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Examiners' report

BIOLOGY A

H420

For first teaching in 2015

H420/03 Summer 2023 series

Version 1

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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.

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Paper 3 series overview

H420/03 is one of the three examination units 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. Some candidates found this paper challenging because of its synoptic nature but also because of all the skills they were assessed on. Candidates were assessed on their ability to analyse, interpret, evaluate ideas, and provide evidence to reach conclusions, as well as 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 writing around the provided lines. This is very good practice and we encourage all centres to advise their candidates to do, the same.

Centres are advised to encourage candidates read the stem of the question carefully and ensure their answers include information that is relevant to the question.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• recalled the meaning and definitions of terms accurately • showed mathematical fluency in calculations and interpreted graphs correctly • produced clear, well organised and concise responses to questions • did not repeat too much material from the question stem in their responses • read the question carefully and paid attention to the information and data provided • could interpret information given in diagrams, graphs and tables and use it to answer related questions • were able to extend their responses to follow a process through to describe the logical result of a change in conditions • had a good practical knowledge, with the ability to understand and apply the information given to the questions being asked.	• confused certain key terms such as sympatric and allopatric • found it difficult to answer mathematical based calculations • left answers unfinished or blank • found it difficult to apply knowledge in an unknown context • wrote responses which lacked depth, particularly to practical based questions • produced responses which were very wordy and often simply repeated information provided in the stem of the question • found it difficult to interpret and use images and information supplied in the question paper to answer related questions.

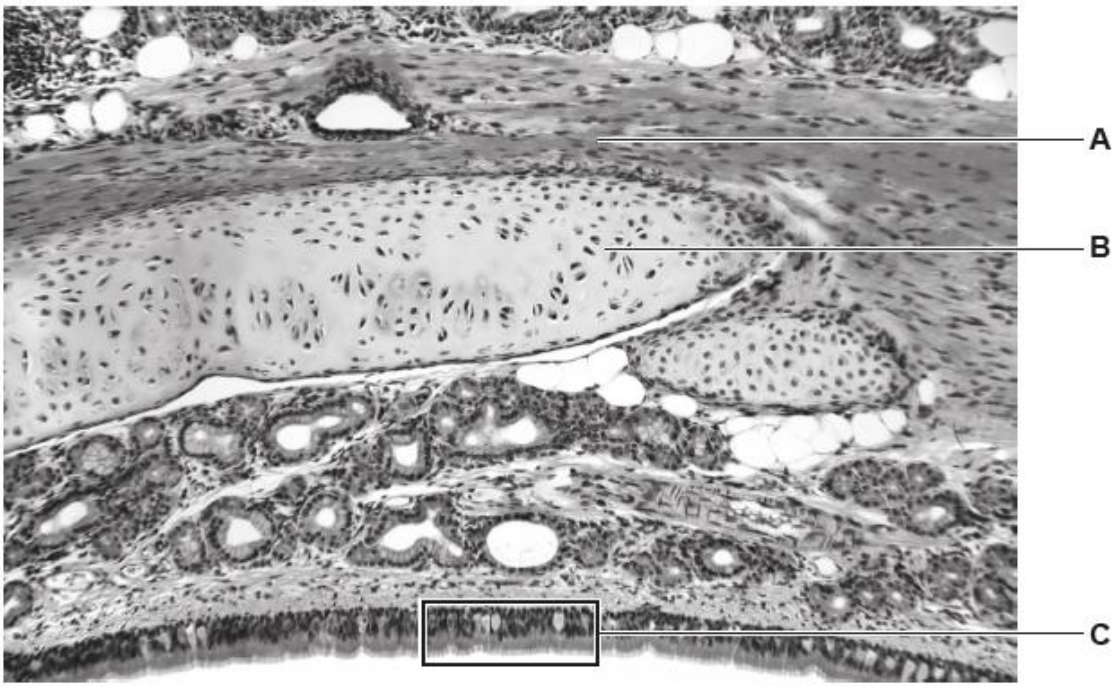
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Question 1 (a) (i)

1 Cats are mammals.

(a) A light micrograph of a section through the trachea of a cat is shown in **Fig. 1.1**.

Fig. 1.1



(i) Name the tissues labelled **A** and **B** in **Fig. 1.1**.

A .....

B .....

[2]

Only a few candidates were able to identify the tissues labelled A and B. Smooth muscle was often confused with skeletal or striated muscle or just labelled as 'muscle', and cartilage was often labelled as collagen or elastic tissue.

Assessment for learning

Showing students images of photomicrographs from which they need to identify structures and describe what they see may help them to answer similar questions in the future.

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Question 1 (a) (ii)

(ii) Name the **two** types of cell in the box labelled **C** in **Fig. 1.1 and** outline their functions.

1 Name .....

Function .....

2 Name .....

Function .....

[2]

This question was generally well answered, with many candidates identifying the cells as 'goblet cells' that secrete mucus and ciliated epithelial cells that beat to move mucus towards the throat. Some candidates lost a mark for naming the cell as a 'ciliated cell' *without* 'epithelium' or just naming it as cilia. Some incorrectly stated that ciliated epithelial cells move mucus to the stomach, or that they move dust or particulates, rather than moving mucus.

Question 1 (b) (i)

(b) Alveoli increase the surface area to volume ratio (SA:V) in the lungs of cats and other mammals.

(i) An alveolus in the lung of a cat has:

- a spherical shape
- a diameter of 0.13 mm
- a surface area of 0.053 mm^2.

Calculate the SA:V of this alveolus.

Use the formula: volume of sphere = $\frac{4}{3}\pi r^3$

SA:V = ... **[3]**

Some candidates achieved 3 marks easily and most achieved 2 marks, for calculating the radius and the volume correctly. A few candidates didn't score the third mark because they were didn't calculate the correct ratio, e.g. 46:1. Quite a lot of candidates got the ratio the wrong way round or gave an answer to more than 2 significant figures. Some candidates used the diameter rather than the radius, or squared instead of cubing the radius, when working out the volume.

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OCR support

Help with ratios and other mathematical skills can be found in the OCR Biology Maths Skills Handbook

Maths for Biology resources can also be useful to support students with mathematical skills via tutorials and quizzes.

Question 1 (b) (ii)

(ii) Explain why the large SA:V of alveoli is an advantage to mammals.

.....

.....

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

Many candidates just mentioned the increase in surface area without relating this to more oxygen uptake, increased gas exchange or a faster rate of diffusion. Other common errors included linking a large SA:V ratio to a shorter diffusion distance, or to more efficient gas exchange or greater absorption of oxygen.

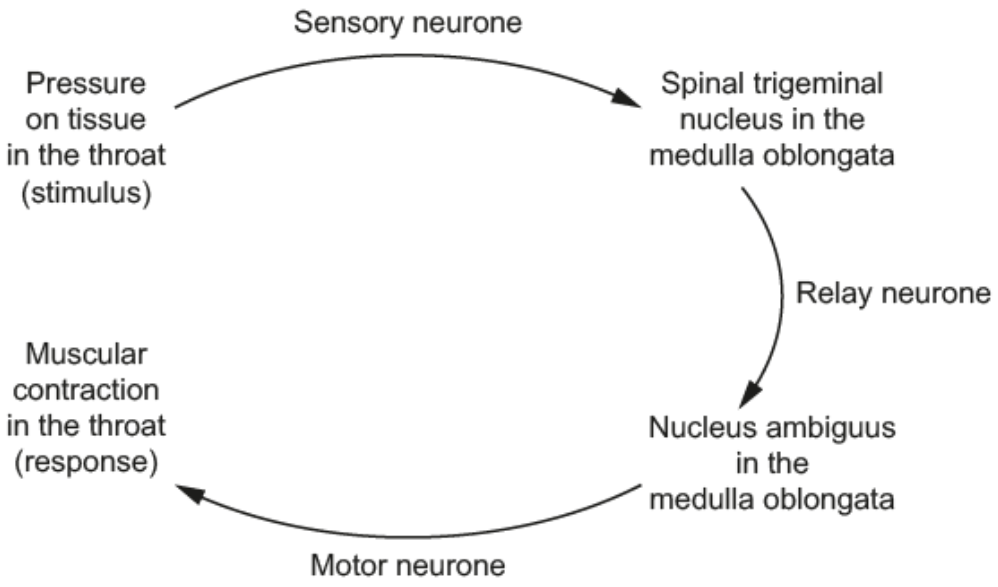
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Question 1 (c)

(c) The nervous system of a cat coordinates a response to stop objects becoming stuck in their throat.

Sensory receptors at the back of the throat detect the stimulus of a large piece of food or a ball of hair pressing on the tissue. The response is shown in **Fig. 1.2**.

Fig. 1.2



Explain **two** conclusions that can be drawn from **Fig. 1.2** about the type of nervous response shown.

.....

.....

.....

.....

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

This was intended to be a challenging question. Many candidates understood that the response was involuntary or a reflex but found it difficult to explain why. Some seemed to have little knowledge on neural pathways and reflexes in general, believing that this was not a reflex as it involved the brain, or that it was an automatic response. Higher scoring candidates could identify it as an involuntary reflex response and linked this to being controlled by the medulla oblongata or only involving a few neurones.

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Question 2 (a) (i)

2 Vitamins are molecules that are consumed in the diet of animals and have essential roles in the body.

(a) Thin layer chromatography (TLC) was used to separate a mixture of vitamins from a vitamin supplement tablet.

(i) Most vitamins are colourless.

Suggest **one** method for visualising the vitamins in TLC.

.....

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

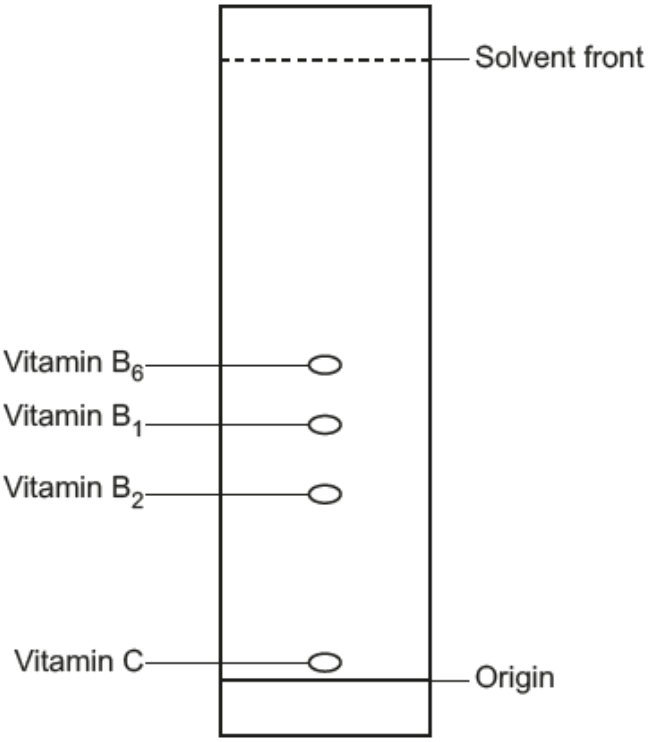
Most candidates gained this mark. Mistakes included the use of 'a solvent' or the suggestion that a 'chemical' or 'tagged antibody', should be attached to the vitamins before the chromatography is performed (which would affect R_f values).

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Question 2 (a) (ii)

(ii) The results of the TLC are shown in the chromatogram in **Fig. 2.1**.

Fig. 2.1



Use **Fig. 2.1** to calculate the R_f value of vitamin B_2.

R_f = ... **[2]**

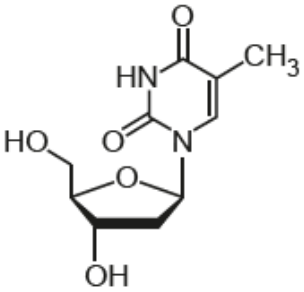
Most candidates attempted this question, the majority scored both marks, although a few candidates did not score any marks. Those scoring no marks usually did so because of an incorrect calculation of 8/2.4. or measured the wrong vitamin, outside the range of 2.3 – 2.5. Some candidates lost 1 mark as they answered to more than 2 significant figures.

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Question 2 (b)

(b) Vitamin B_9 is needed for the synthesis of molecule **D**, shown in **Fig. 2.2**.

Fig. 2.2



Molecule **D**

Molecule **D** is a component in the structure of DNA.

A deficiency of vitamin B_9 in the diet can cause interphase to stop in some cells.

Use **Fig. 2.2** to explain why a deficiency of vitamin B_9 can cause interphase to stop.

.....

.....

.....

.....

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

A relatively large proportion of candidates mentioned in their answers that DNA replication would be incomplete, scoring 1 mark. A small number of candidates did not attempt this question, some candidates scored no marks as they only gave a general description of what interphase is without including details of how the lack of B_9 would alter it. Many candidates suggested that 'no molecule D' could be produced, overlooking the wording in the stem ('deficiency'), which would suggest some D could be synthesised. Quite a few answers that described checkpoints did not specify the G2 checkpoint and therefore did not gain credit.

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Question 2 (c) (i)

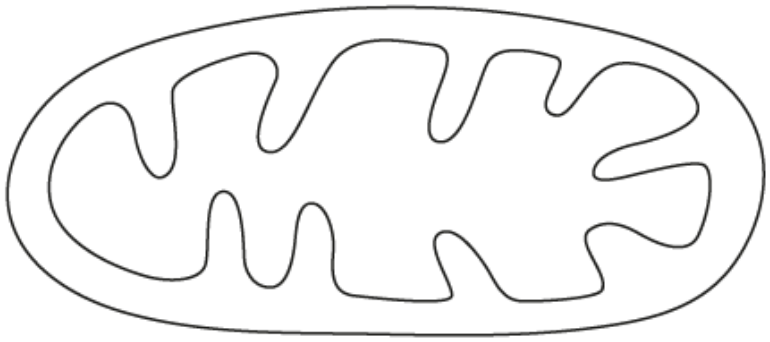
(c) Vitamin B_2 is used by the body to make FAD. Vitamin B_3 is used by the body to make NAD.

(i) A mitochondrion is shown in **Fig. 2.3**.

Label **Fig. 2.3** to show the locations where FAD gains H atoms and where FAD releases H atoms during respiration.

- Use the letter **E** to show where FAD gains H atoms.
- Use the letter **F** to show where FAD releases H atoms.

Fig. 2.3



[2]

Few candidates did not score any marks on this question. The labelling of letter **E** was more commonly scored than **F**, but many candidates scored both marks. The most common misconception was that FAD released H atoms (letter **F**) in the inter-membranal space, rather than on the inner mitochondrial membrane.

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Question 2 (c) (ii)

(ii) The table lists features that are correct for FAD, NAD, both or neither.

Complete the table by adding a tick (✓) to a box where the feature is correct and a cross (✗) where the feature is incorrect. You should add either a tick or a cross to every box in the table.

Feature	FAD	NAD
Is a prosthetic group		
Is reduced in the link reaction		
Oxidises molecules in the electron transport chain		

[2]

FAD and NAD are often described as coenzymes, but FAD can be considered a prosthetic group. The categorisation of coenzymes and prosthetic groups differs between textbooks and other sources. For this reason both '✓' and '×' were accepted as correct for the 'FAD is a prosthetic group'. Most candidates knew that NAD is not considered a prosthetic group. Few candidates realised that neither FAD nor NAD oxidise molecules in the ETC (reduced FAD and reduced NAD reduce molecules in the ETC).

Question 2 (c) (iii)

(iii) ATP is produced in respiration. Some of these molecules of ATP are used to release energy for processes in respiration. For example, ATP is used in the early stages of glycolysis.

Suggest **one other** way in which ATP contributes to the process of respiration.

.....

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

This question proved challenging to many candidates. Many candidates named the phosphorylation of glucose in glycolysis and did not realise this example is already described in the question. A common misconception was that protons are moved into the inter-membrane space using energy from ATP. Candidates did not realise that the energy for this process came from the electrons. Several answers correctly named the movement of pyruvate into the mitochondria but did not make reference to active transport. Very few candidates mentioned using ATP to synthesise respiratory enzymes such as ATP synthase.

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Question 2 (d) (i)

(d) Vitamin C affects the activity of enzymes in different ways.

(i) Vitamin C acts as a coenzyme for several enzymes in the synthesis of collagen.

Outline the role of coenzymes in biological reactions.

.....

.....

.....

.....

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

Most candidates scored 1 mark, usually for describing the mechanism of how a coenzyme might work, e.g. coenzyme attaching to the active site or making it easier for substrates to bind to the active site. Only a few candidates mentioned that coenzymes assisted enzymes without being permanently bound to them. A small number of candidates thought that they bind permanently to the enzymes which was not credited.

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Question 2 (d) (ii)

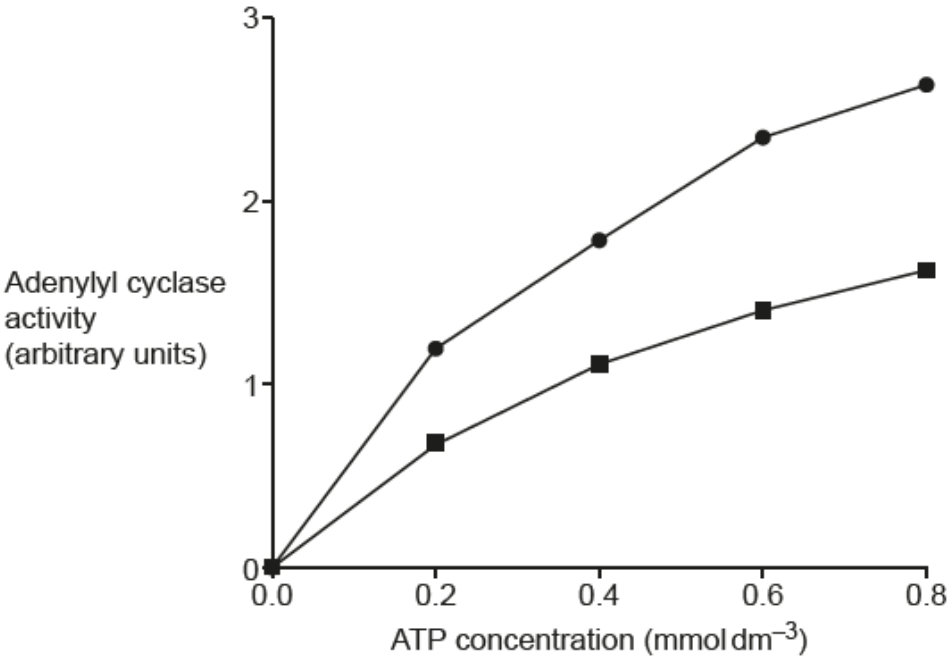
(ii) A scientist investigates the effect of vitamin C on the activity of the enzyme adenylyl cyclase.

Adenylyl cyclase catalyses the conversion of ATP to cAMP.

The scientist measures the activity of adenylyl cyclase without vitamin C and with 1 mmol dm^{-3} of vitamin C.

The scientist's results are shown in **Fig. 2.4**.

Fig. 2.4



Explain what can be concluded from the results in **Fig. 2.4** about the effect of vitamin C on the activity of adenylyl cyclase.

.....

.....

.....

.....

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

Most candidates were able to interpret the graph to state that vitamin C reduces the activity of adenyl cyclase or acts as an inhibitor. However, very few were able to explain that the shape of the curve with vitamin C present, indicates that it is a non-competitive inhibitor, or that as the enzyme activity had not plateaued you could not decide which type of inhibition was shown.

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OCR support

Our teaching guide on 'Enzymes' offers an overview of key concepts and suggest classroom activities.

Question 3 (a) (i)

3 Genetic modification and selective breeding can be used to improve the characteristics of crop plants, such as maize.

(a) In high light intensity, photosystem II absorbs excess light energy.

A process called nonphotochemical quenching (NPQ) converts the excess light to heat energy.

NPQ can continue when light intensity is no longer in excess. This makes photosynthesis inefficient.

Scientists genetically modified (GM) crop plants to limit NPQ.

The scientists exposed unmodified plants and GM plants to a period of high light intensity followed by lower light intensity. The scientists then compared the rate of NPQ and the rate of carbon dioxide (CO_2) fixation in unmodified plants and GM plants.

Some of the results are shown in the table.

Time after decrease in light intensity (s)	Rate of NPQ (arbitrary units)		Rate of CO_2 fixation (mmol CO_2 m^{-2} s^{-1})	
	Unmodified plant	GM plant	Unmodified plant	GM plant
0	1.00	1.00	26	26
150	0.35	0.25	11.5	13.2

(i) State **one** dependent variable in this investigation.

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

This question was answered correctly by most candidates who demonstrated a good knowledge of variables. The most common mistake was to give light intensity as the answer. Some lost the mark for stating the amount of CO_2 taken in rather than rate of CO_2 fixation .

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Question 3 (a) (ii)

(ii) Explain the effect of genetic modification on the rate of CO_2 fixation after 150 seconds of low light intensity.

.....

.....

.....

.....

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

Some candidates misinterpreted the data and stated that genetic modification 'decreased the rate of carbon fixation'. These answers compared the rate at 0 and 150 seconds for the GM plant rather than making the correct comparison; GM and non-GM plants at 150 seconds. Some explained why the rate of fixation fell with reduced light rather than why fixation was higher in the GM plants or described the higher rate of fixation in the GM plants (including quoting data from the table) but did not explain why. Nonetheless, many answers did state that the rate was increased by genetic modification because of a reduced NPQ rate. Far fewer were able to make the link between reduced NPQ and increased ATP and NADPH for the Calvin cycle.

Question 3 (a) (iii)

(iii) Often a single company holds the patent for a GM crop plant.

Suggest a potential ethical issue that may exist if one company holds the patent for a GM crop plant.

.....

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

Candidates generally had the right idea and gained the mark for this question. Marks were mostly awarded for the idea of the plant being expensive. A few described what a 'patent' is rather than the possible consequences. Some candidates gave other possible concerns around GM plants which were not related to patenting/access.

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Question 3 (b)

(b) Humans have been selectively breeding maize as a crop plant for thousands of years, which has resulted in many different varieties of maize.

Different varieties of maize have different genomes.

Describe how bioinformatics and computational biology can be used to compare the genomes of different varieties of maize.

.....

.....

.....

.....

.....

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

This question was proven challenging for the candidates. Only a few candidates were confident with these processes and knew what a genome is. These candidates mentioned storing information on databases or using software or models to compare and identify similarities or differences between the DNA sequences of different varieties of maize. Lots of candidates included irrelevant descriptions of lab methods such as PCR, Southern Blotting, or referenced sequencing amino acids, rather than sequencing genomes. Some candidates went into detail about how sequencing is carried out, or just repeated the stem of the question and talked about 'comparing genomes'.

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Question 3 (c)

(c) Two characteristics that farmers have selectively bred in maize are colour and kernel (fruit) shape.

Colour is determined by a gene with two alleles:

- Allele **A** is dominant and results in a purple colour.
- Allele **a** is recessive and results in a yellow colour.

Kernel shape is determined by a gene with two alleles:

- Allele **B** is dominant and results in a smooth shape.
- Allele **b** is recessive and results in a wrinkled shape.

The two genes are found on different chromosomes.
Two maize plants are crossed.

- One parent plant is purple and smooth and heterozygous for both genes.
- One parent plant is yellow and smooth and heterozygous for gene **B/b**.

Complete the answer lines below to show this genetic cross.

Parental genotypes: ..... × .....

Gametes: .....

Expected offspring phenotypes: .....

.....

Expected phenotypic ratio: .....

[4]

Relatively few candidates were able to work through this cross to deduce the correct offspring phenotypic ratio. Many candidates were prepared for a standard dihybrid cross with heterozygous parents, giving a 9:3:3:1 ratio. Most candidates were able to give the parental genotypes but couldn't identify how the gametes were derived from the genotype. A few candidates did not know what a phenotype is, and several candidates who did work through this cross correctly lost a mark for not matching up the correct phenotype with the phenotypic ratio.

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Assessment for learning



Candidates could be given a range of possible parental genotype combinations to work through hybrid cross, not just the standard dihybrid cross with two heterozygous parents.

Placing gametes in circles might help candidates understand how the gametes are derived from the genotype.

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Question 4 (a)*

4 The Convention on International Trade in Endangered Species (CITES) came into effect in 1975.

(a)* **Fig. 4.1** shows the percentage of species threatened with extinction that have been protected under CITES.

Fig. 4.1

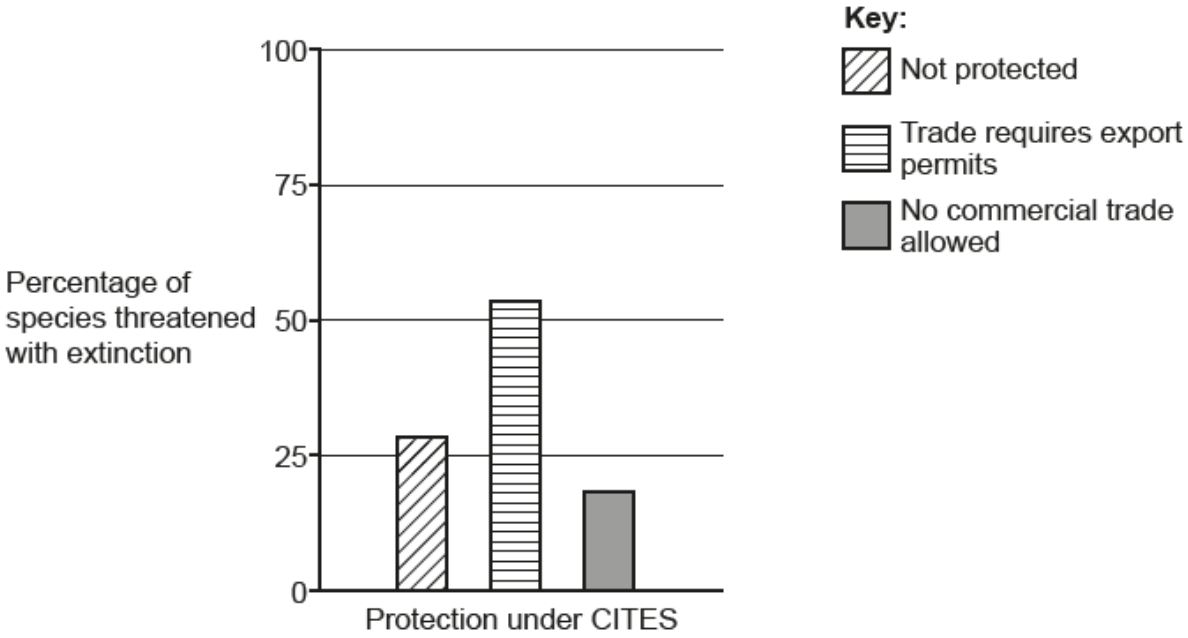
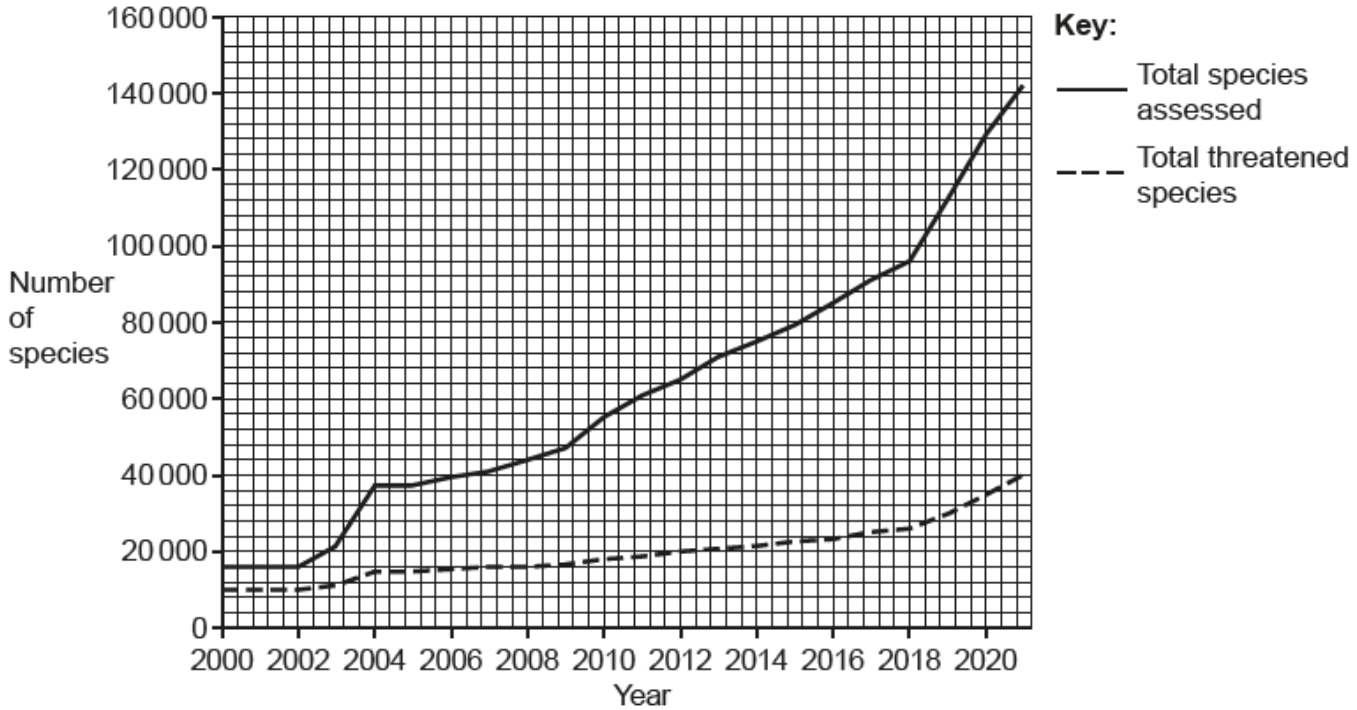


Fig. 4.2 shows the number of species assessed and the number of species categorised as threatened with extinction by the International Union for Conservation of Nature (IUCN) each year.

Fig. 4.2



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The aim of CITES is to monitor and regulate the international trade of threatened species to prevent extinctions.

Using the data in **Fig. 4.1** and **Fig. 4.2**, evaluate how successful CITES has been in achieving its aim.

.....

.....

.....

.....

.....

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

Many candidates structured their answer clearly with separate sections for positive and negative comments or used side headings to good effect. In some cases, it was not always clear that candidates were evaluating the data, and often included unstructured comments about the data that did not indicate whether CITES had achieved its aims or not. Candidates who did not access the higher levels often misinterpreted graph 4.1. They thought that the graph showed the effect of different categorisations on the % of threatened species rather than the % of threatened species in each category. This led to confused phrases such as "making trade require permits increases the risk of extinction compared to not protecting at all''. Graph 4.2 was generally well understood and effectively commented on.

Assessment for learning

The majority of candidates were able to gain some marks on this question, but exam technique could be improved to maximise their success.

The acronym ReBUGG could be used:

Re read the question
B box in command words
U underline key words
G gauge the number of points needed
G glance back and read what you have written.

When candidates are asked to evaluate, they should aim to find positives and negatives. When they are asked to use data from two sources, they need to make sure they use both. So as a **minimum** they should be aiming to make 4 points.

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Exemplar 1

In figure 4.1, you can see that around 53% of species threatened with extinction need ~~permits to~~ export permits to trade, and around 20% of them are not allowed to be comercially traded, and also 26% are not being protected. The fact that 53% of the endangered species require export permit shows that CITES are protecting over half of the endangered species and so you could say they have been successfull in that manner, but 26% are not protected by CITES so there is a threat of extinction there that CITES is not regulating. In figure 4.2, there is a clear increase of total species assessed over the ~~6~~ years, which shows that CITES has been assessing many species to ensure their protection, and also there has been a 89% increase in species assessed. Also in figure 4.2 the total species threatened has remained fairly constant between 16,000 - 25,000 from 2000 to 2016 which shows CITES had been regulating ~~ex. the number of endang~~ and preventing an increase in extinction, but in 2016 the number of ~~endang~~ threatened species started to increase until 2020 when it hit 40,000 threatened species. This shows that CITES has not been so successful over the ~~past~~ 4 years of 2016-2020. ~~in regulation~~ **[6]**

Additional answer space if required.

This response was given Level 3 and scored 6 marks. There is a positive comment about graph 4.1 (53% of endangered species require permits) and a negative comment (26% are not protected by CITES). There is a positive comment about Fig. 4.2 (increase in total species assessed) and a negative comment (number of threatened species is increasing). The structure is fine (i.e., dealing with Fig. 4.1 then Fig. 4.2) and so the communication mark is given.

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Exemplar 2

& Fig. 4.1 shows that CITES is only successful when there is a ban on commercial trade as this has the lowest percentage of species threatened for extinction, below 2.5. When allowing trade only with Permits there was a highest percentage of species threatened for extinction, above 60, even higher than when trade was not protected by CITES. Therefore CITES is only successful when ~~banning~~ there is a ban on commercial trade.

Fig. 4.2 shows CITES to be successful as the number of threatened species by the year 2020 is drastically low compared to the total number of species assessed, there are around 100,000 species not threated with extinction compared to the total of over 140,000. **[6]**

Additional answer space if required.

Therefore CITES is successful in preventing extinction of threatended species

This response was given Level 1 and scored 2 marks. The comments about Fig. 4.1 are incorrect as the candidate has misinterpreted the graph and has concluded that by imposing trade restrictions this increases the number of threatened species. Fig 4.2 has a correct positive statement about CITES, and so it meets the criteria for Level 1. The answer is well structured so can be awarded the communication mark.

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Question 4 (b) (i)

(b) The kakapo, shown in **Fig. 4.3**, is an endangered species of flightless bird that lives in New Zealand. The population size of kakapos has experienced a large decrease over the past few hundred years. There are now fewer than 250 kakapos living in the wild.

Fig. 4.3



(i) State the term for a large decrease in population size that reduces the gene pool.

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

Most candidates correctly answered this question. Common incorrect answers included genetic drift or mass extinction.

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Question 4 (b) (ii)

(ii) Adaptations can be categorised into three different types:

- anatomical
- behavioural
- physiological.

The table lists four traits that kakapos have evolved.

Complete the table by naming the type of adaptation represented by each of the four kakapo traits.

Kakapo trait	Type of adaptation
Active at night to avoid predators	
Green feathers that camouflage with its surroundings	
Slow digestion to extract nutrients from a high-fibre, low-protein diet	
Strong beak and claws to climb trees	

[2]

This question was well answered with most candidates gaining at least 1 mark. A minority thought that green feathers, strong beak and claw were physiological adaptations and 'slow digestion' was anatomical adaptation.

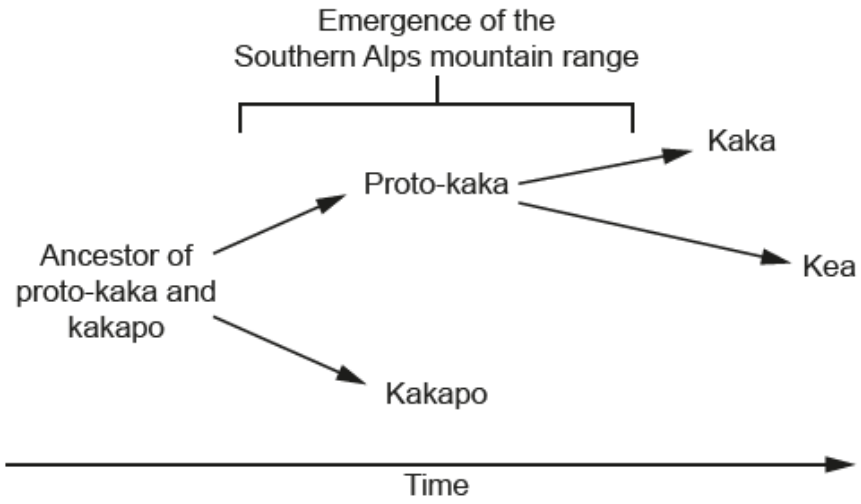
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Question 4 (b) (iii)

(iii) The kakapo and two other species of bird, the kaka and the kea, evolved from a common ancestor approximately 70 million years ago.

The evolutionary timeline of the three species is shown in **Fig. 4.4**.

Fig. 4.4



- The kakapo cannot fly. It forages for leaves and roots on the ground in forests and grasslands.
- The kaka can fly. It eats seeds, fruit, and occasionally the eggs of other birds in forest habitats.
- The kea can fly. It eats plants, larvae and other small animals. It lives in mountainous forest habitats.
- All three species live on the South Island of New Zealand and had overlapping ranges until the population size of kakapos started to decrease. Populations of kakas also live on the North Island of New Zealand.

A student studied the information and suggested that all three species evolved by sympatric speciation.

Evaluate the student's conclusion.

This was intended as a challenging question that required more than the standard descriptions of reproductive isolation, and few candidates were given full marks. Good answers linked the presence in the same geographical area and the differences in diets as evidence for the possibility of ecological or behavioral isolation, which can lead to sympatric speciation. Many answers also linked the emergence of the Southern Alps with possible geographical isolation, leading to allopatric speciation.

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Question 4 (b) (iv)

(iv) New Zealand has a high species biodiversity compared to many countries.

Species biodiversity includes the concepts of species richness and species evenness.

Explain the difference between species richness and species evenness.

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

Many candidates had a good understanding of the difference between species richness and species evenness although less successful candidates' responses often lacked the precision required to gain both marks. For example, referring to 'amount' instead of 'number' when describing species richness, and the 'spread' or 'distribution' of a species rather than the relative abundance of each species, when describing species evenness.

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Question 5 (a) (i)

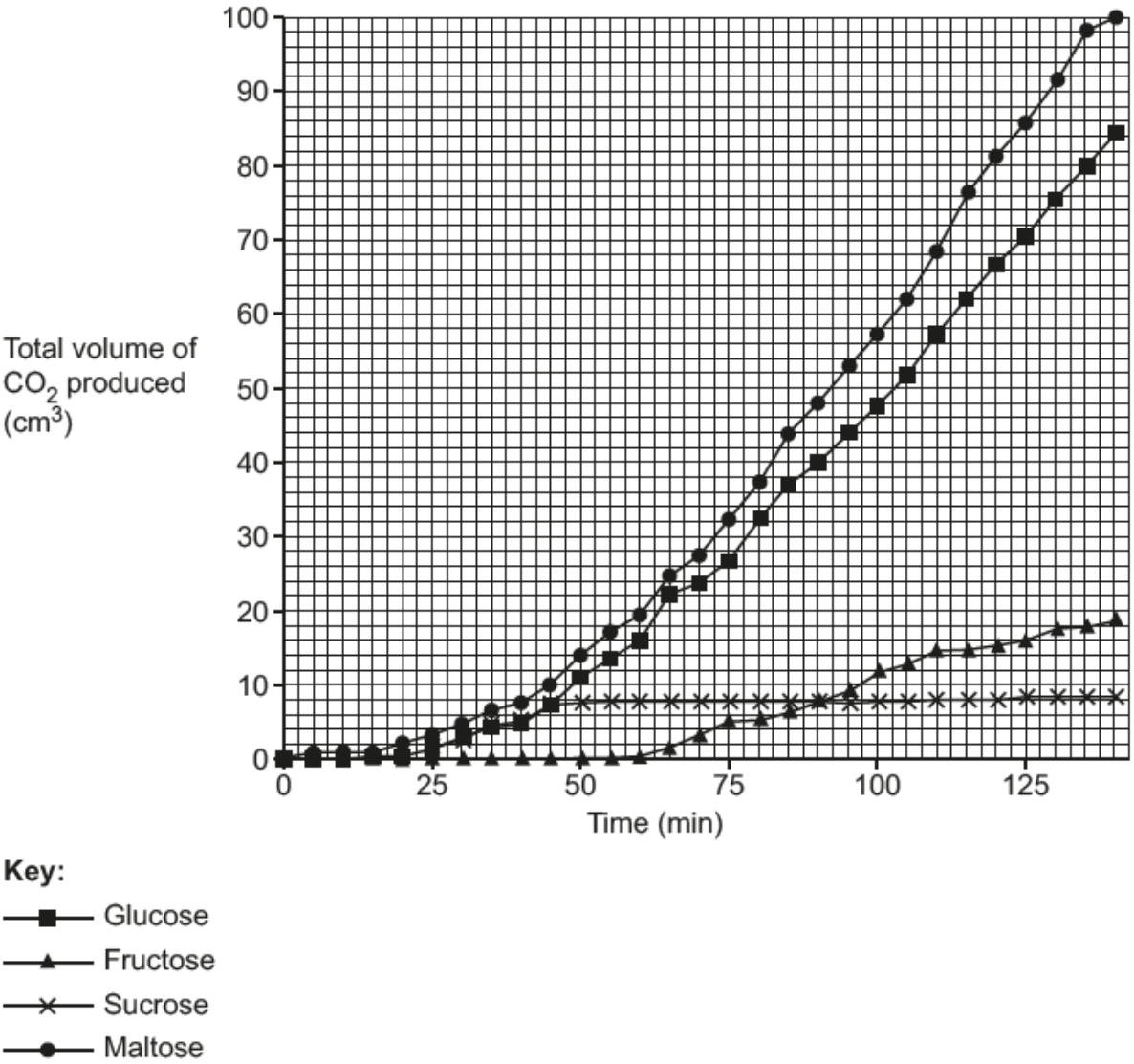
5 Yeast can respire aerobically or anaerobically.

(a) A student investigated how the type of respiratory substrate affects the rate of aerobic respiration in yeast.

Four different populations of yeast were provided with fructose, glucose, maltose or sucrose as a respiratory substrate. The student measured the CO_2 produced by each population over 150 minutes.

The student's results are shown in **Fig. 5.1**.

Fig. 5.1



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(i) Compare CO_2 production when the substrate is glucose and CO_2 production when the substrate is maltose.

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

Many candidates were given credit for a direct statement comparing CO_2 production, or a correct data quote for CO_2 production being higher with maltose. A minority were also credited for recognising the earlier production with maltose. Some candidates who recognised that carbon dioxide was produced earlier, did not get the mark because they either stated the wrong time or stated the time interval in seconds rather than minutes. Others made a comparison of the curves but most of these were too vague to gain credit, e.g. ''curves are a similar shape'', without describing how they are similar. A common mistake was referring to rate of reaction and using terminology such as "faster" or "quicker".

Question 5 (a) (ii)

(ii) The student wrote a note:

'The CO_2 production with fructose is approximately the same as the CO_2 production with sucrose'.

Explain whether you agree with the student's note.

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

Most candidates disagreed with the student's conclusion and were credited for stating that the carbon dioxide concentration plateaus with sucrose - this was the most common response. Many candidates also quoted data from graph for the final volumes of carbon dioxide production, for sucrose and fructose and gained credit for the *idea* that the final volume for fructose was double that of sucrose. Only a few candidates agreed with the conclusion and identified that at two times on the graph, sucrose and fructose, had the exact same volume. They usually mentioned that at 90 minutes the volumes of carbon dioxide produced for sucrose and fructose were the same.

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Question 5 (b) (i)

(b) A student plans to compare the rate of anaerobic respiration in two species of yeast.

(i) The student uses glucose as the respiratory substrate in their experiment.

The student produces a 0.01 mol dm^{-3} glucose solution for each yeast population. This is the method that they use to produce each 0.01 mol dm^{-3} glucose solution:

- Make two 10-fold dilutions from a 1.0 mol dm^{-3} stock solution.
- In each dilution, use a measuring cylinder to measure the volume of water and a dropping pipette to transfer the glucose solutions.

Suggest **two** ways in which the student can reduce the percentage error in their measurements when producing the glucose solutions.

1 .....

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2 .....

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[2]

Candidates found this experimental design question very challenging and found naming apparatus with a higher resolution very difficult. Many candidates didn't link their suggestions to the reduction of percentage error, as per the question. This led to references such as: repeating the experiment and identifying anomalies, calculating means, and controlling variables such as temperature. A substantial number of candidates referred to rinsing/drying equipment (i.e., glucose being left in the pipette), or using a clean/new pipette every time. Some candidates used the terms 'accuracy' and 'precision' rather than 'resolution' when referring to the measuring equipment. 'Accuracy' and 'precision' are terms used to describe data and experimental results rather than equipment. Some candidates also described changes to volumes as a way to reduce percentage error. This is relevant in many cases, but volumes were not stated in the question stem, therefore an increase in the volume measured would not represent an improvement based on the information provided.

A common mistake was the reference to **more** intervals/divisions rather than **smaller** intervals/divisions when talking about measuring equipment. Candidates who read and understood the instructions in the question often gained 2 marks for naming a piece of equipment, and explained they had higher resolution.

OCR support

Advice on language of measurement can be found in this OCR resource

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Question 5 (b) (ii)

(ii) Complete the sentences using appropriate words or phrases.

This is the method that the student uses in their experiment:

- To avoid contamination, place the yeast in glucose solutions that are produced using ..... water.
- Culture each species of yeast in different flasks.
- Ensure anaerobic conditions by using a ..... flask.
- Use the rate of CO_2 production as a measure of respiration rate.
- Standardise all other variables.
- Repeat the measurements with 10 populations from each species and calculate two means and two ..... .
- Analyse the data using a Student's *t*-test.

[3]

Most candidates found this word-fill straightforward. Some candidates lost a mark for the first blank by stating deionised water, however the majority got this mark for stating distilled water. The most common mistake for the second blank was simply stating "conical" and not referring to the need for the flask to be sealed/airtight, etc. The incorrect answers for the third blank included means, medians, modes, averages, hypotheses, anomalies, and ranges.

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Question 6*

6* Homeobox genes, including Hox genes, code for transcription factors and regulate the expression of structural genes.

Describe the general roles of homeobox genes in the human body **and** suggest the roles of these genes in the development of the brain.

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

Candidates who achieved Level 3 in this question were able to accurately describe the roles of homeobox genes in general and in the brain in equal measure. The best responses generally included reference to body plan, apoptosis and mitosis and the control of gene expression. Better answers suggested that homeobox genes may determine the placement of particular lobes or regions (e.g. the cerebellum at the back of the brain, the medulla oblongata in the brainstem), that the control of apoptosis and mitosis may shape neuronal pathways and synapses, and that certain genes will be turned on and off the production of neuronal cells in the brain.

However, few candidates gained Level 3 overall. Candidates not achieving Level 3 often lost out because their responses were unbalanced, with a much larger proportion relating to the general role of homeobox genes and far less attention given to their role in the brain. Many responses began with a description of homeobox genes as being 'highly conserved' and 'containing 180 base pairs' and the differences between homeobox genes. Some candidates used much of the answer space to write these descriptions without linking their response with the question. Some responses also included lengthy descriptions of the role of homeobox genes as transcription factors, but without relating this to the switching on or off of genes. Some candidates gave very detailed descriptions of the mechanism of the *lac* operon, while others wrote at length about the role of RNA polymerase, which was not relevant to the question. Almost all candidates were able to gain at least Level 1 by demonstrating knowledge of at least one role of homeobox genes but struggled to link their knowledge to the brain.

OCR support

Our teaching guide on 'Cellular control' offers overview of key concepts and suggested classroom activities.

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Exemplar 3

Homeobox genes are a set of 180 base pairs present in all animals, plants and fungi, and their role is body plan development. These genes are highly conserved so they are the same in all plants humans and fungi. A subset of this are Hox genes which are only present in humans. Hox genes contain clusters, and each cluster codes for a different development in the human body, these are also highly conserved so that the correct anatomical structures are present. Hox genes code for transcription factors which regulate gene expression in eukaryotic cells and can turn genes on and off, also in the post translational expression which activates proteins such as the phosphorylation of adenyl cyclase. Homeobox genes are very important in the development of the brain as it allows different lobes and structures to be created and have their own individual role, for instance the cerebellum which controls fine muscle movement and the cerebrum [6]

Additional answer space if required.

which controls conscious thought and memory. Another role of homeobox genes are the transcription factors which code for introns and exons and are involved in the process of RNA splicing which codes for the primary structure of a protein

This response was given Level 2 and scored 4 marks. The response mentions a couple of general points about homeobox genes (…. ''correct anatomical structures present''….. and ''turn genes on and off'') and one clear potential role in brain development (….. ''allows different lobes to be developed''e.g., cerebellum). More than one role in brain development would be needed to gain Level 3. The answer is well organised and so was given the communication mark.

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Question 7 (a)

7 Organisms are classified into three domains: Archaea, Bacteria and Eukarya.

Scientists have compared the structures of molecules, such as DNA polymerase and helicase, and organelles in the three domains.

(a) The table shows a comparison of some features of the three domains.

Feature	Archaea	Bacteria	Eukarya
Type of DNA polymerase	SFB and SFD	SFA and SFC	SFB
Type of helicase	SF1 and SF2	SF1 and SF2	SF1 and SF2
Histone proteins	Present	Absent	Present
Size of ribosomes	70S	70S	80S
Mitochondria	Absent	Absent	Present

Explain what conclusions can be drawn from the table about which two domains are most closely related.

.....

.....

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.....

.....

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

Many candidates were able to score 2 marks for correctly stating that Archaea and bacteria could be closely related as well as Archaea and Eukarya, with evidence to support. Less successful responses stated the similarities but did not relate this to the question, and so could not be credited. Few candidates mentioned that bacteria and Eukarya were least related as they only have helicase in common, or that helicase comparison provided no useful evidence.

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Question 7 (b)

(b) State the roles of DNA polymerase and helicase in cells.

DNA polymerase .....

.....

Helicase .....

.....

[2]

Generally, many candidates were able to access both marks for this question and gave good, detailed responses. A number of candidates mixed up the role of helicase and DNA polymerase gaining no credit. Common errors included:

- not being able to state the specific bond that is made by DNA polymerase. Some candidates stated it to be a hydrogen bond, while some stated it to be sugar bond
- mixing up translation and transcription with DNA replication and referring to mRNA formation
- not making it clear that the two strands of DNA were being separated by helicase, e.g., ''unwinds DNA'' rather than ''unwinds DNA double helix/strands''.

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Question 1, Fig. 1.1, Photo of trachea, © DR KEITH WHEELER/SCIENCE PHOTO LIBRARY

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