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Examiners' report

BIOLOGY B (ADVANCING BIOLOGY)

H422

For first teaching in 2015

H422/02 Summer 2024 series

Version 1

Contents

Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates.

The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. A selection of candidate answers is also provided. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report.

A full copy of the question paper and the mark scheme can be downloaded from OCR.

Paper 2 series overview

H422/02 is one of three components of the GCE A Level Biology B specification assessed during this examination session. For H422/02 candidates needed to demonstrate knowledge and scientific literacy skills across all modules (1 to 5). There is an Advance Notice Article (ANA) for candidates to study and use in responding to items in Question 1. Two Level of Response (LoR) questions are included in the 100 marks.

There are no changes to the format or demand of the question paper and mathematical and practical skills continue to be embedded within the questions throughout. Certain aspects of the exam paper continue to be challenging, although some questions were accessible to candidates across the ability range. There was no evidence to suggest that candidates were under any time constraints towards the end of the paper.

Overall, candidates demonstrated a wide range of ability with more successful candidates giving succinct responses and appearing more adept at coping with the demands of the paper's mathematical and practical content to gain higher level marking points. There is evidence that candidates are making good use of the ANA and show confidence in tackling Level of Response questions. Credit is given for responses that show use of the ANA and associated diagrams in Question 1. Most candidates were able to demonstrate their ability to learn and recall facts.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• used information in the ANA to apply knowledge and formulate good responses to Question 1 • could apply knowledge to the new contexts in the question paper • demonstrated the ability to use mathematical skills in complex calculations • evaluated conclusions effectively to give balanced arguments • offered detailed responses to LoR questions in Questions 2 (e)* and 6 (b)*.	• used knowledge to recall facts and attempt definitions • could complete some stages of a calculation and make estimates • could formulate a response to short-answer questions • performed less well when asked to analyse or evaluate.

Question 1 (a) (i)

1 This question is based on the Advance Notice Article **'The Eye'**.

(a) A person's genotype determines their eye colour phenotype.

(i) Define the term **genotype**.

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..... **[1]**

Generally well-answered. The term 'allele' was required to gain credit for this definition.

Question 1 (a) (ii)

(ii) Define the term **phenotype**.

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..... **[2]**

Many candidates achieved 1 mark for describing 'expression of the genotype' and alternative wording, such as 'observable characteristics' was credited. However, the full definition required mention of 'interacting with the environment' which was often omitted.

Assessment for learning

Definitions and meanings of scientific terms are an important part of the specification and candidates should be encouraged to learn these in full.

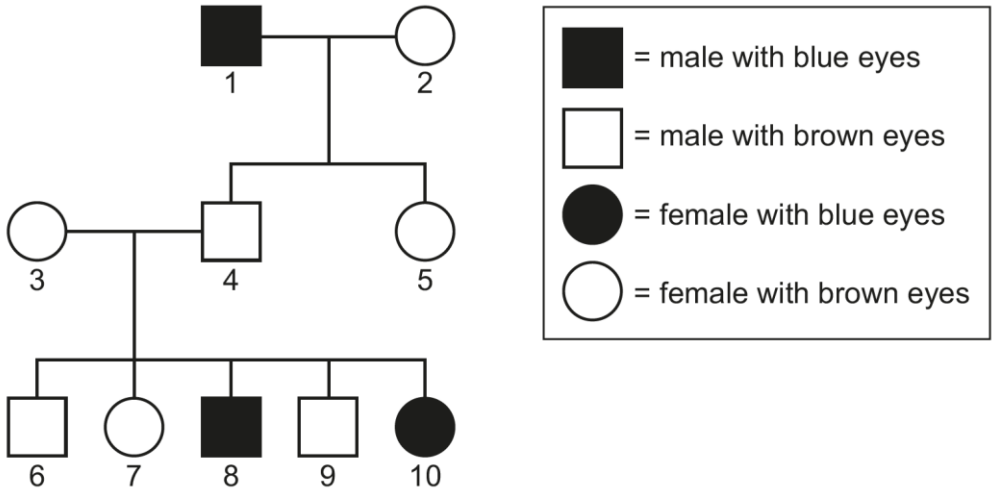
Question 1 (b) (i)

(b) **Fig. 1.1** shows the inheritance of eye colour in one family.

Squares represent males and circles represent females.

Filled shapes represent individuals with blue eyes and unfilled shapes represent individuals with brown eyes.

Fig. 1.1



(i) Explain **one** piece of evidence from **Fig. 1.1** that indicates the allele for blue eyes is recessive.

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..... **[2]**

Candidates who could interpret the diagram performed well on this question by looking for evidence of a recessive trait and then explaining this. The most common evidence used was the observation that parents 3 and 4, who did not have the characteristic (brown eyes), had offspring (8 and 10) who did have blue eyes. Good responses then provided the explanation that 3 and 4 were, therefore, heterozygous.

Question 1 (b) (ii)

(ii) Explain **one** piece of evidence from **Fig. 1.1** that indicates the allele for blue eyes is located on an autosome and not the X chromosome.

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..... **[2]**

Candidates found this question challenging. Good responses linked the principles of sex linkage to Fig.1.1, noting that 10 has blue eyes but 4 does not (if the gene was X-linked, a dominant brown allele would have been inherited) to gain 1 mark. The second mark was rarely credited for continuing the explanation.

Question 1 (b) (iii)

(iii) The chi squared (χ^2) test is used to determine whether the results of genetic crosses are statistically significant.

Explain why the χ^2 test is appropriate for use in genetic crosses.

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..... **[2]**

Generally well-answered by most candidates across the ability range who could identify that the chi-squared test compares observed and expected values (for 2 marks). Where the observed marking point could not be awarded, candidates had written 'observed genotypes'.

Question 1 (b) (iv)

(iv) Suggest why the χ^2 test would **not** be appropriate for analysing the data in **Fig. 1.1**.

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..... **[1]**

Many candidates knew that if genotypes are unknown a chi- squared could not be used. Some candidates also gained credit for recognising that the sample size in Fig.1.1 would be too small.

Question 1 (c) (i)

(c) A couple with blue eyes had a child with brown eyes.

A friend suggested that a mutation must have caused the child to have brown eyes.

(i) Use the information in the Advance Notice Article to explain why this conclusion is not supported.

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..... **[2]**

Some candidates used information in the ANA noting that eye colour was controlled by multiple genes, or that there would be 'higher levels of P protein' and 'higher levels of melanin produced'. A common error was where candidates formulated a response explaining the reasons for blue eye colour, possibly misreading the question.

Question 1 (c) (ii)

(ii) Suggest an explanation for the child's brown eyes that is supported by the information in the Advance Notice Article.

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..... **[2]**

Candidates providing good responses correctly identified that *OCA2* must be expressed, producing P protein. Research around the ANA was often seen in responses to this question that were worthy of credit e.g. the concept of 'maturation of pigment granules'.

Assessment for learning

As stated in previous reports, candidates should be encouraged to research the topics included in the Advanced Notice Article (ANA) thoroughly in preparation for the examination.

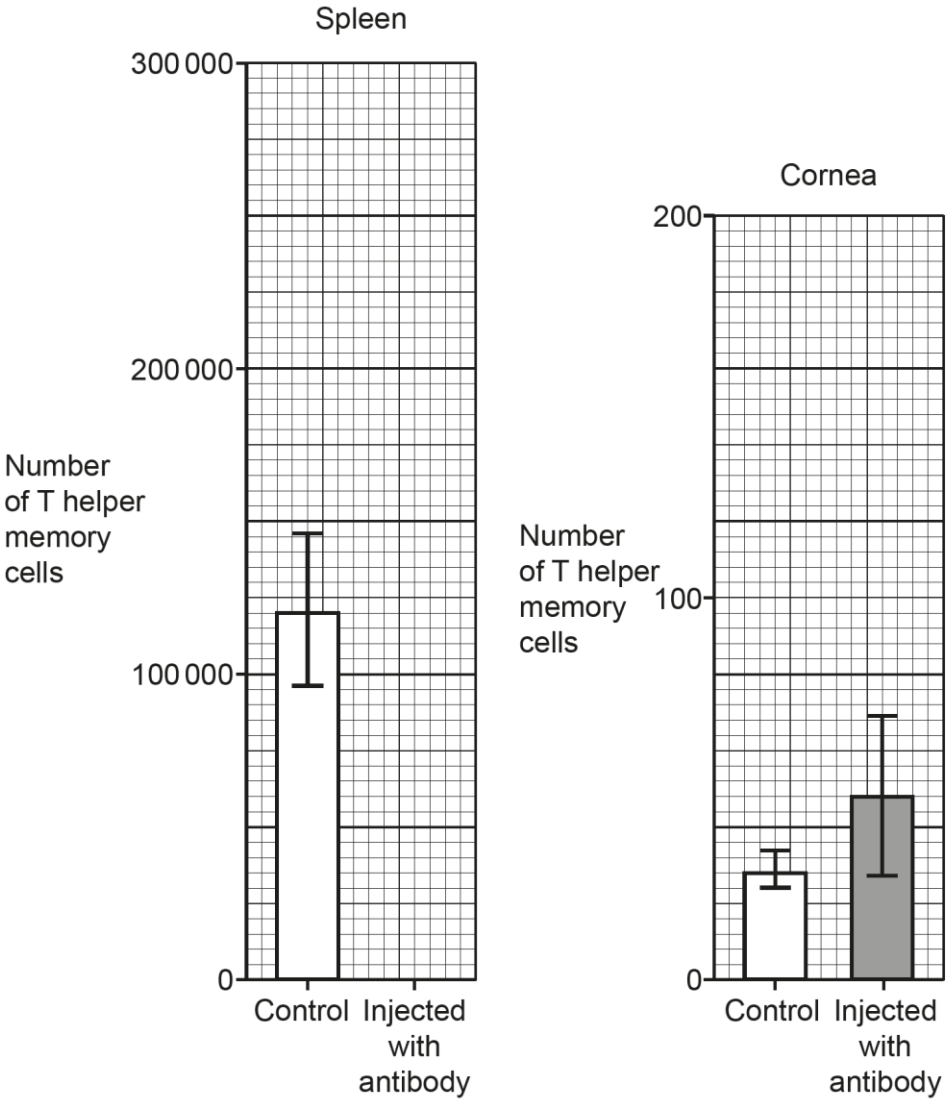
Question 1 (d) (i)

(d) The Advance Notice Article refers to a study that investigated T lymphocyte responses in the cornea of mice after herpes simplex virus (HSV) infection. The researchers performed two experiments on groups of mice four weeks after the initial HSV infection.

In the first experiment, the researchers injected a group of mice with an antibody that caused the removal of circulating T lymphocytes from the blood.

They then measured the number of T helper memory cells in the spleen and cornea of a control group and in the mice injected with antibody. The results are shown in **Fig. 1.2**.

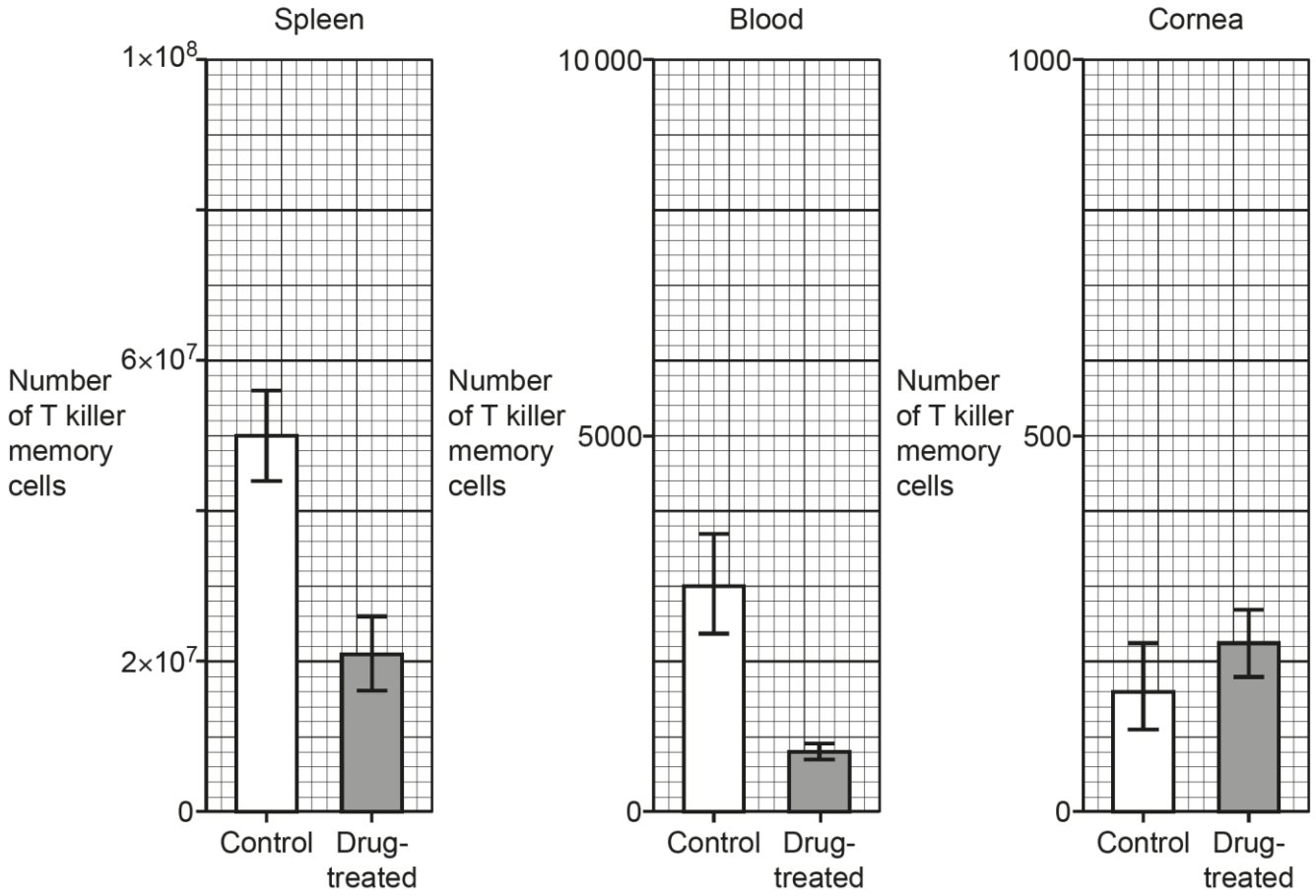
Fig. 1.2



In the second experiment, the researchers treated another group of mice with a drug that is known to reduce the number of T killer memory cells in the spleen and blood.

They then measured the number of T killer memory cells in the spleen, blood and cornea of a control group and the drug-treated mice. The results are shown in **Fig. 1.3**.

Fig. 1.3



(i) State what treatment the mice in the control group would have received in both experiments.

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..... **[1]**

This question required an understanding of controlled drug trials. Saline was the most seen correct response.

Misconception

Common misconceptions focused on injection of the pathogen (HSV) as a treatment for the control group or the administration of a placebo. A placebo is a substance or treatment which is designed to have no therapeutic value. It was ignored in responses so candidates could still gain credit for a correct response alongside this term.

Question 1 (d) (ii)

(ii) Calculate how many times more T killer memory cells were present in the spleen of control mice compared with the cornea of control mice.

Give your answer in standard form.

..... times more **[2]**

Generally, well-answered. Good responses achieved 2 marks for a correct calculation written in standard form.

Calculation:

Readings from graph:

spleen = 5.0×10^7, cornea = 160

$5.0 \times 10^7 \div 160 = 3.1(25) \times 10^5$ (times more)

OCR support

Calculations involving standard form is a mathematical skill included in this specification.

Maths skills handbook can be found to support candidates preparing for assessment.

Extra support on maths skills can be found in 'Maths for Biology' resources which can be accessed on Teach Cambridge. Reporting answers using standard form tutorial and quiz.

Question 1 (d) (iii)

(iii) The researchers concluded that the corneas of mice four weeks after infection with HSV contained tissue-resident T helper memory cells and tissue-resident T killer memory cells.

Explain how the data in **Fig. 1.2** and **Fig. 1.3** support this conclusion.

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..... **[3]**

Candidates often correctly identified an increase in (the correct) memory cell in response to (the correct) treatment. Good responses identified that as the antibody treatment removed all helper memory cells from the spleen, presence of these cells in the cornea after treatment suggests that they must not have come from the circulation.

Question 2 (a)

2 Regulation of the menstrual cycle involves interaction between several hormones.

(a) Complete the sentences using the most appropriate words or phrases.

FSH is secreted by the ..... and transported in the blood to the ovary, where it stimulates follicle development. The mature follicle releases oestrogen that stimulates a surge in secretion of ..... , which causes ..... and development of the follicle into the ..... .

[4]

Generally well-answered by many candidates.

Question 2 (b)

(b) During each cycle, FSH stimulates the development of multiple follicles.

One of these, known as the dominant follicle, grows faster than the others and produces more oestrogen.

Suggest how oestrogen produced by the dominant follicle leads to a reduction in the development of the other follicles.

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..... **[1]**

This question was generally well-answered, and most candidates knew that oestrogen inhibited FSH. Good responses clearly stated that it inhibits '***release'*** of FSH which was the desired response.

Question 2 (c)

(c) Oestrogen also thickens the lining of the uterus in preparation for implantation of the blastocyst after fertilisation by a sperm cell.

Describe **two** functions of the acrosome in fertilisation.

1 .....

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2 .....

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[2]

Most candidates were able to describe that the acrosome contained hydrolytic enzymes for digesting the zona pellucida. Few candidates gained a second mark, and common errors included references to streamlining, genetics and hardening of the secondary oocyte.

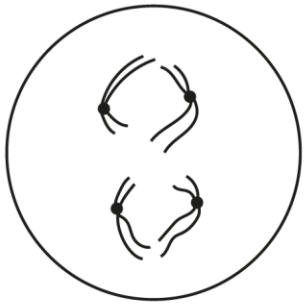
Misconception

It was a common misconception that the acrosome binds to the cell surface membrane to be able to break it down for entry to the oocyte.

Question 2 (d)

(d) The diagrams show three stages of meiosis in a model cell with two pairs of chromosomes.

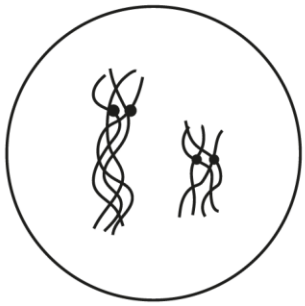
Identify the stage of meiosis shown in each diagram. For each diagram, explain the evidence that indicates which stage is shown.



Stage .....

Explanation .....

.....



Stage .....

Explanation .....

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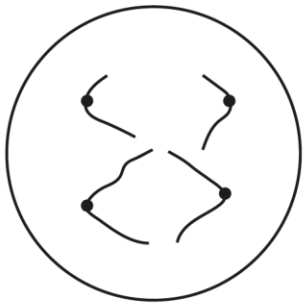

Stage .....

Explanation .....

.....

[6]

Two stages of meiosis were identified correctly by most candidates. The most common misconception was to identify the first diagram as metaphase I, despite chromosomes resembling the 'v' shape characteristic of anaphase.

Question 2 (e)*

(e)* Explain the importance of meiosis and fertilisation in increasing genetic variation.

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..... **[6]**

Knowledge of meiosis was applied well in this Level of Response question. Explanations of the importance of fertilisation were often limited to 'fusion of haploid gametes' and 'random fertilisation'. Common reasons why the quality of written communication mark could not be supported were misidentification of stages (e.g. crossover of chromosomes in metaphase 1, when it should be prophase 1); use of the term 'egg' rather than secondary oocyte; and the misconception that sperm are ejaculated in thousands rather than millions.

Exemplar 1

- chromosomes cross over during prophase I to create bivalents,
- allow chromosomes to exchange genetic info to create new variants of DNA between gametes, some genes are separated, not inherited together
- independent assortment of chromosomes + chromatids in metaphase I and II create variation as chromosomes are pulled apart in different ways, resulting in different combinations of genes within gametes
- gametes are haploid, containing half of genetic info from the mother and half from the father - genetically varied offspring are produced when → diploid with new combination of genes + alleles
- fertilisation is random, with random mating and millions of sperm that could fertilise an ovum
- creates genetically varied offspring (2 in divisions, 4 genetically different daughter cells produced) to create variation within a population
- population more resistant to disease / prey / other survival pressures as mutations and differences may provide some selection / survival pressures as mutations and differences may provide some [6]

Extra answer space if required.

individuals protection - ensures longevity of species

The exemplar shows a good L3 response with explanations for the importance of both meiosis and fertilisation in increasing genetic variation. The candidates loses the communication mark for stating that there would be different combinations of 'genes,' rather than using the correct term 'alleles'.

Question 3 (a)

3

(a) Water has some unique properties that make it particularly important as a biological molecule.

The table lists some properties of water.

Complete the table to describe how each of the properties is important in biological systems.

Property of water	Description of how the property is important in biological systems
Is a polar solvent	
Has a high specific heat capacity	
Has a high latent heat of vaporisation	
Has adhesive and cohesive properties	

[4]

Many candidates achieved 3 marks on this question for describing the importance of the first three properties, i.e. transport of solutes, maintaining a stable internal environment, and the cooling effect of sweating. The fourth property proved more challenging, and only high achieving candidates suggested the idea of it acting as a lubricant. Many candidates attempted to describe the movement of water in xylem but didn't include the idea of maintaining the column of water to gain credit.

Question 3 (b) (i)

(b) The table shows the total concentration of solutes and electrolytes in different biological fluids.

Fluid	**Concentration (mmol dm^{-3})**
Blood plasma	175
Tissue fluid	165
Cytosol	205

(i) Explain why the different fluids have different total concentrations of solutes and electrolytes.

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..... **[3]**

This question proved challenging. Good responses included interpretation of the data in the table and demonstrated a secure understanding of cytosol. Some candidates were able to suggest comparisons between plasma and tissue fluid, but other candidates did not include a full explanation to gain credit.

Question 3 (b) (ii)

(ii) Based on the values in the table, state **and** explain the direction you would expect water to move between the tissue fluid and cytosol.

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..... **[1]**

To achieve the mark in this question, both the concepts of 'tissue fluid to cytosol' and down 'water potential gradient' were necessary. Many candidates were successful in this. Common errors were stating the water moved from cytosol to tissue fluid, focusing on solutes rather than water or mentioning 'concentration of water'.

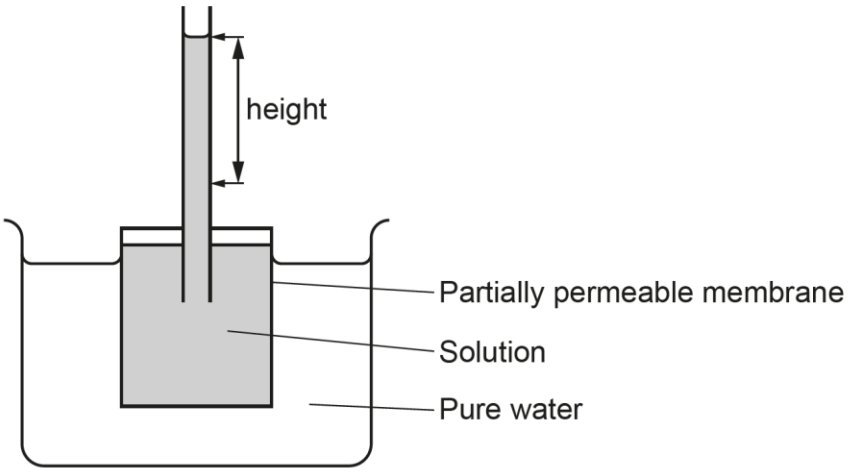
Assessment for learning

Candidates at this level should be encouraged in the use of the correct terminology. Some candidates still describe 'water potential' in terms of 'concentration of water'.

Question 3 (c) (i)

(c) Wilhelm Pfeffer was a German scientist who studied osmosis. In 1877, Pfeffer published the design of an apparatus that included a partially permeable membrane. He used this apparatus to demonstrate osmosis and measure osmotic pressure.

The diagram below shows a version of Pfeffer's apparatus.



Pfeffer measured the increase in height of the solution to calculate the hydrostatic pressure and osmotic pressure of the solution.

(i) Explain **one** variable that should be controlled in an experiment to measure the osmotic pressure of different solutions.

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..... **[2]**

This question required candidates to understand the concept of pressure and apply this to the apparatus. Many candidates were able to identify a variable to control e.g. temperature. However, it proved more challenging for candidates to go on to explain why it should be controlled so restricted them to 1 mark.

Question 3 (c) (ii)

(ii) Describe **one** improvement to the method to increase the accuracy of the individual measurements.

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..... **[1]**

Good responses were rarely seen. Some candidates were credited for suggesting use of a data logger, but many did not seem to have knowledge of equipment used for measuring pressure such as, a manometer or 'pressure gauge'.

Questions 3 (c) (iii) and 3 (c) (iv)

(iii) A student plans to use Pfeffer's method to study the formation of tissue fluid.

A textbook gave the osmotic pressure of blood as 780 kPa at 25 °C.

The relationship between the concentration of a solution and its osmotic pressure is given by the equation:

osmotic pressure = $c \times i \times RT$

where:
the osmotic pressure is in kPa
c is the concentration in mol dm^{-3}
i is the van't Hoff factor (for sucrose, i = 1)
R is the gas constant = 8.314 m^3 Pa K^{-1} mol^{-1}
T is the absolute temperature in Kelvin (K), 25 °C = 298 K.

The student plans to use a sucrose solution with the same osmotic pressure as blood.

Use this information to calculate the concentration of sucrose, in mol dm^{-3}, that the student should use.

Concentration = ... mol dm^{-3} **[2]**

(iv) The student also plans to use a sodium chloride solution with the same osmotic pressure as blood.

The van't Hoff factor takes account of the number of particles formed when a substance dissolves. 1 mol of sodium chloride forms 2 mol of particles (Na^+ and Cl^-) when it dissolves. This means that the van't Hoff factor for sodium chloride is 2.

Estimate the concentration of sodium chloride that would be required to make a solution of the same osmotic pressure as blood.

Concentration = ... $mol\,dm^{-3}$ **[1]**

Most candidates showed good mathematical skills in substituting values and rearranging the equation for both marks in part 3 (c) (iii).

Question 3 (c) (iv) was generally well-answered as candidates could be credited using 'error carried forward' if their response to 3 (c) (iii) was incorrect.

OCR support

A common error was in correct rounding of their answer in **Q3(c)(iii)**. Guidance for candidates is found in the Mathematical skills handbook, section 1.1.

Maths skills handbook can be found to support candidates preparing for assessment.
https://www.ocr.org.uk/subjects/science/maths-for-biology/

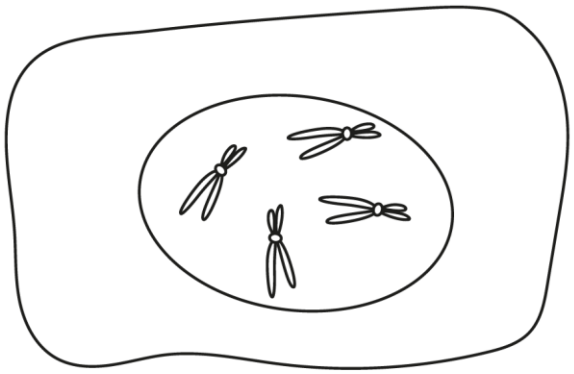
Question 4 (a)

4 Tumour formation is the result of uncontrolled mitosis.

Uncontrolled mitosis can occur when processes that regulate mitosis and the cell cycle stop functioning.

Cancer treatments often target these processes.

(a) The diagram shows a cell with two pairs of chromosomes.



In the space below, draw an annotated diagram of this cell in the anaphase stage of mitosis.

Indicate the features that show the cell is in anaphase.

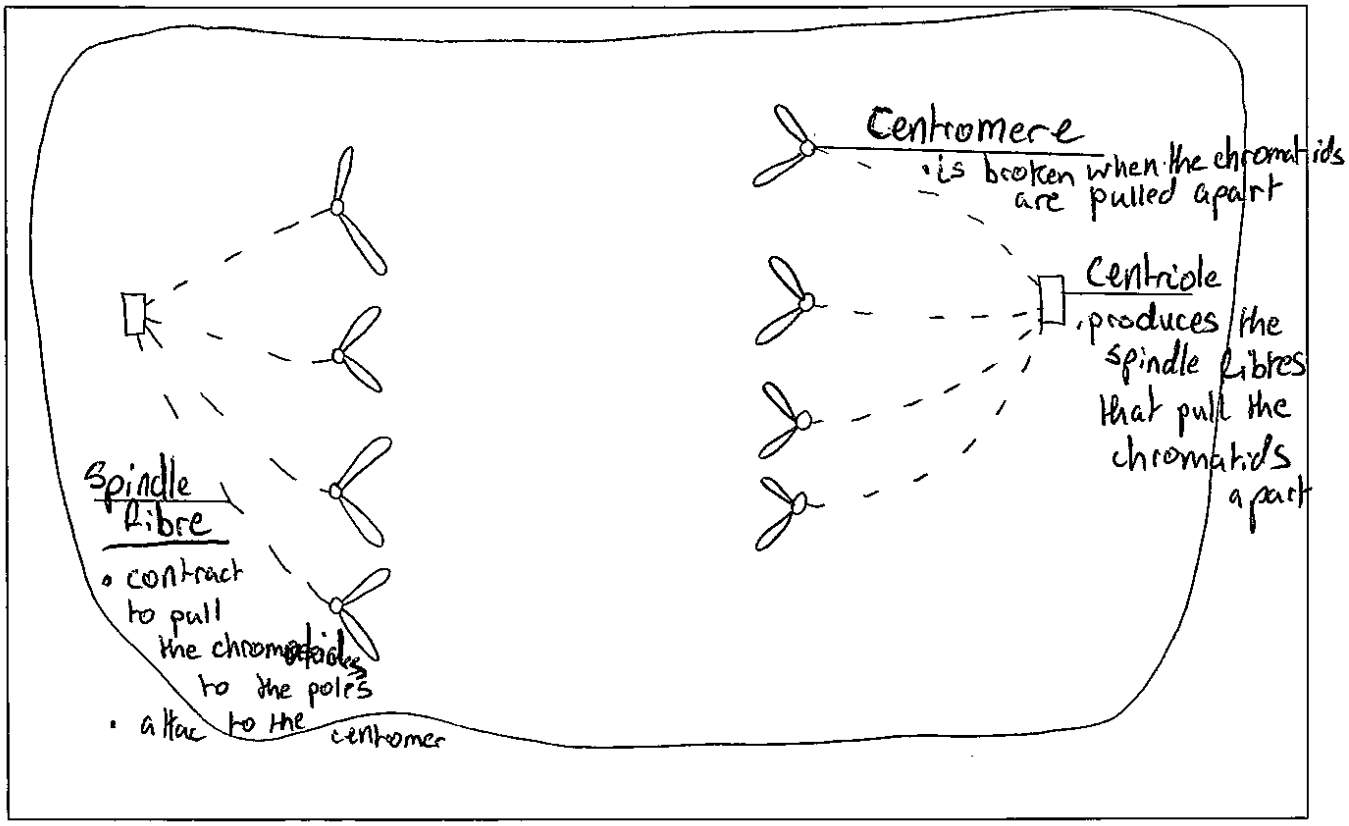
[4]

In this question 4 marks were awarded to candidates whose drawing skills were secure (marking point 1) and who could correctly communicate anaphase (marking points 2, 3 and 4). Common errors included presence of a nuclear envelope and separation of pairs of chromosomes rather than individual chromosomes into chromatids. Some candidates also lost marking point 1 for drawings that were too small or had sketchy outlines.

OCR support

Support for drawing diagrams can be found in the Biological Drawing Skills Handbook.
www.ocr.org.uk/Images/251799-biology-drawing-skills-handbook.pdf

Exemplar 2



The exemplar shows a good response with all 4 marks credited for drawing skills and appropriate annotation.

Question 4 (b)

(b) Discuss the advantages and disadvantages of the use of plants as sources of anti-cancer drugs.

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..... **[3]**

Many candidates achieved at least 1 mark for this question with correct mention of side effects as either an advantage or a disadvantage.

Question 4 (c) (i)

(c) Paclitaxel and topotecan are two anti-cancer drugs. Both drugs were initially isolated from natural sources.

Paclitaxel interferes with microtubule formation during cell division.

Topotecan causes breaks in the DNA double strand during DNA replication.

Researchers carried out a clinical trial to compare the efficacy of paclitaxel and topotecan.

They selected patients with advanced epithelial ovarian cancer who had not responded to previous anti-cancer treatments.

The patients were then treated with either paclitaxel or topotecan.

(i) Describe how patients would be assigned to the two treatment groups **and** explain why they were assigned in this way.

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..... **[2]**

Most candidates were able to use their knowledge of clinical trials to achieve both marks for understanding the concepts of 'random allocation' and 'avoiding bias'.

Question 4 (c) (ii)

(ii) The results of the clinical trial are shown in the table.

	Paclitaxel group	Topotecan group	Statistical significance
Median time to progression of disease (weeks)	14	23	p = 0.002
Median survival (weeks)	43	61	p = 0.515

The researchers concluded that topotecan has efficacy at least equivalent to that of paclitaxel.

Explain why the researchers reached this conclusion.

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..... **[3]**

Candidates who could interpret the table often gained 2 marks for recognising that topotecan made the time to progression of the disease **and** survival time longer. However, most candidates could not reference statistical significance correctly. Many interpreted 'p' as a critical value rather than a probability. Compared with p 0.05, p 0.002 is much lower, meaning that difference in progression is not due to chance and, therefore, highly significant. Compared with p 0.05, p 0.515 is much higher, meaning that difference in survival is due to chance and, therefore, not significant.

OCR support

Statistical analysis and interpretation of data is an essential mathematical skill and candidates are encouraged to study examples and refer to appropriate sections in the Maths skills handbook.

Maths skills handbook can be found to support candidates preparing for assessment.
https://www.ocr.org.uk/subjects/science/maths-for-biology/

Extra support on statistical analysis and interpretation can be found on Teach Cambridge.
Statistics for Biology.

Question 4 (c) (iii)

(iii) Other researchers have proposed that paclitaxel and topotecan could be more effective if they are used at the same time in a combined treatment of advanced cancers.

Suggest why the two drugs may be more effective when used together in a combined treatment.

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..... **[2]**

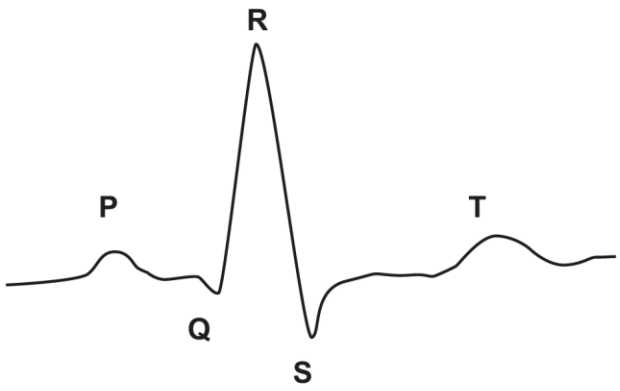
Few candidates achieved both marks for this question. Many candidates provided responses that included rewriting of the question stem; such responses were not credited.

Question 5 (a)

5

(a) **Fig. 5.1** shows an electrocardiogram (ECG) of one beat of a healthy heart.

Fig. 5.1



Describe the cause of the two waves labelled **P** and **T** in **Fig. 5.1**.

P .....

.....

T .....

.....

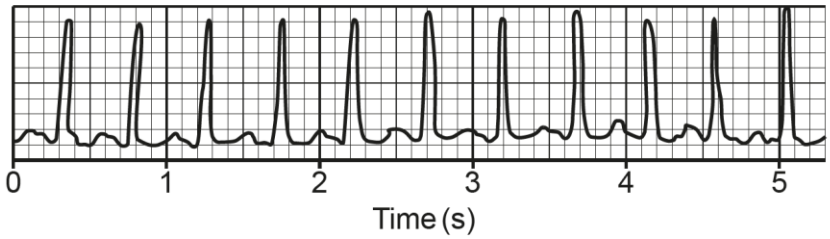
[2]

Generally well-answered with many candidates giving the ideal response from the left- hand side of the mark scheme, although candidates were also credited for using the terms in the additional guidance column.

Question 5 (b) (i)

(b) **Fig. 5.2** shows an ECG of a faulty heartbeat in a resting patient.

Fig. 5.2



(i) Use **Fig. 5.2** to calculate the resting heart rate of this patient.

Heart rate = ... beats min^{-1} **[2]**

There were different methods used by candidates to calculate resting heart rate. It should be noted that best practice is to use as much of the available data as possible, which in this case was using the time for the full trace of 10 or 11 beats.

Question 5 (b) (ii)

(ii) Identify the heart problem indicated by the ECG in **Fig. 5.2**.

..... **[1]**

Question 5 (c) (i)

(c) **Fig. 5.3** shows part of an ECG of a patient undergoing myocardial infarction (heart attack).

Fig. 5.3

(i) Describe the feature of this ECG that shows the patient is having a myocardial infarction.

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..... **[1]**

Straightforward application of knowledge of ECGs required in these question parts and most candidates correctly identified tachycardia as the condition and 'elevated ST' (section) as the feature.

Question 5 (c) (ii)

(ii) Explain the circumstances in which a defibrillator should be used.

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..... **[2]**

Some candidates were able to achieve both marks for 'cardiac arrest' and 'restore normal rhythm'. However, it is a common misconception that a defibrillator can be used when the heart has completely stopped beating or during a heart attack or myocardial infarction.

Question 5 (d)

(d) ECG can be used to predict the risk of mortality from heart failure.

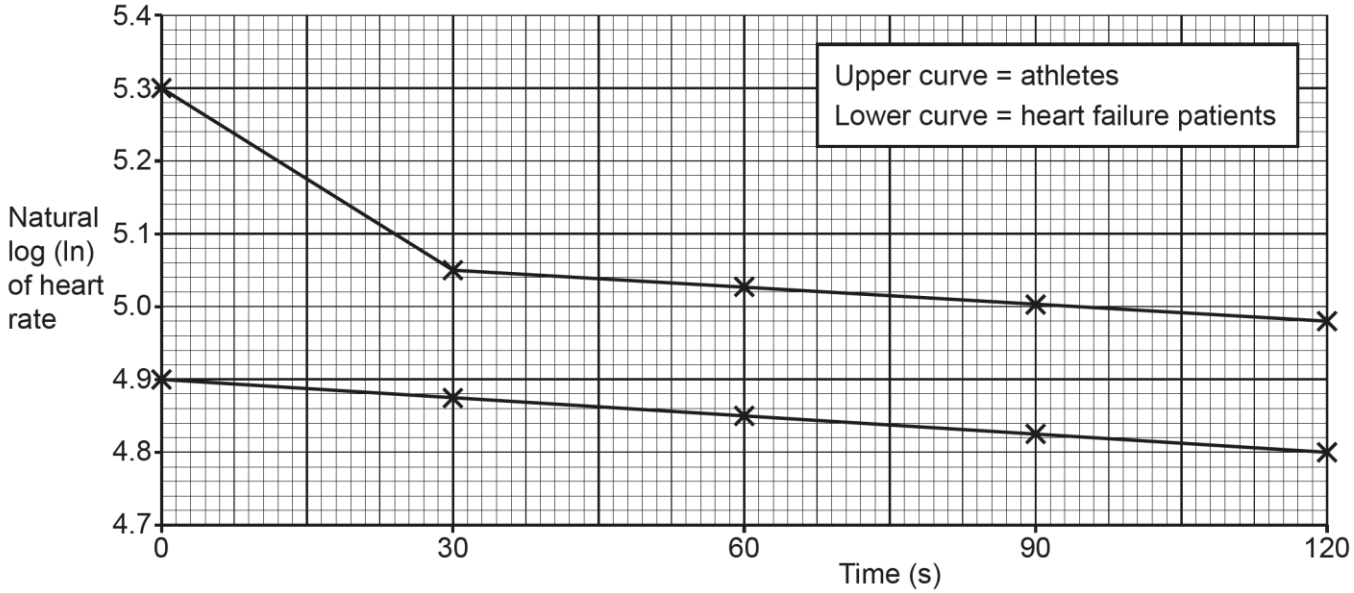
Patients with heart failure were monitored by ECG for a few minutes after exercising on a treadmill.

This group was compared with a group of trained athletes.

The researchers analysed the results by plotting a graph of the natural log (ln) of heart rate against time.

The results are shown in **Fig. 5.4**.

Fig. 5.4



Compare the results in **Fig. 5.4** for the athletes and heart failure patients.

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..... **[3]**

This question required interpretation of a graph of heart rate (given as natural log, ln) after exercise. Good responses achieved full marks, often quoting data to support their statements. Some candidates tried to convert values of natural log bpm to bpm but did not realise that natural log is often not given to base 10. This resulted in calculated figures such as 200bpm, that could not be credited for use of data. Candidates should be aware that 120 bpm is considered a high heart rate.

Exemplar 3

The heart rate of heart failure for patients remains lower than the athletes heart rate throughout the experiment. Where there is a steeper decreare in the first 30 seconds for athletes in heart rate returning to a resting level, there is only a slight decrease for individuals with heart failure. In addition, the natural log of heart rate at 120 seconds remains lower for heart disease patients at 4·8 in, whereas for athletes it is 4·98 in. **[3]**

The exemplar shows a good response. The candidate makes clear statements using the data in Fig.5.4 and supports these statements by using comparable data quotes.

Question 6 (a) (i)

6
(a)
(i) State the name of a test that can be used to diagnose red-green colour blindness.

..... **[1]**

Many candidates correctly identified 'Ishihara' as a colour blindness test. A variety of phonetic spellings were accepted.

Question 6 (a) (ii)

(ii) Explain why rod cells in the retina are described as receptors and transducers.

.....

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.....

.....

..... **[2]**

Many candidates achieved 1 mark for this question as they could explain that receptors in the eye absorbed light. However, describing photoreceptors as transducers was more challenging for candidates, possibly due to the misconception that light energy was converted to chemical energy (rather than electrical energy).

Question 6 (b)*

(b)* The eye has structures and mechanisms that:

- protect it against light
- provide physical protection
- provide chemical protection.

Describe the structures and mechanisms that protect the eye from potential harm.

.....

.....

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.....

..... **[6]**

Sound understanding of protective eye anatomy was shown in many responses. Many candidates could also describe in detail the structures and mechanisms for protection against light and chemical defences. The communication mark was not supported where incorrect biological statements were made e.g. radial muscles contracting and circular muscles relaxing in response to high light intensity.

Question 7 (a)

7

(a) State the **two** products of the light-dependent stage of photosynthesis that are used in the Calvin cycle.

1 .....

2 .....

[2]

Generally well-answered by many candidates.

Question 7 (b) (i)

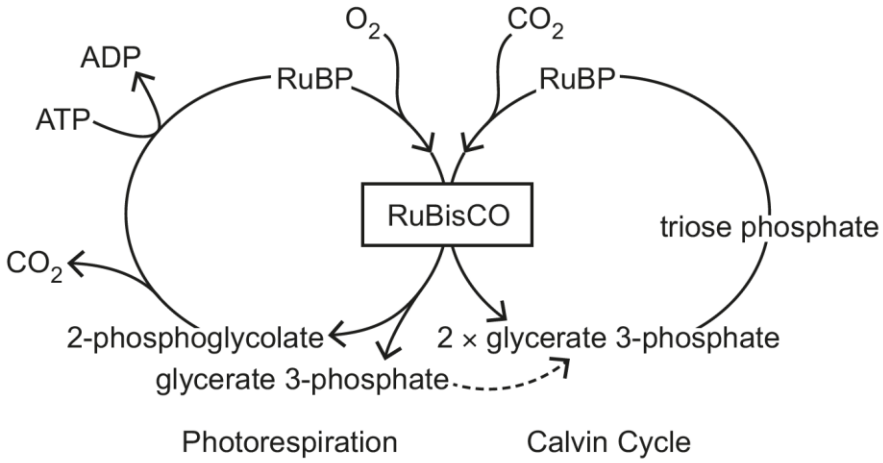
(b) In photorespiration, RuBisCO catalyses the reaction of oxygen with RuBP to produce one molecule of 2-phosphoglycolate and one molecule of glycerate 3-phosphate.

The glycerate 3-phosphate can enter the Calvin cycle.

2-phosphoglycolate is converted to RuBP.

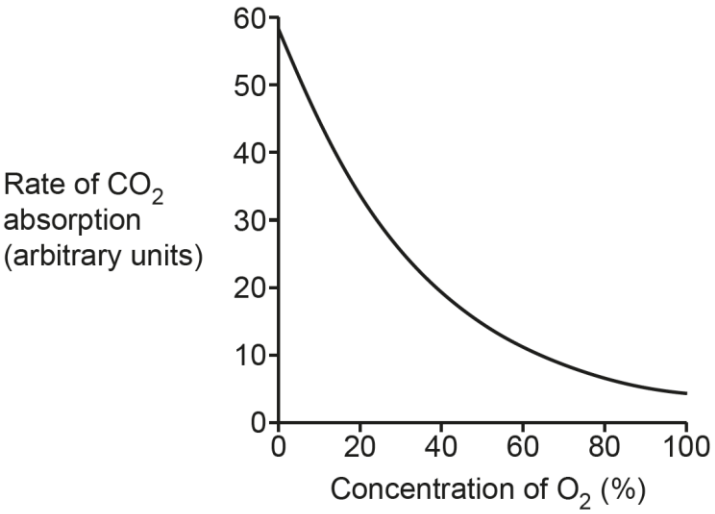
These pathways are summarised in **Fig. 7.1**.

Fig. 7.1



(i) **Fig. 7.2** shows the effect of oxygen concentration on the rate of absorption of carbon dioxide by the leaves of a crop plant.

Fig. 7.2



Use the information in **Fig. 7.1** to explain the results shown in **Fig. 7.2**.

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..... **[2]**

Responses were often incomplete, and some candidates found it difficult to interpret the photorespiration diagram to explain the results. For full marks, candidates were required to make links to RuBP and RuBisCO in their response.

Question 7 (b) (ii)

(ii) Use your knowledge of the Calvin cycle and the information in **Fig. 7.1** and **Fig. 7.2** to explain why higher concentrations of oxygen reduce the yield of this crop plant.

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..... **[2]**

Both marks were often credited together where candidates understood that 'less TP' would result in 'less glucose'.

Question 7 (c) (i)

(c) Melvin Calvin and his co-workers studied the reactions of the Calvin cycle by injecting a suspension of photosynthesising algae with radioactive CO_2 ($^{14}CO_2$).

They took samples of the suspension after 2 s, 5 s and 30 s.

They then used paper chromatography to identify the compounds that had taken up the radioactive carbon (^{14}C).

(i) The table shows different compounds that had taken up ^{14}C during the course of the experiment.

Compound(s)	
Amino acids	**A**
Glucose phosphates	**B**
Glycerate 3-phosphate (GP)	**C**
Triose phosphate (TP)	**D**

Use the **letters** in the table to indicate the order in which ^{14}C would have appeared in the compounds.

..... **[1]**

Many candidates could order GP, TP, Glucose phosphates, Amino acids for 1 mark. A common misconception was that amino acids were made before glucose phosphates.

Question 7 (c) (ii)

(ii) Explain the order you have listed the compounds in part **(i)**.

.....

.....

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.....

.....

..... **[3]**

Candidates could gain credit for correct statements here, even if they had muddled the order of compounds in Question 7 (c) (i). Some candidates achieved all 3 marks by describing GP formation (from RuBP and CO_2), TP formation (from GP and reduced NADP) and glucose phosphate formation (from TP). Marks were not credited for a description of the molecules without explanation.

Question 7 (c) (iii)

(iii) Explain how ^{14}C would be incorporated into triglycerides in a plant.

.....

.....

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.....

..... **[3]**

The last marking point was often awarded for stating that triglycerides are made from glycerol and fatty acids. However, it was noticeable that many candidates did not know that glycerol came from TP or that GP is converted to acetyl coA which is then converted to fatty acids, thereby limiting the number of marks achieved.

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