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Examiners' report

BIOLOGY B (ADVANCING BIOLOGY)

H422
For first teaching in 2015

H422/02 Summer 2019 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. 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 can be downloaded from OCR.

Paper 2 series overview

H422/02 is one of the three examination components for the A Level linear examination for GCE Biology B. This Scientific Literacy in Biology component has 20 marks dedicated to the pre-release material. The remaining marks can be given for short answer questions, extended writing and analytical skills including drawing graphs and interpreting varied data sets.

One feature of the 2019 paper was a question related to statistical aspects of biology. Candidates didn't perform well with the mathematical terminology required for this style of questioning.

Questions candidates found easiest	*Questions candidates found most challenging*
• 1(a)(ii) state names related to allele frequency changes • 2(a) (i) bond identification • 2(a)(ii) stating type of reaction • 2(b)(ii) Rf calculation & interpretation • 4(b)(i) naming Rubisco • 6(a)(i) explanation of reduction division • 6(a)(iii) naming a syndrome caused by chromosome mutations	• 2(d)(iii) suggest reason for mutation remaining high in population • 4(e) explanation of winter wheat seeds treatment and flowering times • 6(a)(iv) suggesting why cancers are not as a result of meiosis • 7(c)(i) genotype identification with corresponding gametes • 7(c)(ii) phenotypic ratios • 7(c)(iv) conclusion from calculated (previous) answer

Comparing the questions candidates found easiest with those that candidates found the most challenging, it is apparent that candidates were usually well-prepared in terms of subject knowledge. Candidates approached the levelled response questions well and averaged a Level 2 response for both. The non-statistical, mathematical analysis part questions were well answered and illustrates a focused attempt to deal with the increased maths requirements of this specification. Candidates found it difficult to identify the genotype from given information and did not appear to understand the term 'phenotypic ratio' as very few candidates attempted to write the correct phenotype next to their ratio (if not all equivalent).

Exam technique was clear, with many key terms underlined in the question and scaffolding visible for the level of response questions. This correlated well with high scoring candidates. Calculations were well set out with clear and logical processes shown.

Note

From this series students have been provided with a fixed number of answer lines and an additional answer space. The additional answer space will be clearly labelled as additional, and is only to be used when required. Teachers are encouraged to keep reminding students about the importance of conciseness in their answers. Please follow this link to our SIU (https://www.ocr.org.uk/administration/support-and-tools/siu/alevel-science-538595/)

Question 1 (a) (i)

1 This question is based on the Advance Notice article **'Learning from Iceland's model for genetic research'** in the **Insert**.

(a) The article explains how Iceland has one of the most genetically homogeneous populations in Europe.

(i) State what is meant by the following genetic terms.

1. Gene .....

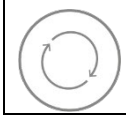
.....

2. Allele .....

.....

[2]

Most candidates could define allele and all candidates attempted the definitions. Gene descriptions were often given to GCSE standard with the use of 'coding for a characteristic' rather than protein.

	**AfL**	It is useful to tabulate or highlight key points that are extended at A Level compared to the candidate's GCSE knowledge/ specification.

Question 1 (a) (ii)

(ii) Allele frequencies will remain constant in a stable population. However, population changes can alter allele frequencies.

For each of the following events, give the term used to describe the effect on allele frequencies.

1. Iceland was settled by a relatively small number of explorers in the 9th century.

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2. The Icelandic population decreased due to the two waves of plagues during the 15th century, smallpox in the early 1700s and a volcanic eruption in 1783.

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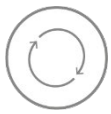
[2]

This was a well answered question by candidates who could clearly identify the relevant terms in relation to the example given. A few candidates simply stated bottleneck for example 2.

	**AfL**	Splitting key terms to see their origins often helps to consolidate knowledge and avoid candidates attempting to summarise terms that then give a different meaning. Placing words separately into a search engine is a quick way of allowing students to suggest definitions of key terms they have not previously encountered.

Question 1 (a) (iii)

(iii) Explain how the events described in **(ii)** resulted in the low genetic diversity of the Icelandic population.

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

Most candidates recognised that alleles would be lost and limited in these circumstances and some candidates related that to the size of the gene pool in the population. Answers often referred to inbreeding but did not connect this to limited allele number.

Question 1 (b)

(b) The article describes the use of flow cytometry ('automated blood analysers') to identify genetic variants linked to the risk of developing multiple myeloma.

Explain how flow cytometry could be used to identify genetic variants linked to the risk of developing multiple myeloma.

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

Candidates clearly recognised this technique and most candidates discussed the counting of cells and the use of fluorescence. To achieve full marks, candidates had to follow a sequential logic of the labelling technique. Some candidates did refer to DNA probes as they made the connection between searching for genetic variants and the direct use of these probes.

Question 1 (c)

(c) Some genetic diseases, such as sickle cell anaemia, are caused by single mutations.

Explain how a single gene mutation causes sickle cell anaemia.

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

Many candidates clearly knew the amino acid substitution causing sickle cell anaemia but often struggled to describe the type of mutation. Many candidates recognised it as a substitution but did not state base/nucleotide thus not differentiating it from the mark for amino acid substitution. Candidates then struggled to relate this change to an alteration in haemoglobin, referring straight to the altered erythrocyte shape. A few candidates discussed the gene mutation with the erythrocyte directly, confusing a cell with the protein inside.

	**OCR support**	OCR delivery guide on Population genetics and epigenetics (5.1.2) can offer support: https://www.ocr.org.uk/qualifications/as-a-level-gce-biology-b-advancing-biology-h022-h422-from-2015/delivery-guide/module-bb05-module-5-genetics-control-and-homeostasis/delivery-guide-bbdg028-population-genetics-and-epigenetics-512

Question 1 (d)

(d) The goal of the researchers at the International Myeloma Foundation is to identify people who develop multiple myeloma after having monoclonal gammopathy of undetermined significance (MGUS).

Evaluate the advantages and disadvantages of this approach compared with pedigree analysis.

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

Candidates knew the relevance of pedigree analysis and answered this question from this perspective. It was clear the pre-release material had been read as the most common mark point was the expense of this technique from this section of the pre-release; '*Researchers at the IMF store thousands of blood ……..These expensive tests allow the identification of genetic variants that might be linked to the risk of developing multiple myeloma.'* Many candidates also recognised the relevance of the 'identification' aspect of this quote and stated this approach was more accurate. All mark points were seen as some candidates not only used the pre-release material to gain information but realised the limitations of a pedigree analysis to those who have a family history and would not detect those who did not have this history.

Question 1 (e)

(e) In MGUS, B cells produce an abnormal polypeptide called M protein.

Production of M protein involves the processes of transcription and translation.

Complete the table by putting a tick (✓) in the appropriate box to indicate whether the feature is involved in transcription, translation, both or neither.

Feature	Transcription only	Translation only	Both	Neither
C pairs with G				
A pairs with T				
Phosphodiester bonds are made				
Peptide bonds are made				

[4]

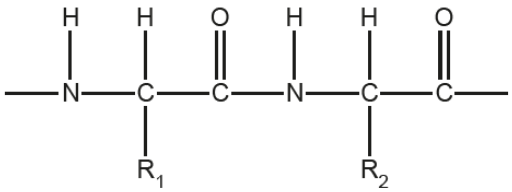
Few candidates achieved full marks, with many candidates scoring at least 2 marks. Most candidates did not realise that the T base would not be present during translation and that the only covalent bonds made during translation are peptide bonds.

Question 2 (a) (i)

2 Antimicrobial peptides (AMPs) are peptides found in animals and plants that destroy a wide range of pathogenic bacteria, fungi and viruses.

The α–defensins are a group of AMPs that contain 18–45 amino acids.

(a) The diagram below shows part of the structure of an α–defensin molecule.



(i) Draw a circle around the part of the structure that represents the peptide bond.

[The response to this question should be drawn on the diagram.] **[1]**

Most candidates circled the correct bond area. Many candidates focused their circle to the relevant bond only which is excellent practice, although circles encompassing the relevant functional groups and their bonds, was acceptable.

Question 2 (b) (i)

(b) A student used paper chromatography to investigate the amino acid composition of a sample of α–defensin.

(i) Suggest the importance of the following steps in the paper chromatography procedure.

1. The sample of α–defensin was heated with hydrochloric acid.

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2. Care was taken not to touch the paper with fingers.

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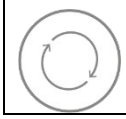
..... **[2]**

Candidates answered part 2 well and recognised the need to not contaminate the paper. A few candidates referred to not interfering with the solute* and solvent.

Part 1 proved to be more difficult for candidates to phrase and few used the correct terminology.

	**AfL**	This type of incorrect word association* can be minimised by key words constantly listed with particular techniques or annotated diagrams repeatedly drawn.

Question 2 (c)

(c)* AMPs are produced by epithelial cells in the intestines, respiratory tract, urinary tract and vagina.

The actions of AMPs include:
- destruction of many pathogenic bacteria, fungi and viruses
- stimulation of mast cells
- attraction and activation of phagocytes
- aggregation of pathogens (bacteria, fungi, viruses).

Use this information to explain how AMPs play an important role in the body's **non-specific** defence mechanisms.

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

This was a well answered level of response. Candidates identified the role of phagocytes and mast cells, often in great detail. Some candidates didn't connect this to the role of AMP's and they often referred to AMP's as antibodies and described antibody functions. Candidates clearly understood the use of the term 'non-specific' as few candidates referred to T and B cells.

Exemplar 1

~~AMPs~~ non specific ~~immune~~ defence mechanisms are the same regardless of the type of pathogen or whether it is the primary or secondary infection. AMPs stimulate mast cells, which promotes inflammation (inflammatory response). Mast cells secrete ~~cytokines~~ histamines, prostaglandins and serotonins which cause the vasodilation of arterioles and capillaries become more leaky, so there is a greater exchange of tissue fluid and phagocytes, which ensures that specific T helper and B ~~cells~~ lymphocytes are attracted to the site of infection. AMPs act as ~~a~~ cell signalling markers that attract phagocytes to the antigen and pathogen, promoting an immune response in the form of general phagocytosis. AMPs also take part in positive chemotaxis, attracting phagocytes. Phagocytes engulf the pathogen by endocytosis, then fuses with a lysosome to use the hydrolytic enzymes to digest the pathogen and then releasing the ~~all~~ other debris by exocytosis. Specific, complementary receptors on the surface of the phagocyte may bind to the AMP, activating phagocytosis. AMPs are produced by epithelial cells [6]

Additional answer space if required.

in the respiratory tract, where they may ~~help~~ bind to glycocalyx to form a ~~the~~ glycoprotein, mucus, that traps ~~microorganisms~~ pathogens. Furthermore, AMP may be a form mucus ~~with~~ in the vagina to inhibit microbial growth. AMP also aids the aggregation of pathogens by clumping them together.

This is a full mark response. The last part of the answer illustrates how Level 3 is achieved with a clear indication of the role of AMP's beyond that inferred in the question stem.

Question 2 (d) (i)

(d) The β–defensins are another group of peptides found in the male reproductive tract.

One β–defensin is coded for by the *DEFB126* gene. Men who are homozygous for a mutation in *DEFB126* have a normal sperm count with normal motility, but the sperm have a reduced ability to penetrate hyaluronic acid (a model for female cervical mucus).

(i) Suggest why it is thought that the *DEFB126* mutation reduces the chance of successful fertilisation.

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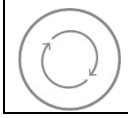
..... **[2]**

A lot of candidates were able to suggest an inability to reach or pass through the fallopian tubes/oviduct but many referred to the sperm fertilising an egg not a secondary oocyte. Some candidates discussed the acidity of the vagina without mentioning the restriction of movement and its consequences.

	**AfL**	It is useful to tabulate or highlight key points that are extended at A Level compared to the candidate's GCSE knowledge/ specification.

Question 2 (d) (ii)

(ii) It is estimated that 22% of all Europeans are homozygous for the recessive mutant form of *DEFB126*.

Calculate the allele frequency of the mutant form of *DEFB126* in all Europeans (men and women).

Use the Hardy-Weinberg equations:

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

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

frequency = ... **[2]**

The majority of the candidates attempted this calculation and a few candidates were able to score full marks. Most candidates did related q (or p) to 0.22 but often did not realise this value is for the square of q (or p) and thus did not square root it to obtain the answer. Some candidates did not answer correctly to 2 significant figures.

	OCR support	'Maths for Biology' website can offer support on the correct use of the significant figures: https://ocr.org.uk/subjects/biology/maths-for-biology/handling-data/ OCR delivery guide on the 'Population genetics and epigenetics': https://www.ocr.org.uk/qualifications/as-a-level-gce-biology-b-advancing-biology-h022-h422-from-2015/delivery-guide/module-bb05-module-5-genetics-control-and-homeostasis/delivery-guide-bbdg028-population-genetics-and-epigenetics-512v

Question 2 (d) (iii)

(iii) The fact that the *DEFB126* mutation reduces the chances of successful fertilisation means that, in theory, the allele frequency should have fallen.

Suggest why the allele frequency of the *DEFB126* mutation remains high.

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

The majority of the candidates attempted an answer to this question. A few candidates did correlate this with malaria and sickle cell anaemia and were thus able to suggest the idea of a selective advantage. Many answers referred to artificial techniques of fertilisation which were ignored as this would not have a significant impact on worldwide allele frequencies over generations.

Question 3 (a)

3 The extracellular matrix (ECM) can be thought of as the 'glue' that holds together the cells in a tissue. The ECM consists of water, proteins and polysaccharides.

Matrix metalloproteinases (MMPs) are a group of proteases that hydrolyse proteins in the ECM.

Each MMP consists of a single polypeptide chain.

(a) For each of the following features of MMP structure, draw a line connecting the feature to the correct description.

Feature	Description
The active site of MMP contains a Zn^{2+} ion that is required for substrate binding.	Primary structure
	Secondary structure
The enzyme contains a β-pleated sheet and three α-helices.	Tertiary structure
	Competitive inhibition
The amino acid histidine occurs in three places in the sequence making up the active site of all MMPs.	Cofactor

[3]

All candidates answered this question, with the most common, correct answer being the recognition of secondary structure. A lot of candidates stated tertiary structure for the third feature, clearly focusing on the term 'active site' and not reading the feature as a whole.

Question 3 (b) (i)

(b) MMP activity has been linked to the development of cancer.

Women with tumours in their breasts will often have biopsies (tissue samples) taken and tested to see if the tumours are malignant (cancerous) or benign (non-cancerous).

In one study, the total MMP activity was measured in breast biopsies that were classed as either:

- benign
- malignant grade I (the least malignant)
- malignant grade II
- malignant grade III (the most malignant).

Table 3 shows the results of this study.

Tumour classification	MMP activity (units per μg protein)
Benign	6.58
Malignant grade I	1.34
Malignant grade II	6.80
Malignant grade III	32.29

Table 3

(i) The researchers carried out a statistical test to compare the MMP activity in grade III tumours with the mean activity in all other tumours (benign, grade I and grade II).

Suggest a null hypothesis that the researchers would have used.

.....

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

A few candidates answered this correctly. Although most candidates did attempt a negative idea, e.g. no effect/ no change, they did not phrase their answer in a statistical manner with emphasise on 'the difference'.

	AfL	With statistical style terminology, candidates should always look for the two groups of data. Many examples can be given, relevant to them, e.g. hours of sleep and playtime on Fortnite, and students have to write the null hypothesis etc. for these examples.

	OCR support	'Mathematical skills statistics booklet' can offer support the correct use of statistical tests: https://www.ocr.org.uk/Images/338621-mathematical-skills-statistics-booklet.doc

Question 3 (b) (ii)

(ii) The result of this test gave $p < 0.0001$.

Use the words 'probability' and 'chance' to describe the conclusion the researchers would make.

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.....

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

Candidates found it difficult to answer this question even with the scaffolding of the question. Candidates often related probability to 'p' and the 'p value' but struggled with 'chance'. Candidates often referred to a correlation with the two groups without using set statistical terminology for a 'difference' between the data of the two groups. More able candidates used their null hypothesis to aid with this answer. Quite a few candidates did not attempt this question.

i	**OCR support**	Help with probability and chance definitions can be found at; https://ocr.org.uk/subjects/biology/maths-for-biology/handling-data/

Exemplar 2

Use the words 'probability' and 'chance' to describe the conclusion the researchers would make.

The probability that this result was purely down to chance is less than 0.0001

This is a correct response showing a clear understanding of the p value and the probability and chance terms.

Question 3 (b) (iii)

(iii) Use the data in Table 3 to evaluate the hypothesis that MMP activity increases the severity of breast cancer.

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

Most candidates achieved 2 marks, recognising the trend in the data and the differences with benign tumours. A few candidates evaluated this effectively, however. Candidates should remember that evaluate in this context requires a recognition of a point and then why this may occur.

Question 3 (c)

(c) Marimastat is an MMP inhibitor that was used in clinical trials as a potential treatment for cancer.

Suggest how marimastat could inhibit MMPs to reduce the hydrolysis of proteins in the ECM.

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

Most candidates recognised that it would inhibit in a competitive or non-competitive manner. Marks were lost for lack of clarity when describing these types of inhibition. Candidates should be very clear about naming each stage, especially when lots of acronyms are being used.

Question 4 (a)

4 In the 1950s, Melvin Calvin studied the series of reactions that we now know as the Calvin Cycle.

Calvin's 'lollipop' experiment was so called because it used a lollipop-shaped glass flask containing single-celled photosynthetic algae growing in culture.

A diagram of the apparatus Calvin used is shown in Fig. 4.1.

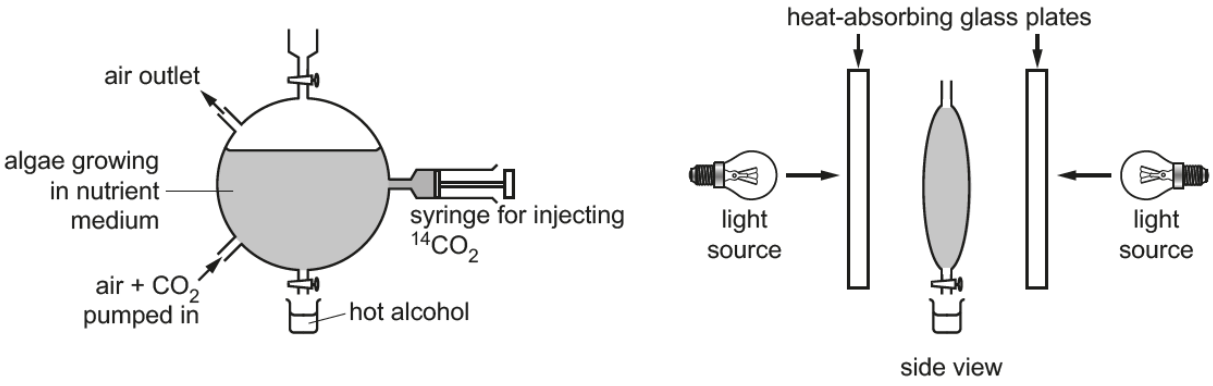

Fig. 4.1

The algae were illuminated for 30 minutes before the start of the experiment. Air and carbon dioxide were pumped into the suspension throughout.

At time zero, a small amount of radioactively-labelled carbon dioxide ($^{14}CO_2$) was injected from the syringe.

At intervals after addition of the $^{14}CO_2$, samples of the suspension were run off into hot alcohol before being analysed.

(a) Suggest the reasons for the following steps in the experiment.

1. Illuminating the algae for 30 minutes before the start of the experiment.

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2. Placing heat-absorbing glass between the light sources and the flask.

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3. Running each sample into hot alcohol before analysis.

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[3]

Majority of the candidates attempted this question with most candidates recognising the relevance of reason 1.

Many candidates discussed reason 2 in terms of not wanting to increase the rate of photosynthesis, from a positive standpoint.

A lot of candidates equated alcohol with sterilisation and discussed this in terms of lack of microbial or radioactive contamination. However, the relevance of 'hot' alcohol was not being addressed, in their answers.

Question 4 (b) (i)

(b) Calvin measured the relative radioactivity in various compounds at 2 seconds, 10 seconds and 30 seconds after addition of the $^{14}CO_2$.

The results of the analysis are shown in Table 4. Presence of radioactivity is represented in the table as '+' and no radioactivity as '–'.

Organic compound	Relative radioactivity present at time after addition of $^{14}CO_2$		
	2 s	10 s	30 s
Amino acids	–	–	+
Glycerate-3-phosphate (GP)	+	+	+
Sucrose	–	–	+
Sugar phosphates	–	–	+
Triose phosphate (TP)	–	+	+

Table 4

(i) Name the enzyme responsible for the initial incorporation of radioactive CO_2 into organic compounds.

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

The majority of candidates achieved this mark. A few candidates wrote carboxylase only.

Question 4 (b) (ii)

(ii) Use the results in Table 4 to explain the order in which the organic compounds are produced during photosynthesis.

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

Most candidates scored maximum marks. Candidates that did not score full marks, did not use the results in the table, they only referred to it. A lot of candidates discussed the fate of each compound in the Calvin cycle which was irrelevant as the fate could not be ascertained by the table of data. Candidates should relate the mark total with the data where there is a clear connection of 3 marks and 3 different timings.

Question 4 (c)

(c) Calvin isolated the compounds formed at the earliest time points and found they contained three carbon atoms.

This led him to conclude that the first reaction in the cycle was between CO_2 and a 2-carbon compound.

Explain why Calvin's conclusion was **incorrect**.

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

This was well answered with a lot of candidates scoring 1 mark for RuBP reacting with carbon dioxide. The second mark was often lost as candidates jumped straight to this reaction producing GP without referring to the 6C compound intermediate. Some candidates confused the carbon number in each compound.

Question 4 (d) (i)

(d) Fig. 4.2 shows the relationship between the net rate of photosynthesis and light intensity in a plant growing at atmospheric CO_2 concentration (0.04%).

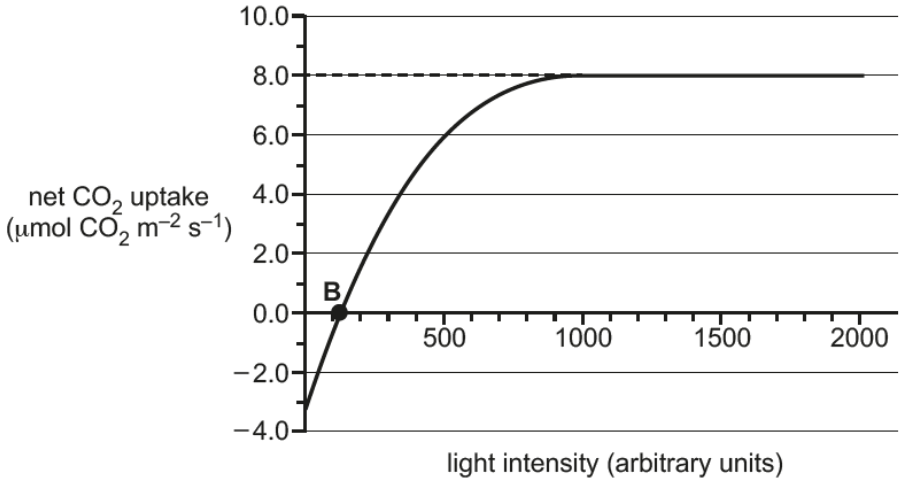


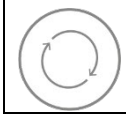
Fig. 4.2

(i) The plant had a leaf area of 0.97 m^2.

Calculate the maximum amount of CO_2 that the plant can take up in 1 minute.

maximum amount of CO_2 taken up in 1 minute = ... μmol **[2]**

Answers to this question were well calculated and well set out with logical steps. Candidates that did not score maximum marks did not take into account the leaf area for their maximum amount (per second) even though they did recognise the relevance of one minute in relation to the units on the y-axis.

	**AfL**	It is good practice to tick off all data given when used so any calculations will use all the data provided. Candidates should be reminded that data is only given if relevant to a calculation/part question.

Question 4 (d) (ii)

(ii) Explain the significance of the point labelled **B** on Fig. 4.2.

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

The majority of candidates correctly recognised point B, either referring to the equal rates or the term 'compensation point'. Some candidates referred to a decrease in carbon dioxide with an increase in oxygen.

Question 4 (e)

(e) Winter wheat seeds are usually sown in the autumn and flower the following summer. Seeds sown in the spring will usually not flower.

The Russian geneticist Lysenko discovered that winter wheat seeds can be treated with cold and moisture.

Explain why winter wheat seeds treated in this way and sown in spring are able to flower.

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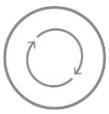
..... **[2]**

A lot of candidates recognised this example in the context of vernalisation but struggled to connect this with 'switching on' genes. Consequently, most answers reworded the information in the question without providing any further detail. Some answers referred to activating gibberellins, showing a confusion of flowering with germination.

	**AfL**	Word bounce is an effective teaching tool to get students to associate key terms correctly, e.g. a student is given the word 'flowering' and needs to bounce a word back that is relevant to this term in their specification. This can be bounced around the class until words are exhausted! It is good to help eliminate wrong words as well, as in this part question example.

Question 4 (f)

(f) Chrysanthemums normally flower only in autumn.

Commercial growers obtain flowers earlier in the year by growing the chrysanthemums in greenhouses where they can use screens or curtains to provide at least 12 hours of darkness.

Explain how this method stimulates early flowering and why it will not work if the plants are exposed to a brief period of light during the 12 hours of darkness.

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

The majority of candidates recognised these as short-day plants. Candidates who were familiar with phytochromes were able to proceed with their answer and gain full marks. Some candidates confused the 2 isomeric forms but clearly understood their role in flowering. Candidates who had not connected phytochromes with this question part, discussed the effect of light on photosynthesis, in terms of light intensity and glucose formation.

Question 5 (a) (i)

5 Fig. 5 shows a vertical section through the human eye.

The regions labelled **C**, **D** and **E** are affected by degenerative diseases of the eye associated with ageing.

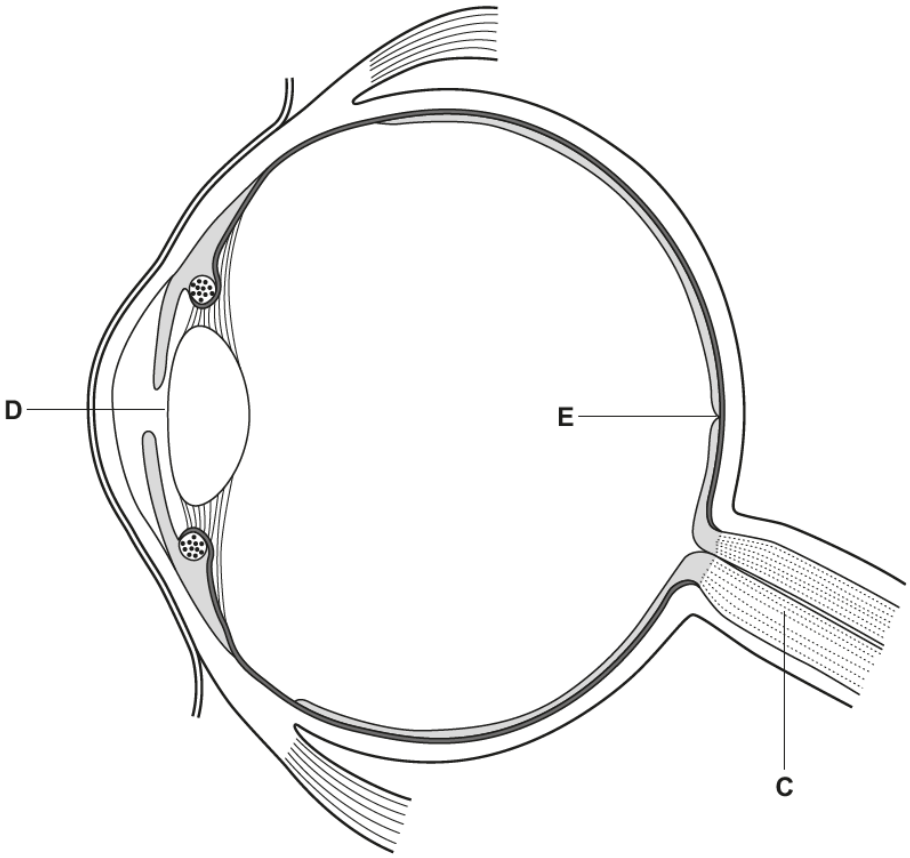

Fig. 5

(a) (i) For regions **C** and **D** in Fig. 5, name the degenerative disease **and** explain why vision would be affected.

Region **C**

name of disease .....

explanation .....

.....

.....

.....

Region **D**

name of disease .....

explanation .....

.....

.....

.....

[4]

Most candidates recognised region D and correctly identified cataracts, with varied spelling, and most connected this correctly with an opaque lens although most stated 'cloudy'.

Only a few candidates named a disease associated with region C. Common errors were Alzheimer's, Parkinson's disease and macula degeneration.

Question 5 (a) (ii)

(ii) Ranibizumab is a monoclonal antibody-based drug that inhibits the growth of new blood vessels.

Suggest how ranibizumab would be effective in treating a degenerative disease that affects the region labelled **E** in Fig. 5.

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

Well answered with a lot of candidates correctly identifying region E and connecting it with preventing macula degeneration. Candidates that did not achieve a mark could not name region E.

Question 5 (b) (i)

(b) The retina contains light-sensitive photoreceptor cells.

(i) Explain why photoreceptor cells in the retina are described as transducers.

.....

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

Only a few candidates correctly answered this part question. Common errors were conversion of light energy to electrical energy. Some candidates discussed transducers in the sense of transmission, of an action potential for example.

Question 5 (b) (ii)

(ii) Rod cells undergo various changes when they are stimulated by light.

Complete the following table by writing 'Rest' or 'Light' in the space provided to indicate whether the description refers to a rod cell at rest or when stimulated by light.

The first row has been completed for you.

Process in rod cell	**Rest or Light**
Rhodopsin is broken down to form opsin and *trans*-retinal	Light
Rod cell membrane is hyperpolarised	
Neurotransmitter is released by exocytosis from the rod cell into the synaptic cleft	
Sodium ion channels open	

[2]

All candidates attempted this answer. Many candidates achieved full marks and all variations were seen. Some candidates wrote 'dark' instead of 'rest'. Candidates should check their answers to make sure they have used the correct terminology. Some answers were correct for normal neurotransmitters so candidates hadn't appreciated that rods and cones are associated with an inhibitory neurotransmitter.

Question 5 (c)

(c) Red-green colour blindness is a sex-linked inherited disorder that affects mostly males.

Suggest why red-green colour blindness affects mostly males.

.....

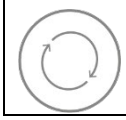
.....

.....

.....

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

This was well answered question with many candidates recognising this as an X chromosome disorder and some were able to link this with only 1 allele required for males to have the condition. The most common error was linking this to a Y chromosome disorder. Candidates should realise that sex linked disorders will always be on the X chromosome.

	**AfL**	It is visually effective for students to see the differences between some of the genes on the X and the Y chromosome, which can be found on images when performing a search on Y chromosome genes.

Question 6 (a) (i)

6 **(a)** Meiosis is the nuclear division that forms gametes.

(i) Explain why meiosis is referred to as a **reduction** division.

.....

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

Most candidates achieved this mark. A few candidates referred to a reduced number of chromosomes without referring to the idea of half and they didn't score any marks.

Question 6 (a) (ii)

(ii) Errors in meiosis can lead to chromosome mutations.

State the name of an event in meiosis that leads to chromosome mutations.

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

A lot of candidates referred to a stage of meiosis without referring to or describing the event that leads to chromosome mutations.

Question 6 (a) (iii)

(iii) State the name of one syndrome caused by a chromosome mutation.

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

The majority of candidates answered this question correctly with the most common syndrome being Downs Syndrome.

Question 6 (a) (iv)

(iv) Some cancers that develop later in life are caused by chromosome mutation.

Suggest why these cancers are unlikely to be the result of errors in meiosis.

.....

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

Only a few candidates were able to score this mark. Most candidates referred to the idea of it occurring earlier in life if due to meiosis but not stating why.

Question 6 (b)

(b)* Events before conception and during pregnancy can have a significant effect on the health of a baby.

Recently, scientists found there is only a small correlation between light alcohol consumption and small birth weight.

They found no evidence for a link between light-to-moderate alcohol consumption and the more serious effects of fetal alcohol syndrome, which can be caused when a mother drinks alcohol heavily during pregnancy.

Using this information and your own knowledge about the effects of alcohol on fetal development, evaluate this advice from the NHS website:

The Chief Medical Officers for the UK recommend that if you're pregnant or planning to become pregnant, the safest approach is not to drink alcohol at all.

.....

.....

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.....

.....

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

Most candidates were able to state effects of fetal alcohol syndrome and recognise the relevance of light/moderate and heavy drinking in relation to this. Thus, many candidates achieved at least a Level 1 answer. Few candidates were able to recognise clues in the information to assist with both sides of the evaluation, e.g. 'Recently, scientists found…' and lack of information given e.g. how many scientists/ where are these scientists? All aspects of information given for an evaluate level of response should be checked for these areas otherwise evaluate questions will focus on only one side of the discussion.

Question 7 (a)

7 **(a)** Fig. 7 is a diagram of a maize plant showing the male and female flowers.

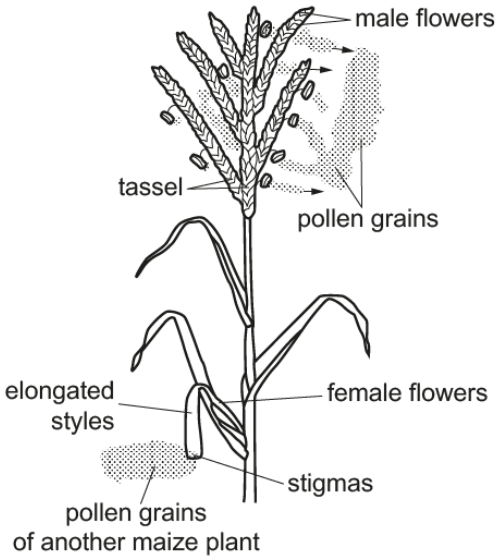

Fig. 7

Using the information in Fig. 7, identify **one** way in which maize is adapted for wind pollination.

.....

.....

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

Well answered with candidates recognising the position of the stigmas but some failing to make it clear that they hand outside of the plant.

Question 7 (b)

(b) When maize pollen grains land on the stigma of a maize plant, a pollen tube grows towards the ovule.

Describe the events that lead to the formation of the embryo **and** the endosperm.

.....

.....

.....

.....

.....

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

Only a few candidates scored full marks in this question. This was well answered especially by high ability candidates. Some candidates recognised this as double fertilisation even if they could not recall details.

Question 7 (c) (i)

(c) As well as being a popular food (corn on the cob), maize is a useful model for studying patterns of inheritance.

Each maize cob contains hundreds of seeds known as kernels.

In maize, one gene determines the colour of the kernels, which is either yellow or colourless.

Another gene determines the amount of endosperm in each kernel. Kernels filled with endosperm are smooth whereas kernels with shrunken endosperm appear wrinkled.

(i) Two pure breeding strains of maize were crossed. One strain had smooth yellow kernels. The other strain had wrinkled colourless kernels.

All the kernels of the offspring (F_1) were smooth and yellow.

The plants in the F_1 generation were then crossed with plants that had pure-bred wrinkled colourless kernels.

State the parental genotypes and gametes of this cross.

Use the following to represent the alleles:
- **A** and **a** for colour (yellow or colourless)
- **B** and **b** for appearance (smooth or wrinkled).

parental genotypes: ..... × .....

gametes: .....

[2]

Few candidates correctly identified the parental genotypes and often incorrectly extrapolated the gametes from their genotype.

i	**OCR support**	OCR delivery guides on 'Patterns of inheritance' (5.1.1): https://www.ocr.org.uk/qualifications/as-a-level-gce-biology-b-advancing-biology-h022-h422-from-2015/delivery-guide/module-bb05-module-5-genetics-control-and-homeostasis/delivery-guide-bbdg027-patterns-of-inheritance-511

Question 7 (c) (ii)

(ii) Using a genetic diagram and your answer to **(c)(i)**, predict the phenotypic ratio that you would expect from the second cross.

phenotypic ratio: ..... **[2]**

Very few candidates achieved full marks. Many were able to identify the ratio correctly but did not refer to the phenotypes in any part of their answer. Those candidates that incorrectly predicted a non-equivalent ratio did not appreciate that, without phenotypes, the ratio is not clear enough for a mark.

Question 7 (c) (iii)

(iii) The actual results of the second cross are shown in Table 7.1.

Phenotype	Number of kernels
Smooth yellow	275
Wrinkled yellow	277
Smooth colourless	235
Wrinkled colourless	213

Table 7.1

Calculate χ^2 for these data.

Use the formula: $\chi^2 = \Sigma\frac{(f_o - f_e)^2}{f_e}$

You may use the table below for working out.

χ^2 = ... **[3]**

Most candidates used the table to assist with their calculations. Most candidates were able to recognise and apply the data in table 7.1 to correctly estimate the expected column, applying their ratio from the previous answer.

i	**OCR support**	'Mathematical skills handbook' contains worked examples using the chi squared test in biology. Section M1.9 'Select and use a statistical test': https://www.ocr.org.uk/Images/294471-biology-mathematical-skills-handbook.pdf

Question 7 (c) (iv)

(iv) Table 7.2 shows a χ^2 probability table.

Degrees of freedom	Probability (p)				
	0.50	**0.10**	**0.05**	**0.01**	**0.001**
1	0.46	2.71	3.84	6.64	10.83
2	1.39	4.61	5.99	9.21	13.82
3	2.37	6.25	7.82	11.35	16.27
4	3.36	7.78	9.49	13.28	18.47

Table 7.2

What can you conclude about the results shown in Table 7.1 based on the χ^2 value you calculated in **(c)(iii)**?

.....

.....

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

Few candidates were able to use the correct, statistical terminology to answer this question. Many candidates referred to the results being significant or not, due to chance or not, without referring to the 'difference between pairs' as discussed for Question 3bi.

Question 7 (c) (v)

(v) Suggest an explanation for your conclusion in part **(iv)**.

.....

.....

.....

.....

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

Very few candidates recognised this as a linkage effect. Most answers centred on the calculated value and the critical value.

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