Example Candidate Responses

Cambridge International AS & A Level

Cambridge International AS and A Level Biology

9700

Paper 4 – A Level Structured Questions

For examination from 2016

Cambridge Advanced

CAMBRIDGE International Examinations

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Contents

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 (high, middle and low) relate to the subject's curriculum and assessment objectives.

In this booklet candidate responses have been chosen to exemplify a range of answers. Each response is accompanied by a brief commentary explaining the strengths and weaknesses of the answers.

For each question, each response is annotated with a clear explanation of where and why marks were awarded or omitted. This, in turn, is followed by examiner comments on how the answer could have been improved. In this way it is possible for you to understand what candidates have done to gain their marks and what they will have to do to improve their answers. At the end there is a list of common mistakes candidates made in their answers for each question.

This document provides illustrative examples of candidate work. These help teachers to assess the standard required to achieve marks, beyond the guidance of the mark scheme. Some question types where the answer is clear from the mark scheme, such as short answers and multiple choice, have therefore been omitted.

The questions, mark schemes and pre-release material used here are available to download as a zip file from Teacher Support as the Example Candidate Responses Files. These files are:

Question Paper 22, June 2016	
Question paper	9700_s16_qp_22.pdf
Mark scheme	9700_s16_ms_22.pdf
Question Paper 33, June 2016	
Question paper	9700_s16_qp_33.pdf
Mark scheme	9700_s16_ms_33.pdf
Question Paper 41, June 2016	
Question paper	9700_s16_qp_41.pdf
Mark scheme	9700_s16_ms_41.pdf
Question Paper 52, June 2016	
Question paper	9700_s16_qp_52.pdf
Mark scheme	9700_s16_ms_52.pdf

Past papers, Examiner Reports and other teacher support materials are available on Teacher Support at **https://teachers.cie.org.uk**

How to use this booklet

Example candidate response – high	Examiner comments
Answer **all** the questions. 1 Statements **A** to **E** are about the structure and functioning of enzymes. State the correct term to match each of the statements **A** to **E**. 1 …that needs to be overcome by reactants in order … …es on the active site being partially flexible and …e. …n… …n enzyme, with a tertiary or quaternary structure that results in an approximately spherical shape. Globular **D** The term for enzymes that function outside cells. Extracellular **E** The concentration of substrate that enables an enzyme to achieve half the maximum rate of reaction. Km value [5] [Total: 5]	1 This candidate has responded as requested and given answers that are concise and are **Total mark awarded = 5 out of 5**

Answers by real candidates in exam conditions. These show you the types of answers for each level.

Discuss and analyse the answers with your learners in the classroom to improve their skills.

Examiner comments are alongside the answers, linked to specific part of the answer. These explain where and why marks were awarded. This helps you to interpret the standard of Cambridge exams and helps your learners to refine their exam technique.

How the candidate could have improved their answer

Stating for **E** the 'Michaelis-Menten constant' wou…
However, knowledge that this is also referred to a…
was able to gain full marks.

This explains how the candidate could have improved their answer and helps you to interpret the standard of Cambridge exams and helps your learners to refine exam technique.

Common mistakes candidates made in this question

A. Some candidates only gave the term 'activation' … strictly correct it was allowed.

B. Some candidates gave a mixture of terms, such … 'induced substrate', 'lock and key fit'. The examiner …

C. Named globular proteins were incorrectly given as a response. Of these, 'haemoglobin' was most commonly seen. The spellings of 'globular' were not always correct.

This lists the common mistakes candidates made in answering each question. This will help your learners to avoid these mistakes at the exam and give them the best chance of achieving a high mark.

Assessment at a glance

Candidates for Advanced Subsidiary (AS) certification take Papers 1, 2 and 3 (either Advanced Practical Skills 1 or Advanced Practical Skills 2) in a single examination series.

Candidates who, having received AS certification, wish to continue their studies to the full Advanced Level qualification may carry their AS marks forward and take Papers 4 and 5 in the examination series in which they require certification.

Candidates taking the full Advanced Level qualification at the end of the course take all five papers in a single examination series.

Candidates may only enter for the papers in the combinations indicated above.

Candidates may not enter for single papers either on the first occasion or for resit purposes.

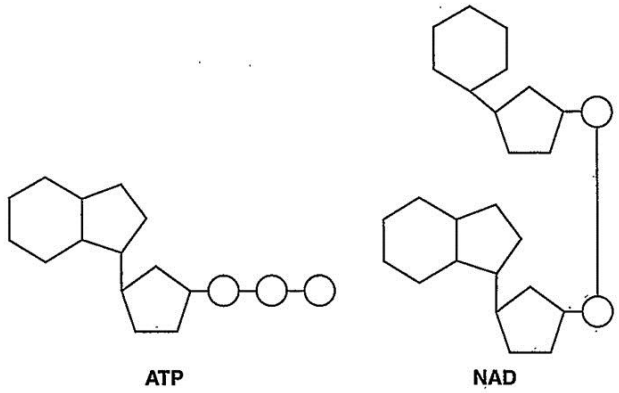
All components will be externally assessed.

Component	Weighting	
	AS Level	A Level
Paper 1 Multiple Choice **1 hour** This paper consists of 40 multiple choice questions, all with four options. All questions will be based on the AS Level syllabus content. Candidates will answer all questions. Candidates will answer on an answer sheet. [40 marks]	31%	15.5%
Paper 2 AS Level Structured Questions **1 hour 15 minutes** This paper consists of a variable number of questions, of variable mark value. All questions will be based on the AS Level syllabus content. Candidates will answer all questions. Candidates will answer on the question paper. [60 marks]	46%	23%
Paper 3 Advanced Practical Skills **2 hours** This paper requires candidates to carry out practical work in timed conditions. This paper will consist of two or three experiments drawn from different areas of the AS Level syllabus. Candidates will answer all questions. Candidates will answer on the question paper. [40 marks]	23%	11.5%
Paper 4 A Level Structured Questions **2 hours** This paper consists of a variable number of structured questions each with a variable mark value (Section A) and a choice of one free response style question worth 15 marks (Section B). All questions will be based on the A Level syllabus but may require knowledge of material first encountered in the AS Level syllabus. Candidates will answer on the question paper. [100 marks]	–	38.5%
Paper 5 Planning, Analysis and Evaluation **1 hour 15 minutes** This paper consists of a variable number of questions of variable mark value based on the practical skills of planning, analysis and evaluation. Candidates will answer on the question paper. [30 marks]	–	11.5%

Teachers are reminded that the latest syllabus is available on our public website at **www.cie.org.uk** and Teacher Support at **https://teachers.cie.org.uk**

Paper 4 – A Level structured questions

Question 1

Example candidate response – high	Examiner comments
1 (a) ATP and NAD both play important roles in respiration. Both compounds are nucleotides. Fig. 1.1 represents the molecular structures of ATP and NAD.  ATP NAD **Fig. 1.1** Using Fig. 1.1, compare the structures of ATP and NAD. ATP contains one nitrogenous base (adenine) while NAD has two nitrogenous bases, one purine and one pyrimidine. ATP has three phosphate groups while NAD has two. ATP has one pentose sugar (ribose) while NAD has two pentose sugars. [3]	1 The sentence structure 'ATP has . . . **while** NAD has . . .' makes it clear that differences are being highlighted. Only NAD has a pyrimidine base so this scores a mark. 2 The difference in the number of phosphates scores a second mark. 3 The difference in the number of pentose sugars scores a third mark. Mark for (a) = 3/3

Example candidate response – high, continued

(b) ATP provides an immediate energy source for metabolic processes such as anabolic reactions.

State two examples of anabolic reactions in a **mammal** that require ATP as an energy source.

1 DNA replication 4

2 protein synthesis 5 [2]

(c) Name the type of chemical reaction by which ATP is made during the Krebs cycle.

substrate level phosphorylation 6 [1]

(d) Outline the roles of NAD in the **cytoplasm** of a cell.

NAD is a hydrogen carrier. It accepts hydrogen 7 from glycolysis in cytoplasm and become reduced. NAD then transport it to oxidative phosphorylation 8 in (mitochondria) 9 mitochondrial cristae.

[2]

(e) Carbohydrates and lipids are used as respiratory substrates.

Table 1.1 shows the energy values of carbohydrates and lipids.

Table 1.1

respiratory substrate	energy value/kJ g^{-1}
carbohydrate	15.8
lipid	39.4

Explain why lipids have a higher energy value than carbohydrates.

Lipids have a higher calorific value as it has more C-H bonds, so more hydrogens are released. 10 So more reduced NAD are available for oxidative phosphorylation. 11 Most ATP synthesized is during oxidative phosphorylation 12

[2]

[Total: 10]

Examiner comments

4 Anabolic reactions make a larger more complex molecule from smaller subunits. Polynucleotides like DNA are polymers of smaller monomers, and the process of making new DNA is known as DNA replication since a template strand is needed to construct a second. One mark.

5 Joining amino acids at ribosomes to make a polypeptide chain is a second example of an anabolic reaction. This can be referred to as protein synthesis or translation.

Mark for (b) = 2/2

6 During the Krebs cycle some ATP is made directly without using the electron transport chain and the name for this process is substrate-level phosphorylation.

Mark for (c) = 1/1

7 The role of NAD is to carry hydrogen atoms released in one reaction to a second reaction where they are used. The term 'hydrogen carrier' is frequently used to describe this role.

8 The question states 'in the cytoplasm of a cell' so identifying the specific role of NAD in binding to hydrogen atoms released during glycolysis scores a mark.

Example candidate response – high, continued	Examiner comments
	9 This answer already has a mark for the term 'hydrogen carrier' but if it had not included this, the same point is made here when the candidate explains that NAD becomes reduced (i.e. gains hydrogen). Mark for (d) = 2/2 10 The fact that lipids have long tails of carbon atoms bound to hydrogen atoms (more C-H bonds) begins to explain why lipids release more energy than carbohydrates. 11 The hydrogens are removed and joined to NAD and as there are more of them to start with, more reduced NAD is the result. This part of the explanation is awarded a second mark. 12 The answer already scores full marks but the candidate concludes their explanation by stating that the greater quantity of reduced NAD will be used in oxidative phosphorylation, from which we infer there will be more oxidative phosphorylation (compared to carbohydrates). Mark for (e) = 2/2 **Total marks awarded = 10 out of 10**

How the candidate could have improved their answer

(a) The answer uses a multitude of terms to mean the same thing and so doesn't state similarities clearly enough. Saying that ATP has adenine while NAD has a purine is not stating a similarity, whereas the answer 'they both have adenine' or 'they both have a purine' would do. Similarly, the two molecules are similar in both possessing ribose sugar but this answer does not make this clear. It says ATP has ribose but that NAD has a pentose (not named), so it is not clear that both molecules have ribose.

(e) The explanation is logical and thorough but just falls short of saying that more ATP will be made per molecule or gram or unit mass of lipid compared to the same quantity of carbohydrate.

Mark awarded = **(a) 3/3**
Mark awarded = **(b) 2/2**
Mark awarded = **(c) 1/1**
Mark awarded = **(d) 2/2**
Mark awarded = **(e) 2/2**

Total marks awarded = 10 out of 10

Example candidate response – middle

1 (a) ATP and NAD both play important roles in respiration. Both compounds are nucleotides.

Fig. 1.1 represents the molecular structures of ATP and NAD.

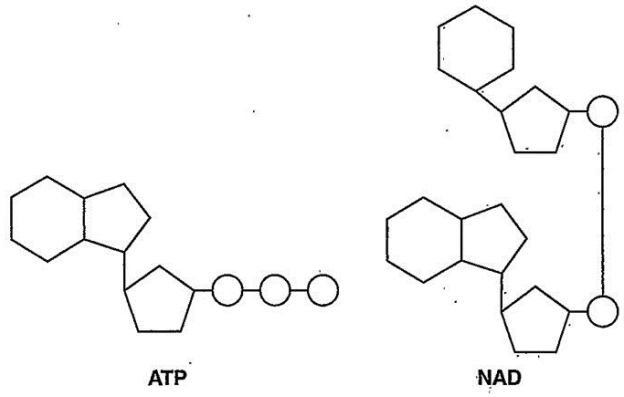


Fig. 1.1

Using Fig. 1.1, compare the structures of ATP and NAD.

ATP is made up of one ribose sugar, a nitrogenous base which is a purine, ~~and is also~~ ATP is also known as Adenosine triphosphate. The ribose sugar is bonded to three phosphate groups.

NAD is made up of ~~two~~ ribose sugars, two Nitrogenous bases; a purine and pyrimidine. The two ribose sugars are bonded to a single phosphate group, each to a single phosphate group. The two phosphate group are linked together.

[3]

Examiner comments

1 This answer does not draw together the points of similarity and difference between the two molecules, but describes each separately. Therefore, no marks are awarded until line 4 when comments about the second molecule are made. The examiner has to do work for the candidate in looking for one (ribose) on ATP in the first line versus two on NAD in the fourth line. This scores a mark but is not the best way of structuring the answer.

2 Here the examiner sees evidence that the candidate knows that both molecules possess ribose sugar, so a second mark is awarded.

3 The candidate has already stated that ATP has a purine and here they state that NAD does too, so a third mark is awarded here.

4 Only NAD has a pyrimidine so this is awarded a mark.

5 The candidate states that ATP has three phosphate groups in line 3 and here they give the second part of the difference, that NAD has two. Although five good points are made the maximum mark allocation for the question is three.

Mark for (a) = 3/3

Example candidate response – middle, continued

(b) ATP provides an immediate energy source for metabolic processes such as anabolic reactions.

State two examples of anabolic reactions in a **mammal** that require ATP as an energy source.

1 ~~Active transport~~ Creatine phosphate formation 6

2 ~~Muscle contraction~~ ~~M. Br~~ ~~Acetyl choline~~ ~~Cyclic~~ ~~Calvin~~ ~~Krebs Cycle~~ Active transport of minerals and ion into the cell. [2]

(c) Name the type of chemical reaction by which ATP is made during the Krebs cycle.

Chemiosmosis [1]

(d) Outline the roles of NAD in the **cytoplasm** of a cell.

NAD provides hydrogen for oxidative phosphorylation in the form of reduced NAD 7, the hydrogen is used to provide energy for ATP synthase. NAD is used to synthesize dopamine

[2]

(e) Carbohydrates and lipids are used as respiratory substrates.

Table 1.1 shows the energy values of carbohydrates and lipids.

Table 1.1

respiratory substrate	energy value/kJ g^{-1}
carbohydrate	15.8
lipid	39.4

Explain why lipids have a higher energy value than carbohydrates.

Lipids have a higher energy value than carbohydrates because the contain more carbon and hydrogen per molecule than carbohydrates. The higher the number of hydrogens atoms 8 present, the more ATP is synthesized.

[2]

[Total: 10]

Examiner comments

6 This is a specific example of a reaction where two smaller subunits (creatine and a phosphate group) are joined to make a more complex molecule, so this is an acceptable example of an anabolic reaction.

Mark for (b) = 1/2

Mark for (c) = 0/1

7 The key role of NAD is transporting hydrogen atoms and the reference here to reduced NAD implies this role.

Mark for (d) = 1/2

8 A comparative point is made, that lipids have more carbon and hydrogen present.

Mark for (e) = 1/2

Total marks awarded = 6 out of 10

How the candidate could have improved their answer

(a) The candidate scored well, but writing two separate descriptions shows a lower level of understanding and ability than listing the five similarities and differences as pairs of matching statements about the two molecules.

(b) The candidate gave an example of an ATP-requiring process for their second example but this is not an anabolic reaction so it did not meet the criteria set in the question.

(c) Chemiosmosis happens during oxidative phosphorylation, not during the Krebs cycle.

(d) The answer stated what the hydrogen attached to reduced NAD would be used for, but did not state where it comes from in the cytoplasm of a cell, so didn't pick up on some of the instructions in the question.

(e) The answer was incomplete as it did not pick up on the information given about the energy values of the two respiratory substrates in Table 1.1, where the figures are quoted in units of kJg^{-1}. The conclusion of a full explanation therefore is that more ATP will be made per gram (or per mole or molecule).

Mark awarded = **(a) 3/3**
Mark awarded = **(b) 1/2**
Mark awarded = **(c) 0/1**
Mark awarded = **(d) 1/2**
Mark awarded = **(e) 1/2**

Total marks awarded = 6 out of 10

Example candidate response – low

1 (a) ATP and NAD both play important roles in respiration. Both compounds are nucleotides.

Fig. 1.1 represents the molecular structures of ATP and NAD.

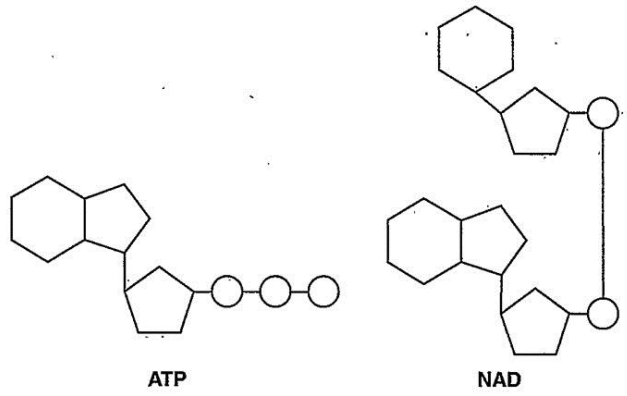


Fig. 1.1

Using Fig. 1.1, compare the structures of ATP and NAD.

ATP, has ribose sugar and Adenine, 1
Nitrogen containing base is attached to
carbon number 5 and three phosphate
group are attached to carbon number one,
NAD is a co-enzyme have phosphodiester
bond and have two different types, monomers
of nitrogen containing base and one
phosphate group. 2

[3]

Examiner comments

1 This candidate doesn't make any comparisons. They describe ATP and NAD separately but do not make matching pairs of points. For example, on line 1 they state that ATP has ribose and adenine but in line 5 they don't mention that NAD also has ribose and adenine, missing the opportunity to note two points of similarity.

2 The candidate states that ATP has three phosphate groups so the examiner will be looking for the information that NAD has only two, but the rest of the answer is ambiguous and appears to suggest that NAD has only one.

Mark for (a) = 0/3

Example candidate response – low

(b) ATP provides an immediate energy source for metabolic processes such as anabolic reactions.

State two examples of anabolic reactions in a **mammal** that require ATP as an energy source.

1 muscle contraction

2 reabsorption in kidneys. 3 [2]

(c) Name the type of chemical reaction by which ATP is made during the Krebs cycle.

light independent reaction 4 [1]

(d) Outline the roles of NAD in the **cytoplasm** of a cell.

NAD is co-enzyme

NAD is used to 5 take hydrogen during

hydrogenation to be reduced NAD. 6

[2]

(e) Carbohydrates and lipids are used as respiratory substrates.

Table 1.1 shows the energy values of carbohydrates and lipids.

Table 1.1

respiratory substrate	energy value / kJ g^{-1}
carbohydrate	15.8
lipid	39.4

Explain why lipids have a higher energy value than carbohydrates.

lipids have higher hydro carbon bond than ~~eat~~ ~~more~~ ~~eats~~ carbohydrates. 7

more bonds are broken during hydrolysis

[2]

[Total: 10]

Examiner comments

3 These energy-requiring processes are not reactions and there is not enough detail at the molecular level to judge whether an anabolic building-up of a more complex molecule from smaller ones is happening in either of these examples.

Mark for (b) = 0/2

4 The light independent reaction is part of photosynthesis and has no direct relevance to the question about the Krebs cycle in respiration.

Mark for (c) = 0/1

5 The term 'co-enzyme' describes a role of NAD as it plays an essential supporting role alongside another enzyme such as a dehydrogenase.

6 The role of NAD in carrying hydrogen is referred to, as it takes hydrogen and becomes reduced NAD. The statement that this happens during hydrogenation is misleading, as it happens when the respiratory substrate is dehydrogenated. However, this ambiguity is ignored here.

Mark for (d) = 2/2

7 'Higher hydrocarbon bond' is an inadequate description. If the answer had said 'a higher number of bonds between carbon and hydrogen atoms' it would have gained a mark.

Mark for (e) = 0/2

Total marks awarded = 2 out of 10

How the candidate could have improved their answer

(a) The candidate should have tried to make paired comparisons between ATP and NAD here. If they had broken down the descriptions in this way, they might have matched up information about NAD with the correct points made at the start about ATP. A better choice of words at the end might have clarified that NAD has two phosphate groups. As their answer stated that a phosphodiester bond is present, the candidate may have known this, but they did not express the fact that two phosphates are present clearly enough.

(b) This answer fitted the context of a mammal and the examples used ATP but the candidate didn't pick up on or did not understand the term 'anabolic reaction'.

(c) The answer needed to narrow its focus to the Krebs cycle and respiration.

(d) Including the word 'hydrogenation' without specifying of what made this answer ambiguous. Usually we talk about the substrate being dehydrogenated while the NAD becomes reduced.

(e) The candidate clearly had some understanding or memory of the relevant part of the structure of a lipid but did not select their words carefully enough to demonstrate this. Lipids and fatty acids are not themselves hydrocarbons as they contain oxygen atoms. We usually refer to the repeating carbon and hydrogen structure of a fatty acid as the fatty acid 'tail'.

Mark awarded = **(a) 0/3**
Mark awarded = **(b) 0/2**
Mark awarded = **(c) 0/1**
Mark awarded = **(d) 2/2**
Mark awarded = **(e) 0/2**

Total marks awarded = 2 out of 10

Common mistakes candidates made in this question

(a) Not structuring the comparison as paired points in the form 'ATP is like this and NAD is like that' led to missed opportunities in pinpointing similarities and differences.

(b) Candidates often missed 'anabolic reactions' and just gave ATP-requiring processes like muscle contraction and active transport. Another mistake was to miss applying these to the context of a mammal and to give plant examples of anabolic reactions like building glucose subunits into starch.

Mistakes were made in **(d)** and **(e)** owing to a less than firm grasp of chemistry terms. For example, in **(d)** it was correct to say that NAD carries hydrogen atoms (H) but not hydrogen molecules since hydrogen molecules form the diatomic gas H_2, which is explosive. It was also not correct to say NAD carries hydrogen ions (H^+) as it binds to a hydrogen ion and electron (i.e. a hydrogen atom effectively) simultaneously. In **(e)** the chemical terms hydrocarbon and hydrogen bond were often used inappropriately. The larger number of bonds between carbon atoms and hydrogen atoms in the fatty acid tail of a lipid are covalent bonds, not hydrogen bonds.

Question 2

Example candidate response – high

2 The concentration of carbon dioxide in the atmosphere and the light intensity often limit the rate of photosynthesis.

(a) Explain what is meant by a *limiting factor* in relation to photosynthesis.

When a reaction involves more than one factor (eg: light intensity, CO_2 concentration) the factor present in its lowest concentration limits and determines the rate of the reaction. [2]

(b) Investigations were carried out in Florida, USA, into the effect of different concentrations of atmospheric carbon dioxide and of light intensity on the rate of photosynthesis of soybean plants.

Plants were grown from seed in outdoor, computer-controlled growth chambers at different concentrations of carbon dioxide. The upper parts of the chambers were transparent so that the plants received natural sunlight.

After the seedlings emerged, the air in the soil was separated from the air around the leaves by a gas-tight seal in each chamber.

Suggest why the air in the soil and the air around the leaves of the plants were separated.

The leaves begin the ~~respire~~ photosynthesize and produce ~~CO2~~ O_2 by using up CO_2 whereas the ~~the~~ parts of the plant beneath the soil only respire to give off CO_2 by using O_2. [2]

(c) In one investigation, two sets of plants, **A** and **B**, were grown from seed at different concentrations of carbon dioxide:

- **A** – normal atmospheric concentration of carbon dioxide (0.033%)
- **B** – normal atmospheric concentration of carbon dioxide ×2 (0.066%).

Then, keeping each set of plants in its particular concentration of carbon dioxide, measurements were made of their rates of photosynthesis at different light intensities.

The results are shown in Fig. 2.1 on page 5.

Examiner comments

1 The answer correctly identifies that the limiting factor is the one at its lowest or minimum value. It is important to use the superlative here, low**est** concentration not just 'lower' or 'low'.

2 The answer states that several factors are involved and that they affect the **rate** of the reaction (photosynthesis). This earns a second mark.

Mark for (a) = 2/2

3 The answer is incomplete but has expressed the idea that respiration going on underneath the soil, for example in plant roots, could affect the concentration of carbon dioxide in the air around the leaves. The answer does not name the plant parts below ground as the roots, but the examiner has given the answer a benefit of the doubt mark. The candidate also doesn't fully adapt their idea to the context of the question and to say that the separation ensures that addition of carbon dioxide does not happen or is prevented.

Mark for (b) = 1/2

Example candidate response – high, continued

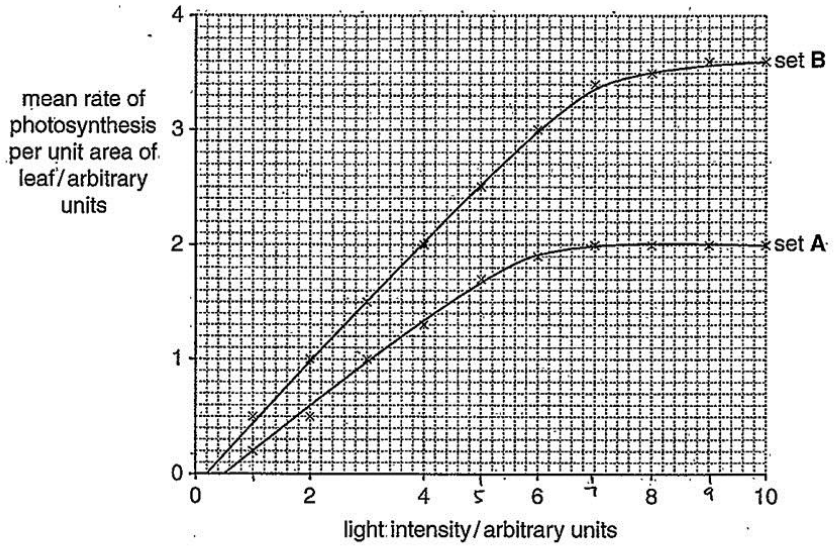


Fig. 2.1

With reference to Fig. 2.1:

(i) describe and explain, in terms of limiting factors, the results from the plants in set **A**.

At lower light intensities (0 to ~~around~~ 7) the light intensity was the limiting factor (4) so an increase in light intensity caused an increase in rate of photosynthesis (5) ~~from 0~~ from 0.2 (at 1 au (light intensity) to 2 (at 7au light intensity). As light intensity increases beyond 7, the CO_2 concentration becomes the limiting factor (6). Light dependent reactions may increase in rate but light independent reactions using CO_2 is ~~limiting~~ limited because of limited conc of CO_2 in the ~~leaf~~ leaves. So rate stays at 2. (7) [3]

(ii) explain the difference between the results of set **A** and set **B** at high light intensities.

In set B, CO_2 concentrations (conc) ~~is~~ is twice as high as in set A. (8) ~~If~~ CO_2 conc becomes a limiting factor at higher light intensities (9) and reaches a greater rate of photosynthesis since more CO_2 for light independent reactions (the Calvin cycle) in the chloro. (10) [2]

Examiner comments

4 The first mark given is for the explanation of what is happening at low light intensity, i.e. that the reason for the positive relationship is that the light intensity is limiting.

5 The second mark is for the description of what is happening at low light intensity: as the light intensity increases the rate of photosynthesis also increases.

6 The third creditworthy point is the explanation that at high light intensity (above 7) another factor that is not light intensity, but something else such as carbon dioxide concentration, is the limiting factor.

7 A fourth mark can be given for the description of what occurs at the high light intensity end of the graph. The answer given is that the rate **stays** at 2, or, in other words, that the rate plateaus or stays the same.

Mark for (c) (i) = 3/3

8 The answer gets a mark for the most obvious reason for the difference, that the plants in set B have more carbon dioxide available.

9 The examiner understands that the context of the second sentence is still set B, so the idea that it is only at higher light intensities that carbon dioxide concentration becomes the limiting factor scores a mark.

Example candidate response – high, continued

(d) In a second investigation, two sets of plants, **C** and **D**, were grown from seed, as before, in different carbon dioxide concentrations:

- **C** – normal atmospheric concentration of carbon dioxide (0.033%)
- **D** – normal atmospheric concentration of carbon dioxide ×2 (0.066%).

When the plants matured, conditions in the growth chambers were changed to investigate the rate of photosynthesis of each set of plants in different concentrations of carbon dioxide.

The results are shown in Fig. 2.2.

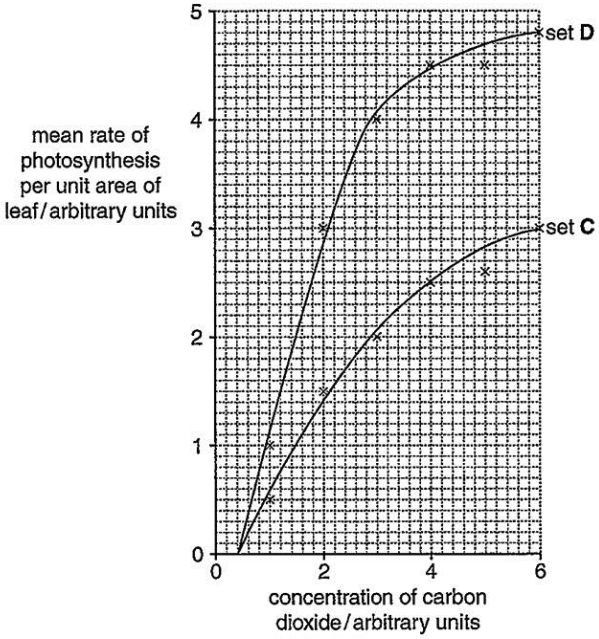


Fig. 2.2

Suggest explanations for the higher rate of photosynthesis **per unit area of leaf** shown by the plants in set **D** compared with those in set **C**.

Plants in set D grown in twice the CO_2 concentration may have more chloroplasts per unit area of leaf than set C 11 more chloroplasts enable more photosynthetic reactions to occur and so greater rate of photosynthesis overall in set D than in C. In set C, the limiting factor e.g. the number of chloroplasts so fewer light dependent and independent reactions occur. Plants in D may also have a more (per unit area of leaf) 12 stomata for CO_2 to diffuse into the leaf 13 whereas in C the number of stomata may also be a limiting factor

[4]

[Total: 13]

Examiner comments

10 Although the maximum mark is 2, this answer has made three good points. The third is the reference to the higher carbon dioxide concentration being used for more (or faster) light independent reactions.

Mark for (c) (ii) = 2/2

11 The answer states clearly that the plants in set D were only grown in twice the carbon dioxide concentration but does not make the mistake of thinking that they are still in these conditions. As a result of the early conditions, the answer suggests that the plants in set D may have more chloroplasts. This scores a mark. The answer then elaborates on this theme for a further four lines.

12 A second suggestion is that the plants with earlier access to higher levels of carbon dioxide may have more stomata. The candidate is careful to add 'per unit area of leaf' so has read the *y*- axis of the graph carefully.

13 The use of the correct term 'diffusion' in connection with the extra stomata and entry of carbon dioxide earns a third mark.

Mark for (d) = 3/4

Total marks awarded = 11 out of 13

How the candidate could have improved their answer

(b) It would have been better if the candidate had named the parts of the plant below ground as the roots. It would also have led to an additional mark if they had tied in their thoughts about root respiration with the experimental design and the way the question was framed to say that the seal prevented extra carbon dioxide from root respiration from adding to the concentration around the leaves.

(c) (i) The candidate made all the points, describing and explaining each part of the graph, the positive correlation at low light intensities, and the plateau at high light intensities. It would have been more logical, however, to describe the relationship in each case first and to explain it afterwards.

(d) This was a good answer to a challenging question, but having started on the right track the candidate could have expanded on the significance of more chloroplasts in terms of more rubisco, since this relates directly to the plants making better use of available carbon dioxide.

Mark awarded = **(a) 2/2**
Mark awarded = **(b) 1/2**
Mark awarded = **(c) (i) 3/3, (ii) 2/2**
Mark awarded = **(d) 3/4**

Total marks awarded = 11 out of 13

Example candidate response – middle	Examiner comments

2 The concentration of carbon dioxide in the atmosphere and the light intensity often limit the rate of photosynthesis.

(a) Explain what is meant by a *limiting factor* in relation to photosynthesis.

limiting factor means in a series of reaction is limited by the slowest in this reaction. for instance if we increased the carbon dioxide concentration the rate of photosynthesis increase till it reaches a plateau where other factors such as light intensity is affecting the reaction. so carbon dioxide is no long a limiting factor. [2]

1

1 This answer includes the idea that the limiting factor is one of several that affect the rate of a reaction.

Mark for (a) = 1/2

(b) Investigations were carried out in Florida, USA, into the effect of different concentrations of atmospheric carbon dioxide and of light intensity on the rate of photosynthesis of soybean plants.

Plants were grown from seed in outdoor, computer-controlled growth chambers at different concentrations of carbon dioxide. The upper parts of the chambers were transparent so that the plants received natural sunlight.

After the seedlings emerged, the air in the soil was separated from the air around the leaves by a gas-tight seal in each chamber.

Suggest why the air in the soil and the air around the leaves of the plants were separated.

air in the soil contained greater amount of oxygen as waste of photosynte so that will not be taken up by the leaves of the plant so it doesn't affect the experiment. [2]

2

2 This answer is contradictory, as there will not be photosynthesis producing oxygen in parts of the plant below the soil, and leaves in the light do not have a net take-up of oxygen.

Mark for (b) = 0/2

(c) In one investigation, two sets of plants, **A** and **B**, were grown from seed at different concentrations of carbon dioxide:

- **A** – normal atmospheric concentration of carbon dioxide (0.033%)
- **B** – normal atmospheric concentration of carbon dioxide ×2 (0.066%).

Then, keeping each set of plants in its particular concentration of carbon dioxide, measurements were made of their rates of photosynthesis at different light intensities.

The results are shown in Fig. 2.1 on page 5.

Example candidate response – middle, continued

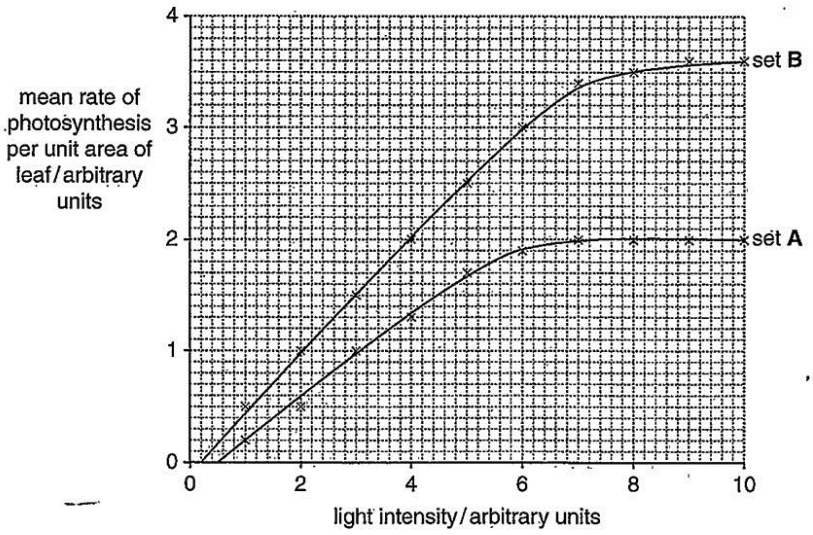


Fig. 2.1

With reference to Fig. 2.1:

(i) describe and explain, in terms of limiting factors, the results from the plants in set (A)

As the light intensity increases, the mean rate of photosynthesis per unit area of leaf increases from 0 arbitary units till 2 arbitary units at Light intensity of 7 arbitary units beyond that it becomes a plateau till 10 arbitary units at 2 arbitary unit. As up till 7 arbitary units light was the limiting factor in the experiment, 7 arbitary units onward till light intensity of 10 arbitrary unit, concentration of carbondioxide became the limiting factor, not the light intensity. [3]

(ii) explain the difference between the results of set **A** and set **B** at high light intensities.

It undergo more photosynthesis due to presence of more carbon dioxide than A. It absorbs light better than set A.

[2]

Examiner comments

3 A mark is earned for the description of the relationship under conditions of low light intensity which is qualified as up to 7 a.u.

4 The second mark is for the description of the relationship beyond 7 a.u. of light intensity.

5 The third mark is earned for explaining the low light intensity part of the graph.

6 A fourth tick can be given for explaining the high light intensity part of the graph.

Mark for (c) (i) = 3/3

7 The examiner assumes that 'it' is set B here because the answer compares 'it' with A. One correct reason is found for the difference in rate, the fact that B has more carbon dioxide available.

Mark for (c) (ii) = 1/2

Example candidate response – middle, continued

Examiner comments

(d) In a second investigation, two sets of plants, **C** and **D**, were grown from seed, as before, in different carbon dioxide concentrations:

- **C** – normal atmospheric concentration of carbon dioxide (0.033%)
- **D** – normal atmospheric concentration of carbon dioxide ×2 (0.066%).

When the plants matured, conditions in the growth chambers were changed to investigate the rate of photosynthesis of each set of plants in different concentrations of carbon dioxide.

The results are shown in Fig. 2.2.

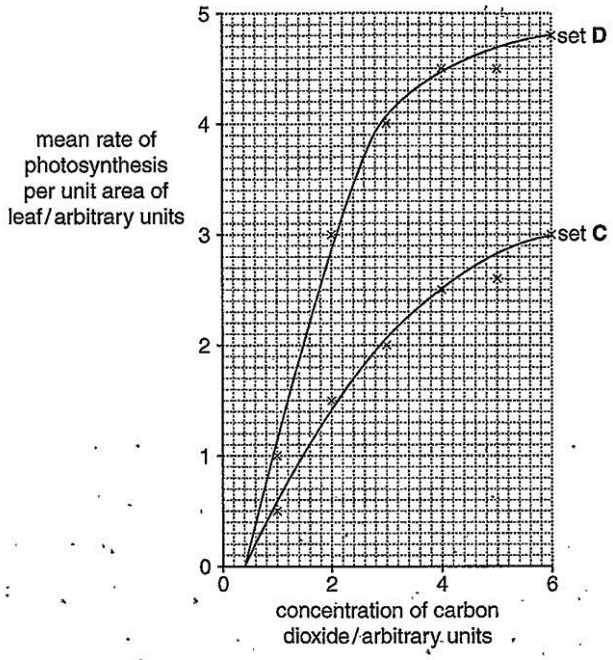


Fig. 2.2

Suggest explanations for the higher rate of photosynthesis **per unit area of leaf** shown by the plants in set **D** compared with those in set **C**.

As more concentration of co2 Carbondioxide, increases the mean rate of photosynthesis per unit area of leaf. As more Carbon binds with more RuBp (ribulose bisphosphate) and so more Calvin cycle and more GP produced that is reduced into more TP and more RuBp regenerated than C that took less amount of carbon dioxide. 8

..... [4]

[Total: 13]

8 This answer is based on the mistaken premise that D has a higher concentration of carbon dioxide throughout the experiment. In fact, as the *x*-axis of Fig. 2.2 shows, both set C and set D are treated the same to obtain the two line plots.

Mark for (d) = 0/4

Total marks awarded = 5 out of 13

How the candidate could have improved their answer

(a) The comment about the slowest reaction limiting the rate was close to what was needed, but did not state that the limiting factor itself would be in shortest supply or at the lowest level.

(b) If the candidate had considered carbon dioxide as well as oxygen here, they would have come closer to a reasonable and logical explanation.

(c) (i) This was a well-structured and careful answer but in **(ii)** the fact that only half the answer space was used and only one reason was given should have alerted the candidate that they needed to expand their answer, for instance by saying what the extra carbon dioxide was used for.

(d) The fundamental error shown in the answer could only have been remedied by a more thorough reading of the question stem on page 6 and a more careful study of the graph axes in Fig. 2.2.

Mark awarded = **(a) 1/2**
Mark awarded = **(b) 0/2**
Mark awarded = **(c) (i) 3/3, (ii) 1/2**
Mark awarded = **(d) 0/4**

Total marks awarded = 5 out of 13

Example candidate response – low	Examiner comments
2 The concentration of carbon dioxide in the atmosphere and the light intensity often limit the rate of photosynthesis. **(a)** Explain what is meant by a *limiting factor* in relation to photosynthesis. 1 A limiting factor is an environmental factor, which in short supply 2 /scarcity limits the rate of photosynthesis. ..... [2] **(b)** Investigations were carried out in Florida, USA, into the effect of different concentrations of atmospheric carbon dioxide and of light intensity on the rate of photosynthesis of soybean plants. Plants were grown from seed in outdoor, computer-controlled growth chambers at different concentrations of carbon dioxide. The upper parts of the chambers were transparent so that the plants received natural sunlight. After the seedlings emerged, the air in the soil was separated from the air around the leaves by a gas-tight seal in each chamber. Suggest why the air in the soil and the air around the leaves of the plants were separated. They have different concentrations of CO_2 so they are separated to avoid confusion and make it clear on which concentration has caused the rate of photosynthesis. 3 ..... [2] **(c)** In one investigation, two sets of plants, **A** and **B**, were grown from seed at different concentrations of carbon dioxide: • **A** – normal atmospheric concentration of carbon dioxide (0.033%) • **B** – normal atmospheric concentration of carbon dioxide ×2 (0.066%). Then, keeping each set of plants in its particular concentration of carbon dioxide, measurements were made of their rates of photosynthesis at different light intensities. The results are shown in Fig. 2.1 on page 5.	1 The opportunity to explain that a limiting factor is one of several factors affecting the rate of photosynthesis is missed here. 2 The idea of short supply needs to be framed as a superlative to gain a mark here, i.e. that, of the various factors affecting the rate, it is the one that is in the 'short**est**' supply that is described as the limiting factor. Mark for (a) = 0/2 3 The candidate has the right idea but the answer lacks detail and does not come close to any of the marking points. Mark for (b) = 0/2

Example candidate response – low, continued

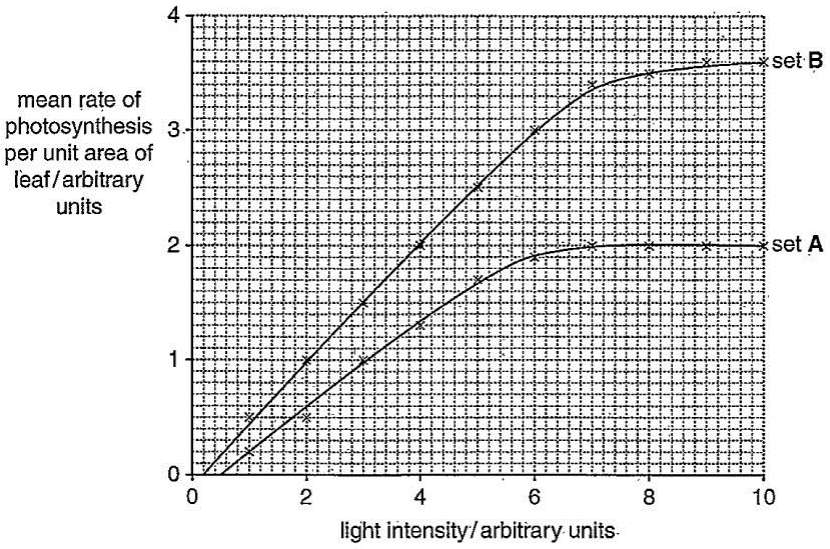


Fig. 2.1

With reference to Fig. 2.1:

(i) describe and explain, in terms of limiting factors, the results from the plants in set **A**

At low light intensity, CO_2 concentration is not the limiting factor, light intensity is. So as light intensity increases, the rate of photosynthesis also increases. Then, when light intensity is 7 arbitrary units, a plateau is reached. No matter how much light intensity increases, the rate of photosynthesis remains constant. This is due to light intensity not being the limiting factor anymore, CO_2 is probably limiting now. [3]

(ii) explain the difference between the results of set **A** and set **B** at high light intensities.

At high light intensities, set B has a higher rate of photosynthesis because the concentration of CO_2 is higher (twice as much), so it takes longer for CO_2 concentrations to be limiting in set B.

..... [2]

Examiner comments

4 The first sentence scores a mark for explaining what is causing the trend at low light intensity.

5 The candidate then describes the relationship at low light intensity.

6 The candidate describes the relationship between the variables on the *x*- and *y*-axes at 7 a.u. of light intensity and above.

7 The plateau at high light intensities is explained in terms of limiting factors.

Mark for (c) (i) = 3/3

8 This reason scores a mark.

9 The candidate possibly wants to say that the plateau for B starts at a higher light intensity than that of A, but instead they describe moving right along the *x* axis in terms of time and say, incorrectly, that it takes longer. In the previous question the candidate uses the time-associated word 'then' in a similar way, meaning further along the *x* axis, but there is enough other information that this slip can be ignored by the examiner. In part (ii), however, this same error in thinking causes more problems.

Mark for (c) (ii) = ½

Example candidate response – low, continued

(d) In a second investigation, two sets of plants, **C** and **D**, were grown from seed, as before, in different carbon dioxide concentrations:

- **C** – normal atmospheric concentration of carbon dioxide (0.033%)
- **D** – normal atmospheric concentration of carbon dioxide ×2 (0.066%).

When the plants matured, conditions in the growth chambers were changed to investigate the rate of photosynthesis of each set of plants in different concentrations of carbon dioxide.

The results are shown in Fig. 2.2.

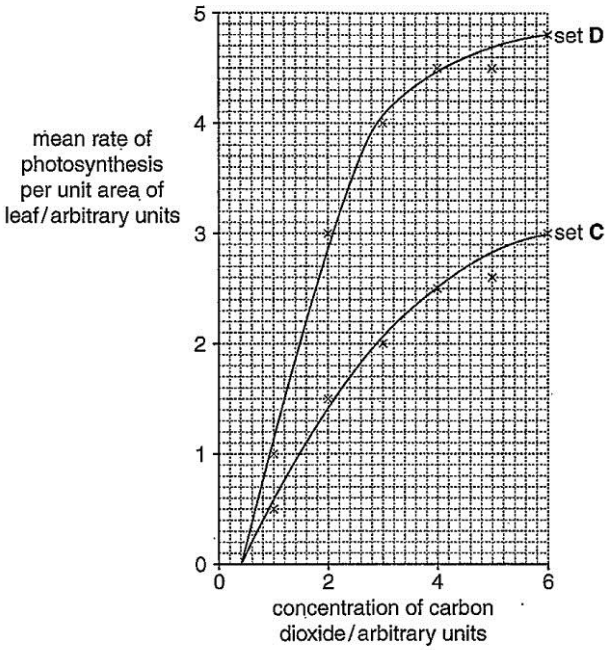


Fig. 2.2

Suggest explanations for the higher rate of photosynthesis **per unit area of leaf** shown by the plants in set **D** compared with those in set **C**.

As seeds from plant C were used to carrying out photosynthesis at slightly lower levels of CO_2 concentration than plant D, when CO_2 concentrations increase, the rate of photosynthesis also increases, but less steeply than in D. 10

Carbon dioxide can't be fixed that fast by rubisco than in D. 11

Light intensity might be more limited for C than D. 12

[4]

[Total: 13]

Examiner comments

10 The first part of the answer describes Fig. 2.2, without suggesting explanations for it.

11 The rate in D is faster than in C so this sentence contradicts the data.

12 The suggestion that the experimenters varied a second variable without mentioning it or doesn't control it adequately does not score.

Mark for (d) = 0/4

Total marks awarded = 4 out of 13

How the candidate could have improved their answer

(a) The candidate needed to add detail to both parts of their answer: that the environmental factor was one of many, and that it was not just in short supply but 'short**est'** supply.

(b) The candidate needed to think harder about their basic idea by asking how the concentrations were different (more in the air in the soil) and why this was so (respiration by roots, seeds or soil organisms). They needed to identify the likely difference and the reasons for it.

(c) The answer to **(i)** was well-structured and logical, but the error of thinking all graphs have time on the *x* axis slightly marred the answer. In **(ii)** it meant the second idea was incorrectly expressed and doesn't score the mark. In discussing the idea of moving to the right along the *x* axis the candidate needed to say 'as light intensity increased' or 'at higher light intensities', not 'then' and 'takes longer'.

(d) The answer needed to suggest explanations for the data, not just describe them. Unless a question asks for uncontrolled variables in an experiment to be pointed out, it is safest to assume that all control variables have been adequately controlled; suggesting that errors were made in carrying out the experiment will not earn marks.

Mark awarded = **(a) 0/2**
Mark awarded = **(b) 0/2**
Mark awarded = **(c) (i) 3/3, (ii) 1/2**
Mark awarded = **(d) 0/4**

Total marks awarded = 4 out of 13

Common mistakes candidates made in this question

(a) The concept of limiting factors is hard to put into words and a learned correct definition from a textbook would be a sensible way of answering this question. Where candidates tried to express the definition in their own words, many omitted key information.

(b) The most common mistake was not to imagine the experimental set-up as described and to consider in enough detail how the air in the two places would differ and why.

(c) (i) Assuming that the *x*-axis referred to time was a frequent mistake, seen in answers like 'at first rate increased but then after a while it plateaued.' Some answers described a positive correlation and a plateau but did not link each to low or high light intensities respectively, or to figures from the *x*-axis like 0.6–7 a.u. of light intensity and 7–10 a.u.

(d) The most common mistake was to assume the conditions listed in the bullet points for the descriptions of C and D persisted during the experiment. The second most common mistake was to ignore the units on the *y* axis of Fig. 2.2 and to say that the plants in D had a larger leaf surface area.

Question 3

Example candidate response – high

3 Malaria is a serious and often fatal infectious disease caused by *Plasmodium*. Drugs such as chloroquine are widely used to decrease the risk of getting malaria and also to treat people who have become infected. However, in many parts of the world, *Plasmodium* populations have become resistant to chloroquine.

Sequencing the genome of *Plasmodium* and the application of bioinformatics has provided several new targets for the development of anti-malarial drugs.

(a) (i) Define the term *bioinformatics*.

the biological data, sequences of DNA stored in a computer software base 3D structures of proteins could be stored. [2]

(ii) Outline how sequencing the genome of *Plasmodium* **and** the use of bioinformatics can suggest new targets for anti-malarial drugs.

the DNA sequence of Plasmodium could be stored on the computer ~~not~~ to find the proteins that it synthesises and make 3D models of enzymes an inhibitor that could on the computer ~~inhibit~~ block the active site of the enzymes made making its effect harmless. Or finding previously stored substances that have the same shapes as the active site. 3D structures of the enzyme made could be displayed on the computer [3]

Examiner comments

1 The candidate uses the appropriate term 'database', which is awarded a mark.

2 The knowledge that a computer is used in bioinformatics is awarded the second mark.

Mark for (a) (i) = 2/2

3 There is little detail about the jump from DNA sequence information to knowing which molecule can block the active site of an enzyme, but the idea that this is a target way in which a drug could work earns a mark.

4 The answer backtracks to the idea of using the DNA sequence data to generate a three-dimensional model of the protein product (enzyme) and gets another mark.

Mark for (a) (ii) = 2/3

Example candidate response – high, continued

(b) In parts of the world where *Plasmodium* is resistant to chloroquine, one of the most effective anti-malarial drugs currently in use is artemisinin. Artemisinin works by binding to an enzyme in *Plasmodium* called PfATP6, acting as an inhibitor.

A substance called curcumin, which has long been used as a spice and yellow food colouring in India and other countries, is also known to act against chloroquine-resistant *Plasmodium*. A group of researchers predicted that curcumin acts by binding to the same enzyme as artemisinin.

In order to test this hypothesis, and to try to find similar substances that might work even better than curcumin, the researchers used theoretical modelling to:

- look at the chemical structures of various molecules with a similar structure to curcumin (curcumin analogues)
- generate a three-dimensional model of the structure of the enzyme PfATP6
- investigate whether each curcumin analogue could bind to PfATP6.

The researchers predicted that several of the curcumin analogues would bind more strongly than curcumin to PfATP6.

(i) Suggest advantages of using theoretical models in this research, rather than testing possible drugs in the laboratory.

So not to waste lab animals or materials in the lab if it does'nt work. ~~To minimise the risk of the curcumin got being released the~~ it. It takes a longer time to try many different drugs ~~at a lab~~ without seeing their structure or a model, less efficient. You ~~can't~~ can minimise the amount of drugs needed to be tested. (5) (6)

[3]

(ii) Suggest why theoretical modelling cannot completely replace laboratory trials in the search for new drugs.

Because something that works in theory might not always work in real life, drugs will affect many people so the ~~chances~~ probability of the it working must be above 97%. it might have side effects that are not shown on the computer. (7) (8)

[2]

[Total:10]

Examiner comments

(5) A mark is awarded for not needing to conduct tests on animals. Lab 'materials' is too vague to score a mark for needing less equipment.

(6) A mark is awarded for the idea that theoretical modelling is quicker, though the answer is given in rather a back-to-front way.

Mark for (b) (i) = 2/3

(7) The key idea of the drug needing to be tested to see if it actually works (in treating the disease) gains a mark.

(8) The candidate recognises that, as well as beneficial effects, a drug may have negative 'side effects' on some users and that this problem must be investigated before a drug can be approved for use.

Mark for (b) (ii) = 2/2

Total marks awarded = 8 out of 10

How the candidate could have improved their answer

(a) (ii) This answer did not proceed logically in steps from a sequence of letters (A, C, G and T in DNA) to the idea of a drug molecule binding to a three-dimensional enzyme product. The missing list of explanatory connections includes finding a specific gene, using it to predict the sequence of amino acids in the protein it codes for and then applying knowledge of amino acid properties to predict how the polypeptide will fold into its tertiary shape.

(b) (i) The question asked for the advantages of the theoretical approach, but, for the second point, the candidate stated what is bad about the practical approach ('would take longer'). This did not answer the question and the candidate was lucky that the mark scheme was relaxed in this case to give credit to answers that pointed out the disadvantages of the other method. A correct answer here is that theoretical modelling takes less time.

Mark awarded = **(a) (i) 2/2, (ii) 2/3**
Mark awarded = **(b) (i) 2/3, (ii) 2/2**

Total marks awarded = 8 out of 10

Example candidate response – middle	Examiner comments

3 Malaria is a serious and often fatal infectious disease caused by *Plasmodium*. Drugs such as chloroquine are widely used to decrease the risk of getting malaria and also to treat people who have become infected. However, in many parts of the world, *Plasmodium* populations have become resistant to chloroquine.

Sequencing the genome of *Plasmodium* and the application of bioinformatics has provided several new targets for the development of anti-malarial drugs.

(a) (i) Define the term *bioinformatics*.

The organizing, processing, analysing of biochemical information of an organism into computer systems. [2]

1 Analysing biological information scores a mark.

2 The candidate says a computer is needed and this scores a second mark.

Mark for (a) (i) = 2/2

(ii) Outline how sequencing the genome of *Plasmodium* **and** the use of bioinformatics can suggest new targets for anti-malarial drugs.

of the genes that are responsible for the resistent strain can be determined by ~~compa~~ comparing the genome of resistence ~~plasmo~~ *Plasmodium* with the genome of a regular bioinformatics that where stored in bioinformatics ~~...~~. New alleles are dishinguished and an ~~a~~-anti malarial drug for the resistant base sequence may be developed. [3]

3 The only substantive point here is that the researchers will first need to identify the target genes, in this example, those that are different in chloroquine-resistant parasites.

Mark for (a) (ii) = 1/3

Example candidate response – middle, continued

(b) In parts of the world where *Plasmodium* is resistant to chloroquine, one of the most effective anti-malarial drugs currently in use is artemisinin. Artemisinin works by binding to an enzyme in *Plasmodium* called PfATP6, acting as an inhibitor.

A substance called curcumin, which has long been used as a spice and yellow food colouring in India and other countries, is also known to act against chloroquine-resistant *Plasmodium*. A group of researchers predicted that curcumin acts by binding to the same enzyme as artemisinin.

In order to test this hypothesis, and to try to find similar substances that might work even better than curcumin, the researchers used theoretical modelling to:

- look at the chemical structures of various molecules with a similar structure to curcumin (curcumin analogues)
- generate a three-dimensional model of the structure of the enzyme PfATP6
- investigate whether each curcumin analogue could bind to PfATP6.

The researchers predicted that several of the curcumin analogues would bind more strongly than curcumin to PfATP6.

(i) Suggest advantages of using theoretical models in this research, rather than testing possible drugs in the laboratory.

testing possible drugs in the laboratory may form a different strains of resistance Plasmodium. 4
testing possible drugs in the laboratory may have a different outcome or result than if tested outside the laboratory. Using theoretical models ~~are~~ is more safer and Cheaper too. 5

..... [3]

(ii) Suggest why theoretical modelling cannot completely replace laboratory trials in the search for new drugs.

The effect of new drugs on ~~people~~ living organisms is important ~~to~~, in order to observe
6 if any side effects might show. To test if also to test and see the strength of drugs (~~to~~ whether they are effective or not). 7

..... [2]

[Total:10]

Examiner comments

4 This suggestion is not a great danger of doing practical drug tests in the laboratory, as there is little danger of the parasites escaping to a real world situation.

5 The cheapness of theoretical trials is an advantage that scores a mark.

Mark for (b) (i) = 1/3

6 The potential negative consequences of a trial drug on the patient are considered here.

7 The candidate also considers assessing the positive effectiveness of the drug and begins to hint at the idea of calculating dosage rates when they mention 'strength'.

Mark for (b) (ii) = 2/2

Total marks awarded = 6 out of 10

How the candidate could have improved their answer

(a) (ii) The candidate didn't move on from finding a genetic sequence difference between resistant and non-resistant forms to considering how drugs interact with their targets. If they had developed the base sequence idea at the end to amino acid sequences and protein structure, they would have progressed successfully from the first part of the question – the genome sequence – to the last part, anti-malarial drugs.

(b) (i) The candidate focused chiefly on the problems of practical tests, not on the advantages of theoretical modelling. An improved answer would begin: 'The advantages of using theoretical models are . . .' and would have stuck to positive points, considering time, cost and facilities needed.

Mark awarded = **(a) (i) 2/2, (ii) 1/3**
Mark awarded = **(b) (i) 1/3, (ii) 2/2**

Total marks awarded = 6 out of 10

Example candidate response – low	Examiner comments
3 Malaria is a serious and often fatal infectious disease caused by *Plasmodium*. Drugs such as chloroquine are widely used to decrease the risk of getting malaria and also to treat people who have become infected. However, in many parts of the world, *Plasmodium* populations have become resistant to chloroquine. Sequencing the genome of *Plasmodium* and the application of bioinformatics has provided several new targets for the development of anti-malarial drugs. **(a) (i)** Define the term *bioinformatics*. at Altering and changing factors in the environment to change the behaviour of a cell. 1 [2] **(ii)** Outline how sequencing the genome of *Plasmodium* **and** the use of bioinformatics can suggest new targets for anti-malarial drugs. Sequencing the genome of plasmodium to work in and only switch on in environments where humans are vulnerable. When a mosquito is taking a meal, the plasmodium can be sequenced to not be suitable to enter the blood stream because of size or of a chemical reaction 2 [3]	1 The answer includes no relevant information about using computer programs to store and analyse large quantities of biological gene sequence data. Mark for (a) (i) = 0/2 2 The answer is vague and ambiguous and shows an unwillingness to move from the life cycle of the parasite to the molecular level of interaction targeted in the question. Mark for (a) (ii) = 0/3

Example candidate response – low, continued

(b) In parts of the world where *Plasmodium* is resistant to chloroquine, one of the most effective anti-malarial drugs currently in use is artemisinin. Artemisinin works by binding to an enzyme in *Plasmodium* called PfATP6, acting as an inhibitor.

A substance called curcumin, which has long been used as a spice and yellow food colouring in India and other countries, is also known to act against chloroquine-resistant *Plasmodium*. A group of researchers predicted that curcumin acts by binding to the same enzyme as artemisinin.

In order to test this hypothesis, and to try to find similar substances that might work even better than curcumin, the researchers used theoretical modelling to:

- look at the chemical structures of various molecules with a similar structure to curcumin (curcumin analogues)
- generate a three-dimensional model of the structure of the enzyme PfATP6
- investigate whether each curcumin analogue could bind to PfATP6.

The researchers predicted that several of the curcumin analogues would bind more strongly than curcumin to PfATP6.

(i) Suggest advantages of using theoretical models in this research, rather than testing possible drugs in the laboratory.

Saves time and money to firstly use theoretical models and deduce which molecules would bond to PfATP6. ~~It~~ It is also safer to use models instead of handling with plasmodium and ~~tea~~ trying to extract the enzyme

[3]

(ii) Suggest why theoretical modelling cannot completely replace laboratory trials in the search for new drugs.

In order to be 100% sure the drug works and that it has no side effects it needs to be used in laboratory trials to ~~make~~ Make sure nothing has been missed and to gain further information on the effeciency of the drug [2]

[Total:10]

Examiner comments

3 The candidate understands what an advantage is and immediately scores two marks by suggesting two distinct advantages: saving time and saving money.

4 There should not be any safety risk to researchers working on in vitro systems involving PfATP6 and curcumin analogues. A risk assessment for maintaining and handling the parasites in the lab should eliminate risk to research staff.

Mark for (b) (i) = 2/3

5 The answer correctly identifies the need to test drug efficacy.

6 The answer also considers the potential for side-effects on patients.

Mark for (b) (ii) = 2/2

Total marks awarded = 4 out of 10

How the candidate could have improved their answer

(a) (i) A learned definition was needed here and this candidate did not appear to remember one.

(a) (ii) The candidate appeared to think that sequencing the genome causes a change in its functioning rather than just records what bases are present. With this major misconception in place, there was little the candidate could do to bring the answer back to any sensible ideas. The answer also appears to suggest making the genome 'work' when humans are vulnerable, making the problem worse, and to suggest altering a lab parasite, which would do nothing to tackle the millions of unaltered parasites in the real world. The best thing this candidate could have done would have been to reread the question more carefully and to focus on the molecular topics of genome, bioinformatics and drugs, not on the life cycle of *Plasmodium*.

Mark awarded = **(a) (i) 0/2, (ii) 0/3**
Mark awarded = **(b) (i) 2/3, (ii) 2/2**

Total marks awarded = 4 out of 10

Common mistakes candidates made in this question

(a) (ii) Some candidates leapt from a gene sequence to a drug interacting with a folded protein, without filling in the conceptual links along the way.

(b) (i) Some candidates wrote about the disadvantages of practical tests, not the *advantages* of theoretical modelling, as requested.

Question 4

Example candidate response – high

4 Maize is an important food crop that has been improved both by selective breeding and by genetic modification.

(a) Outline how selective breeding has been used to improve maize.

Maize with desirable characteristics such as high yield of kernel ① ~~and~~ by humans are selected to be breeded with others with desirable ② characteristics. Their alleles are passed on to their offspring. This ③ process is repeated over many generations producing species with improved features. However inbreeding as such may lead to Allele frequency changes inbreeding depression ~~and loss~~ due to increased homozygosity. Therefore it is important to ~~re~~breed maize with other types / relatives to increase hybrid vigour ④ and increase genetic diversity ⑤.

[4]

Examiner comments

① An example of a desirable characteristic in maize is given, scoring 1 mark.

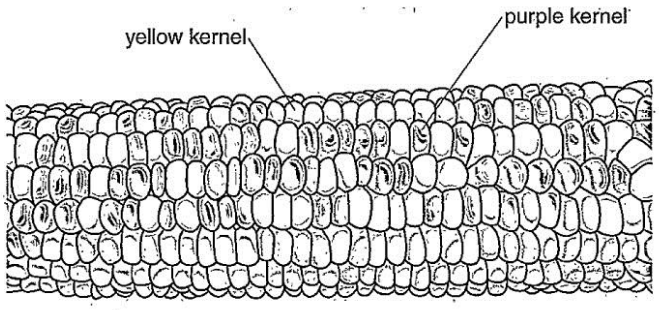
② The principle of breeding together maize plants with desirable characteristics gets a mark.

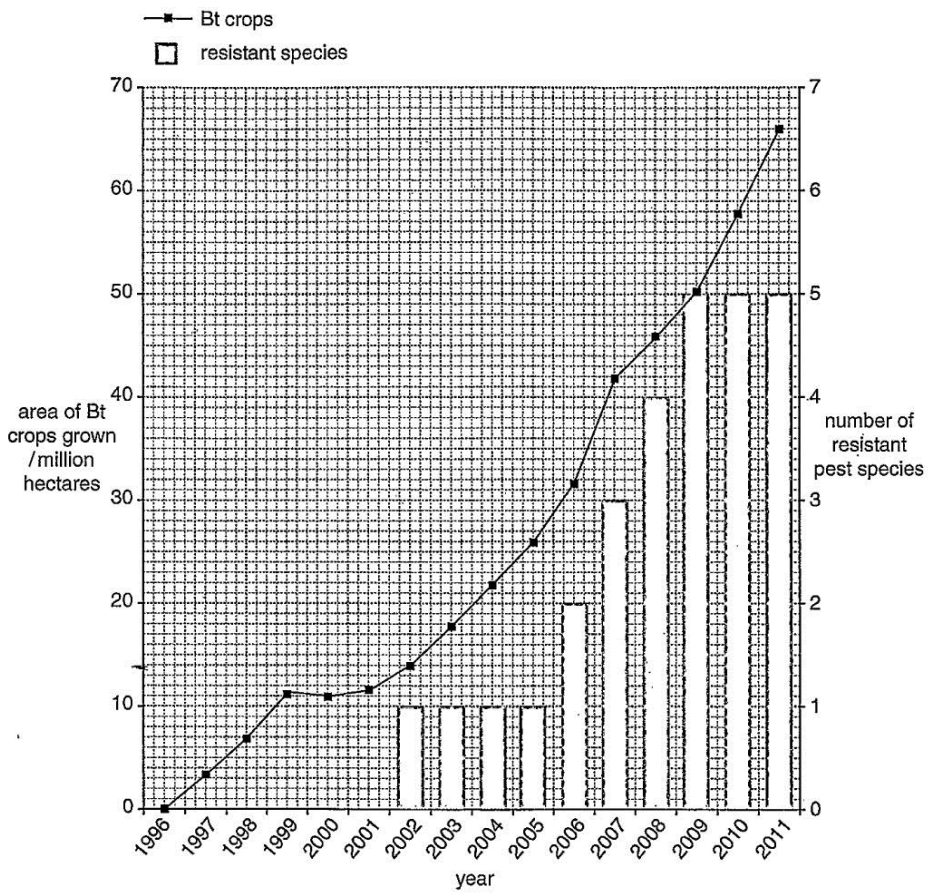
③ A third mark is given for the idea of repeating the process over many generations.

④ There is enough here about creating hybrid varieties to earn a mark.

⑤ The increase in vigour resulting from outbreeding gets a fifth tick, although the maximum mark available is 4.

Mark for (a) = 4/4

Example candidate response – high, continued	Examiner comments
(b) Fig. 4.1 shows part of a maize cob. The cob is made up of many individual seeds called kernels. Each kernel results from a separate fertilisation of a male and a female gamete. Some kernels are yellow and some are purple.  **Fig. 4.1** Name the type of variation shown in Fig. 4.1. Suggest a genetic explanation for this pattern of variation in colour. *type of variation* ..... Phenotypic variation 6 ..... *explanation* ..... Difference in colour is due to genotypic variation and ..... different alleles giving different phenotypes (colour of kernel in ..... this case) - (one from male one from female gamete) 7 .... [3]	6 While this variation is indeed visible in the phenotype, the question asks for a specific named type of phenotypic variation that has been studied at A Level. 7 There is a reference to different alleles here, but the fact that two determine colour, as one comes from each gamete, does not argue that the trait of kernel colour is specifically controlled by a single gene which only has two possible variants (alleles). The fact that this is a monogenic cross can be inferred by the fact that there are only two kernel colours and that the ratio of colours on the cob is roughly 1:1. Mark for (b) = 0/3

Example candidate response – high, continued	Examiner comments
(c) Maize and other crops have been genetically modified since 1996 to produce the Bt toxin to kill insect pests. Fig. 4.2 shows the area of Bt crops grown (plotted points) and the number of insect pest species in which resistance to Bt has been reported (bars).  **Fig. 4.2**	

Example candidate response – high, continued

(i) Describe **and** suggest an explanation for the relationship between the area of Bt crops grown and the number of resistant pest species.

As area of Bt crops grown increased, numbers of resistant pest species also increased. (8) From 1996 to 2001 there were no resistant species but as the area of Bt crops grown increased from 0 to 14 (9) million acres, the ~~species started~~ one species appeared in 2002. The Bt (10) crops toxin acts as a selection pressure. Mutation may have occured (11) and a ~~seed~~ an insect became resistant to the toxin, giving it a selective advantage to survive while others with no resistance died. It (12) reproduces to pass on the resistant allele to offspring. Allele ~~freq~~ frequency changes & and more of the species have resistance. More Bt crops grown result in greater selection pressure so ~~more~~ pest species evolve to have resistance [4]

(ii) Suggest **one** social advantage and **one** environmental advantage of growing this Bt maize.

social advantage ~~there is~~ higher yield of maize so more food supply for humans and economic benefit (13)

environmental advantage ~~To~~ Decrease Reduce number of harmful ~~bug~~ pests by killing them beneficial to other plants as well (14) [2]

[Total: 13]

Examiner comments

(8) The main trend (a positive correlation) is described, earning one mark.

(9) This date quote scores the AVP mark.

(10) The units are quoted incorrectly and no year date is given for the zero figure.

(11) The answer begins to explain the pattern by naming mutation as the source of the first resistant insects. This gets a mark.

(12) The explanation of the evolution of resistance due to natural selection is developed and scores one mark. The final mark is 4: 2 for descriptive and 2 for explanatory points.

Mark for (c) (i) = 4/4

(13) The advantage to human society of a higher yield of maize scores one mark.

(14) Reducing the number of insects that feed on maize is unlikely to benefit other plants since the caterpillars targeted by Bt will be specialist feeders on maize. Environmentally, it is a disadvantage to decrease the numbers of these pests since caterpillars and butterflies provide a food source for birds and other insectivores.

Mark for (c) (ii) = 1/2

Total marks awarded = 9 out of 13

How the candidate could have improved their answer

(b) The candidate needed to think beyond genetic and phenotypic variation to the two distinct patterns of variation seen in organisms, continuous and discontinuous.

(c) (i) When quoting data, the candidate should have given *x* axis quotes (years) and should have checked the units carefully and reproduced what was written on the *y* axis of the graph.

Mark awarded = **(a) 4/4**
Mark awarded = **(b) 0/3**
Mark awarded = **(c) (i) 4/4, (ii) 1/2**

Total marks awarded = 9 out of 13

Example candidate response – middle	Examiner comments

4 Maize is an important food crop that has been improved both by selective breeding and by genetic modification.

(a) Outline how selective breeding has been used to improve maize.

maize that has short stems are produce a high yield of seeds were selected. Artificial selection; then those ~~to~~ with ~~their~~ desirable traits were breed together. This new generation ~~how possess~~ posses on allele that hcve a selective advantage over other maize population. Those artificially selected (by humans) are allowed to breed together to pass on the alleles to co next generations. This improved maize and harvesting short stemed maize costs less money. [4]

Now always.

1 An example of a desirable trait (high yield) is given. It is not immediately obvious why short stems are desirable so this would need to be explained (see comment 4).

2 The key principle of selective breeding is explained, gaining a second mark.

3 The answer falls short of saying that this whole process of selecting and breeding is repeated over many generations.

4 Short stems can be credited as a desirable feature (higher ratio of grain to vegetative growth, less chance of being blown over), but explicit mention of this and the fact that special dwarf varieties have been bred is needed to score a mark.

Mark for (a) = 2/4

Example candidate response – middle, continued

(b) Fig. 4.1 shows part of a maize cob. The cob is made up of many individual seeds called kernels. Each kernel results from a separate fertilisation of a male and a female gamete. Some kernels are yellow and some are purple.

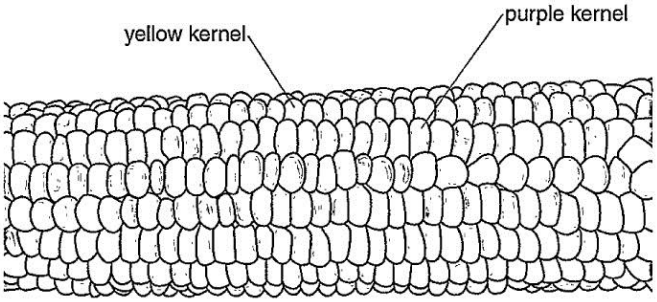


Fig. 4.1

Name the type of variation shown in Fig. 4.1. Suggest a genetic explanation for this pattern of variation in colour.

type of variation Discontinuous variation 5

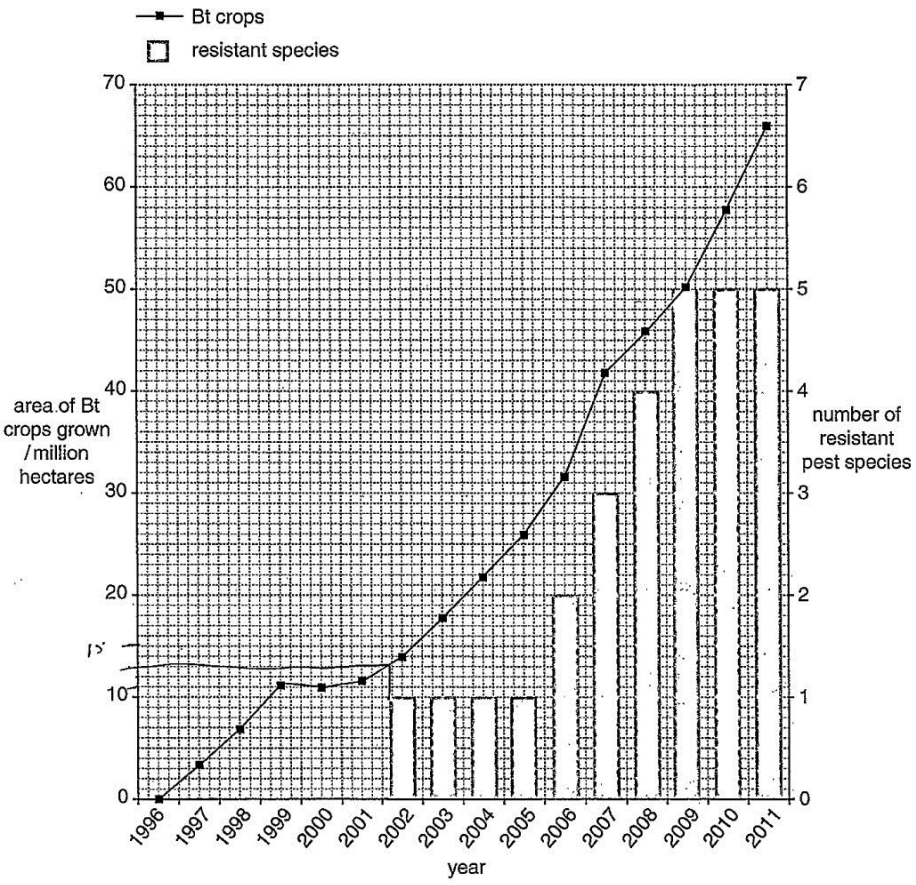
explanation ~~When each fertil~~ Fertilisation of each kernel separately makes them independent of each other. As There are different alleles of the colour genes that are carried by males and ~~female~~ females gametes. The random ~~fertil~~ fertilisation is a reason for such variation to appear. Also independent assortment of ~~f~~ chromosomes during fertilisation plays a role in such variation to appear. 6 [3]

Examiner comments

5 This is the correct answer and scores one mark.

6 This answer is vague and describes some principles of sexual reproduction generating variation in offspring, without using Fig. 4.1 to probe the genetic underpinnings of the ratio observed in detail.

Mark for (b) = 1/3

Example candidate response – middle, continued	Examiner comments
(c) Maize and other crops have been genetically modified since 1996 to produce the Bt toxin to kill insect pests. Fig. 4.2 shows the area of Bt crops grown (plotted points) and the number of insect pest species in which resistance to Bt has been reported (bars).  **Fig. 4.2**	

Example candidate response – middle, continued

(i) Describe **and** suggest an explanation for the relationship between the area of Bt crops grown and the number of resistant pest species.

As area of Bt crops grown increases from 1996 till 2002, there was no effect, and no resistant strain of these pests was formed, but furthermore as the area of Bt crops start to increase from 13 million hectares till 66, the number of resistant pest species started to appear. During 2002 till 2005, number of resistant pests where were constant at 1 but started increasing from 2006 till 2011 2009, then again becomes constant from 2009 till 2011 at 5 species. Increasing the selection pressure put on insects, those insects with selective advantages survive only and reproduce increasing in number and reproducing. re-producing [4]

(ii) Suggest **one** social advantage and **one** environmental advantage of growing this Bt maize.

social advantage number of ~~pest~~ maize production increases, ~~pro~~

environmental advantage number of pests killed increases so less damage to plants [2]

[Total: 13]

7 By 2002 one resistant insect species was recorded, so the candidate has misread and misquoted the information on the graph.

8 This is an odd figure to pick as it does not coincide with the centre point of a year or with the first record of a resistant pest species. No *x* axis figure (year) is given for this figure quote or for the next.

9 A mark is given for a correct description of the plateau in resistance between 2002 and 2005.

10 This marking point has already been awarded (the AVP, marking point 7).

11 The candidate does not say that the insects are resistant to Bt, so does not get a mark for the attempt to explain the data in terms of natural selection for resistance.

Mark for (c) (i) = 1/4

12 The advantage of Bt maize to human society is succinctly expressed.

13 This answer is vague as we do not know what plants are meant. In fact, the insects killed by Bt are unlikely to feed on other wild plants.

Mark for (c) (ii) = 1/2

Total marks awarded = 5 out of 13

How the candidate could have improved their answer

(a) The reference to generations could have been developed to give the idea of many repetitions of the process, and the specific name for extremely short-stemmed varieties could have been used (dwarf varieties).

(b) The candidate could have considered how many genes and alleles would be needed to give the pattern seen on Fig. 4.1.

(c) (i) Data quotes from graphs always need an *x* and a *y* axis reference to score. The candidate spent most of their time and the space available on attempts at description that lacked full coordinates. The one cramped sentence of explanation needed the word 'resistant'.

Mark awarded = **(a) 2/4**
Mark awarded = **(b) 1/3**
Mark awarded = **(c) (i) 1/4, (ii) 1/2**

Total marks awarded = 5 out of 13

Example candidate response – low

4 Maize is an important food crop that has been improved both by selective breeding and by genetic modification.

(a) Outline how selective breeding has been used to improve maize.

a Maize is out breeded with other species (1)
of maize to give taller and more yield (2)
of the maize that has allele that can
be best adapted to the environment
if it was breeded with same species less
yield will be give and shorter ones. (3)

[4]

(b) Fig. 4.1 shows part of a maize cob. The cob is made up of many individual seeds called kernels. Each kernel results from a separate fertilisation of a male and a female gamete. Some kernels are yellow and some are purple.

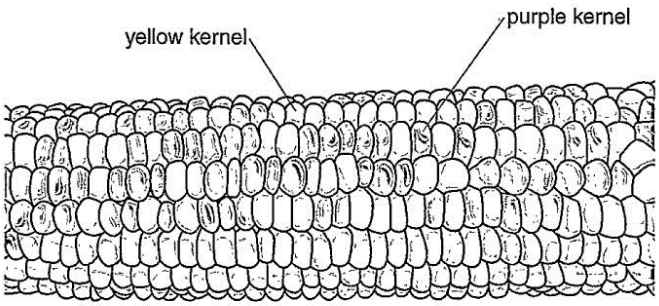


Fig. 4.1

Name the type of variation shown in Fig. 4.1. Suggest a genetic explanation for this pattern of variation in colour.

type of variation dis Continuous variation (4)

explanation it is only influced by gene (5)
and ~~to~~ there is no intermediates.
different alleles of this gene has a great
effect on the phenotype.

[3]

Examiner comments

(1) Food crop maize varieties all belong to one species, *Zea mays*, so this is a mistake.

(2) A mark is gained for describing a desirable characteristic of maize.

(3) Owing to the error about crossing species, no more marks are awarded and the candidate does not adequately develop the idea of hybridisation between inbred lines.

Mark for (a) = 1/4

(4) This name is correct.

(5) This is true but the number of genes and alleles needed are not considered.

Mark for (b) = 1/3

Example candidate response – low, continued	Examiner comments

(c) Maize and other crops have been genetically modified since 1996 to produce the Bt toxin to kill insect pests.

Fig. 4.2 shows the area of Bt crops grown (plotted points) and the number of insect pest species in which resistance to Bt has been reported (bars).

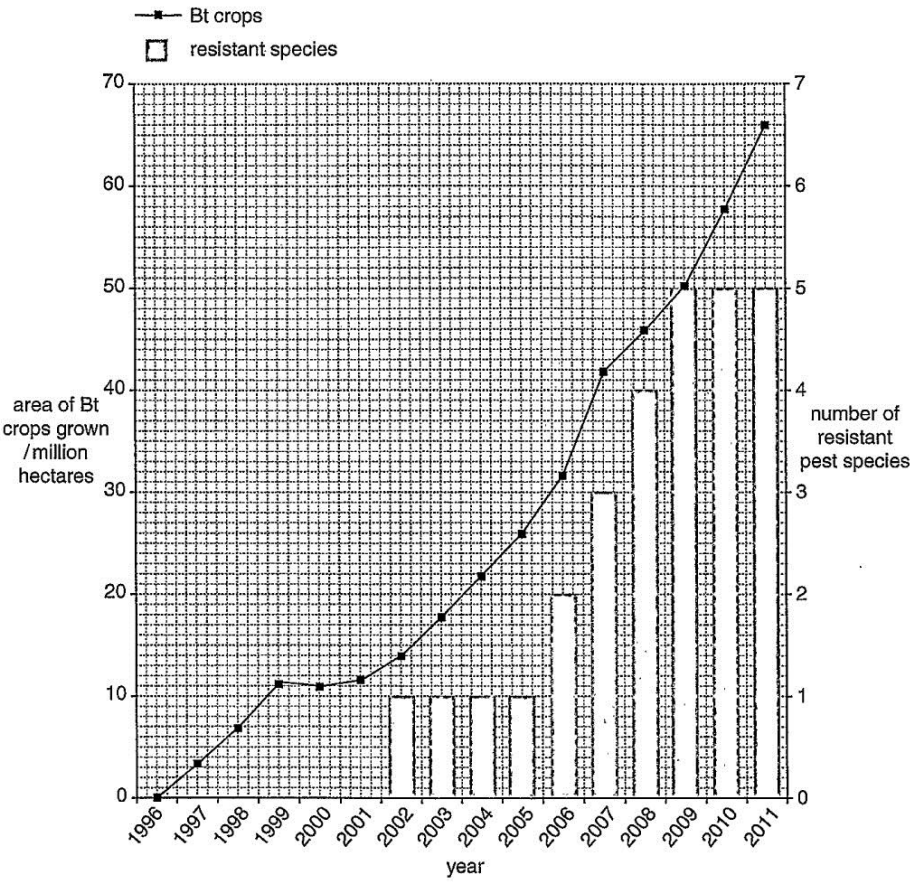


Fig. 4.2

Example candidate response – low, continued	Examiner comments
(i) Describe **and** suggest an explanation for the relationship between the area of Bt crops grown and the number of resistant pest species. number of resistant pest species ie is discontinous variation as no intermediate and as the years increase the more the resistant pest. 6 the are of Bt crops grow increase within the year and it between to too extremes 7 [4] (ii) Suggest **one** social advantage and **one** environmental advantage of growing this Bt maize. *social advantage* more variety of food 8 *environmental advantage* Symbiosis 9 [2] [Total: 13]	6 This is true but the question asks for the relationship between two variables not just over time, so no mark is awarded. 7 The area increases over 16 years, not one year, and this sentence is not linked to the previous one. Mark for (c) (i) = 0/4 8 Growing more of one type of food does not increase the variety available. 9 This unexplained word does not answer the question. Mark for (c) (ii) = 0/2 **Total marks awarded = 2 out of 13**

How the candidate could have improved their answer

(a) The candidate should have applied the definition of the biological concept of a species and used the words *variety* or *line* for specific breeding groups within the maize species.

(b) The comment 'only influenced by genes' needed developing further.

(c) (i) The candidate was asked to describe a relationship between two variables plotted against time, and would have done well to model their answer on 'as the first *y* axis variable increases, the second *y* axis variable also increases'.

(c) (ii) This answer contradicts the known facts. If 'variety of' had been left out of the answer, it would have been awarded a mark.

Mark awarded = **(a) 1/4**
Mark awarded = **(b) 1/3**
Mark awarded = **(c) (i) 0/4, (ii) 0/2**

Total marks awarded = 2 out of 13

Common mistakes candidates made in this question

(a) When candidates discussed selective breeding in general, they often didn't add any detailed case study examples relating to maize, such as creating F1 hybrid varieties, or cross-breeding with dwarf individuals containing mutant alleles for synthesis of gibberellin.

(b) Many candidates assumed Fig. 4.1 was there to show that corn cob kernels are one of two colours. This could have been said in words without a diagram. Candidates didn't pick up on the ratio information shown in the figure.

(c) (i) Many candidates made errors reading off numbers from the graph. Many did not give both *x* and *y* coordinates for points along the area of Bt crops grown line.

(c) (ii) The major advantage to the environment of Bt maize is that insects feeding on plants other than maize do not get killed, as general insecticides no longer need to be sprayed. Candidates seemed unpractised at considering the positive advantages of Bt crops.

Question 5

Example candidate response – high

5 Fig. 5.1 shows a water vole, *Arvicola amphibius*. This species is native to Great Britain.

Fig. 5.1

The numbers of water voles are estimated to have fallen by 94% in the last century.

This is thought to be due to habitat fragmentation and also to extensive predation by mink, *Neovison vison*, shown in Fig. 5.2. Mink originated in North America but were brought to Great Britain for fur farming. Some escaped or were released into the wild, where their numbers rapidly increased.

Fig. 5.2

(a) Name **and** describe a method for estimating the abundance of water voles in a local area.

This mark, release and recapture method can be used. 1

Capture a certain number of voles (eg: 100) and mark them using a method that won't harm them or affect their survival (eg: shaving a patch of fur on their backs). Release them and after 2

3 36 hours recapture as many voles as possible, counting how many in total are recaptured and of those how many are marked. Abundance = total no. of voles marked − those marked + recaptured / no. of voles recaptured 4

[4]

Examiner comments

1 A mark is given for the name of the method.

2 No detail is given about how the voles are trapped but there is a wealth of detail about the marking process.

3 The length of time that elapses before the second round of trapping earns a mark.

4 The formula provided finds the difference between the number of voles caught in the first and second samples; however, these two figures should be multiplied together on the top line of the calculation.

Mark for (a) = 3/4

Example candidate response – high, continued

(b) Both water voles and mink are classified as class Mammalia, phylum Chordata, kingdom Animalia.

Outline two features of the **cells** of members of the kingdom Animalia that distinguish them from the cells of other multicellular eukaryotes.

1 ~~&~~ May have cilia 5

2 No cell wall 6

[2]

(c) (i) Discuss the reasons why alien species should be controlled.

Alien species have no natural predators and their prey have not evolved natural defense mechanisms against them. As a 7 result, their numbers will increase at the cost of other species' survival. This may lead to other species becoming 8 endangered or extinct due to reducing population sizes and can also lead to destruction of habitat 9 they must be controlled to conserve and ~~&~~ maintain biodiversity and ~~&~~ genetic diversity, and maintain balance in the ~~food~~ food chain of the ecosystem. [3]

(ii) Suggest **one** way of controlling mink numbers in Great Britain.

By ~~&~~ giving minks chemical contraception to keep numbers of offspring at a manageable level 10

[1]

[Total: 10]

Examiner comments

5 This answer is too brief and it lacks a subject. However, it refers to the target of the question (animal cells) so this gets a mark.

6 Although this is a negative feature, something animal cells don't have, it is considered markworthy because other cells of multicellular eukaryotes, plants and fungi, do have cell walls (on all cells).

Mark for (b) = 2/2

7 A mark is given for the idea that the alien species may be a predator of another native species.

8 Reduction in another species' abundance scores here.

9 The impact of the alien species in changing or destroying the habitat scores a mark.

Mark for (c) (i) = 3/3

10 The Contraceptive measures are credited on the mark scheme, along with hunting the mink or using a disease agent specific to mink.

Mark for (c) (ii) = 1/1

Total marks awarded = 9 out of 10

How the candidate could have improved their answer

(a) The candidate could have described how the voles would be captured each time, e.g. type of traps used.

(b) The candidate should have used full sentences, e.g. 'Animal cells may have cilia'.

Mark awarded = **(a) 3/4**
Mark awarded = **(b) 2/2**
Mark awarded = **(c) (i) 3/3, (ii) 1/1**

Total marks awarded = 9 out of 10

Example candidate response – middle	Examiner comments

5 Fig. 5.1 shows a water vole, *Arvicola amphibius*. This species is native to Great Britain.

Fig. 5.1

The numbers of water voles are estimated to have fallen by 94% in the last century.

This is thought to be due to habitat fragmentation and also to extensive predation by mink, *Neovison vison*, shown in Fig. 5.2. Mink originated in North America but were brought to Great Britain for fur farming. Some escaped or were released into the wild, where their numbers rapidly increased.

Fig. 5.2

(a) Name **and** describe a method for estimating the abundance of water voles in a local area.

By random sampling. a quadrat is used/in which
all water voles in that Mark-release-recapture because
method because it is a mobile animal. The area of the
local area is calculated. Some water voles are captured and
marked and counted. Then they are released into the wild and
allowed to mix, then the water voles are again captured,
the marked water voles are counted and the unmarked water
voles are counted. The ratio of marked to unmarked is assumed
to be the same for the whole population so that ratio is the same [4]
as the ratio of originally marked spec water voles to the unmarked
rest of water voles
the

1 The correct name for the technique scores a mark.

2 No details of capturing or marking are given.

3 The time that elapses until 'then' is not specified.

Mark for (a) = 1/4

Example candidate response – middle, continued

(b) Both water voles and mink are classified as class Mammalia, phylum Chordata, kingdom Animalia.

Outline two features of the **cells** of members of the kingdom Animalia that distinguish them from the cells of other multicellular eukaryotes.

1 they have ~~centromeres and~~ centrioles 4 and centrioles

2 they ~~are~~ don't have cell walls 5, large vacuoles or chloroplast. [2]

(c) (i) Discuss the reasons why alien species should be controlled.

Because they compete 6 for food and habitat with ~~original~~ local species causing their numbers to drop 7. They might not have any natural predators in that area causing their numbers to increase uncontrollably. Some ~~are~~ alien plants grow on buildings, destroy them. They don't 8 fit in the food chain. They might feed on an endangered species uncontrollably causing it to get extinct 9 [3]

(ii) Suggest **one** way of controlling mink numbers in Great Britain.

Allowing people to hunt them, legalise hunting 10 mink.

[1]

[Total: 10]

Examiner comments

4 'They' is taken to mean animal cells so this scores a mark.

5 Absence of a cell wall is considered an identifying feature of animal cells. Not having large vacuoles is potentially a third mark but only two marks are available for this question. Not having chloroplasts is ignored as a neutral point.

Mark for (b) = 2/2

6 Identification of alien species as possible competitors scores a mark.

7 This scores marking point 1, that numbers of other species could decrease.

8 This is incorrect as, in order to compete with others, the alien species must eat the same food as a native species. However, it is not a direct opposite of the mark point already given so was ignored.

9 This is the same marking point as 'causing their numbers to drop', already given in line 2.

Mark for (c) (i) = 2/3

10 This idea scores a mark.

Mark for (c) (ii) = 1/1

Total marks awarded = 6 out of 10

How the candidate could have improved their answer

(a) The details about how the voles are trapped, marked and how long they are left for could have been expanded, as could the formula used to calculate the population size.

(c) (i) This answer contradicted itself and then repeated itself. It could have been improved with more methodical thinking about all the ways in which alien species can fit into a pre-existing food web.

Mark awarded = **(a) 1/4**
Mark awarded = **(b) 2/2**
Mark awarded = **(c) (i) 2/3, (ii) 1/1**

Total marks awarded = 6 out of 10

Example candidate response – low

5 Fig. 5.1 shows a water vole, *Arvicola amphibius*. This species is native to Great Britain.

Fig. 5.1

The numbers of water voles are estimated to have fallen by 94% in the last century.

This is thought to be due to habitat fragmentation and also to extensive predation by mink, *Neovison vison*, shown in Fig. 5.2. Mink originated in North America but were brought to Great Britain for fur farming. Some escaped or were released into the wild, where their numbers rapidly increased.

Fig. 5.2

(a) Name **and** describe a method for estimating the abundance of water voles in a local area.

By sampling, ~~then~~ choosing a certain area, counting how many water voles there are in that certain area and then multiplying by how large the Area is. 1

[4]

Examiner comments

1 No reference to the mark-release-recapture method is made. The method described seems to assume the water voles will be easy to see and count in the same way that plants are.

Mark for (a) = 0/4

Example candidate response – low, continued

(b) Both water voles and mink are classified as class Mammalia, phylum Chordata, kingdom Animalia.

Outline two features of the **cells** of members of the kingdom Animalia that distinguish them from the cells of other multicellular eukaryotes.

1 Contain Lysosomes 2

2 May have microvilli. 3

[2]

(c) (i) Discuss the reasons why alien species should be controlled.

They can exterminate other species 4 Will affect the biodiversity (ecosystem) of that area, and also will change food chains. 5

[3]

(ii) Suggest **one** way of controlling mink numbers in Great Britain.

By releasing a predator of the mink. 6

[1]

[Total: 10]

Examiner comments

2 The cells of all multicellular eukaryotes contain lysosomes so this is not a unique animal cell feature.

3 This is awarded a mark, although the candidate has left the examiner to guess the identity of the cells which may have microvilli.

Mark for (b) = 1/2

4 This scores marking point 1 for the idea of reducing the number of another species.

5 Altering food chains scores a mark.

Mark for (c) (i) = 2/3

6 Since mink are medium-sized carnivores, the predators that could catch and eat them are likely to be a danger to the health of humans, farm and domestic animals as well as mink. Releasing a new alien predator species like the lynx into the British countryside is not considered a feasible idea.

Mark for (c) (ii) = 0/1

Total marks awarded = 3 out of 10

How the candidate could have improved their answer

(a) The candidate needed to look more closely at Fig. 5.1 and realise that voles cannot be counted by sightings alone.

(c) (i) The answer should have gone on to consider how the alien species might exterminate another species or change food chains.

Mark awarded = **(a) 0/4**
Mark awarded = **(b) 1/2**
Mark awarded = **(c) (i) 2/3, (ii) 0/1**

Total marks awarded = 3 out of 10

Common mistakes candidates made in this question

(a) Candidates who did not look closely at Fig. 5.1 to see what sort of animals water voles are incorrectly referred to the possibility of counting these fast-moving and secretive creatures using quadrat frames.

(b) Candidates frequently abandoned the most basic elements of an English sentence (subject, verb, object) when answering this question.

(c) (i) Candidates often repeated the same idea, such as a reduction in biodiversity, without going on to consider how this occurs or what causes it.

(c) (ii) Candidates didn't consider what predators of mink might be like and their potential effect on the ecosystem and on human activities when suggesting that the answer to one problem alien species is to introduce another.

Question 6

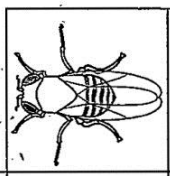
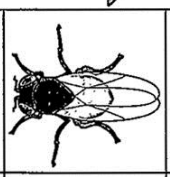
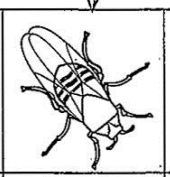
Example candidate response – high

6 The fruit fly, *Drosophila melanogaster*, has eyes, a striped abdomen and wings longer than its abdomen. This is called a 'wild-type' fly.

Mutation has resulted in many variations of these features.

Table 6.1 shows diagrams of a wild-type fly and three other flies, each of which shows **one** recessive mutation.

Table 6.1

				
eyes	present	present	recessive absent	present
abdomen	striped	recessive black	striped	striped
wing description	long	long	long	recessive short

(a) Using appropriate symbols, complete the genetic diagram below.

symbols

E → eyes present

e → eyes absent

A → striped abdomen 1

a → black abdomen

parental phenotypes: Ee aa (with eyes, black abdomen) X eeAa (no eyes, striped abdomen)

parental genotypes: Ee aa eeAa 2

gametes: Ea ea eA ea 3

offspring genotypes: Eeaa eeaa EeAa eeAa 4

offspring phenotypes: with eyes black abdomen | no eyes black abdomen | with eyes striped abdomen | no eyes striped abdomen

[4]

Examiner comments

1 The symbols are correct and identified appropriately. The misspelling 'stribed' is assumed to be 'striped'.

2 Using the symbols given, these parental genotypes match the phenotypes and lead to four different offspring genotypes.

3 The gametes are haploid and correctly deduced from the parental genotypes.

4 The offspring genotypes follow on from the previous working and are in the correct order to match the offspring phenotypes.

Mark for (a) = 4/4

Example candidate response – high, continued

(b) State how you would carry out a test cross.

Cross breed the drosophila showing the dominant feature with a homozygous recessive one. [1]

5

(c) A cross was carried out between a fly heterozygous for striped abdomen and long wings and a fly with a black abdomen and short wings.

The results are shown below in Table 6.2.

AaLl x aall

Table 6.2

offspring	number
striped abdomen long wing	86
black abdomen long wing	87
striped abdomen short wing	81
black abdomen short wing	78
total	332

AL Aa Ll

Al Aa ll

aL aa Ll

al aall

A chi-squared test (χ^2) was carried out on these data.

Complete Table 6.3 **and** calculate the value of χ^2.

Table 6.3

observed number (O)	expected number (E)	O – E	$(O - E)^2$	$\frac{(O - E)^2}{E}$
86	83	3	9	0.11
87	83	4	16	0.19
81	83	-2	4	0.05
78	83	-5	25	0.30
332	332			

6

$$\chi^2 = \Sigma\frac{(O - E)^2}{E}$$

Σ = sum of...

7

χ^2 = 0.65 [3]

5 This answer shows awareness that a test cross involves crossing an organism of dominant phenotype with an organism that is homozygous recessive for that feature.

Mark for (b) = 1/1

6 All lines of the table are correct. The expected number has been calculated as the total divided by 4. Where the difference O – E is negative, the square of that number is shown as being positive. The final column figures are given to an appropriate number of decimal places, two reflecting two steps of processing in the last two columns.

7 The figures in the final column in Table 6.3 are added together correctly to find their sum.

Mark for (c) = 3/3

Example candidate response – high, continued

(d) Table 6.4 shows χ^2 values.

Table 6.4

degrees of freedom	probability						
	0.50	0.20	0.10	0.05	0.02	0.01	0.001
3	2.37	4.64	6.25	7.82	9.84	11.34	16.27

Using Table 6.4, explain what conclusions can be made about the results of the χ^2 test.

The value of χ^2 shows a probability greater than 0.05. So the ~~different~~ difference between observed numbers and expected numbers is not significant and only due to chance. 8 9

..... [2]

[Total: 10]

Examiner comments

8 A mark is awarded for identifying which side of probability value 0.05 the chi-squared value falls on. In this case the calculated value is very small and is to the left of that for probability 0.05, reflecting a high probability of this amount of deviation between observed and expected occurring by chance.

9 The reasoning leads to the correct conclusion, that the difference between what was expected and what was observed is not significant.

Mark for (d) = 2/2

Total marks awarded = 10 out of 10

How the candidate could have improved their answer

The candidate followed all the steps of working out and explaining correctly. Although candidates are not penalised for spelling mistakes where the misspelt word cannot be mistaken for another word, care should be taken especially where the word is written in the question. Here, 'stribed' was accepted as 'striped'.

Mark awarded = **(a) 4/4**
Mark awarded = **(b) 1/1**
Mark awarded = **(c) 3/3**
Mark awarded = **(d) 2/2**

Total marks awarded = 10 out of 10

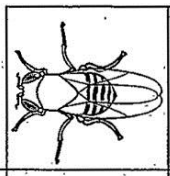
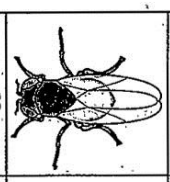
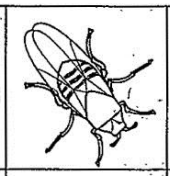
Example candidate response – middle

6 The fruit fly, *Drosophila melanogaster*, has eyes, a striped abdomen and wings longer than its abdomen. This is called a 'wild-type' fly.

Mutation has resulted in many variations of these features.

Table 6.1 shows diagrams of a wild-type fly and three other flies, each of which shows **one** recessive mutation.

Table 6.1

				
eyes	present	present	absent	present
abdomen	striped	black	striped	striped
wing description	long	long	long	short

(a) Using appropriate symbols, complete the genetic diagram below.

symbols

E – With Eyes (Dominant)

e – without eyes

S – Striped Abdomen (Dominant)

s – Black abdomen

1

parental phenotypes with eyes black abdomen X no eyes striped abdomen

parental genotypes EeSs X eeSs

gametes (ES) or (es) X (eS) (es)

offspring genotypes EeSS eeSs EeSs eeSs

2

offspring phenotypes with eyes black abdomen | no eyes black abdomen | with eyes striped abdomen | no eyes striped abdomen

[4]

Examiner comments

1 The symbols are correct.

2 The cross is worked correctly.

Mark for (a) = 4/4

Example candidate response – middle, continued

(b) State how you would carry out a test cross.

A test cross is carried out using two heterozygous species. 3

..... [1]

(c) A cross was carried out between a fly heterozygous for striped abdomen and long wings and a fly with a black abdomen and short wings.

The results are shown below in Table 6.2.

Table 6.2

offspring	number
striped abdomen long wing	86
black abdomen long wing	87
striped abdomen short wing	81
black abdomen short wing	78
total	332

A chi-squared test (χ^2) was carried out on these data.

Complete Table 6.3 **and** calculate the value of χ^2.

Table 6.3

observed number (O)	expected number (E)	O – E	$(O-E)^2$	$\frac{(O-E)^2}{E}$
86	83	3	9	0.11
87	83	4	16	0.19
81	83	−2	4	0.05
78	83	−5	25	0.30
332	332			

$$\chi^2 = \sum \frac{(O-E)^2}{E}$$

$\sum$ = sum of... 0.11 + 0.19 + 0.05 + 0.30

χ^2 0.65 4 ..... [3]

Examiner comments

3 The word 'species' is used inappropriately and a test cross is defined as involving one parent that is homozygous recessive for the feature of interest.

Mark for (b) = 0/1

4 The working and concluding figure of the chi squared test are all correct, gaining three marks.

Mark for (c) = 3/3

Example candidate response – middle, continued

(d) Table 6.4 shows χ^2 values.

Table 6.4

degrees of freedom	probability						
	0.50	0.20	0.10	0.05	0.02	0.01	0.001
3	2.37	4.64	6.25	7.82	9.84	11.34	16.27

Using Table 6.4, explain what conclusions can be made about the results of the χ^2 test.

5 Using the 0.05 probability, it can be seen that the X^2 result is far below 7.82. This means that the value is by chance and not significant. 6

.....

.....

..... [2]

[Total: 10]

Examiner comments

5 The candidate understands that they must compare their calculated chi squared value with the one in the table at probability 0.05. This gains a mark.

6 The fact that the candidate's calculated value is smaller than 7.82 tells us something about the difference between the observed and the expected results, not about 'the value'.

Mark for (d) = 1/2

Total marks awarded = 8 out of 10

How the candidate could have improved their answer

(b) The candidate did not seem familiar with the meaning of 'test cross', but their answer could still have been improved if 'two species' had been corrected to 'two *members* of the species'.

(d) The candidate showed a lack of precision in using technical terms. If they had said 'the difference' instead of 'the value', they would have been awarded another mark.

Mark awarded = **(a) 4/4**
Mark awarded = **(b) 0/1**
Mark awarded = **(c) 3/3**
Mark awarded = **(d) 1/2**

Total marks awarded = 8 out of 10

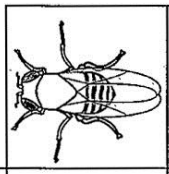
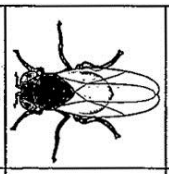
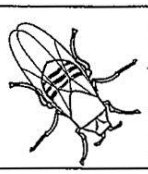
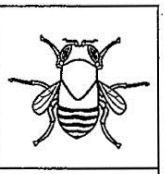
Example candidate response – low

6 The fruit fly, *Drosophila melanogaster*, has eyes, a striped abdomen and wings longer than its abdomen. This is called a 'wild-type' fly.

Mutation has resulted in many variations of these features.

Table 6.1 shows diagrams of a wild-type fly and three other flies, each of which shows **one** recessive mutation.

Table 6.1

				
eyes E	present	present	absent	present
abdomen A	striped	black	striped	striped
wing description	long	long	long	short

(a) Using appropriate symbols, complete the genetic diagram below.

symbols dominant E A
recessive e a 1

parental phenotypes with eyes black abdomen X no eyes striped abdomen

parental genotypes EeAa eeAa 2

gametes EA Ea eA ea EA Ea eA ea 3

offspring genotypes EeAa , Eeaa, eeAa, eeaa 4

offspring phenotypes with eyes black abdomen | no eyes black abdomen | with eyes striped abdomen | no eyes striped abdomen

[4]

Examiner comments

1 While E, e, A and a are appropriate symbols, the meaning of each has not been specified so the first mark was not awarded.

2 The symbols used here correctly reflect parents that are homozygous recessive for one characteristic and heterozygous for the other.

3 Although they do not need to be written twice in each case, the gamete symbols are correct.

4 While the offspring listed match the cross carried out, they have not been placed in the correct order to match the offspring phenotype information written below them. So, for example, EeAa will have eyes and a striped abdomen, not a black one.

Mark for (a) = 2/4

Example candidate response – low, continued

(b) State how you would carry out a test cross.

to dihybrid cross 5

.....[1]

(c) A cross was carried out between a fly heterozygous for striped abdomen and long wings and a fly with a black abdomen and short wings.

The results are shown below in Table 6.2.

EePa → 4
eePa → 4
Eeaa → 4

Table 6.2

offspring	number
striped abdomen long wing	86
black abdomen long wing	87
striped abdomen short wing	81
black abdomen short wing	78
total	332

	Ea	Ea	ea	ea
eA	EePa	EePa	eePa	eePa
ea	Eeaa	Eeaa	eeaa	eeaa
eA	EePa	EePa	eePa	eePa
ea	Eeaa	Eeaa	eeaa	eeaa

A chi-squared test (χ^2) was carried out on these data.

Complete Table 6.3 **and** calculate the value of χ^2.

Table 6.3

observed number (O)	expected number (E)	O – E	$(O - E)^2$	$\frac{(O-E)^2}{E}$
86	83	3	9	0.11
87	83	4	16	0.19
81	83	-2	4	0.05
78	83	-5	25	0.30
332	332			

4/16

$\chi^2 = \sum \frac{(O-E)^2}{E}$

Σ = sum of...

6

χ^2 0.65 .....[3]

Examiner comments

5 A test cross can be monogenic, digenic or trigenic, etc., and the key detail of what a test cross involves has not been given.

Mark for (b) = 0/1

6 All the steps of the chi squared calculation have been performed correctly.

Mark for (c) = 3/3

Example candidate response – low, continued

(d) Table 6.4 shows χ^2 values.

Table 6.4

degrees of freedom	probability						
	0.50	0.20	0.10	0.05	0.02	0.01	0.001
3	2.37	4.64	6.25	7.82	9.84	11.34	16.27

Using Table 6.4, explain what conclusions can be made about the results of the χ^2 test.

to see if observed and expected value are significant or no 7

there is significance between observed and expected value. 8

..... [2]

[Total: 10]

Examiner comments

7 The statistical test aims to discover whether the **difference** between observed and expected values is significant or not.

8 No reasoning using Table 6.4 is given to support this wrong conclusion.

Mark for (d) = 0/2

Total marks awarded = 5 out of 10

How the candidate could have improved their answer

(a) The candidate should have specified the meanings of the symbols they used here. The final line of answers needed to be rearranged to match up with the final printed line.

(d) The candidate needed to make use of Table 6.4 to draw a conclusion using their own figure. The answer should have contained at least two numerical values, their own calculated value and either probability 0.05 or the figure 7.82 from the table.

Mark awarded = **(a) 2/4**
Mark awarded = **(b) 0/1**
Mark awarded = **(c) 3/3**
Mark awarded = **(d) 0/2**

Total marks awarded = 5 out of 10

Common mistakes candidates made in this question

(a) The most common mistake was to ignore the information given above Table 6.1 and to make the black abdomen allele dominant instead of recessive. Some candidates did not realise that two phenotypic features meant that the cross was dihybrid, needing two pairs of symbols, one letter for each gene.

(b) Some candidates knew that one cross partner must be homozygous recessive but they crossed this individual with a known heterozygous or homozygous dominant individual, instead of with an individual showing the dominant phenotype but unknown genotype (which the test cross is designed to deduce).

(c) Some candidates made errors in rounding figures from many decimal places to two or three. Some candidates did not know how to calculate the expected values from an understanding of the genetic cross to give a 1:1:1:1 ratio of offspring.

(d) The most common mistake was for candidates not to know that the chi-squared test measures the probability of the **difference** between the observed and expected results occurring by chance. A small chi-squared value shows little difference, which is not significant and is likely to have arisen due to chance events. A large chi-squared value represents a large difference. This has a small probability of being due to chance and if the difference is significant (the probability of it occurring is less than 0.05), we must reject our original hypothesis. In this case, the hypothesis was of the two genes assorting independently to give a 1:1:1:1 ratio in the results.

Question 7

Example candidate response – high	Examiner comments
7 (a) An important function of control systems in mammals is homeostasis. Explain what is meant by the term *homeostasis*. Maintaining a stable internal environment of an organism near to a set value 1 [1] **(b)** Insulin plays a part in homeostasis. It affects muscle and liver cells to bring about a decrease in blood glucose concentration, particularly after a meal. **(i)** Insulin is composed of two polypeptides which are made in β cells in the pancreas. State precisely where in β cells polypeptide molecules are synthesised. 2 ribosomes on rough endoplasmic reticulum [1] **(ii)** Name the process by which insulin is secreted from β cells. exocytosis 3 [1]	1 The definition of homeostasis is complete and correct. Mark for (a) = 1/1 2 The correct part of the cell is named. Mark for (b) (i) = 1/1 3 The correct process is given. Mark for (b) (ii) = 1/1

Example candidate response – high, continued

(iii) Describe the effects of insulin on muscle cells.

Insulin stimulates muscle cells to increase their uptake of glucose from blood, and to increase their rate of respiration using glucose as substrate. ~~They~~ Insulin also stimulates muscle cells to convert glucose to glycogen in glycogenisis

[3]

(c) During periods of stress or extreme exercise more glucose needs to be released into the blood. The hormone adrenaline is released and binds to receptors on the cell surface membranes of liver cells.

Describe how the effect of adrenaline on liver cells results in an increase in blood glucose concentration.

Adrenaline binds to receptors on cell surface membranes of liver cells activating a G protein. G protein activates a membrane bound enzyme that converts ~~(ATP)~~ ATP to cyclic AMP. cyclic AMP activates Kinase enzyme. Kinase enzymes activates a series of enzyme cascade that eventually activates glycogen phosphorylase enzyme which catalyses break down of glycogen to glucose. glucose diffuses out of liver cells into the blood increasing blood glucose concentration.

[5]

[Total: 11]

Examiner comments

4 The first effect listed is correct and gains a mark.

5 The comment about increased rate of respiration of glucose scores a second mark.

6 A third effect is described correctly and named (the spelling mistake is ignored).

Mark for (b) (iii) = 3/3

7 This scores marking point 2.

8 The enzyme is not named so does not score marking point 3.

9 The product is named and scores marking point 4.

10 This stage in the process earns marking point 6.

11 The term 'enzyme cascade' earns marking point 7.

12 The wording 'break down' instead of 'hydrolysis' is allowed, so this statement earns marking point 8.

Mark for (c) = 5/5

Total marks awarded = 11 out of 11

How the candidate could have improved their answer

(a) & (b) All the answers were full and precise. In **(c)**, additional details like the name 'adenyl cyclase' and the fact that cyclic AMP can be described as a second messenger could have been added.

Mark awarded = **(a) 1/1**
Mark awarded = **(b) (i) 1/1, (ii) 1/1, (iii) 3 /3**
Mark awarded = **(c) 5/5**

Total marks awarded = 11 out of 11

Example candidate response – middle	Examiner comments
7 (a) An important function of control systems in mammals is homeostasis. Explain what is meant by the term *homeostasis*. to maintain body temperature constant. 1 [1] (b) Insulin plays a part in homeostasis. It affects muscle and liver cells to bring about a decrease in blood glucose concentration, particularly after a meal. (i) Insulin is composed of two polypeptides which are made in β cells in the pancreas. State precisely where in β cells polypeptide molecules are synthesised. pancreas 2 [1] (ii) Name the process by which insulin is secreted from β cells. exocytosis 3 [1]	1 This is not a general definition but an example of homeostasis so does not score a mark. Mark for (a) = 0/1 2 The question asks for a location **in** the beta cells, not where the beta cells are. Mark for (b) (i) = 0/1 3 The correct name is given. Mark for (b) (ii) = 1/1

Example candidate response – middle, continued	Examiner comments
(iii) Describe the effects of insulin on muscle cells. insulin bind to receptors and the cell surface membrane receptors activate the glucose transporter protein to merge with the cell surface membrane 4 to allow glucose to enter to the cell 5 [3] **(c)** During periods of stress or extreme exercise more glucose needs to be released into the blood. The hormone adrenaline is released and binds to receptors on the cell surface membranes of liver cells. Describe how the effect of adrenaline on liver cells results in an increase in blood glucose concentration. Adrenaline bind to receptor on live cells which activate G-protein 6 and a G protein activate enzyme 7 to catalyse ATP to cyclic AMP 8 which will activate protein kinase 9 which will the activate cascade protein 10 that activate glucose phosphrylase to break down glycogen to glucose. 11 [5] [Total: 11]	4 This scores marking point 2. 5 A mark is given for the effect of causing uptake of glucose. Mark for (b) (iii) = 2/3 6 This earns marking point 2. 7 The name of this enzyme is missed out. 8 This scores marking point 4. 9 The next step described matches marking point 6 in the sequence. 10 The candidate uses the word 'cascade' but has not included 'enzyme' or 'cascade of reactions'. 11 The final step described scores marking point 8. Mark for (c) = 4/5 **Total marks awarded = 7 out of 11**

How the candidate could have improved their answer

(a) The candidate needed to think generally about an umbrella definition covering all examples of homeostasis.

(b) (i) The candidate needed to read the question more carefully to see that it asked for an intracellular location where polypeptides are made.

(c) The answer followed a logical sequence of steps but could have given more names and details to be awarded the last mark available.

Mark awarded = **(a) 0/1**
Mark awarded = **(b) (i) 0/1, (ii) 1/1, (iii) 2 /3**
Mark awarded = **(c) 4/5**

Total marks awarded = 7 out of 11

Example candidate response – low	Examiner comments
7 (a) An important function of control systems in mammals is homeostasis. Explain what is meant by the term *homeostasis*. The maintenance of a constant internal environment. 1 [1] **(b)** Insulin plays a part in homeostasis. It affects muscle and liver cells to bring about a decrease in blood glucose concentration, particularly after a meal. **(i)** Insulin is composed of two polypeptides which are made in β cells in the pancreas. State precisely where in β cells polypeptide molecules are synthesised. Islets of Langerhans. 2 [1] **(ii)** Name the process by which insulin is secreted from β cells. Glucogeonesis. 3 [1]	1 A correct definition. Mark for (a) = 1/1 2 This is not an intracellular location. The word 'in' and the general sense of what the question is asking has been missed. Mark for (b) (i) = 0/1 3 This is a misspelling of a word that is not concerned with secretion. Mark for (b) (ii) = 0/1

Example candidate response – low, continued	Examiner comments
(iii) Describe the effects of insulin on muscle cells. When there is a ~~decrease~~ increase of blood glucose concentration, insulin is secreted by the β-cells. 4 Insulin binds to receptors in the ~~cell~~ surface membrane of muscle cells, which activate a G-protein. 5 6 [3] **(c)** During periods of stress or extreme exercise more glucose needs to be released into the blood. The hormone adrenaline is released and binds to receptors on the cell surface membranes of liver cells. Describe how the effect of adrenaline on liver cells results in an increase in blood glucose concentration. β-cells, secrete insulin to lower the increase of blood glucose concent. 7 [5] [Total: 11]	4 The first sentence is redundant as it does not answer the question but provides background detail. 5 This statement is true but the effects that this causes are not given. 6 Insulin does not work in this way. Mark for (b) (iii) = 0/3 7 The answer does not relate to the question. Mark for (c) = 0/5 **Total marks awarded = 1 out of 11**

How the candidate could have improved their answer

(b) (i) The candidate needed to read the question more carefully and not jump to conclusions when they read 'where' and 'β cells'.

(b) (ii) & (c) The candidate appeared to be trying to remember random facts to do with insulin and did not focus on working out answers to the actual questions asked. Rough paper working might have helped this candidate to gather their thoughts, focus on what the questions were really asking and reason their way to a sensible answer.

(b) (iii) The candidate wasted time filling in the back story and never got on to what the question was asking about, namely the effects of insulin.

Mark awarded = **(a) 1/1**
Mark awarded = **(b) (i) 0/1, (ii) 0/1, (iii) 0 /3**
Mark awarded = **(c) 0/5**

Total marks awarded = 1 out of 11

Common mistakes candidates made in this question

(a) The definition given was sometimes incomplete. It should have three parts: the idea of keeping or maintaining, the idea of constancy and the location inside the mammalian body (the internal environment).

(b) (i) Many candidates misread this question. There was a tendency for candidates to focus exclusively on biological terms like β cells and to ignore small common words like 'in'. Here, the word 'in' was crucial to understanding the sense of the question and to narrowing down the possible answers to somewhere inside the cell.

(b) (ii) This was a synoptic question. Candidates were not necessarily expected to have learned that insulin is secreted by exocytosis. Instead, the examiner expected that candidates would know that insulin is a large protein and that they could survey the methods (studied at AS Level) by which molecules enter and leave cells and rule out osmosis, diffusion and active transport. This left endocytosis and exocytosis, and since the direction of transport was *out* of the cell (secretion) the correct answer was exocytosis. Some candidates seemed unwilling to think this through for themselves. When they could not recall a relevant name, they left a blank or wrote an unrelated word.

(b) (iii) & (c) The two 'describe' questions relied on factual recall and were generally well answered. The main mistake on **(c)** was to ignore the new context of adrenaline and write about the learned example, glucagon, instead.

Question 8

Example candidate response – high

8 (a) Fig. 8.1 is a diagram of a sensory neurone and some receptor cells.

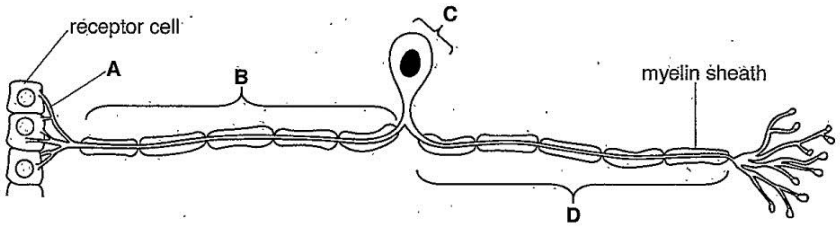


Fig. 8.1

Name the parts of the neurone labelled **A**, **B**, **C** and **D**.

A dendrites 1

B axon 2

C cell body 3

D dendron 4 ~~(axon)~~ [4]

(b) Explain how the myelin sheath increases the speed of conduction of nerve impulses.

Myelin sheath insulates 5 the axon. No action potentials occur ~~(in)~~ in myelinated regions. action potentials only occur at nodes of Ranvier where myelin is absent. 6

7 local circuits between node of ranvier make the impulse jump from one node to another in what is called saltatory conduction 8 [2]

Examiner comments

1 The correct name is given.

2 This is an acceptable term, although the term 'dendron' can also be used.

3 This is one of three acceptable names for the part of the neurone that houses the nucleus.

4 The term 'dendron' is reserved for the part of the neurone between the sensory dendrites and the cell body, so is not applicable here.

Mark for (a) = 3/4

5 The explanation begins with the correct use of the term 'insulates'.

6 A second mark is scored. The candidate is careful to include the word 'only', which is important here, and makes the distinction between the nodes of Ranvier and the myelinated sections of the neurone.

7 This statement earns marking point 3.

8 The correct name for this phenomenon gains another mark, although the maximum allowed is 2 marks.

Mark for (b) = 2/2

Example candidate response – high, continued	Examiner comments

(c) Fig. 8.2 shows the changes in the membrane potential of a sensory neurone when the receptor cells are stimulated.

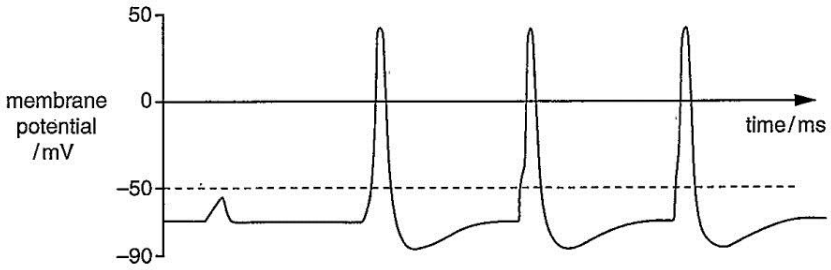


Fig. 8.2

Fig. 8.3 shows the strength of the stimuli applied to these receptor cells.

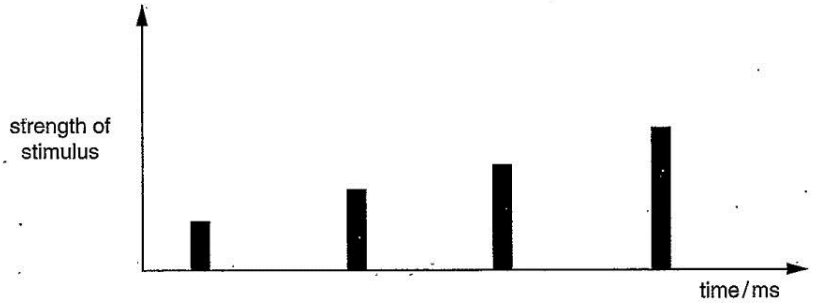


Fig. 8.3

With reference to Fig. 8.2 and Fig. 8.3, describe the relationship between the strength of the stimulus and the resulting action potential.

If the strength of stimulus is too low then the threshold won't be reached and action potential is not generated. 9
Increasing the strength of stimulus increases the frequency of action potentials. Strength of stimulus doesn't affect potential difference of action potentials as all action potentials produced had the same p.d. 10 [2]

[Total: 8]

9 This statement is correct but is not quite complete. The examiner also wanted to know that if the strength of stimulus **does reach** the threshold then an action potential **is** generated.

10 This gains a mark, marking point 2.

Mark for (c) = 1/2

Total marks awarded = 6 out of 8

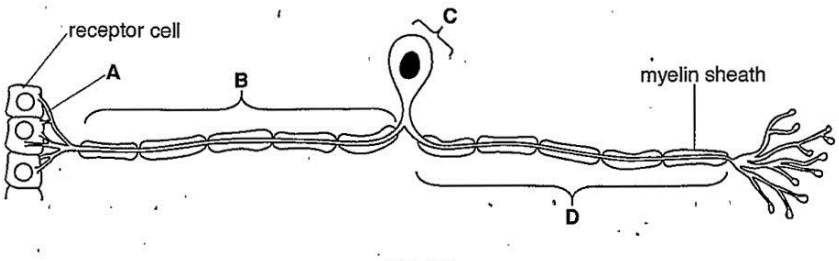
How the candidate could have improved their answer

(a) The candidate used all the right terms but not in the right order. If B and D were reversed, they would have been fully correct.

(c) The candidate wrote knowledgeably and used technical terms correctly but didn't quite fully explain their first point. The word 'only' (used to good effect in the preceding question) was also required here. If they had said '**only** a stimulus that reaches the threshold causes an action potential', they would have covered the situation both below and above the threshold.

Mark awarded = **(a) 3/4**
Mark awarded = **(b) 2/2**
Mark awarded = **(c) 1/2**

Total marks awarded = 6 out of 8

Example candidate response – middle	Examiner comments
8 **(a)** Fig. 8.1 is a diagram of a sensory neurone and some receptor cells.  **Fig. 8.1** Name the parts of the neurone labelled **A, B, C** and **D.** **A** Dendrites **B** axon **C** cell body **D** axon 1 [4] **(b)** Explain how the myelin sheath increases the speed of conduction of nerve impulses. *it makes the impulse travel jumps from node of ranvier to another by saltatory 2 movement. Increasing speed of conduction so time It's impreamble. [2]	1 All four names are correct. Mark for (a) = 4/4 2 Saltatory conduction is described for one mark. Mark for (b) = 1/2

Example candidate response – middle, continued

(c) Fig. 8.2 shows the changes in the membrane potential of a sensory neurone when the receptor cells are stimulated.

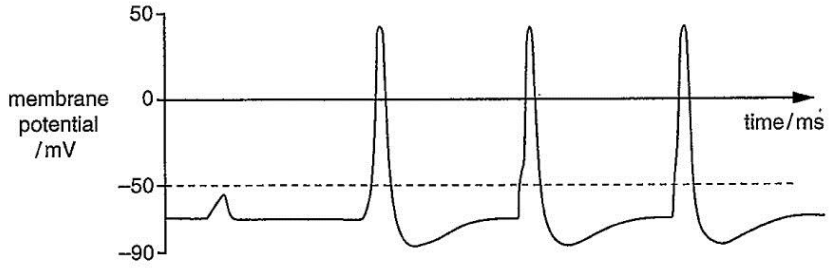


Fig. 8.2

Fig. 8.3 shows the strength of the stimuli applied to these receptor cells.

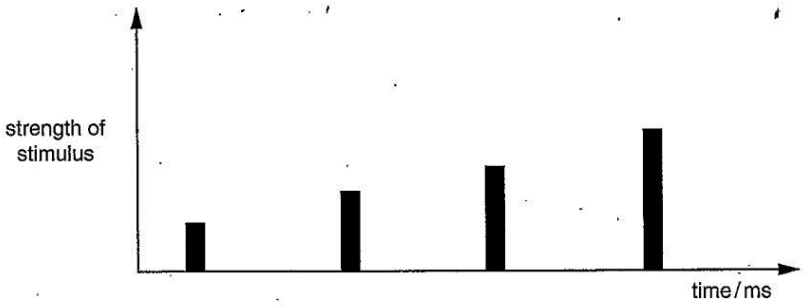


Fig. 8.3

With reference to Fig. 8.2 and Fig. 8.3, describe the relationship between the strength of the stimulus and the resulting action potential.

As more action potential is stimulated, the strengths of stimulus increases. 3 Action potential happens at +30 V, means it passed threshold 4. if more impulses are given each minute increases. [2]

[Total: 8]

Examiner comments

3 The candidate links the variables the wrong way round. As the stimulus causes depolarisation and possibly an action potential, it makes sense to say 'as the strength of the stimulus increases . . .' and then to say what effect this has on action potentials.

4 The idea that there is a threshold (at –50 mV) which must be crossed to generate the full action potential peaking at +30 mV is hinted at but not fully described. The examiner needs to know that below this threshold of depolarisation there is not action potential but above it there is.

Mark for (c) = 0/2

Total marks awarded = 5 out of 8

How the candidate could have improved their answer

(b) The candidate needed to add more detail to their answer.

(c) The candidate needed to read the diagrams from left to right along the *x* axes and to realise that the strength of the stimulus is the independent variable and that the pattern shown in Fig. 8.3 is the dependent variable.

Mark awarded = **(a) 4/4**
Mark awarded = **(b) 1/2**
Mark awarded = **(c) 0/2**

Total marks awarded = 5 out of 8

Example candidate response – low

8 (a) Fig. 8.1 is a diagram of a sensory neurone and some receptor cells.

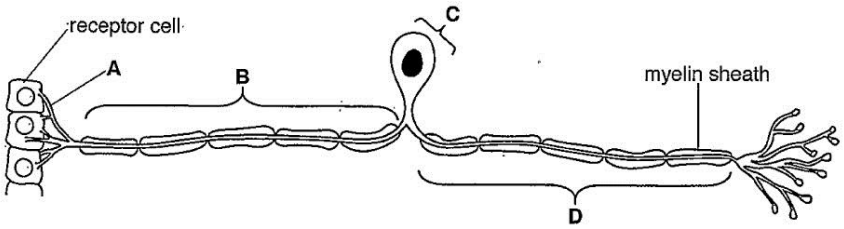


Fig. 8.1

Name the parts of the neurone labelled **A**, **B**, **C** and **D**.

A dendrite 1

B Sensory neurone 2

C cell body 3

D motor neurone [4]

(b) Explain how the myelin sheath increases the speed of conduction of nerve impulses.

action potential occur each at different discrete 4 each at node of ranvier

local circuit occurs at node of ranvier. 5

[2]

Examiner comments

1 This was accepted, despite the spelling mistake.

2 The whole structure in Fig. 8.1 is one neurone so B and D are wrong.

3 C is correctly named.

Mark for (a) = 2/4

4 This is true but the examiner needs to know that the action potentials occur **only** at the nodes of Ranvier and nowhere else along the myelinated sections of the neurone.

5 This looks close to marking point 3 but is wrong because the circuit occurs between two points, two nodes of Ranvier, not at a single one.

Mark for (b) = 0/2

Example candidate response – low, continued	Examiner comments

(c) Fig. 8.2 shows the changes in the membrane potential of a sensory neurone when the receptor cells are stimulated.

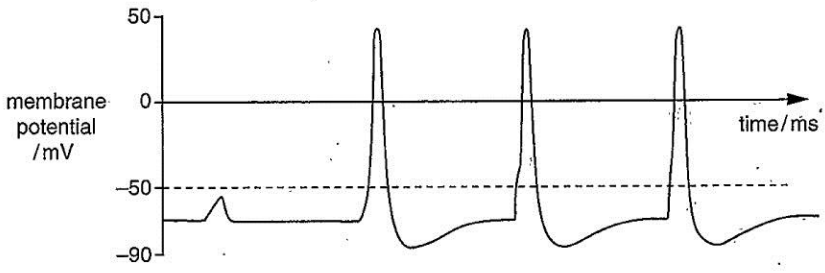


Fig. 8.2

Fig. 8.3 shows the strength of the stimuli applied to these receptor cells.

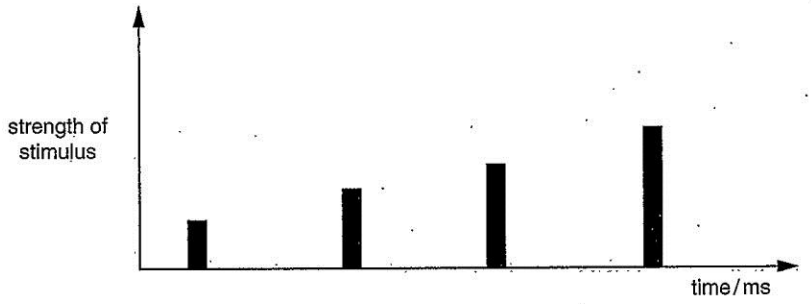


Fig. 8.3

With reference to Fig. 8.2 and Fig. 8.3, describe the relationship between the strength of the stimulus and the resulting action potential.

As the strength of stimulus increase the action potential increase, 6 the first stimulus, potential difference didn't reach threshold so depolarisation occured 7 at higher strength of stimulus, the potential difference reaches threshold, action potential occurs [2]

[Total: 8]

6 This contradicts what the diagrams show.

7 The information that a small depolarisation occurs but that this does not generate a full action potential is missing here.

Mark for (c) = 0/2

Total marks awarded = 2 out of 8

How the candidate could have improved their answer

(a) The candidate should have noticed the question wording which stated that the names of 'parts of the neurone' were needed, not the names of whole neurones, as given in the answers to B and D.

(b) The ideas should have been worded more carefully and with more supporting detail.

(c) The answers should have been more thorough and detailed, with more care taken to express the ideas clearly.

Mark awarded = **(a) 2/4**
Mark awarded = **(b) 0/2**
Mark awarded = **(c) 0/2**

Total marks awarded = 2 out of 8

Common mistakes candidates made in this question

(b) Most candidates knew and used the term ‘saltatory conduction’, but few could describe what is meant by a local circuit in a myelinated neurone.

(c) Many candidates used the terms ‘depolarisation’ and ‘action potential’ interchangeably. They did not realise that the term ‘action potential’ is reserved for a very specific all-or-nothing depolarisation which has the characteristics shown in the last three peaks on Fig. 8.2. The small peak associated with the first stimulus is not an action potential but is a small depolarisation of the membrane that does not reach the threshold value and so does not trigger an action potential.

Question 9

Example candidate response – high

9 (a) Outline how ATP is synthesised by oxidative phosphorylation. [8]

(b) Describe respiration in yeast cells in anaerobic conditions. [7]

[Total: 15]

9 a) In oxidative phosphorylation, ATP is synthesised by a process known as chemiosmosis. Oxidative phosphorylation occurs in the mitochondrial cristae. Reduced NAD and FAD from glycolysis and Krebs cycle pass their hydrogen to the first protein in a series of electron transport chain in inner mitochondrial membrane. NAD reduced NAD and FAD become free to bind to hydrogen again. Hydrogen is split into a proton and an electron. The electron is passed along a series of electron transport chain from high energy level to lower energy level down an energy gradient releasing energy. Energy released by the electron is used to actively pump protons into the intermembrane space creating a concentration gradient across the inner membrane. Protons then diffuse into the matrix of mitochondria down their concentration gradient by facilitated diffusion through a channel protein. These channel proteins have the enzyme ATP synthase attached to them that uses the chemical potential energy of proton passing through it to synthesize ATP, by converting ADP and Pi to ATP.

Examiner comments

1. Stating the location gets marking point 3.
2. Naming the starting molecule of the process earns a mark.
3. The release of hydrogen scores a mark.
4. This step is marking point 5 of the process.
5. The candidate omits to say ‘carriers’ or ‘proteins’ here.
6. Marking point 7 is scored here.
7. Marking point 8 is described here.
8. This statement matches marking point 9.
9. This reference gets marking point 10.
10. This reference gets marking point 11.

Example candidate response – high, continued

Hydrogen electrons and protons then bind to oxygen (11) which acts as final electron acceptor, reducing it to water. (12)

b) During anaerobic respiration in yeast cells, only glycolysis (13) takes place in the cytoplasm. Glucose is phosphorylated using 2 ATP molecules to produce fructose bisphosphate, which then breaks down into 2 triose phosphate molecules. Triose Phosphate is then dehydrogenated producing 2 reduced NAD molecules, (14) also 4 ATP molecules are produced by substrate level phosphorylation. Triose phosphate is converted to pyruvate, (15) a 3-carbon compound. Pyruvate is then decarboxylated (16) to produce ethanal (17) and a carbon dioxide molecule. ethanal accepts hydrogen (18) from ~~(NAD)~~ reduced NAD (19) converting it to ethanol. (20) NAD is now free to bind to hydrogen again (21) so that glycolysis can ~~(continue)~~ continue. (22) Ethanal is converted to ethanol by an enzyme called ethanol dehydrogenase. (23) Net 2 ATP molecules are made. Link reaction, Krebs cycle and oxidative phosphorylation doesn't take place.

Examiner comments

(11) Marking point 12.

(12) The answer ends by making marking point 13.

Mark for (a) = 8/8

(13) The word 'glycolysis' is noted by the examiner since it will be important for awarding later marks.

(14) Marking point 2 is scored since the context of glycolysis has been established.

(15) The description of glycolysis is unnecessarily lengthy but marking point 1 is now scored.

(16) Marking point 3 is described.

(17) Marking point 4 is awarded. The handwriting is easy to read and the examiner can see that the answer reads 'ethanal' (not 'ethanol').

(18) This is marking point 6.

(19) This is marking point 7.

(20) The product 'ethanol' is named, marking point 8.

(21) The candidate describes the idea of marking point 11.

(22) Marking point 12.

(23) This extra detail scores marking point 9.

Mark for (b) = 7/7

Total marks awarded = 15 out of 15

How the candidate could have improved their answer

(a) This answer was detailed and ideas were presented in a logical sequence. The response was very much a textbook answer, although marking point 6 was missed due to leaving out the idea of carrier proteins.

(b) The answer exceeded the maximum number of marks and was appropriately detailed and sequenced, although marking points 5 and 10 were not scored.

Mark awarded = **(a) 8/8**
Mark awarded = **(b) 7/7**

Total marks awarded = 15 out of 15

Example candidate response – middle

9 (a) Outline how ATP is synthesised by oxidative phosphorylation. [8]

(b) Describe respiration in yeast cells in anaerobic conditions. [7]

[Total: 15]

9

(a) Hydrogens from red NAD & FAD are split into protons (H^+) and electrons (e^-). 1

Electrons are then transported to the ~~etc~~ e^- transport chain, releasing energy. H^+ are pumped from the mitochandrial matrix into the intermembrane space, using the energy released from the e^- Transport chain. H^+ are then pumped back to the matrix down a concentration gradient, releasing energy. The energy released from the proton pump is used by the enzyme ATP synthase to ~~phosphorylate~~ Phosphorylate ADP → ATP, by a process known as Chemiosmosis.

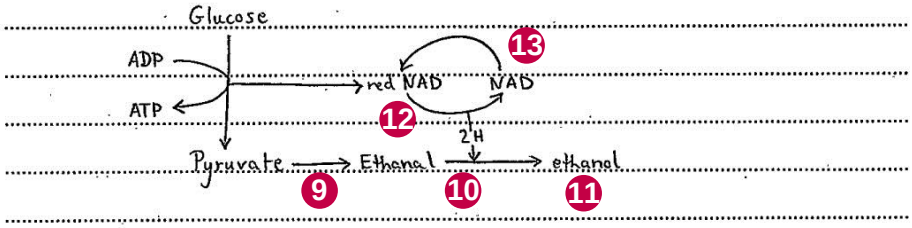
Oxygen is the final electron acceptor and combines with H^+ and e^- to make water. This is the last stage of aerobic respiration.

~~b~~ Anaerobic

Examiner comments

1. The introductory sentence scores marking points 4, 1 and 5.
2. Reduced NAD is transported to the electron transport chain, and the electrons are released there, so this sentence is not correct.
3. The candidate describes the events of marking point 7.
4. 'Pumped' is an error. The hydrogen ions 'diffuse'.
5. Reference to 'ATP synthase' scores marking point 10.
6. 'Inorganic phosphate' is missing so the answer does not get marking point 11.
7. This is marking point 12.
8. This is marking point 13.

Mark for (a) = 7/8

Example candidate response – middle, continued	Examiner comments
(b) Anaerobic respiration – (Yeast cells).  	9 The production of pyruvate does not score marking point 1 since glycolysis is not named. However, the conversion of pyruvate to ethanal gets marking point 4. 10 The acceptance of hydrogen by ethanal gets marking point 6. 11 The conversion of ethanal to ethanol gets marking point 8. 12 The origin of the hydrogen from reduced NAD gets marking point 7. 13 Regeneration of NAD gets marking point 11. Mark for (b) = 5/7 **Total marks awarded = 12 out of 15**

How the candidate could have improved their answer

(a) This answer achieved 7 out of 8 marks but also included several mistakes and omissions along the way. The candidate could have reread and checked their answer and altered their choice of some key words.

(b) Presenting the answer as a series of reactions in diagrammatic form was appropriate but conveyed only key points, and omitted some details. The candidate could have added the name 'glycolysis' and the names of enzymes catalysing the steps shown, or, if time allowed, could have briefly described the diagram in words, as a description might have yielded some extra information such as the irreversibility of the reaction or the term 'decarboxylation'.

Mark awarded = **(a) 7/8**
Mark awarded = **(b) 5/7**

Total marks awarded = 12 out of 15

Example candidate response – low

9 (a) Outline how ATP is synthesised by oxidative phosphorylation. [8]

(b) Describe respiration in yeast cells in anaerobic conditions. [7]

[Total: 15]

(9)(a) ~~NADPH~~ NADH looses its H^+ ions as it reaches the cristae. by ~~photolysis~~ using energy from ATP that was produced earlier from glycolysis, and ~~Kerbs~~ Krebs cycle, energy pumps H^+ ions against their concentration gradient from high to low into the intermembrane space of the mitochondria. As the concentration of H^+ ions increases, then they diffuse down their concentration gradient through ATP synthase that is placed in membrane of cristae. For each $3H^+$ passing through it, one ATP molecule is produced. also ~~water breaks down to~~

Examiner comments

1. The answer begins appropriately and scores marking point 1.
2. This is an oversimplification and does not score marking point 4.
3. The correct location earns marking point 3.
4. The candidate makes an error here.
5. Marking point 7 is awarded despite the error as the candidate has already lost marking point 6 due to their misunderstanding.
6. Marking point 8 is missed but marking point 9 is earned here.
7. This reference gets marking point 10.

Mark for (a) = 5/8

Example candidate response – low, continued	Examiner comments
(b) Because of ~~oxygen~~ lack of oxygen during respiration, the yeast cells will respire anaerobically. ~~The pyruvate that~~ 2 GP compounds are converted by into 2 pyruvate [8] compounds that act as final hydrogen acceptor instead of oxygen from NADH that was reduced during glycolysis. [9] by hydrogenation, ~~pyruvate is~~ ~~for~~ is converted into [10] lactate with help of enzyme called Lactase. lactate is then stored in the cell, till oxygen debt is repaid to break down lactate.	[8] Glycolysis has not been mentioned so no marking point 1. [9] The candidate belatedly mentions glycolysis and scores marking point 2. There is no mark awarded for hydrogen coming from NADH as it is not true that they are accepted by pyruvate. Therefore, no marking point 7 as the context is wrong. [10] Lactate fermentation does not occur in yeast cells. Mark for (b) = 1/7 **Total marks awarded = 6 out of 15**

How the candidate could have improved their answer

(a) Better punctuation (capital letters and full stops, or bullet points) might have helped the candidate to organise their jumbled thoughts into separate sequential stages and made their meaning clearer.

(b) The candidate could have tried to put their ideas into a logical order on rough paper before starting to write.

Mark awarded = **(a) 5/8**
Mark awarded = **(b) 1/7**

Total marks awarded = 6 out of 15

Common mistakes candidates made in this question

(a) As this question required a descriptive recall answer, it was generally done well. Candidates with stronger sequencing skills who used technical terms with precision did best. The main mistakes were omissions of stages and confusion between hydrogen atoms and hydrogen ions and when each is important.

(b) Again, the answers were mostly good. The most common mistake was to write about the lactate pathway instead of the *ethanol* pathway.

Question 10

Example candidate response – high	Examiner comments

(10) (a) Describe the behaviour of chromosomes during meiosis. [9]

(b) Outline the differences between structural and regulatory genes. [6]

[Total: 15]

Meiosis is divided into meiosis I and Meiosis II. reduction in number of chromosomes occur during meiosis I while meiosis II led to like mitosis. This lead to formation of 4 daughter gametes having half number of chromosomes. In prophase I, chromosomes began to condense, nuclear envelope and nucleolus degenerate. During Metaphase I, chromosomes that consist of double chromatids are lined at equator and joined to one spindle fibres. half number of chromosomes goes to other side and half also goes to opposite site leading to two groups of haploid number and all of them composed of double chromatids. During telophase I, some plant cells do not undergo telophase I, where nucleolus and nuclear envelope degenerate. Meiosis II began by

1 Although these unlabelled diagrams do not help to describe the behaviour of chromosomes, they may help the candidate plan their essay.

2 This earns marking point 13.

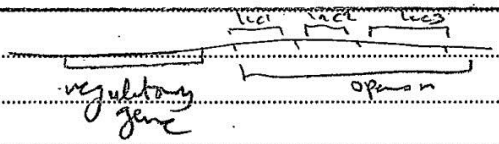
3 Scores marking point 1.

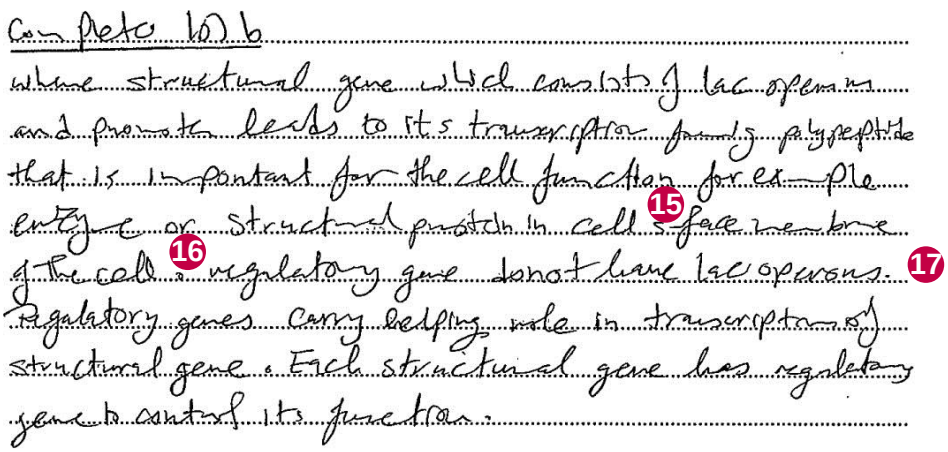
4 Scores marking point 3.

5 This statement is misleading. The chromosomes do consist of pairs of chromatids, but in meiosis 1 the pairing of the homologous chromosomes into bivalents is what it is important to describe.

6 There is no mention of centromeres here for marking point 5.

7 This gets marking point 8.

Example candidate response – high, continued	Examiner comments
Complete question 10.) a) prophase II, where chromosomes are seen as double chromatids with no shape. During Metaphase II, chromosomes is attached to spindle fibres, 8 and split into two sister chromosomes during Anaphase II, which each have single chromatid. 9 Telophase II, chromosomes decondense once more, cross over which is a cause of variation occurs at prophase I, 10 where chromosome are lined in bivalents 11 forming chiasmata 12 and crossing over of genes takes place leading to new allelic combination and other cause of variation is random assortment of chromosomes during Metaphase I and Metaphase II 10) b)  Regulatory gene and structural gene both codes for polypeptide chains that are responsible for specific function. Structural gene has an operator that lead to binding of RNA polymerase to start transcription. Regulatory gene sometimes codes for protein that bind to such promoter 13 to control its transcription rate. 14 Regulatory gene carry transcription to code for protein that is not carrying physical process for the cell, but it help in regulating the transcription rate for structural gene	8 Again, there is no mention of centromeres. 9 The wording is a little confusing but there is enough here to earn marking point 12. 10 This mark (MP 3) has already been given. 11 Marking point 2 can be seen here. 12 This is marking point 4. Mark for (a) = 7/9 13 Marking point 6 is given here. 14 Marking point 4 is given here.

Example candidate response – high, continued	Examiner comments
	15 Marking point 3 is awarded here. 16 Marking point 1 is awarded here. 17 Confusion over the identity of the structural and regulatory components of the lac operon means marking point 10 is not given. Mark for (b) = 4/6 **Total marks awarded = 11 out of 15**

How the candidate could have improved their answer

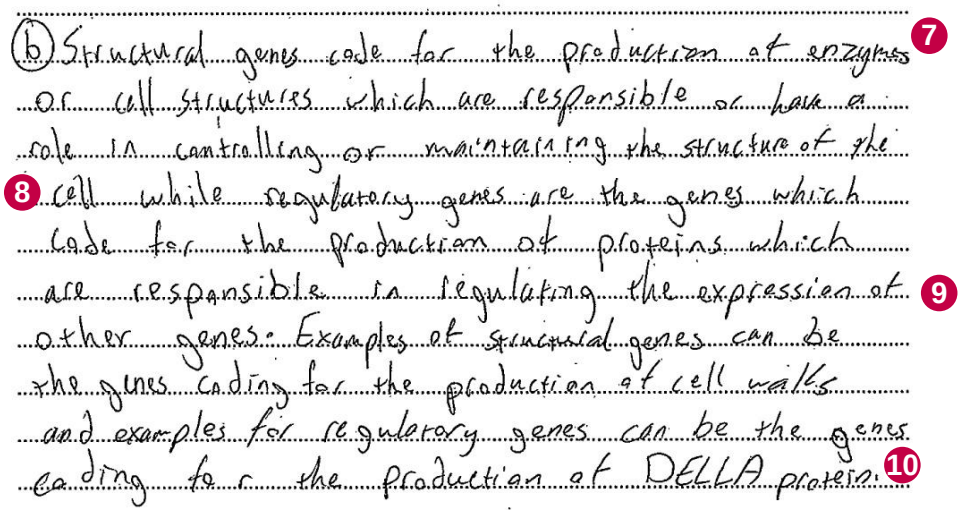
(a) The candidate could have used technical terms more precisely (e.g. centromere, chromatid, chromosome, etc.) and should have structured the essay as a clear sequence of steps.

(b) The answer repeated itself and the description of the contribution of the lac operon to understanding the difference between structural and regulatory genes was not correct. The candidate could have achieved extra marks by giving named examples of structural and regulatory genes.

Mark awarded = **(a) 7/9**
Mark awarded = **(b) 4/6**

Total marks awarded = 11 out of 15

Example candidate response – middle	Examiner comments
10 (a) Describe the behaviour of chromosomes during meiosis. [9] **(b)** Outline the differences between structural and regulatory genes. [6] [Total: 15]	
10 (a) During meiosis I, chromosomes are arranged at the equator of the cell. Homologous chromosomes are pulled to opposite poles (1) without the separation of their centromeres. This results in 2 daughter cells each with one set of chromosomes, 2 haploid (2) cells. In meiosis 2, chromosomes are again arranged at the equator (3) of the cell and ~~sister~~ centromeres are ~~pulled apart~~ separated (4) and sister chromatids are pulled apart to opposite poles (5). Each daughter cell divides into 2 others. This results in the formation of four daughter cells which are all genetically unidentical to each other. Each of the 4 daughter cells is haploid. (6)	(1) This scores marking point 8. (2) This scores marking point 13. (3) Marking point 9 is given for this. (4) Marking point 11 is given for this. (5) Marking point 12 is given for this. (6) This mark (MP 13) has already been given. Mark for (a) = 5/9

Example candidate response – middle, continued	Examiner comments
 (b) Structural genes code for the production of enzymes or cell structures which are responsible or have a role in controlling or maintaining the structure of the cell while regulatory genes are the genes which code for the production of proteins which are responsible in regulating the expression of other genes. Examples of structural genes can be the genes coding for the production of cell walls and examples for regulatory genes can be the genes coding for the production of DELLA protein.	7 This earns marking point 1. 8 This earns marking point 3. 9 This matches marking point 4. 10 Marking point 10 is awarded for this. Mark for (b) = 4/6 **Total marks awarded = 9 out of 15**

How the candidate could have improved their answer

(a) The candidate could have earned several extra marks by giving details of the behaviour of chromosomes in prophase 1, when crossing-over occurs.

(b) The overview of the difference between the two types of genes was good but more marks could have been obtained for naming a structural gene and for explaining the sequence of events by which the product of a regulatory gene controls transcription.

Mark awarded = **(a) 5/9**
Mark awarded = **(b) 4/6**

Total marks awarded = 9 out of 15

Example candidate response – low

10 (a) Describe the behaviour of chromosomes during meiosis. [9]

(b) Outline the differences between structural and regulatory genes. [6]

[Total: 15]

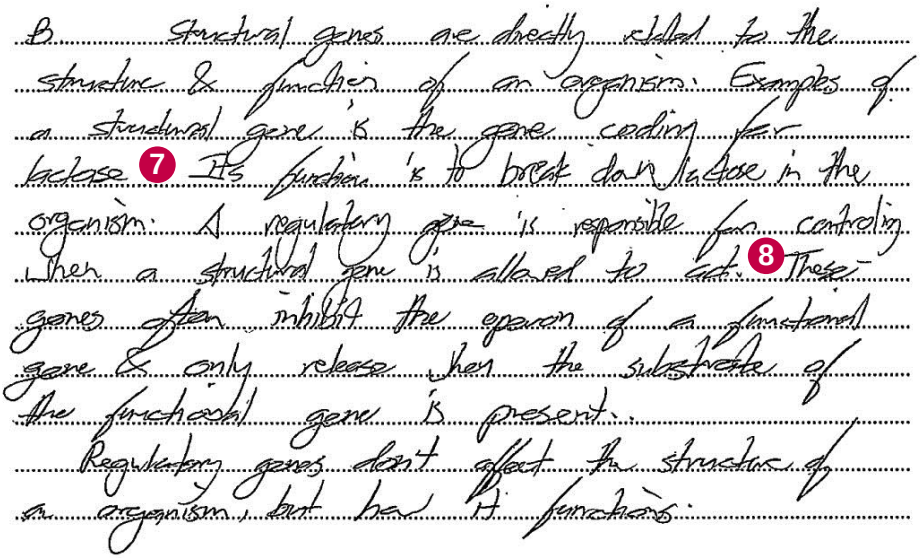
a. During ~~meiosis~~ prophase I of meiosis chromosomes match up together in their homologous pairs (1). During this phase crossing over can occur (2) & parts of chromatids of adjacent chromosomes are switched. In the metaphase I the chromosomes line up along the equator of the cell (3) & ~~are~~ each complementary ~~two~~ chromosome in a homologous pair ~~get~~ to opposing ~~sides~~ poles of the dividing cells (4). In anaphase I. Then, the cell divides.

In ~~prophase~~ metaphase 2, chromosomes line up (5) along the equator of a cell, & are pulled apart (6) along the centromere of each chromosome. In anaphase II. Then, Telophase, the nucleus reforms & chromatids ~~are~~. Each gamete now has a full set of chromatids

Examiner comments

1. Marking point 2 is earned here.
2. Marking point 3 is given for this.
3. The candidate omits to say that it is bivalents that line up.
4. Marking point 8 is awarded for this.
5. Marking point 9 is given for this.
6. This wording is not clear enough to score marking point 11.

Mark for (a) = 4/9

Example candidate response – low, continued	Examiner comments
	7 A named example of an enzyme earns marking point 1 here. A second named example could have earned marking point 2. 8 The candidate has the right idea but controlling when a gene 'is allowed to act' is not precise enough for marking point 4. Mark for (b) = 1/6 **Total marks awarded = 5 out of 15**

How the candidate could have improved their answer

(a) This answer lacked detail. While the names of the individual stages of meiosis were not required, using them might have helped this candidate to write more precisely about the changes in behaviour of the chromosomes across the eight stages.

(b) The second part of the answer showed that the candidate had an understanding of what was being asked, but they needed to use terms more precisely to be awarded marks. For instance, 'These (regulatory) genes often inhibit the operon of a functional gene' should have been corrected to 'These (regulatory) genes code for *DNA-binding proteins that stop the normal function of the promoter* of a structural gene'.

Mark awarded = **(a) 4/9**
Mark awarded = **(b) 1/6**

Total marks awarded = 5 out of 15

Common mistakes candidates made in this question

(a) Many candidates did not understand the difference between meiosis 1 and meiosis 2. Errors in choosing which of the terms *chromosome* and *chromatid* to use in different circumstances were common. Descriptions often lacked detail and use of the right technical terms.

(b) Some candidates had poor knowledge of the difference between the two types of genes, and few made use of the terms *inducible* and *repressible,* which are mentioned in the syllabus, or of the mechanism of control of gene expression by the plant growth hormone gibberellin.

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