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A LEVEL

Examiners' report

BIOLOGY A

H420

For first teaching in 2015

H420/03 Summer 2022 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 are 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.

Advance Information for Summer 2022 assessments

To support student revision, advance information was published about the focus of exams for Summer 2022 assessments. Advance information was available for most GCSE, AS and A Level subjects, Core Maths, FSMQ, and Cambridge Nationals Information Technologies. You can find more information on our website.

Paper 3 series overview

H420/03 is one of the three examination components for GCE Biology A. This component assesses content from across all areas of Biology, and links together the different areas, within different contexts, some practical, some familiar and some novel. To do well on this paper, candidates need to be comfortable applying their knowledge and understanding to unfamiliar contexts and be familiar with a range of practical techniques. They must also be able to analyse, interpret and evaluate ideas and evidence to be able to reach conclusions and develop and refine practical design and procedures. All questions were accessible to candidates, and there seemed to be no time issues with completing the examination. The examination produced a good spread of marks, and most candidates attempted all the questions.

Many candidates used the additional answer spaces provided in the paper, rather than continuing their answers outside the provided lines, and this is something we would encourage all centres to advise their candidates to do.

Candidates who did well on this paper generally did the following:	Candidates who did less well on this paper generally did the following:
• Recalled names and key concepts accurately • Showed mathematical fluency in calculations using standard form, finding a negative logarithm and interpreting a logarithmic scale on a graph correctly • Produce clear and concise responses for Level of Response questions • Have a good practical knowledge, with the ability to understand and apply the information given to the questions being asked • Could interpret information given in diagrams, graphs and tables and use it to answer related questions	• Used biological terminology in the wrong context • Could not answer mathematical based calculations • Left answers unfinished or blank • Did not apply what they had learnt to unfamiliar situations, scoring most of their marks on questions involving recall and understanding • Produced responses which lacked depth, particularly to practical based questions • Produced responses which were often peripheral to what had been asked, sometimes simply repeating information provided • Did not use images supplied in the exam paper to answer related questions

Question 1 (a)

1 The heart can be affected by a variety of disorders, some of which involve the immune system.

(a) **Fig. 1.1** shows the roles of three different types of antibody, labelled **R**, **S** and **T**.

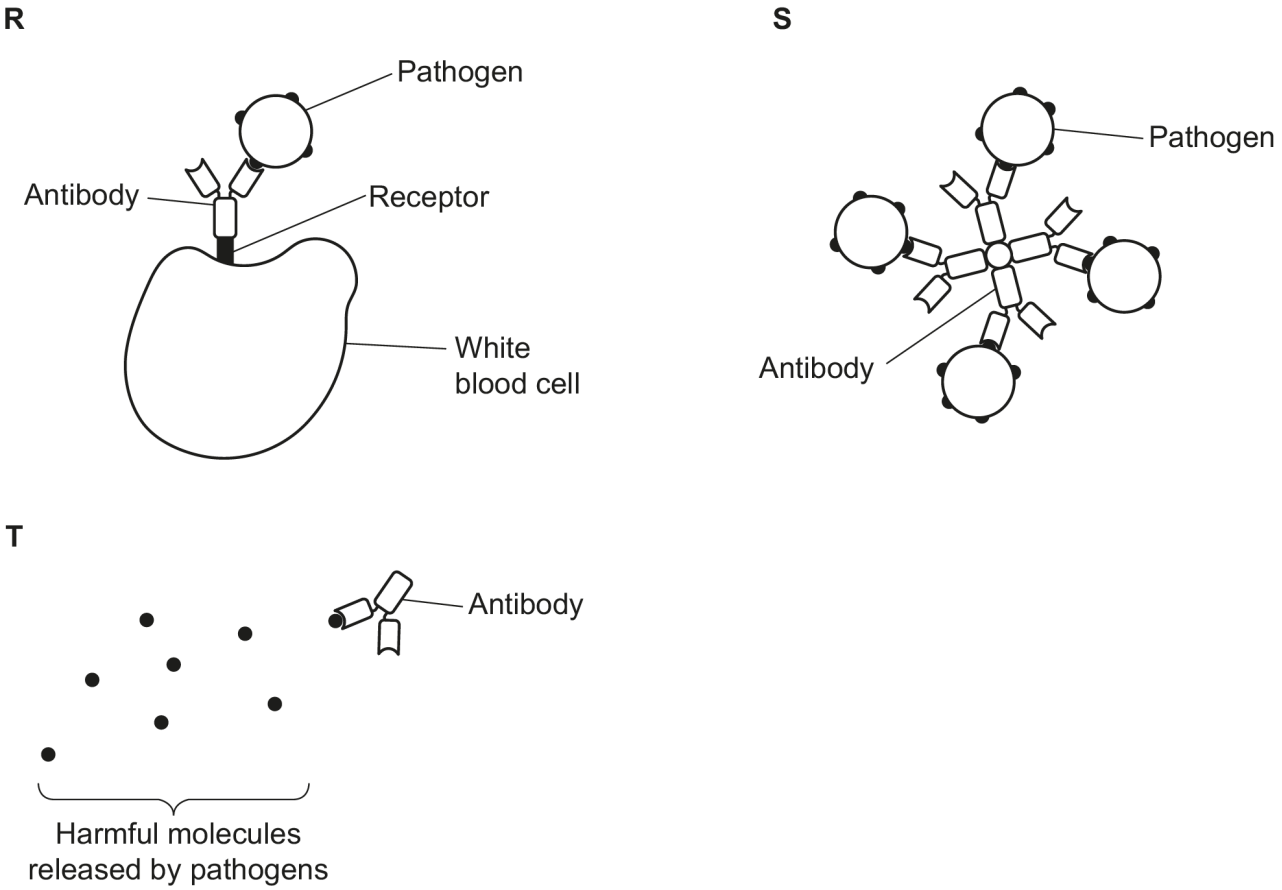


Fig. 1.1

State the names of the **three** different types of antibody shown in **Fig. 1.1**.

R .....

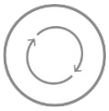
S .....

T .....

[3]

Most candidates could identify at least two types of antibodies. The most poorly answered option was for R where they didn't write **opsonin** for their answer. Option S was the best answered, with the majority of candidates knowing the answer or using '**agglutination or agglutin**' as alternatives. The candidates who were not given any marks either fell into the category of 'no response' or named different types of white blood cell. Phonetic spellings were accepted for the names of the antibodies.

Assessment for learning



Some candidates may have struggled to identify opsonins, agglutinins, and anti-toxins as antibodies because in some cases, 4.1.1(h) (the structure and function of antibodies) and 4.1.1(i) (the action of opsonins, agglutinins, and anti-toxins) might not be taught together. It is important that teaching should emphasise that all three are examples of antibodies, and that their structure is related to their function.

Question 1 (b)

(b) A condition called rheumatic heart disease can occur when a person's antibodies attack antigens on their own heart cells.

State the name of the **type** of disease represented by rheumatic heart disease.

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

A very well answered question, upwards of 90% of candidates knew the correct answer. Incorrect answers included names examples of autoimmune diseases (e.g. rheumatoid arthritis) or other general disease names, e.g. communicable disease, coronary heart disease, immunodeficiency.

Question 1 (c)

(c) **Fig. 1.2** shows two electrocardiogram (ECG) traces:
- an ECG of normal heart activity
- an ECG of a person with a type of heart disease

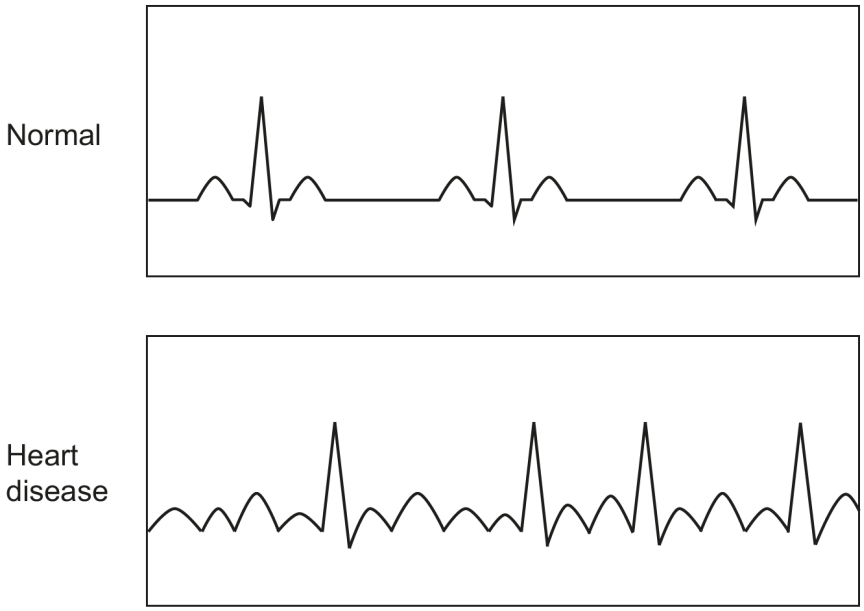


Fig. 1.2

Describe how the ECG trace of the heart with heart disease is different from the ECG trace of a normal heart.

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.....

.....

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

This was completed well in the majority of cases and 1 or 2 marks were often given. Candidates often used correct medical terminology like tachycardia, atrial fibrillation and arrhythmia. Candidates appeared to have a clear understanding of the normal ECG trace and could apply this to the trace with heart disease. Responses varied greatly in terms of referencing to the waves on the trace or relating it to the heart function. Those students whose responses were given no marks suffered from lack of detail, only referring to peaks or spikes, or incorrect use of terminology identifying fibrillation without 'atrial'.

Question 1 (d) (i)

(d) Gene therapy is a possible future treatment for heart disease.

The *AC6* gene codes for one form of the enzyme adenylyl cyclase.

Clinical trials have tested the effect of increasing levels of the *AC6* gene in heart cells.

(i) Suggest how using gene therapy to increase levels of the *AC6* gene in heart cells may improve heart function.

.....

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.....

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

There were a range of responses for this question; and many candidates did not score any marks as they only described what adenylyl cyclase and cAMP do, rather than what happens to their levels when the genes are expressed. The most commonly scored marks were for **increased** adenylyl cyclase and **increased** cAMP, followed by improved heart contraction. Almost no examples of greater effect of adrenaline or the idea of adenylyl cyclase being found on cell surface membranes were seen. Some achieved a mark for increased heart contraction, but many just repeated 'improved heart function' or stated that it could increase or decrease contractions, which gained no marks.
Very few answers mentioned adrenaline, and those that did described it as the fight or flight hormone.

Question 1 (d) (ii)

(ii) State **one** method for inserting the *AC6* gene into the heart cells during gene therapy.

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

Generally, this question was poorly answered. Few candidates were able to identify a method of inserting the gene during gene therapy. Those that did access the mark here said that you should use a virus or plasmid, with a few mentioning liposomes. Common incorrect answers included: somatic cell nuclear transfer, somatic cell gene therapy, injection (unqualified), vector (unqualified) and genetic engineering/restriction enzymes.

Question 1 (d) (iii)

(iii) The results from gene therapy trials are published in peer-reviewed journals.

State why the results from gene therapy trials are published in journals.

.....

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

A large majority of candidates obtained the mark here. While a wide variety of responses were given, most candidates were able to get across the idea that publishing data was to allow other scientists to see the information, compare the results, or check the validity/reproducibility. Those candidates whose responses were given no marks suffered from lack of detail, mentioning just peer review, or describing what is included in a journal. Some wrote about the idea of sharing results with the public, not understanding that these are specialist journals.

Question 2 (a) (i)

2 **(a)** **Fig. 2.1** shows a light micrograph of a blood smear.

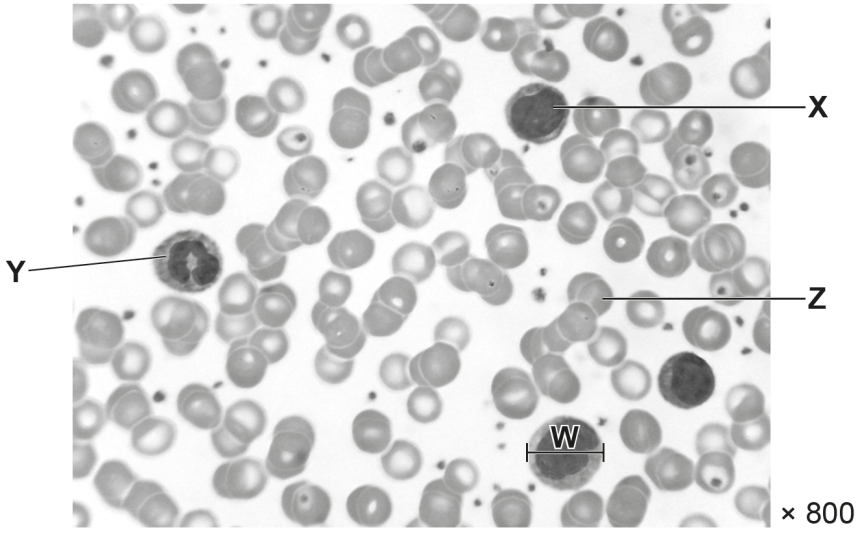

Fig. 2.1

(i) The cells labelled **X** and **Y** in **Fig. 2.1** are two different types of white blood cell.

Identify the types of white blood cell labelled **X** and **Y**.

X .....

Y .....

[2]

Most candidates only got 1 mark for correctly naming Y as a neutrophil. The most common errors were incorrectly naming X as a macrophage or monocyte, with few candidates correctly identifying it as a lymphocyte.

Question 2 (a) (ii)

(ii) The blood cell labelled **Z** in **Fig. 2.1** contains a high concentration of haemoglobin.

Outline **two** other ways in which the blood cell labelled **Z** is adapted for its function.

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.....

.....

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

This question was generally answered well by a wide range of candidates. Common errors included omitting 'bi' from 'biconcave' and describing the lack of a nucleus as giving more space for oxygen (rather than haemoglobin). Some candidates lost marks for linking an adaptation to the wrong benefit, especially biconcave with being able to fit through capillaries, rather than increasing surface area.

Question 2 (a) (iii)

(iii) The diameter of another blood cell is represented by the line **W** in **Fig. 2.1**.

The magnification used to produce **Fig. 2.1** was × 800.

Calculate the actual diameter, **W**, of the blood cell.

Give your answer in μm.

Diameter = ... μm **[2]**

About half of candidates gained the full 2 marks for this question. Marks were most often lost for measuring in cm then an incorrect conversion to micrometres – most multiplying by 1000 rather than 10,000. Candidates who showed working, including the measurement of the diameter with units divided by 800, could access 1 mark even if their final answer was incorrect.

Question 2 (b) (i)

(b) Some white blood cells have a high concentration of lysosomes.

(i) State the role of lysosomes in white blood cells.

.....

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

Most candidates gained this mark. The most common reason for losing the mark was suggesting that the lysosome engulfed the pathogen, rather than the phagocyte engulfing it, or for suggesting that lysosomes are enzymes. Very few candidates gave acceptable alternatives to pathogens, such as damaged or old cells, rather giving vague answers such as breaking down molecules.

Question 2 (b) (ii)

(ii) A scientist calculated two values for the lysosomes in a white blood cell:

- mean volume of a lysosome = $6.5 \times 10^{-14}\,cm^3$
- mean number of H^+ ions per lysosome = $1.3 \times 10^{-21}\,mol$

Use these values to calculate the mean H^+ ion concentration per lysosome in this white blood cell.

Give your answer in $mol\,dm^{-3}$.

Mean H^+ ion concentration = ... $mol\,dm^{-3}$ **[2]**

Few candidates scored both marks for this question. Many candidates did not convert cm^3 into dm^3 or divided the numbers the wrong way round. Often incorrect answers were from not multiplying $2x10^{-8}$ by 1000 giving the final answer as $2x10^{-8}$. Subsequently many candidates achieved ECF for 2biii and 2biv.

Question 2 (b) (iii)

(iii) The formula used to calculate pH is

$pH = -\log [H^+]$
where $[H^+]$ is H^+ ion concentration in $mol\,dm^{-3}$.

Use your answer from **part (ii)** to calculate the mean pH of the lysosomes in this white blood cell.

Give your answer to **2** significant figures.

pH = ... **[1]**

This mark was for a correct calculation, therefore ECF from Question 2 (b) (ii) was allowed, even if outside the normal pH range, including correctly calculated negative values. Many candidates did not have an awareness of physiological pH values or that a pH>14 or <0 was not plausible which may have helped them revisit 2bii. A small number of candidates recorded to 2 decimal places rather than 2 significant figures.

OCR support

Advice on using calculators to find logarithm functions for maths skill M0.5 can be found on page 16 of the Biology mathematical skills handbook on this page:

https://www.ocr.org.uk/qualifications/as-and-a-level/biology-a-h020-h420-from-2015/planning-and-teaching/

A tutorial, quiz sheet and teacher answers are available here under M0.5.

https://www.ocr.org.uk/subjects/science/maths-for-biology/arithmetic-and-numerical-computation/

Question 2 (b) (iv)

(iv) The scientist stained the lysosomes in a sample of living white blood cells.

The table shows the properties of five stains, **A** to **E**.

Stain	Properties
A	Suitable to stain alkaline components. Taken up by active cells.
B	Suitable to stain acidic components. Taken up by active cells.
C	Suitable to stain neutral components. Taken up by active cells.
D	Suitable to stain alkaline components. Can be used to stain fixed sections of tissue.
E	Suitable to stain acidic components. Can be used to stain fixed sections of tissue.

Select the most appropriate stain for the scientist to use, based on your answer from **part (iii)**.

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

Again, an ECF was allowed from Question 2 (b) (iii). A common error by candidates was the selection of C for pH values just above or below a neutral pH, recorded between 6.7 and 7.7.

Question 2 (c)

(c) Differential staining can be used to distinguish between bacteria with thick cell walls and bacteria with thin cell walls.

Four substances are used when differentially staining bacteria:
- Crystal violet, which stains bacteria purple.
- Safranin, which stains bacteria pink but is not visible in the presence of crystal violet.
- Alcohol, which removes fixed stains from bacteria with thin cell walls.
- Iodide solution, which fixes crystal violet to bacterial cells.

Suggest a practical procedure for staining a slide that would allow thin-walled bacteria to be differentiated from thick-walled bacteria.

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

Some candidates did not take into consideration all the details provided in the question and lost all marks. A few responses lost the marks by talking about different types of microscopes. Most gained 1 mark overall. A common error was for implying crystal violet and iodine should be applied at the same time, rather than one followed by the other. The second mark was often lost for not including the use of safranin and believing that bacteria with thin walls would still be visible without a stain.

Question 2 (d) (i)

(d) **Fig. 2.2** shows stained tissue that includes two different blood vessels, labelled **L** and **M**, and a substance labelled **N**.

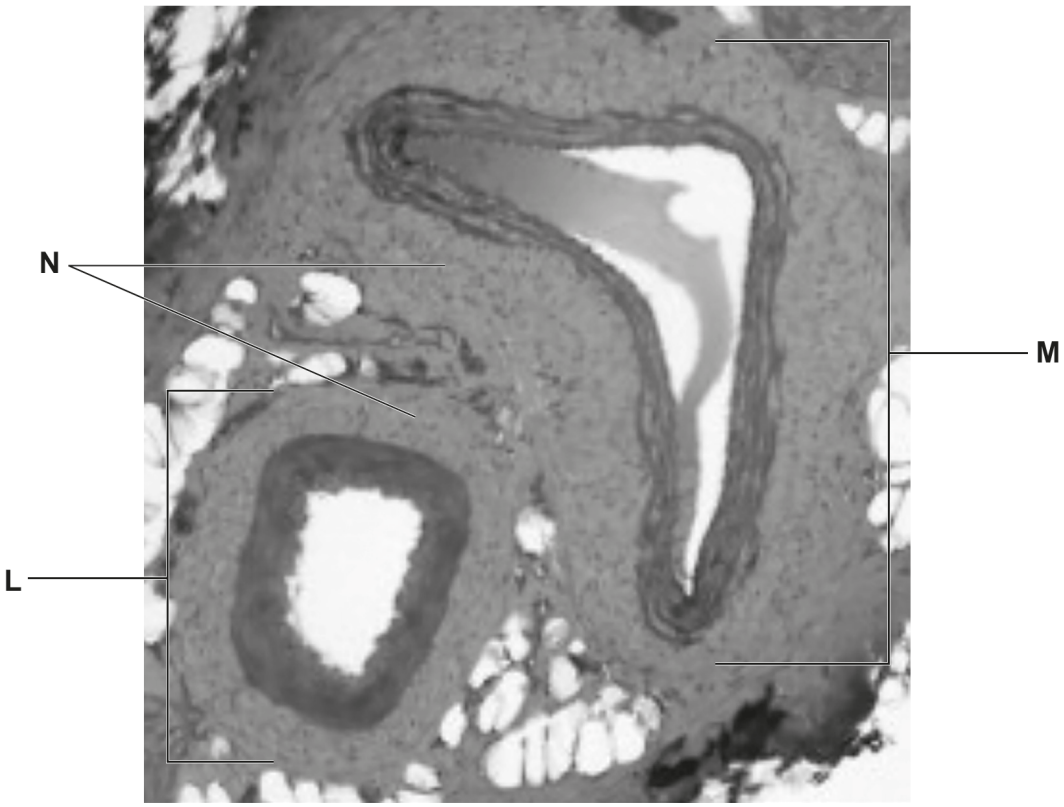

Fig. 2.2

(i) State whether **L** is an artery or a vein **and** give **two** pieces of evidence from **Fig. 2.2** that allow you to reach your decision.

L .....

Evidence 1 .....

.....

Evidence 2 .....

.....

[2]

Most candidates correctly identified the vessel as an artery and managed to gain 1 or 2 marks here. A noticeable error was the omission of the terms layer or wall and led to phrasing such as thick smooth muscle or thick elastic fibres, which gained no marks. Some candidates made reference to no valves in the artery, even though they were not visible in the image.

Question 2 (d) (ii)

(ii) State the substance labelled **N**.

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

Very few candidates could correctly label 'collagen' for N. Most common incorrect answers were tissue fluid, smooth muscle or elastic fibres.

Question 3 (a)

3 **(a)** A student wrote a method for taking a cutting to clone a plant:

- Select a stem with many flowers and leaves.
- Make a slanting cut in the stem, below some leaves.
- Dip the cut stem in rooting powder.
- Plant the cutting in watered compost.

Describe and explain how the student's procedure could be improved.

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.....

.....

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

The topic focus of Question 3 was 5.1.5 Plant and Animal Responses, learning outcomes a-f. Few candidates scored 3 marks for this section. Where marks were gained, most candidates were able to describe one or two improvements with many identifying the need for aseptic technique, reducing the leaf number to between 1-4 or removal of flowers. Explanations of improvements as instructed by the second command term in the question stem were less frequent. Specific levels of detail were missed out in numerous responses, such as quoting 'some flowers should be removed' or 'all the leaves should be removed'. Another frequent error seen where few/no marks were given was candidates repeating the procedure given in the question stem in more detail without making any specific changes or qualifying improvements, e.g., how to preserve the meristem while making a cut or the use of rooting powder or a slant cut to the stem -both of which were mentioned in the question. Some candidates misinterpreted this question and described alternative techniques such as using tissue culture or growing in agar jelly.

Question 3 (b) (i)

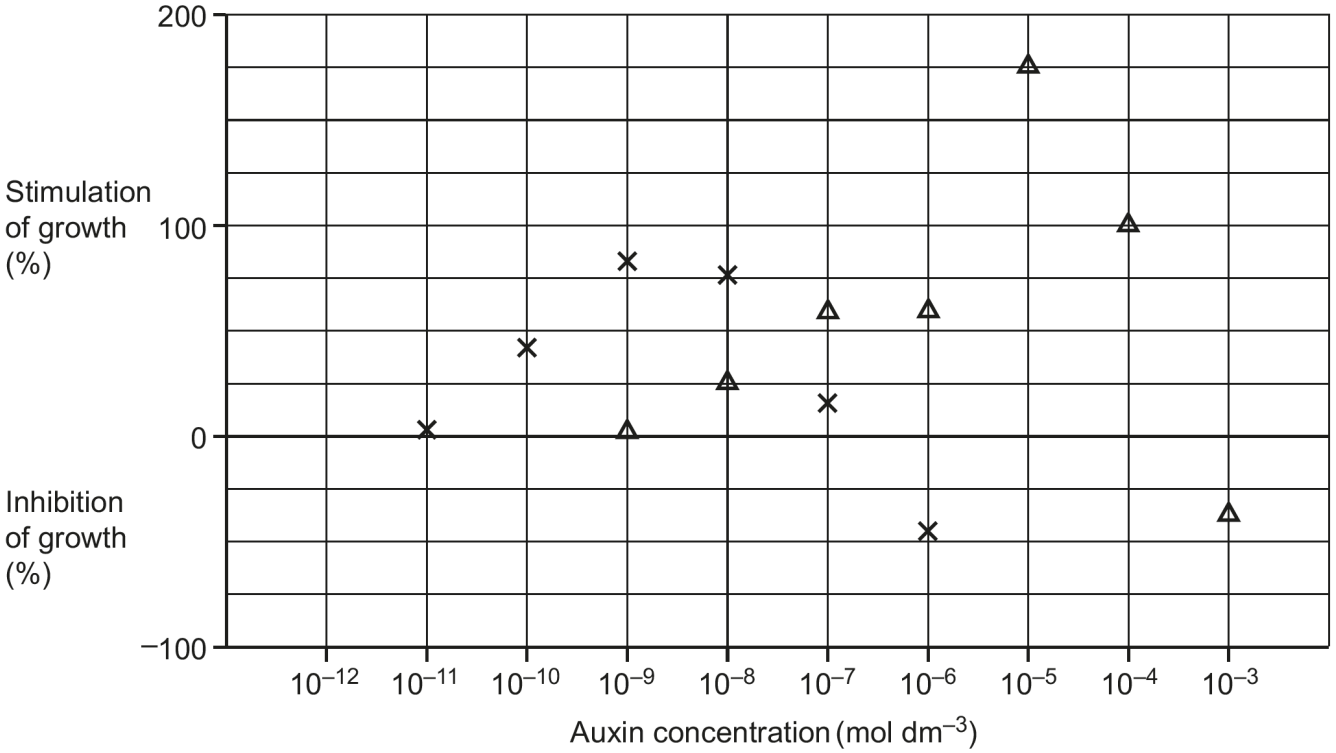
(b) The student investigated the effect of auxin concentration on the growth of shoots.

The student applied different concentrations of auxin to the apical shoot and the lateral shoots.

The student measured the percentage of growth stimulation or inhibition compared to normal.

Normal growth was represented by 0%.

The student's results are shown in the graph.



Key: × = lateral shoots

Δ = apical shoot

(i) Use the graph to estimate the auxin concentration at which inhibition of lateral shoots is 100%.

Auxin concentration = ... mol dm^{-3} **[1]**

Most candidates gave the correct answer, but some did not read the *x* scale correctly giving incorrect standard form notations in their responses such as $10^{-5.2}$. A few candidates confused the key and put the value apical shoots were inhibited instead or gave an intermediate value.

Question 3 (b) (ii)

(ii) The student identified a possible anomaly in their results: the data point for the apical shoot receiving 10^{-6} mol dm^{-3} of auxin.

State what the student could do to determine whether this data point was an anomaly.

.....

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

Successful candidates appreciated the importance of using all the information given in this question and gained the mark by stating that the experiment should be repeated at 10^{-6} moldm^{-3} of auxin. Less successful responses omitted reference to the required concentration of auxin, simply stating 'repeat the experiment', or referred to using a statistical test which would identify but not correct an anomaly.

Question 3 (b) (iii)

(iii) Using the graph, describe the conclusions that can be drawn about the role of different auxin concentrations in the control of apical dominance.

.....

.....

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.....

.....

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

Successful responses described the conclusions that could be drawn from the data clearly referring to auxin concentrations and relating these to stimulation or inhibition of apical and lateral growth. There were many good answers here, showing that graph interpretation is a highly achieved skill among many candidates. Not quoting data or making reference to high/low concentrations of auxin or if the effect on growth was affecting apical or lateral shoots were the most common errors. Where fewer than 3 marks were given, many focused on the effects of auxin on growth of either apical shoots or lateral shoots. The most successful responses embedded data from the graph in their responses to support their ideas. Those candidates who did not score any marks on this question did not understand the graph axes and often thought that 10^{-9} mol dm^{-3} was a higher auxin concentration than 10^{-6} mol dm^{-3}. A few candidates did not refer to the graph at all and gave a general description about the role of apical dominance.

Exemplar 1

10^{-5} mol dm^{-3} promotes the most apical dominance. The growth of the apical shoot is 175% greater than normal, and inhibition of lateral shoots are estimated at 100%. At 10^{-9} mol dm^{-3}, lateral shoots are not inhibited, and the growth of apical shoot is the same as without auxin. The greatest concentration of 10^{-3} inhibited the growth of the apical shoot and had no data on the lateral shoots. [3]

there is no data however on the number of shoots sampled, ~~growth~~ or the concentration auxin already present in each plant. so, no definite conclusion can be drawn from the graph alone.

This exemplar clearly shows how conclusions can be drawn using data quotes from the graph to gain maximum marks. It gets the second mark point for describing how apical dominance peaks at 10^{-5} mol dm^{-3} and also the last marking point for saying that at the same concentration the growth of lateral shoots is inhibited. It also gets the third mark point later in the response for saying that at a concentration of 10^{-3} apical shoot growth is inhibited.

OCR support

Advice on using a logarithmic graph scale for maths skill M2.5 can be found on page 43 of the Biology mathematical skills handbook on this page:

https://www.ocr.org.uk/qualifications/as-and-a-level/biology-a-h020-h420-from-2015/planning-and-teaching/

A tutorial, quiz sheet and teacher answers on the use of logarithmic scales are available here under M2.5:

https://www.ocr.org.uk/subjects/science/maths-for-biology/algebra/

Question 3 (c) (i)

(c) Another student plans to investigate the effect of gibberellin concentration on the rate of stem elongation in the pea plant, *Pisum sativum*.

(i) Suggest appropriate units for the dependent variable in this investigation.

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

Many candidates did not identify the units were required for rate of stem elongation rather than length of stem elongation and thus gave units appropriate for measured distances only (mm, cm, etc). A good proportion also gave incorrect answers referring to concentration (e.g. mol dm^3). Of those who were suggesting a measurement for the rate of stem elongation, errors included using min or s as the unit of time (not a suitable measurement for growing plants) or combining two conventions such as using a slash and $^{-1}$ after the time term.

Question 3 (c) (ii)*

(ii)* The student has access to standard laboratory equipment and planting materials.

Outline a method that the student could use to investigate the effect of gibberellin concentration on stem elongation in *P. sativum*.

In your answer, you should include details of an appropriate statistical test for this investigation.

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.....

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

Many candidates answered this question in depth and detail, including all the required variables, validity and reference to statistical tests. Examples of concentrations of gibberellin were included together with specific and appropriate sample sizes and control variables. Most candidates could identify at least two of the variables - the independent variable and at least one control variable. Some candidates did not gain marks through lack of precision in describing how to measure the dependent variable, stem elongation, referring to 'measuring growth' or 'measure the plant' rather than measuring the length of the stem. Validity was sometimes not considered at all. If it was, there was reference to a control group with no gibberellin and a suitable sample size to allow repeats. Most candidates were able to refer to the use of a statistical test but the understanding of the purpose of these tests was often inadequate and candidates lost marks by referring to a statistical test which was not appropriate to the data that their experiment would generate. The most frequently quoted test was the *t*-test which was usually not appropriate to the candidate's experimental design, when using a range of gibberellin concentrations for example.

Exemplar 2

The student should use at least 33 individuals, three for each concentration, these individuals should be clones of eachother. The student should then make the gibberellin concentration solutions of 10^{-12}, 10^{-11}, 10^{-10}, 10^{-9}, 10^{-8}, 10^{-7}, 10^{-6}, 10^{-5}, 10^{-4}, 10^{-3} mol dm^{-3} and then a control. The student should ~~apply the~~ measure the starting length of the stem, then apply the concentration solution. ~~after~~ The student should leave the plants for 72 hr, in the same ~~place, making~~ room, making sure that all areas have the same light intensity and soil conditions, and measure the final lengths. They should the calculate the change in length and calculate a mean average for each concentration. A graph should be plotted of mean change... **[6]**

Additional answer space if required.

in stem length against gibberellin concentration. The standard deviation of each value should be calculated and represented on the graph. ~~as a~~ This allows it to be seen easily if there is a statistical different between the values.

This response clearly contains detailed reference to variables (use of different gibberellin concentrations as the independent variable, measuring shoot length as dependent variable and using cloned plants, same light intensity and soil conditions as control variables). It has an outline of a valid experimental method (3 plants per gibberellin concentration, use of a control group) but lacks the use of a statistical test to analyse the results, i.e., use of Spearman's rank or Pearson correlation test. It does use means and standard deviation to do some statistical analysis and so meets the criteria for L2 – 4 marks.

Question 3 (d)

(d) A friend of the student had an apple tree in their garden. The friend asked the student if there was a way to ripen the fruit on the apple tree more quickly so that it would be ready to eat within a few days.

The student gave this advice:

'You should spray the tree with ethene.'

Evaluate whether acting on the student's advice would produce fruit that was ready to eat within a few days.

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.....

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

Most candidates got at least 1 mark, knowing that ethene encouraged fruit ripening, many also knew that it also encouraged fruit drop. The most successful candidates recognised that there were 3 marks available and so extended their answers often suggesting that the concentration of ethene or the stage of maturity of the fruit needed to be known or that the fruit should be picked before being sprayed. Few candidates stated that ethene was a gas and so many were not able to gain marks for reference to its effectiveness outside.

Question 4 (a) (i)

4 The sea sponge, *Aplysina aerophoba*, and the zebra shark, *Stegostoma fasciatum*, are both animals.

(a) *A. aerophoba* does not have an internal circulatory system. Instead, it filters food and oxygen from the surrounding water, as shown in **Fig. 4.1**.

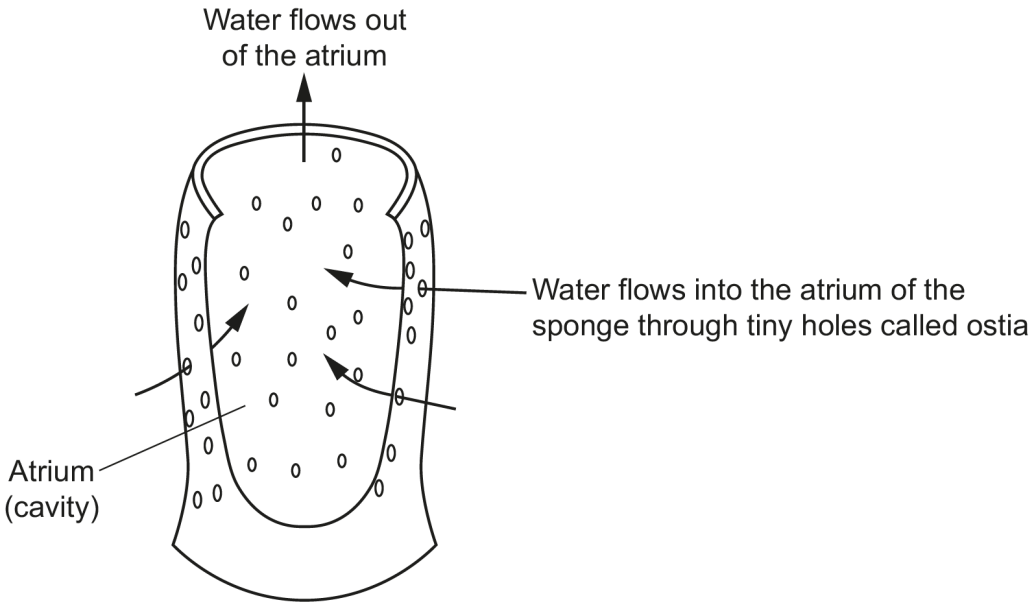

Fig. 4.1

(i) Suggest why *A. aerophoba* does not need a circulatory system.

.....

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

Most candidates could explain why the sponge did not need a circulatory system. Common correct answers referred to the large surface area to volume ratio of the sponge, its short diffusion pathway and the sponge's inactivity giving a low metabolic rate. Responses that did not gain marks focused on the filter-feeding system of water flowing through the ostia. A few hinted at low metabolic rate but weren't specific enough, e.g., it doesn't move much, with no reference to energy needed.

Question 4 (a) (ii)

(ii) A diagram of the circulatory system of *S. fasciatum* is shown in **Fig. 4.2**.

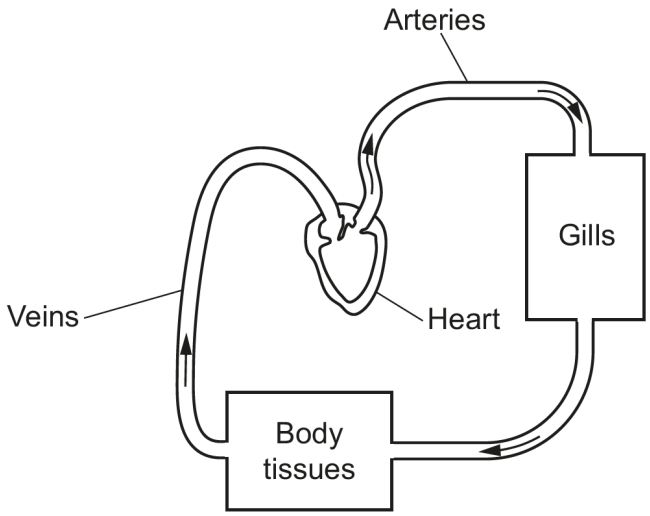

Fig. 4.2

Describe the type of circulatory system that *S. fasciatum* has.

.....

.....

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

Most candidates correctly describe the circulatory system of the zebra shark as being single and closed.

Question 4 (b)

(b) Both *A. aerophoba* and *S. fasciatum* reproduce sexually, but under particular conditions they are both able to reproduce asexually.

In asexual reproduction in *A. aerophoba*:
- clumps of diploid cells detach from the body of the sponge
- the cells reattach to a surface and grow into new, adult sponges.

In asexual reproduction in *S. fasciatum*:
- meiosis occurs in a female
- two of the haploid cells produced by meiosis fuse to form a diploid cell
- the diploid cell develops into a new shark.

A student stated, 'When they reproduce asexually, both animals produce clones of themselves.'.

Evaluate the student's statement.

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.....

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

Strong responses provided an evaluation of the student statement that both animals produce clones of themselves by naming each animal in turn and discussing whether the claim was justified. Candidates with a sound understanding of mitosis and meiosis responded correctly that *A. aerophoba* (the sponge) produces clones but that *S. fasciatum* (the zebra shark) does not. For *S. fasciatum* strong responses explained that new allele combinations form due to crossing over or independent assortment in meiosis. Many candidates realised that production of gametes involved meiosis but did not gain marks by not linking it to crossing over or independent assortment or just saying that it produced variation rather than genetic variation.

Misconception

? Less successful responses stated that meiosis generates genetic variation by mutation. Most mutation occurs in DNA replication during S phase of the cell cycle and the mutation rate will be the same preceding mitosis or meiosis. The processes that 'reshuffle' pre-existing alleles to give new genetic combinations in meiosis are a different source of genetic variation to the mutation events that change the DNA sequence to give brand new alleles.

Question 4 (c)*

(c)* Humans can produce artificial clones of animals.

Describe **two** methods for producing artificial clones of animals.

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.....

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.....

.....

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

This 6 mark levels of response question required candidates to describe two methods for producing artificial clones of animals. Many candidates gave detailed descriptions of embryo splitting and somatic cell nuclear transfer. Strong responses showed care in their use of terminology. In embryo splitting a multicellular embryo containing totipotent cells is divided into groups of cells. Poor descriptions referred to splitting the single-celled zygote or fertilised egg or splitting the cells of the embryo. Most candidates described SCNT in textbook fashion but answers that showed awareness that in fact a donor somatic cell is used rather than a separated somatic nucleus gained marks. Some less successful responses confused the cloning process with genetic engineering.

Exemplar 3

(c)* Humans can produce artificial clones of animals.

Describe **two** methods for producing artificial clones of animals.

Twinning

SCNT

Artificial twinning is when the mother is injected with hormones than increase the number of ova she releases. These ova are then fertilized this can be done naturally or in a lab, the ~~fertilised~~ eggs are then extracted and after a few days when the cumps of cells are still totipotent they are separated. Each of the ~~new~~ separated clumps are then implanted into different uteruses of the same species and when they are born they are clones of eachother. Another method is somatic cell nuclear transfer. A somatic cell is extracted from the mother, an egg cell from a different individual of the same species is extracted and ~~the~~ ~~nuc~~ is enucleated. An electric shock is then applied to the somatic cell nucleus and the empty egg cell causing them to fuse. [6]

higher success rate

Additional answer space if required.

~~The~~ ~~new~~ This cell is then implanted into a different individual of the same species uterus. The offspring will be a clone of the mother that the somatic cell came from.

This response contains a detailed description of firstly artificial twinning and secondly somatic cell nuclear transfer. Both descriptions cover most of the points seen in the indicative scientific points listed in the mark scheme. Terminology used is accurate and the information presented is relevant and substantiated. The response is clear and logically structured and so meets the criteria for Level 3 – 6 marks.

Question 5 (a)

5 DNA must be extracted from cells before it can be analysed.

(a) The sentences describe how DNA is extracted from a sample of tissue.

Complete the sentences using the most appropriate words or phrases.

Detergent is used to break down ..... . Proteins, such as histones, surrounding DNA can be hydrolysed by the addition of ..... . The DNA is precipitated from solution by adding ..... .

[3]

Candidates generally scored 2 or 3 marks. Most knew that detergent is used to break down membranes (often nuclear membranes mentioned). Relatively few knew that protease was required and often offered water as a suitable way to hydrolyse the histones. More knew that (ice cold) ethanol is used although many suggested salt was used to precipitate the DNA.

Question 5 (b)

(b) DNA analysis can be used to assess genetic biodiversity within populations.

A scientist assessed genetic biodiversity in four populations, **A** to **D**, of yellow horn, which is a small tree. They used two measures of genetic biodiversity:

- the percentage of polymorphic gene loci
- observed heterozygosity (the proportion of heterozygous loci in a population)

and analysed 23 gene loci in each individual tree they sampled.

The results are shown in the table.

Population	Number of trees sampled	Percentage of polymorphic loci	Observed heterozygosity
A	6	86.96	0.68
B	16	100.00	0.66
C	6	91.30	0.63
D	6	100.00	0.80

Another scientist stated that these results may not allow an accurate assessment of genetic biodiversity in these four populations.

Identify **two** pieces of evidence that support this scientist's evaluation.

1 .....

.....

2 .....

.....

[2]

Few candidates gained both marks. Marks were given most often for saying the sample size was too small and some commented that only 23 loci were studied. The most common misconception was that the difference between sample sizes of trees in group B (16) and A/C/D (6) was a limitation. Many candidates were not familiar with the terms 'polymorphic loci' and 'heterozygosity'; hence the idea that the two measures show different patterns of results was rarely given. This lack of familiarity with the subject matter was also demonstrated by candidates who suggested that every locus should have been studied or that homozygosity should have been studied as well. Further misunderstanding was demonstrated by candidates who described the subjectivity of observing heterozygosity.

Question 5 (c)

(c) The Hardy-Weinberg principle can be used to calculate allele and genotype frequencies in populations.

The common morning glory plant, *Ipomoea purpurea*, has a range of flower colours.

Two colours, purple and pink, are determined by a single gene.

The allele, **F**, coding for purple flowers is dominant to the allele, **f**, coding for pink flowers.

A field contained 600 *I. purpurea* plants, 150 of which had pink flowers.

Using the Hardy-Weinberg principle, calculate the number of plants that had a homozygous dominant (FF) genotype.

Use the equations:

$p + q = 1$

$p^2 + 2pq + q^2 = 1$

Number of plants with genotype FF = ... **[2]**

Candidates who were able to calculate the allele frequency correctly (q^2=150/600=0.25) often later reached the correct answer of 150 for 2 marks, or gained a mark for their calculations, even if they didn't reach the correct answer. The most common error was to assume 150/600 was q rather than q^2.

Question 6 (a)

6 Haemoglobin is an important protein in many animals, including humans.

(a) Sickle cell disease (SCD) is a disease caused by the production of abnormal haemoglobin.

A treatment for SCD is based on a technique called CRISPR gene editing and allows SCD patients to begin production of fetal haemoglobin.

The treatment has the following steps:

- Bone marrow stem cells are removed from the patient with SCD.
- An enzyme called Cas9 is added to the stem cells.
- Cas9 deletes bases from the *BCL11A* gene.
- The *BCL11A* gene usually switches off the fetal haemoglobin gene in adults.
- The gene-edited stem cells are placed back in the patient.
- The patient can now produce fetal haemoglobin.

This CRISPR gene editing method is different from traditional genetic engineering, which uses restriction enzymes and plasmids.

Describe the similarities and other differences between CRISPR gene editing and traditional genetic engineering methods.

.....

.....

.....

.....

.....

..... **[4]**

This was probably the most challenging question on the paper because of the amount of novel information that needed to be processed. Very few candidates achieved more than half marks. The candidates who scored highly organised their answer clearly with a list of similarities separated from a list of differences. Responses were aften confused and appeared more like attempts to describe the processes rather than compare and contrast them. The most common statement given was that CRISPR deletes bases, but then the comparative statement regarding genetic engineering was not correct. Many candidates wrote about the formation of sticky ends and many also rewrote information that was already given to them regarding reference to plasmids, restriction enzymes and Cas9. Specificity of language was not strong – many candidates referred to both techniques requiring enzymes – but didn't describe what for in terms of the similarity, i.e. to cut DNA.

Question 6 (b)

(b) Haemoglobin plays a crucial role in transporting oxygen in animals. Several ions also have roles in oxygen transport.

Three ions are listed in the table below.

Place ticks (✓) in the correct boxes to indicate which properties and features are true for each ion.

Ion	Has a negative charge	Binds to haemoglobin	A product of the dissociation of carbonic acid	Involved in the chloride shift
Hydrogen				
Hydrogencarbonate				
Chloride				

[3]

Candidates generally gained 2 or 3 marks. Not all candidates knew that hydrogen ions bind to haemoglobin but most identified the two properties/features of chloride ions correctly. Many candidates did not recognise that hydrogencarbonate ions are involved in the chloride shift. On the whole candidates were good at identifying the correct charges of the ions.

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