ fuse in the gut of the mosquido to form infective stages and then deliver to the salivery gland of mosquito. [1]

0

(iii) After circulating in the blood for a short time, the pathogen enters liver cells of the newly infected person and then enters red blood cells.

In the liver cells infective stages develop into the plasmodium, where ~~late~~ they find place to develop. Then enter red blood cells, where they reproduce and multiply and when leave red blood cell, ~~that~~ destroy [2]

2

Examiner comment – grade C

The intention of the question has been understood and well-attempted by the candidate, especially with a clear response in **(iii)**. The response given in **(i)**, by noting '…her eggs' did confirm understanding, but could have been improved with a comparative sentence to make it clear that only the female *Anopheles* mosquito was involved in the disease. In **(ii)**, the candidate made a good start to the response, but did not link back to the anticoagulant and transmission to the uninfected person.

Example candidate response – grade E

(c) Explain the significance of the following statements in the control of malaria.

(i) The female *Anopheles* mosquito has been more closely studied with regard to malaria than the male *Anopheles* mosquito.

The females are the ones that carry the plasmodium being
& are the main cause of malaria hence their studied. [1]

(ii) The infective stages of the malarial organism are present in anti-coagulant produced by the mosquito.

infected
The mosquito regurgitates the anticoagulant which contains
the plasmodium pathogen which is now in the victim's blood stream [1]

(iii) After circulating in the blood for a short time, the pathogen enters liver cells of the newly infected person and then enters red blood cells.

..... [2]

Examiner comment – grade E

Part **(iii)**, which does require more thought and is a challenging question for candidates at the grade E standard, has not been attempted by this candidate. This may have been a good strategic decision if the candidate realised that too much time might be taken up trying to work out what was required as an answer. However, the candidate clearly had a good overview of aspects of the disease and mode of transmission and if a few factual points had been given, one of the many available mark points may well have been highlighted.

Question 2(d)

(d) Discuss the factors that determine the distribution of malaria worldwide. [4]

Mark scheme

(d) *if virus / bacterium / disease used instead mark to max 3*
in marking accept
Plasmodium / pathogen / causative organism / malarial organism *where parasite is given below*

distribution described for one mark

either
(mainly in) tropics / between the tropics
or
any **two** named, areas and/or countries, affected ;
e.g. *areas* (sub-Saharan) Africa, Central America, South America, South Asia, Central Asia, Middle East, Caribbean
e.g. *countries* India, Sri Lanka, China, Vietnam, Cambodia, Brazil, Kenya

discussion to max four

1 (areas where) both parasite, **and**, vector / mosquito / Anopheles, are present ;
2 Anopheles / mosquito / vector, survives / breeds / lives, in, hot and humid areas / moist tropical areas ; ***ora*** **A** standing / stagnant, water

3 parasite, needs to reproduce within the mosquito (at temperatures above 20°C) ;

4 eradicated in some countries / any e.g. (USA, Italy) ;

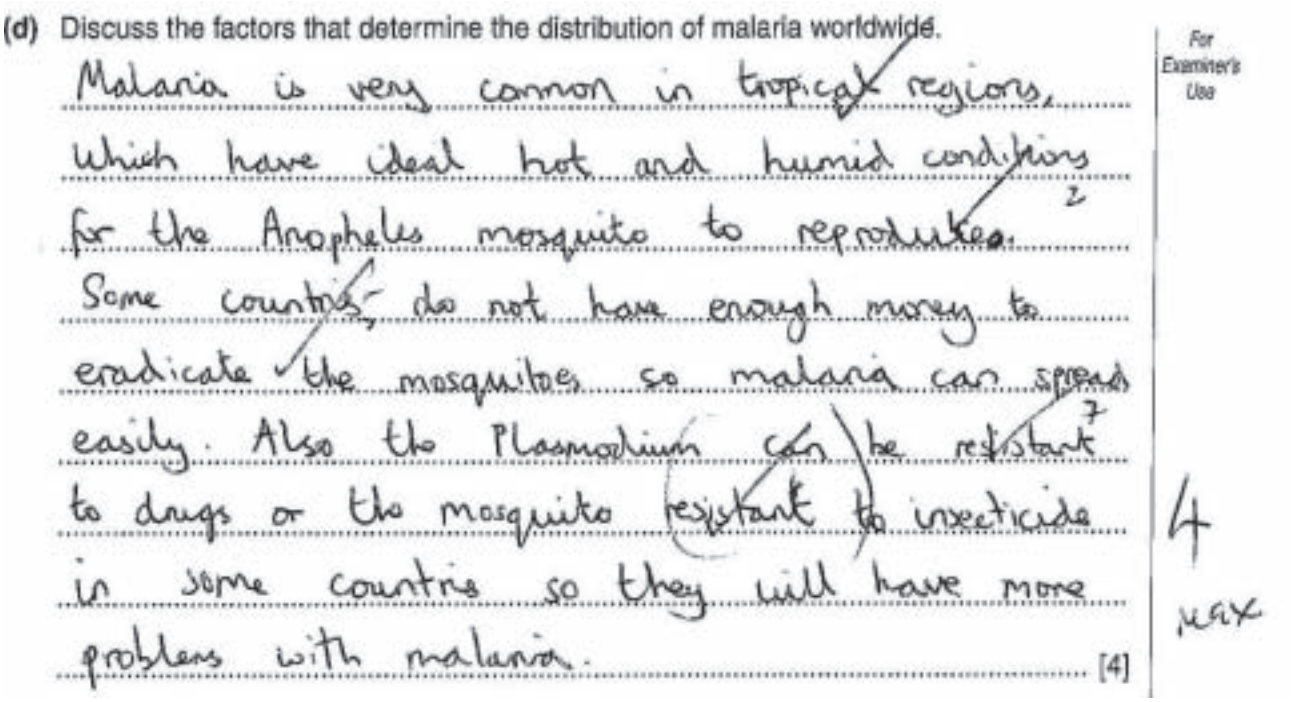
5 ref to LEDCs and, poor / non-existent, control programmes ;
A poor health facilities / poor drug supplies / AW

6 mosquitoes resistant to, DDT / insecticides / pesticides ;
7 parasite resistant to, chloroquine / drugs ;

8 link between human population density and *Anopheles* ;
e.g. human activity provides (lots of) breeding sites for *Anopheles*
9 occurs where named high risk group(s) exist ;
e.g. refugees, HIV-positive pregnant women (more likely to pass HIV to unborn children), (young) children
10 (outside tropics) disease spread by, travellers / tourists / migrants / refugees ;

11 AVP ;
most cases / over 90% cases, in (sub-Saharan) Africa
not, at high altitude / in deserts
different species of *Plasmodium* differ in geographical distribution / AW
misdiagnosis (so not reported)
changing pattern linked to, global warming / changes in land use / deforestation / irrigation / other relevant named
R references to sickle cell [max 4]

Example candidate response – grade A



(d) Discuss the factors that determine the distribution of malaria worldwide.

Malaria is very common in tropical regions, which have ideal hot and humid conditions for the Anopheles mosquito to reproduce. Some countries do not have enough money to eradicate the mosquitoes so malaria can spread easily. Also the Plasmodium can be resistant to drugs or the mosquito resistant to insecticide in some countries so they will have more problems with malaria. [4]

For Examiner's Use

2 7 4 MAX

Examiner comment – grade A

The candidate has organised their response so that it is easy to identify relevant mark points. The response begins by pointing out the regions affected most by malaria and explaining why this is so. There is no confusion between *Anopheles*, the vector, and *Plasmodium*, the causative organism. Reasons as to why some areas have a higher incidence of the disease are also discussed. The candidate has been able to gain maximum marks within the lines provided.

Example candidate response – grade C

(d) Discuss the factors that determine the distribution of malaria worldwide.

For Examiner Use

A hot and humid environment is necessary for plasmodium to reproduce in the female anopheles mosquito. Mosquitos are resistant to antimalarial drugs, bodies of water where the mosquito lay eggs may be small causing difficulty in detecting them. In addition, poor medical facilities will result in the malarial distribution. There is no proper vaccine to cure the disease as plasmodium completes its life cycle in two host cells and each stage has a different antigen. In addition, there is antigenic concealment in the liver and the RBCs. Consequently, there is no world wide vaccine. Antibiotics cannot cure this disease as they interfere with prokaryotic metabolism. There is high migration rate. [4]

[Total: 11]

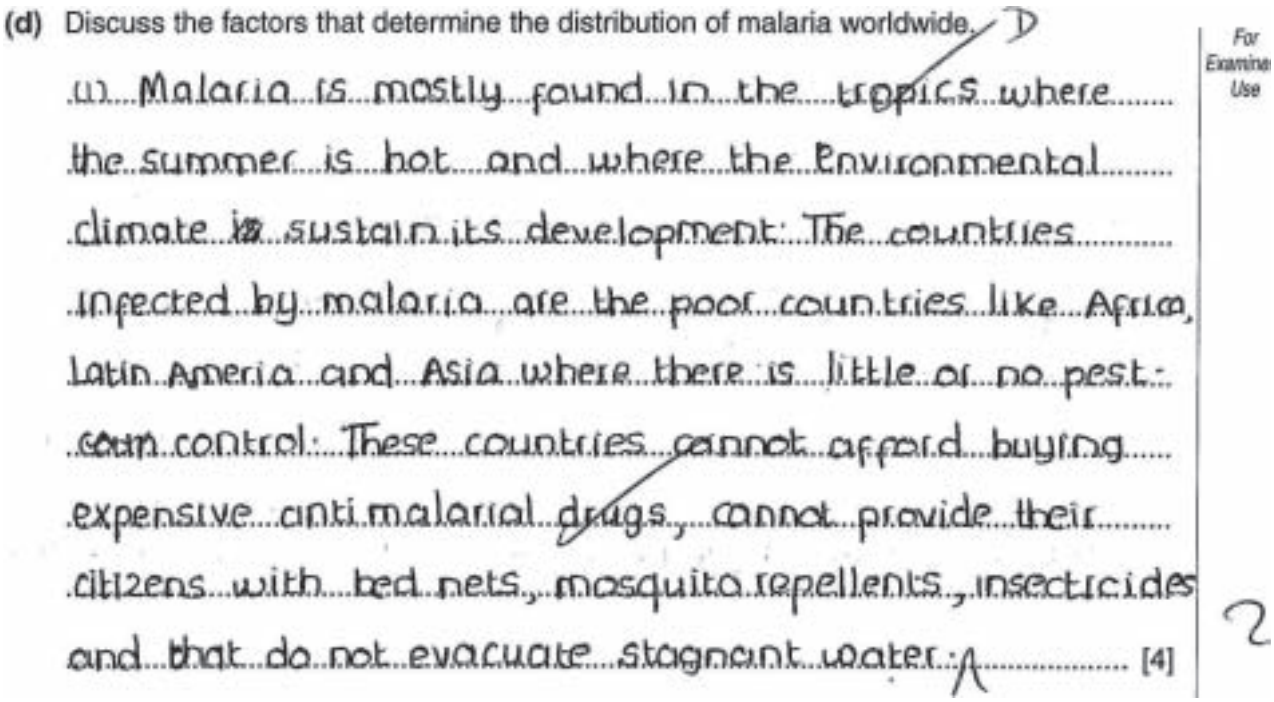
7

3

Examiner comment – grade C

This candidate has begun well, answering directly the question about factors determining distribution of the disease and after stating 'Mosquitos are resistant to antimalarial drugs..', they have gained three out of the four marks. There are no mistakes within these points and appropriate scientific terminology, including organism names, has been used. The response then switches emphasis and discusses problems with the control of malaria, which was not required. The candidate has quite small writing and does not need to fill all the lines given, let alone extend beyond the printed lines. The final sentence may have been worthy of the final mark point if it had been qualified further.

Example candidate response – grade E



(d) Discuss the factors that determine the distribution of malaria worldwide. D

(a) Malaria is mostly found in the tropics where the summer is hot and where the Environmental climate is sustain its development. The countries infected by malaria are the poor countries like Africa, Latin America and Asia where there is little or no pest control. These countries cannot afford buying expensive anti malarial drugs, cannot provide their citizens with bed nets, mosquito repellents, insecticides and that do not evacuate stagnant water. [4]

For Examiner Use

2

Examiner comment – grade E

The candidate has outline knowledge of the disease and has gained two marks for a general statement of the distribution of the disease and a relevant reference to LEDCs (less economically developed countries). It is not clear whether the candidate understands the relationship between the mosquito, the parasite and reasons for their particular global distribution.

Question 3(a)

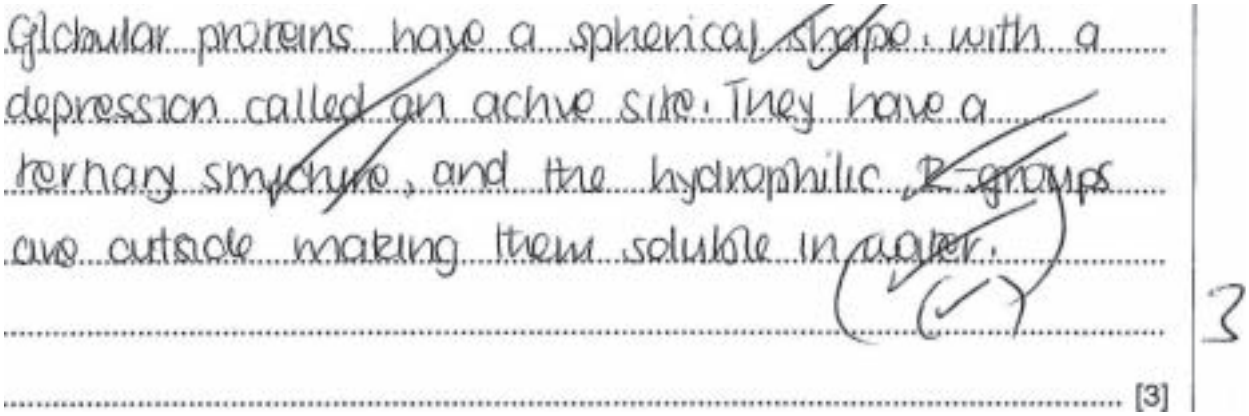
3 (a) Enzymes are globular proteins that catalyse metabolic reactions.

Describe the features of globular proteins. [3]

Mark scheme

3 (a) spherical / ball-shaped / AW ; **A** round(ed) / circular
has tertiary structure ; **R** 3D
hydrophilic / polar, (R) group(s), on outside / face to watery exterior ;
hydrophobic / non-polar, (R) group(s), in centre ;
water soluble ; [max 3]

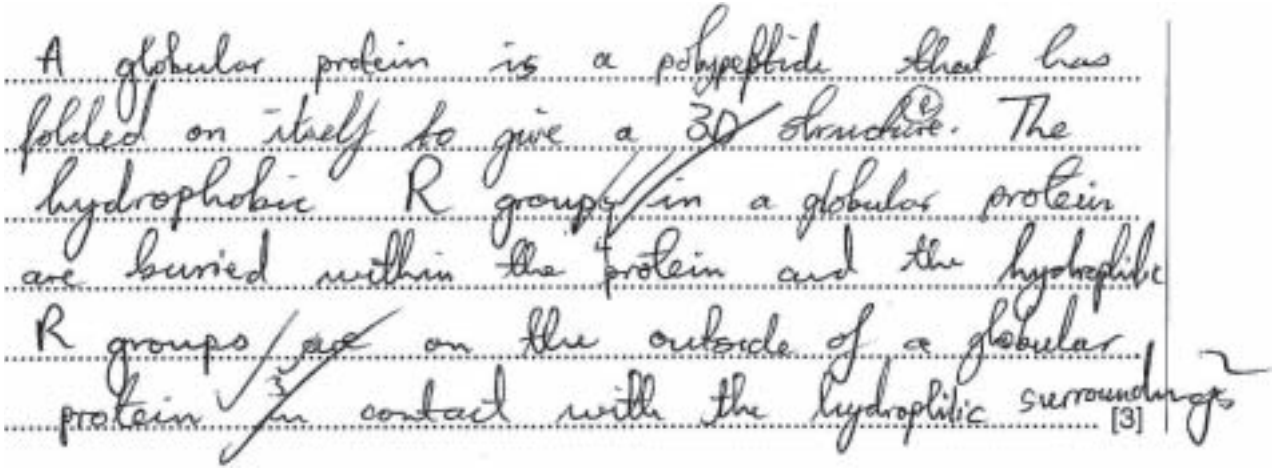
Example candidate response – grade A



Examiner comment – grade A

The candidate has produced a confident answer, giving four mark points for a maximum of three marks and only needing to use four lines. The use of the scientific terms 'spherical', 'tertiary', 'hydrophilic' and 'R-groups' is in the correct context and is evidence of good understanding of the meaning of the term 'globular' in relation to proteins.

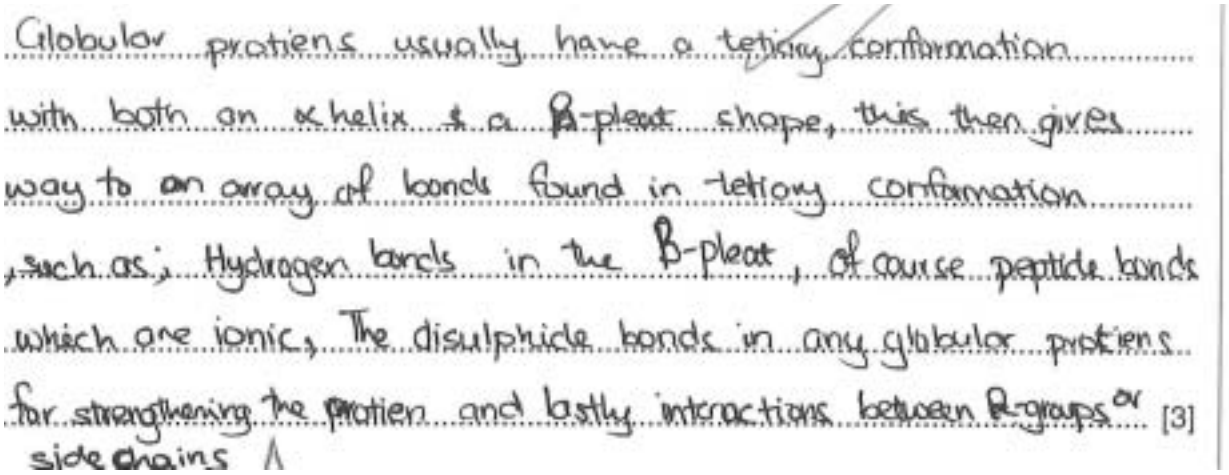
Example candidate response – grade C



Examiner comment – grade C

This candidate has not had difficulty in deciding what was required in the response and has written quite a lot in order to gain two marks. The overall approximate shape of the protein could easily have been included to give the third mark. This account could have been more concise and should have used terminology appropriate to proteins, that is, *tertiary structure*, rather than '3D structure'.

Example candidate response – grade E


Globular protiens usually have a tetiary conformation with both an α helix & a β-pleat shape, this then gives way to an array of bonds found in tetiary conformation such as; Hydrogen bonds in the β-pleat, of course peptide bonds which are ionic, The disulphide bonds in any globular protiens for strengthening the protien and lastly interactions between R-groups or side chains [3]

Examiner comment – grade E

The candidate has gained one of the available three marks for an acceptable alternative description of tertiary structure. There is an attempt to give a general account of protein structure: there is some confusion between secondary and tertiary protein organisation, but in any case this area was not being assessed. An understanding of the difference between globular and fibrous proteins would have helped to give a full account of the features of globular proteins.

Question 3(b)

(b) Enzymes can be used to remove cell walls from plant and fungal cells. The cells are incubated in a solution that contains a mixture of enzymes.

(i) Suggest an explanation for the fact that a different mixture of enzymes is required to remove the walls of plant cells compared to the walls of fungal cells. [2]

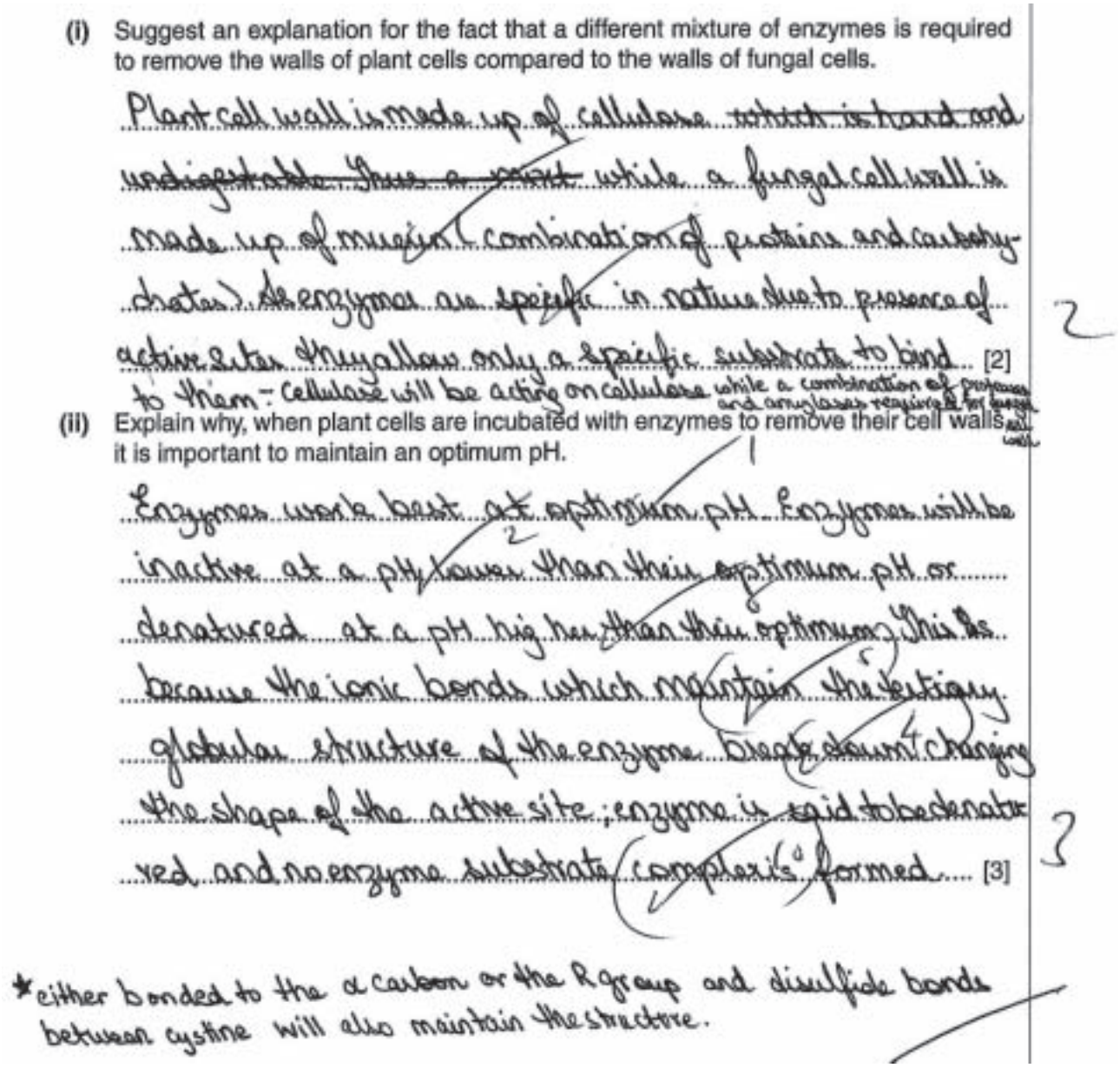
(ii) Explain why, when plant cells are incubated with enzymes to remove their cell walls, it is important to maintain an optimum pH. [3]

Mark scheme

(b) (i) *idea that plant cell walls and fungal cell walls have different components*
fungal cell walls made of, glucans / chitins / fungal cellulose / different components to plant cell walls ; **A** peptidoglycan / murein
A plant cell walls contain cellulose, but fungi do not
idea of specificity in context of question
enzymes are specific ;
A specificity explained e.g. both substrates not complementary / shape of active site specific to one substrate [2]

(ii)
1 (at optimum pH) maximum / peak, activity ; **A** most efficient / works best
2 above / below, optimum, activity declines ;
A description / graph sketched with pH and rate / activity
3 changing pH changes hydrogen ion concentration ;
4 hydrogen / ionic, bonds (between amino acids), break / disrupted ;
5 hydrogen / ionic, bonds, important in maintaining shape of, tertiary structure / active site ;
R 4 and **5** if refer to disulfide, hydrophobic interactions, peptide
at sub-optimum pH
6 active site / tertiary, shape altered ; **A** enzyme denatured
7 charges at the active site may be affected ;
8 further detail ; e.g. transfer of electrons may not be possible
9 the substrate may be altered by pH changes ; **R** cell wall unqualified
10 (therefore) substrate no longer fits / ES complexes not formed ; [max 3]

Example candidate response – grade A



(i) Suggest an explanation for the fact that a different mixture of enzymes is required to remove the walls of plant cells compared to the walls of fungal cells.

Plant cell wall is made up of cellulose which is hard and undigestable. Thus a ~~yeast~~ while a fungal cell wall is made up of murein (combination of proteins and carbohydrates) the enzymes are specific in nature due to presence of active sites which allows only a specific substrate to bind to them: Cellulase will be acting on cellulose while a combination of proteases and amylases required for fungal cell wall. [2]

(ii) Explain why, when plant cells are incubated with enzymes to remove their cell walls, it is important to maintain an optimum pH.

Enzymes work best at optimum pH. Enzymes will be inactive at a pH lower than their optimum pH or denatured at a pH higher than their optimum. This is because the ionic bonds which maintain the tertiary globular structure of the enzyme breaks down changing the shape of the active site; enzyme is said to be denatured and no enzyme substrate complexes formed. [3]

*either bonded to the α carbon or the R group and disulfide bonds between cystine will also maintain the structure.

Examiner comment – grade A

For this theoretical practical situation, the candidate has skilfully applied knowledge and understanding of different sections of the syllabus, in particular section C (enzymes) to gain maximum marks. In **(i)**, from an understanding that enzymes are specific in nature, the candidate was able to deduce that fungal and plant cell walls must be composed of different substances, if different mixtures of enzymes are used for their digestion. As this was a 'suggest' question and candidates were not required to know the chemical nature of the fungal cell wall, the correct idea was not negated by the suggestion that the fungal wall is composed of murein. This substance is the only other one within the confines of the syllabus that is different to the plant cellulose cell wall, so it was a sensible suggestion from the candidate. In **(ii)** the candidate gives a fluent, factual account of the importance of maintaining an optimum pH for enzyme action, and has covered more than enough points to gain the available marks.

Example candidate response – grade C

(i) Suggest an explanation for the fact that a different mixture of enzymes is required to remove the walls of plant cells compared to the walls of fungal cells.

Enzymes are specific in action. Hence enzyme concerned with the digestion of cellulose will not act on any other substrate as their active site is only specific for one substrate only. Thus next different mixture of enzymes will be required. [2]

(ii) Explain why, when plant cells are incubated with enzymes to remove their cell walls, it is important to maintain an optimum pH.

This is because enzyme activity is affected by pH. Extremes pH results in the H^+ ions interacting with the R-groups of the enzyme. Thus disrupting the structure of the enzyme. The shape of the active site is no longer the same and enzymes are denatured. [3]

Examiner comment – grade C

On reading the response it seems evident that the candidate appears to have a good knowledge and understanding of the topic areas covered by this question, and has not made any errors. However, in **(i)** the candidate has made the mistake of not qualifying the initial statement by stating some basic points: that plant cell walls are made of cellulose and that this means that fungal cell walls must be composed of a different substance. In **(ii)**, the same style has been used: more detail would have resulted in more marks. Considerable thought and planning is required for both **(i)** and **(ii)** before giving a written response.

Example candidate response – grade E

(i) Suggest an explanation for the fact that a different mixture of enzymes is required to remove the walls of plant cells compared to the walls of fungal cells.

Plant cell walls are made of cellulose and probably it has inhibitors that can slow down enzyme action, and prevent E/S complexes from forming, for some enzymes, hence a mixture lowers the chances of that happening. [2]

6

(ii) Explain why, when plant cells are incubated with enzymes to remove their cell walls, it is important to maintain an optimum pH.

Because Each type of enzyme functions best at its optimum pH. Therefore, in order to keep the enzymes actively working, optimum pH must be maintained.

[3]

1

Examiner comment – grade E

This response is an attempt to answer the question: 'Suggest an explanation for the fact that a mixture of enzymes is required to remove the walls of plant cells'. It is important to read through each question twice before answering.

For **(ii)** this candidate gained the introductory mark for knowledge of the term *optimum* and did not attempt to give more detailed information about the effect on enzymes above or below the optimum. More knowledge of the details regarding the effect of pH on enzyme action was required.

Question 3(c)

(c) A student carried out an investigation into osmosis using red blood cells.

Red blood cells were placed in sodium chloride (salt) solutions at five different concentrations. For each concentration, a sample was added immediately to a microscope slide and the cells were viewed using a light microscope for a period of time. The observations recorded are shown in Table 3.1.

Table 3.1

concentration of salt solution/%	observation of red blood cells
0.0	swell and burst, numbers decrease
0.4	increase in size
0.9	remain the same size
1.5	decrease in size
3.0	smaller and shrivelled

Explain, in terms of **water potential** and osmosis, the results that the student obtained. [4]

Mark scheme

(c) osmosis, defined in terms of water potential / used in correct context ;
0% and / or 0.4%
higher / less negative, water potential outside so water enters ;

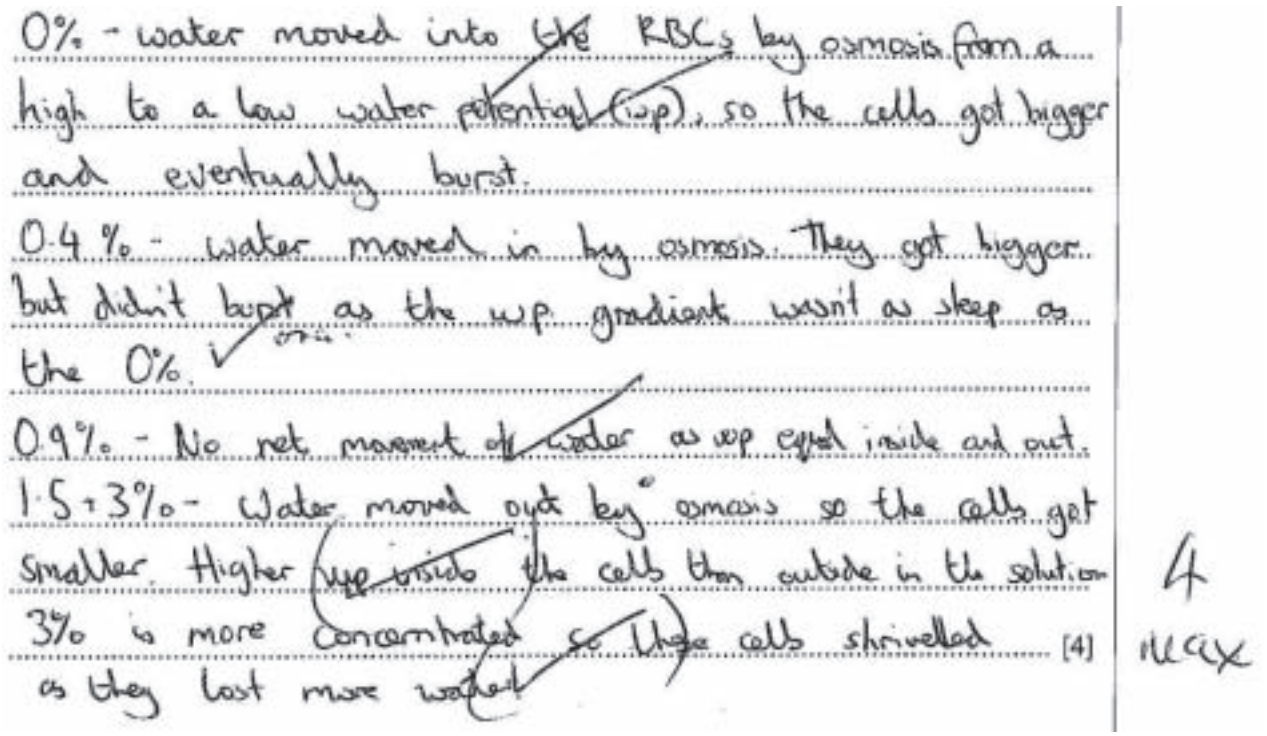
0%, higher / less negative, water potential than 0.4%, so cells burst ; *ora*

0.9%
equal / same, water potential inside and outside cells, water in = water out ;
A no net movement of water / ref. to isotonic / no water potential gradient
R 'no osmosis' / no movement of water

1.5% and / or 3.0%
lower / more negative, water potential outside so water moves out ;

3.0%, lower / more negative, water potential than 1.5% so cells, smaller / AW ; [max 4]

Example candidate response – grade A


0% - water moved into the RBCs by osmosis from a high to a low water potential (w.p.), so the cells got bigger and eventually burst.

0.4% - water moved in by osmosis. They got bigger but didn't burst as the w.p. gradient wasn't as steep as the 0%.

0.9% - No net movement of water as w.p. equal inside and out.

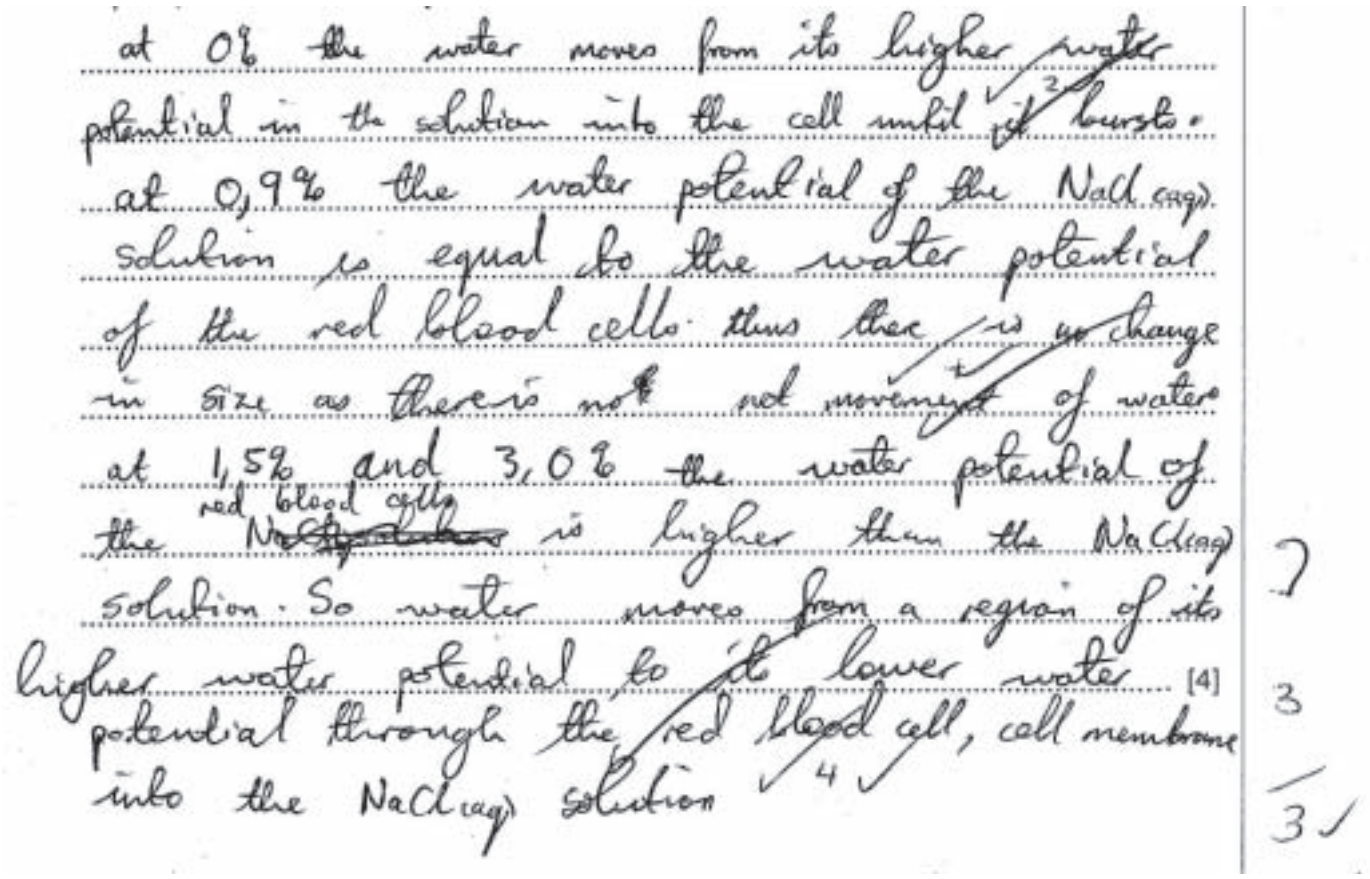
1.5+3% - Water moved out by osmosis so the cells got smaller. Higher w.p. inside the cells than outside in the solution. 3% is more concentrated so these cells shrivelled as they lost more water. [4]

4 MAX

Examiner comment – grade A

The candidate has consistently used the correct terminology, as instructed, throughout their response and has compared the differences in water potential inside and outside of the red blood cells in order to explain the movement of water. There is a clear structure to the answer, with each result being fully explained and comparisons made between 0% and 0.4% and between 1.5% and 3.0% salt solutions. To save time the candidate has used 'w.p.' for water potential and has indicated this in the first sentence, which is acceptable. 'RBCs' for red blood cells was also acceptable in this instance as the candidate was clear as to the direction of movement into or out of 'cells'.

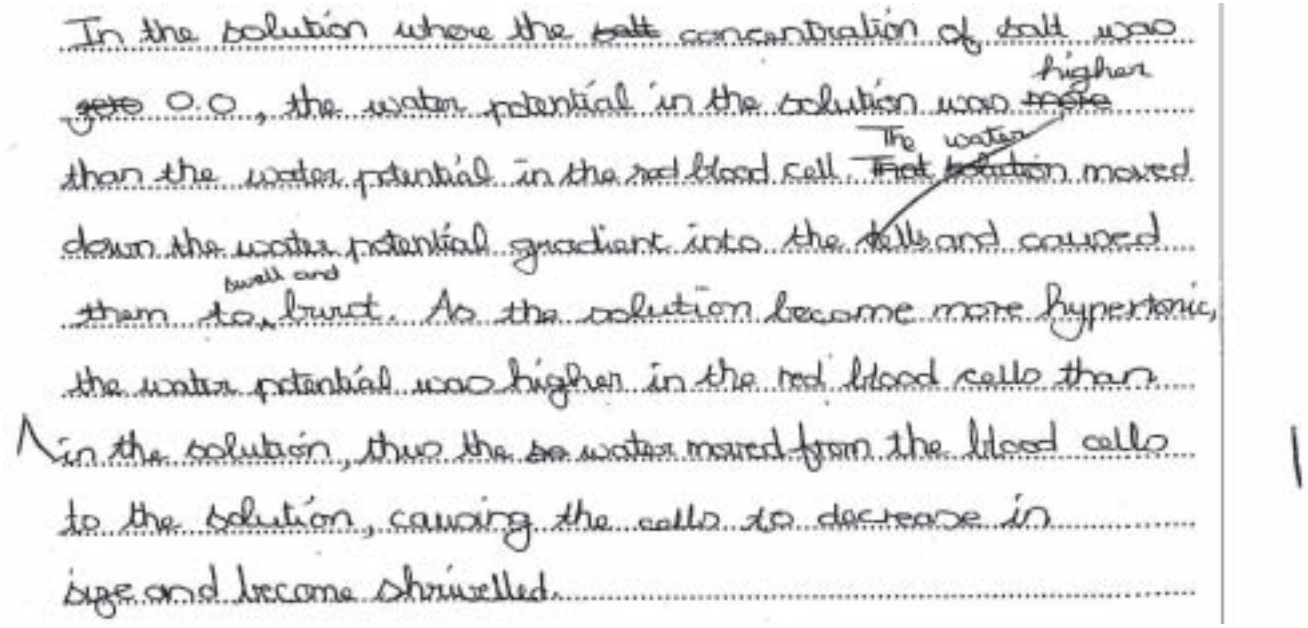
Example candidate response – grade C



Examiner comment – grade C

The movement of water should be described in terms of water potential: the candidate did use the term correctly, but did not use the term *osmosis*, as instructed. Clear comparative statements concerning the water potentials inside and outside the red blood cells were given and each was followed up with an explanation of how this would affect water movement.

Example candidate response – grade E



Examiner comment – grade E

Although the term 'water potential' was used in the response, the term 'osmosis' was not used, and a relatively easy mark was lost. Apart from the 0% salt concentration, the candidate did not refer specifically to the other concentrations and gave a general explanation which would only link to the 1.5 and 3.0% salt concentrations.

Question 3(d)

(d) The student also carried out a similar investigation using plant cells with cell walls removed. These cells were suspended in a 12% mannitol solution so that the water potential inside and outside of the cells was equal.

Fig. 3.1 is a photomicrograph of these cells.

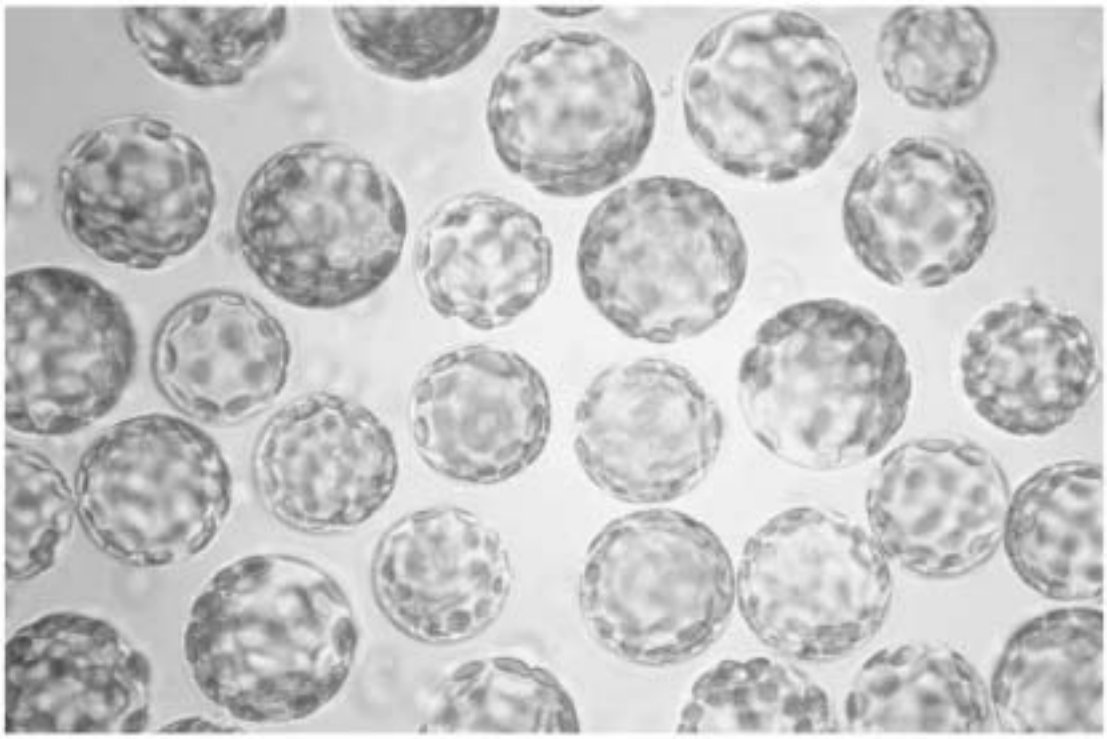


Fig. 3.1

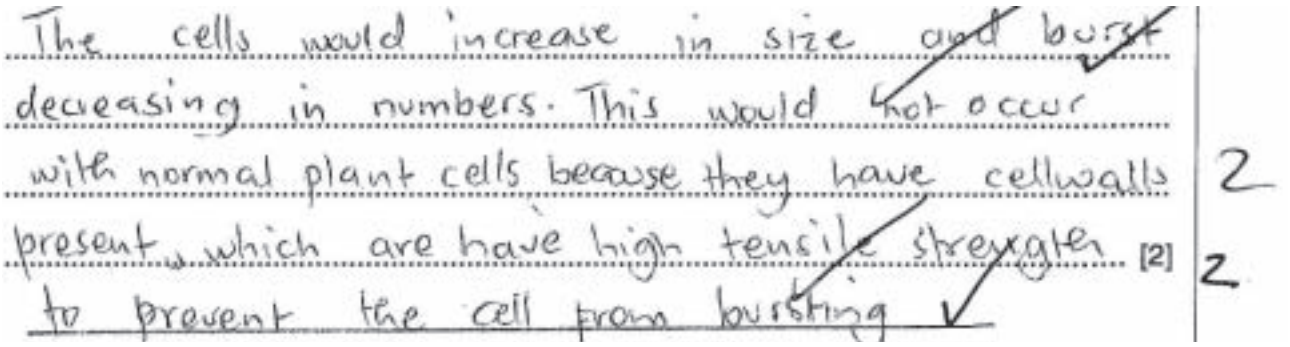
The student removed a sample of these cells. The sample was placed into distilled water and was viewed using a light microscope.

Describe what you would expect the student to observe and explain why this would not occur with normal plant cells. [2]

Mark scheme

(d) cells, increase in size / burst ; **A** vacuole increases in size **R** becomes turgid
no cell wall to, prevent cell bursting / withstand (turgor) pressure ;
A *idea that* cell membrane alone cannot withstand increase in size / bursting [2]

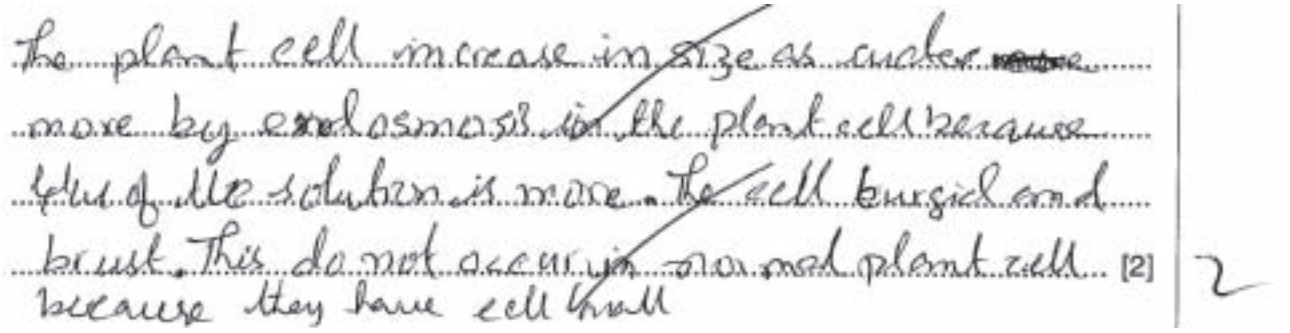
Example candidate response – grade A



Examiner comment – grade A

This response is clear and to the point. A good explanation follows a correct description of what would be observed.

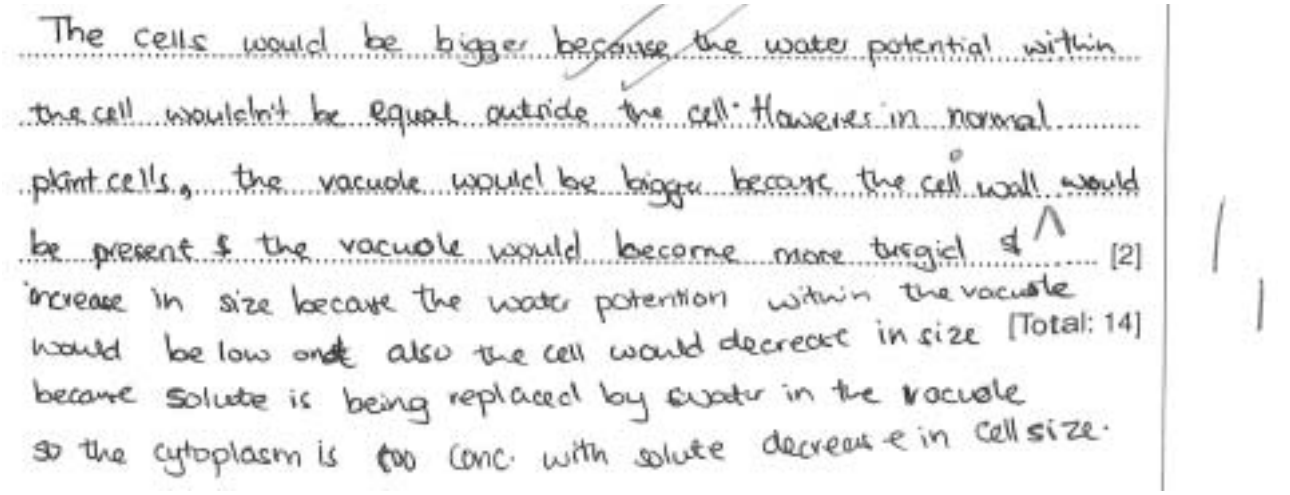
Example candidate response – grade C



Examiner comment – grade C

The candidate has gained the two marks allocated for the question but has wasted some time explaining why the cells would increase in size, which was not required. The incorrect spelling of 'burst' has been noted but has not negated the mark. The spelling mistake may have been spotted if the candidate had checked through their answer.

Example candidate response – grade E



Examiner comment – grade E

The candidate has realised that the cells observed would increase in size. The exceedingly long second sentence is confused. The candidate has wasted time with such a long response and should have noted that a two mark allocation would not require eight lines of writing. A simple follow-up sentence noting that a normal plant cell has a cell wall to prevent lysis, or bursting, would have sufficed.

Question 4(a)

4 Fig. 4.1 is an incomplete flow chart showing some of the events of the primary immune response that occur after a person has been given a vaccine.

Fig. 4.1

(a) Choose the correct term from the list below to complete Fig. 4.1.

lymphocytes	**antigens**	**mitosis**	**vaccine**
T_h-lymphocytes	**plasma cells**	**macrophages**	

[3]

Mark scheme

4 (a)

vaccine
macrophages } ;

antigens

lymphocytes
mitosis } ;

plasma cells *and* T_H-lymphocytes ; [3]

no ecf from **(a)** to **(b)**

Example candidate response – grade A / C

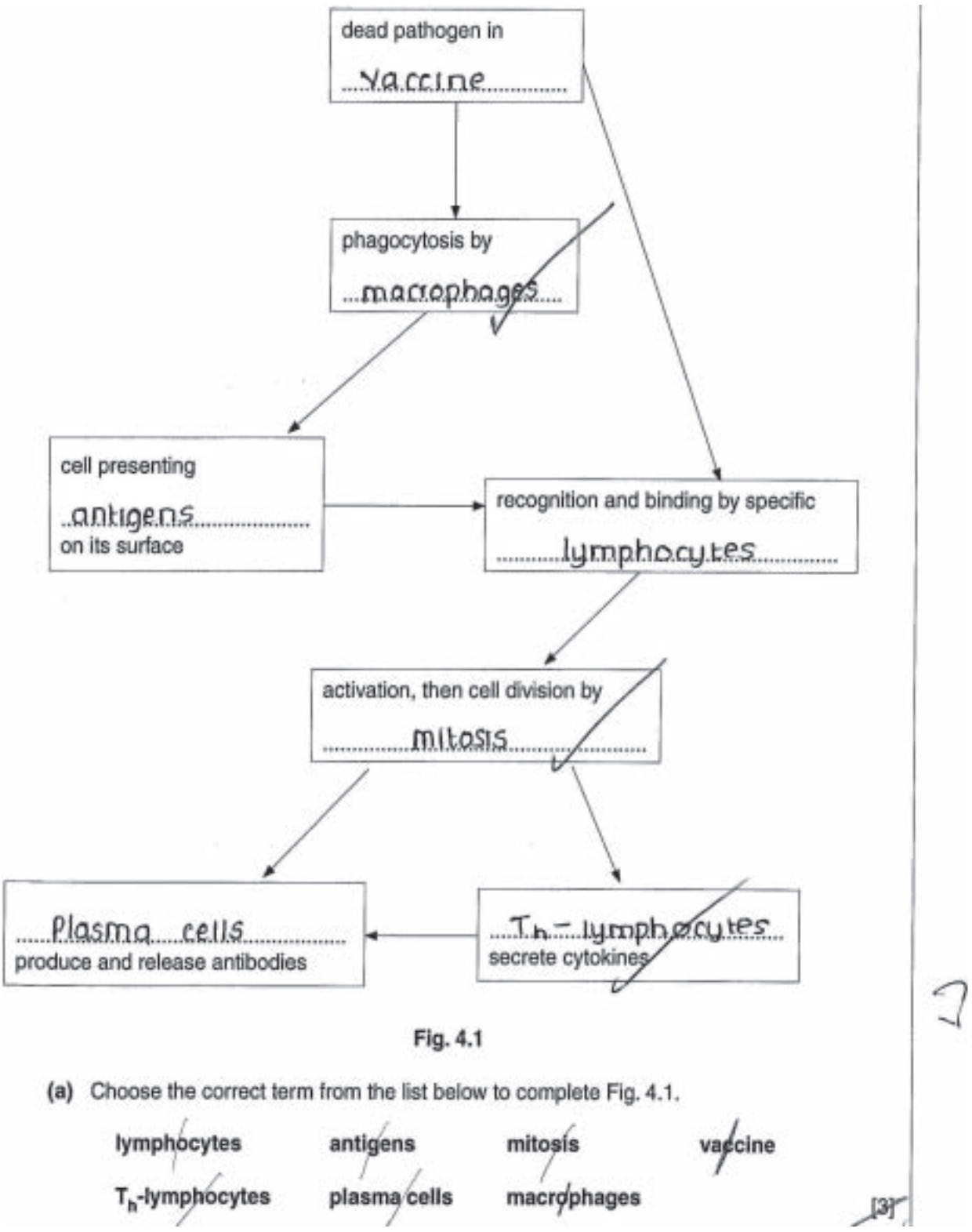


Fig. 4.1

(a) Choose the correct term from the list below to complete Fig. 4.1.

lymphocytes	antigens	mitosis	vaccine
T_h-lymphocytes	plasma cells	macrophages	

[3]

Examiner comment – grade A / C

This is a straightforward task for those candidates who have learned this area of the syllabus and who can think in a sequential manner. Grade A–C candidates should be able to gain maximum marks.

This candidate has correctly completed the flow chart and all spellings are correctly transferred from the list. The words have been crossed out, suggesting that the candidate has taken a methodical approach to the question.

Example candidate response – grade E

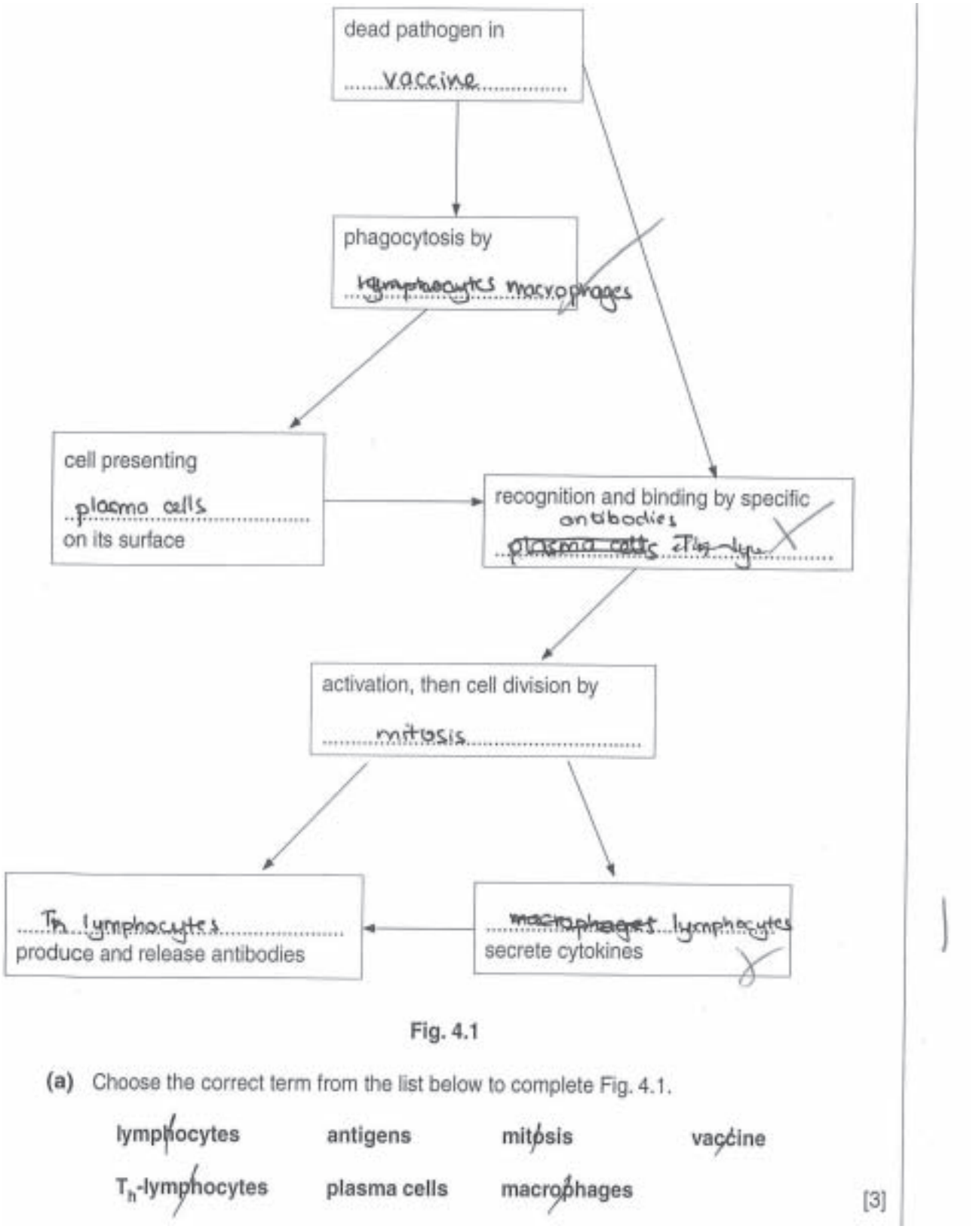


Fig. 4.1

(a) Choose the correct term from the list below to complete Fig. 4.1.

lymphocytes	antigens	mitosis	vaccine
T_h-lymphocytes	plasma cells	macrophages	

[3]

Examiner comment – grade E

The candidate has had a number of attempts to complete the flow chart and has gained a mark for correct knowledge of vaccine and macrophages. There has not been a check on the completion of the chart, as the term 'antibodies' has been written into a blank space, when the word did not appear on the list. It is clear that this area of the syllabus, section J, Immunity, has not been well learned or understood.

Question 4(b)

(b) Explain why the person is unlikely to become ill if they are infected by the same pathogen some months later. [3]

Mark scheme

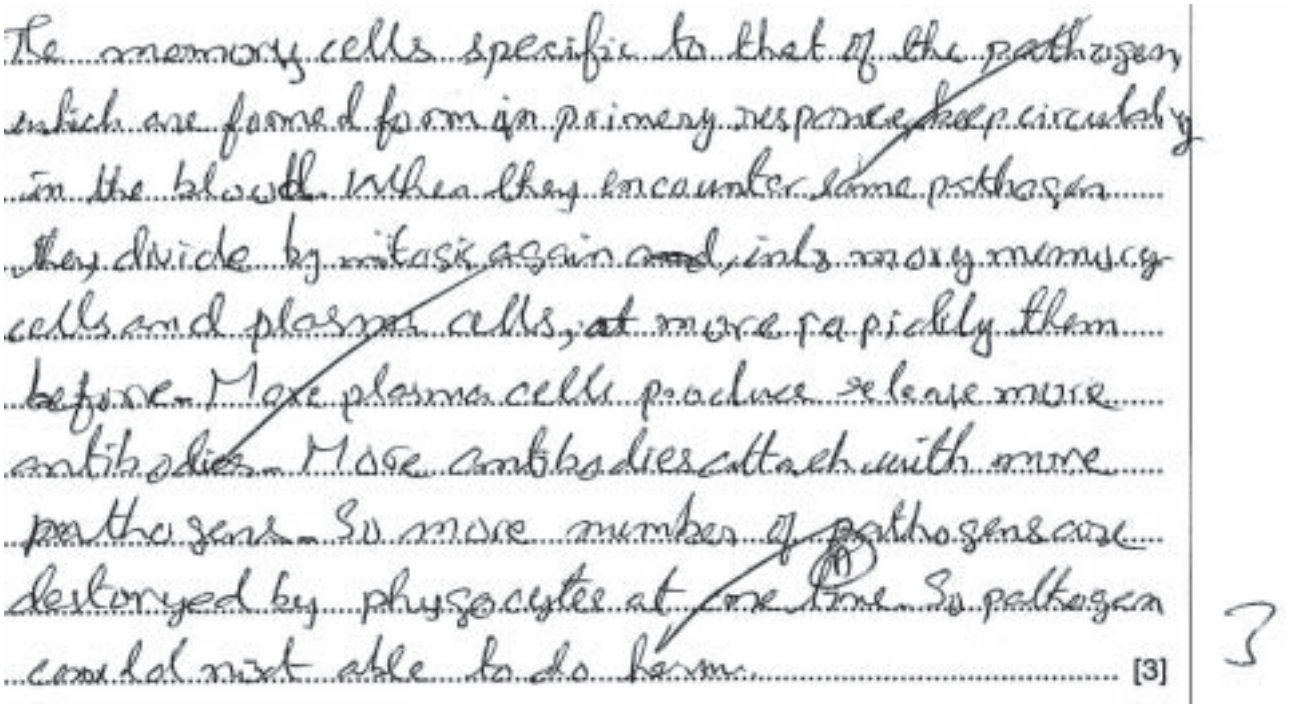
(b) 1 active (artificial) immunity ;

2 memory cells / immunological memory ;
3 *idea that* many specific, B-cells / T-cells / lymphocytes, in the body ;
A large(r) clones of specific, B- / T-cells *or* lymphocytes

actual invasion by the pathogen
4 fast secondary (immune) response ;
5 fast increase in antibodies / immediate production of antibodies ;
ignore incorrect type of cell secreting antibodies

6 high(er) concentration of antibodies are produced ; **A** more antibodies produced
7 pathogen destroyed before person becomes ill / AW ; **R** antigen
A pathogen do not, increase in number / infect cells / AW [max 3]

Example candidate response – grade A

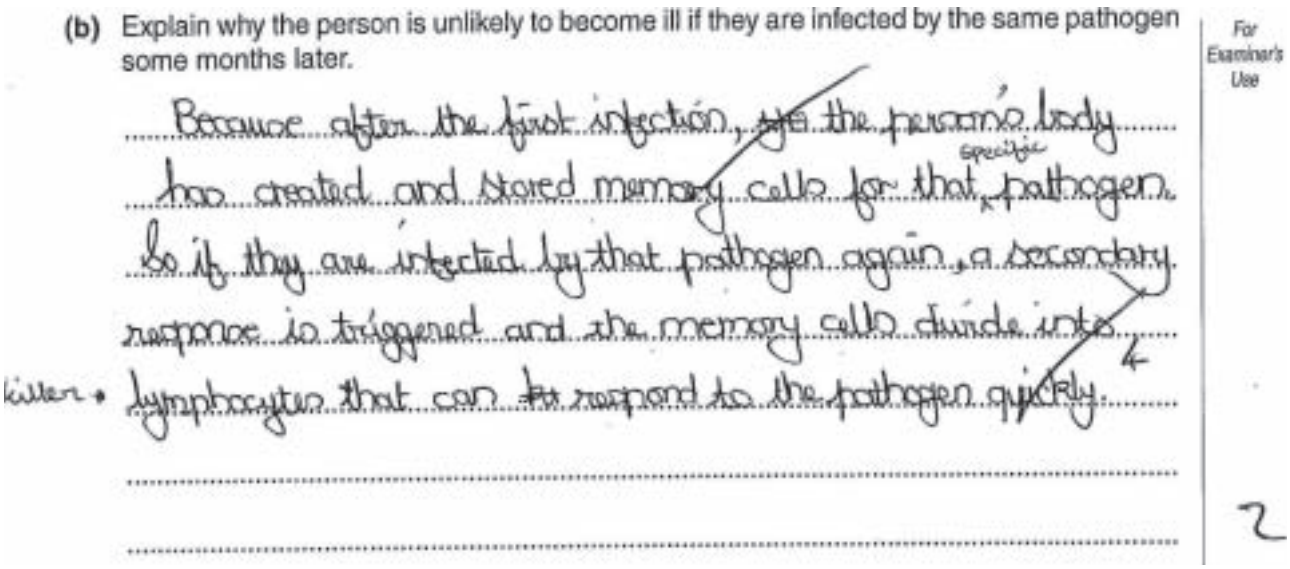

The memory cells specific to that of the pathogen which are formed from primary response keep circulating in the blood. When they encounter same pathogen they divide by mitosis again and, into many memory cells and plasma cells, at more rapidly than before. More plasma cells produce release more antibodies. More antibodies attach with more pathogens. So more number of pathogens are destroyed by physocytes at one time. So pathogen could not able to do harm. [3]

3

Examiner comment – grade A

This candidate has given a good sequential and a clear consequential account of the immune response and has geared the response to explaining why the person is unlikely to become ill again. The correct scientific terminology has been used in the correct context.

Example candidate response – grade C


(b) Explain why the person is unlikely to become ill if they are infected by the same pathogen some months later.

For Examiner's Use

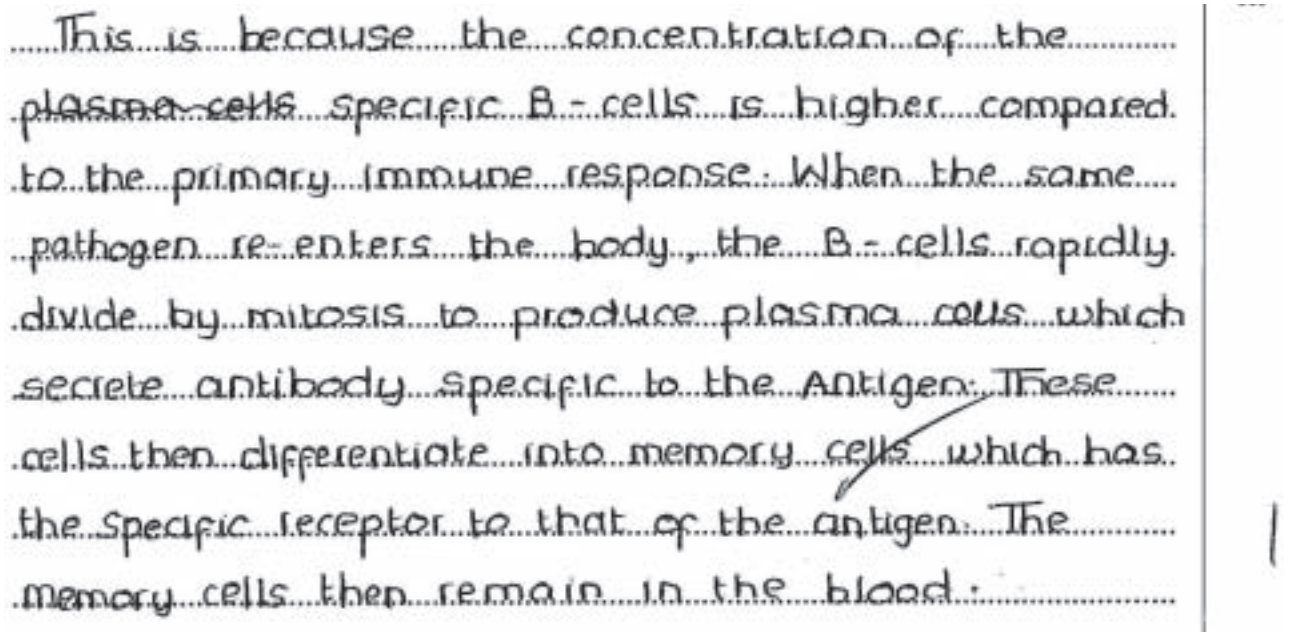
Because after the first infection, the person's body has created and stored memory cells (specific) for that pathogen. So if they are infected by that pathogen again, a secondary response is triggered and the memory cells divide into lymphocytes that can respond to the pathogen quickly. killer •

2

Examiner comment – grade C

This candidate has attempted to convey the right idea, but is short of further detail and could qualify the answer with an explanation that there would be more lymphocytes produced in a shorter time period. The humoral (antibody production) side of the immune response has not been covered.

Example candidate response – grade E


This is because the concentration of the plasma cells specific B-cells is higher compared to the primary immune response. When the same pathogen re-enters the body, the B-cells rapidly divide by mitosis to produce plasma cells which secrete antibody specific to the Antigen. These cells then differentiate into memory cells which has the specific receptor to that of the antigen. The memory cells then remain in the blood.

1

Examiner comment – grade E

This candidate has not focused on explaining why the person is unlikely to become ill. A mark has been awarded to the benefit of the candidate, despite the fact that there is also some confusion as to the role of memory cells, as these are only mentioned as a product of the secondary immune response. To answer the question the candidate needed to get across the idea of fast speed of response and high level of antibody production.

Question 4(c)

(c) Some parents decide that their children should not take part in a vaccination schedule.

Suggest how a country-wide vaccination schedule can give protection against infection to **unvaccinated** children. [2]

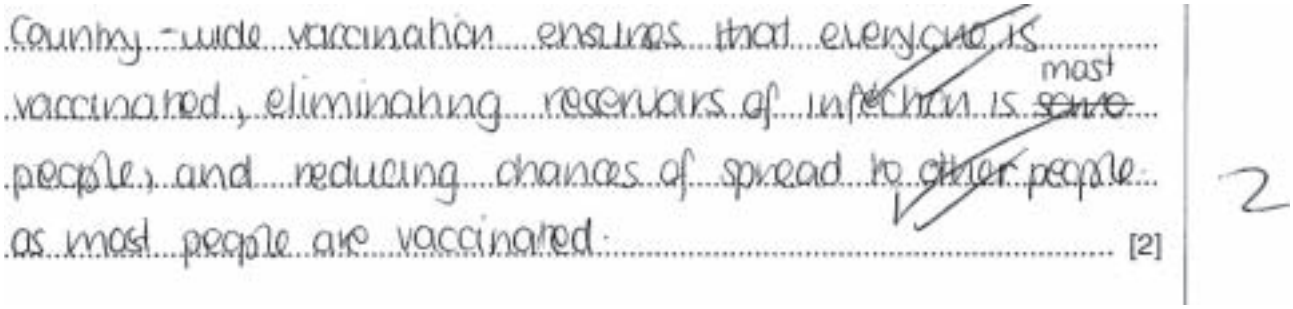
Mark scheme

(c) *two points to look for*

(if) most / sufficient / many / AW, people / children, immunised / vaccinated ;
A herd immunity

reduces the pool of infected, people / children, in the, community / population ;
A fewer people can catch disease and be source of infection
A protects those unvaccinated as, disease / illness, does not spread
A less chance of transmission
A pathogen cannot develop in immunised people
A reduced exposure to pathogen [max 2]

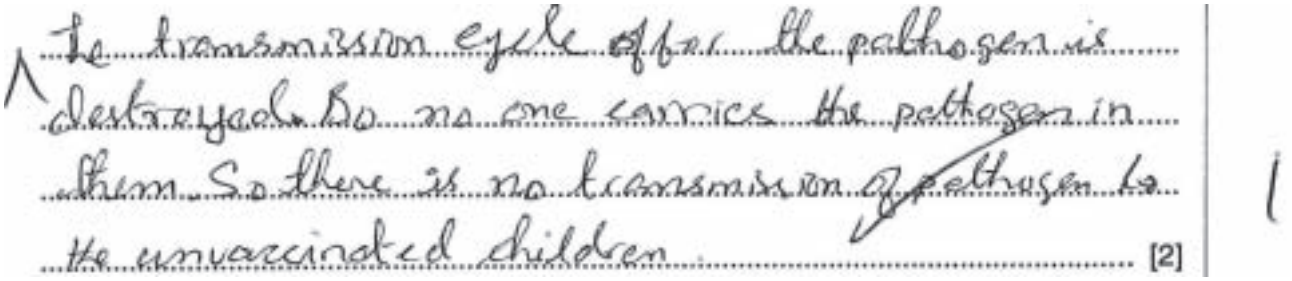
Example candidate response – grade A



Examiner comment – grade A

This candidate has explained the concept of herd immunity and it is evident that the candidate understands the concept. This answer could have been improved if the slight contradiction of 'everyone is vaccinated' and 'most people are vaccinated' had been corrected and if the 'other people' had been named as the 'unvaccinated children'.

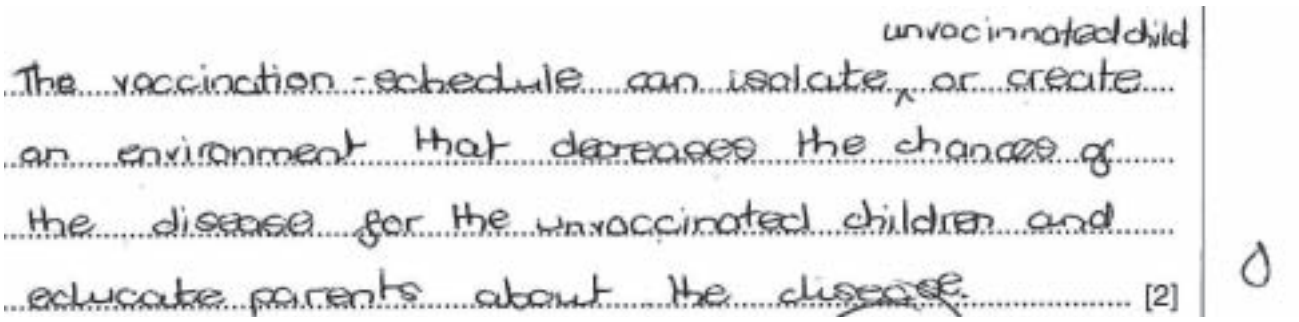
Example candidate response – grade C



Examiner comment – grade C

This answer has gained a mark but it is not entirely clear that the candidate has a full understanding of the concept of herd immunity as the explanation is weak. The idea of a reduced pool of infected people, or protection of unvaccinated children as there is very little spread of the diseases should have been given. The second sentence suggests that the candidate is not confident with their initial explanation.

Example candidate response – grade E



Examiner comment – grade E

This response, while possibly on the right lines, is too vague for marks to be awarded. Although the question concerns a health and social issue, the response should have been given in biological mark points.

Question 5(a)–(e)

5 State the term that applies to each of the descriptions **(a)** to **(e)**.

(a) Storage polysaccharide in animals made of chains of 1,4 linked α-glucose with 1,6 linkages forming branches.

..... [1]

(b) A plant that has adaptations to enable it to live in areas where water is in short supply.

..... [1]

(c) Any cell containing one complete set of chromosomes.

..... [1]

(d) The name of the trophic level to which photosynthetic organisms belong.

..... [1]

(e) A process carried out by bacteria that involves the conversion of atmospheric nitrogen into nitrogenous compounds that can be used directly by plants.

..... [1]

[Total: 5]

Mark scheme

5 (a) glycogen ; [1]

(b) xerophyte / xerophyllic ; **A** phonetic e.g. zerophyte [1]

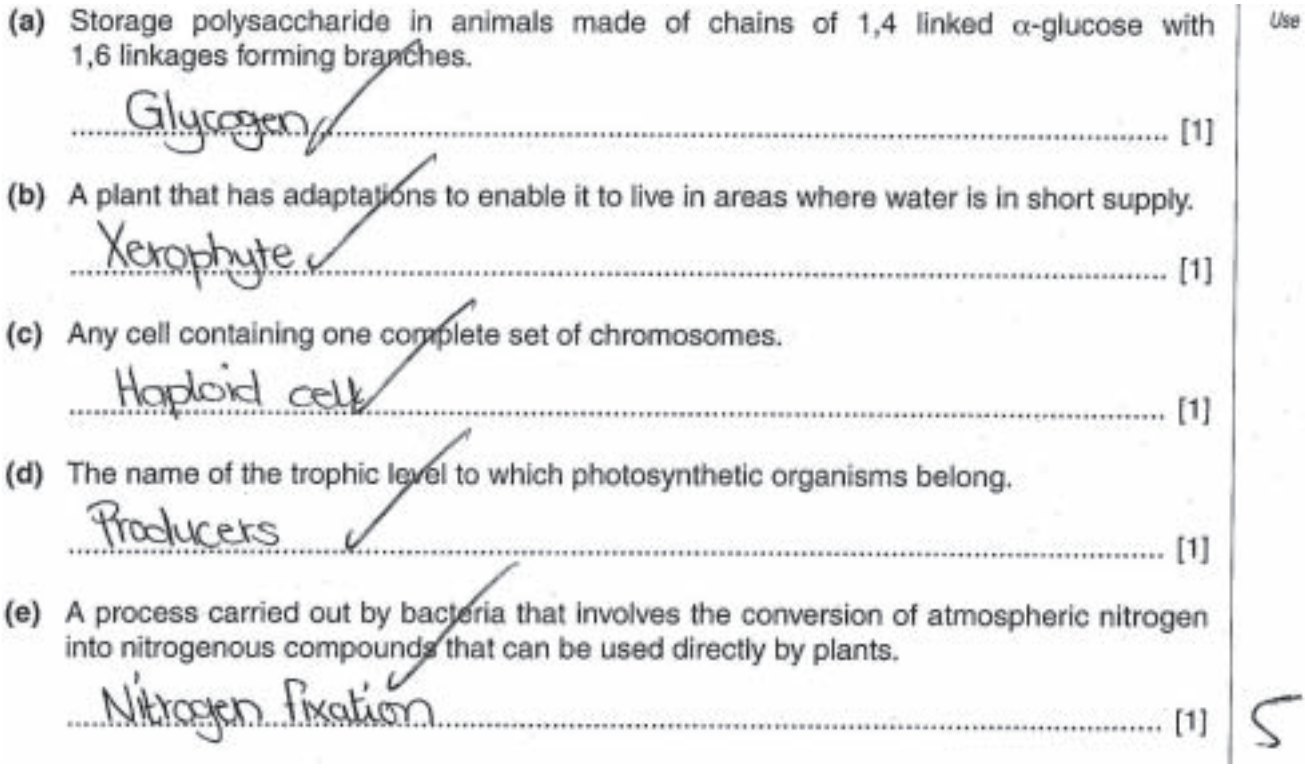
(c) haploid (cell) ; **A** monoploid [1]

(d) (primary) producer ; **R** first ***ignore*** autotrophic [1]

(e) (nitrogen) fixation ; **A** nitrogen fixing bacteria [1]

[Total: 5]

Example candidate response – grade A



(a) Storage polysaccharide in animals made of chains of 1,4 linked α-glucose with 1,6 linkages forming branches.

Glycogen [1]

(b) A plant that has adaptations to enable it to live in areas where water is in short supply.

Xerophyte [1]

(c) Any cell containing one complete set of chromosomes.

Haploid cell [1]

(d) The name of the trophic level to which photosynthetic organisms belong.

Producers [1]

(e) A process carried out by bacteria that involves the conversion of atmospheric nitrogen into nitrogenous compounds that can be used directly by plants.

Nitrogen fixation [1]

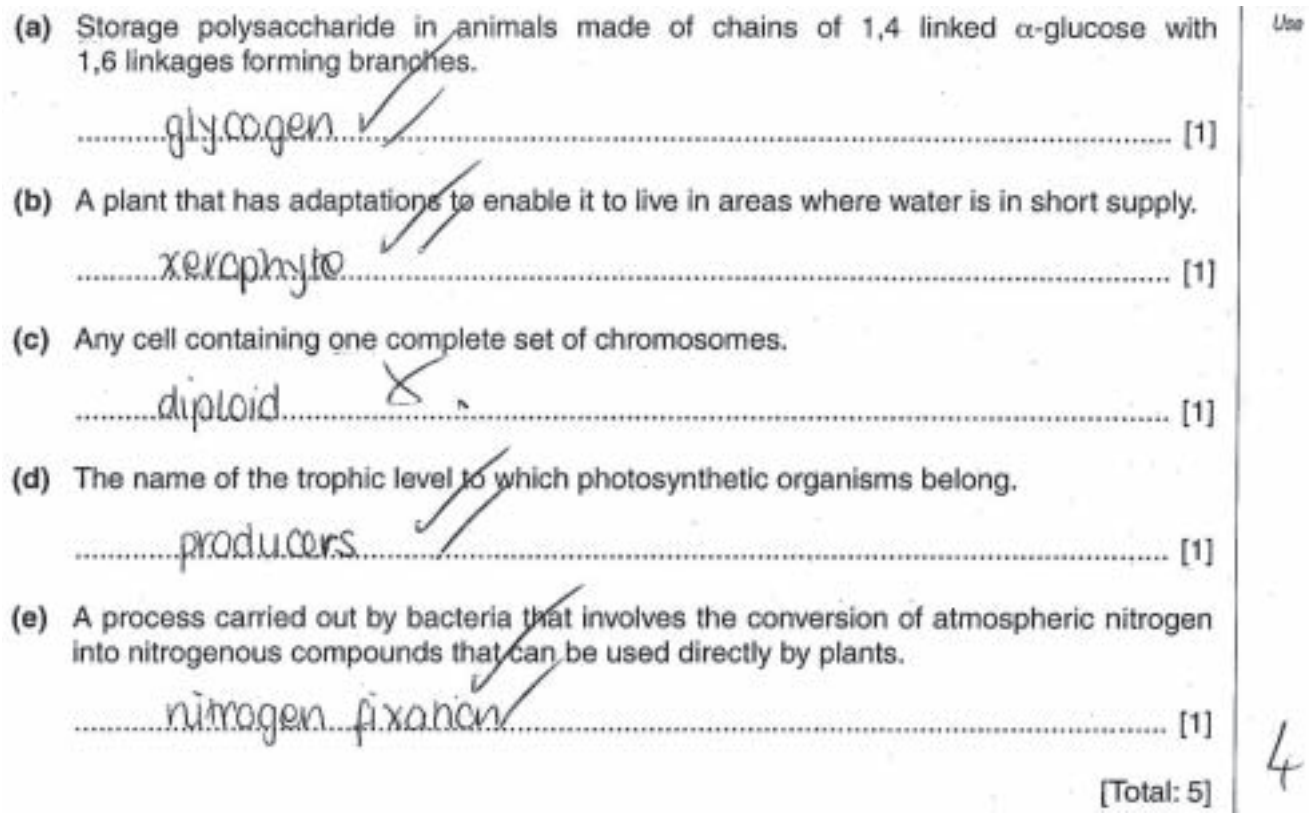
Use

5

Examiner comment – grade A

The candidate has demonstrated knowledge and understanding from across the syllabus, as five different sections are represented. Spellings are all correct.

Example candidate response – grade C



(a) Storage polysaccharide in animals made of chains of 1,4 linked α-glucose with 1,6 linkages forming branches.

glycogen ✓✓ [1]

(b) A plant that has adaptations to enable it to live in areas where water is in short supply.

xerophyte ✓✓ [1]

(c) Any cell containing one complete set of chromosomes.

diploid ✗ [1]

(d) The name of the trophic level to which photosynthetic organisms belong.

producers ✓✓ [1]

(e) A process carried out by bacteria that involves the conversion of atmospheric nitrogen into nitrogenous compounds that can be used directly by plants.

nitrogen fixation ✓✓ [1]

[Total: 5]

Use

4

Examiner comment – grade C

This candidate has a good knowledge of different areas of the syllabus. The incorrect answer for **(c)** may reflect a question that was not read carefully enough.

Example candidate response – grade E

(a) Storage polysaccharide in animals made of chains of 1,4 linked α-glucose with 1,6 linkages forming branches.

Starch - amylose & amylopectin - ✗ [1]

(b) A plant that has adaptations to enable it to live in areas where water is in short supply.

Xerophytes ✓ [1]

(c) Any cell containing one complete set of chromosomes.

Diploid ✗ [1]

(d) The name of the trophic level to which photosynthetic organisms belong.

Producers ✓ [1]

(e) A process carried out by bacteria that involves the conversion of atmospheric nitrogen into nitrogenous compounds that can be used directly by plants.

Nitrification ✗ [1]

[Total: 5]

2

Examiner comment – grade E

This candidate has gaps in their knowledge and has only been able to give two correct terms for the descriptions. This style of question, while outwardly appearing easy to tackle, requires candidates to think across a broad range of biological topics. It is most important for the candidate to re-consider and confirm the response in the light of re-reading the question carefully.

Question 6(a)

6 Fig. 6.1 is a section through lung tissue showing an alveolus and its blood supply.

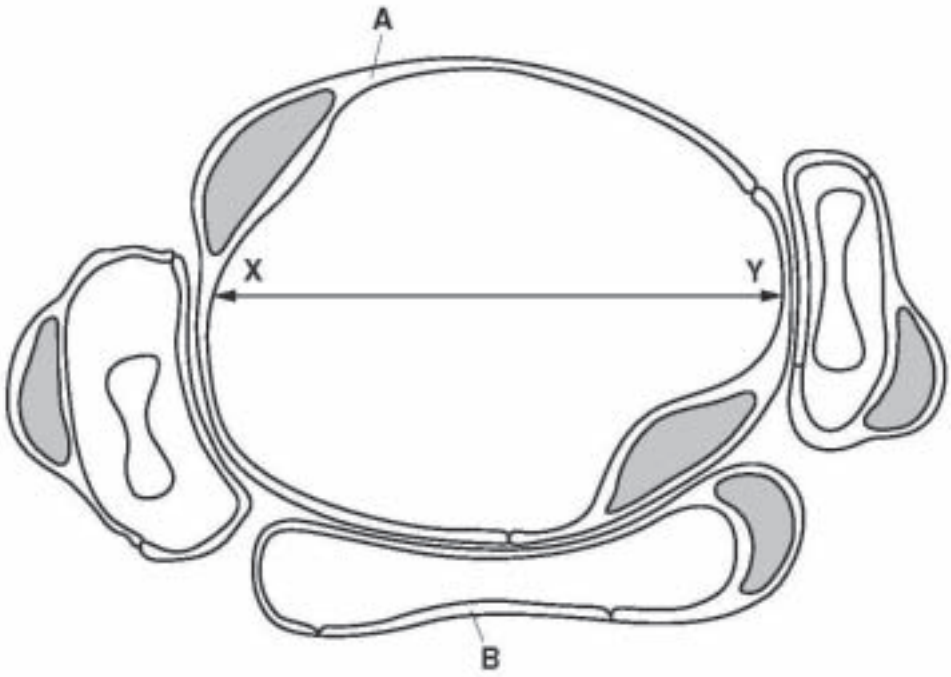


Fig. 6.1

(a) (i) Name the type of epithelial cell shown by label lines **A** and **B**.

..... [1]

(ii) Describe how the elastic fibres of the alveoli contribute to the healthy functioning of the lungs. [2]

Mark scheme

6 (a) (i) squamous / pavement (epithelial) ; [1]

(ii) stretch / expand, on inspiration and recoil on expiration ; **R** contraction

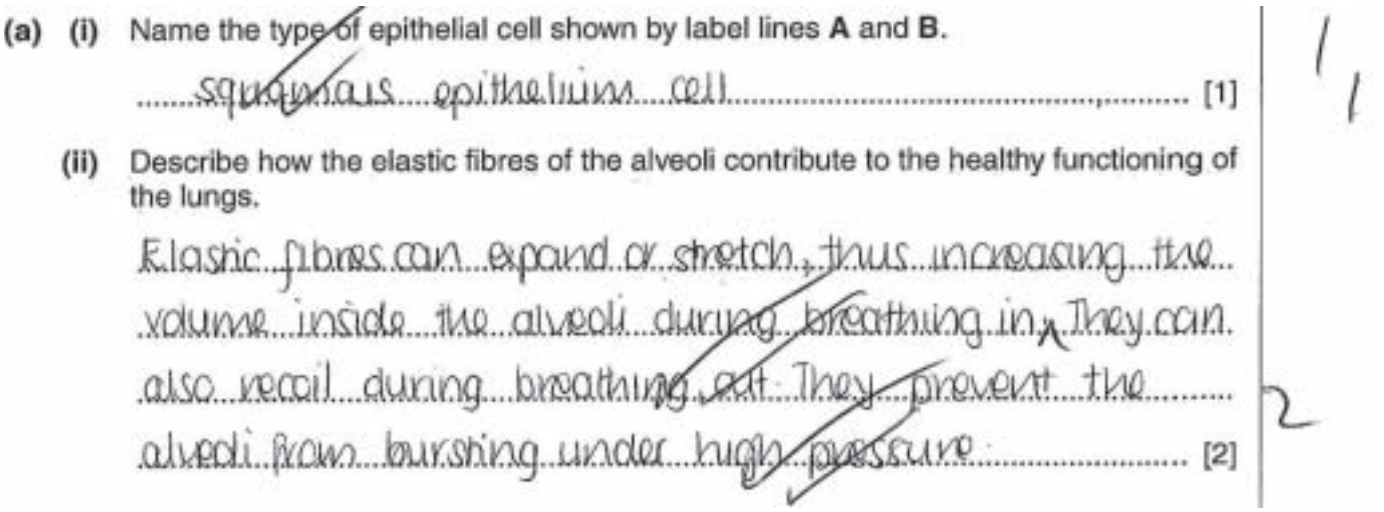
(stretch) to increases, surface area / volume of air, for, diffusion / gas exchange ;

(recoil) to help, expel air / force air out ; **A** carbon dioxide
A if destroyed then cannot expel air

prevent alveoli, bursting / breaking / AW ;

ref. to emphysema if elastic fibres destroyed ; [max 2]

Example candidate response – grade A



(a) (i) Name the type of epithelial cell shown by label lines **A** and **B**.

squamous epithelium cell [1]

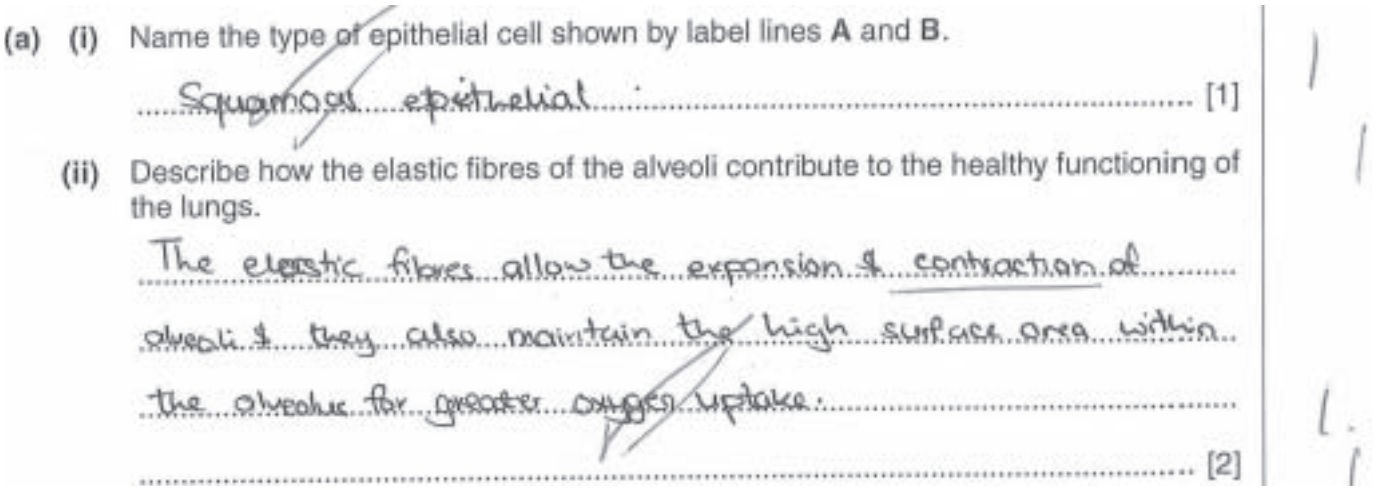
(ii) Describe how the elastic fibres of the alveoli contribute to the healthy functioning of the lungs.

Elastic fibres can expand or stretch, thus increasing the volume inside the alveoli during breathing in. They can also recoil during breathing out. They prevent the alveoli from bursting under high pressure. [2]

Examiner comment – grade A

In **(i)**, the candidate has given the correct type of cell, spelt correctly. The answer for **(ii)** is concise and to the point, with the correct use of terminology.

Example candidate response – grade C



(a) (i) Name the type of epithelial cell shown by label lines **A** and **B**.

Squamous epithelial [1]

(ii) Describe how the elastic fibres of the alveoli contribute to the healthy functioning of the lungs.

The elastic fibres allow the expansion & contraction of alveoli & they also maintain the high surface area within the alveolus for greater oxygen uptake. [2]

Examiner comment – grade C

The type of epithelial cell is named correctly in **(i)**. The mark in **(ii)** was given to the candidate's benefit, as the description could have been improved with a clearer link between the expansion on inspiration and an increase in surface area for oxygen uptake. The correct scientific terminology is not used – 'recoil' was required, rather than 'contraction'.

Example candidate response – grade E

(a) (i) Name the type of epithelial cell shown by label lines **A** and **B**.

A = Epithelium B = endothelium [1]

(ii) Describe how the elastic fibres of the alveoli contribute to the healthy functioning of the lungs.

These elastic fibers use to contract and ~~relax~~ stracks. This ability give the alveolus to remove the air from the alveolus after gaseous exchanges have been done [2]

0

1

Examiner comment – grade E

The candidate has misinterpreted the question in **(i)** and has attempted to give two types of epithelial cell. Incorrect terminology, 'contract' has been used in **(ii)** instead of 'recoil'. The candidate has a grasp of the idea that elastic fibres help to expel air, however the wording used is poor and the mark is only just warranted.

Question 6(b)

(b) The actual diameter of the alveolus along the line **X–Y** is 220 micrometres (μm). Calculate the magnification of Fig. 6.1.

Show your working and give your answer to the nearest whole number.

answer × ..... [2]

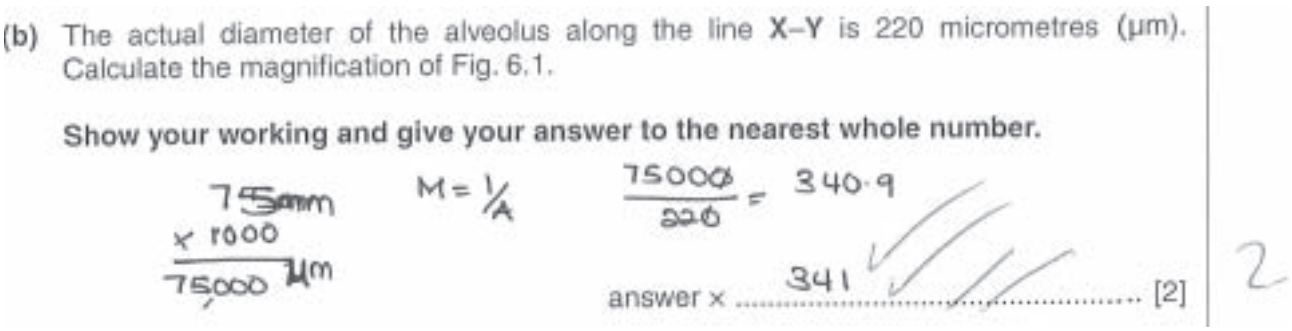
Mark scheme

(b) *award two marks if correct answer (anything in range 336–346)*
allow +/– 1 mm in reading the line (74–76 mm)

75000 μm / 220 μm =
341 ;;

if answer incorrect, award one mark for correct measurement with unit and division by 220
award one mark if correct answer given to one or more decimal places [2]

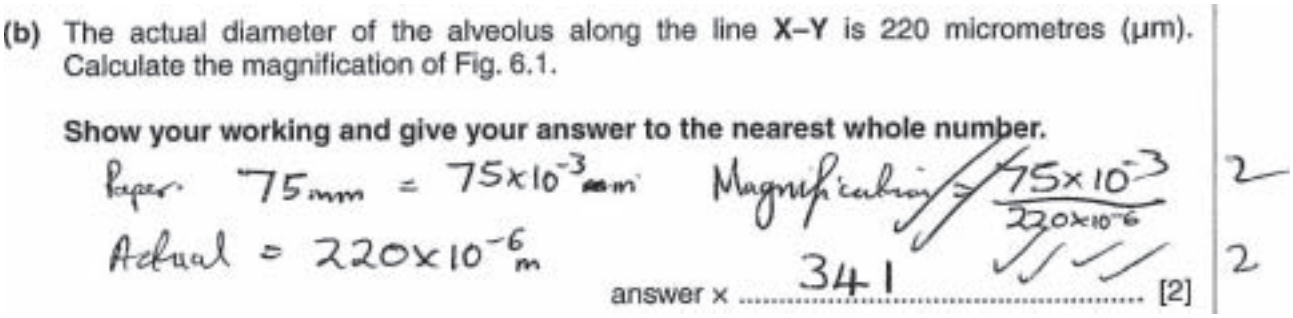
Example candidate response – grade A



Examiner comment – grade A

There is evidence that the candidate has measured the line X-Y as 75 mm, which has then been converted correctly to μm by multiplying by 1000. The correct formula for calculating magnification is given and the candidate has shown the calculated value as 340.9, correctly rounding up as instructed. Every step leading up to the correct answer is clear.

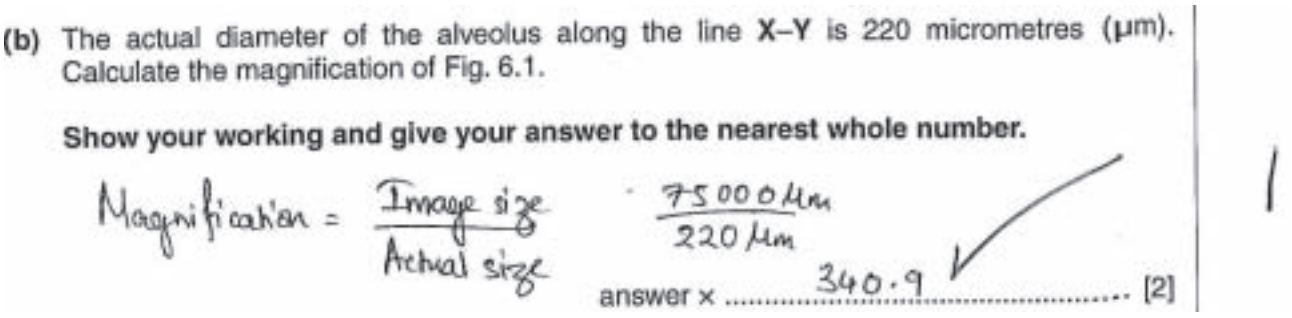
Example candidate response – grade C



Examiner comment – grade C

This candidate has gained the two marks for the correct answer and most steps leading to this can be seen, although this is less clear than the grade A example. This particular candidate has used a different method, by converting the mm and μm values to the SI base unit, the metre.

Example candidate response – grade E



Examiner comment – grade E

The candidate knows the correct formula to use but has not noticed that the answer was required to the nearest whole number and has lost a mark.

Question 6(c)

(c) Outline two features of a gas exchange surface **that are shown on Fig. 6.1.**

1. .....

.....

2. .....

..... [2]

Mark scheme

(c) *look for two ideas – follow usual rules for marking numbered answer lines*

thin, alveolar wall / epithelial lining / AW ;
A short diffusion distance (between air in alveolus and blood in capillary)
A squamous cells are thin
R thin, membrane / cell membrane **R** large surface area

surrounded by, capillaries / capillary network ;
A close contact with, capillaries / blood (vessels / cells)
A many capillaries
A large area of alveolus in contact with, capillaries / blood [2]

Example candidate response – grade A

(c) Outline two features of a gas exchange surface **that are shown on Fig. 6.1.**

1. There is a decreased diffusion distance for gas exchange as the alveolar wall is thin (only 1 cell thick)

2. Each alveolus has a rich supply of blood capillaries so more blood can be oxygenated. [2]

2

Examiner comment – grade A

From the list of features of a gas exchange surface that has been learned, the candidate has correctly identified two of these features that are also visible on Fig. 6.1. Note that the candidate has ensured that the mark point is given by including a brief qualification of the clearly-stated feature.

Example candidate response – grade C

(c) Outline two features of a gas exchange surface **that are shown on Fig. 6.1.**

1. The blood capillaries are in very close contact to the alveolus

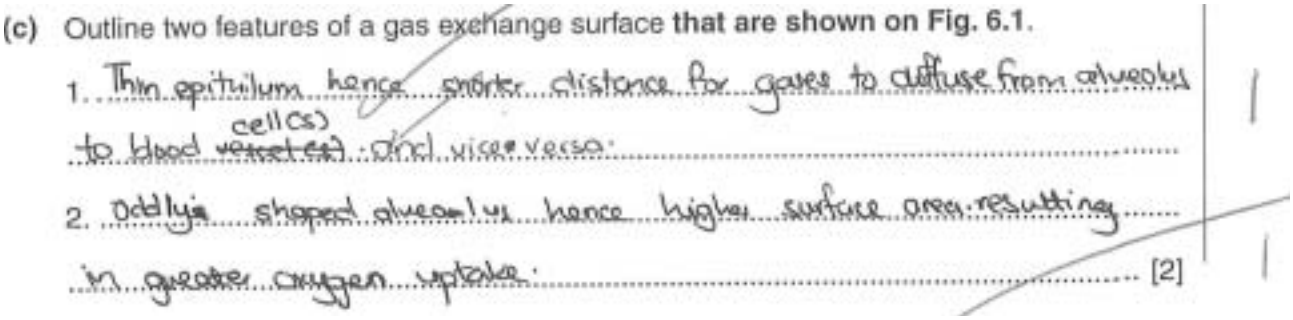
2. There is a short diffusion distance between the alveolar wall and the blood capillary. [2]

2

Examiner comment – grade C

There are two correct visible features outlined in this response. Both features could have been briefly qualified with a reference to gas exchange, for example in part 1 the sentence could have ended with '… for efficient uptake of oxygen', and in part 2 the candidate could have included 'for gases' after the 'short diffusion distance'.

Example candidate response – grade E


(c) Outline two features of a gas exchange surface **that are shown on Fig. 6.1.**

1. Thin epithilum hence shorter distance for gases to diffuse from alveolus to blood vessel (cells) and vice versa. 1

2. oddly shaped alveolus hence higher surface area resulting in greater oxygen uptake. [2] 1

Examiner comment – grade E

A correct feature is given, with the incorrect spelling of epithelium being close enough to the correct word to be allowed the mark. The 'large surface area' feature of gas exchange surfaces is linked to the presence of many alveoli rather than the one alveolus shown, so the candidate's idea of 'higher surface area' is not relevant; also this feature is not visible in Fig. 6.1.

Question 6(d)

(d) Fig. 6.2 is a simplified diagram of the circulatory system of a human, showing gas exchange in the lungs and in respiring tissue. The partial pressures of oxygen (pO_2) and carbon dioxide (pCO_2) at four locations are also shown.

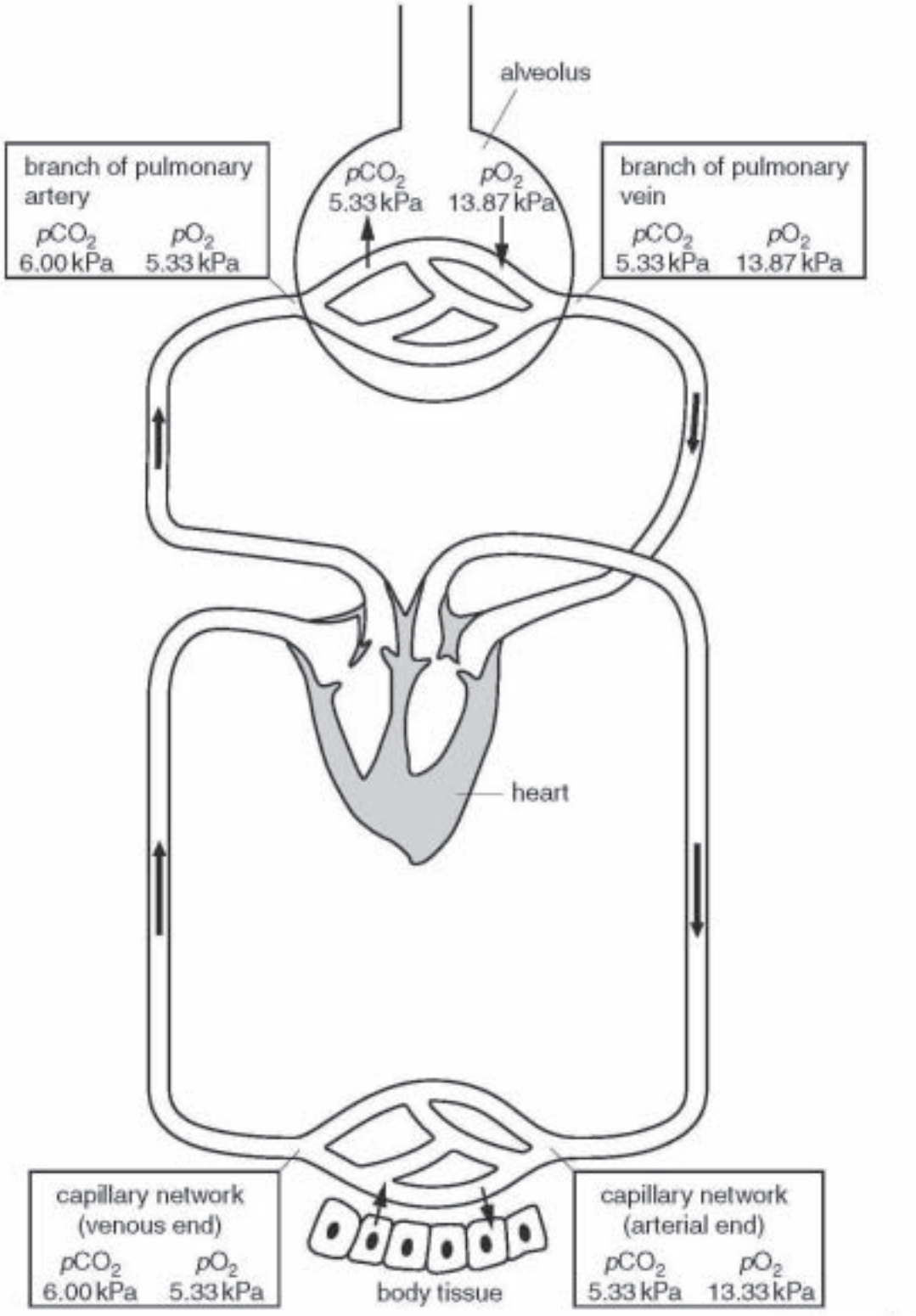


Fig. 6.2

With reference to Fig. 6.2, explain how the differences in *p*O2 and *p*CO[illegible] and in blood enable gas exchange in the lungs **and** respiring tissue.

Mark scheme

(d) ***max 3 if no ref. to diffusion***

(named) gas(es), diffuse down, pressure gradients / concentration gradient / AW ;
A from high(er) partial pressure to low(er) partial pressure
A high(er) concentration to low(er) concentration
ignore 'along a concentration gradient'

in the answers accept the following AWs
capillaries / haemoglobin for blood
lungs for alveoli
body for tissues

lungs

valid statement linking information in table below – 1 mark for each row

comparison in partial pressure may be 'higher / lower' not both or high and low, but if not then figures have to be given

blood	ref. to gas	blood partial pressure	alveolar air partial pressure	gas exchange	
in pulmonary artery / entering alveolar capillaries	pO_2	5.33 / lower	13.87 / higher	into blood from alveolus	;
	pCO_2	6.00 / higher	5.33 / lower	out of blood into alveolus	;

respiring tissue

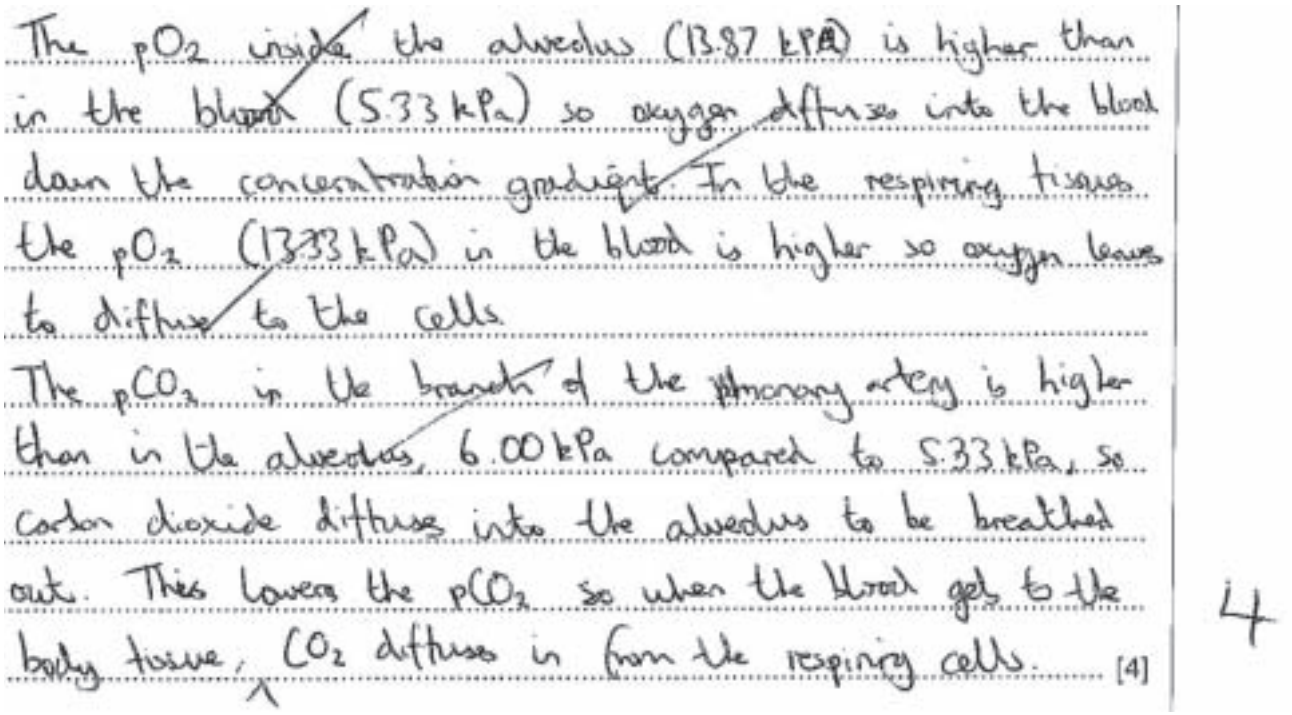
valid statement linking information in table below – 1 mark for each row

blood	ref. to gas	blood partial pressure	tissue partial pressure	gas exchange	
in systemic artery / entering tissue capillaries	pO_2	13.33 / higher	< 5.33 / lower	into tissue from blood	;
	pCO_2	5.33 / lower	> 6.00 / higher	out of tissue into blood	;

[max 4]

R differences between pO_2 and pCO_2 in the same place

Example candidate response – grade A



The pO_2 inside the alveolus (13.87 kPa) is higher than in the blood (5.33 kPa) so oxygen diffuses into the blood down the concentration gradient. In the respiring tissues the pO_2 (13.33 kPa) in the blood is higher so oxygen leaves to diffuse to the cells.

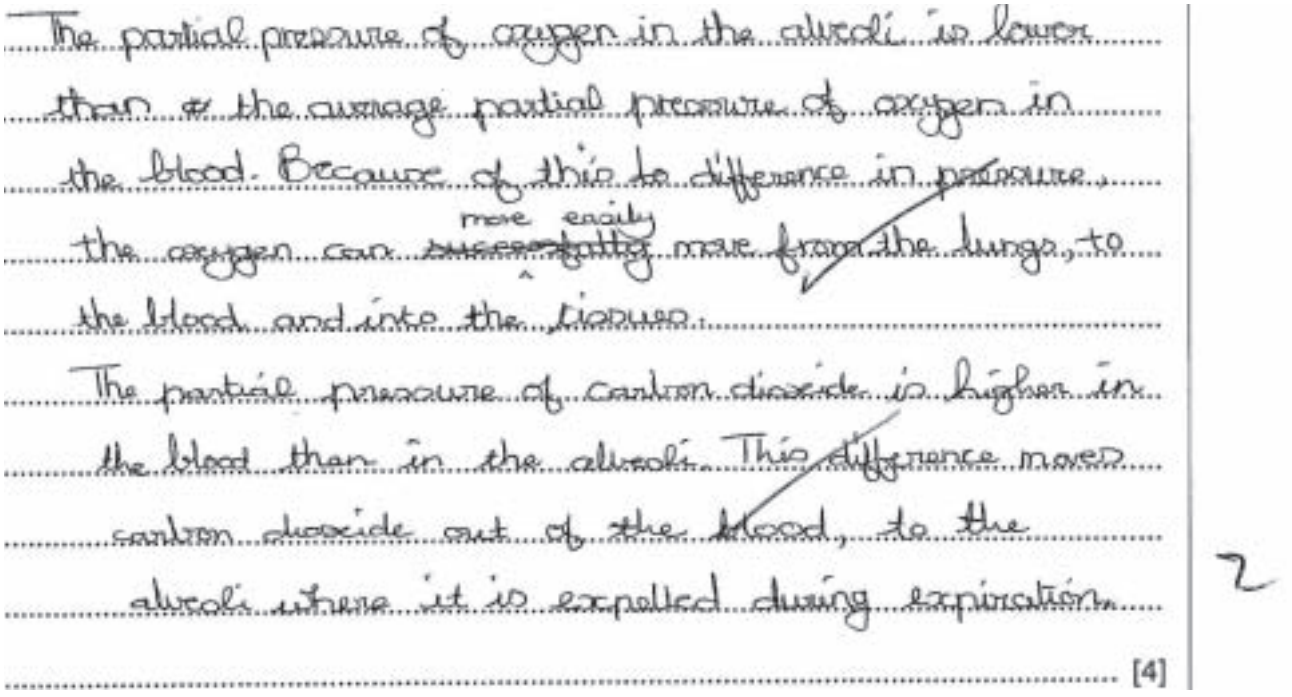
The pCO_2 in the branch of the pulmonary artery is higher than in the alveolus, 6.00 kPa compared to 5.33 kPa, so carbon dioxide diffuses into the alveolus to be breathed out. This lowers the $p(O_2$ so when the blood get to the body tissue, CO_2 diffuses in from the respiring cells. [4]

4

Examiner comment – grade A

The correct terminology, *diffusion* and *concentration gradient*, has been used to describe and explain the movement of gases. The candidate has organised the response in a logical way and has used a separate paragraph for the explanation for each gas. Good reference has been made to Fig. 6.2. In explaining the direction of movement of oxygen in the lungs, a descriptive comparison concerning pO_2 in the alveolus and in the blood is given, which is supported by comparative numerical data. The situation in the respiring tissue is also explained correctly and in a concise manner. A similar style is adopted for the explanation for carbon dioxide.

Example candidate response – grade C



The partial pressure of oxygen in the alveoli is lower than the average partial pressure of oxygen in the blood. Because of this difference in pressure, the oxygen can more easily move from the lungs, to the blood and into the tissues.

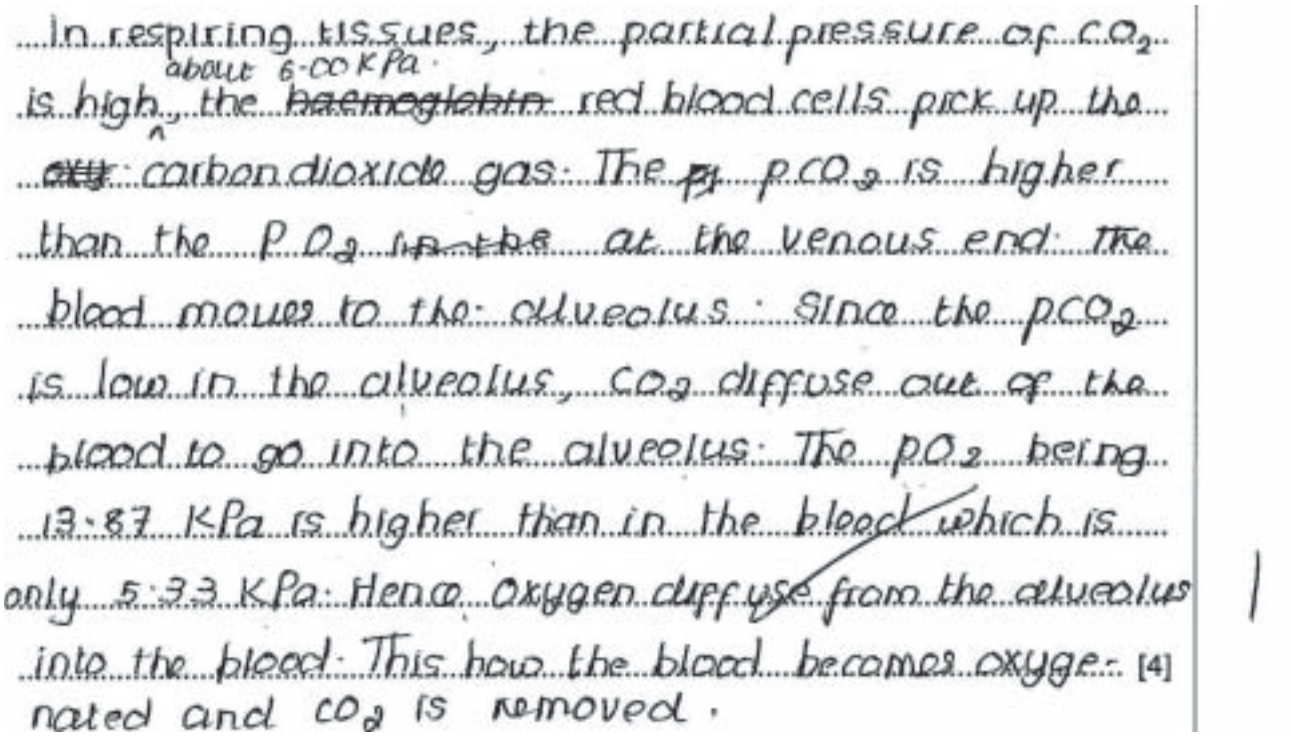
The partial pressure of carbon dioxide is higher in the blood than in the alveoli. This difference moves carbon dioxide out of the blood, to the alveoli where it is expelled during expiration. [4]

2

Examiner comment – grade C

This candidate was able to apply well their understanding of gas exchange in the lungs to Fig. 6.2 and correctly compared differences in partial pressures of oxygen separately to differences in partial pressures of carbon dioxide. The question also asked for an explanation of gas exchange in the respiring tissue and the candidate ignored this half of the question, limiting the marks that could be achieved. An additional mark could have been gained for the use of the term *diffusion* in the correct context.

Example candidate response – grade E


In respiring tissues, the partial pressure of CO_2 is high, about 6.00 KPa. the ~~haemoglobin~~ red blood cells pick up the ~~oxy~~ carbon dioxide gas. The ~~p~~ pCO_2 is higher than the PO_2 ~~in the~~ at the venous end. The blood moves to the alveolus. Since the pCO_2 is low in the alveolus, CO_2 diffuse out of the blood to go into the alveolus. The pO_2 being 13.87 KPa is higher than in the blood which is only 5.33 KPa. Hence oxygen diffuse from the alveolus into the blood. This how the blood becomes oxygenated and CO_2 is removed. [4]

Examiner comment – grade E

The candidate knew that the movement of oxygen was by diffusion from a higher to a lower partial pressure but has incorrectly made a comparison of the pO_2 with the pCO_2 in each location. A confident understanding of diffusion would have led the candidate to a comparison of the the partial pressures of oxygen in the blood with that in the alveolus, and then a comparison of the partial pressures of carbon dioxide.

Paper 3 – Advanced Practical Skills

Question 1

1 When plant tissue is soaked in methylene blue the tissue takes up the stain and is coloured blue.

Copper sulfate solution affects the selective permeability of cell membranes.

You are provided with

labelled	contents	hazard	concentration / %	volume / cm^3
C	copper sulfate solution	harmful irritant	0.3	60
W	distilled water	none	–	100

labelled	contents	hazard	details	quantity
P	stained plant tissue	methylene blue will stain your skin	same cross-sectional area, stained with methylene blue and washed	5

If any methylene blue comes into contact with your skin wash off immediately with water.

It is recommended that you wear safety goggles/glasses.

You are required to investigate the effect of the independent variable, concentration of copper sulfate solution, on samples of plant tissue which have been soaked in methylene blue.

(a) (i) Decide on the concentrations of copper sulfate solution you will use in your investigation.

You will need 10 cm^3 of each concentration of copper sulfate solution.

Prepare the space below to show

- the concentrations of copper sulfate solution
- the volumes of copper sulfate solution
- the volumes of distilled water.

[3]

Make up the copper sulfate solutions that you have chosen in the containers provided.

Put 10 cm^3 of the appropriate concentration of copper sulfate solution into a labelled test-tube.

You are provided with five pieces of plant tissue with the same cross-sectional area in a container of water, labelled **P**.

Proceed as follows:

(Always use blunt forceps when handling the plant tissue to avoid contact with the methylene blue).

1. Remove the pieces of plant tissue from the container, labelled **P**, and place them onto a white tile.

   You will need to prepare one sample of plant tissue to put into each of the concentrations of copper sulfate solution.

(ii) State which variable you will need to control when preparing the plant tissue samples.

.....[1]

(iii) Describe how you will control this variable and prepare the samples of plant tissue.

.....

.....[2]

2. Prepare the samples of plant tissue as you described in **(iii)**.
3. Empty the coloured water from the container, labelled **P**.
4. Place the samples back into the empty container, labelled **P**.
5. To remove excess methylene blue change the water five times, either using a syringe or by pouring off the water. Do not touch the plant tissue.
6. Remove the samples of plant tissue and add one sample of plant tissue to each test-tube of copper sulfate solution.
7. Immediately start timing.
8. Observe the test-tubes for 5 minutes and record your observations.
9. After five minutes, mix the contents of the test-tubes, by inserting a bung and inverting each test-tube.

(iv) Prepare the space below and record your observations. [5]

(v) Suggest how copper sulfate solution affects plant cell membranes. [1]

(vi) Identify **three** significant sources of error in your investigation. [3]

(vii) Suggest how you would make **three** improvements to this investigation. [3]

[Total: 18]

Mark scheme

Question		Expected Answers		Additional guidance
1 (a) (i)		**Decide on the concentrations of copper sulfate solution you will use in your investigation.**		**[3]**
MMO decisions 3	[1]	any 4 or more (volumes/concentrations);		
	[1]	(highest concentration) 0.3 to 0.15;		
	[1]	any three consecutive concentrations (including 0 if present) with two intervals • the same • or serial dilution by half • or serial dilution by ten;		
	(ii)	**State which variable you will need to control when preparing the plant tissue samples.**		**[1]**
MMO decision 1	[1]	length or surface area or size or dimensions or volume; **Allow** methylene blue		
	(iii)	**Describe how you will control this variable and prepare the samples of plant tissue.**		**[2]**
MMO decisions 2	[1]	(control) measure cut (methylene) rinsing/washing	the same any example of length 3 cm or less/size; excess	
	[1]	(prepare samples) use of scalpel/knife or ruler; (methylene blue) water		

	(iv)	**Prepare the space below and record your observations.**		**[5]**
PDO recording 2	[1]	**Reject** • if units for % in body of table • other units e.g. mol dm^{-3}		
		table with all cells drawn	**AND** heading (top or left) percentage conc(entration);	
	[1]	**Reject** • if headings/columns for method/volumes/time 5 mins or size/lengths		
		(heading) colour or observations or description;		
MMO collection 2	[1]	(records clear separate observations/colours) after/during 5 min/before mixing	**AND** after mixing (after/at 5 min);	
	[1]	difference in the strength of colour between the first and last test-tube observations;		Key e.g. + = colour
MMO decision 1	[1]	5 or more concentrations or observation for water or replicate recorded;		
	(v)	**Suggest how copper sulfate solution affects plant cell membranes.**		**[1]**
ACE conclusion 1	[1]	In correct context of increasing or just copper sulfate Idea of damages or destroys	it or ((cell) membrane(s)) phospholipid(s) fluid mosaic (model/structure)	
		or makes more	(fully) permeable	
		denatures	protein	
		(increases copper sulfate) } increases (decreases copper sulfate) } decreases	fluidity permeability	
		(increases copper sulfate) } decreases (decreases copper sulfate) } increases	selective permeability;	

(vi) Identify three significant sources of error in your investigation. **[3]**

ACE interpretation MAX 3

Reject
temperature pH
evaporation
any errors which affect all test-tubes equally

	Cause of error	Error	
	(dependent)		
[1]	qualitative;		
	colour/colour change/observations	difficult judging	
[1]		seeing;	
[1]		qualitative;	
[1]	mixing	more difficult to judge colour/colours the same;	
	(standardised variables) potato		
	or position in potato	not same	
	or age	different/variety	
[1]	or storage	old;	
[1]	lengths/size/surface areas/volumes **Allow** mass	not same;	
		not same	
	staining/washing/handling/forceps	loses stain damages potatoes	
[1]		ends not stained or middle more stain;	
[1]	potato/samples (into test-tubes)	time not same/delayed time/not at same time;	max 3

	(vii)	**Suggest how you would make *three* improvements to this investigation.**	**[3]**
ACE improvements MAX 3	[1]	same potato or position in same age or storage or fresh use micrometer/cork borer/vernier callipers/ruler with smaller divisions;	
	[1]	leave in methylene blue longer/stronger concentration/more than 5 minutes idea of wash more;	
	[1]	more/wider/narrower/different/examples range of concentrations or use burette or graduated pipette or smaller syringe or with smaller divisions;	
	[1]	stagger start or do individually or use more stop clocks or use help;	
	[1]	colorimeter or datalogger with light sensor; **Reject** calorimeter	
	[1]	repeat or replicate;	max 3
		[Total: 18]	

Example candidate responses – grade A

(a) (i) Decide on the concentrations of copper sulfate solution you will use in your investigation.

You will need 10 cm^3 of each concentration of copper sulfate solution.

Prepare the space below to show

- the concentrations of copper sulfate solution
- the volumes of copper sulfate solution
- the volumes of distilled water.

[3]

Relative concentration of copper sulphate solution	Volume of copper sulphate solution /cm^3	Volume of distilled water /cm^3
0.30	10	0
0.24	8	2
0.18	6	4
0.12	4	6
0.06	2	8
0.00	0	10

[3]

Make up the copper sulfate solutions that you have chosen in the containers provided.

Put 10 cm^3 of the appropriate concentration of copper sulfate solution into a labelled test-tube.

3

The length of the plant tissue [1]

(iii) Describe how you will control this variable and prepare the samples of plant tissue.

A ruler is used to measure 1cm of the ~~potato~~ plant tissue and then cuts vertically with a knife. [2]

(iv) Prepare the space below and record your observations. [5]

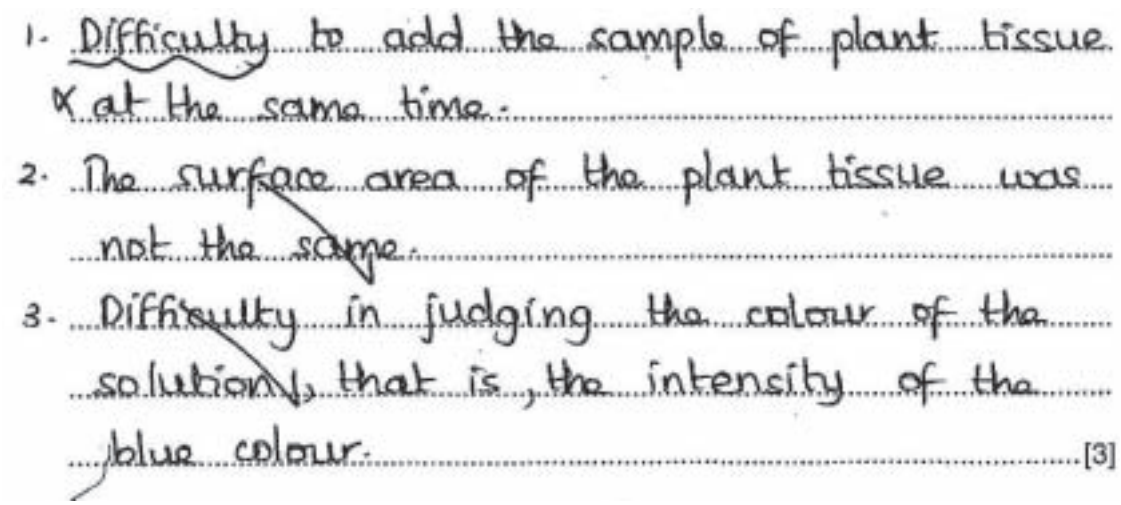
concentration of copper sulphate solution/mbldm^{-3}	colour of solution after mixing. ~~observations colour of solution~~
0.30	Dark blue
0.25	Dark blue
0.20	blue
0.15	blue
0.10	pale blue

X
X
3

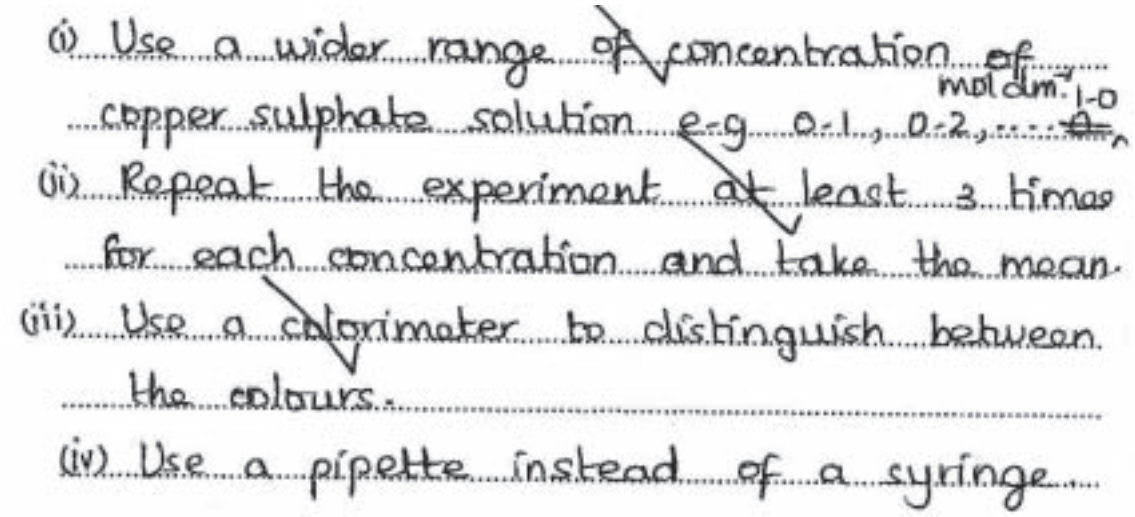
(v) Suggest how copper sulfate solution affects plant cell membranes. [1]

When concentration of copper sulphate solution increases, the plant cell membranes become more permeable and more ~~blue~~ methylene blue pigment diffuses out of the cells. [1]

(vi) Identify **three** significant sources of error in your investigation. [3]


1. Difficulty to add the sample of plant tissue at the same time.
2. The surface area of the plant tissue was not the same.
3. Difficulty in judging the colour of the solution, that is, the intensity of the blue colour. [3]

(vii) Suggest how you would make **three** improvements to this investigation. [3]


(i) Use a wider range of concentration of copper sulphate solution e.g. 0.1, 0.2, ... 1.0 mol dm^{-3},
(ii) Repeat the experiment at least 3 times for each concentration and take the mean.
(iii) Use a colorimeter to distinguish between the colours.
(iv) Use a pipette instead of a syringe.

Examiner comment – grade A

(i) Three marks were awarded for making the correct decisions. This candidate showed a clear understanding of selecting more than four concentrations, using the 0.3% copper sulfate solution provided and the selected concentrations gave a good range to provide good results.

(ii) The candidate selected the correct variable of length.

(iii) The candidate answered the question by describing how the plant tissue would be measured and cut using a ruler to measure and the knife to cut the material.

(iv) Of the two marks for collection, the candidate gained the mark for deciding to collect at least five readings, for the second mark this candidate did not record their observations 'after the first five minutes' as required in step 8.

The marks for PDO recording were for presenting a clearly ruled table with headings for the independent and dependent variables including units which were only in the column heading.

The candidate changed the units for the concentration so could not be awarded this mark. The mark for the dependent variable was awarded.

(v) The candidate showed an understanding that the cell surface membrane had become more permeable as a result of the copper sulfate solution.

(vi) The candidate correctly selected two significant errors. It is important that only those errors which might vary the readings are included.

(vii) The candidate gave three clearly described improvements to gain full credit.

Example candidate response – grade C

(a) (i) Decide on the concentrations of copper sulfate solution you will use in your investigation.

You will need 10 cm^3 of each concentration of copper sulfate solution.

Prepare the space below to show

- the concentrations of copper sulfate solution
- the volumes of copper sulfate solution
- the volumes of distilled water.

Volumes of copper sulfate solution / cm^3	Volumes of distilled water / cm^3	concentration of copper sulfate solution / mol dm^{-3}
10	0	5
8	2	4
6	4	3
4	6	2
2	8	1
0	10	0

50 cm^3 → 0·3 mol

1000 cm^3 → $\left(\frac{0.3}{50} \times 1000\right)$ mol

= 5 mol dm^{-3}

AW ✓

1B, 1D

[3]

(ii) State which variable you will need to control when preparing the plant tissue samples.

The length of the samples [1]

(iii) Describe how you will control this variable and prepare the samples of plant tissue.

By measuring and cutting the sample at same known length [2]

(iv) Prepare the space below and record your observations.

	Observations	
	After 5 minutes.	After mixing contents.
A	Only a small amount of the blue stain came out in the solution.	A very pale blue solution was observed.
B	~~The the solution was much~~ more the diffused stains was more than A	A pale blue solution was observed.
C	~~The~~ More stain diffused out than B	The solution was slightly darker than B
D	~~More~~ Much more stain diffused out than C	The solution was blue
E	The amount of stains diffused out was much more than the above as the upper level of solution was almost dark blue.	The solution was dark blue.

[5]

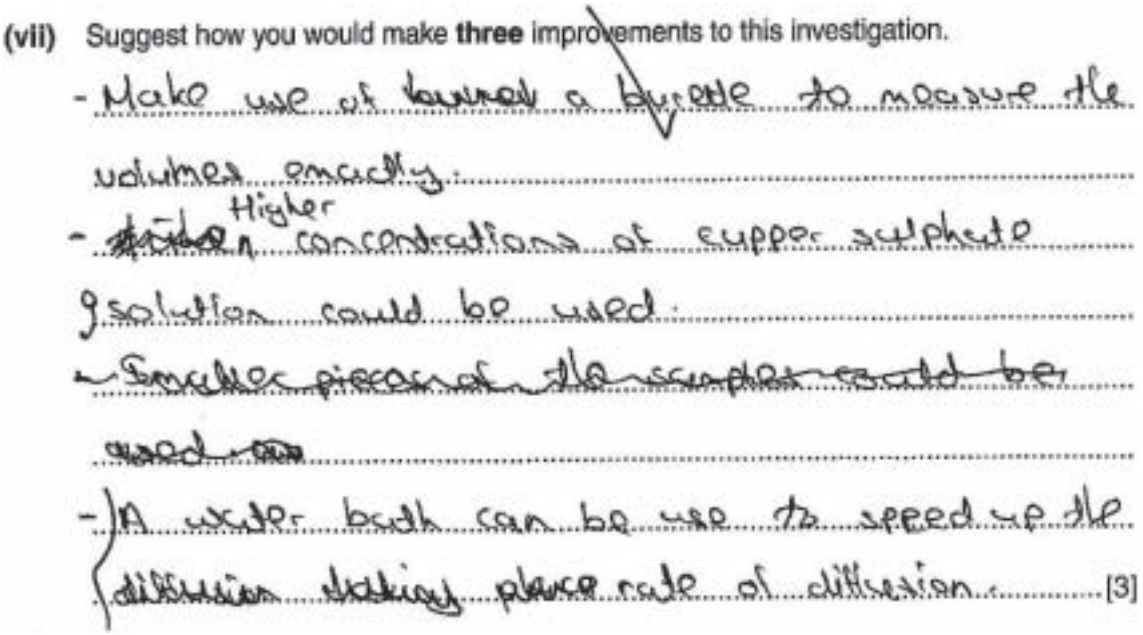
(v) Suggest how copper sulfate solution affects plant cell membranes.

Copper sulphate is a large ion which can diffuses into the cells & makes hole onto it. [1]

(vi) Identify **three** significant sources of error in your investigation.

- When measuring the amount of volumes of either copper sulphate or water, it was not exact with the syringe.
- The samples were not of the same length
- ~~The~~ When putting the samples in ~~different~~ the different concentration of copper sulphate, and starting timing, the time was recorded [3]

not the for all ~~the~~ of them as some were put after starting the


(vii) Suggest how you would make **three** improvements to this investigation.

- Make use of learned a burette to measure the volumes exactly.
- Higher concentrations of copper sulphate solution could be used.
- Smaller pieces of the sample could be used.
- A water bath can be use to speed up the diffusion taking place rate of diffusion. [3]

Examiner comment – grade C

(i) This candidate gained the marks for the four or more concentrations and choosing a suitable range. The candidate did not use the concentration provided to gain full credit.

(ii) The candidate selected the correct variable of length.

(iii) The candidate gained credit for one mark but did not describe how the material would be measured or cut.

(iv) The candidate gained both marks for the collection skills and the mark for deciding to collect at least five readings.

The marks for PDO recording were for presenting a clearly ruled table with headings for the independent and dependent variables including units only in the column heading. This candidate did not have a column for the independent variable. A table of results should aim to provide the data so that trends and patterns can be observed.

(v) The candidate did not understand that the cell surface membrane had been damaged.

(vi) The candidate identified two significant errors correctly. For example the use of the syringe would affect all readings equally.

(vii) The candidate gained credit for describing how one improvement would be made. Candidates should try to consider improvements for the different variables, for example independent, dependent and standardised variables.

Example candidate response – grade E

(a) (i) Decide on the concentrations of copper sulfate solution you will use in your investigation.

You will need 10 cm^3 of each concentration of copper sulfate solution.

Prepare the space below to show

- the concentrations of copper sulfate solution
- the volumes of copper sulfate solution
- the volumes of distilled water.

Concentration of Copper Sulfate Solution / %	Volume of Copper Sulfate Solution added	Volume of distilled water added / cm^3
0.3	60 cm^3 of 0.3%	~~0 cm^3~~ 0
< 0.2	40 cm^3 of 0.3%	20
< 0.1	25 cm^3 of 0.2%	25
0.05	25 cm^3 of 0.1%	25
0.025	25 cm^3 of 0.5%	25

[3]

(ii) State which variable you will need to control when preparing the plant tissue samples.

Length of the plant tissue added ..... [1]

(iii) Describe how you will control this variable and prepare the samples of plant tissue.

Cut each of the plant tissues to a standard length of e.g. 20mm before adding to the test tubes. ..... [2]

1

(iv) Prepare the space below and record your observations.

Test Tube	Length of Plant tissue added/mm	Time that ~~as~~ Plant Added/s min	Observations after 5 min of adding Plant Tissue	observation after shaking test tube with lung attached
0.3 %	20	0.00	A lot of methylene colour released from plant tissue into the surrounding solution.	Solution turned dark blue with Plant tissue still releasing methylene colour.
0.2 %	20	0.10	Slightly less methylene colour released from plant tissue into the surrounding solution compared to that of 0.3 %.	Solution turned blue & shade lighter than that of 0.3 %.
0.1 %	20	0.20	Very little methylene colour released from plant tissue into the surrounding solution.	Solution turned light blue.
0.05 %	20	0.30	Very slight methylene colour released from plant tissue into the surrounding solution.	Solution just had a slight tint of blue.
0.025 %	20	0.40	Almost no methylene colour released from plant tissue.	Solution practically clear, very slight blue colour in the light.

(v) Suggest how copper sulfate solution affects plant cell membranes.

They cause the cell membranes to deteriorate therefore releasing the methyl blue colour. [1]

(vi) Identify **three** significant sources of error in your investigation.

1. The same plant tissue was not used for each test tube & therefore should be controlled X
2. The amount of methyl blue colour standard to each plant tissue ✓
3. Syringes are not the most accurate ~~way~~ ways of measuring solutions. X [3]

(vii) Suggest how you would make **three** improvements to this investigation.

Use ~~egg~~ equal masses instead of measuring length of strips.

Use a wider range of concentrations of copper sulfate.

x Use gloves when handling the strips.

[3]

Examiner comment – grade E

(i) This candidate gained full credit although the range was not even throughout the selected concentrations.

(ii) The candidate selected the correct variable of length.

(iii) The candidate gained credit for one mark but did not describe how the material would be measured or cut.

(iv) The candidate gained both marks for the collection skills and the mark for deciding to collect at least five readings.

The marks for PDO recording were for presenting a clearly ruled table with headings for the independent and dependent variables including units only in the column heading.

This candidate did not head the independent variable column as 'percentage concentration' and also included '%' with the different concentrations. The candidate should not have included additional columns which were not recording results.

(v) The candidate showed an understanding that the copper sulfate solution had damaged the cell surface membrane.

(vi) The candidate attempted to correct the error or did not describe how a particular error would result in the readings varying as a result of the error instead of the change in the independent variable.

(vii) The candidate gained credit for describing how one improvement would be made. Candidates should try to consider improvements for the different variables, for example independent, dependent and standardised variables.

Question 2

2 **K1** is a slide of a stained transverse section through a plant organ.

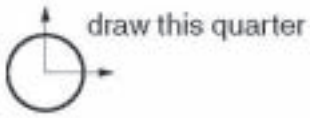


Fig. 2.1

(a) **(i)** Draw a large plan diagram of a quarter of the specimen as shown in Fig 2.1.

Label the endodermis and the cortex. [5]

(ii) Make a high-power drawing of one large xylem vessel and the single layer of cells touching a quarter of the vessel's circumference.

Labels are not required. [5]

Fig. 2.2 is a photomicrograph of a transverse section through a quarter of a different organ from the same plant species.

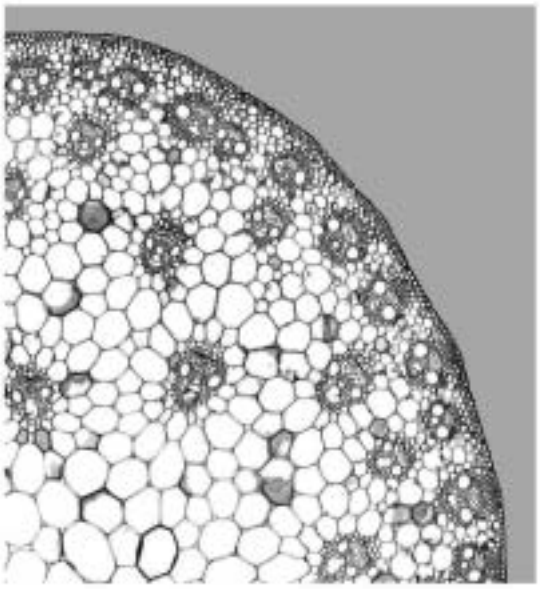


Fig. 2.2

(b) Prepare the space below so that it is suitable for you to record the observable differences between the specimens on **K1** and that in **Fig. 2.2**.

Record your observations in the space you have prepared.

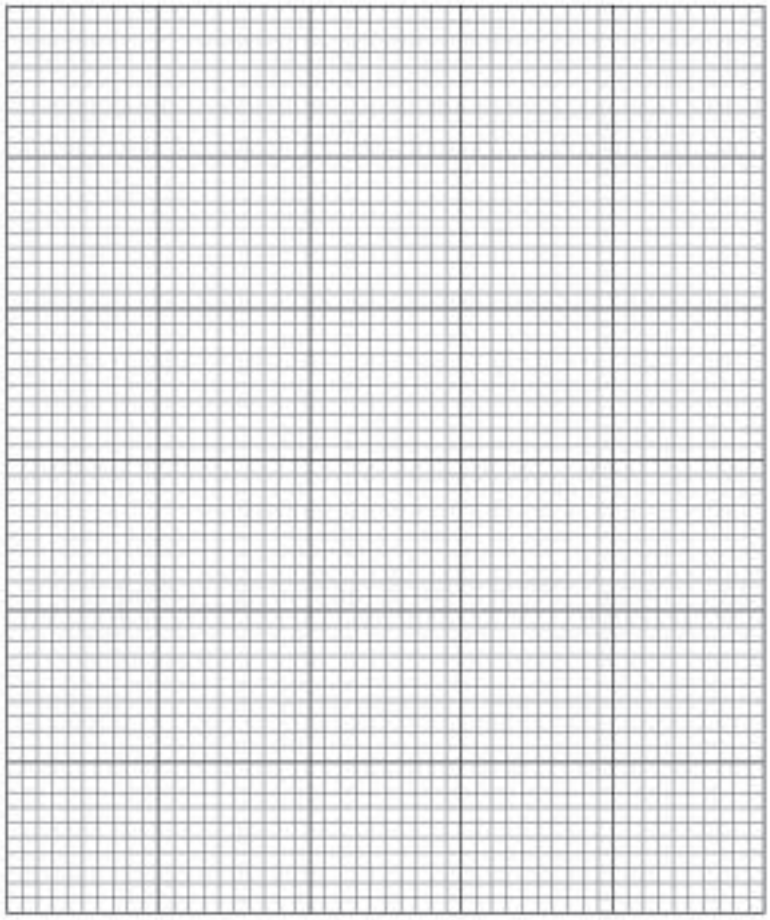
[4]

(c) (i) Table 2.1 shows the results of an investigation into the contents of phloem sieve tube elements.

Table 2.1

contents	concentration in phloem sieve tube elements / $\mu g\,cm^{-3}$
sucrose	120
ammonium ions	45
calcium ions	85
magnesium ions	105
sodium ions	115

Plot a chart of the data shown in Table 2.1.



[4]

(ii) The contents of the xylem vessels were also investigated and the concentration of calcium ions was found to be 190 $\mu g\,cm^{-3}$.

Use the result for the xylem vessels and the data from Table 2.1 to calculate the percentage difference between the concentration of calcium ions in the xylem vessels and the concentration of calcium ions in the phloem sieve tube elements.

You may lose marks if you do not show your working or if you do not use appropriate units. [2]

(d) The investigation into xylem vessel contents also found that there was no sucrose present.

Suggest why there is 120 $\mu g\,cm^{-3}$ of sucrose in the phloem sieve tube elements.

.....

.....

.....

.....

.....

.....

.....

.....[2]

[Total: 22]

Mark scheme

2 (a) (i)		Draw a large plan diagram of a quarter of the specimen as shown in Fig. 2.1. Label the endodermis and cortex.			[5]
PDO layout 1	[1]	**Reject** • if drawn over the print of question			
		Reject • thick lines-than grid • feathery lines • 3 'tails' or overlaps or gaps	**AND** no shading	**AND** uses most of space provided;	
		clear, sharp, unbroken lines			
MMO collection 3	[1]	no additional cells drawn	**AND** (epidermis shows) only the correct quarter;		
	[1]	epidermis drawn with two lines 3 mm or closer for most of length;			
	[1]	innermost line is wavy/undulating line;			
MMO decision 1	[1]	**Reject** • if any label is biologically incorrect e.g. regions belonging to other organs or animals. • label within drawn area			
		correct label with label lines to cortex and endodermis ;			

	(ii) **Make a high-power drawing of one large xylem vessel and the single layer of cells touching a quarter of the vessel's circumference. Labels are not required.** [5]				
PDO layout 1	[1]	**Reject** • if drawn over the print of question			
		Reject • thick lines – than on grid • feathery lines • 4 'tails' or overlaps or gaps if double lines for all cells • 1 if single line for any cell	**AND** no shading	**AND** uses most of space provided;	
		clear, sharp, unbroken lines			
MMO collection 3	[1]	one xylem vessel drawn **Ignore** band inside	**AND** only single layer of surrounding cells ;		
	[1]	**Reject** if layer of cells all round xylem vessel If xylem vessel not circular/polygonal			
		(surrounding cells) (single layer) three to eight cells in a layer only; **Allow** not touching.			
	[1]	**Reject** any spaces if single line for cell walls. any gaps between cell walls – floating cells			
		(all cells including xylem vessel) no enclosed spaces more than 1mm between adjacent double cell walls;			
Coding 1	[1]	cell walls drawn as double lines with middle lamella between three adjacent cells from surrounding cells;			

(b) Prepare the space below so that it is suitable for you to record the observable differences between the specimens on K1 and that in Fig. 2.2. **[4]**

PDO recording 1	[1]	organise as a table/Venn diagram/ruled boxes		**AND** headed K1 and Fig 2.2	**AND** first difference opposite each other;	K1 | Fig 2.2
ACE interpretation 3						**Ignore** • tick and cross without a key • ref. to non-observable features • 3D shapes
			feature	K1	Fig.2.2	
	[1]	1	epidermis	hairs/trichomes **Ignore** root	no hairs/trichomes;	
	[1]			thick(er) or more/2 layers	thin(ner) or few(er);	
	[1]	2	cortex	yes/present/more	no(one)absent/less;	
	[1]	3	endodermis	yes/present	no(one)/absent;	
	[1]	4	pericycle	yes/present	no(one)/absent;	
	[1]	5	vascular bundles xylem	ring/centre/no(one)/absent/ fewer	scattered/AW/towards edge/yes/present/more;	
	[1]	6	thickened cells/ sclerenchyma **Allow** collenchymas bundle sheath/AW	either way round for present/absent/under epidermis;		
	[1]			no(one)/absent	yes/present;	
	[1]	7	pith pith/centre cells	yes/present	no(one)/absent;	
	[1]			rounded	angular/pentagonal/AW;	
	[1] [1]	8	air spaces/lenticels stomata	yes/present no(one)/absent	no(one)/absent; yes/present;	max 3

(c) (i) **Plot a chart of the data shown in Table 2.1.** **MAX 2 for O and S if line graph drawn**				**[4]**
PDO layout 4	O [1]	*x*-axis content(s)	**AND** *y*-axis conc(entration in) phloem or sieve tube/element (*l*) $\mu g\ cm^{-3}$;	Must have units
	S [1]	scale as even widths to 2 cm	**Reject** scale on *y*-axis any other than 20 to 2 cm. AND *y*-axis 20 to 2 cm;	
	P [1]	**Reject** if *y*-axis scale is awkward if bars arranged differently from order of table if horizontal lines are too thick – 1mm/half square or not clear **Allow** bars if scale 20 to 2 cm. even if not 0 25 to 2 cm correct plotting of each bar;	horizontal top line must be clear, sharp and ruled to show plot line must be on horizontal line for sucrose line must be between two lines for all other contents	
	L [1]	each bar separate if vertical lines only then must be at least 1 cm apart.	**AND** quality – vertical lines no thicker than on grid, not feathery for the complete line; bars – • ruled lines **Reject** irregular thickness • labelled clearly with contents – any clear labels e.g. chemical formulae NH_4, Ca, Mg, Na or mixture – underneath, must be directly below correct bar or inside bar or shaded with key.	**Reject** solid shading If line shading outside a bar

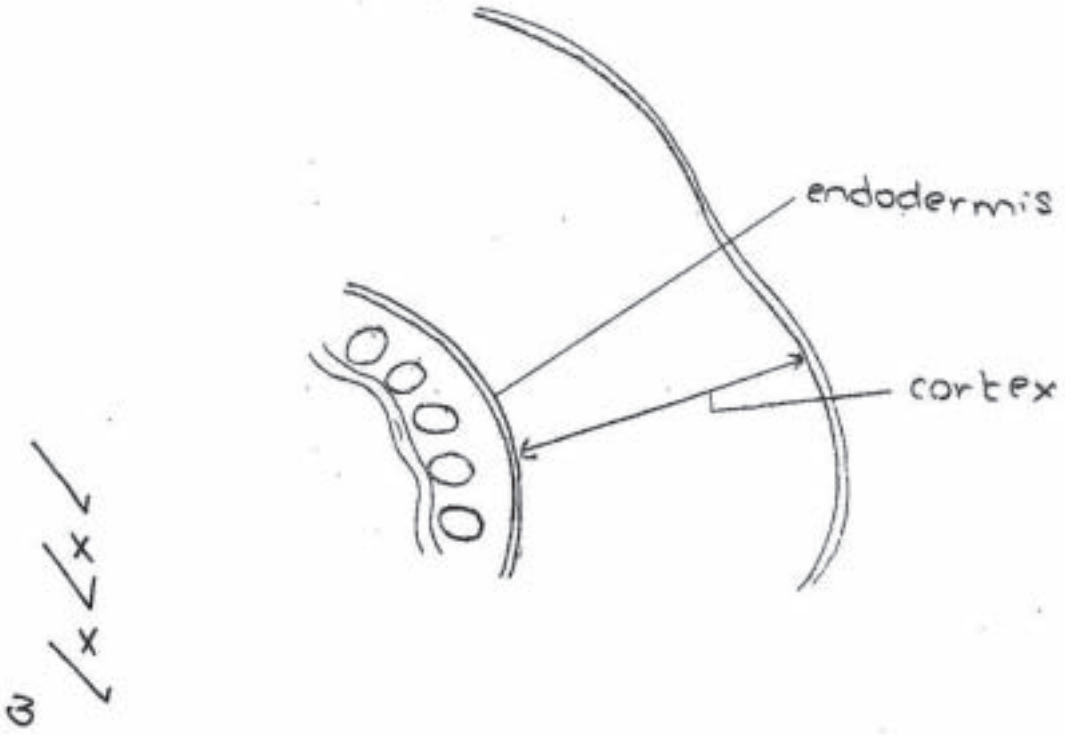
	(ii) Calculate the percentage difference between the concentration of calcium ions in the xylem vessels and the concentration of calcium ions in the phloem sieve tube elements.			**[2]**
PDO display 2	[1]	shows subtraction (190 – 85) divided by 190 multiplied by 100; (190/190 – 85/190) × 100 or (1 – 85/190) × 100		
	[1]	**Reject** if no working **Allow** any answer less than 100 to no more than 3 significant figures 1 decimal place	**AND** percentage/%;	
	(d) Suggest why there is 120 µg cm^{-3} of sucrose in the phloem sieve tube elements.			**[2]**
ACE conclusions MAX 2	[1]	(phloem sieve tube elements) (sucrose) transported leaf(ves)/allow type of leaf cell/source to roots/other tissues/sink(s);		
	[1]	(detail) load(ed) (in source) or (transported by) mass flow/bulk transport/translocation (sucrose) too large to move out of phloem or sieve tubes or xylem walls impermeable;		
			[Total: 22]	

Example candidate response – grade A

(a) (i) Draw a large plan diagram of a quarter of the specimen as shown in Fig. 2.1.

Label the endodermis and the cortex.

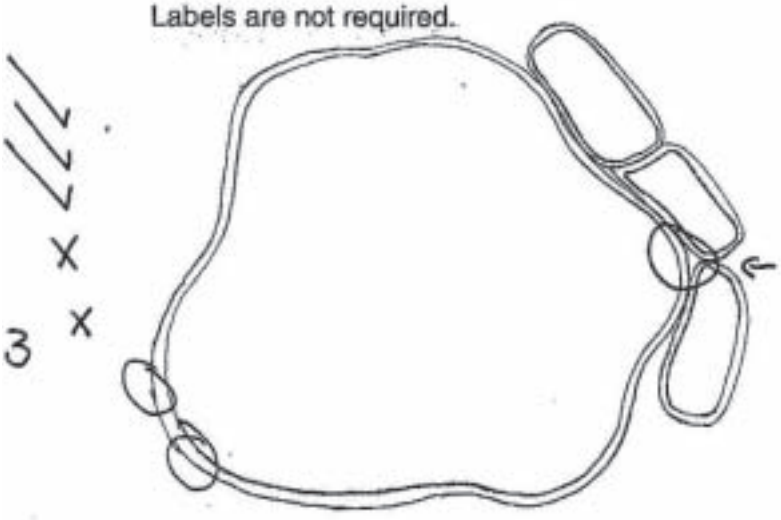
Let 1 e.p.g = 1cm.



[5]

(ii) Make a high-power drawing of one large xylem vessel and the single layer of cells touching a quarter of the vessel's circumference.

Labels are not required.



[5]

(b) Prepare the space below so that it is suitable for you to record the observable differences between the specimens on **K1** and that in **Fig. 2.2**.

Record your observations in the space you have prepared.

Features	K1	Fig. 2.2.
Cortex	small x	large
xylem and phloem cells	closely packed	widespread
parenchyma	absent	present
xylem and phloem cells	far from epidermis, in the centre of cell	near epidermis also

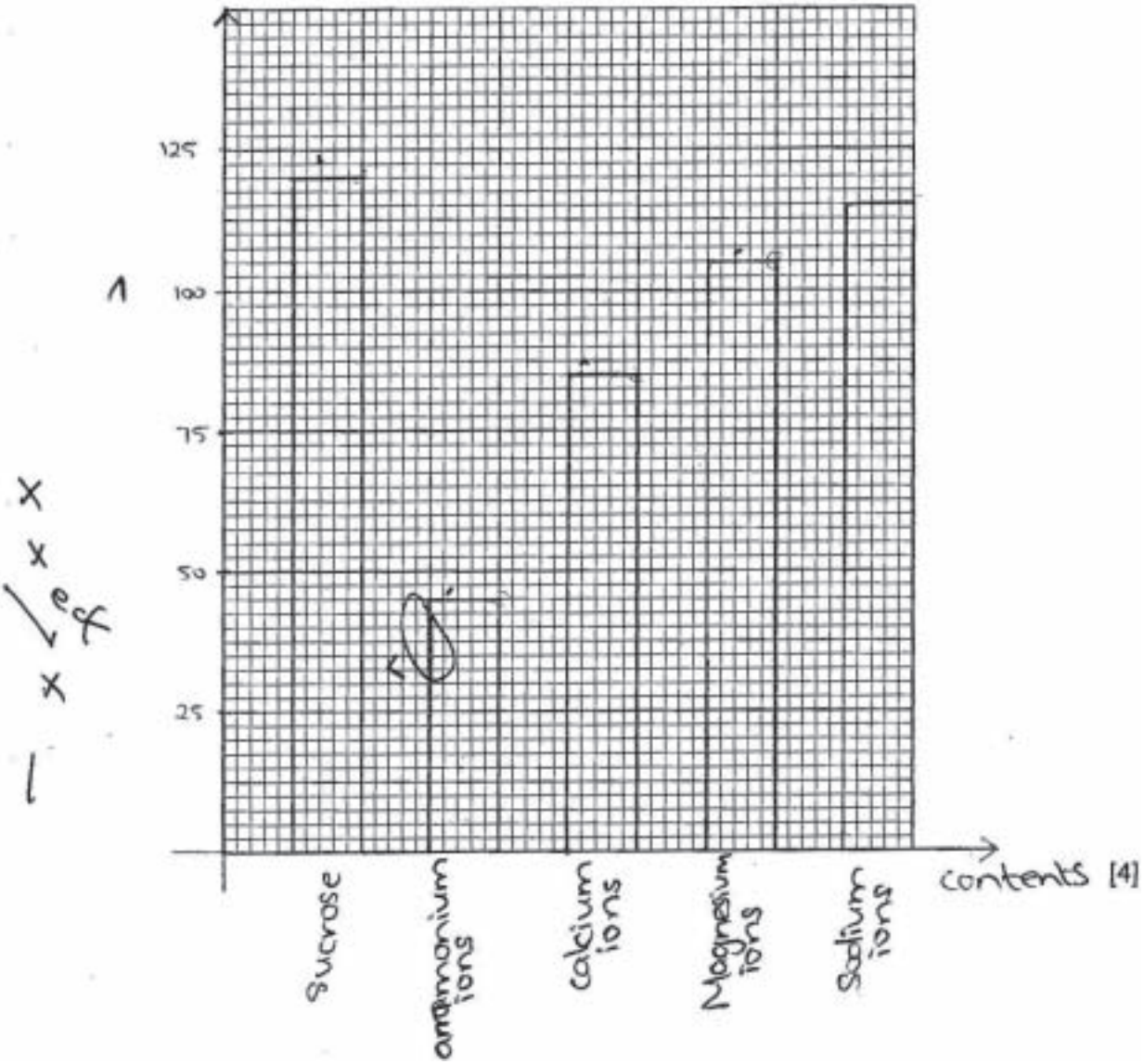
[4]

(c) (i) Table 2.1 shows the results of an investigation into the contents of phloem sieve tube elements.

Table 2.1

contents	concentration in phloem sieve tube elements / $\mu g\,cm^{-3}$
sucrose	120
ammonium ions	45
calcium ions	85
magnesium ions	105
sodium ions	115

Plot a chart of the data shown in Table 2.1.



[4]

(ii) The contents of the xylem vessels were also investigated and the concentration of calcium ions was found to be 190 $\mu g\,cm^{-3}$.

Use the result for the xylem vessels and the data from Table 2.1 to calculate the percentage difference between the concentration of calcium ions in the xylem vessels and the concentration of calcium ions in the phloem sieve tube elements.

You may lose marks if you do not show your working or if you do not use appropriate units.

$$\text{percentage difference} = \frac{(190 - 85)}{190} \times 100$$

$$= \frac{105}{190} \times 100$$

$$= 55.3\%$$

2

[2]

(d) The investigation into xylem vessel contents also found that there was no sucrose present.

Suggest why there is 120 $\mu g\,cm^{-3}$ of sucrose in the phloem sieve tube elements.

Xylem vessel transports water and mineral salts from roots to leaves whereas phloem sieve tube translocates sucrose from leaves to every parts of the plant. Leaves synthesize sugar by photosynthesis. Moreover, phloem has companion cells for active transport of sucrose whereas ~~xylem~~ this is not possible in xylem vessel. [2]

2

Examiner comment – grade A

(a) (i) The candidate gained the PDO layout mark for the quality of their drawing which was un-shaded and used most of the space provided.

For the three collection marks, this candidate understood that the plan diagram should not contain cells but did not follow the instructions to draw a quarter. The epidermis was drawn correctly with two lines. The innermost line did not follow the outline of each vascular bundle so this mark could not be awarded.

The candidate used their knowledge and understanding of the AS syllabus to decide to correctly label the cortex and endodermis.

(ii) The candidate's quality of drawing was awarded the PDO layout mark.

The candidate was awarded the two collection marks for following the instructions carefully and observing a correct number of cells in a quarter. However, no air spaces would have been observed so this mark was not awarded. The PDO recording mark was for the detailed recording of the cell walls by drawing the middle lamella and the thickness of the cell wall between the surrounding cells. Two of the cells were drawn only just touching and this would not have been observed.

(b) The PDO recording mark was for organising their observable differences into a table. This candidate was awarded the mark for a clear table with three columns for the feature and the two specimens.

The candidate did not record any clear observable differences using the correct tissue terms and used the term 'cell' in the incorrect context.

(c) (i) These were PDO layout skill marks for plotting the chart.

The candidate orientated the chart correctly but did not label the *y*-axis so could not be awarded the first mark.

The scale selected for the *y*-axis did not use as much of the grid as 20 to 20 mm and was an awkward scale. The candidate needed to consider the precision of plotting to half a square so 2 mm would be 2.5 and half a square 1.25 $\mu g\ cm^{-3}$, which is awkward, whereas 20 to 20 mm would be 2.0 to 2 mm and so half square would be 1 $\mu g\ cm^{-3}$.

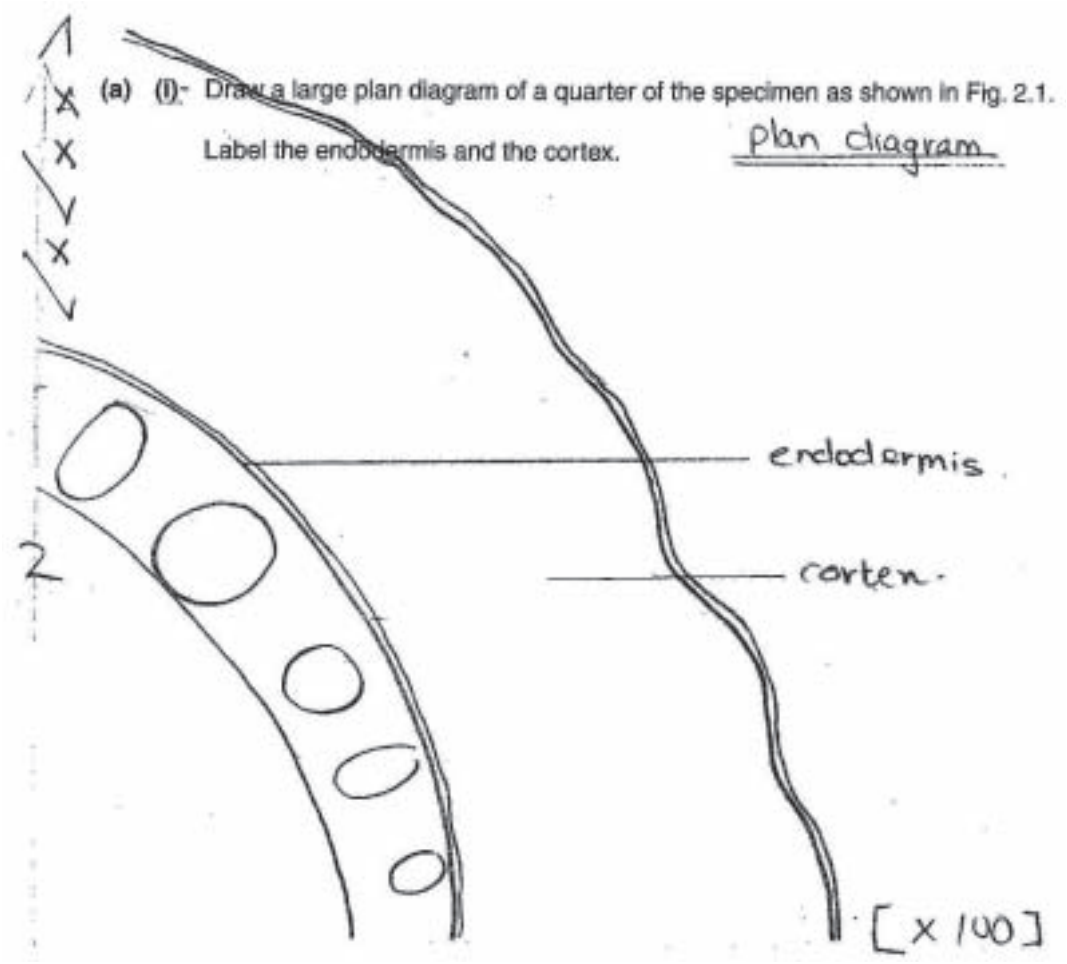
The candidate was awarded the plotting mark.

The line mark could not be awarded as all lines should be sharp, clear and have an even thickness less than 1 mm. The corners of the bars should meet neatly.

(ii) The two marks for PDO display were for showing clearly the arithmetic formula and giving an answer to no more than three significant figures This answer was clearly presented and gained full credit.

(d) The candidate read the question carefully and showed their knowledge and understanding of the translocation of sugars in phloem and the direction of movement to gain full credit.

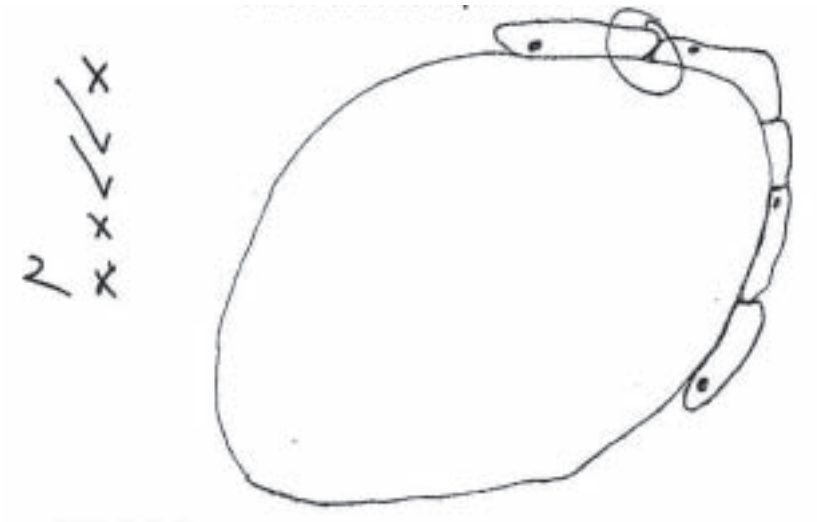
Example candidate response – grade C



[5]

(ii) Make a high-power drawing of one large xylem vessel and the single layer of cells touching a quarter of the vessel's circumference.

Labels are not required. [5]



(b) Prepare the space below so that it is suitable for you to record the observable differences between the specimens on **K1** and that in **Fig. 2.2**.

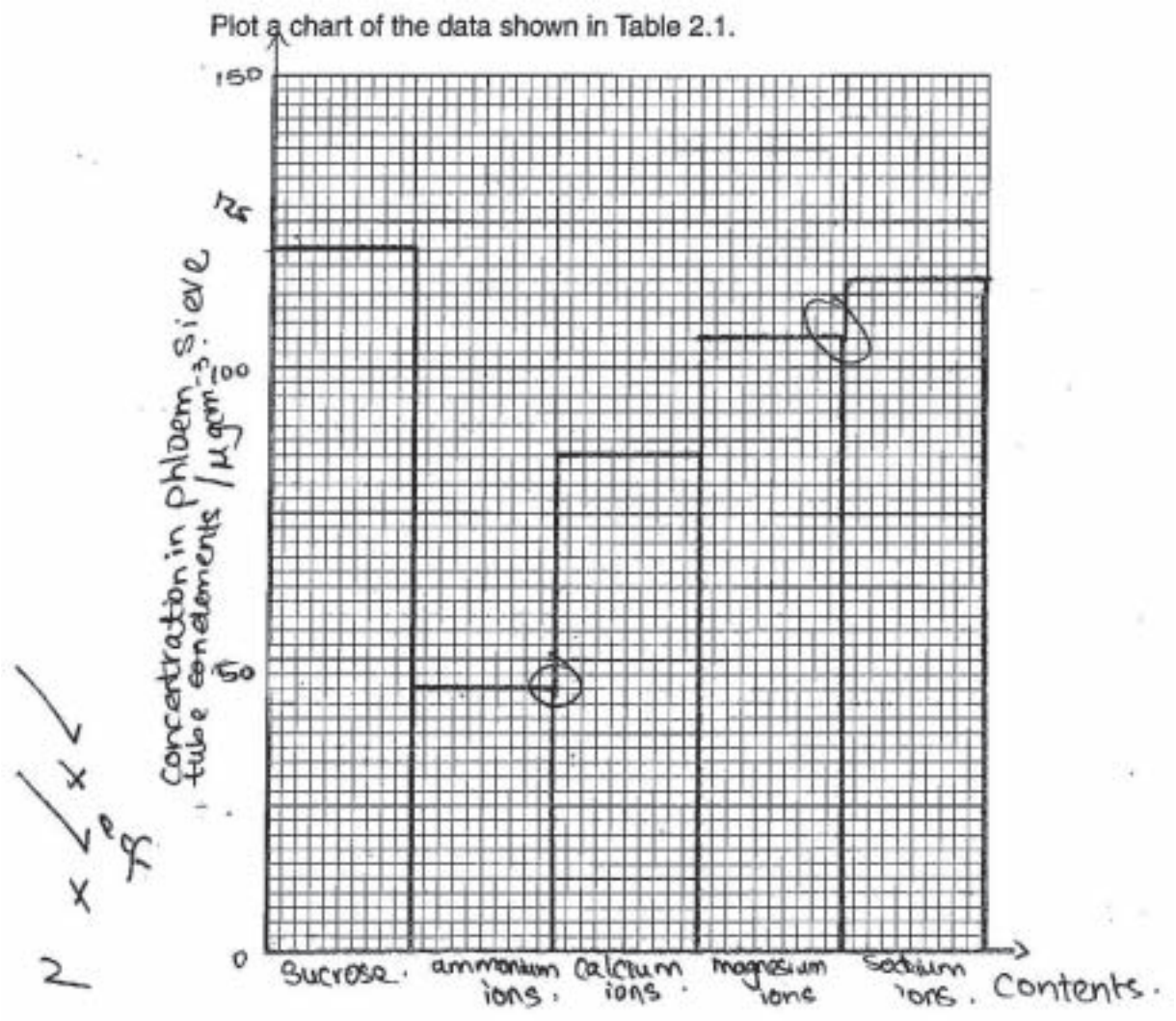
Record your observations in the space you have prepared.

[4]

Structures	K1	Fig 2.2.
1. Vascular bundle	In an orderly manner at the ~~s~~ center ~~from~~	Scattered.
2. corter size	large.	small.
3. endodermis	presence of endodermis	absence of endodermis.
4		

(c) **(i)** Table 2.1 shows the results of an investigation into the contents of phloem sieve tube elements. [4]

Plot a chart of the data shown in Table 2.1.



(ii) The contents of the xylem vessels were also investigated and the concentration of calcium ions was found to be 190 µg cm^{-3}.

Use the result for the xylem vessels and the data from Table 2.1 to calculate the percentage difference between the concentration of calcium ions in the xylem vessels and the concentration of calcium ions in the phloem sieve tube elements.

You may lose marks if you do not show your working or if you do not use appropriate units. [2]

Phloem - 85 µg cm^{-3}
xylem - 190 µg cm^{-3}

difference in concentration = (190 - 85)
= 105 µg cm^{-3}

∴, difference in concentration = $\frac{105}{190+85}$ × 100%
= ~~38%~~ 38.181818%

(delete existing tick)

(Put a tick on answer)

~~Ans 38%~~ Ans 38.2%

(d) The investigation into xylem vessel contents also found that there was no sucrose present.

Suggest why there is 120 µg cm^{-3} of sucrose in the phloem sieve tube elements.

This is because, phloem consists of living cells which transport food substances which include sucrose and also for the living cells to get energy they uses sucrose. but xylem consists of dead cells which transport water and thus no living cells implies no need of energy for cells to work, thus no sucrose.

0

[2]

Examiner comment – grade C

(a) **(i)** The candidate could not be awarded the PDO layout mark as the drawing went over the text of the question.

For the three collection marks, this candidate understood that the plan diagram should not contain cells but did not follow the instructions to draw a quarter. The epidermis was drawn correctly with two lines. The innermost line did not follow the outline of each vascular bundle to be wavy.

The candidate used their knowledge and understanding of the AS syllabus to decide to correctly label the cortex and endodermis.

(ii) The candidate's quality of drawing was not awarded the PDO layout mark as the nuclei were shaded.

The candidate was awarded two collection marks for following the instructions carefully and observing a correct number of cells in a quarter. However no air spaces would have been observed so this mark was not awarded. The candidate did not draw cell walls so the PDO recording mark was not awarded.

(b) The PDO recording mark was for organising their observable differences into a table. This candidate was awarded the mark for a clear table with three columns for the feature and the two specimens.

The candidate gave three very clear observable differences using the correct tissue terms.

(c) **(i)** These were PDO layout skill marks for plotting the chart.

The candidate orientated the chart correctly and labelled the *y*-axis fully so was awarded the first mark.

The scale selected did not use as much of the grid as 20 to 20 mm and did not label every 20 mm on scale. The scale used was an awkward scale. The candidate needed to consider the precision of plotting to half a square so 2 mm would be 2.5 and half a square 1.25 $\mu g\ cm^{-3}$, which is awkward, whereas 20 to 20 mm would be 2.0 to 2 mm and so half square would be 1 $\mu g\ cm^{-3}$.

The candidate was awarded the plotting mark.

The line mark could not be awarded as all lines should be sharp, clear and have an even thickness less than 1 mm. The corners of the bars should meet neatly. The bars should not have been drawn touching but as separate evenly spaced bars.

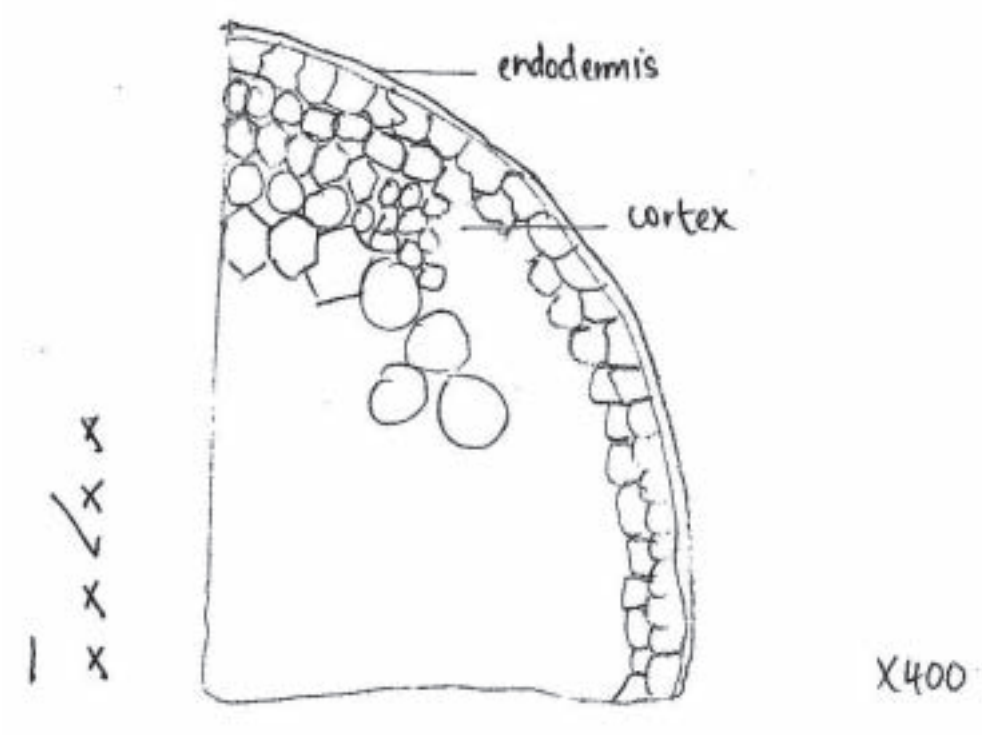
(ii) The two marks for PDO display were for showing clearly the arithmetic formula and giving an answer to no more than three significant figures. The candidate showed the answer to the correct number of significant figures but did not show the complete working.

(d) The question required an answer in terms of why there was sucrose in the phloem not why there was no sucrose in xylem.

Example candidate responses – grade E

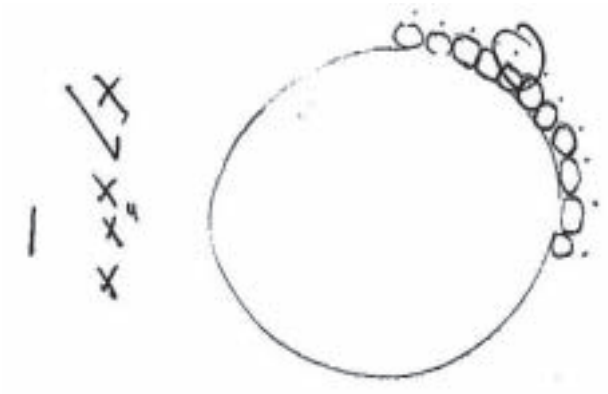
(a) **(i)** Draw a large plan diagram of a quarter of the specimen as shown in Fig 2.1.

Label the endodermis and the cortex. [5]



(ii) Make a high-power drawing of one large xylem vessel and the single layer of cells touching a quarter of the vessel's circumference.

Labels are not required. [5]



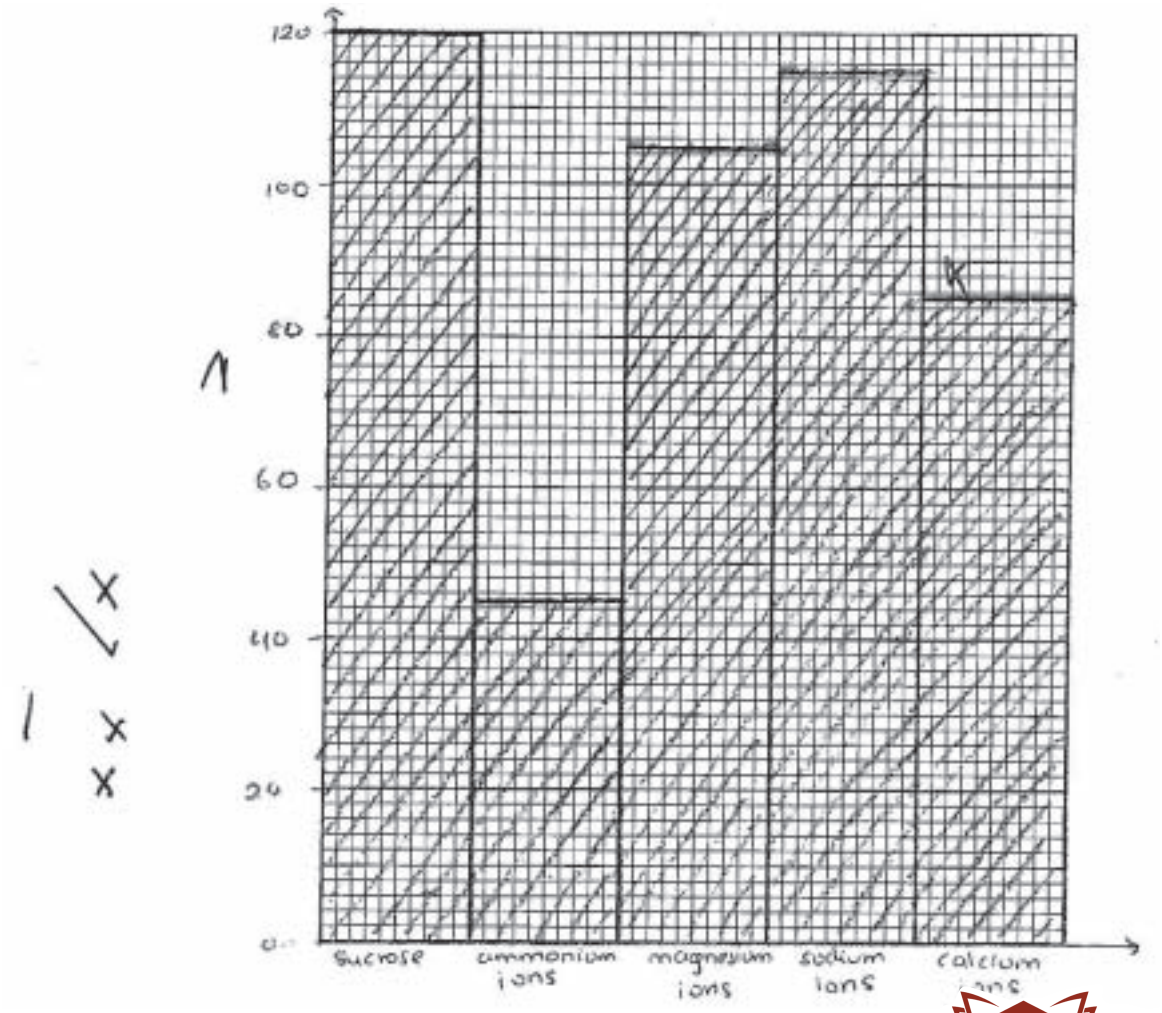
(b) Prepare the space below so that it is suitable for you to record the observable differences between the specimens on **K1** and that in **Fig. 2.2**.

Record your observations in the space you have prepared. [4]

K1	Fig. 2.2.
K1 is only on vascular bundle.	In Fig 2.2 there are many vascular bundle.
The outer lining consists of big cells.	The outer lining consists of smaller cells.
There are white holes which are align in a circle in the cell.	The white holes are scattered or in the centre but align in a circle near the outer layer of cells.
In the sample there is a number of small cells making a circle inside the sample.	There is no such cells inside the sample but the outer layer is relatively very small.

(c) **(i)** Table 2.1 shows the results of an investigation into the contents of phloem sieve tube elements.

Plot a chart of the date shown in Table 2.1. [4]



(ii) The contents of the xylem vessels were also investigated and the concentration of calcium ions was found to be 190 $\mu g\,cm^{-3}$.

Use the result for the xylem vessels and the data from Table 2.1 to calculate the percentage difference between the concentration of calcium ions in the xylem vessels and the concentration of calcium ions in the phloem sieve tube elements.

You may lose marks if you do not show your working or if you do not use appropriate units.

concentration of calcium ions in the phloem sieve tube elements = 85 $\mu g cm^{-3}$.

concentration of calcium ions in the xylem vessels = 190 $\mu g cm^{-3}$.

Difference between both concentrations = 190 − 85
= 105 $\mu g cm^{-3}$

Total concentrations = 190 + 85
= 275 $\mu g cm^{-3}$

Percentage difference = $\frac{105}{275} \times 100$ = 38%. [2]

(d) The investigation into xylem vessel contents also found that there was no sucrose present.

Suggest why there is 120 $\mu g\,cm^{-3}$ of sucrose in the phloem sieve tube elements.

This is because in plants ~~phloem sieve tube elements is~~ the function of phloem sieve tube elements is for the translocation of solutes. Therefore sucrose is found since it is a form of solute. Whereas the function of xylem vessels is to transport water and mineral ions (calcium ions). So there will be no sucrose present. [2]

Examiner comment – grade E

(a) **(i)** The candidate was not awarded the PDO layout mark for the quality of their drawing as the lines did not join up neatly.

For the three collection marks, this candidate did not understand that the plan diagram should not contain cells. The epidermis was drawn correctly with two lines. The candidate did not draw a line for the innermost layer.

The candidate confused the epidermis with the endodermis.

(ii) The candidate's quality of drawing was not awarded the PDO layout mark as there were dots of unknown origin present.

The candidate was awarded one collection mark for following the instructions carefully and drawing one xylem vessel with cells for a quarter. However too many cells were drawn in the quarter and no air spaces would have been observed so these marks were not awarded. The candidate did not draw cell walls so the PDO recording mark was not awarded.

(b) The PDO recording mark was for organising their observable differences into a table. This candidate was awarded the mark for a clear table with two columns for the two specimens.

The candidate did not record any clear observable differences using the correct tissue terms and used the term 'cell' in the incorrect context.

(c) **(i)** These were PDO layout skill marks for plotting the chart.

The candidate orientated the chart correctly but did not label the *y*-axis so could not be awarded the first mark. The candidate selected the correct scale as 20 to 20 mm.

The candidate did not plot the bars in the order in which the data was provided so could not be awarded the mark. The line mark could not be awarded as the bars were drawn touching and should have been drawn evenly spaced.

(ii) The two marks for PDO display were for showing clearly the arithmetic formula and giving an answer to no more than three significant figures. The candidate showed the answer to the correct number of significant figures but did not show the complete working.

(d) The candidate correctly identified translocation as the process used in the transport of sucrose in phloem.

Paper 4 – A2 Structured Questions

Question 1(a)

1 The Great Lakes, in North America, lie between the USA and Canada. A survey of birds of the Lake Ontario area has shown the relative abundance of birds between 1995 and 2005.

Table 1.1 shows the feeding habits and the relative change in numbers of some of the birds in the survey.

Table 1.1

name	feeding habit	percentage change in numbers between 1995 and 2005
mallard *Anas platyrhynchos*	amphibia, plants	+10.0
tree swallow *Tachycineta bicolor*	flying insects	−6.2
blue-winged teal *Anas discors*	aquatic insects, molluscs, plants	−12.3
pied-billed grebe *Podilymbus podiceps*	amphibia, aquatic insects, fish	−15.9
black tern *Chlidonias niger*	aquatic insects, fish, flying insects	−18.7

(a) Using the information in Table 1.1 suggest reasons for the changes in numbers of these birds.

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.....

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..... [4]

Mark scheme

1	(a)	1	mallard numbers have increased **and** the others have decreased ;	
			decrease due to	
		2	pesticides / pollution / fertilisers ;	
		3	change in temperature or pH of water ;	
		4	lack of <u>named</u> food source ;	
		5	<u>increased</u> competition / AW ;	
		6	direct human interference on **lake** ; e.g. fishing / sailing etc *not related to marking point 2*	
			mallard increase due to	
		7	doesn't eat, insects / molluscs / fish ;	
		8	less other birds so <u>less</u> competition ;	[4 max]

Example candidate response – grade A

(+10%) Mallard birds have the highest Percentage change in numbers due to abundance of amphibians and plants in the lake. Also there is less competition for food. While the black tern have the lowest Percentage change in numbers. It decreased steeply in numbers due to competition for food as aquatic and flying insects. Maybe due to predation and hunting. [4]

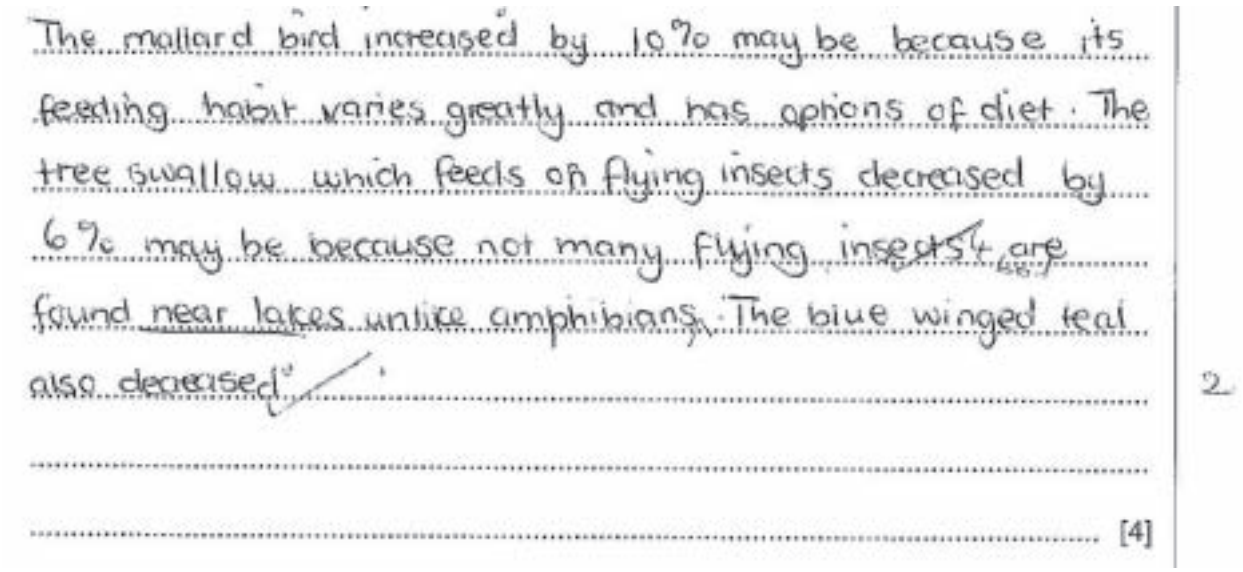
2

The tree swallow feeds on only 1 type of food thus there's no variety in food, they are likely to decrease in number.

Examiner comment – grade A

The candidate was able to correctly show that the reason why the mallard increased in numbers was due to a decrease in competition. Reference was also made to the reduction in numbers of the other birds being the result of hunting. The candidate could have got extra marks by referring to abiotic factors such as water pollution, pH or temperature changes.

Example candidate response – grade C


The mallard bird increased by 10% may be because its feeding habit varies greatly and has options of diet. The tree swallow which feeds on flying insects decreased by 6% may be because not many flying insects are found near lakes unlike amphibians. The blue winged teal also decreased. ✓

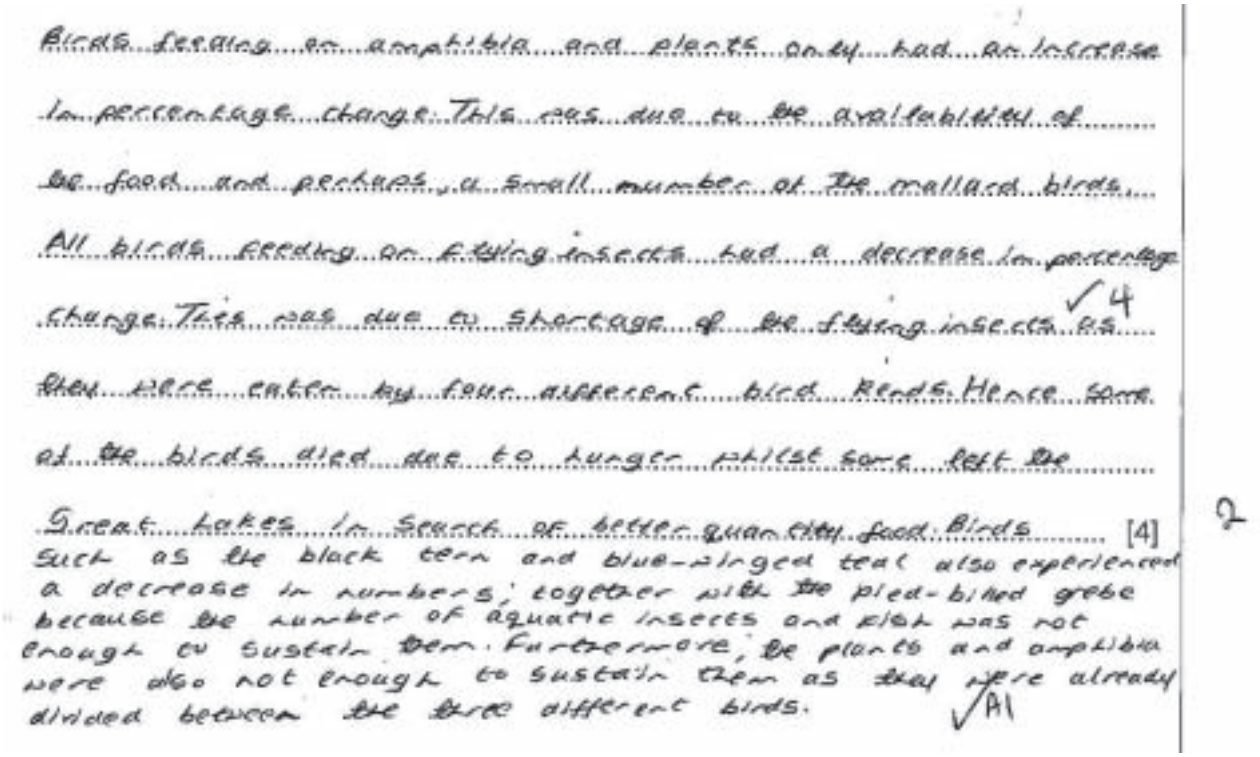
2

[4]

Examiner comment – grade C

This candidate was able to score the first marking point by linking the increase in mallard numbers at the beginning of the answer with the fall in tree swallows and blue winged teals elsewhere in the answer. A reduction in a named food source, flying insects, also gained credit.

Example candidate response – grade E


Birds feeding on amphibia and plants only had an increase in percentage change. This was due to the availability of the food and perhaps a small number of the mallard birds. All birds feeding on flying insects had a decrease in percentage change. This was due to shortage of the flying insects as they were eaten by four different bird feeds. Hence some of the birds died due to hunger whilst some left the Great Lakes in search of better quantity food. Birds [4] ✓4

such as the black tern and blue-winged teal also experienced a decrease in numbers, together with the pied-billed grebe because the number of aquatic insects and fish was not enough to sustain them. Furthermore, the plants and amphibia were also not enough to sustain them as they were already divided between the three different birds. ✓A1

2

Examiner comment – grade E

This question was designed to be accessible to grade E candidates and marks were achieved for mentioning a lack of flying insects as a food source. The first marking point was also achieved in two different parts of the answer.

Question 1(b)

(b) An ecosystem that has a wide range of species has a high biodiversity.

Explain the benefits of maintaining biodiversity.

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.....

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.....

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.....

.....

..... [4]

Mark scheme

(b)

1 cultural / aesthetic / leisure, reasons ;

2 moral / ethical, reasons ; e.g. right to exist / prevent extinction

3 resource material ; e.g. wood for building / fibres for clothes / food for humans

4 ecotourism ;

5 economic benefits ;

6 ref. resource / species, may have use in future / AW ; e.g. medical use

7 maintains, food webs / food chains ; **A** description

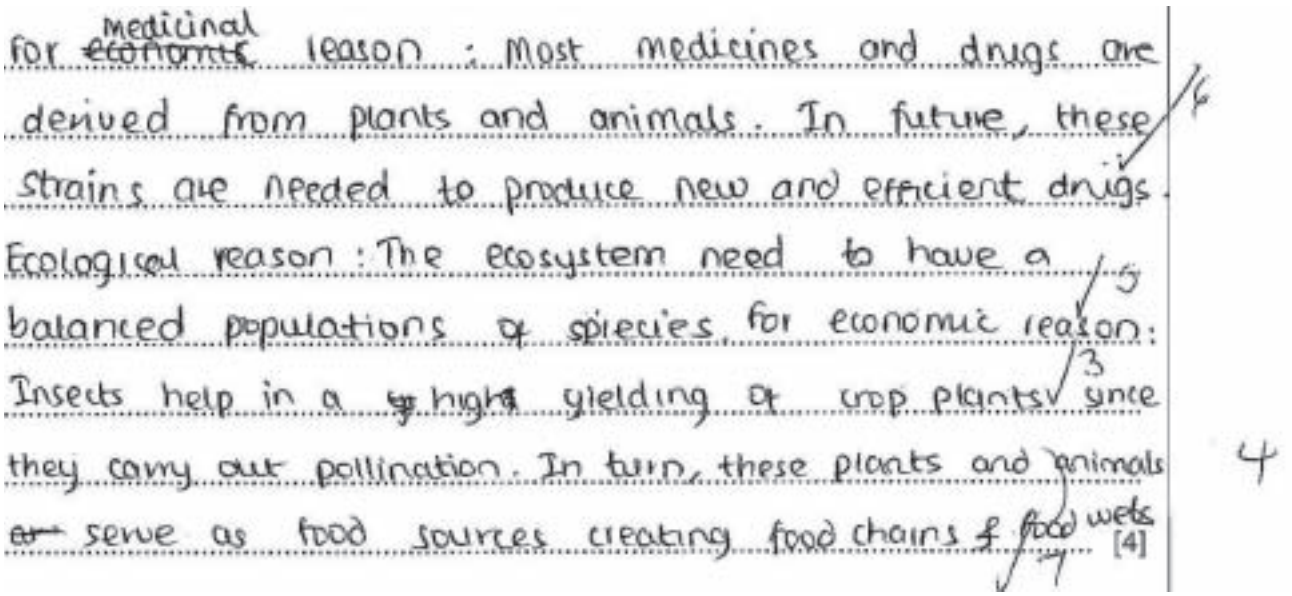
8 nutrient cycling / protection against erosion ;

9 climate stability ;

10 maintains, large gene pool / genetic variation ;

[4 max]

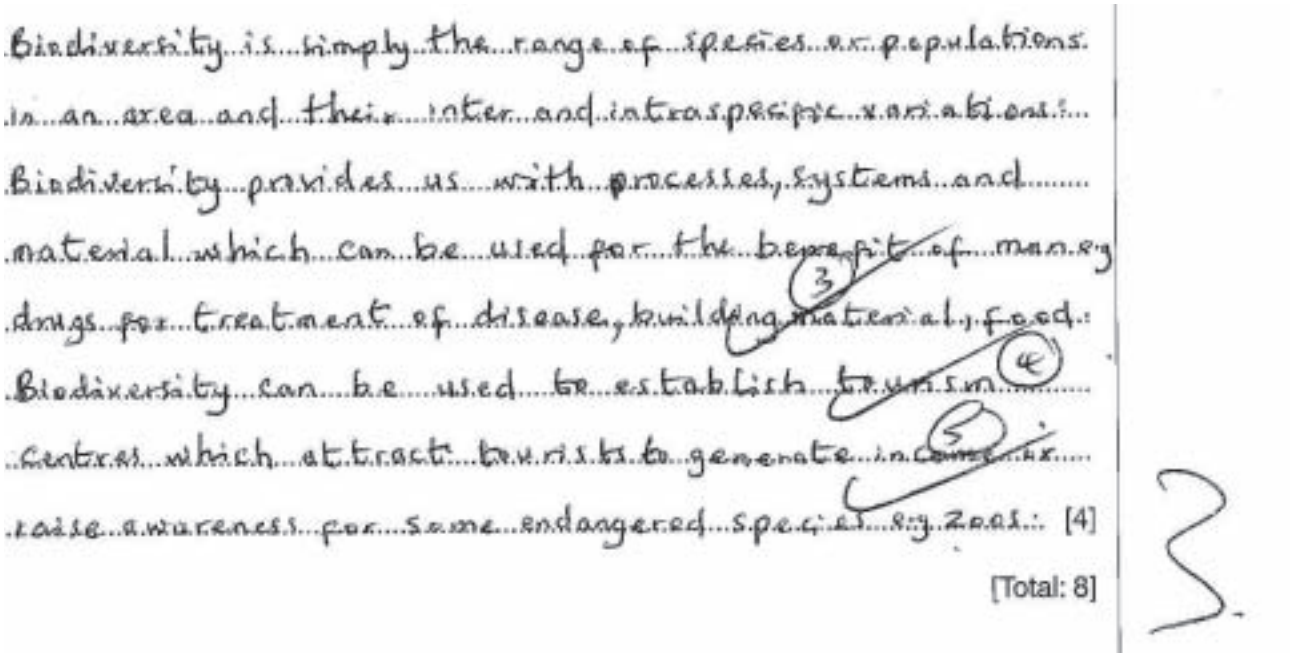
Example candidate response – grade A



Examiner comment – grade A

The candidate clearly understood and explained several of the benefits of maintaining biodiversity. The fact that animals or plants may have medical uses in the future was stated along with economical reasons. A good link between insects and effective pollination of crop plants was made. The importance of maintaining food webs is a key factor in questions on biodiversity.

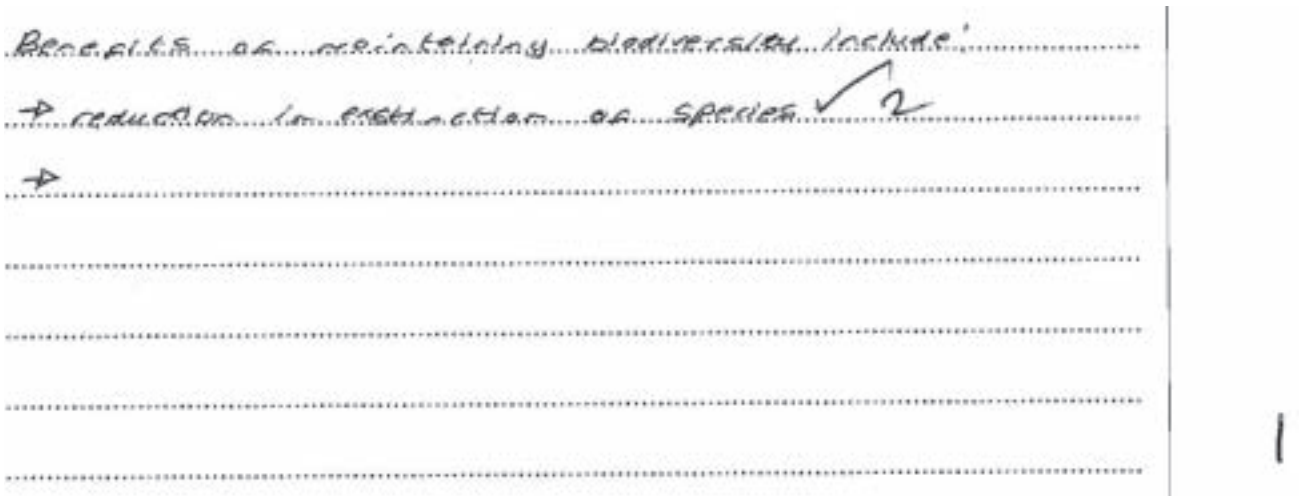
Example candidate response – grade C



Examiner comment – grade C

This candidate was able to give three good answers to illustrate the benefits of biodiversity, namely the use of building materials and tourism to give income to local communities.

Example candidate response – grade E



Examiner comment – grade E

This answer highlights the possible consequences of starting a question with a view to returning to it later. Only one correct answer was eventually given.

Question 2(a)(i)

2 The disease-causing bacterium, *Pseudomonas aeruginosa*, may occur in the form of a 'biofilm'. A biofilm consists of a layer of bacteria, growing on a surface and attached to one another. Such biofilms are difficult to control by antibiotics.

A mutant strain of *P. aeruginosa* has been found which produces biofilms that are indistinguishable from those of the wild-type bacteria. However, the mutant strain differs from the wild-type in its resistance to an antibiotic, **A**.

(a) Antibiotic **A** belongs to a group of antibiotics known as anti-pseudomonal penicillins.

(i) Describe the mode of action of penicillin on bacteria.

.....

.....

.....

.....

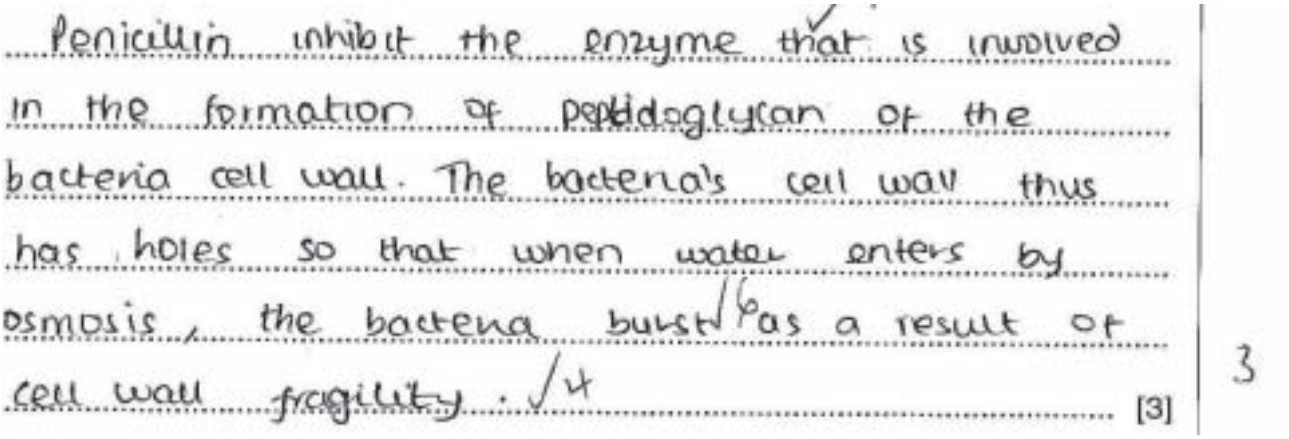
.....

..... [3]

Mark scheme

2	(a)	(i)	1	penicillin inhibits, enzyme / peptidase ;	
			2	blocks / alters shape of, active site ;	
			3	peptidoglycan chains cannot link up / stops cross-links forming ;	
			4	cell wall weaker / AW ;	
			5	turgor of cell not resisted (by cell wall) / AW ;	
			6	cell / wall / bacterium, bursts ;	[3 max]

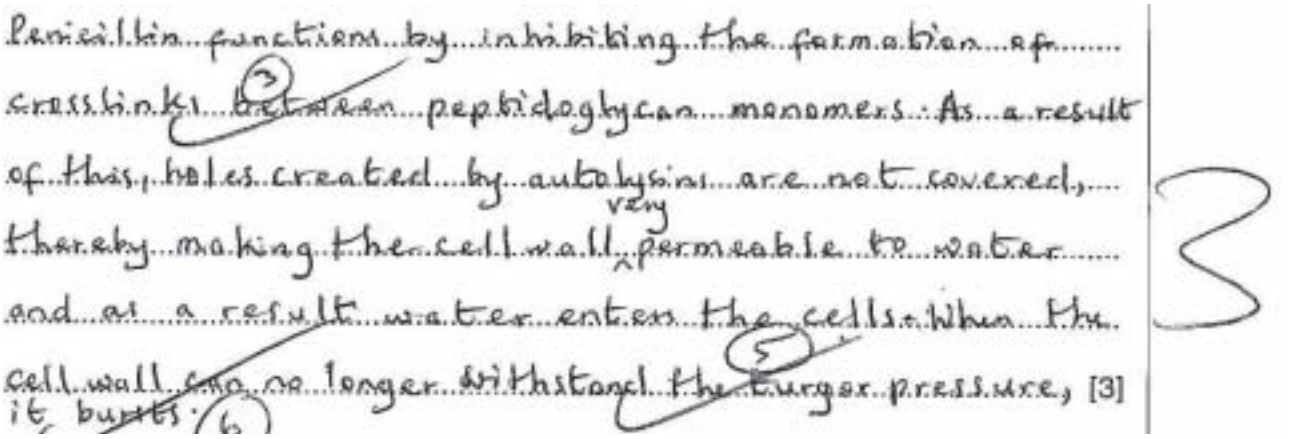
Example candidate response – grade A



Examiner comment – grade A

The candidate was able to clearly state that the enzyme used in the formation of the peptidoglycan wall is inhibited. This was followed by an accurate description of the bursting of the bacteria due to weaknesses in their cell walls.

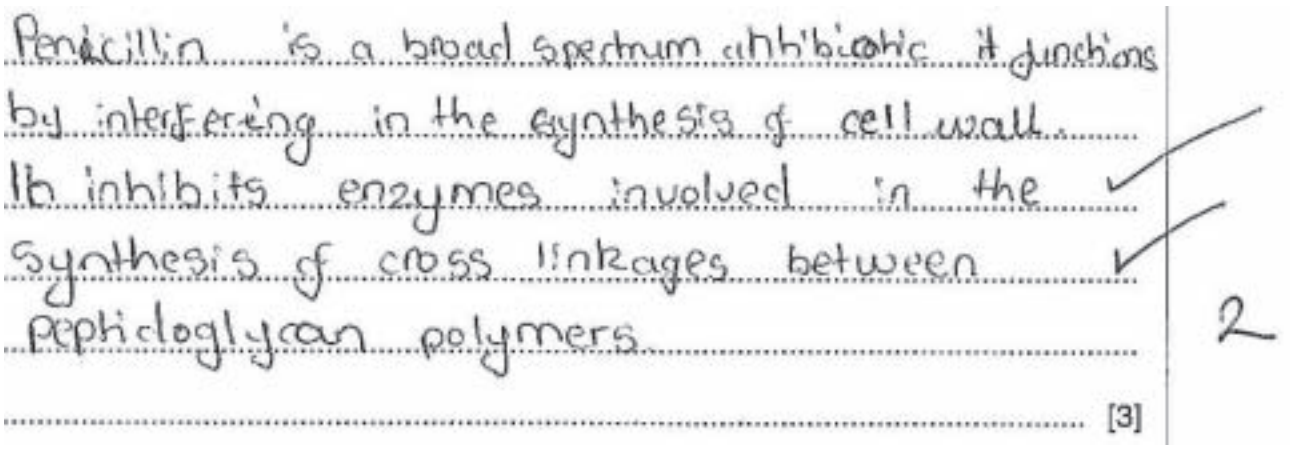
Example candidate response – grade C



Examiner comment – grade C

This candidate has accessed similar marking points to the grade A candidate such as the bursting of the cells due to an inability to withstand turgor pressure. A specific reference to the technical aspect of cell wall production, formation of cross-links between peptidoglycan molecules, was also made earlier.

Example candidate response – grade E


Penicillin is a broad spectrum antibiotic it functions by interfering in the synthesis of cell wall. It inhibits enzymes involved in the synthesis of cross linkages between peptidoglycan polymers

[3]

2

Examiner comment – grade E

The candidate has displayed reasonable knowledge of this topic by mentioning that enzymes involved in the formation of peptidoglycan cross-links are inhibited.

Question 2(b)

(b) Wild-type and mutant bacteria were grown on solid culture media both with antibiotic **A** and without antibiotic **A**.

The subsequent change in numbers of living bacteria is shown in Fig. 2.1.

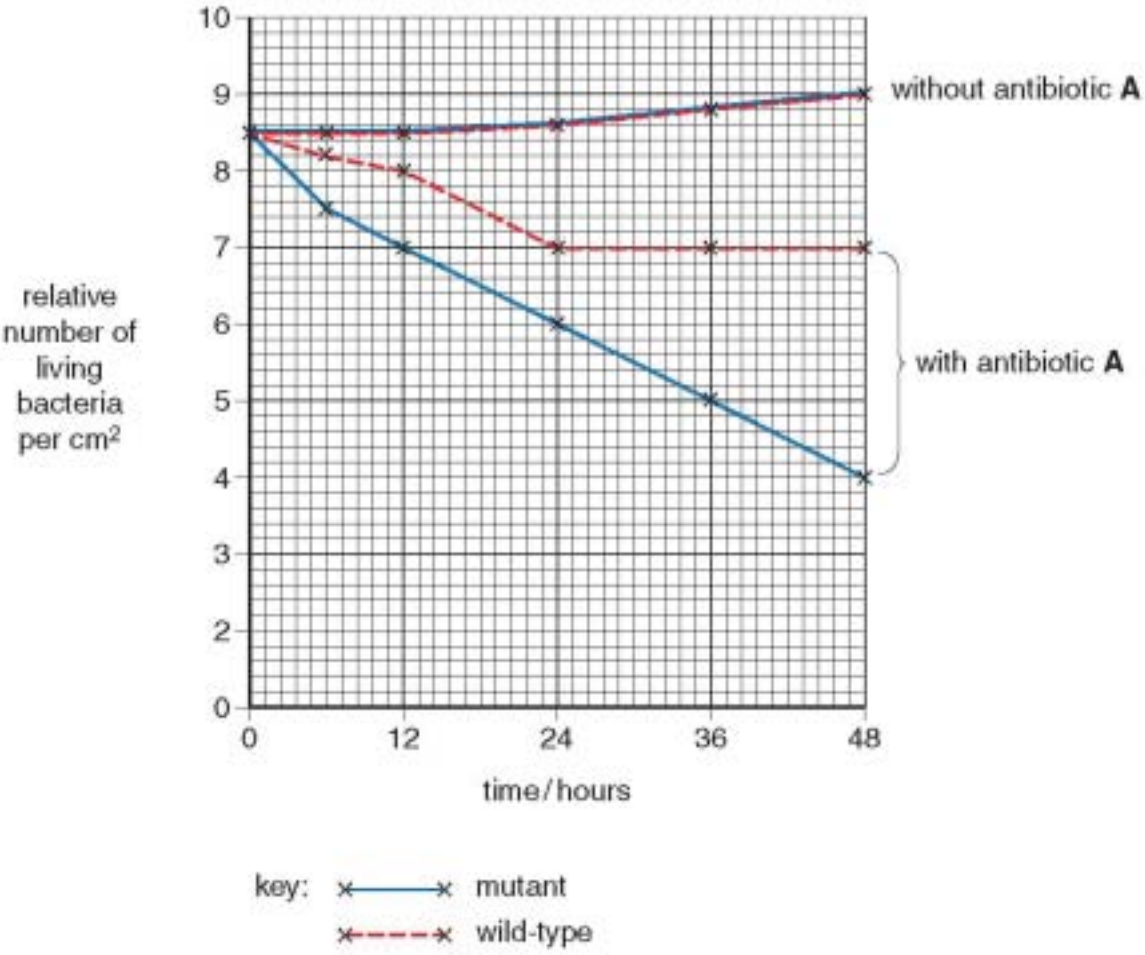


Fig. 2.1

With reference to Fig. 2.1, describe the changes in numbers of the wild-type and mutant bacteria on culture media with antibiotic **A and** without antibiotic **A**. [4]

Mark scheme

(b) *without antibiotic*

1 numbers of both wild-type and mutant strains, increase / hardly changes ;

with antibiotic

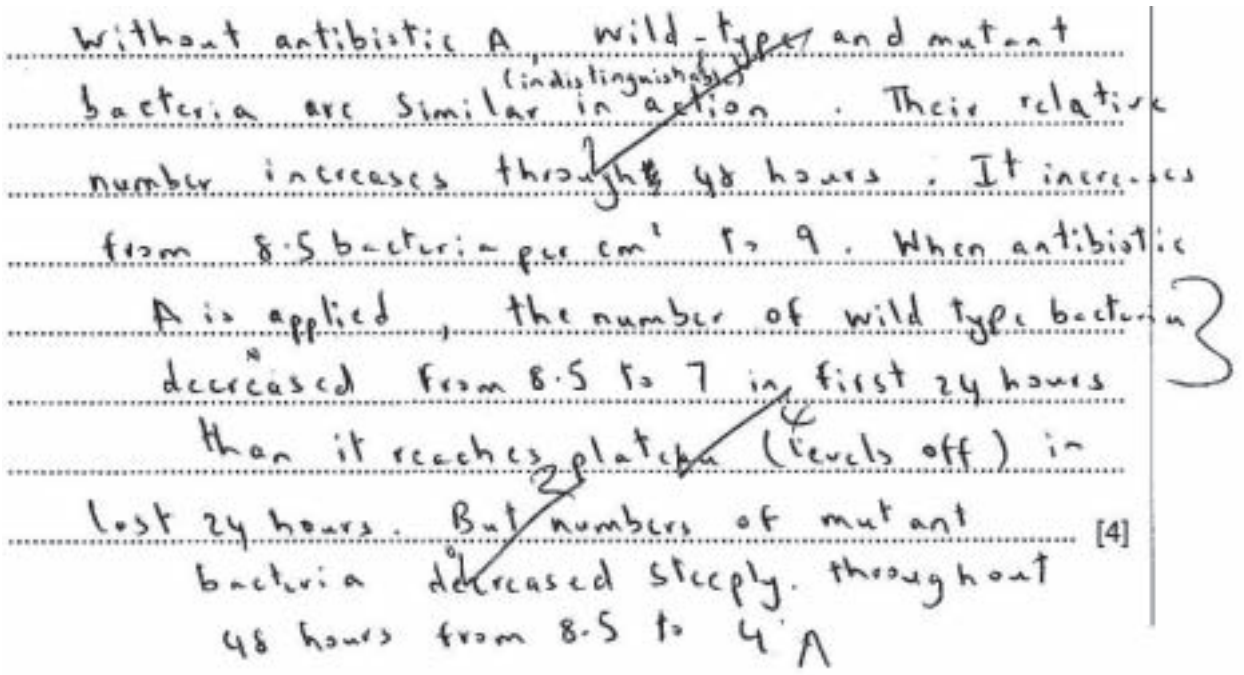
2 numbers of both wild-type and mutant strains decrease ;

3 mutant strains decrease more than wild-type ; **A** faster
this subsumes marking point 2

4 after 24h, wild-type plateaus and mutant strain continues to decrease ;

5 ref. comparative figures at any <u>one</u> time ; *ignore units for bacteria*
blue with blue
red with red
red with blue – with antibiotic [4 max]

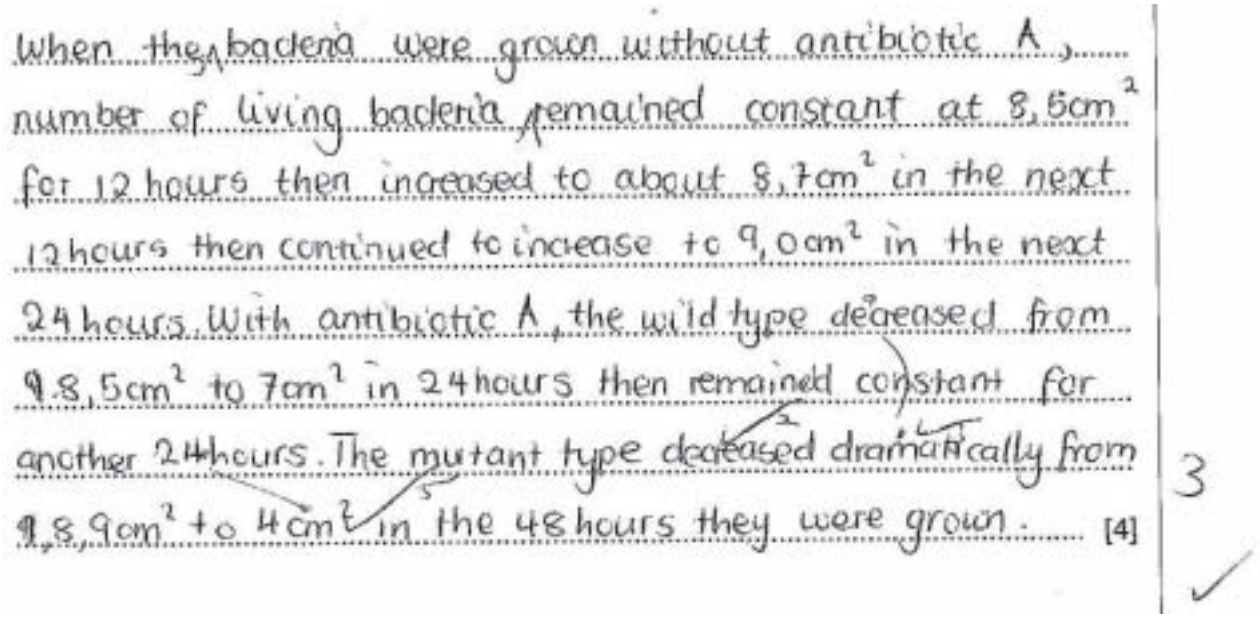
Example candidate response – grade A



Examiner comment – grade A

The candidate was presented with a graph showing the effect of antibiotics on different strains of bacteria. This candidate firstly indicated that without antibiotics the bacteria numbers would increase. Correct comments were then made regarding the decrease in numbers of both strains of bacteria when treated with antibiotics but that the wild type managed to maintain their numbers after 24 hours. Further credit could have been achieved by quoting figures from the graph.

Example candidate response – grade C

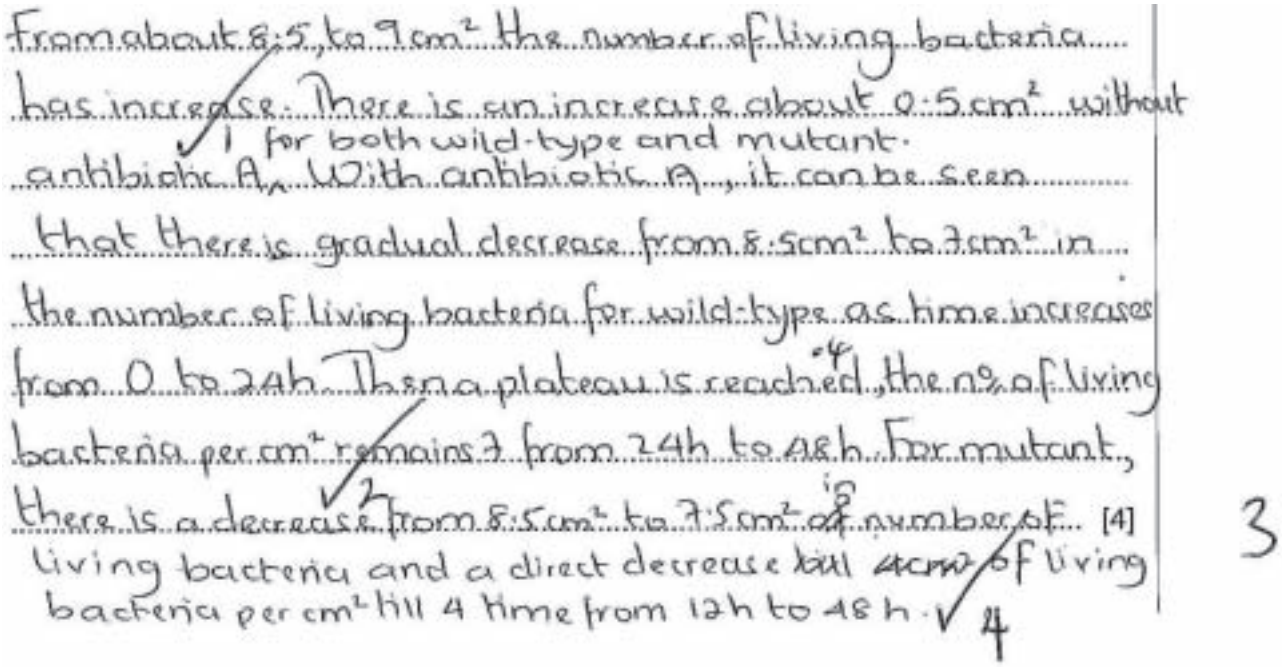

When the bacteria were grown without antibiotic A, number of living bacteria remained constant at 8,5cm² for 12 hours then increased to about 8,7cm² in the next 12 hours then continued to increase to 9,0cm² in the next 24 hours. With antibiotic A, the wild type deceased from 8,5cm² to 7cm² in 24 hours then remained constant for another 24 hours. The mutant type deceased dramatically from 8,9cm² to 4cm² in the 48 hours they were grown. [4]

3

Examiner comment – grade C

This candidate was able to obtain marks by using figures successfully to give a comparison between the effects of antibiotics on both strains. It is worth noting that marking point one was not awarded as both strains were not clearly mentioned.

Example candidate response – grade E


From about 8,5 to 9cm² the number of living bacteria has increase. There is an increase about 0,5cm² without antibiotic A. With antibiotic A, it can be seen that there is gradual decrease from 8,5cm² to 7cm² in the number of living bacteria for wild-type as time increases from 0 to 24h. Then a plateau is reached, the n% of living bacteria per cm² remains 7 from 24h to 48h. For mutant, there is a decrease from 8,5cm² to 7,5cm² of number of living bacteria and a direct decrease till 4cm² of living bacteria per cm² till 4 time from 12h to 48h. [4]

3

Examiner comment – grade E

The response of this candidate shows the accessibility of this question as marking points one, two and four were given for clear descriptive statements.

Question 2(d)

(d) Explain the role of natural selection in the evolution of antibiotic resistance in bacteria.

[3]

Mark scheme

(d)

1 antibiotic, is selective agent / provides selective pressure ;

2 resistant bacteria, survive / reproduce ;

3 pass allele for resistance to offspring ;

4 frequency of allele in population increases ; [3 max]

Example candidate response – grade A

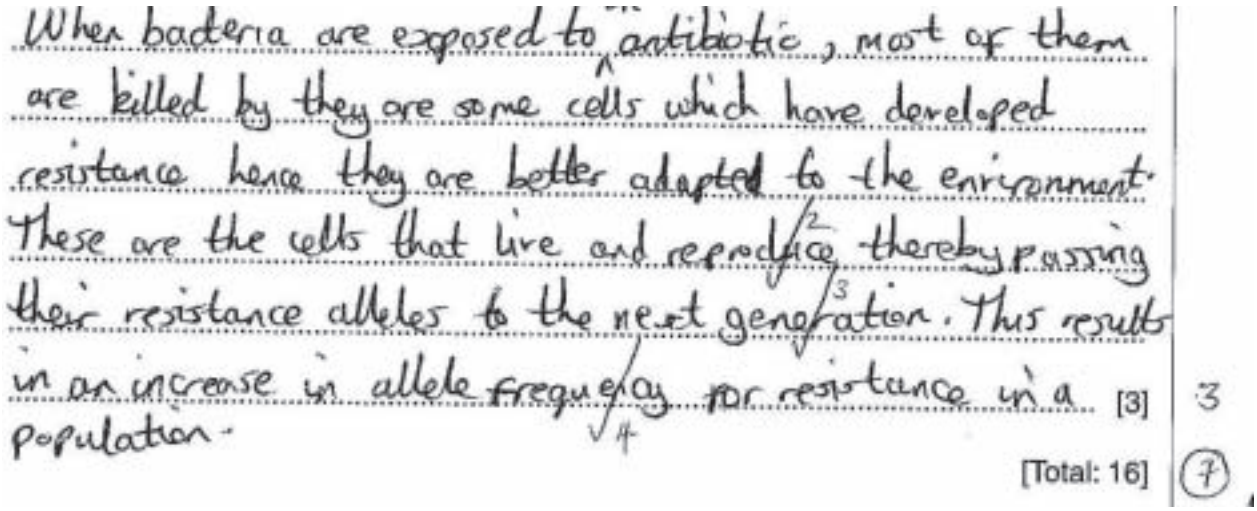
Antibiotic act as Selection pressure on genetically varied bacteria. Bacteria with resistant allele resulting from mutation will have selective advantage and will survive to produce offs carrying resistant allele to their offspring by plasmid transfer. Susceptible bacteria will have selective disadvantage and will die and won't carry their alleles to offspring [3]

[Total: 16]

Examiner comment – grade A

This question required the candidate to link novel information about the relative survival of bacteria strains to the principles of natural selection. The mark scheme allowed only four correct responses for three marks and this candidate was able to state that the antibiotic acted as a selection pressure resulting in resistant bacteria surviving and passing on the advantageous alleles to their offspring.

Example candidate response – grade C


When bacteria are exposed to antibiotic, most of them are killed by they are some cells which have developed resistance hence they are better adapted to the environment. These are the cells that live and reproduce thereby passing their resistance alleles to the next generation. This results in an increase in allele frequency for resistance in a population. [3]

[Total: 16]

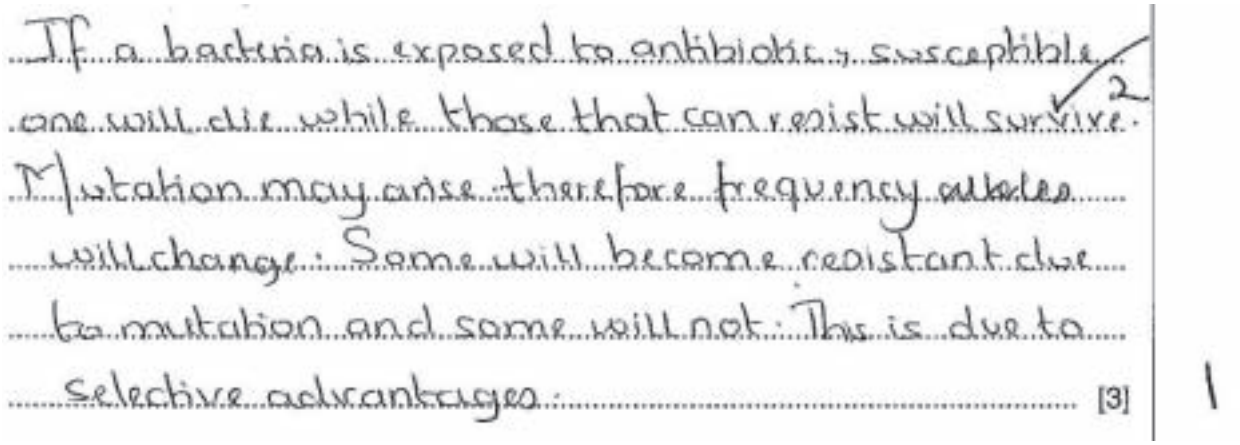
3

7

Examiner comment – grade C

Candidates sometimes lose marks by confusing allele with gene but this was not the case here where the candidate successfully referred to alleles throughout and scored full marks.

Example candidate response – grade E


If a bacteria is exposed to antibiotics, susceptible one will die while those that can resist will survive. Mutation may arise therefore frequency alleles will change. Some will become resistant due to mutation and some will not. This is due to selective advantages. [3]

2

1

Examiner comment – grade E

This candidate was only able to state that resistant bacteria would survive and did not really address the question in terms of natural selection.

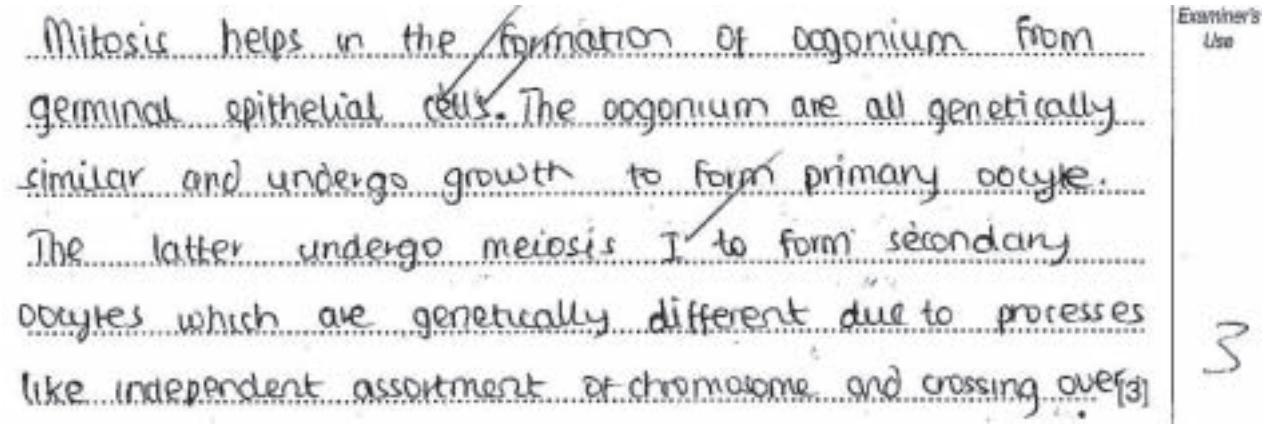
Question 3(b)

(b) State the roles of mitosis and meiosis in producing an immature secondary oocyte. [3]

Mark scheme

(b)	1	germinal epithelial cell divides by mitosis ;	
	2	giving oogonia ;	
	3	primary oocyte divides by meiosis I (to give a secondary oocyte) ;	
	4	idea of diploid to haploid	[3 max]

Example candidate response – grade A


Mitosis helps in the formation of oogonium from germinal epithelial cell. The oogonium are all genetically similar and undergo growth to form primary oocyte. The latter undergo meiosis I to form secondary oocytes which are genetically different due to processes like independent assortment of chromosome and crossing over [3]

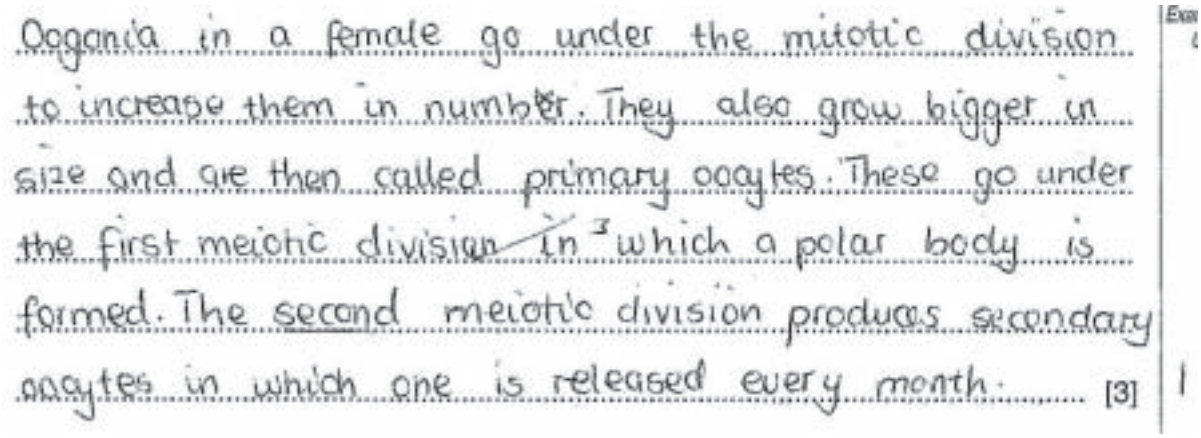
Examiner's Use

3

Examiner comment – grade A

This question relied on knowledge and understanding of oogenesis and should have been straightforward. This candidate was able to achieve the first three marking points quite clearly. The only piece of information not given was the reduction in the number of chromosomes during meiosis.

Example candidate response – grade C

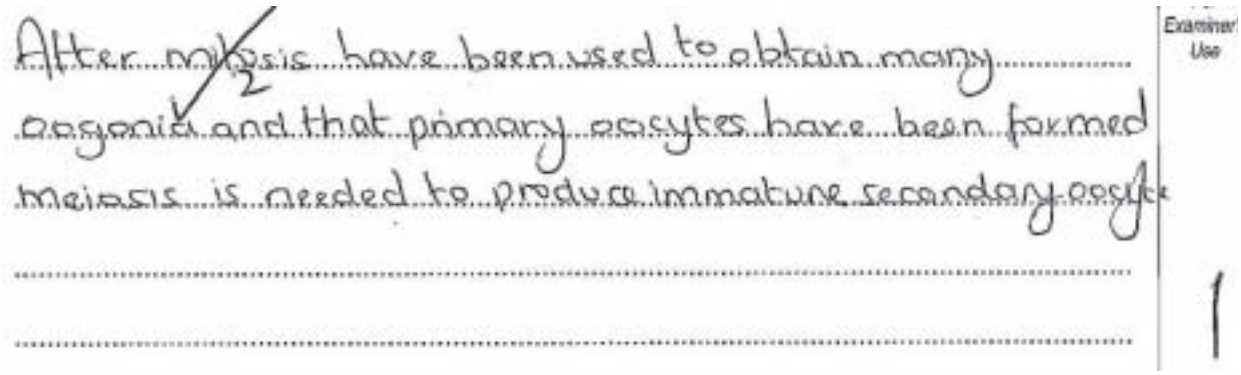

Oogonia in a female go under the mitotic division to increase them in number. They also grow bigger in size and are then called primary oocytes. These go under the first meiotic division in which a polar body is formed. The second meiotic division produces secondary oocytes in which one is released every month. [3]

1

Examiner comment – grade C

The candidate was too imprecise in describing the role of mitosis by concentrating on the multiplication stage of the oogonia rather than the more important role in the production of oogonia in the first place. A correct reference to the division of a primary oocyte by meiosis was given but there was no mention of reduction division.

Example candidate response – grade E



Examiner comment – grade E

This candidate was only able to mention that the oogonia were produced by mitosis. The statement that meiosis produces secondary oocytes was too vague to score a mark.

Question 4(a)

4 The secretion of insulin by the islets of Langerhans in the pancreas stimulates the liver to reduce the blood glucose concentration.

(a) Describe how the **liver** reduces blood glucose concentration, when insulin is secreted.

.....

.....

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.....

.....

..... [3]

Mark scheme

4 (a) 1 binds to receptors (on liver cell membranes) ;

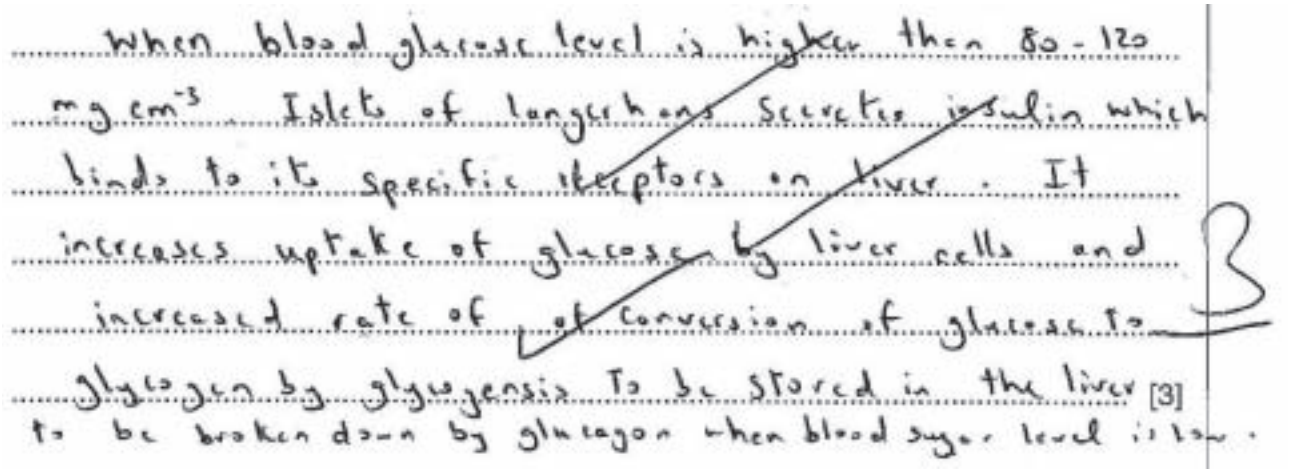
2 conversion of glucose to glycogen / glycogenesis ;

3 (because) insulin activates enzyme ; e.g. glucokinase / phosphofructokinase / glycogen synthase

4 increased use of glucose in respiration ;

5 increased uptake of glucose / increased permeability to glucose (of liver cells) ; [3 max]

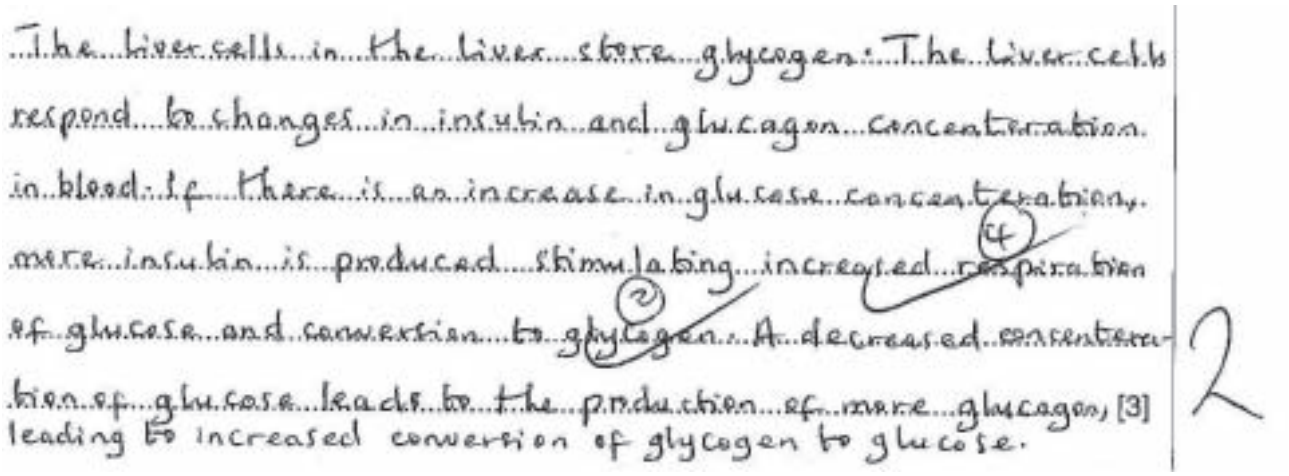
Example candidate response – grade A



Examiner comment – grade A

The candidate was able to give a good description of the effect insulin has on the liver in the reduction of blood glucose concentration. It was good to see that the candidate had mentioned the binding of insulin to liver cell receptors. Increased uptake of glucose by the cells and increased glycogenolysis were responses that many grade A candidates would be expected to make.

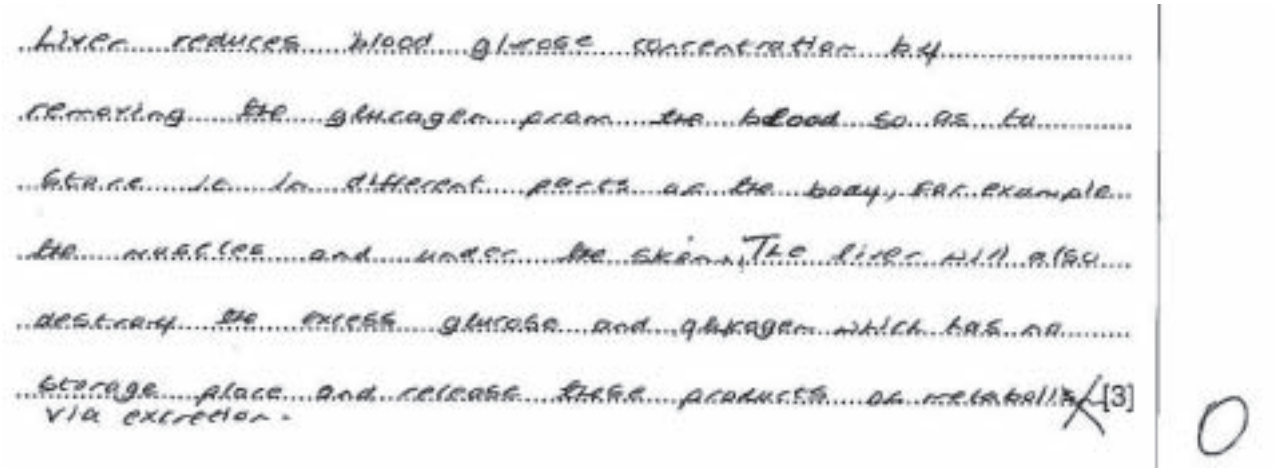
Example candidate response – grade C



Examiner comment – grade C

This candidate's answer highlights a common error which is to not read the question carefully enough. Here there is reference to both insulin and glucagon and their effects whereas only the effects of insulin were required. The candidate still managed to score two marks but time has been wasted.

Example candidate response – grade E



Examiner comment – grade E

The answer given by this candidate shows how important it is to thoroughly learn what would appear to be straightforward parts of the syllabus. The answer here is confused and contains inaccurate biology.

Question 4(c)(i)

(c) Most people with type I diabetes inject insulin. A recent product contains insulin that can be administered using a nasal spray. The spray is inhaled and the insulin is taken up through the lungs.

Fig. 4.2 shows the concentration of insulin in the blood plasma in the 480 minutes after injecting or inhaling insulin. In both cases, the insulin was of the same type, obtained from genetically engineered *Escherichia coli*.

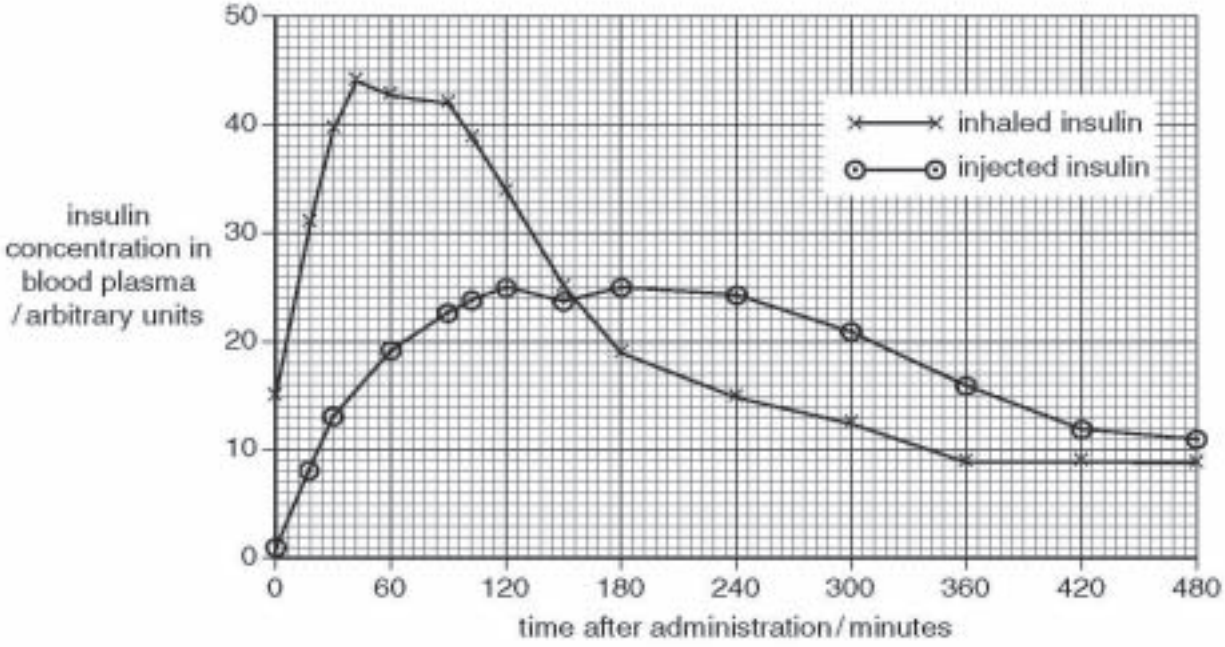


Fig. 4.2

Fig. 4.3 shows the concentration of glucose in the blood plasma in the 480 minutes after injecting or inhaling insulin.

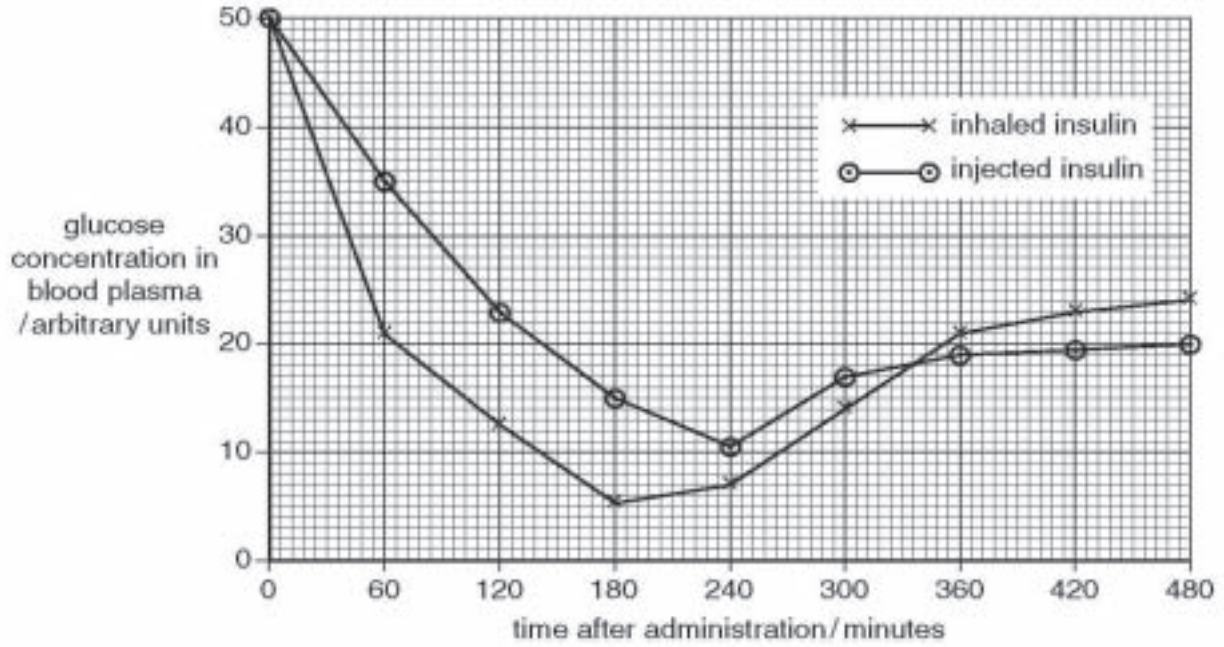


Fig. 4.3

(i) Compare the results for injected insulin and inhaled insulin shown in Fig. 4.2.

[3]

Mark scheme

(c) (i) *all statements must be comparative*
inhaled (accept ora for injected)

1 insulin concentration rises more rapidly when inhaled ;

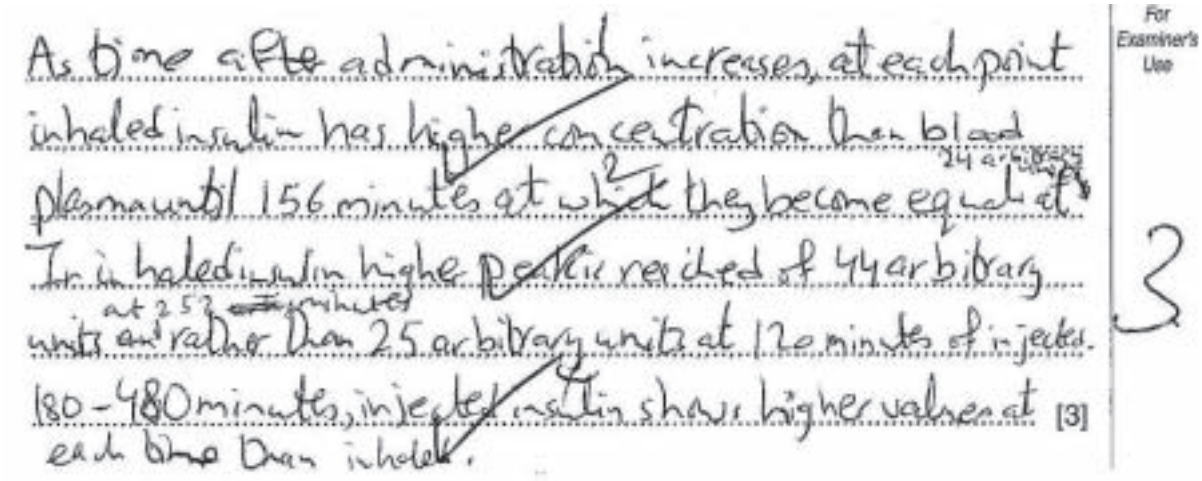
2 higher peak ;

3 falls, more rapidly / earlier ;

4 (after 150 mins) lower (than injected) ;

5 use of comparative figures ; *figures for both at one time* [3 max]

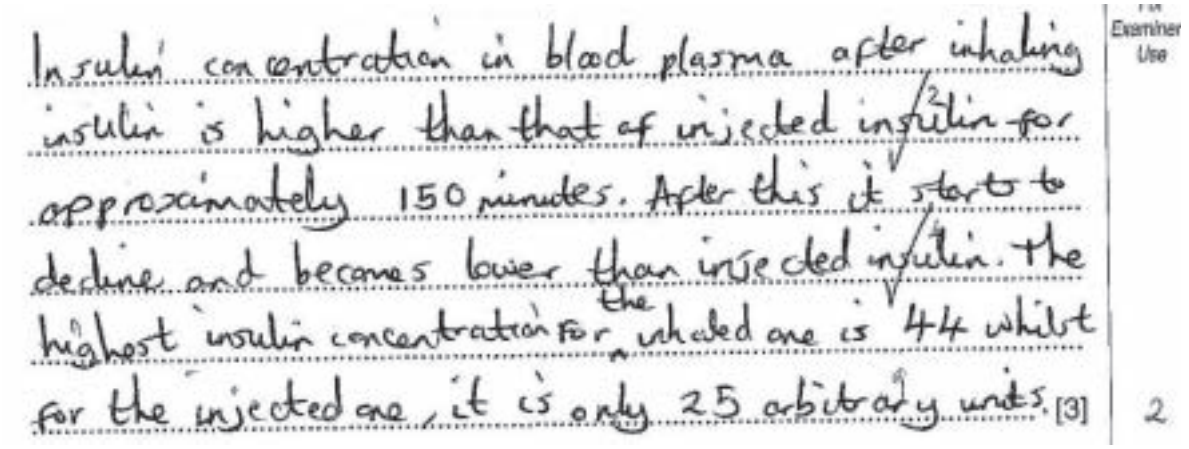
Example candidate response – grade A



Examiner comment – grade A

This question required the candidate to compare the concentration of injected and inhaled insulin in the blood by referring to a graph. This candidate gave a clear answer using comparative statements and scoring full marks. Credit could also have been gained by using figures to back up the statements.

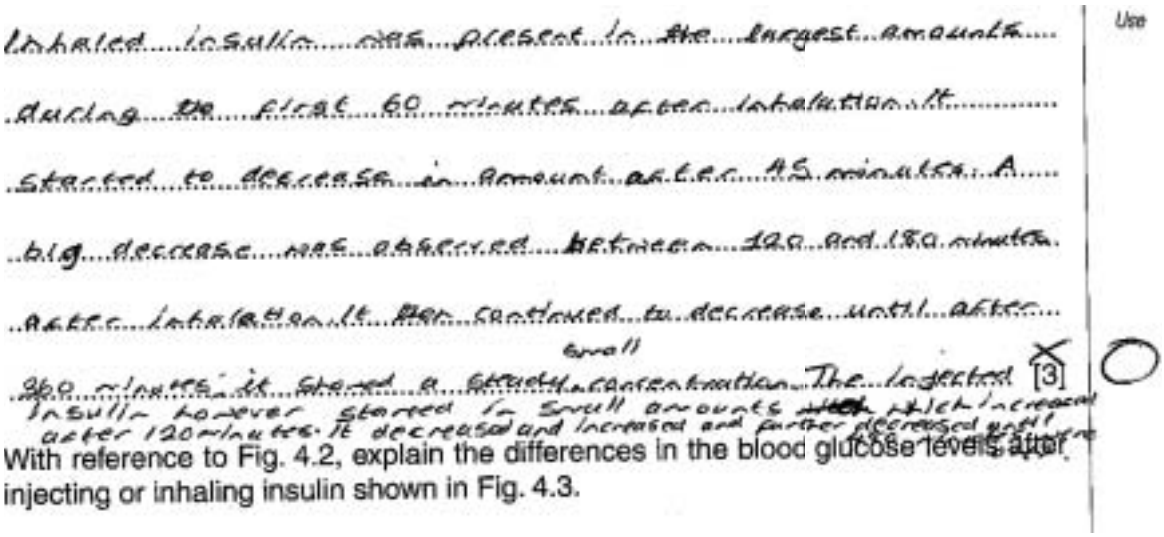
Example candidate response – grade C



Examiner comment – grade C

This candidate gave two clear comparative statements which gained credit. The last sentence attempted to use the data from the graph but was not precise enough.

Example candidate response – grade E


Inhaled insulin was absorbed in the largest amount during the first 60 minutes after inhalation it started to decrease in amount after 45 minutes. A big decrease was observed between 120 and 180 minutes after inhalation it then continued to decrease until after 360 minutes it stayed a straight concentration. The injected insulin however started in small amounts which increased after 120 minutes it decreased and increased and further decreased until

Use

X [3]

With reference to Fig. 4.2, explain the differences in the blood glucose levels after injecting or inhaling insulin shown in Fig. 4.3.

Examiner comment – grade E

This answer is a good example of a candidate not following the command word of the question, namely *compare*. Here a description of the concentration of inhaled insulin was given followed by injected insulin.

Question 4(c)(ii)

(ii) With reference to Fig. 4.2, explain the differences in the blood glucose levels after injecting or inhaling insulin shown in Fig. 4.3. [3]

Mark scheme

(ii) 1 glucose conc. is linked to insulin conc. ;

inhaled (accept ora for injected)

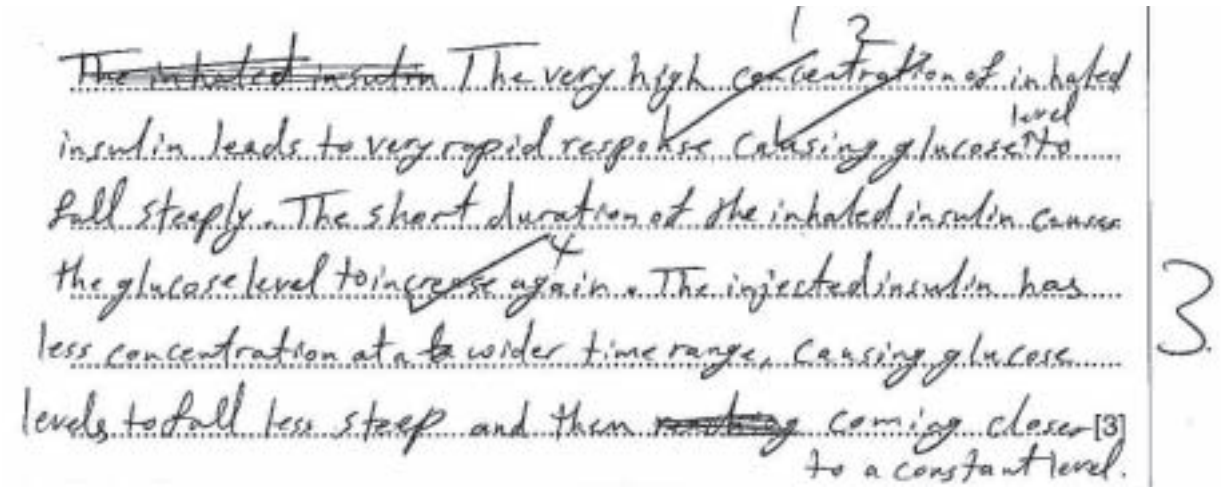
2 (initially) glucose falls <u>because</u> insulin conc. rises ;
this subsumes marking point 1

3 glucose conc. falls lower <u>because</u> insulin conc. is higher ;
this subsumes marking point 1

4 (later) glucose rises higher <u>because</u> insulin conc. is lower ;
this subsumes marking point 1

5 use of figures ;
e.g. one glucose conc. for inhaled and one for injected at <u>one</u> time
or
one glucose conc. linked to an insulin conc. at <u>one</u> time
(either inhaled or injected) [3 max]

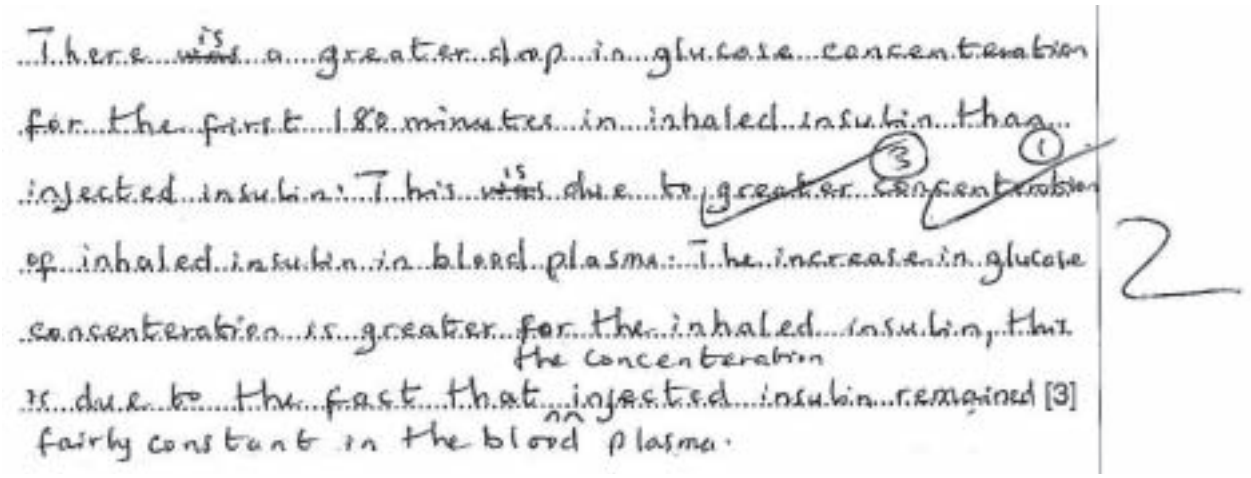
Example candidate response – grade A



Examiner comment – grade A

This question required a high level of analytical skill from the candidate. The relationship between two graphs was required to answer the question which this candidate did very successfully. A link between high concentrations of insulin in the blood, in one graph, to reduction of blood glucose concentration in the other graph was well made. A further point was also made of the reverse effect later on.

Example candidate response – grade C



Examiner comment – grade C

This candidate made a good effort to link the two graphs and was able to show that the greater initial drop in blood glucose concentration for inhaled insulin was due to the greater concentration of insulin in the blood. Comparative figures could have been used here to gain the third mark.

Example candidate response – grade E

After injecting insulin (insulin increase slightly below that of inhaled) hence blood glucose levels decrease but that of inhaled decrease sharply. 60 to 180 mins insulin levels decrease gently and that of inhaled increases sharply at 240-360 mins whereas that of injected increases gently. [3]

1

Examiner comment – grade E

This answer illustrates the difficulty of this question for a grade E candidate. One general mark was achieved for linking insulin increase to glucose decrease but no explanation of the differences was forthcoming.

Question 5(a)

5 Rice, *Oryza sativa*, is a staple food in many parts of the world. Rice is often grown in fields that are flooded with water for part of the growing season.

(a) The roots of young rice plants are highly tolerant of ethanol. Explain how this helps them to survive when the fields are flooded.

[2]

Mark scheme

5 (a) 1 oxygen availability low (when soil is flooded) ;

2 plants carry out anaerobic respiration ;

3 ethanol produced ;

4 roots can continue to respire ; [2 max]

Example candidate response – grade A

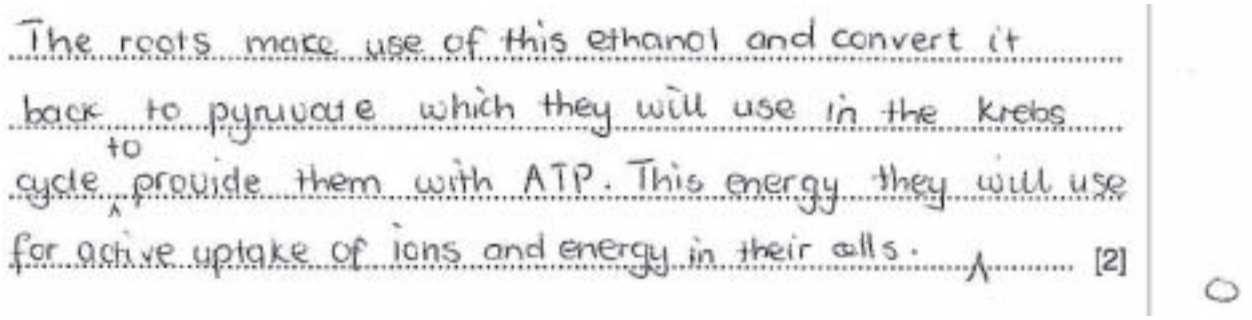
When submerged in water, there is very low concentration of oxygen. The roots carry out anaerobic respiration producing ethanol which is usually toxic. As the roots are tolerant to ethanol, the plant survives. [2]

2

Examiner comment – grade A

The candidate displayed good knowledge in relating the ethanol tolerance of plants in flooded fields to the anaerobic respiration carried out by those plants.

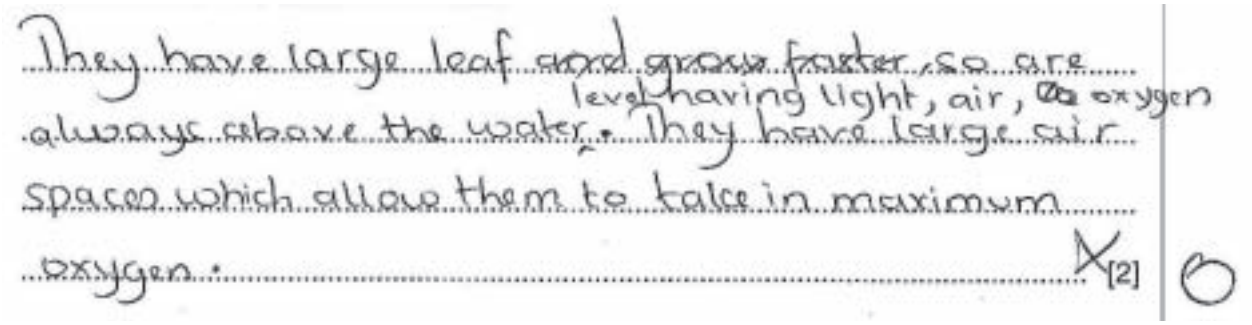
Example candidate response – grade C


The roots make use of this ethanol and convert it back to pyruvate which they will use in the krebs cycle to provide them with ATP. This energy they will use for active uptake of ions and energy in their cells. [2]

Examiner comment – grade C

This candidate has completely misunderstood the question as the answer has attempted to use some biology to show how the plants can make use of the ethanol; unfortunately this is inaccurate.

Example candidate response – grade E


They have large leaf and grass faster, so are level having light, air, & oxygen always above the water. They have large air spaces which allow them to take in maximum oxygen. [2]

Examiner comment – grade E

Unlike the grade C candidate this answer has avoided the question by describing some of the adaptations of plants such as rice growing in flooded fields.

Question 6(b)

(b) State whether the likely life expectancy is high or low in West Africa for individuals with the following genotypes. In each case give a reason for your answer.

Hb^AHb^A .....

.....

Hb^AHb^S .....

.....

Hb^SHb^S .....

..... [4]

Mark scheme

(b) *marks for reasons only*

Hb^A Hb^A
low – susceptible to / die from, malaria ;

Hb^A Hb^S
high – no (full blown) SCA / have SC trait ;
not, susceptible to / likely to die from, malaria ;

Hb^S Hb^S
low – susceptible to / die from, SCA ; [4]

Example candidate response – grade A

Hb^AHb^A low life expectancy as they carry normal haemoglobin so they are susceptible to malaria.

Hb^AHb^S high life expectancy as sickle cell trait are resistant to malaria and won't die from anaemia.

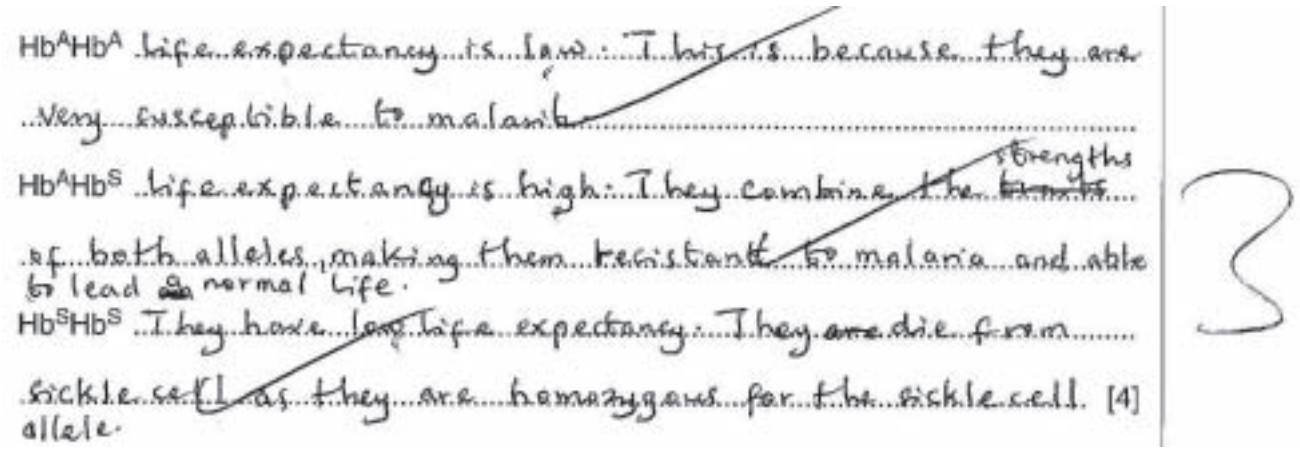
Hb^SHb^S low life expectancy as they are more likely to die from sickle cell anaemia due to reduced ability of haemoglobin to carry O_2. [4]

4

Examiner comment – grade A

The candidate has made the link between the genotypes given with the resulting phenotypes and then has been able to explain the life expectancies of the three individuals.

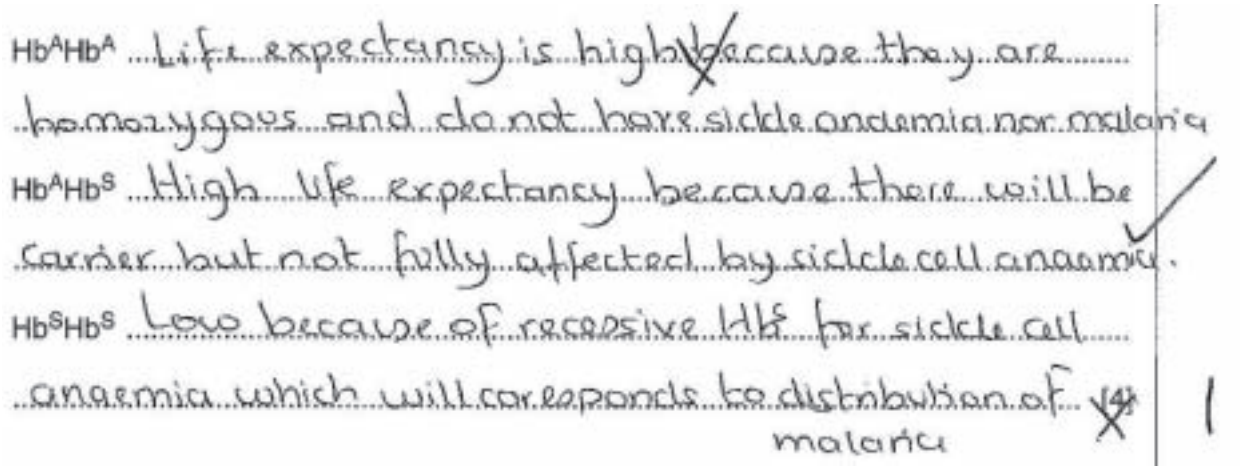
Example candidate response – grade C



Examiner comment – grade C

The candidate has successfully explained the life expectancy of the three individuals but has not realised the significance of the heterozygote. The answer states that the individual would be resistant to malaria but not that they would not have full blown sickle cell anaemia.

Example candidate response – grade E



Examiner comment – grade E

Here the candidate has not fully understood the significance of the link between the HbS allele and malaria. The only correct answer refers to the heterozygote not suffering from sickle cell anaemia.

Question 7(a)

7 An investigation was carried out into the effects of a plant growth regulator, auxin (IAA), on apical dominance.

- The apical buds of 20 pea plants were cut off and discarded.
- The cut surfaces of 10 pea plants were coated with an inert paste containing auxin.
- The cut surfaces of the other group of 10 pea plants were coated with the inert paste alone.
- A further group of 10 pea plants did not have their apical buds removed and were not coated with paste. This was a control group.

The lengths of the side shoots of plants in each of the three groups were measured at regular time intervals and mean values calculated.

The results are shown in Fig. 7.1.

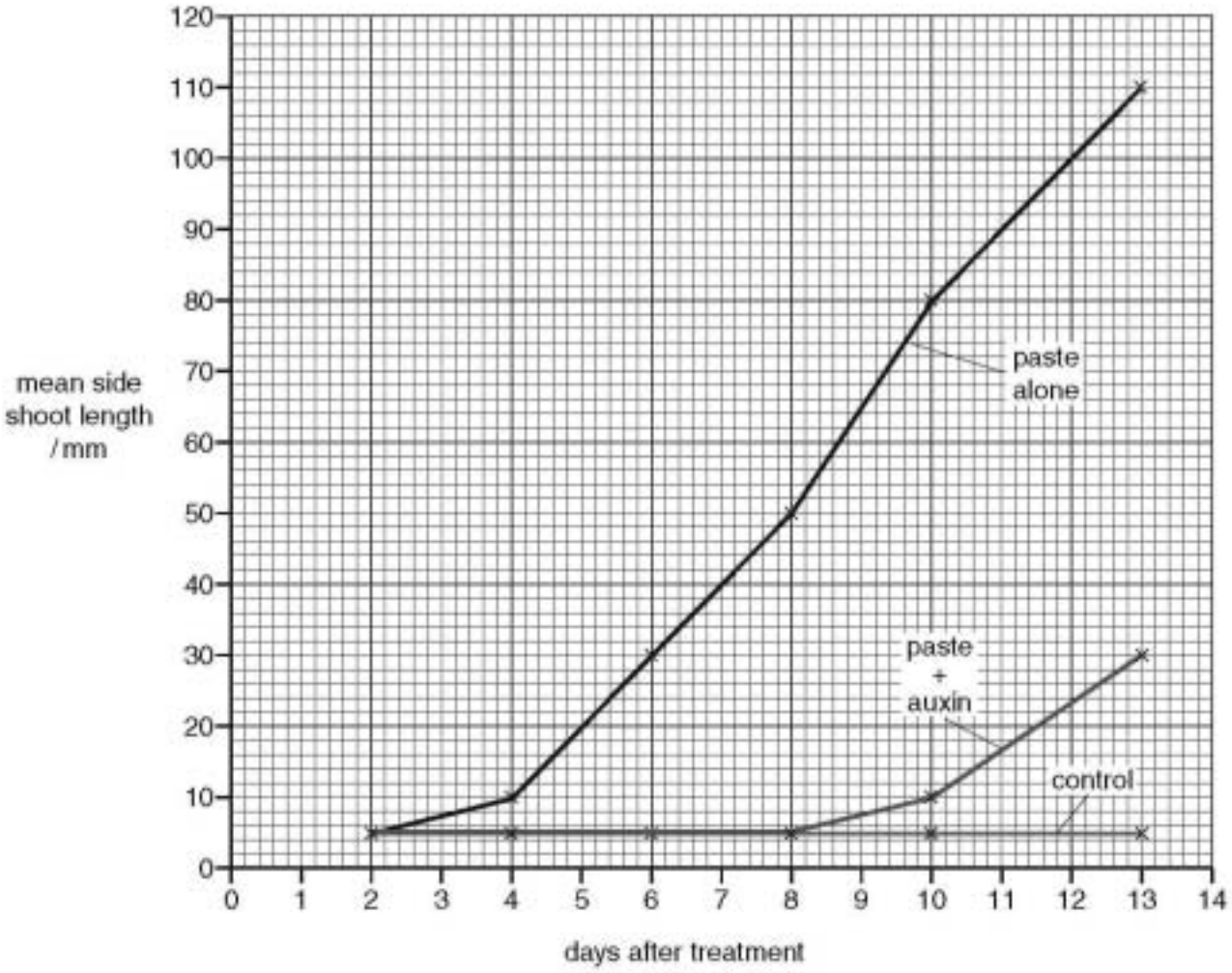


Fig. 7.1

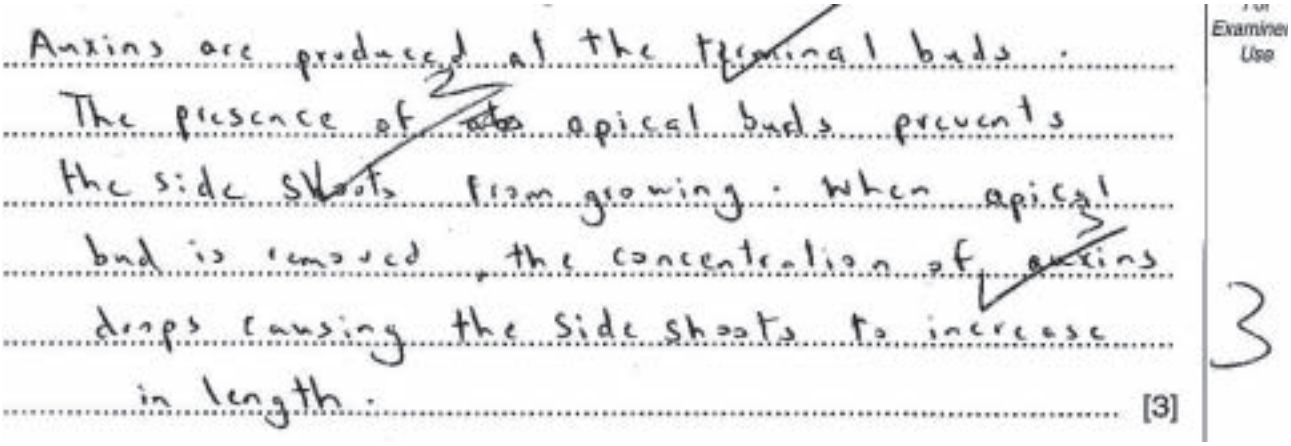
(a) Explain why the side shoots increase in length when the terminal buds are removed.

[3]

Mark scheme

7	(a)	1	apical bud is source of auxin ;	
		2	auxin inhibits growth of side shoot ;	
		3	remove bud and auxin conc falls ;	
		4	this allows cell, division / elongation, to take place (in side shoots) ;	[3 max]

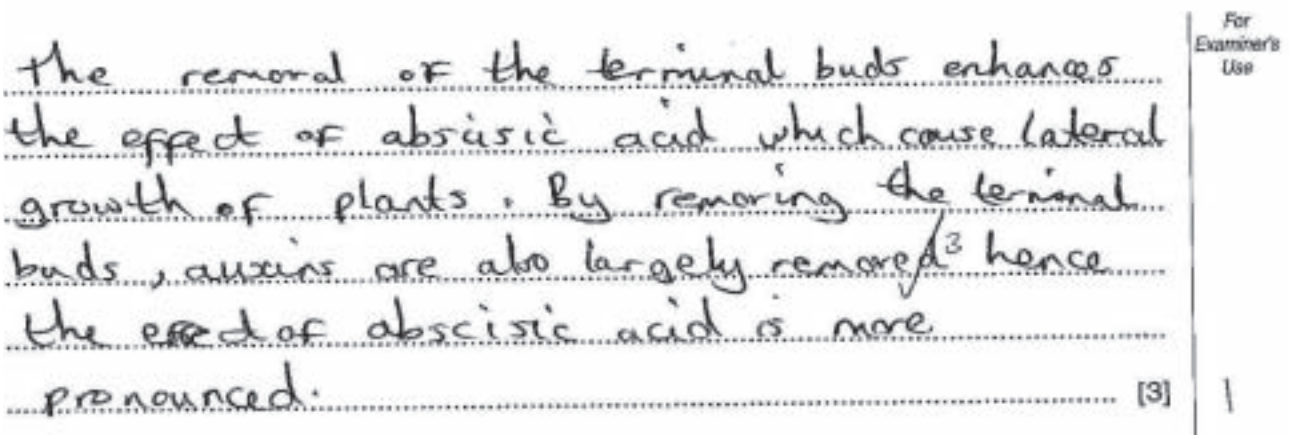
Example candidate response – grade A



Examiner comment – grade A

Answers to this question needed to be very precise to score full marks. The candidate has achieved this by clearly stating the source and action of auxin plus the effects on auxin concentration if the terminal buds were to be removed.

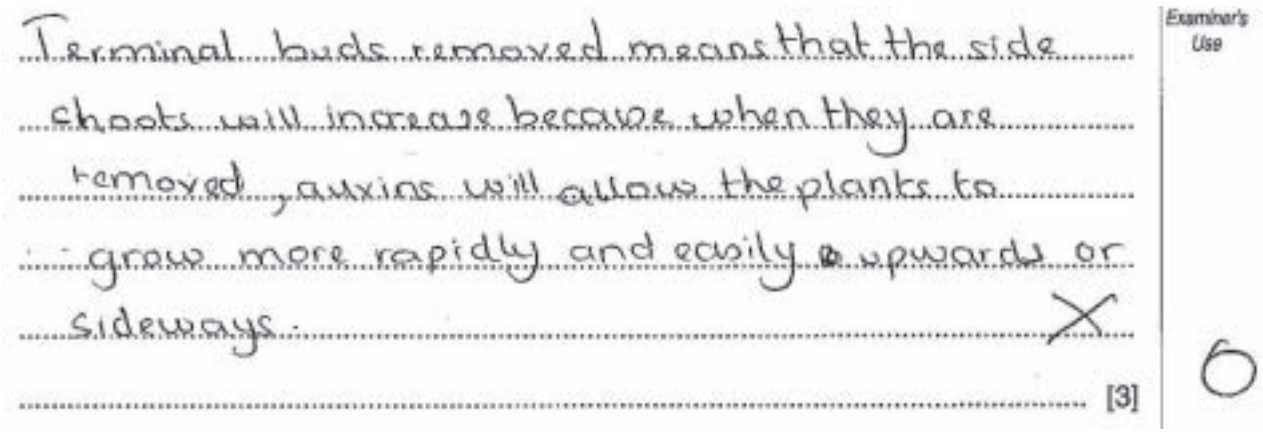
Example candidate response – grade C



Examiner comment – grade C

This candidate was able to show that the auxin concentration would fall if the terminal buds were removed but did not explain why this would cause the side shoots to increase in length.

Example candidate response – grade E


Terminal buds removed means that the side shoots will increase because when they are removed, auxins will allow the plants to grow more rapidly and easily upwards or sideways. X

[3]

Examiner's Use

6

Examiner comment – grade E

This candidate's answer illustrates a common error which is that auxin promotes lateral growth whereas in high concentrations it has the opposite effect.

Question 7(c)

(c) Using data from Fig. 7.1, describe **and** explain the effect of auxin on the growth of side shoots. [3]

Mark scheme

(c)

days 2 to 8

D1 no increase in length with paste plus auxin (compared to control) ;

E2 auxin moves from paste into plants ;

E3 inhibits growth ;

days 8 to 13

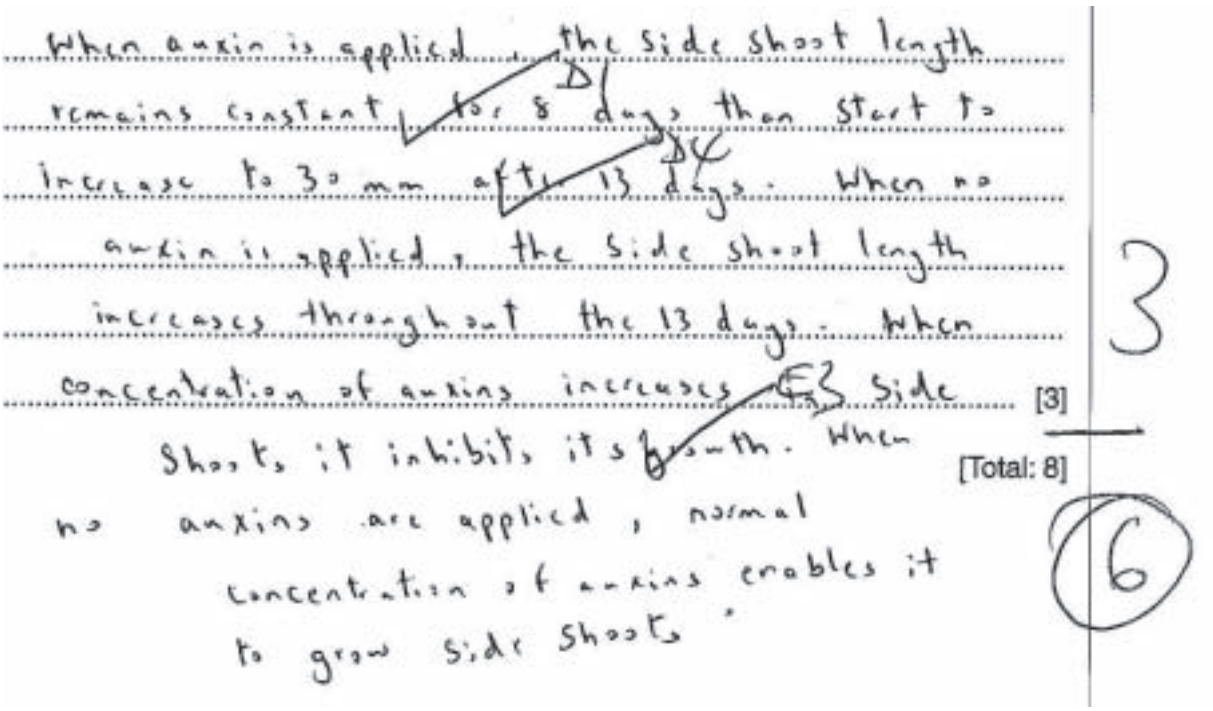
D4 increase in length occurs (with paste and auxin) ;

E5 less auxin left ;

D6 supportive figs ; e.g. two blue points on two days plus units or one red and one blue point on same day plus units

must have at least one D (description) and one E (explanation) to score 3 marks [3 max]

Example candidate response – grade A


When auxin is applied, the side shoot length remains constant for 8 days then start to increase to 30 mm after 13 days. When no auxin is applied, the side shoot length increases throughout the 13 days. When concentration of auxins increases in side shoots, it inhibits its growth. When no auxins are applied, normal concentration of auxins enables it to grow side shoots. [3]

[Total: 8]

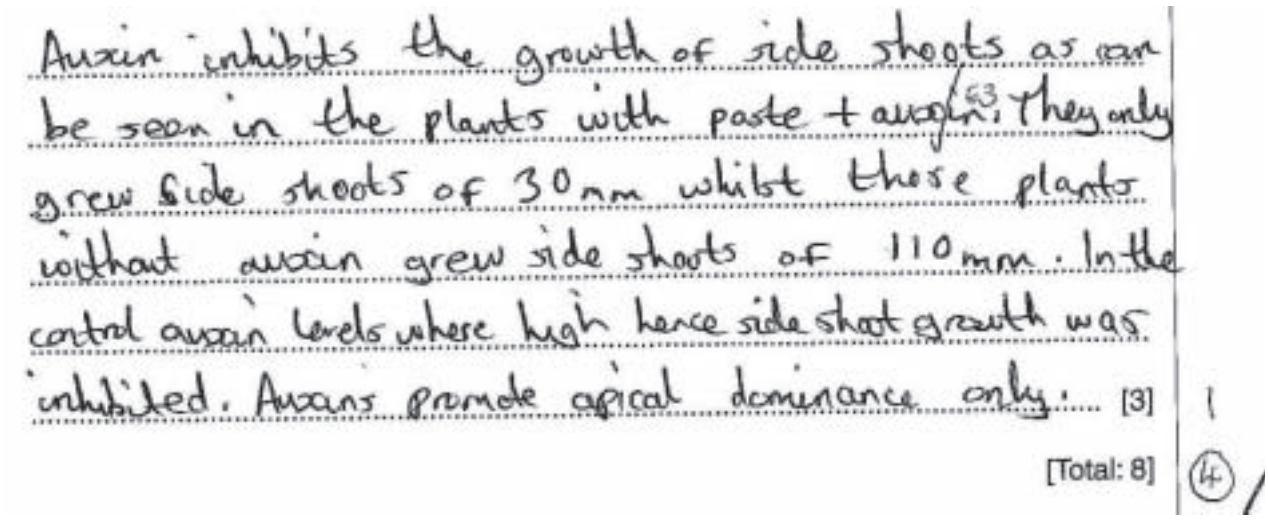
3

6

Examiner comment – grade A

The candidate was asked to describe and explain the effect of auxin on the growth of side shoots. This answer scored full marks because valid points were made that included at least one descriptive marking point and one explanation marking point.

Example candidate response – grade C


Auxin inhibits the growth of side shoots as can be seen in the plants with paste + auxin, they only grew side shoots of 30 mm whilst these plants without auxin grew side shoots of 110 mm. In the control auxin levels where high hence side shoot growth was inhibited. Auxins promote apical dominance only. [3]

[Total: 8]

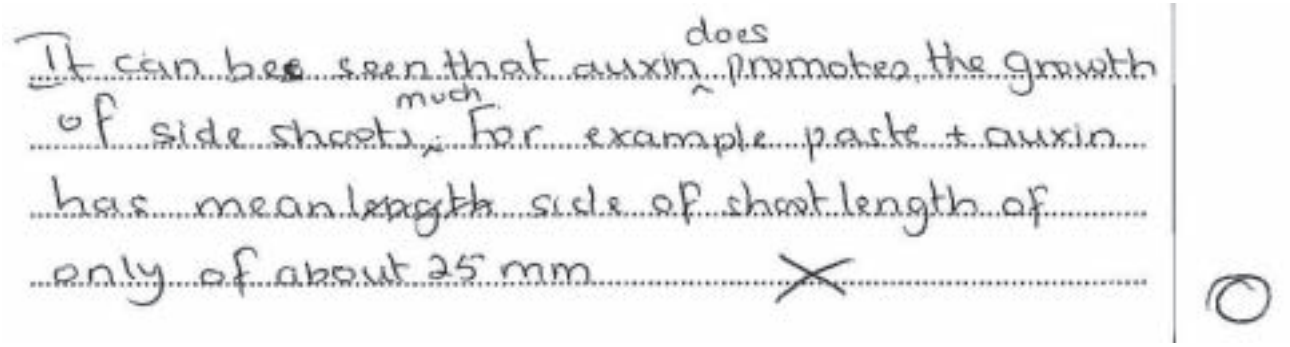
1

4

Examiner comment – grade C

This answer only obtained one explanation mark, that auxin inhibits the growth of side shoots. An attempt was made to use the figures from the graph but the wrong curves were compared.

Example candidate response – grade E



Examiner comment – grade E

This candidate has assumed that auxin does promote the growth of side shoots because of the rise in the curve for paste plus auxin after 8 days. No comment has been made about the lack of growth during the first 8 days which contradicts the candidate's statement.

Question 8(b)

(b) Photosynthetic pigments are arranged in photosystems. There are two photosystems, PS I and PS II. PS I takes part in cyclic photophosphorylation but PS II does not.

Outline the differences between cyclic and non-cyclic photophosphorylation. [4]

Mark scheme

(b)

cyclic photophosphorylation

1 electron emitted returns to, PSI / same photosystem or same chlorophyll molecule ;

non-cyclic photophosphorylation

2 electron emitted from PSII absorbed by PSI ;

3 reduced NADP produced ;

4 photolysis occurs ; **A** splitting of water

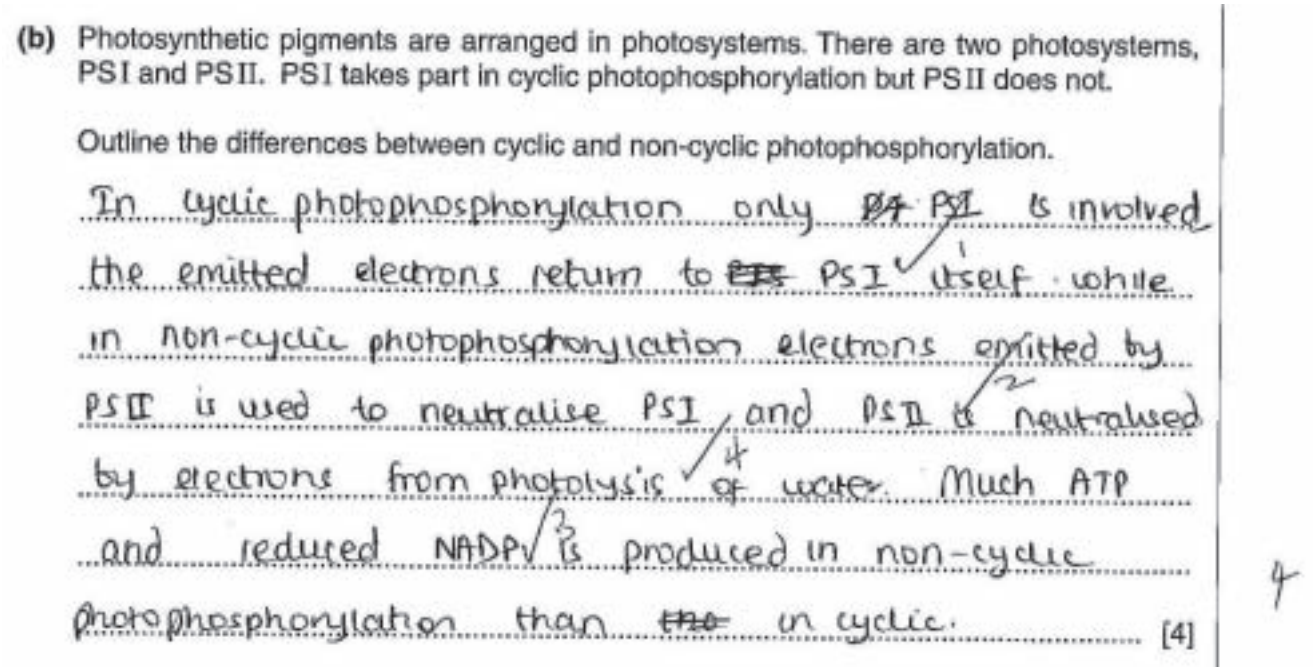
5 (photolysis) only involves PSII ;

6 oxygen produced *3 max*

accept ora for cyclic for marking points 3, 4 and 6

mark to max 3 if cyclic and non-cyclic are described the wrong way round [4 max]

Example candidate response – grade A



(b) Photosynthetic pigments are arranged in photosystems. There are two photosystems, PSI and PSII. PSI takes part in cyclic photophosphorylation but PSII does not.

Outline the differences between cyclic and non-cyclic photophosphorylation.

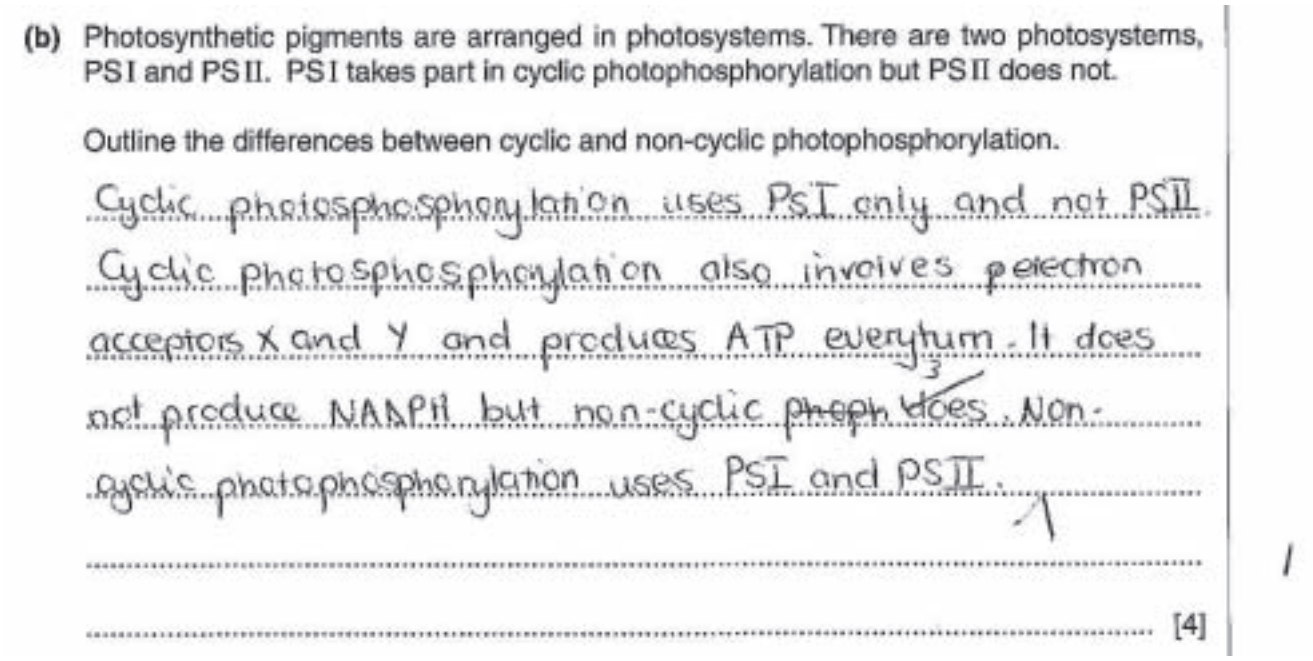
In cyclic photophosphorylation only ~~Ø4~~ PSI is involved the emitted electrons return to ~~PSI~~ PSI itself while in non-cyclic photophosphorylation electrons emitted by PSII is used to neutralise PSI and PSII is neutralised by electrons from photolysis of water. Much ATP and reduced NADP is produced in non-cyclic photophosphorylation than ~~the~~ in cyclic. [4]

4

Examiner comment – grade A

This candidate has produced a clear outline of the differences between the two types of photophosphorylation to score full marks. It is worth noting that the mark scheme has an internal maximum of three marks for non-cyclic photophosphorylation so, in order to score full marks, a candidate must comment on both processes.

Example candidate response – grade C



(b) Photosynthetic pigments are arranged in photosystems. There are two photosystems, PSI and PSII. PSI takes part in cyclic photophosphorylation but PSII does not.

Outline the differences between cyclic and non-cyclic photophosphorylation.

Cyclic photosphosphorylation uses PSI only and not PSII. Cyclic photosphosphorylation also involves electron acceptors X and Y and produces ATP everytum. It does not produce NADPH but non-cyclic photo does. Non-cyclic photophosphorylation uses PSI and PSII.

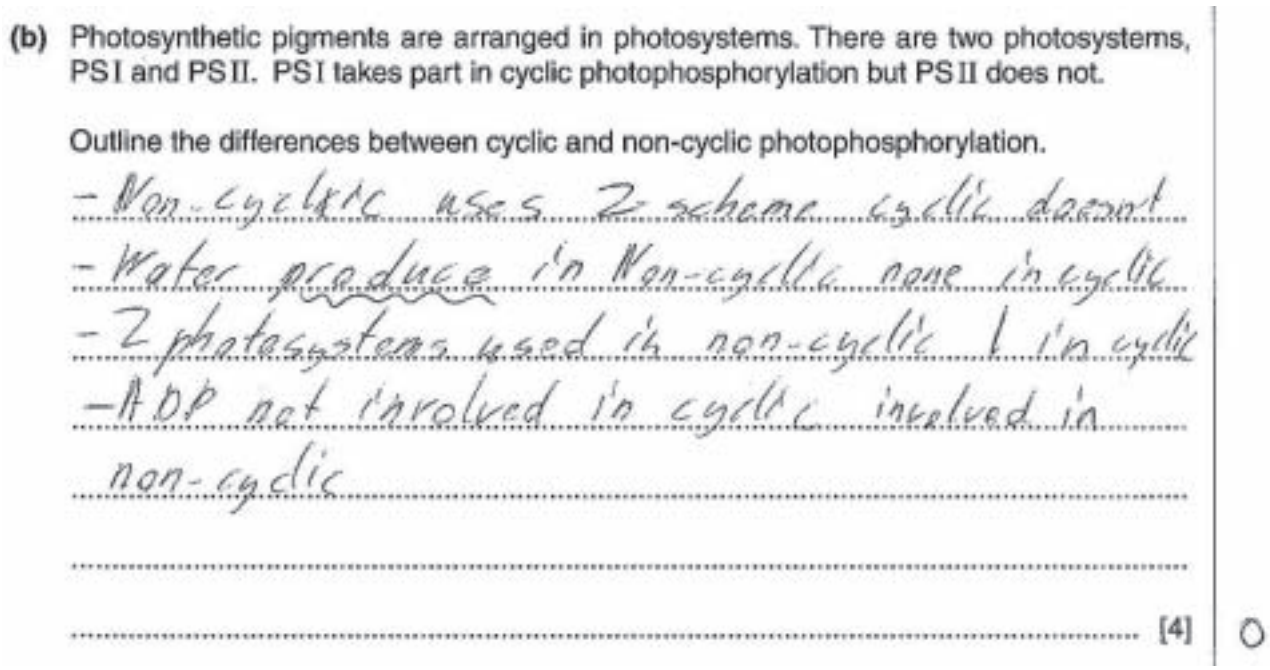
[4]

1

Examiner comment – grade C

The candidate has started the answer by repeating a large part of the introductory information; this is both unnecessary and time consuming.

Example candidate response – grade E



(b) Photosynthetic pigments are arranged in photosystems. There are two photosystems, PS I and PS II. PS I takes part in cyclic photophosphorylation but PS II does not.

Outline the differences between cyclic and non-cyclic photophosphorylation.

- Non-cyclic uses 2 scheme cyclic doesn't
- Water produce in Non-cyclic none in cyclic
- 2 photosystems used in non-cyclic 1 in cyclic
- ADP not involved in cyclic involved in non-cyclic

[4]

Examiner comment – grade E

An attempt has been made to list differences between the two systems, which is a valid way to answer such a question. However, none of the statements made were credit-worthy.

Question 9(a)

9 (a) Outline the behaviour of **chromosomes** during meiosis. [9]

Mark scheme

9 (a) *do not credit marking points out of sequence*

prophase 1

1 idea of condensation of chromosomes ;

2 homologous chromosomes pair up / bivalent formed ;

metaphase 1

3 homologous chromosomes / bivalents, line up on equator ;

4 of spindle ;

5 by centromeres ;

6 independent assortment / described ;

7 chiasmata / described ;

8 crossing over / described ;

anaphase 1

9 chromosomes move to poles ;

10 homologous chromosomes / bivalents, separate ;

11 pulled by microtubules ;

12 reduction division ;

metaphase 2

13 chromosomes line up on equator ;

14 of spindle ;

anaphase 2

15 centromeres divide ;

16 chromatids move to poles ;

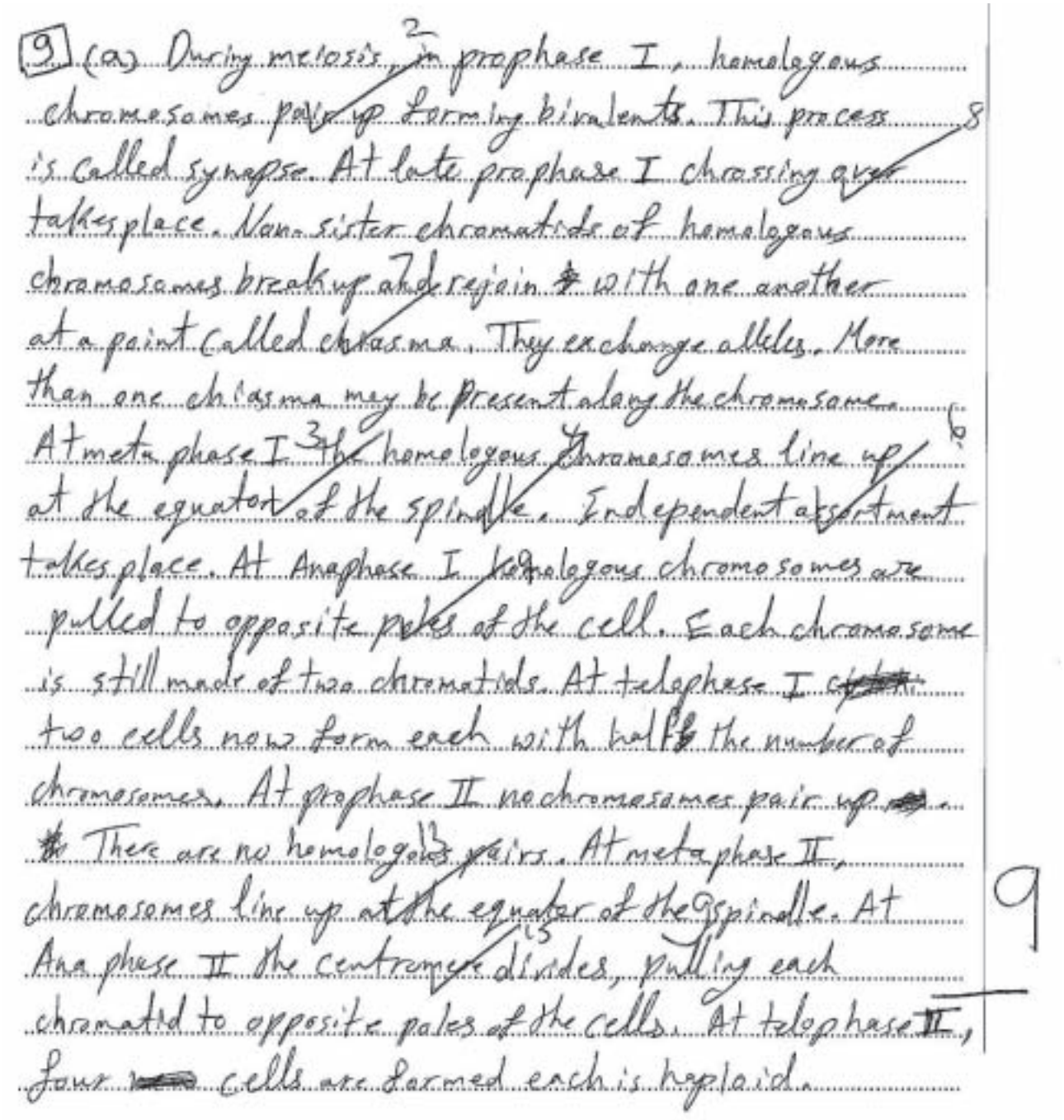
17 pulled by microtubules ;

18 ref. haploid number ;

*allow 4 **or** 14*
*allow 11 **or** 17*

[9 max]

Example candidate response – grade A



9 (a) During meiosis, in prophase I, homologous chromosomes pair up forming bivalents. This process is called synapse. At late prophase I crossing over takes place. Non-sister chromatids of homologous chromosomes break up and rejoin with one another at a point called chiasma. They exchange alleles. More than one chiasma may be present along the chromosome. At metaphase I homologous chromosomes line up at the equator of the spindle. Independent assortment takes place. At Anaphase I homologous chromosomes are pulled to opposite poles of the cell. Each chromosome is still made of two chromatids. At telephase I two cells now form each with half the number of chromosomes. At prophase II no chromosomes pair up. There are no homologous pairs. At metaphase II, chromosomes line up at the equator of the spindle. At Anaphase II the centromere divides, pulling each chromatid to opposite poles of the cells. At telophase II, four cells are formed each is haploid.

8 6 9

Examiner comment – grade A

This free response question asked the candidate to outline the behaviour of chromosomes during meiosis. The answer was very well written and scored full marks due to the clear way it was presented. The candidate had learnt the topic well and could visualise the process in order to describe it in a sequential way.

Example candidate response – grade C

9a. During Prophase 1 of the 1st meiotic division, the chromosomes shorten and thicken and they become visible under a light microscope. DNA replication occurs during this phase and the chromosomes are visible as two chromatids held together by a centromere. Homologous chromosomes pair up and bivalents are formed. Crossing over occurs and chiasma are formed with each chromatid binded to a piece that was not origionally its. The centrioles replicate and move to opposite poles of the cell. After this phase is metaphase 1. During this phase chromosomes lie on the equator of the cell. Spindle fibres form with each chromosome held to the spindle at the centromere. Esters also form. The nuclear envelope and nucleolus would have dispersed. The next phase would be anaphase. Here the chromosomes are pulled to opposite poles, centromeres first. The nucleolus and nuclear envelop develop and spindle fibres disintegrate. Telophase then follows with the division replication of the the cell and this leads to cytokinesis. Metaph The second meiotic division follows. Metaphase occurs and spindle fibres are formed with chromosomes lining at the equater. They now appear as chromatids and during anaphase, they are pulled to opposite poles of the cell, leading to telophase where four daughter cells are produced each with in the haploid state.

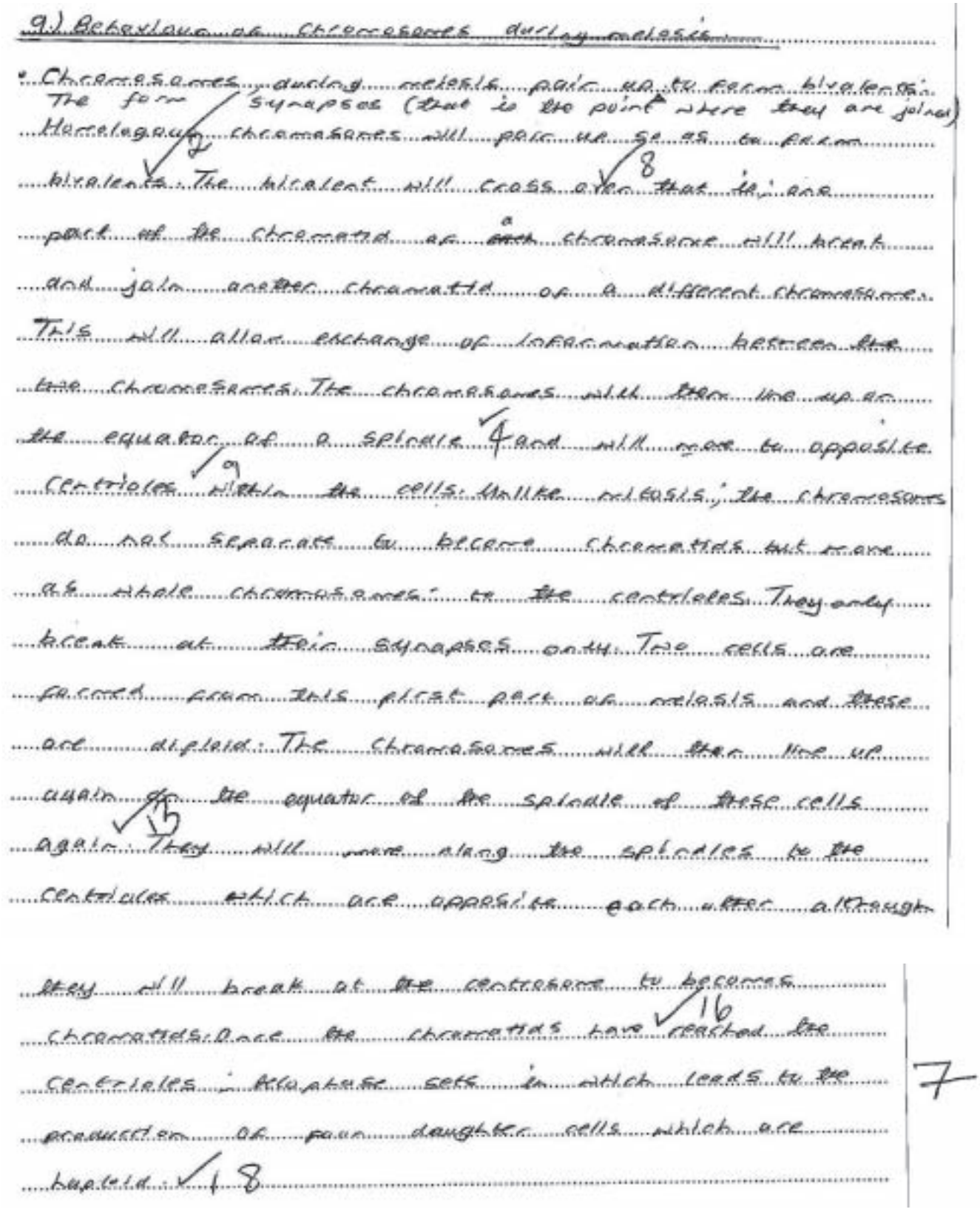
For Examiner's Use

8

Examiner comment – grade C

This candidate's response was very similar to that of the grade A candidate and was very clearly written. It is useful to note that grade C candidates can score high marks in these types of question with thorough learning and careful planning.

Example candidate response – grade E



Examiner comment – grade E

The accessibility of this question is shown by the good answer given by this grade E candidate.

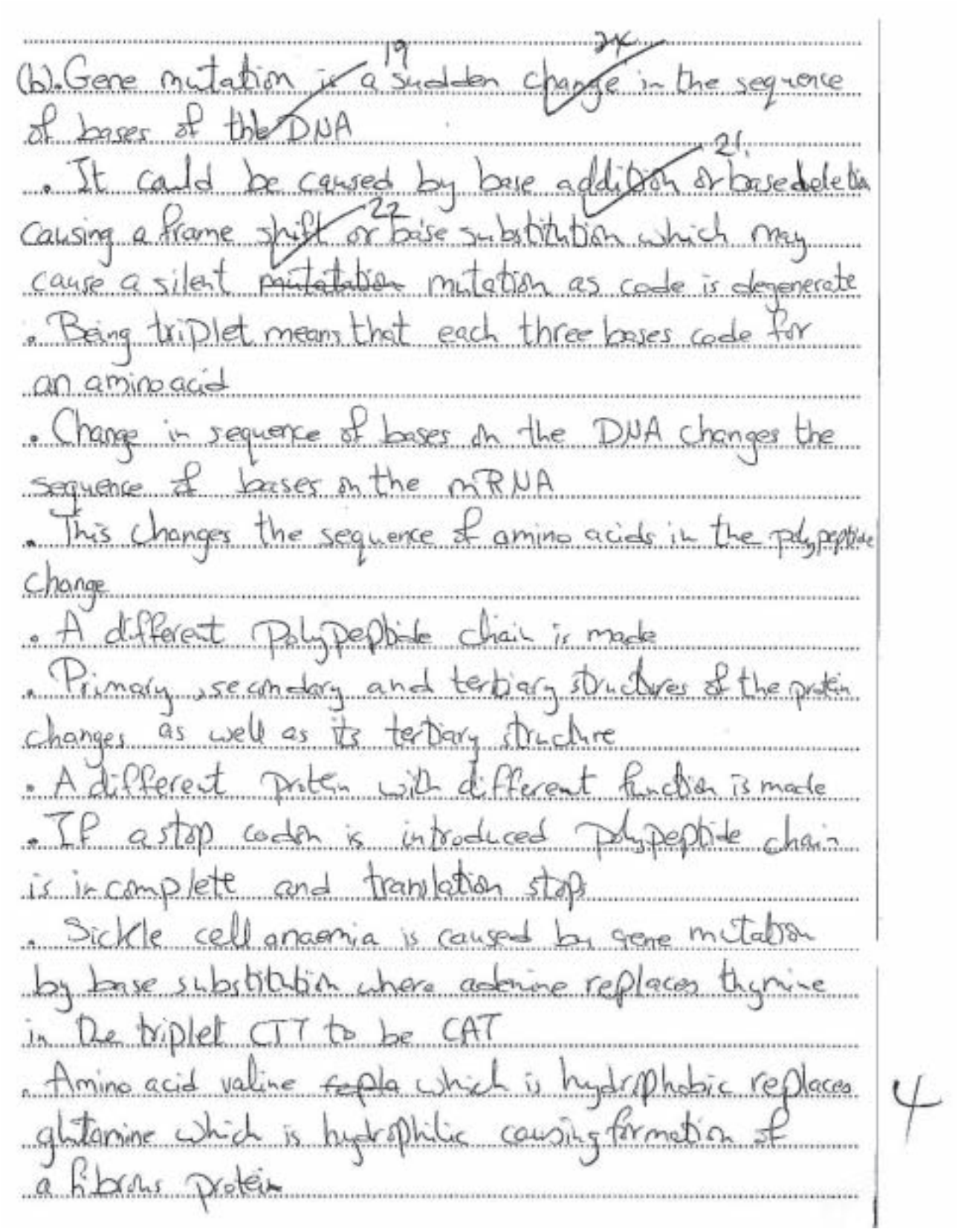
Question 9(b)

(b) Describe the ways by which **gene** mutations can occur. [6]

Mark scheme

(b)	19	change in, base / nucleotide, sequence (in DNA) ;	
	20	during DNA replication ;	
	21	detail of change ; e.g. base, substitution / addition / deletion	
	22	frame shifts / AW ;	
	23	different / new, allele ;	
	24	random / spontaneous ;	
	25	mutagens ;	
	26	ionising radiation ;	
	27	UV radiation / mustard gas ;	[6 max]

Example candidate response – grade A



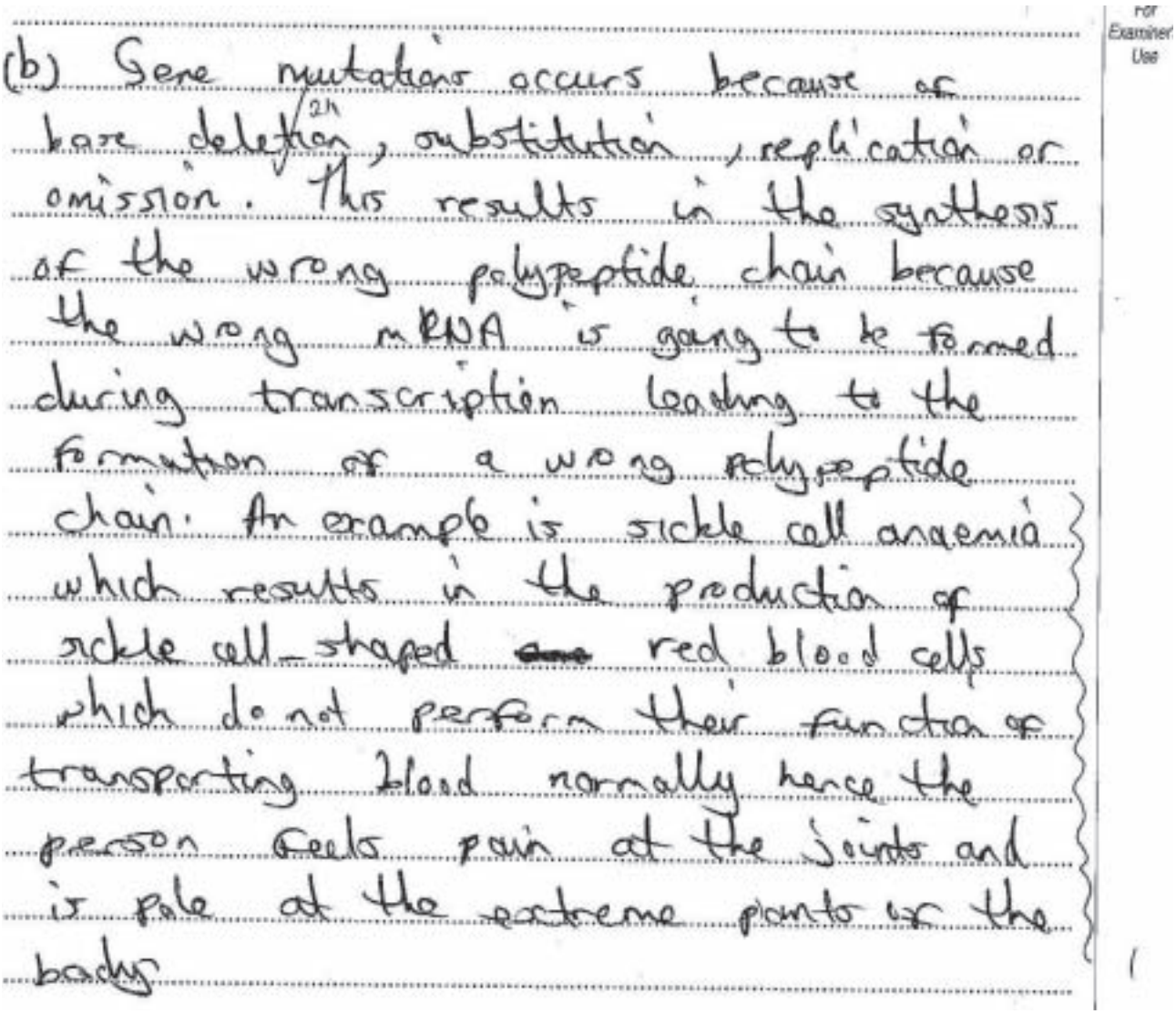
(b). Gene mutation is a sudden change in the sequence of bases of the DNA
. It could be caused by base addition or base deletion causing a frame shift or base substitution which may cause a silent mutation as code is degenerate
. Being triplet means that each three bases code for an amino acid
. Change in sequence of bases on the DNA changes the sequence of bases on the mRNA
. This changes the sequence of amino acids in the polypeptide change
. A different Polypeptide chain is made
. Primary, secondary and tertiary structures of the protein changes as well as its tertiary structure
. A different protein with different function is made
. If a stop codon is introduced polypeptide chain is incomplete and translation stop
. Sickle cell anaemia is caused by gene mutation by base substitution where adenine replaces thymine in the triplet CTT to be CAT
. Amino acid valine ~~repla~~ which is hydrophobic replaces glutamine which is hydrophilic causing formation of a fibrous protein

4

Examiner comment – grade A

This carried fewer marks than part **(a)** and answers required more precision. This candidate scored four marks early on about the ways that gene mutation can occur but then gave a lot of irrelevant information about protein synthesis and the consequences of gene mutation.

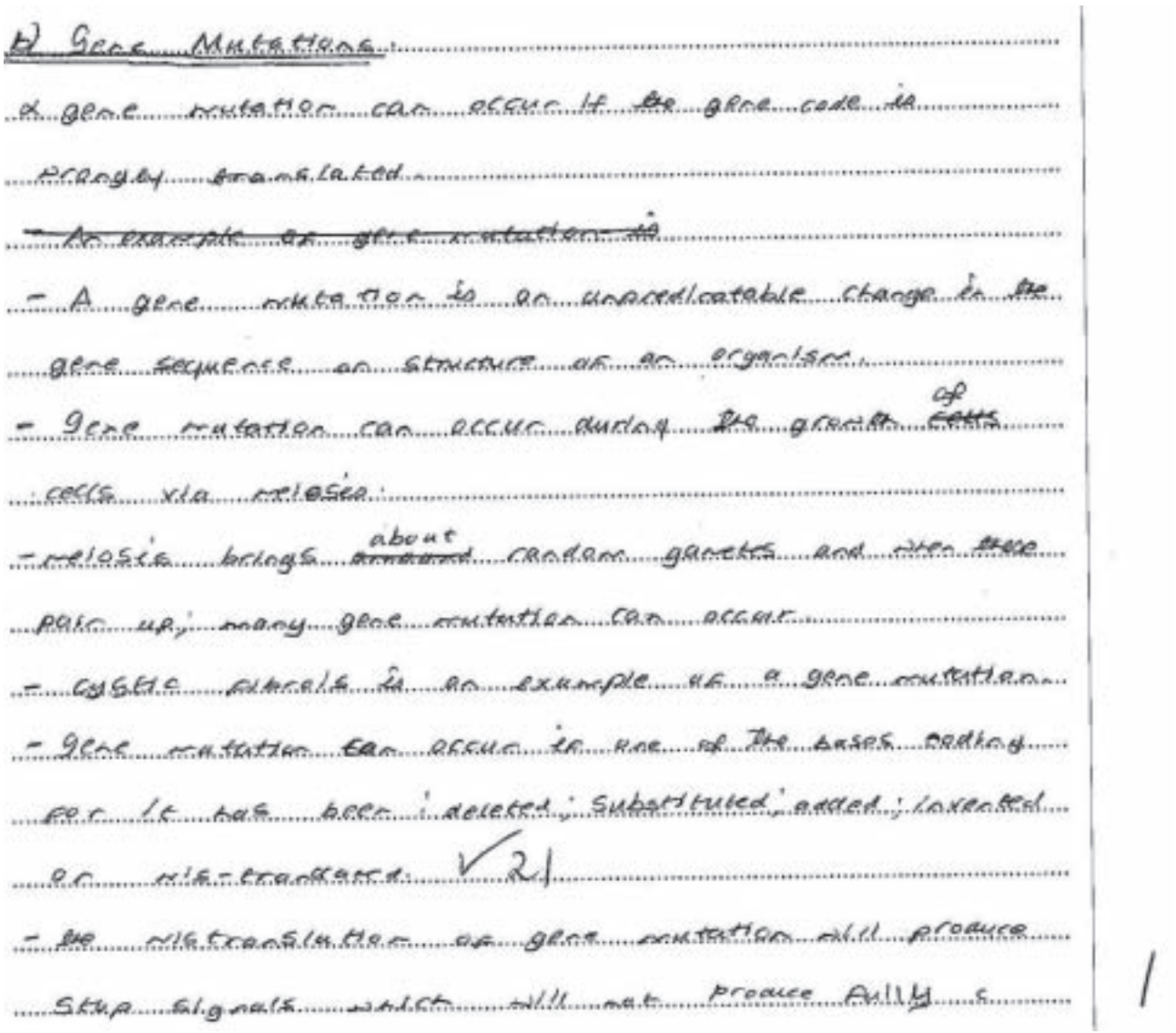
Example candidate response – grade C



Examiner comment – grade C

This candidate noted that gene mutation could be due to base substitution but wasted time with unnecessary information about sickle cell anaemia.

Example candidate response – grade E



Examiner comment – grade E

The candidate has not really tackled the question properly and has simply listed random statements loosely concerning gene mutation, several of which are incorrect.

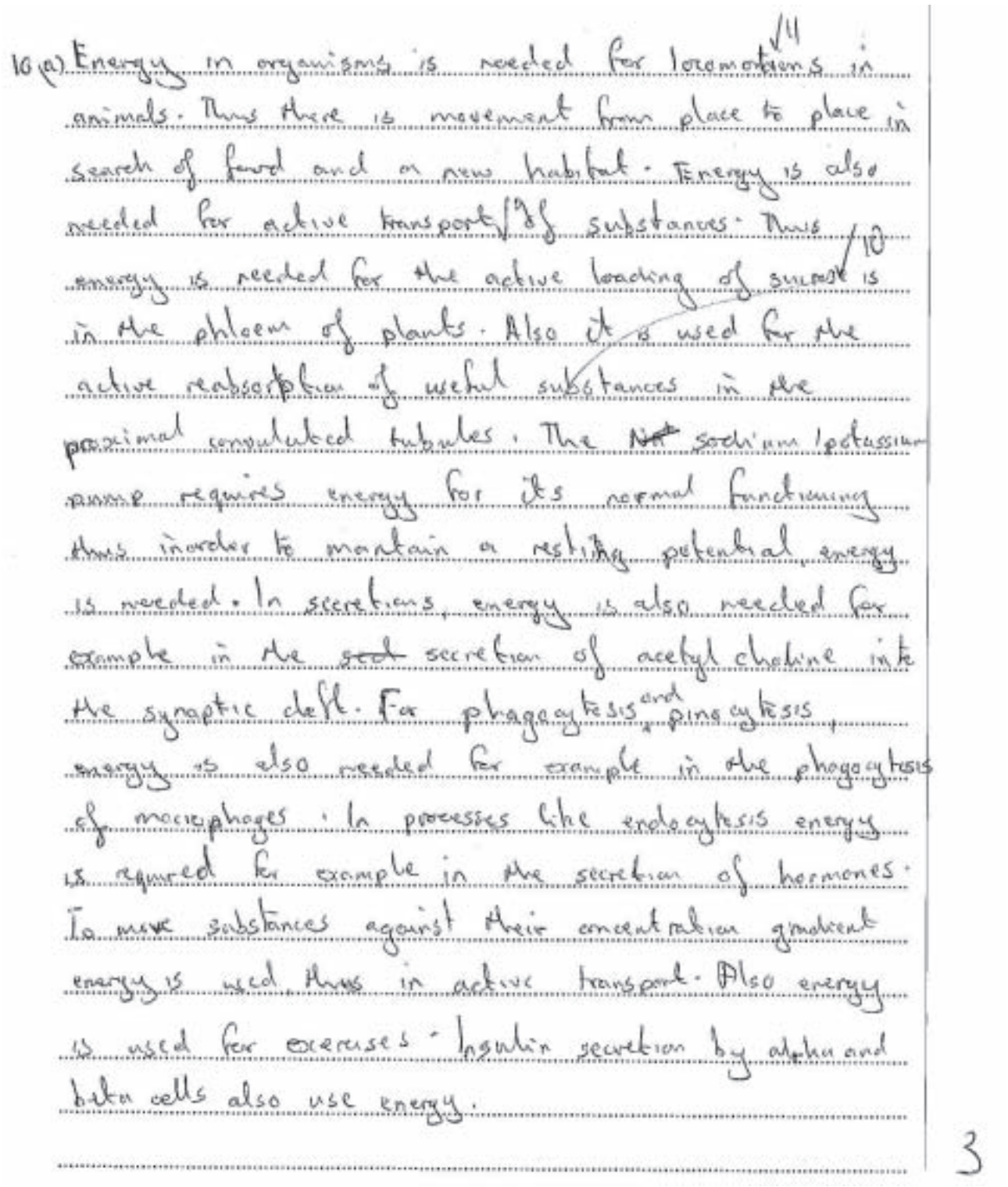
Question 10(a)

10 (a) Outline the need for energy in living organisms using named examples. [9]

Mark scheme

10	**(a)**	1	ATP as universal energy currency ;	
		2	light energy needed for photosynthesis ;	
		3	ATP used conversion of GP to TP ;	
		4	ATP used to regenerate RuBP ;	
		5	(energy needed for) anabolic reactions ;	
		6	protein synthesis / starch formation / triglyceride formation ;	
		7	activation energy ;	
		8	(activate) glucose in glycolysis ;	
		9	active transport ;	
		10	example ; e.g. sodium / potassium pump	
		11	movement / locomotion ;	
		12	example ; e.g. muscle contraction / cilia beating	
		13	endocytosis / exocytosis / pinocytosis / bulk transport ;	
		14	temperature regulation ;	[9 max]

Example candidate response – grade A



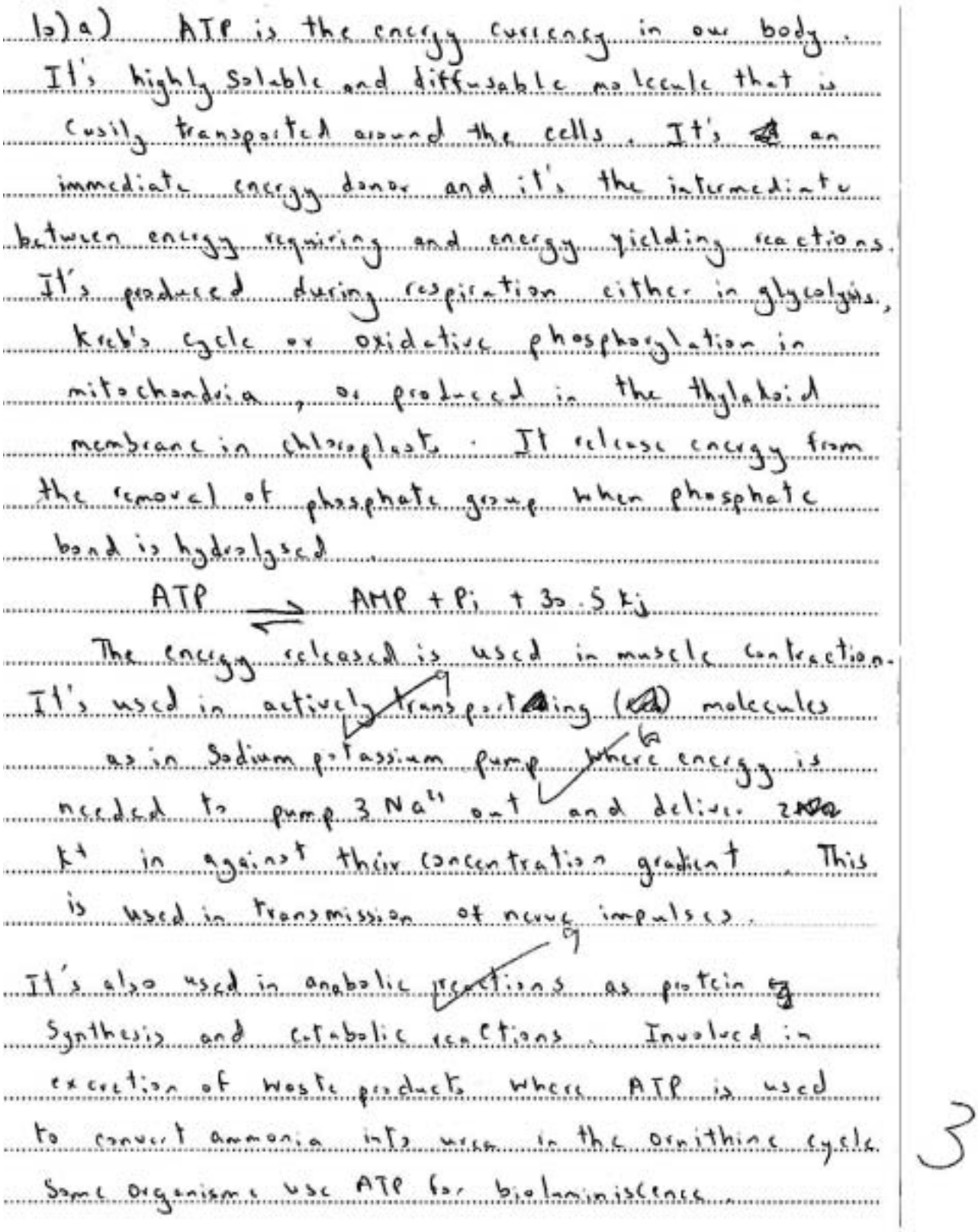
10 (a) Energy in organisms is needed for locomotions in animals. Thus there is movement from place to place in search of food and a new habitat. Energy is also needed for active transport of substances. Thus energy is needed for the active loading of sucrose is in the phloem of plants. Also it is used for the active reabsorption of useful substances in the proximal convoluted tubules. The ~~Na~~ sodium/potassium pump requires energy for its normal functioning thus inorder to maintain a resting potential energy is needed. In secretions, energy is also needed for example in the ~~sod~~ secretion of acetyl choline into the synaptic cleft. For phagocytosis and pinocytosis energy is also needed for example in the phagocytosis of macrophages. In processes like endocytosis energy is required for example in the secretion of hormones. To move substances against their concentration gradient energy is used. Thus in active transport. Also energy is used for exercises. Insulin secretion by alpha and beta cells also use energy.

3

Examiner comment – grade A

This question required the candidate to think synoptically and bring together various parts of the syllabus. This proved to be difficult and many candidates found it hard to score more than a few marks. Three marks were awarded to this candidate.

Example candidate response – grade C



b) a) ATP is the energy currency in our body. It's highly soluble and diffusable molecule that is easily transported around the cells. It's an immediate energy donor and it's the intermediate between energy requiring and energy yielding reactions. It's produced during respiration either in glycolysis, Kreb's cycle or oxidative phosphorylation in mitochondria, or produced in the thylakoid membrane in chloroplast. It release energy from the removal of phosphate group when phosphate bond is hydrolysed

$ATP \rightleftharpoons AMP + P_i + 30.5\ kJ$

The energy released is used in muscle contraction. It's used in actively transporting molecules as in Sodium potassium pump where energy is needed to pump $3\ Na^{+}$ out and deliver $2\ K^{+}$ in against their concentration gradient. This is used in transmission of nerve impulses.

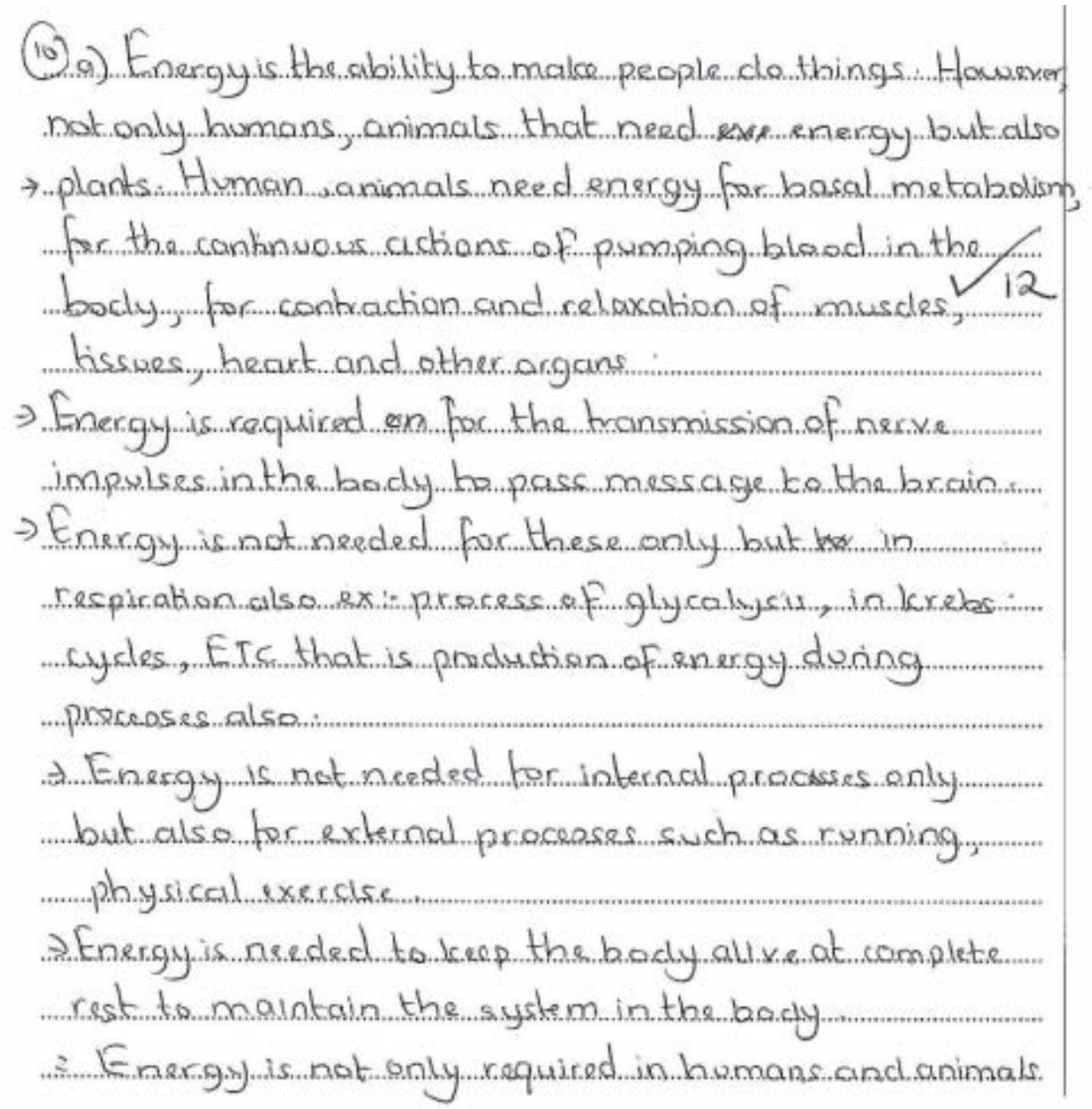
It's also used in anabolic reactions as protein synthesis and catabolic reactions. Involved in excretion of waste products where ATP is used to convert ammonia into urea in the ornithine cycle. Some organisms use ATP for bioluminiscence.

3

Examiner comment – grade C

This candidate has tried to cover many parts of the syllabus but the examples given are too vague and many are not of A level standard.

Example candidate response – grade E



(10) a) Energy is the ability to make people do things. However, not only humans, animals that need energy but also plants. Human animals need energy for basal metabolism, for the continuous actions of pumping blood in the body, for contraction and relaxation of muscles, tissues, heart and other organs. ✓12

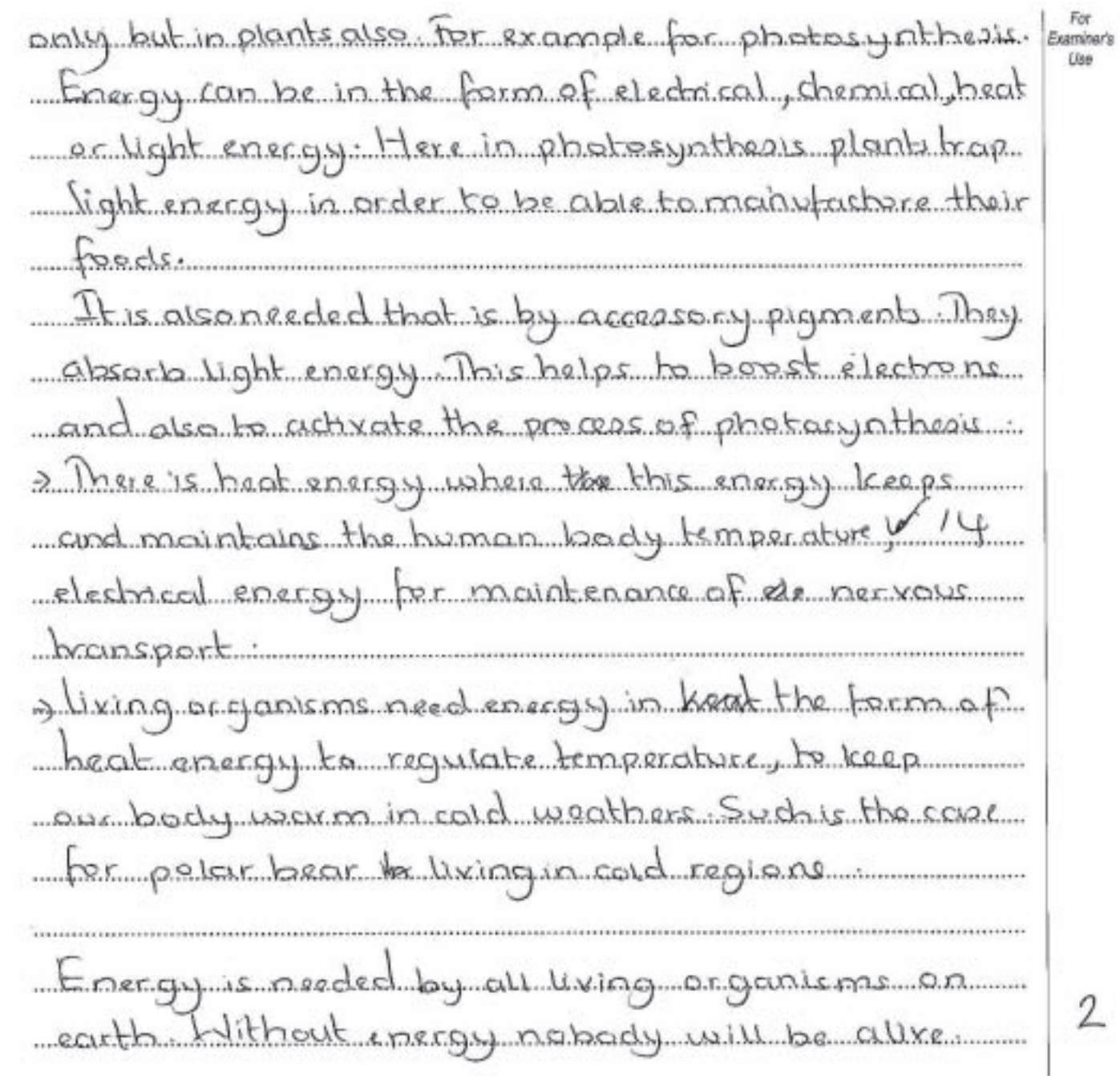
→ Energy is required on for the transmission of nerve impulses in the body to pass message to the brain.

→ Energy is not needed for these only but in respiration also ex: process of glycolysis, in krebs cycles, ETC that is production of energy during processes also.

→ Energy is not needed for internal processes only but also for external processes such as running, physical exercise.

→ Energy is needed to keep the body alive at complete rest to maintain the system in the body.

→ Energy is not only required in humans and animals.



only but in plants also. For example for photosynthesis. Energy can be in the form of electrical, chemical, heat or light energy. Here in photosynthesis plants trap light energy in order to be able to manufacture their foods.

It is also needed that is by accessory pigments. They absorb light energy. This helps to boost electrons and also to activate the process of photosynthesis.

→ There is heat energy where the this energy keeps and maintains the human body temperature ✓ 1/4

electrical energy for maintenance of the nervous transport.

→ living organisms need energy in heat the form of heat energy to regulate temperature, to keep our body warm in cold weathers. Such is the case for polar bear to living in cold regions.

Energy is needed by all living organisms on earth. Without energy nobody will be alive.

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2

Examiner comment – grade E

This candidate has made a very similar attempt to the grade C candidate, with similar results.

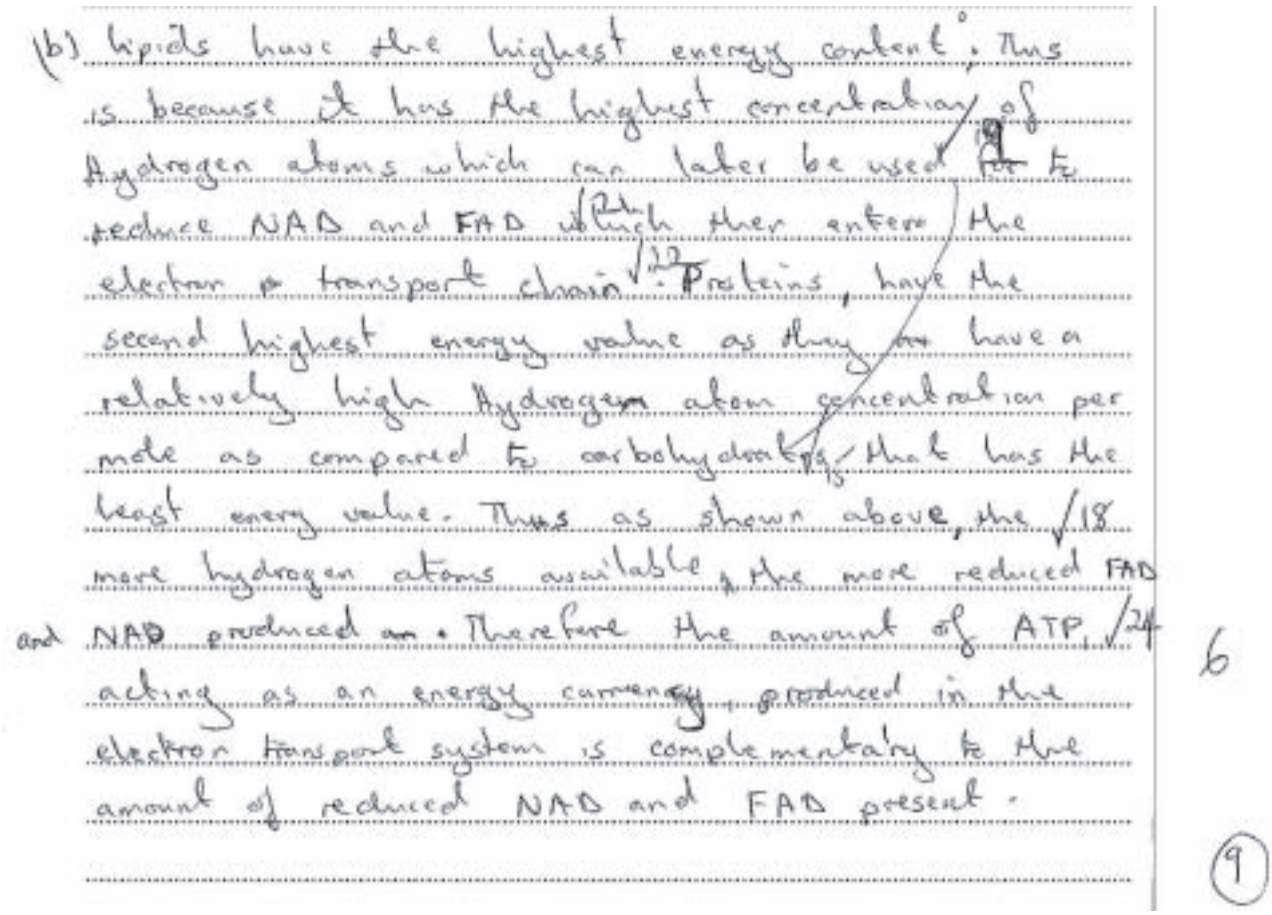
Question 10(b)

(b) Explain the different energy values of carbohydrate, lipid and protein as respiratory substrates. [6]

Mark scheme

(b)	15	idea of lipid > protein > carbohydrate / AW ; **A** lipid has more energy than either protein or carbohydrate	
	16	comparative figures ; e.g. 39.4, 17.0 and 15.8	*accept any two*
	17	kJ g^{-1} / per unit mass ;	
	18	more hydrogen atoms in molecule, more energy ;	
	19	lipid have more, hydrogen atoms / C-H bonds ;	
	20	(most) energy comes from oxidation of hydrogen to water ;	
	21	using reduced, NAD / FAD ;	
	22	in ETC ;	
	23	detail of ETC ;	
	24	ATP production	
			[6 max]

Example candidate response – grade A


(b) lipids have the highest energy content, this is because it has the highest concentration of Hydrogen atoms which can later be used to reduce NAD and FAD which then enters the electron transport chain. Proteins, have the second highest energy value as they have a relatively high Hydrogen atom concentration per mole as compared to carbohydrates, that has the least energy value. Thus as shown above, the more hydrogen atoms available, the more reduced FAD and NAD produced are. Therefore the amount of ATP, acting as an energy currency, produced in the electron transport system is complementary to the amount of reduced NAD and FAD present.

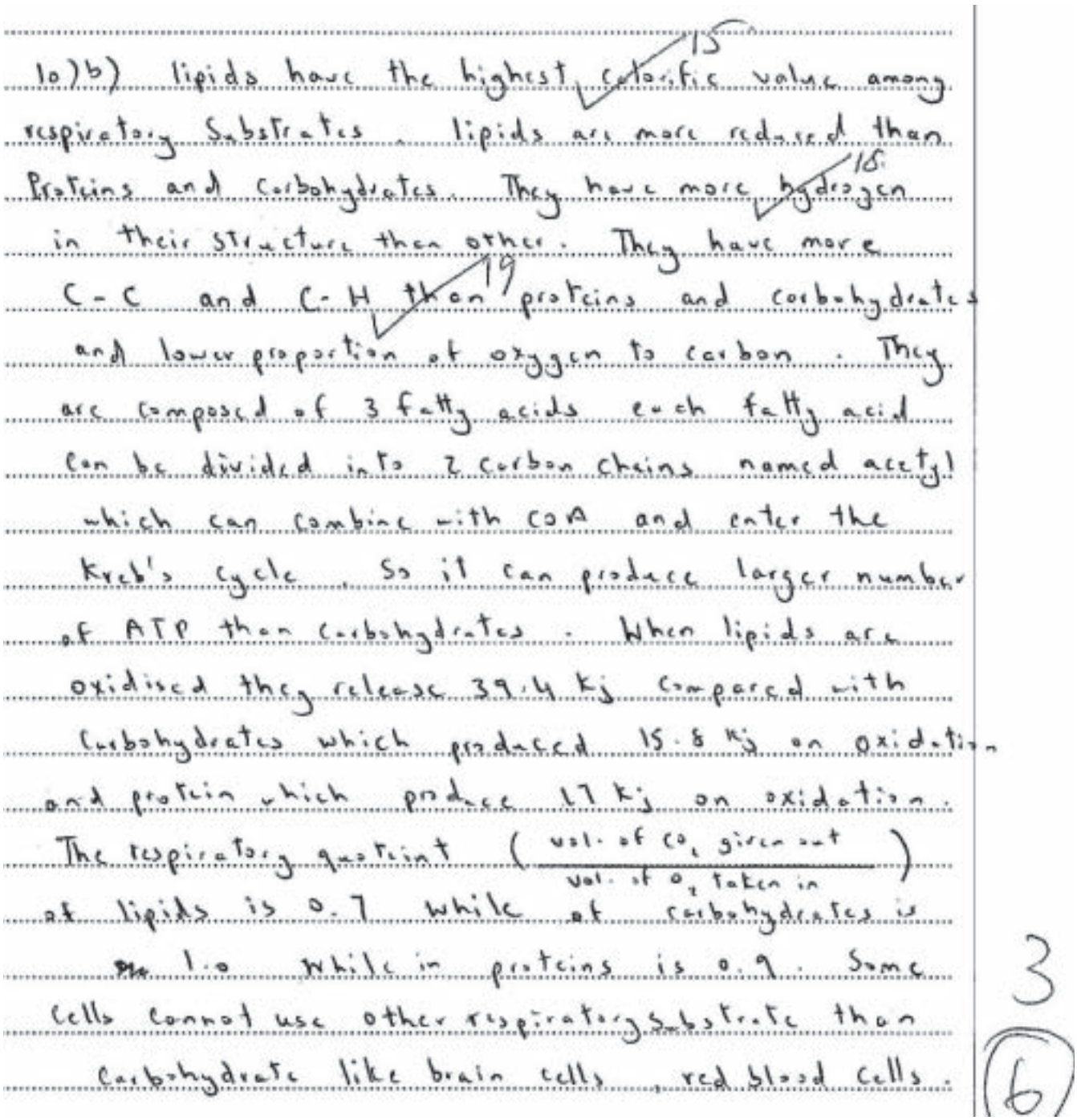
6

9

Examiner comment – grade A

This question was much more straightforward than part **(a)** and the candidate was able to give a good comparison of the different energy values of the three respiratory substrates. Full marks were awarded.

Example candidate response – grade C



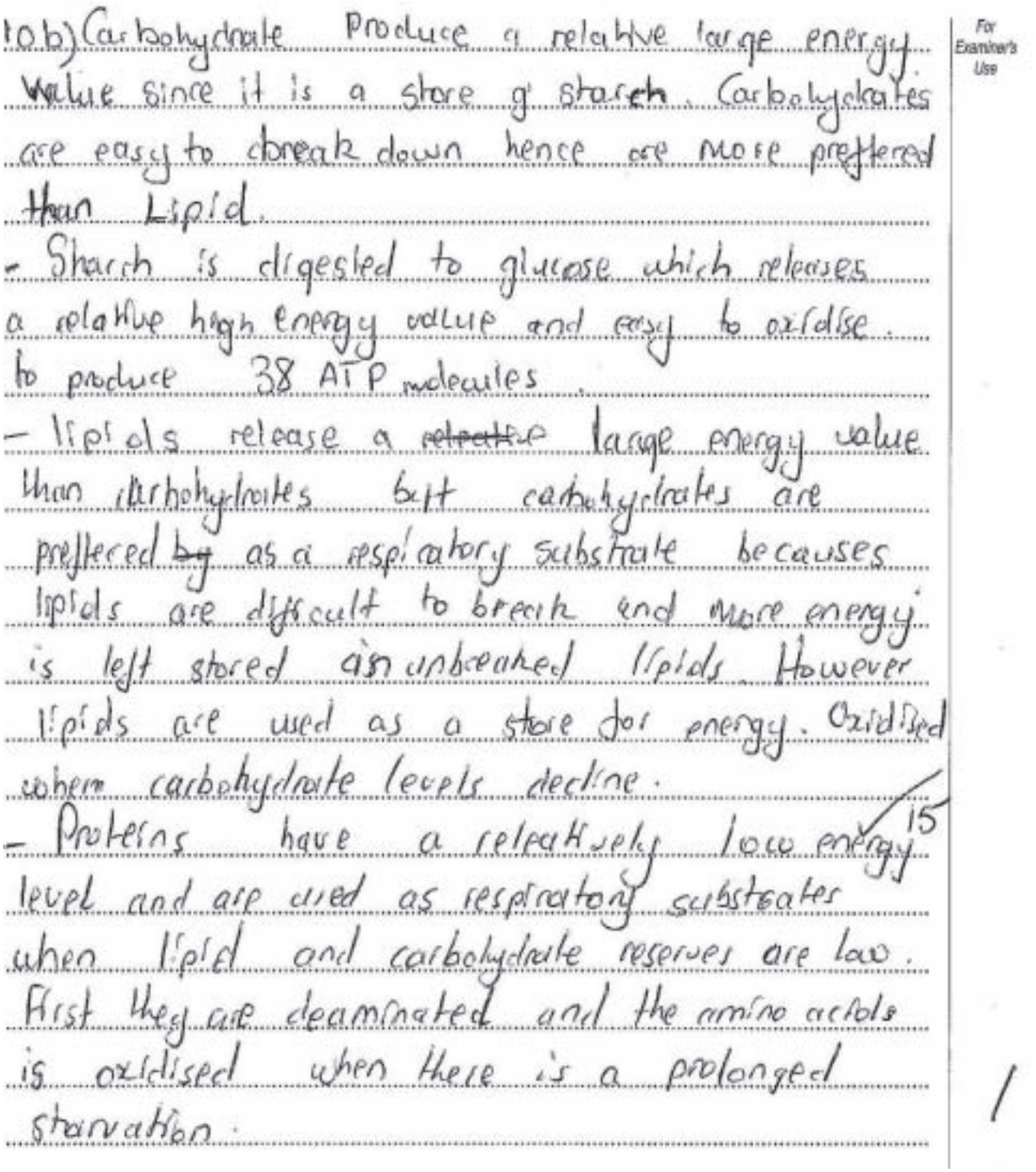
10)b) lipids have the highest calorific value among respiratory substrates. lipids are more reduced than Proteins and carbohydrates. They have more hydrogen in their structure than other. They have more C-C and C-H than proteins and carbohydrates and lower proportion of oxygen to carbon. They are composed of 3 fatty acids each fatty acid can be divided into 2 carbon chains named acetyl which can combine with CoA and enter the Kreb's cycle. So it can produce larger number of ATP than carbohydrates. When lipids are oxidised they release 39.4 kj compared with carbohydrates which produced 15.8 kj on oxidation and protein which produce 17 kj on oxidation. The respiratory quotient $\left(\frac{\text{vol. of } CO_2 \text{ given out}}{\text{vol. of } O_2 \text{ taken in}}\right)$ of lipids is 0.7 while of carbohydrates is 1.0 while in proteins is 0.9. Some cells cannot use other respiratory substrate than carbohydrate like brain cells, red blood cells.

15 16 19 3 6

Examiner comment – grade C

This candidate made an accurate statement about the higher energy values of lipids and did link this to lipids having more hydrogen atoms and more C-H bonds. Credit could have been obtained by further detail regarding the use of lipids as respiratory substrates.

Example candidate response – grade E



10 b) Carbohydrate Produce a relative large energy value since it is a store of starch. Carbohydrates are easy to break down hence are more preffered than Lipid.
- Starch is digested to glucose which releases a relative high energy value and easy to oxidise. to produce 38 ATP molecules
- lipids release a ~~relative~~ large energy value than carbohydrates but carbohydrates are preffered by as a respiratory substrate because lipids are difficult to break and more energy is left stored in unbreaked lipids. However lipids are used as a store for energy. Oxidised when carbohydrate levels decline.
- Proteins have a relatively low energy level and are used as respiratory substrates when lipid and carbohydrate reserves are low. First they are deaminated and the amino acids is oxidised when there is a prolonged starvation.

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15

1

Examiner comment – grade E

This candidate has given a brief description of each substrate in turn with little or no explanation for the differences in energy values.

Paper 5 – Planning, Analysis and Evaluation

Question 1(a)

1 A student noticed that the leaves on a plant growing close to a wall had two sorts of leaves. The leaves next to the wall were in the shade and looked different from the leaves on the side away from the wall that were exposed to the sun. The length of the internodes on the stem also looked different.

The student decided to investigate the differences by measuring some features of 30 leaves and internodes from each side of the plant.

Fig. 1.1 shows the leaf shape

Fig. 1.1

Fig. 1.2 shows an internode

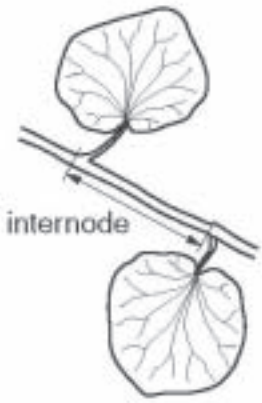

Fig. 1.2

Table 1.1 shows the student's results.

Table 1.1

	shaded leaves	exposed leaves
mean internode length / mm	23±4	15±3
mean surface area of leaves / mm^2	2750±12	1800±15
mean mass of leaves / mg	50±8	60±10
mean leaf surface area : leaf mass ratio	55±9	30±6
rate of water loss / mg mm^{-2} h^{-1}	50±11	65±12

(a) (i) State the independent variable being investigated.

.....[1]

(ii) Outline the procedures the student could use to obtain these results. [8]

Mark scheme

Question	Expected answer	Extra guidance	Mark
1 (a) (i)	light + intensity / exposure;	do not allow light unqualified or position in shade / sun	[1]
(ii)	8 of: *independent variable:* 1. ref. to a systematic way of obtaining leaves; *dependent variables:* 2. ref. to a **method** of measuring surface area; 3. ref. to how surface area is calculated; 4. ref. to idea of both sides needed to get total surface area; 5. ref. to a method of measuring mass; 6. ref. to finding dry mass; 7. ref. to a method of measuring internode length either on the plant or a cut section from a plant; 8. ref. to a method of measuring water loss; 9. ref. method of using the transpiration apparatus; 10. ref. to keeping constant environment when measuring water loss; (max. 6) *safety:* 11. ref. to low risk investigation; *reliability* 12. ref. to mean values of the whole sample; 13. ref. to method of working out SA : mass ratio; 14. ref. to calculating standard deviation;	*ignore any reference to planting seeds / potted plants* 1. e.g. 3rd leaf from the apex / different heights / all from the same height / equal light exposure 2. e.g. draw round each leaf on grid or use transparent grid over leaf / measure **diameter(s)** of leaf 3. count squares / use formula πr^2 5. e.g. digital balance / scales 6. e.g. sample leaves dried in oven until mass constant 7. by holding against a ruler / use string or cotton to mark distance measure with ruler 8. e.g. use a potometer / weigh leaf / place leaf inside a plastic bag (to collect water) 9. measure distance moved by water / weigh at hourly intervals / weigh bag or leaf after a stated time 11. e.g. ref. heat and suitable precaution if use dry mass / leaf allergy 12. do not allow 'mean of three idea' 14. ignore formula	[8]

Example candidate response – grade A

(a) (i) State the independent variable being investigated.

The type of leaf. X [1]

0

(ii) Outline the procedures the student could use to obtain these results.

For internode length, the student can use a ruler to measure the distance between pairs of leaves all over the plant. For shaded and exposed leaves separately. To calculate the mean surface area of the leaves, the student can trace the outline of the leaf onto a grid, and count the number of squares the outline occupies, then multiply by the area of one square. This should be repeated with leaves from different parts of the plant, and then averaged. For the mean mass, the student can

use a sensitive electronic weighing scale. This too, should be used on diffe leaves from different regions. When finding all these values, the student should use the formula $\sqrt{\frac{\Sigma(x-\bar{x})^2}{n-1}}$, to calculate the standard deviation, where x is the value measured, $\bar{x}$ is the mean value, and n is the number of sets of data. [8]

To calculate the ratio, he needs to divide mean surface area by mean mass. To get the rate of water loss, the student should use a potometer. He can get the volume of water lost by multiplying the distance moved by by the bubble in the capillary tube, and the cross-sectional area of the capillary tube.

8 m

Examiner comment – grade A

(a) (i) This answer was typical and incorrect. Although it was recognised that the source of the leaves was relevant, this concept was not followed through to reach the correct conclusion that it was the light exposure or light intensity that caused any observed differences in the two types of leaf.

(ii) The answer gained the maximum number of marks for this section and exemplifies the expected approach. Each aspect of the leaf measurements shown in Table 1.1 was addressed and a suitable method by which the results could have been obtained was described. The suggested methods were not always fully described. For example, to obtain the total surface area both sides must be included, this answer only explains how to calculate one surface. Similarly, the answer refers to using a weighing scale to find the mass of leaves, but does not consider that dry mass would be more effective.

Example candidate response – grade C

State the independent variable being investigated.

The number of 30 leaves and internodes from each side of the plants. [1]

0

(ii) Outline the procedures the student could use to obtain these results.

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The student can collect 30 leaves and internodes from each side of the plant, taking care to not mix the two. To obtain the mean internode length, 30 internodes are cut from the shaded leaves. Their lengths are measured using a 30 cm ruler ✓7 and the mean of this is calculated ✓12. Thus, a mean internode length in cm is obtained and this can be converted to mm. This experiment is repeated for the internodes of the exposed leaves.

The mean mass of leaves / mg is obtained by taking each leaf from the shaded part of the plant and weighing it on a scale ✓5. This is repeated for all 30 leaves and then a mean mass obtained. It is repeated for the light-exposed leaves.

The mean surface area of leaves is obtained by measuring the width and length of the surface of a shaded leaf. This is repeated for all 30 shaded leaves and, for each, the surface area is measured using L x W = Area. An average of all the areas is obtained. The experiment is repeated with the light-exposed leaves.

The mean leaf surface area : leaf mass ratio is obtained by using the previously obtained $\bar{x}$ surface area and $\bar{x}$ leaf mass and expressing them as a ratio of each other.

The rate of water loss is obtained by placing a shaded leaf on ~~a potato tube~~ a scale, recording its mass and then leaving it for 12 hours. At hourly ✓3 intervals, the mass of the leaf is recorded. The rate of water loss is ~~calculated~~ obtained by calculating the ~~mass~~ loss of mass per hour. This is repeated for all 30 leaves. ~~and so on~~ It is then repeated using leaves from the light-exposed side of the plants. [8]

5

Examiner comment – grade C

(a) (i) This answer shows a misunderstanding of the difference between an independent variable and a standardised variable. The answer is effectively repeating the information given in the question in the introduction to Fig.1.1 and 1.2.

(ii) The answer shows the expected approach, but the methods described for measuring the various features of the leaf are not, in all cases, well described. The answer refers to cutting internodes, but does not suggest how this is standardised, either by selecting the same height, same location on the stem or any other suitable method of sampling. The method described for measuring the surface area was incorrect. The formula of L x W = Area is suited to a square of rectangle. Using the formula for calculating the area of a circle would have been acceptable. The letters L and W were assumed to refer to length and width as the previous part of the answer stated that these were measured. However, unless recognised SI abbreviations are used, it is better for these to be written in full, or the abbreviation linked to the word at some point in the answer. The description of how to obtain the ratio of mean leaf surface area: leaf mass, stated only that the figures for mass and surface area should be used, but not how they would be used. Answers to this type of question should show how the mathematical processes would be carried out, in this case dividing the surface area by the mass.

Other features of the procedure, such as calculating standard deviation (s) or standard error (S_M) and safety could also have been included.

Example candidate response – grade E

(a) (i) State the independent variable being investigated.

Length of the internodes X [1] 0

(ii) Outline the procedures the student could use to obtain these results.

The student could use different species of leaves in this investigation. Look for plants that have leaves which are exposed to sunlight and those in the shade. To measure the length of the internode, the student will use a ruler to find the measurements. The student can also use a string or thread to get the internode distance. ✓1

In order to find the mass of the leaves, the student will weigh them using a weighing scale. ✓1

From the different masses obtained, the student will be able to know which type of leaves lose more water i.e. exposed leaves lose more water than shaded leaves. The student could use a potometer to find the rate of water loss of the two types of leaves. Apply various conditions for example carbon dioxide concentration, light intensity, wind and humidity to the plant shoot. This helps to know how fast water is being lost. Both to the shaded leaves and exposed leaves. ✓3

A string / thread to measure the distance around the leaves. [8] 3

The student should be able to work with the potometer at a controlled room temperature. This could be maintained by using an air conditioner. There should also be a constant supply of air using a fan.

Examiner comment – grade E

(a) (i) This answer appears to be a guess or an assumption that the first feature in Table 2.2 is the independent variable.

(ii) The first part of this answer suggests a misunderstanding of the information given. The answer refers to using different species and also to different plants. The question clearly refers to using the same plant. This answer illustrates how important it is for candidates to read the question and to make sure that they understand the information provided. The answer did, however, show the expected approach, but was limited to a basic statement about the apparatus that would be used to measure internode length, mass and water loss. Within the answer there were a number of statements that drifted away from the main idea also suggesting a limited understanding of the question. For instance, the statement 'from the mass obtained the student will be able to know which type of leaf lose more water', does not follow from the previous sentence or relate to the following reference to using a potometer. The sentences following the reference to a potometer also drift away from the point of the question. The part of the answer that refers to using a string to measure the distance around the leaf does not give any indication of what this will be used for. If it is to calculate leaf surface area, then this is not the usual way, by using the radius of a circle. In the last paragraph the answer could have gained a mark for maintaining a constant environment while using a potometer, but the suggested method of using an air conditioner is not acceptable. The purpose of air conditioners is to remove heat and humidity not to maintain a constant temperature. The answer also shows confusion about the purpose of a fan, in terms of maintaining a constant environment it would provide a constant air flow rather than a constant air supply.

Question 1(b)

The student carried out *t*-tests for leaf surface area : leaf mass ratio and for internode length.

The leaf surface area : leaf mass ratio gave the value $t = 12.6$

The formula for *t*-test is

$$t = \frac{|\bar{x}_1 - \bar{x}_2|}{\sqrt{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)}}$$

(b) (i) Complete the calculation to find the value of *t* for the internode length. Show your working.

$t =$ $\frac{-}{\sqrt{\frac{4^2}{30} + -}}$

$=$ $\frac{}{0.9}$

$t =$ .....[3]

Table 1.2 shows the critical values at $p < 0.05$ for the *t*-test.

Table 1.2

degrees of freedom	18	20	21	22	23	24	25	26	27	28	29	30	40	60	∞
critical value	2.10	2.09	2.08	2.07	2.06	2.06	2.06	2.06	2.05	2.05	2.04	2.04	2.02	2.00	1.96

The number of degrees of freedom is 58.

(ii) State how the number of degrees of freedom was calculated.

.....

.....[1]

(iii) State and explain the meaning of these results.

.....

.....

.....

.....[2]

(b) (i)	t = **23 – 15** ; $\sqrt{\frac{4^2}{30}} + \frac{3^2}{30}$; $\frac{(8)}{(0.9)}$ = **8.9**;	ignore any working in the answer allow 9 / 8.89 and 8.88 $\dot{8}$ allow ecf for incorrect figure from subtraction	[3]
(ii)	total number of measurements –1 **for each set of measurement /** (30 – 1) + (30 – 1) = 58;	allow 2n – 2 / (n – 1) + (n – 1) 60 – 2 = 58	[1]
(iii)	ref. (both) calculated / t values are greater than the critical value / 0.2; both results are significant / not due to chance / caused by another factor / light exposure;	if the calculation is omitted from **(b)(i)** both marks are still available allow ecf from **(b)(i)** ignore null hypothesis unless explained	[2]

Example candidate response – grade A

(b) (i) Complete the calculation to find the value of *t* for the internode length. Show your working.

$$t = \frac{23 - 15}{\sqrt{\frac{4^2}{30} + \frac{3^2}{30}}}$$

$$= \frac{8}{0.9}$$

$t =$ 8.89 [3]

3

Table 1.2 shows the critical values at $p < 0.05$ for the *t*-test.

Table 1.2

degrees of freedom	18	20	21	22	23	24	25	26	27	28	29	30	40	60	∞
critical value	2.10	2.09	2.08	2.07	2.06	2.06	2.06	2.06	2.05	2.05	2.04	2.04	2.02	2.00	1.96

The number of degrees of freedom is 58.

(ii) State how the number of degrees of freedom was calculated.

$(n_1 - 1) + (n_2 - 1) = (30 - 1) + (30 - 1)$

$= 58$ [1]

1

(iii) State and explain the meaning of these results.

The values of t are greater than the critical value for 58 degrees of freedom (between 2.02 and 2.00). So the null hypothesis is rejected. There are external factors causing differences between the leaves in the shade and leaves exposed to the sun. [2]

2

Examiner comment – grade A

(b) **(i)** This answer is completely correct, with an appropriate rounding up of the recurrent figure of the final answer.

(ii) This answer is an excellent example of how to calculate the number of degrees of freedom as all the steps in the sequence are clearly shown.

(iii) This is also an excellent example of how to explain the meaning of a statistical test. There is a clear statement about the values of *t* in relation to the critical value, and also indicated where this value would lie in Table 1.2. The answer then explained why the values are significant. This answer is particularly good as it is clear that both the value of *t* given in the question, and that which has been calculated, have been considered.

Example candidate response – grade C

(b) (i) Complete the calculation to find the value of *t* for the internode length. Show your working.

$$t = \frac{23 - 15}{\sqrt{\frac{4^2}{30} + \frac{3^2}{30}}}$$

$$= \frac{8}{0.9}$$

$t = 8.9$ [3] 3

Table 1.2 shows the critical values at $p < 0.05$ for the *t*-test.

Table 1.2

degrees of freedom	18	20	21	22	23	24	25	26	27	28	29	30	40	60	∞
critical value	2.10	2.09	2.08	2.07	2.06	2.06	2.06	2.06	2.05	2.05	2.04	2.04	2.02	2.00	1.96

The number of degrees of freedom is 58.

(ii) State how the number of degrees of freedom was calculated.

2n - 2 where n is the number of samples [1] 1

(iii) State and explain the meaning of these results.

It shows the the data is continuous × meaning it is ~~by chance~~

[2] 0

Examiner comment – grade C

(b) (i) This answer is completely correct.

(ii) This answer is correct and illustrates the minimum that would be needed to gain the mark. The formula, 2n-2, would be insufficient if there was no explanation of 'n'.

(iii) This is an answer to a different question, which is why a *t*-test was used for this data. It illustrates the importance of reading the question being asked.

Example candidate response – grade E

(b) (i) Complete the calculation to find the value of t for the internode length. Show your working.

$t = \dfrac{55 - 23}{\sqrt{\frac{4^2}{30} + \frac{2.88^2}{30} \times}}$

$\sqrt{\frac{4^2}{30} + \frac{x}{30}} = 0.9$

$\frac{16}{30} + \frac{x}{30} = 0.81$

$16 + x = 24.3$

$x = 8.3$

$= \dfrac{32}{0.9}$

$= 35.6 = 36$

$\sqrt{\frac{4^2}{30} + x} = 0.9$

$\frac{16}{30} + x = 0.9^2$

$x = 0.81 - 16/30$

$x = \frac{8.3}{300}$

$t =$ ~~36~~ 35.6 [3]

1

Table 1.2 shows the critical values at $p < 0.05$ for the t-test.

Table 1.2

degrees of freedom	18	20	21	22	23	24	25	26	27	28	29	30	40	60	∞
critical value	2.10	2.09	2.08	2.07	2.06	2.06	2.06	2.06	2.05	2.05	2.04	2.04	2.02	2.00	1.96

The number of degrees of freedom is 58.

(ii) State how the number of degrees of freedom was calculated.

Number of degrees of freedom = $(\bar{x}_1 + \bar{x}_2) - 2$ ✗

= 58 [1]

0

(iii) State and explain the meaning of these results.

The critical value is 2.00

The results are significant. The null hypothesis is not rejected. contradicts

0

Examiner comment – grade E

(b) (i) This answer suggests a number of misunderstandings of the question or a limited understanding of how to carry out a *t*-test. The data written in the first line of the formula is not comparing the means of internode length. The figure of 55 is for shaded leaves, mean surface area: mass ratio and the figure of 23 is for shaded leaves, mean internode length. The value in the second line of the formula, based on the additional working, appears to have been obtained by using a simultaneous equation. Table 1.1 shows the standard deviation for each of the data sets. The mark achieved is an allowed mark for correctly using the figure obtained from their incorrect use of the formula. In many cases, 'error carried forward' marks are given for showing the correct method of processing the data, so that a single error does not result in the loss of all of the marks.

(ii) This answer also shows an uncertain knowledge of statistics. The answer is almost correct, but the use of symbol for 'mean' number rather than the actual number meant that the mark could not be given.

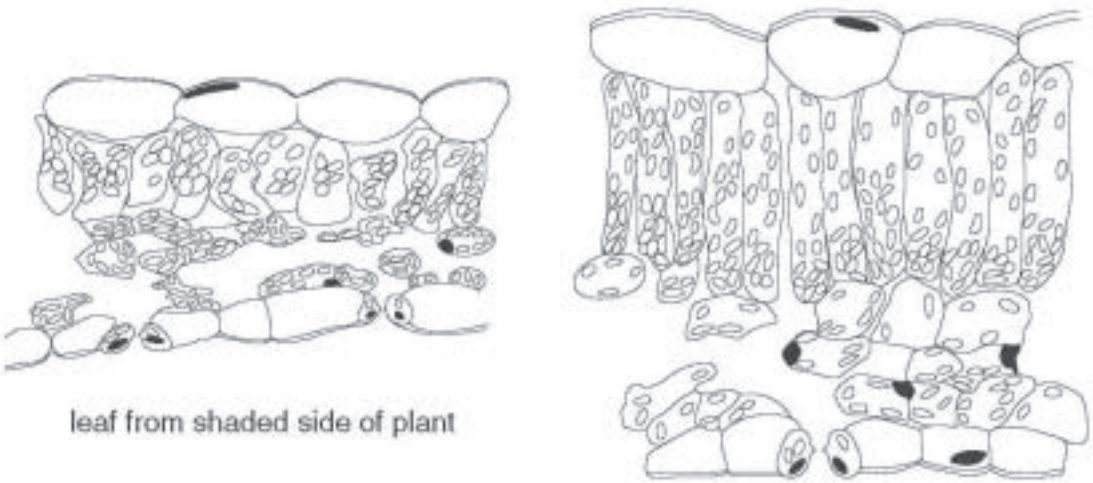
(iii) Although the answer refers to a correct position for the critical value in Table 1.2, there is not enough explanation about how this was used to decide if the value of *t* was significant. The latter part of the answer was a contradiction. The answer suggests a misunderstanding of the meaning of 'null' hypothesis.

Question 1(c)

In a further investigation, the student cut sections of the leaves from the shaded side and from the exposed side of the plant. The following procedures were carried out:

Transverse sections were made of each leaf and high-power drawings were made from these sections. The relative thickness of both the leaf and the cuticle were measured using an eyepiece graticule and the difference in the distribution of chloroplasts was observed.

Fig. 1.3 shows drawings made from transverse sections of these leaves.



leaf from shaded side of plant

leaf from exposed side of plant

Fig. 1.3

(c) (i) Explain how the actual thickness of the leaf could be measured.

.....

.....

.....[2]

(ii) With reference to the student's results, state what conclusions can be drawn about the differences in adaptations shown by shaded leaves and exposed leaves of the plant.

.....

.....

.....

.....

.....

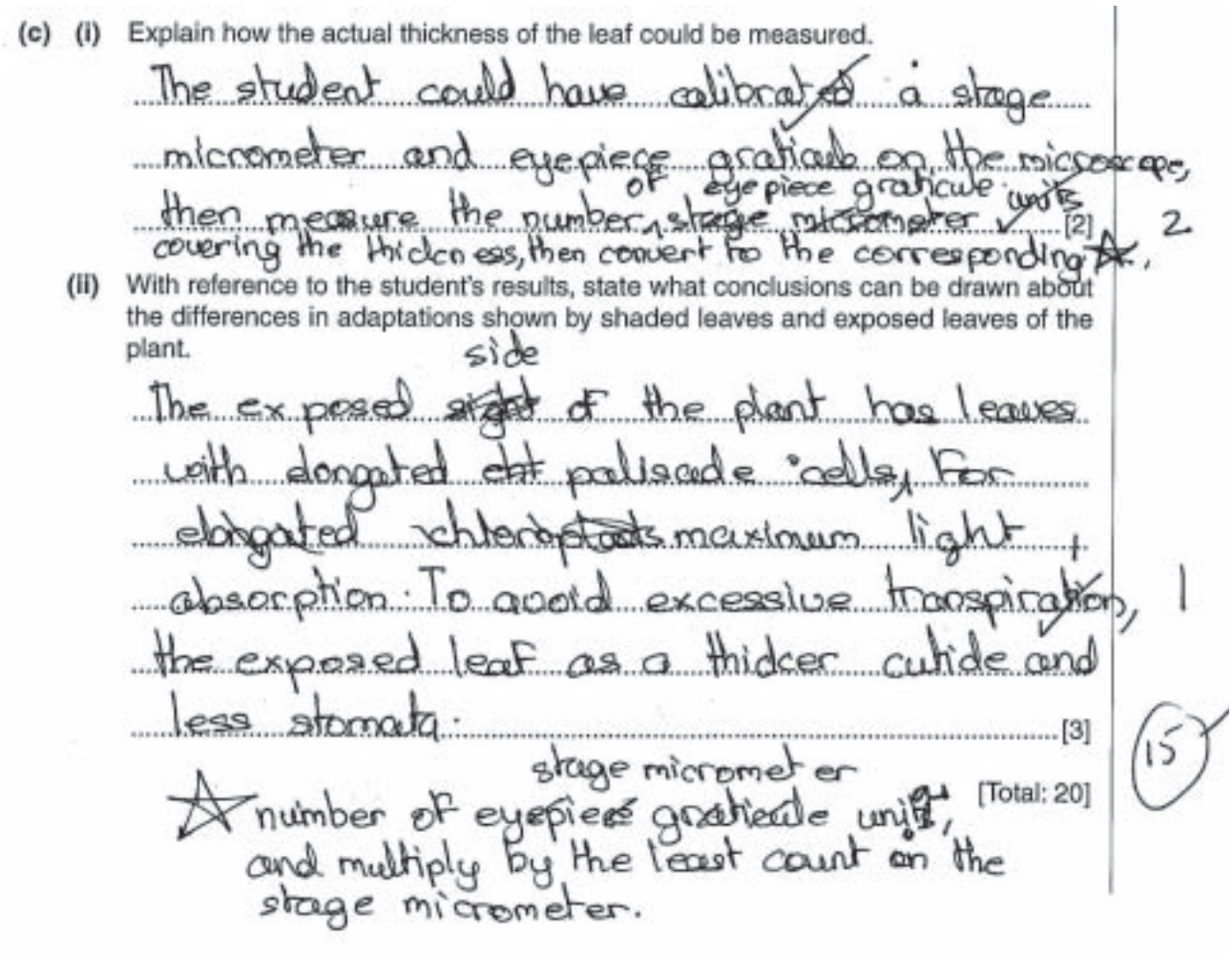
.....[3]

[Total: 20]

Mark scheme

(c) (i)	ref. to counting the number of eye piece graticule units; ref. to idea of finding the value of an eyepiece unit with a stage micrometer	 allow descriptions / ref. to a standard graticule unit value	[2]
(ii)	*Marks are for conclusions about the adaptations shown by the plants. Do not allow marks for answers that restate the data in table 1.1* 3 of: **EITHER** for shade leaves: 1. thinner cuticle increases light penetration; 2. thinner leaf / shorter palisade cells increases light penetration (to inner parts of leaf); 3. spongy mesophyll has more chloroplasts to increase light absorption; 4. cells less densely packed / larger air spaces for better gas diffusion; 5. larger surface area to absorb limited light / enables more photosynthesis with less light availability; **OR** for sun / exposed leaves: 1. thicker cuticle limits water loss; 2. (large / long palisade cells) contain more chloroplasts to absorb maximum light; 3. fewer chloroplasts in spongy mesophyll as little light penetrates / palisade is light saturated; 4. densely packed cells / smaller air spaces reduce water loss; 5. smaller surface area reduces water loss;	*Look for the understanding that shade leaves have adaptations that maximise photosynthesis and sun leaves have adaptations to minimise water loss.* allow mix and match for sun and shade leaves but take care not to give the same mark twice. candidates should make it clear which type of leaf they are referring to. ignore anything related to growth ignore any references to internodes ignore any references to stomata	[3]

Example candidate response – grade A



(c) (i) Explain how the actual thickness of the leaf could be measured.

The student could have calibrated a stage micrometer and eyepiece graticule on the microscope, then measure the number of eyepiece graticule units covering the thickness, then convert to the corresponding stage micrometer units. [2]

2

(ii) With reference to the student's results, state what conclusions can be drawn about the differences in adaptations shown by shaded leaves and exposed leaves of the plant.

The exposed side of the plant has leaves with elongated palisade cells, for elongated chloroplasts maximum light absorption. To avoid excessive transpiration, the exposed leaf as a thicker cuticle and less stomata. [3]

1

15

[Total: 20]

☆ number of eyepiece graticule units, and multiply by the least count on the stage micrometer.

stage micrometer

Examiner comment – grade A

(c) (i) This answer shows an understanding of both of the key ideas for this question. The idea of counting the number of eyepiece units was not well expressed and there was some confusion about how the calibration should be used to find an actual value. However, it was clear that the principles of measuring actual size using a microscope was known.

(ii) The answer addressed the question, but in parts lacked sufficient detail to gain more marks. For instance, the reference to elongated palisade cells in the leaves of the exposed side of the plant was correct, but also needed to link this to the number of chloroplasts as well as to light absorption. The answer also made a correct connection about the thickness of the cuticle and transpiration for the exposed leaves. The answer, however, lacked any conclusions related to the shaded leaves. A better answer would have drawn conclusions about both types of leaf.

Example candidate response – grade C

(c) (i) Explain how the actual thickness of the leaf could be measured.

Using a stage micrometer, the eyepiece graticule can be calibrated. Using that calibration the thickness can be found. [2]

(ii) With reference to the student's results, state what conclusions can be drawn about the differences in adaptations shown by shaded leaves and exposed leaves of the plant.

The shaded leaves have fewer chloroplasts in the palisade cells since there is not enough sunlight falling on them to be captured, unlike the exposed ones. The shaded leaves have a large surface area to capture any amount of light available. The water lost from the leaves is also less as most of it is used for photosynthesis in the spongy mesophyll cells where water is more easily available and more chloroplasts are present. The shaded leaves are also less thick so that gases and water are more concentrated inside them. The shaded leaves are adapted to survive in conditions where sunlight is not available while the exposed leaves are adapted to thrive in normal conditions. [3]

[Total: 20]

16

Examiner comment – grade C

(c) (i) Although this answer makes an acceptable reference to calibration, it was not well explained. A better answer would have described counting the number of eyepiece units matching a slide micrometer unit. The rest of the answer only states 'the thickness can be found', it did not give any indication of how this could be achieved.

(ii) The answer showed an understanding of the requirements of the question, but the connections between the adaptations and environmental factors were often incorrect. The emphasis was on the adaptations of shade leaves and showed an understanding that a large surface area would optimise the absorption of the limited light. The other parts of the answers were rather muddled. For instance, the answer correctly stated that the shaded leaves had fewer chloroplasts in the palisade, but did not relate this to the overall distribution of the chloroplasts. This part of the answer also made a partial link to 'not enough sunlight' but implied that there were fewer chloroplasts because there is less light, which is not a valid conclusion if the spongy mesophyll is taken into account. Later in the answer, the number of chloroplasts in the spongy mesophyll was mentioned but in the incorrect context of water availability. The answer also made a correct statement about the thickness of the shaded leaves, but again made an inappropriate connection to the concentration of gases inside the leaf, rather than the light penetration.

Example candidate response – grade E

(c) (i) Explain how the actual thickness of the leaf could be measured.

The leaf could be plucked and placed in a vernier caliper which can be adjusted and used to measure the actual thickness. [2]

0

Micrometer screw Gauge can use be used.

(ii) With reference to the student's results, state what conclusions can be drawn about the differences in adaptations shown by shaded leaves and exposed leaves of the plant.

Leaves from the shaded side have a longer surface area (2750 ± 12 mm) in order to effectively absorb whatever sunlight falls on them. Moreover, they have a smaller thickness and fewer number of chloroplasts tightly packed together. Whereas leaves from exposed side have a smaller surface area (1800 ± 15 mm) and a larger mass (60 ± 10) mg and thickness. The chloroplasts are more in number and are spread in the leaf. [3]

[Total: 20]

1

9

Examiner comment – grade E

(c) (i) This answer illustrates the importance of reading the information given, which quite clearly stated that an eyepiece graticule was used for the measurements of sections cut from of leaves. The answer described using a micrometer screw gauge and whole leaves.

(ii) The answer started as expected by linking the larger surface area of shade leaves to light absorption. Although it was not well expressed, the implication seemed to be that the light availability was limited, so a mark was awarded. The rest of this answer was a description of the observable differences in structure between the two types of leaf, suggesting some uncertainty about either the expectation of the question, or the reasons for the adaptations of the two types of leaf.

Question 2(a)

2 Fig. 2.1 shows a freshwater crustacean. This animal has a two-chambered heart that can be seen through the exoskeleton.

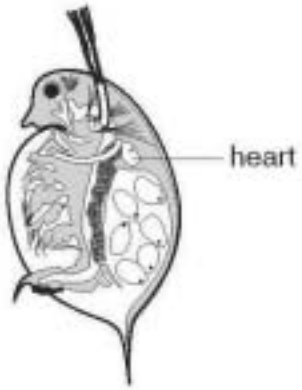


Fig. 2.1

An investigation into the effect of temperature on heart rate was carried out using this organism to test the hypothesis:

Heart rate doubles for every 10 °C increase in temperature.

Five crustaceans, each measuring 5 mm in length, were placed in water of different temperatures and left for five minutes. The heart beat was counted for 20 seconds using a tally counter and stop watch. Table 2.1 shows the results of the investigation.

Table 2.1

	heart rate / beats per minute						
	temperature / °C						
	5	10	15	20	25	30	35
specimen 1	30	45	63	96	132	165	84
specimen 2	33	51	69	105	150	171	87
specimen 3	33	48	66	93	130	174	69
specimen 4	45	57	87	111	168	183	78
specimen 5	24	36	51	78	120	135	75

(a) (i) Identify two variables that have been controlled during this investigation.

1. .....

2. .....[2]

(ii) Suggest **one** other variable that should be controlled.

.....

.....[1]

(iii) Suggest **one** feature of the procedure which may cause the results to be inaccurate.

.....

.....[1]

(iv) Suggest a reason why the student used five specimens at each temperature.

.....

.....[1]

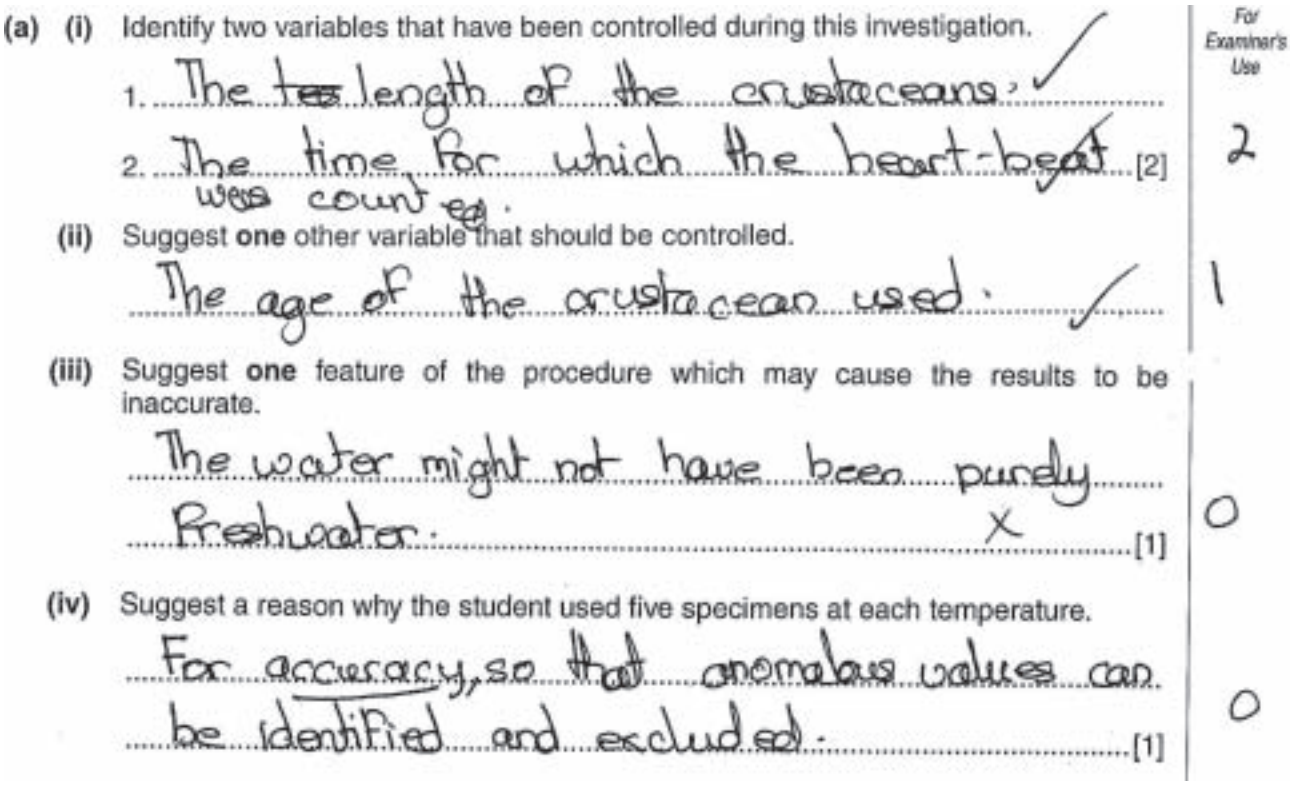
Mark scheme

2 (a) (i)	2 of: length of organism; time for adjustment (to temperature); time of measurement;	do not allow size	[2]
(ii)	1 of: activity / age / sex / mass of organism; source / type / pH / volume of water; oxygen supply;	do not allow microscope lamp / light	[1]
(iii)	1 of: counting high rates is error prone; changes in temperature; activity / stress affect heart rate;	allow oxygen content if not in **(ii)** e.g. light from microscope / cooling	[1]
(iv)	idea of sufficient measurements for reliability / to remove anomalous results;	do not allow accurate ignore reduce error / fair test	[1]

General comment

Two of the examples, both borderline grade C, reflect the pattern of 'better' answers to this question. There is also an example of an answer that did not gain any marks, but showed some of the range of misconceptions that occurred in this question.

Example candidate response – grade C



(a) (i) Identify two variables that have been controlled during this investigation.

1. The ~~tes~~ length of the crustaceans. ✓

2. The time for which the heart-beat was count ed. [2]

For Examiner's Use: 2

(ii) Suggest **one** other variable that should be controlled.

The age of the crustacean used. ✓

For Examiner's Use: 1

(iii) Suggest **one** feature of the procedure which may cause the results to be inaccurate.

The water might not have been purely Freshwater. X [1]

For Examiner's Use: 0

(iv) Suggest a reason why the student used five specimens at each temperature.

For accuracy, so that anomalous values can be identified and excluded. [1]

For Examiner's Use: 0

Examiner comment – grade C

(a) (i) This answer gained both marks as the controlled variables have been described clearly. Often answers stated 'size of the crustacean' which is not acceptable. Other answer stated 'time' without any further expansion, which is also not acceptable.

(ii) The answer was also clearly stated.

(iii) This answer did not really address the question and appeared to be a guess. As the heart rate was the dependent variable, then factors that might cause a change in the heart rate of the crustacean, or the technique used for counting should have been considered.

(iv) This illustrates the common error for this part of the question. The term used was accuracy, but the explanation was about reliability.

Example candidate response – grade C

(a) (i) Identify two variables that have been controlled during this investigation.

1. temperature. ✗

2. length of the crustaceans. ✓ [2]

(ii) Suggest **one** other variable that should be controlled.

the ~~amount~~ volume of ~~oxygen~~ water. ✓ in the chamber.

for each crustacean should be equal. [1]

(iii) Suggest **one** feature of the procedure which may cause the results to be inaccurate.

there is dissolved Oxygen in the water thus

the amount of oxygen in each container is different ✓ [1]

(iv) Suggest a reason why the student used five specimens at each temperature.

this is the to increase the accuracy of ✗

the experiment. [1]

0

Examiner comment – grade C

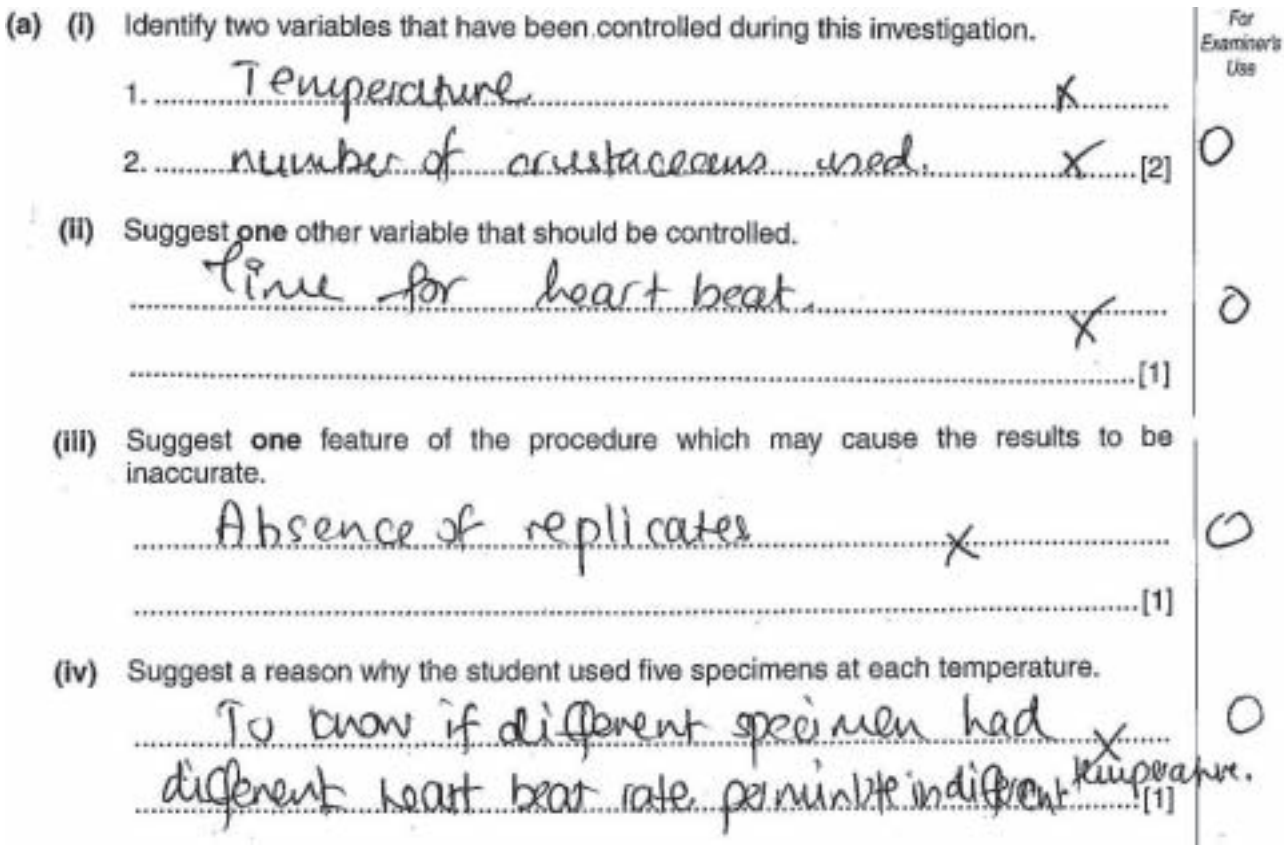
(a) (i) There was some confusion between the controlled variables and the independent variable. It was possible that the answer of 'temperature' was intended to be about keeping each of the individual temperatures used constant during the time of measuring. However, as temperature was the independent variable of the investigation, it could not be credited. It may well be true that the value of the independent variable had to be kept constant at each of the tested points, but this should not be given as an answer about controlled or standardised variables.

(ii) This was a clearly stated answer.

(iii) This was also a clearly stated answer.

(iv) The answer showed a common misunderstanding. The number of replicates is a means of improving reliability. Accuracy is more commonly improved by using a better way of measuring the dependent variable.

Example candidate response – grade E



(a) (i) Identify two variables that have been controlled during this investigation.

For Examiner's Use

1. Temperature. ✗

2. number of crustaceans used. ✗ [2]

0

(ii) Suggest **one** other variable that should be controlled.

time for heart beat. ✗

[1]

0

(iii) Suggest **one** feature of the procedure which may cause the results to be inaccurate.

Absence of replicates ✗

[1]

0

(iv) Suggest a reason why the student used five specimens at each temperature.

To know if different specimen had ✗ different heart beat rate per minute in different temperature.

[1]

0

Examiner comment – grade E

(a) **(i)** Temperature was the independent variable and the number of crustaceans used was a means of improving reliability.

(ii) This was a variable that was controlled.

(iii) This answer suggests a misunderstanding of the experimental procedure in which the five crustaceans were the replicates.

(iv) This further supports the view that reliability, accuracy and the role of replicates was not understood.

Question 2(b) and (c)

The student calculated the percentage change in heart rate for each specimen. Table 2.2 shows these results.

Table 2.2

	percentage change in heart rate					
	temperature / °C					
	5–10	10–15	15–20	20–25	25–30	30–35
specimen 1	50	40	52	38	25	-49
specimen 2	55	35	52	42	14	-49
specimen 3	45	38	40	39	34	-60
specimen 4	27	52	28	51	9	-57
specimen 5	50	41	53	54	12	-44

(b) (i) Suggest why the student converted the raw data to percentage change.

.....

.....[1]

(ii) Describe how the percentage change between 25 °C and 30 °C was calculated.

.....

.....[1]

(iii) Predict the effect on the heart rate of an increase in temperature to 40 °C.

.....

.....[1]

(c) Assess how far the results of the investigation support the hypothesis.

.....

.....[2]

(b) (i)	allows for different starting points between individuals / can see the changes more clearly;	looking for the idea that 'it is easier to see what is happening / make comparisons'	[1]
(ii)	$\frac{\text{rate at 30 °C – rate at 25 °C / difference in rate at 30 °C and 25 °C}}{\text{rate at 25 °C}}$ × 100;	allow correct use of any figures from the table e.g. $\frac{165-132}{132} \times 100$	[1]
(iii)	decrease (by at least 50%) / falls to a very low value / may stop;		[1]
(c)	*support*: 5 °C – 15 °C / 15 °C – 25 °C / 10 °C – 20 °C (as rate approx. doubles with10 °C increase); *does not support:* 20 °C – 30 °C increases but does not double / 25 °C – 35 °C decreases / above 30 °C rapidly decreases with temperature increase;	allow 'below 30 °C' / 'up to 25 °C' allow above 30 °C – 35 °C rapidly decreases with temperature increase;	[2]

Example candidate response – grade A

(b) (i) Suggest why the student converted the raw data to percentage change.

Percentage changes are easier to analyse and deal with to validate the hypothesis than the raw data. [1]

(ii) Describe how the percentage change between 25 °C and 30 °C was calculated.

Calculate difference in heart rate between 25°C and 30°C and divide value by heart rate at 25°C and multiply by 100. [1]

(iii) Predict the effect on the heart rate of an increase in temperature to 40 °C.

Heart rate further decreases until it reaches zero. High temperatures may cause the heart to stop beating. [1]

(c) Assess how far the results of the investigation support the hypothesis.

Heart rate only doubles between 5-25°C beyond 25°C further increase in temperature decreases heart rates. Results support to a great extent. [2]

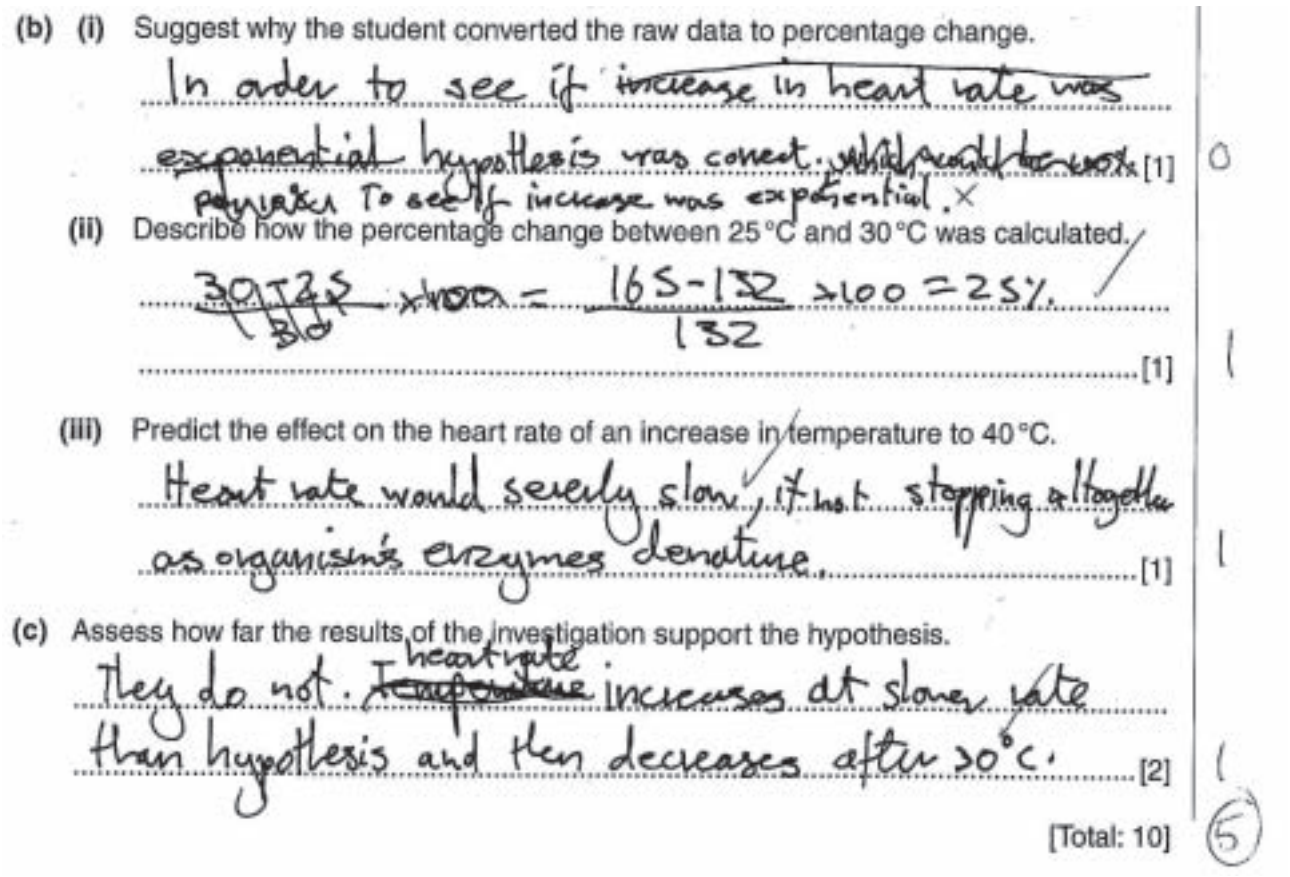
[Total: 10]

1
1
1
2
8

Examiner comment – grade A

This was an excellent answer to both parts **(b)** and **(c)** of the question. Each answer was clearly explained. Part **(c)** was particularly well answered as the temperatures quoted were correct and both aspects of support for the hypothesis were addressed.

Example candidate response – grade C



(b) (i) Suggest why the student converted the raw data to percentage change.

In order to see if ~~increase in heart rate was~~ exponential hypothesis was correct. ~~which would be wrong~~ [1]

To see if increase was exponential. ×

0

(ii) Describe how the percentage change between 25 °C and 30 °C was calculated.

$\frac{30-25}{25} \times 100 = \frac{165-132}{132} \times 100 = 25\%$

[1]

1

(iii) Predict the effect on the heart rate of an increase in temperature to 40 °C.

Heart rate would severely slow, if not stopping altogether as organism's enzymes denature. [1]

1

(c) Assess how far the results of the investigation support the hypothesis.

They do not. ~~Temperature~~ heartrate increases at slower rate than hypothesis and then decreases after 30°C. [2]

1

[Total: 10]

5

Examiner comment – grade C

(b) (i) This answer illustrates a common misconception that percentage change is a way of testing a hypothesis.

(ii) Illustrates a way of answering this question by using a formula and data from Table 2.1.

(iii) Was correct.

(c) This illustrates different features of some weaker answers. The question was an evaluation of results, so the answer should include a reference to both support and lack of support for the hypothesis.

Example candidate response – grade E

(b) (i) Suggest why the student converted the raw data to percentage change.

It makes it easier to compare results ✓ and then makes it easier to see whether the hypothesis is correct. [1] 1

(ii) Describe how the percentage change between 25 °C and 30 °C was calculated.

The difference between 30°C and 25°C is calculated then this, as a fraction of 25°C is calculated as a percentage.

e.g. Specimen 1 : 165 − 132 = 33 $33/132 \times 100 = 25\%$ ✓ [1] 1

(iii) Predict the effect on the heart rate of an increase in temperature to 40 °C.

The heart rate would begin to decrease as protein and enzymes in the crustacean begin to denature. It may then suddenly increase due to the extra stress on the organism. [1] 0

(c) Assess how far the results of the investigation support the hypothesis.

The results of the investigation do up until a certain temperature, support the hypothesis. For specimen 3, its heart rate doubled from 33 beats to 66 beats over the [2]
time span from 5 to 15 minutes. This shows it has doubled. After 35°C, the rate decreases due to damage of the organism. [Total: 10] 0 5

Examiner comment – grade E

(b) **(i)** and **(ii)** were well answered.

(iii) There was a contradiction in this answer. The first sentence about the heart rate decreasing is correct, although the explanation was not required. However, the second sentence was a direct contradiction and is not supported by the data in the question, so a mark could not be allowed.

(c) This answer illustrates the common theme of poorer answers. There is a general understanding of the expected answer, but the data quoted is far too vague. For instance, 'up to a certain temperature' is meaningless; the actual temperature should be quoted. The figures quoted for specimen 3 are from Table 2.1, but were related to time rather than temperature. The reference to time may have been a 'slip of the pen', but there was insufficient evidence in the rest of the answer to give any 'benefit of doubt'. The statement 'after 35°C, the rate decreases' was incorrect as above 30°C the heart rate was decreasing.

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