

Examiners' Report

June 2025

Int GCSE Biology 4BI1 2B

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Introduction

The examiners were very impressed with the high standard of many of the answers presented by candidates. Both candidates and centres should be commended on their hard work in preparing for the examination. Most candidates were confident with the use of scientific vocabulary, handled data with skill, fully understood the different command words used in questions and had excellent mathematical skills. Paper 2B always begins with a comprehension that sets a context for the questions that follow. The questions are usually synoptic and come from a range of different topic areas in the specification and often assess different assessment objectives. In this series, the comprehension focused on water pollution and the questions came from all topic areas. Whilst many candidates answered questions confidently, some candidates found some aspects of the paper challenging. Common errors included: confusing accuracy with reliability when analysing unfamiliar practical work, not giving enough detail to gain full marks for a question, and placing the events of protein using the vocabulary associated with protein synthesis accurately. When asked to suggest how accuracy can be improved, many candidates simply stated that the experiments could be replicated - this would improve reliability rather than the accuracy of a practical method. Protein synthesis is a topic area that many candidates find challenging and it is important that terminology such as transcription and translation are used accurately. Mathematical skills were generally excellent but candidates should always be careful to convert units when necessary. It was very pleasing to see how well most candidates tackled the two longer, evaluative questions - candidates are now answering these questions well by exploring data fully, describing patterns and commenting on the quality of experiments.

Question 1(a)

This question required candidates to give a definition of the term, 'homeostasis'. Most candidates were able to correctly describe homeostasis as the maintenance or control of the internal state of an organism. Some candidates defined specific examples of homeostasis, such as thermoregulation, suggesting that homeostasis only applies to temperature regulation. Candidates should have a full understanding of all terminology listed in the specification.

30 Scientists are looking for ways to prevent river pollution. One way is to reduce the risk of pollution from fertilisers and from cattle urine and faeces. Woodchip bioreactors are being trialled in agricultural fields that are near to rivers. These bioreactors are pits filled with woodchips and denitrifying bacteria. Water drains through these bioreactors, which helps to remove nitrates before they reach the rivers. In some countries, efforts are being made to replant forests in areas upstream of rivers to reduce river flooding and the risk of untreated sewage release.

- (a) Rivers have a homeostatic effect on nature. This is similar to the role of homeostasis in humans.

State what is meant by the term **homeostasis** (lines 2 and 3).

(1)

Maintaining stable internal body conditions in organisms



This excellent answer gained one mark for stating that homeostasis is the maintenance of internal body conditions.



Make sure that you know definitions of all words used in the specification.

30 Scientists are looking for ways to prevent river pollution. One way is to reduce the risk of pollution from fertilisers and from cattle urine and faeces. Woodchip bioreactors are being trialled in agricultural fields that are near to rivers. These bioreactors are pits filled with woodchips and denitrifying bacteria. Water drains through these bioreactors, which helps to remove nitrates before they reach the rivers. In some countries, efforts are being made to replant forests in areas upstream of rivers to reduce river flooding and the risk of untreated sewage release.

- (a) Rivers have a homeostatic effect on nature. This is similar to the role of homeostasis in humans.

State what is meant by the term **homeostasis** (lines 2 and 3).

(1)

the control of the body's internal temperature



This answer did not gain the mark and is an example of a common error. The candidate has specifically referred to thermoregulation rather than homeostasis in general.

30 Scientists are looking for ways to prevent river pollution. One way is to reduce the risk of pollution from fertilisers and from cattle urine and faeces. Woodchip bioreactors are being trialled in agricultural fields that are near to rivers. These bioreactors are pits filled with woodchips and denitrifying bacteria. Water drains through these bioreactors, which helps to remove nitrates before they reach the rivers. In some countries, efforts are being made to replant forests in areas upstream of rivers to reduce river flooding and the risk of untreated sewage release.

- (a) Rivers have a homeostatic effect on nature. This is similar to the role of homeostasis in humans.

State what is meant by the term **homeostasis** (lines 2 and 3).

(1)

The control of an internal environment



This answer gained one mark for correctly stating that homeostasis is the control of an internal environment.

Question 1(b)

This question assessed candidates ability to calculate the mean number of hours that individual pipelines release sewage. It was pleasing to see that most candidates were able to extract the information from the text and correctly calculate the answer as 250 hours.

- (b) Calculate the mean number of hours that each pipeline released sewage into rivers in 2022 (lines 7 and 8).

$$\frac{300000}{1200} = 250 \text{ hours}$$

(1)

mean number = 250 hours



This is an example of a correct answer. The candidate has also shown their working - an example of good practice.



Always show your working when performing calculations.

- (b) Calculate the mean number of hours that each pipeline released sewage into rivers in 2022 (lines 7 and 8).

(1)

$$\begin{array}{r} 300000 \\ = \hline 1200 \end{array}$$

$$= 250$$

mean number = 250 hours



This is another example of a correct answer where the candidate has clearly shown their working.

Question 1(c)ii

This example assessed candidates' understanding of how farming can lead to pollution in rivers and affect biodiversity. Many outstanding answers were seen that gained all four marks. The process of eutrophication due to the release of fertilisers and the development of anoxic conditions due to bacterial decay and respiration were well understood by many candidates. This topic is clearly an area that many candidates are very familiar with and many wrote detailed, well sequenced answers that used excellent terminology. A few candidates gave vague answers about potential harmful toxins affecting species - to gain marks at GCSE level, candidates should ensure that they add sufficient depth and detail to their answers. When answering questions such as this, candidates should think about the mark allocations before putting pen to paper and make sure that they have at least four points (for a four mark question).

(ii) Explain why rivers near to farms may have low biodiversity (lines 13 to 16). ^{Leaching}

(4)

Rivers near farms may have a low biodiversity due to nitrates. These nitrates used in fertiliser or excreted by livestock like cattle can leach, run off, into river. This amount of nitrogen causes the rapid growth of bacteria and algae. As the algae floats on the surface of the water it reduces the amount of sunlight available to river plants. This reduces and stops photosynthesis lowering the amount of oxygen released into the river. The remaining oxygen is used up by bacteria, this lack of oxygen causes fish to suffocate.



This excellent, detailed answer gained all four marks. The candidate correctly states that fertiliser and nitrates would run off into the river and cause algal growth. They go on to state that there is less light and photosynthesis and so oxygen levels become lower.

(ii) Explain why rivers near to farms may have low biodiversity (lines 13 to 16).

(4)

This is due to eutrophication. This happens when fertilisers from farms leach into rivers. The fertilisers cause an increase in the growth of algae. The algae then die due to lack of sunlight. When dead the algae are decomposed by decomposers and microorganisms, they do this by doing aerobic respiration. This means that they use up lots of oxygen, causing fish to die because of the lack of oxygen. Other plants are unable to grow due to lack of oxygen + light, thus causing rivers near farms to have low biodiversity.



This excellent answer gained all four marks. The candidate states that eutrophication occurs due to fertiliser runoff and that dead algae are decomposed resulting in high rates and respiration and oxygen loss. The answer appears well planned as there is a natural sequence to the events.

(ii) Explain why rivers near to farms may have low biodiversity (lines 13 to 16).

(4)

Farms contain cattle which produces manure which can wash into rivers. This causes eutrophication. The sewage washes into the river, then there's an excess of nutrients so algae forms blocking sunlight to plants below, all organisms die out and bacteria and fungi break down the dead organisms, water becomes anoxic so rivers near farms have low biodiversity.



This excellent answer gained all four marks. The candidate correctly states that manure is released into the river causing eutrophication, and that the algae block light, are decomposed and the river becomes anoxic.

(ii) Explain why rivers near to farms may have low biodiversity (lines 13 to 16).

(4)

- Fungi found in polluted waters.
 - Less O_2 in water ~~for~~ for fish/ ^{sea creatures} to respire
 - more CO_2 in water
- As fish + other mammals can't respire, they will die
- They need to be in waters with high oxygen concentration
- ∴ reduces biodiversity / ~~less~~ fewer numbers of different species



This answer gained two marks for correctly stating that oxygen levels decrease so fish are unable to respire.

Question 1(d)i

This question assessed candidates understanding of the function of FSH in a slightly unusual context. Most candidates correctly stated that a reduction in FSH would mean that fewer eggs / follicles mature. A few candidates confused FSH with LH. Most, however, understood the role of FSH in the menstrual cycle.

(d) Oestrogen and progesterone in polluted water lower the levels of FSH and LH in mammals.

(i) State why lower levels of FSH can reduce fertility in mammals.

(1)

FSH causes an egg to mature, low levels of FSH means the egg may not be matured



This answer gained one mark for correctly stating that FSH matures eggs - the mark could also be awarded for the second sentence (that a lack of FSH means eggs may not mature).

(d) Oestrogen and progesterone in polluted water lower the levels of FSH and LH in mammals.

(i) State why lower levels of FSH can reduce fertility in mammals.

(1)

FSH in lower levels cancels the stimulation of progesterone and oestrogen stops the ^{maintenance} lining of the uterus.



This answer did not gain any credit. The candidate has an understanding of the roles of the different hormones but has confused the exact role of each hormone.

(d) Oestrogen and progesterone in polluted water lower the levels of FSH and LH in mammals.

(i) State why lower levels of FSH can reduce fertility in mammals.

(1)

So the ovary of the mammals mature slower.



This answer did not gain any credit. The candidate has appreciated that FSH targets the ovaries but has not stated that it stimulates egg development / maturation.

(d) Oestrogen and progesterone in polluted water lower the levels of FSH and LH in mammals.

(i) State why lower levels of FSH can reduce fertility in mammals.

(1)

It may stimulate the ovaries less to create less eggs which will not be able to mature



This answer gained one mark for correctly stating that less FSH would result in fewer eggs maturing.

Question 1(d)ii

This question assessed candidates' understanding of the role of LH. Many correctly stated that with less LH, fewer eggs would be released or that the role of LH is to induce ovulation. Similarly, to part (d)(i), some candidates appreciated that the different hormones all have roles in the menstrual cycle but confused the roles of each, with some suggesting that LH induces maturation of eggs.

(ii) State why lower levels of LH can reduce fertility in mammals.

(1)

limits release of egg/ovulation.



This answer gained one mark for correctly stating that a lack of LH would limit ovulation.

(ii) State why lower levels of LH can reduce fertility in mammals.

(1)

LH stimulates the secondary sexual characteristics making them ready for fertility.



This answer gained no credit. It is an example of where a candidate understands that the hormones regulate the menstrual cycle but has confused the functions of each hormone.

(ii) State why lower levels of LH can reduce fertility in mammals.

(1)

It reduces the ovulation.



This answer gained one mark for the idea that ovulation is reduced.

Question 1(e)i

This question assessed candidates' understanding of the process of osmosis and the function of the large intestine in a different context. Strong answers correctly explained that if there was less movement of salt into the blood, the water potential would be higher and so less water would be absorbed by osmosis. Candidates should be careful when writing about the movement of water by osmosis - it is important to state whether they are referring to concentrations of salt or water and in most situations, it is better to refer to movement from a higher water potential to a lower water potential. A number of candidates wrote answers about the kidney - the question stem referred to movement of salt in the large intestine. It is important for candidates to read all the words in question stems - a common error, especially when candidates are understandably nervous in the exam room, is to focus on key words in the question and rush pen to paper.

- (e) (i) Pathogenic bacteria produce poisons that prevent the active transport of salt into the blood vessels surrounding the intestines.

Explain why preventing the transport of salt into the blood vessels will cause more water to be present in faeces (lines 22 to 24).

(2)

because it will mean there is more water taken salt in the body's
salt water balance, so more in faeces.



This answer did not gain any marks. The candidate has not considered how a lack of uptake of salt into the blood would affect the movement of water.

- (e) (i) Pathogenic bacteria produce poisons that prevent the active transport of salt into the blood vessels surrounding the intestines.

Explain why preventing the transport of salt into the blood vessels will cause more water to be present in faeces (lines 22 to 24).

(2)

Ions help the body to absorb water, so the collecting duct becomes less permeable and so less more water is lost.



This answer gained no marks. The candidate has unfortunately referred to the uptake of water in the kidney.



Be careful to read questions carefully and structure your answers in the light of the information given. It is easy, when nervous in the exam room, to focus on a few key words in a question and miss the context.

- (e) (i) Pathogenic bacteria produce poisons that prevent the active transport of salt into the blood vessels surrounding the intestines.

Explain why preventing the transport of salt into the blood vessels will cause more water to be present in faeces (lines 22 to 24).

(2)

→ This results in less salt in blood and more water concentration in blood, so water enters large intestine by osmosis because large intestine has lower water potential than the blood.



This answer gained both marks. The candidate has clearly referred to the increased water concentration in the blood, the process of osmosis and the fact that less water is absorbed.

- (e) (i) Pathogenic bacteria produce poisons that prevent the active transport of salt into the blood vessels surrounding the intestines.

Explain why preventing the transport of salt into the blood vessels will cause more water to be present in faeces (lines 22 to 24).

(2)

This will lead to a decrease in osmosis as the water potential in surrounding blood vessels will be higher, so there will be a lower concentration gradient for water to move by osmosis and be absorbed in the large intestine. So, as less water is absorbed in the large intestine, more water will be present in faeces.



This excellent answer gained both marks for correctly stating that the water potential of the blood would be higher so less water would enter by osmosis.

Question 1(e)ii

This question assessed candidates' understanding of how the use of antibiotics has led to an increase in antibiotic resistance in bacteria. Many excellent answers were seen that gained all three marks. Many candidates correctly stated that mutations occurred, that the bacteria would survive, reproduce pass on the allele. A few candidates confused resistance with immunity and incorrectly referred to bacteria becoming immune to antibiotics and producing antibodies. Candidates should be careful when using terms such as resistant and immune - they have very different meanings.

- (ii) Explain why overuse of antibiotics has led to an increase in antibiotic-resistant bacteria (lines 24 and 25).

(3)

As more antibiotics are used, a mutation (change) in the bacteria creates a resistant strand. When antibiotics are used, the non-resistant bacteria die but resistant strand survives to rapidly reproduce and spread the antibiotic resistance. Eventually there will be so many resistant bacteria that the antibiotics do not work effectively anymore.



This excellent answer gained all three marks for the ideas of mutation, survival and reproduction.

- (ii) Explain why overuse of antibiotics has led to an increase in antibiotic-resistant bacteria (lines 24 and 25).

(3)

If antibiotics are overused then some bacteria will develop a mutation which makes them resistant to that type and if that type is overused then this advantage will allow that resistant bacteria to survive and reproduce passing on the advantageous allele over and over, increasing anti-biotic-resistant bacteria.



This excellent answer gained all three marks for the ideas of mutation, survival, reproduction, and passing on the allele.

(ii) Explain why overuse of antibiotics has led to an increase in antibiotic-resistant bacteria (lines 24 and 25).

(3)

- antibiotics are used to pacify bacteria in animals so that it can't cause sickness
- overuse leads to bacteria mutating to resist them because antibiotics contain the same antibodies every time
- the resistant bacteria can't be stopped and spreads to other organisms



This answer gained one mark for the idea of mutation. The candidate then incorrectly suggests that the bacteria could then avoid immune responses.

- (ii) Explain why overuse of antibiotics has led to an increase in antibiotic-resistant bacteria (lines 24 and 25).

(3)

- they have developed an anti biotic - resistance due to memory cells (lymphocytes) producing antibodies to overcome the antibiotics meaning when they are exposed again the response is quicker and more frequent making them resistant



This answer gained no marks - the candidate has confused the development of resistance with immunity.



Make sure that you understand the difference between immunity and resistance.

Question 1(f)i

This challenging question assessed candidates' understanding of the function of denitrifying bacteria and how their use would reduce river pollution. Strong answers correctly stated that the bacteria would convert nitrates into nitrogen and so there would be less risk of eutrophication in the rivers. Some candidates simply stated that the nitrate runoff would reduce - this phrase was given in the text. An example of the pollution, such as algal, growth, was required in the answer for mark point two as the term, 'pollution' was in the question stem.

... an overall increase in antibiotic resistant bacteria.

(f) (i) Explain how woodchip bioreactors reduce pollution in rivers (lines 27 to 31).

(2)

They contain denitrifying bacteria which converts nitrates back into ~~the~~ gas Nitrogen gas. This means the water that passes through loses nitrates, ~~decreases~~ leading to the prevention of eutrophication, as there are less nitrates in the water returned to the river.



This excellent answer gained both marks for correctly stating that the bacteria convert the nitrates into nitrogen gas and there would be less eutrophication.

(most of) the bacteria population to be resistant to antibiotics.

(f) (i) Explain how woodchip bioreactors reduce pollution in rivers (lines 27 to 31).

(2)

- The denitrifying bacteria

- convert nitrates, into nitrogen (gas)

- reducing the chance of eutrophication, from algal bloom.



This excellent answer also gained both marks for correctly stating that the nitrates are converted into nitrogen gas and there is less eutrophication.

(f) (i) Explain how woodchip bioreactors reduce pollution in rivers (lines 27 to 31).

(2)

The woodchip bioreactors help reduce pollution in rivers by draining water which contains nitrates. By removing the harmful nitrates, this can reduce pollution in rivers.



This answer did not gain any marks. Reduced nitrate release and pollution are given in the text and the question stem.



Make sure that you add full details to your answers and show off your knowledge.

Question 1(f)ii

This question assessed candidates' understanding of the effects of reversing deforestation. Many excellent answers were seen that gained both marks. Many candidates appreciated that trees would absorb water, would release water through transpiration, and would stabilise soil to reduce erosion. Many candidates used impressive, highly detailed terminology such as increased rates of infiltration and interception. Weaker answers tended to give vague statements such as trees blocking water.

- (ii) Explain why replanting forests in areas upstream of rivers will reduce flooding (lines 31 to 33).

The roots of trees can prevent soil erosion. They also take up water via the transpiration stream, preventing too much water being present in the soil

(Total for Question 1 = 18 marks)

* (ii)

Pathogens and pesticides may also kill organisms in the river, disrupting food chains and causing knock-on effects on biodiversity.



This excellent answer gained both marks for the idea of soil erosion, water uptake and transpiration. The candidate has also continued an answer from a previous question on the page - if candidates need extra space they should use additional paper as there is a risk that answers written elsewhere in the booklet could be missed.



If you need more space, use extra pages rather than writing in other areas of the booklet.

- (ii) Explain why replanting forests in areas upstream of rivers will reduce flooding (lines 31 to 33).

(2)

The trees in the forest will absorb chemicals like nitrate and etc and will also absorb a heavy amount of water reducing flooding.



This answer gained one mark for the idea of trees absorbing water.

- (ii) Explain why replanting forests in areas upstream of rivers will reduce flooding (lines 31 to 33).

(2)

to the trees will reduce the amount of carbon dioxide in the air and increase the amount of oxygen in the air. The roots of the trees also help to ~~reduce~~ hold together the soil to limit soil erosion. Also, the trees will help to take up any extra water within the soil.



This excellent answer gained both marks for stating that the trees bind the soil together and absorb water.

- (ii) Explain why replanting forests in areas upstream of rivers will reduce flooding (lines 31 to 33).

(2)

Forests Reduces leaching, ~~so~~ more water is taken
By plants in forests. ~~It will have~~
More force is needed to go through the
forests, when flooding

(Total for Question 1 = 18 marks)

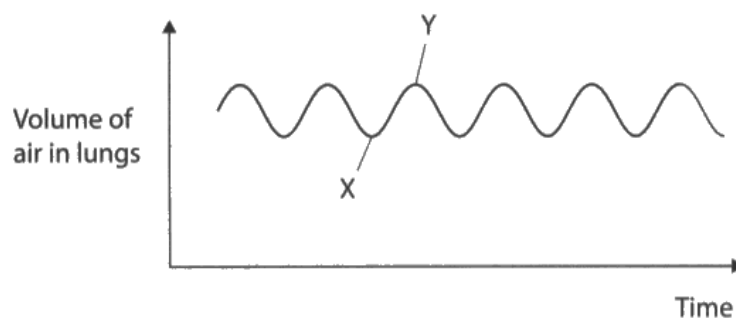


This answer gained one mark for the uptake of water by plants.

Question 2(a)ii

This question assessed candidates' understanding of the process of inhalation. Candidates were asked to interpret a graph that showed the change in lung volume and explain the change. Strong answers stated that the volume was increasing and that this would be due to the contraction of the diaphragm and intercostal muscles, the lowering of the diaphragm, the outward movement of the rib cage and a reduction in pressure in the thorax. Several candidates referred to point X as being a point when exhalation was occurring and Y as a point when inhalation was occurring - candidates should be careful to use precise language as the question asked for an explanation for the change in volume between X and Y. Most candidates gained at least one mark with many going on to gain all three.

(ii) The graph shows how the volume of air in the lungs changes over time.



Explain the change in volume of air in the lungs from point X to point Y.

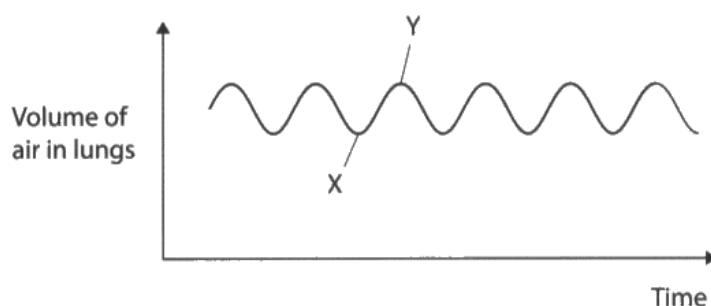
(3)

point x is ~~lower~~ has a lower volume of
air in lungs than Y. This is because x is when
you are exhaling and releasing the oxygen and
point Y is when you are inhaling and your lungs are
full of oxygen.



This answer gained one mark for the idea that the volume at Y is higher than at X. No real explanation for the change in volume is given.

(ii) The graph shows how the volume of air in the lungs changes over time.



Explain the change in volume of air in the lungs from point X to point Y.

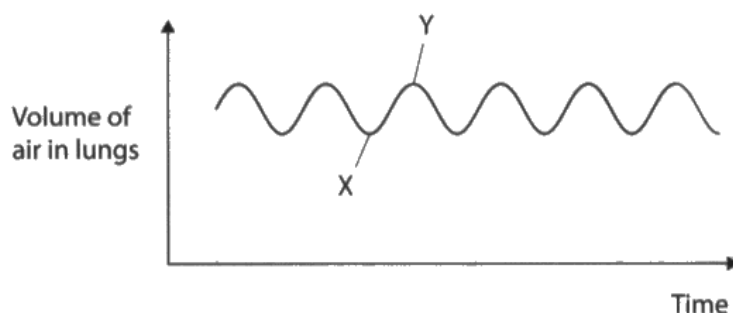
(3)

The air is pulled into the lungs as the pressure has decreased due to the volume of thoracic cavity increasing. As the diaphragm contracts and intercostal muscles contract, pulling the chest up and out. This is used for gas exchange for respiration. This provides the body with oxygen as when the volume of the air in the lungs increases the body is inhaling.



This is an excellent answer that gained three marks. The candidate clearly describes the increase in volume and then explains this in terms of the contraction of diaphragm, intercostal muscles and the decrease in thorax pressure.

(ii) The graph shows how the volume of air in the lungs changes over time.



Explain the change in volume of air in the lungs from point X to point Y.

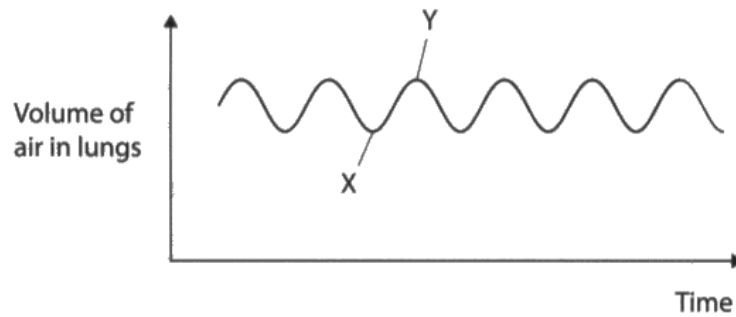
(3)

At point X, the lungs have just exhaled, which means there is less air in the lungs. The intercostal muscles have moved back, compressing the lungs, reducing the volume of air. At point Y, the lungs have inhaled, causing there to be lots of air, as the lungs have expanded. There is much more air in point Y than X.



This answer gained one mark for the idea that inhalation has finished at Y. The candidate has mentioned the intercostal muscles but not that they contract.

(ii) The graph shows how the volume of air in the lungs changes over time.



Explain the change in volume of air in the lungs from point X to point Y.

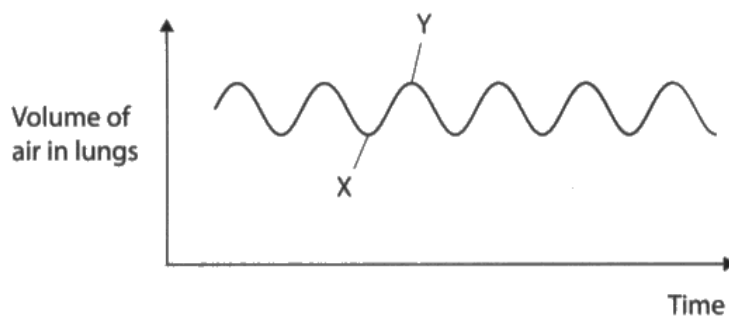
(3)

At X, the person ^{has exhaled} is ~~exhaling~~ as the volume of air is lower than Y. From X to Y, the volume of air increases as the person is inhaling which means the intercostal muscles expand and the ~~thorax~~ thorax expands. ~~which means the pressure of air inside~~



This answer gained one mark for correctly stating that the volume increases.

(ii) The graph shows how the volume of air in the lungs changes over time.



Explain the change in volume of air in the lungs from point X to point Y.

(3)

The volume of air in the lungs increases from point X to Y.

This is due to inhalation. The external intercostal muscles contract, the ribs move out and up. The diaphragm contracts and flattens so ~~there is~~ the volume of the thorax increases and more oxygen can enter the lungs.



This excellent answer gained all three marks. The candidate clearly states that volume increases and explains this in terms of the action of the diaphragm and intercostal muscles.

Question 2(b)

This question assessed candidates' understanding of the reabsorption of glucose in the kidney in an unusual context. Many excellent answers were seen with most gaining at least one mark and many going on to gain all three. Most recognised that diabetic urine must contain glucose as ants are attracted to it and many then went on to state that the proximal convoluted tubule (PCT) must not be able to reabsorb all the glucose by active transport. Where candidates did not gain all three marks, it was often for not referring to the PCT or active transport.

(b) People with a condition called diabetes often have very high blood sugar.

Urine from people with diabetes attracts ants but urine from people without diabetes does not attract ants.

Ants are insects that are attracted to glucose.

Explain why people with diabetes produce urine that can attract ants.

(3)

People with diabetes have high blood sugar levels, therefore less insulin is released so glucose remains in the bloodstream rather than diffusing into liver cells where glucose is converted into glycogen. This ^{also} means that glucagon is not ^{released as there won't be} ~~released~~ ^{times of low} ~~perfect~~ ^{any} glucose levels. Ants will be attracted by urine with glucose as it can use glucose for respiration.



This answer gained one mark for correctly stating that the urine had glucose present in it.

(b) People with a condition called diabetes often have very high blood sugar.

Urine from people with diabetes attracts ants but urine from people without diabetes does not attract ants.

Ants are insects that are attracted to glucose.

Explain why people with diabetes produce urine that can attract ants.

(3)

Diabetes is a condition where insulin is not produced and therefore glucose in the blood is not converted into glycogen. After the glucose diffuses through the Bowman's capsule in the nephron, some of it is selectively reabsorbed in the PCT. However, it cannot reabsorb all the glucose, therefore some of it proceeds into the urine. As people with diabetes have higher blood sugar, more glucose will remain in the filtrate and proceed into the urine, at a high enough concentration to attract ants.

(Total for Question 2 = 7 marks)



This excellent answer gained all three marks. The candidate correctly states that the PCT has not absorbed all the glucose into the blood and so it is present in the urine.

(b) People with a condition called diabetes often have very high blood sugar.

Urine from people with diabetes attracts ants but urine from people without diabetes does not attract ants.

Ants are insects that are attracted to glucose.

Explain why people with diabetes produce urine that can attract ants.

(3)

People with diabetes do not secrete insulin, therefore can't store glucose (in form of glycogen) therefore glucose is being egested/excreted together with urine, due to it being in excess.



This answer gained one mark for the presence of glucose in the urine.

(b) People with a condition called diabetes often have very high blood sugar.

Urine from people with diabetes attracts ants but urine from people without diabetes does not attract ants.

Ants are insects that are attracted to glucose.

Explain why people with diabetes produce urine that can attract ants.

People with diabetes cannot have ^{problems in kidney. (3)} enough insulin to regulate blood sugar level. The glucose cannot be reabsorbed back the blood in proximal convoluted ~~tubule~~ tubule. So glucose are remained in the nephron and go with ~~urea~~ to the collecting duct and be excreted as urine.



This excellent answer gained all three marks for correctly stating that glucose would be present in the urine as it is not all reabsorbed in the PCT.

Question 3(b)i

The context of this question was a practical investigation into the effect of light intensity on the width of the pupil. In this first part, candidates had to calculate a mean value and give their final answer to two significant figures. Most candidates gained both marks with a few mistaking significant figures for decimal places.

(b) A teacher investigates the effect of light intensity on pupil diameter.

This is the teacher's method.

- cover a student's eyes with a mask
- set the light intensity in the room to a low level
- remove the mask and wait 20 seconds
- record an image of the student's pupil and iris with a camera
- measure the diameter of the pupil on the image using a ruler
- repeat two more times at the same light intensity

The teacher repeats the experiment at different light intensities.

The table shows the teacher's results.

Light intensity in arbitrary units	Diameter of pupil in mm			
	test 1	test 2	test 3	mean
1	8.1	8.4	8.2	8.20
2	7.8	7.5	7.4	7.6
3	3.5	3.2	3.6	3.4
4	2.1	2.2	2.2	2.2
5	2.2	2.1	1.9	2.0

(i) Calculate the mean pupil diameter for the light intensity of 1 arbitrary unit.

Give your answer to two significant figures.

(2)

$$8.1 + 8.4 + 8.2 = \frac{24.7}{3} = 8.23$$

mean pupil diameter8.20..... mm



This answer gained one mark - the candidate has correctly calculated the mean but given their final answer to the wrong number of significant figures.

(b) A teacher investigates the effect of light intensity on pupil diameter.

This is the teacher's method.

- cover a student's eyes with a mask
- set the light intensity in the room to a low level
- remove the mask and wait 20 seconds
- record an image of the student's pupil and iris with a camera
- measure the diameter of the pupil on the image using a ruler
- repeat two more times at the same light intensity

The teacher repeats the experiment at different light intensities.

The table shows the teacher's results.

Light intensity in arbitrary units	Diameter of pupil in mm			
	test 1	test 2	test 3	mean
1	8.1	8.4	8.2	
2	7.8	7.5	7.4	7.6
3	3.5	3.2	3.6	3.4
4	2.1	2.2	2.2	2.2
5	2.2	2.1	1.9	2.0

(i) Calculate the mean pupil diameter for the light intensity of 1 arbitrary unit.

Give your answer to two significant figures.

(2)

$$\frac{8.1 + 8.4 + 8.2}{3} = 8.2\dot{3} = 8.23$$

mean pupil diameter 8.23 mm



This answer gained one mark - the calculation is correct but the answer has been given to the wrong number of significant figures.



Make sure that you know the difference between decimal places and significant figures.

Question 3(b)ii

This question required candidates to look at the data in the table for the effect of light intensity on pupil diameter and give a description. Strong answers stated that the diameter decreases with higher light intensity and then described the idea that it begins to level off after 3 au or 4 au or that the largest decrease was between 1 and 2 au. Most candidates correctly stated that there was a decrease but fewer went on to gain a second mark for adding detail. If a description is allocated more than one mark, candidates should look to give more detail, manipulate the data or identify turning points.

- (ii) With reference to data in the table, **describe** the effect of increasing light intensity on the diameter of the pupil.

(2)

Increasing light intensity decreases the light pupil's diameter. At first this is a big decrease between 2 and 3 AU (4.2 mm decrease) but then the decrease becomes smaller between 4 and 5 AU (only 0.2 mm decrease). This is because light intensity can be a limiting factor.



This answer gained two marks for correctly stating that the diameter decreased and then identifying the large decrease between 2 and 3 au

- (ii) With reference to data in the table, **describe** the effect of increasing light intensity on the diameter of the pupil.

(2)

As the light intensity increases, diameter of pupil decreases as evident in the table where the pupil diameter was 8.2 in the lowest light intensity and was much smaller at the highest light intensity.



This answer gained one mark for the idea of a decrease but did not gain the second mark. The candidate refers to data points but does not identify turning points, areas of large change or leveling off.

- (ii) With reference to data in the table, **describe** the effect of increasing light intensity on the diameter of the pupil.

(2)

As light intensity increases, pupil diameter decreases. At 1 arbitrary unit, the mean diameter is 8.2 mm, but at 5 arbitrary units, the mean is 2.0 mm. There is a much larger decrease between 2 and 3 arbitrary units, from 7.6 mm to 3.4 mm.



This excellent answer gained two marks for the idea of a decrease and a large decrease between 2 and 3 au.

- (ii) With reference to data in the table, **describe** the effect of increasing light intensity on the diameter of the pupil.

(2)

Increasing light intensity, decreases diameter of pupil, for example, at 1 arbitrary unit it has 8.2 mm mean, whereas at 5 arbitrary units, it has 2.0 mm mean, so a 6.2 mm ^{decreased} change.



This answer gained both marks for correctly stating that there is a decrease and manipulating the data to describe a change of 6.2 mm.

Question 3(b)iii

This answer asked candidates to explain the change in pupil diameter. Strong answers explained that at high light intensities, the narrow pupil reduced light entry to reduce damage to the retina and went on to state that circular muscles would contract and radial muscles relax. Common errors included simply stating that reducing the light would prevent eye damage (rather than retinal damage), referring to ciliary muscles and focusing, and not mentioning the muscles of the iris.

(iii) **Explain** the effect of increasing light intensity on the diameter of the pupil.

(3)

the Diameter decreases because the muscles contract and relax to make the pupil smaller, these muscles are the ciliary muscles. They do this to limit the amount of light that is shone into the eye. too much light could harm the eye.



This answer gained one mark for the idea of reduced light entering the eye. The candidate has confused the circular muscles of the iris with the ciliary muscles around the lens.



Be careful not to confuse focusing using the lens with the change in diameter of the pupil by the iris.

(iii) **Explain** the effect of increasing light intensity on the diameter of the pupil.

(3)

As the light intensity increased, the ciliary muscles tightened and suspensory ligaments relaxed to shrink the diameter so that less light was let into the eye.



This answer also gained one mark the idea of reducing light entry.

(iii) **Explain** the effect of increasing light intensity on the diameter of the pupil.

(3)

Increasing the light intensity decreased diameter because bright light can damage vision so the eye adjusts to only allow enough light in. In bright light, the radial muscles relax and the circular muscles contract. In dim light, the radial contract and circular muscles relax to expand the pupil.



This strong answer gained all three marks. The candidate correctly states that less light enters the eye and that the circular muscles of the iris contract and the radial muscles relax.

(iii) **Explain** the effect of increasing light intensity on the diameter of the pupil.

(3)

Increasing light intensity causes the diameter of the pupil to shorten due to the body trying to protect the sensitive retina from damage. The circular muscles in the pupil contract while the radial muscles relax in order to close the pupil to limit the amount of light that is let in.



This excellent answer gained all three marks. The candidate states that less light enters the eye, there will be less damage to the retina and correctly states how the circular and radial muscles control the pupil width.

Question 3(b)iv

This question assessed candidates' understanding of generic practical skills by asking for a variable that needed to be controlled in the experiment. Candidates should be able to identify the independent variable, dependent variable and control variables in experiments. Most candidates were able to correctly suggest a variable such as the person being experimented on, the eye, the diet of the person or the distance from the camera. It was pleasing to see that most candidates have a good understanding of the different variables and how to control them.

(iv) State one variable that the teacher should control.

Size of image (zoomed or not)

(1)

The type of mask (very opaque one or very transparent one)



This answer gained a mark for correctly stating that the type of mask would need controlling.

(iv) State one variable that the teacher should control.

(1)

The light intensity



This is an example of an incorrect answer - the candidate has confused the independent variable with control variables.

(iv) State one variable that the teacher should control.

(1)

Person that is being tested on



This answer gained one mark for correctly stating that the same person should be used.

Question 3(b)v

Many candidates found this question challenging. The question asked how the experiment was designed to ensure that the measurements taken were accurate. Strong answers stated that the teacher used an image rather than trying to measure the pupil directly so that the diameter would not change. Other creditworthy answers referred to the 20 seconds taken to enable the pupil to stop changing in size and the idea that the image could be measured when flat with a ruler. Many candidates simply stated that repeating the investigation would make the measurements more accurate - this would improve reliability but not affect the measurements.

- (v) Explain how the teacher's method ensures that the measurement of the pupil diameters are accurate.

(2)

The teacher measures an image, so the diameter of the eye cannot change during their measurement and the teacher repeats their measurements for more accuracy.



This answer gained both marks for correctly stating that the teacher takes the image so that there will be no more changes in the eye.

- (v) Explain how the teacher's method ensures that the measurement of the pupil diameters are accurate.

(2)

The ^{photo} camera allows the pupil to be measured multiple times without obscuring light on a flat surface ~~good~~, and in good lighting to ensure ^{the measurement is} ~~results are~~ more precise.



This answer gained both marks for the use of an image and stating that it can be measured when flat.

- (v) Explain how the teacher's method ensures that the measurement of the pupil ^{and pupil.} diameters are accurate.

(2)

The teacher uses a camera so that it is ^{well image} accurately measured. The teacher uses a ruler. The teacher waits 20 secs before measuring to ensure the pupil has fully adjusted.



This answer gained two marks for the idea of using a camera, waiting 20 seconds and so the eye will have adjusted.

- (v) Explain how the teacher's method ensures that the measurement of the pupil diameters are accurate.

(2)

She uses a ruler which means all the
measurements will be ~~more~~ accurate.
She also uses the same camera so all
the photos will be accurate.



This answer gained one mark for the idea of using a camera.

Question 4(a)

This gap fill question assessed candidates' knowledge of mammalian cloning. Most were able to gain at least three marks with many going on to gain four or five. Common errors included: not referring to a diploid nucleus and stating that the cell division is meiosis. Instead of stating that the nucleus is diploid, many stated 'skin cell' which was given later in the sentence - candidates should make sure that the whole sentence makes sense before moving on.

- 4 The photograph shows Prometea, the first cloned horse.



(Source: © MAURO FERMARIELLO / SCIENCE PHOTO LIBRARY)

Prometea was produced by cloning, using the nucleus of a skin cell from a horse called Stella Cometa.

- (a) Complete the passage about cloning by writing a suitable word or words in each blank space.

(5)

A egg nucleus was taken from a skin cell from Stella Cometa.

This nucleus was inserted into an enucleated body cell that had

been taken from a donor horse. An electric shock was used to start

the type of cell division called mitosis, eventually producing

an embryo. The embryo was then placed into the ~~surrogate~~ uterus of the mother.



This answer gained three marks - the first two points were incorrect.



Make sure that you read sentences fully to ensure that the word you have added is correct.

- 4 The photograph shows Prometea, the first cloned horse.



(Source: © MAURO FERMARIELLO / SCIENCE PHOTO LIBRARY)

Prometea was produced by cloning, using the nucleus of a skin cell from a horse called Stella Cometa.

- (a) Complete the passage about cloning by writing a suitable word or words in each blank space.

(5)

A diploid mammary cell nucleus was taken from a skin cell from Stella Cometa. This nucleus was inserted into an enucleated egg cell that had been taken from a donor horse. An electric shock was used to start the type of cell division called mitosis, eventually producing an embryo. The embryo was then placed into the uterus of the mother.



This excellent answer gained all five marks.

- 4 The photograph shows Prometea, the first cloned horse.



(Source: © MAURO FERMARIELLO / SCIENCE PHOTO LIBRARY)

Prometea was produced by cloning, using the nucleus of a skin cell from a horse called Stella Cometa.

- (a) Complete the passage about cloning by writing a suitable word or words in each blank space.

(5)

A diploid nucleus was taken from a skin cell from Stella Cometa.

This nucleus was inserted into an enucleated egg cell that had been taken from a donor horse. An enzyme was used to start

the type of cell division called meiosis mitosis, eventually producing

an embryo. The embryo was then placed into the ovum / vagina / womb

the mother.



This answer gained three marks. Enzyme is incorrect and the candidate has inserted two words for the last gap so ovum negates the answer womb.

Question 4(b)

This longer evaluative question required candidates to analyse data about cloning in farm animals, information about the cost of cloning and use their own knowledge to discuss the use of cloning to replace pets. Many excellent answers were seen that gained four or five marks and it is very clear that centres and candidates are preparing well for these longer, evaluative questions. Strong answers pointed out that the success for cloning from the data was very low and used manipulated data to support their answers. Many pointed out that the cost of cloning is high and that many people who consider cloning of pets unethical. Many candidates also explained that although the clones would be genetically identical, many traits of pets are due to environmental factors and so would not be replicated. Weaker answers tended to focus on one aspect and / or simply quote data rather than manipulating it. Candidates should always consider all aspects of a question for these longer, evaluative-style questions.

(b) Until recently, most cloning has been attempted with farm animals.

The table shows some information about the success rates of cloning different farm animals during a four-year period.

Animal	Number in four-year period		
	embryos made	live births	surviving at least two years
cattle	7500	75 1%	55 73%
sheep	3500	50 1%	15 30%
goat	500	25 5%	5 20%

Some people now want to use cloning to replace their pets. The cost of cloning a pet cat can be as much as 50 000 United States dollars.

Comment on the use of cloning to replace pets.

Use the information in the table and your own knowledge about variation to support your answer.

like birth rate
goat (5)
the most successful animal made was cattle
having a 5% success rate while cattle and
sheep was 1% however out of the successful
births surviving more than 2 years cattle won
73% of its births survived more than 2 years
unit was ~~4000~~ ^{sheep} with 30% and then goat with
20% ∴ goat most successful but died more while
cattle the opposite. Moreover aside from data
cloning can produce identical copies so can help
with grieving people missing their pets however it
is very expensive and may take a long time
and done many times as seen from data the amount
embryos made vs actual birth rate for success rate
can and they die quickly and may have different
behaviour could be bad behaviour. (Total for Question 4 = 10 marks)



This answer gained all five marks. The candidate identifies the goat as having the highest live birth rate, uses manipulated data and states that the process is not very successful. The candidate also goes on to say that the process is expensive, can help people, produces identical offspring but some behaviours may not be the same.

(b) Until recently, most cloning has been attempted with farm animals.

The table shows some information about the success rates of cloning different farm animals during a four-year period.

Animal	Number in four-year period		
	embryos made	live births	surviving at least two years
cattle	7500	75	55
sheep	3500	50	15
goat	500	25	5

Some people now want to use cloning to replace their pets. The cost of cloning a pet cat can be as much as 50 000 United States dollars.

Comment on the use of cloning to replace pets.

Use the information in the table and your own knowledge about variation to support your answer.

(5)

Cloning ^{pets} is very expensive at 50 000 dollars, and also has a very low success rate, with 1% of cattle embryos made actually being born, 1.4% of sheep being born, and 5% of goats. Additionally those who are born do not survive for long, usually under two years, as shown when only 30% of cloned sheep survive past two years. Also, whilst the clones of the pets may be genetically identical ^{to the pet}, external factors may impact the nature of the clone in comparison to the original pet. ~~Also~~ Additionally, cloning presents ethical issues as cloned animals are more likely to die from the same diseases as they are genetically identical. However, cloned pets provide comfort for the owners who miss their pets too.

(Total for Question 4 = 10 marks)



This excellent answer gained five marks. The candidate explains the the process is not very successful, used manipulated data, states that the offspring are genetically identical, may be different due to other factors, is expensive and may help the owners.

(b) Until recently, most cloning has been attempted with farm animals.

The table shows some information about the success rates of cloning different farm animals during a four-year period.

Animal	Number in four-year period		
	embryos made	live births	surviving at least two years
cattle	7500	75	55
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goat	500	25	5

Some people now want to use cloning to replace their pets. The cost of cloning a pet cat can be as much as 50 000 United States dollars.

Comment on the use of cloning to replace pets.

Use the information in the table and your own knowledge about variation to support your answer.

- (5)
- Cloning is expensive compared to selective breeding, which can produce genetically similar offspring at a much lower cost.
 - However, the cost of cloning other pets (like dogs) is not stated.
 - The clone is unlikely to survive at least two years, which is much shorter than the normal lifespan of a pet.
 - However, the data only gives information about cattle, sheep, and goats, which are not typically viewed as pets.
 - 73% of cattle, 30% of sheep and 20% of goats survived at least 2 years (low, likely to cause considerable disappointment).
 - 1% of cattle, 1.4% of sheep, 5% of goats embryos led to a live birth, suggesting a high number of miscarriages.
 - Random mutations can still occur, ^{making} offspring different.
 - Genetically identical offspring desirable.
 - Not a good way to replace pets.
- (Total for Question 4 = 10 marks)

This excellent answer gained five marks. The candidate explains that the process has a low success rate, uses manipulated data, is expensive, produces genetically identical offspring, and there is only information about farm animals (not pets).

(b) Until recently, most cloning has been attempted with farm animals.

The table shows some information about the success rates of cloning different farm animals during a four-year period.

Animal	Number in four-year period		
	embryos made	live births	surviving at least two years
cattle	7500	75	55
sheep	3500	50	15
goat	500	25	5

Some people now want to use cloning to replace their pets. The cost of cloning a pet cat can be as much as 50 000 United States dollars.

Comment on the use of cloning to replace pets.

Use the information in the table and your own knowledge about variation to support your answer.

(5)

The process is highly inefficient, only a few live births are achieved from thousands of embryos. Only a handful go on to live past two years. The cost is also very high, making it unaffordable for most people for only the top rich can afford it. These animals are also not necessarily the same behaviour as the dead pet, meaning the resemblance may be a poor choice.

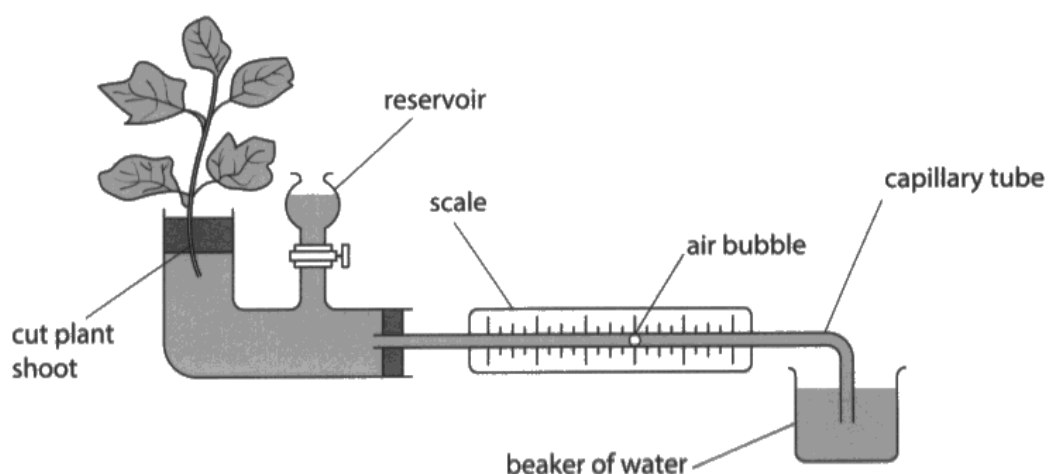


This answer gains three marks for stating that the process has a low success rate, the costs are high and the animals may have different behaviours.

Question 5(b)i

This calculation required candidates to convert the distance the bubble moved from cm into mm, substitute the values into the formula and divide by five to calculate the rate. Most candidates gained at least one mark. The most common error was not converting the cm into mm.

(b) A student uses this apparatus to measure the water uptake by a cut plant shoot.



(i) The inside of the capillary tube is a cylinder shape.

The air bubble moves a length, l , of 5.2 cm in 5 minutes.

The inside of the capillary tube has a radius, r , of 0.50 mm.

Calculate the rate of water uptake, in mm^3 per minute, by the cut plant shoot.

[volume of cylinder = $\pi r^2 l$]

[$\pi = 3.14$]

$$5.2 \text{ cm} = 52 \text{ mm} \quad (2)$$

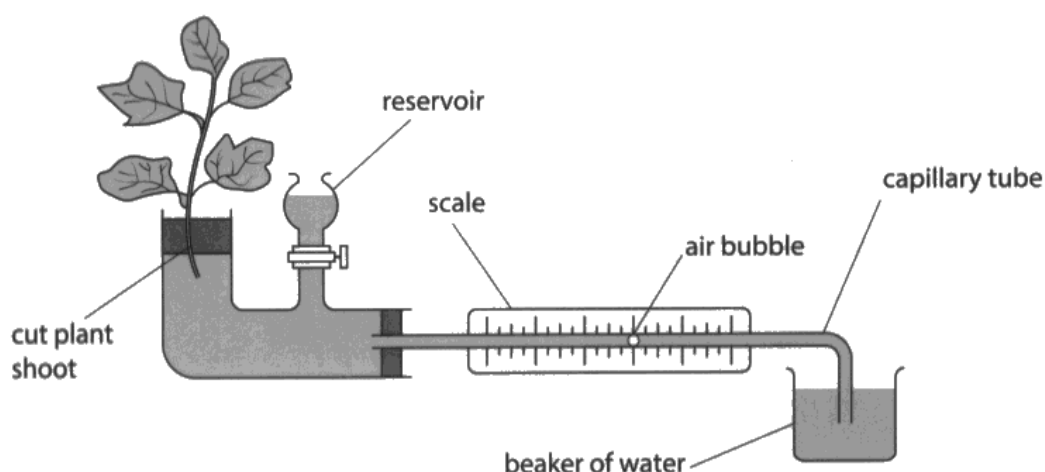
$$\begin{aligned} & \pi r^2 l \\ &= \pi (0.5)^2 \times 52 \\ &= 40.84 \\ & \frac{40.84}{5} = 8.17 \end{aligned}$$

rate = 8.17 mm^3 per minute



This answer gained both marks. The candidate has converted the units and derived the final answer correctly.

(b) A student uses this apparatus to measure the water uptake by a cut plant shoot.



(i) The inside of the capillary tube is a cylinder shape.

The air bubble moves a length, l , of 5.2 cm in 5 minutes.

The inside of the capillary tube has a radius, r , of 0.50 mm.

Calculate the rate of water uptake, in mm^3 per minute, by the cut plant shoot.

[volume of cylinder = $\pi r^2 l$]

[$\pi = 3.14$]

1.04 in 1 minute (2)

$$\pi \times 0.5^2 \times 1.04 = 0.8168$$

rate = 0.82 mm^3 per minute



This answer gained one mark. The candidate has substituted the values into the formula correctly but has not converted cm into mm.

Question 5(b)ii

This question assessed candidates' understanding of the core practical focused on the transpiration. Strong answers described a precaution, such as cutting the shoot under water when setting up the experiment, the use of a fan to change wind speed, measurement of the distance the bubble moves in a set time, repeats, and the control of other relevant variables such as humidity. Most candidates gained at least one mark with many going on to gain three or four. Most candidates seemed very familiar with the practical, although there were some who did not seem to recognise a potometer - candidates should be familiar with all the core practicals listed in the specification. Some answers simply referred to changing wind speed without giving a method - candidates should be careful to give full practical methods.

- (ii) Describe how the student can use the apparatus to investigate the effect of changing wind speed on water uptake by the cut plant shoot.

(4)

Place a fan with different wind speed settings ~~10cm~~ 5cm away from the cut plant shoot. Reset the air bubble of the potometer to the beginning of the scale, and mark its starting point. Turn the fan on to the lowest setting for 5 minutes and record how far the bubble travelled. Repeat for every setting on the fan, keeping the temperature, light intensity and humidity the same each time. Repeat the whole experiment 3x and find an average.



This answer gained four marks. The candidate gives a method using a fan to change wind speed, describes the measurement of distance moved in a set time, explains how to reset the potometer and suggests relevant variables to control.

- (ii) Describe how the student can use the apparatus to investigate the effect of changing wind speed on water uptake by the cut plant shoot.

(4)

He should compare the water uptake per minute of the plant at different wind speeds. He should ensure the plant remains the same size and species. He should use a fan and put it a set distance away from the plant. Then turn it on different windspeeds and measure the water uptake rate over 10 minutes. Repeat the experiment 5 times per fan speed. This works as water uptake = water transpired. He should use the scale / ruler to measure the distance. Finally, ensure water pH and temperature are constant. As wind speed increases, the transpiration rate increases. Transpiration is evaporation and diffusion of water.



This answer gained four marks. The candidate describes the use of a fan to change windspeed, gives a stated time, describes the measurement of the distance, suggests repeats and the control of temperature. Control variables should be relevant to the experiment - pH alone here would not have gained the mark.

- (ii) Describe how the student can use the apparatus to investigate the effect of changing wind speed on water uptake by the cut plant shoot.

(4)

The student can use a fan to increase the wind speed. The fan must be kept at the same distance. The student should then record the water uptake rate by the cut plant shoot at various wind speeds. Each experiment at each speed should be repeated multiple times to ensure accurate results and to calculate the mean. The student should then plot a graph of wind speed against rate of water uptake and compare how the wind speed affects the rate of water uptake by the cut plant shoot.



This answer gained two marks for describing the use of a fan and carrying out repeats. There is no mention of how to measure the rate of water uptake.

- (ii) Describe how the student can use the apparatus to investigate the effect of changing wind speed on water uptake by the cut plant shoot.

(4)

To investigate the ^{effect of} changing wind speed on water uptake by plant shoot, by change the distance between the fan and the plant. The distance will be in 20 to 100 cm the fan will be ~~the~~ turned on for 1 minute. At 20 cm distance, you will see the rate of transpiration increase. As the plant ~~is~~ will transpire more due to high ~~of~~ wind speed, the number of bubbles produced will increase as well. At 100 cm distance, the plant will transpire at a slower rate as there is no wind around it to move the O_2 . This will cause the bubbles to be released at a ~~slower~~ slower rate.



This answer gained two marks for changing the fan distance and for a set time of one minute.

Question 5(c)

This second evaluation question assessed candidates ability to analyse data about the production of a plant growth factor, ABA, and the relative water loss from the leaves. Many excellent answers were seen and most candidates gave answers that described the data patterns and associations between ABA and water loss accurately. Only the very strongest answers linked the ABA production to the closure of stomata and lower water loss. Weaker answers tended to give vague statements about increases and decreases but did not identify the times at which the changes in ABA or water loss occurred. The examiners were impressed with how well many candidates now approach these longer questions.

Comment on the changes in ABA concentration and water loss in the scientist's investigation.

Use information from both graphs in your answer.

(4)

- ABA concentration increases rapidly after 2 days
- after 5 days, the concentration decreases
- it ends even ^{with a} lower concentration than ~~from~~ ^{from} 0-2 days.
- ABA increased to maximise phototropism and geotropism to search for water in the roots and rain in the sky.
- as it detects low water levels after 2 days
- percentage of water loss decreases after 2 days
- on the 5th day, percentage relative water loss increases rapidly again
- experiment not repeated
- species of plants not checked
- roots hair cells are positively geotropic, absorbing water by osmosis.



This answer gained three marks for correctly stating the the ABA increases after day two and then decreases after day five. The candidate also describes the increase in water loss after day five to gain a third mark.

Comment on the changes in ABA concentration and water loss in the scientist's investigation.

Use information from both graphs in your answer.

(4)

In graph 1 the ABA concentration stays very low at 0.5 for the first two days as the lack of water means that they cannot help the plant to grow. However, halfway through day 2, the concentration increases to 7.5 and this may be due to an increase in sunlight as they accumulate on the shaded side of the plant like auxins. Once watered on day 5, they reach a peak concentration of 8.5 before dropping down to 0.5 again at 9 days due to lack of sunshine, it may be the night, so they do not accumulate and instead spread out.

In graph 2, the relative % of water loss stays at 100% for the first 2 days due to the low concentration of ABA but decreases to 4% on days 4-5 once watered as the concentration increases of ABA. They have an inverse correlation.



This excellent answer gained all four marks. The candidate correctly states that ABA concentration is 0.5 at the start, states that the ABA increases after day 4 before decreasing after day 5, they then go on to describe the opposite effect of water loss after day 2.

Comment on the changes in ABA concentration and water loss in the scientist's investigation.

Use information from both graphs in your answer.

(4)

At the start of the experiment, the plant has sufficient water, ^{so the stomata guard cells swell and open the stomata} so there is a high concentration gradient from the leaves to the atmosphere and the water ~~more~~ diffuses out of the leaf (from an area of high concentration to an area of low concentration) so there is a high relative water loss of 100%. ~~There~~ The plant has sufficient water for growth so ABA ^{as it is a growth hormone} is not required in high concentrations and so there is 0.5 ~~per~~ mg per gram of leaf. However on day 2, the plant no longer has sufficient water so the guard cells shrink, closing the stomata and preventing water loss from occurring. (Total for Question 5 = 11 marks)

Due to this water shortage, the ABA concentration increases rapidly up to 8 mg per gram of leaf on day 4. On day 5, the plant is watered, causing the ~~stomata~~ guard cells to swell and open the stomata, allowing water loss to occur and the levels of ABA to drop again.



This excellent answer gained all four marks. The candidate states that the ABA concentration is 0.5 at the start and then increases after day 2. The candidate then explains that the water loss decreases due to the closure of the stomata. The candidate also goes on to state that the water loss decreases after day 5 when the stomata reopen.

Comment on the changes in ABA concentration and water loss in the scientist's investigation.

Use information from both graphs in your answer.

(4)

ABA concentration ~~more~~ level till 2 days
then greatly increases to 8.4 in day 5
from then falls to 4 in day 6 and
~~reacts~~ and levels off at 0.5

100% percentage of water loss till day 2
water loss then decreases greatly 20% in day
3, lowest at 4% during day 4
day 5 when water began plant adjusts to
low watering keeps stomata closed to prevent water
loss so less transpiration occurs and more respirati
after plant begins to take in more water (day 5)

(Total for Question 5 = 11 marks)

more transpiration occur so more uptake of ~~mineral~~ ^{mineral} ions

no information on Temp/humidity / CO_2 species of plant

~~needs~~ more repeat and longer time period

plant adapts to water to less water uptake so
reduces water loss to prevent wilting
water loss reduced by closing stomata so less
 CO_2 and photosynthesis



This answer gains four marks. The candidate describes the increase in ABA after day 2 and then the decrease after day 5. The candidate links this to water loss changes and goes on to explain how stomatal opening and closing affect the water loss.

Question 6(a)i

This question assessed candidates' ability to extract data from a graph and use it to calculate a percentage increase. Most candidates were able to gain at least one mark, with many going on to gain the second. A common error was to divide the change by 75 rather than the starting time of 5 minutes. Candidates should understand how to complete the calculations for percentage increases and percentage decreases.

6 Apples contain an enzyme called phenol oxidase.

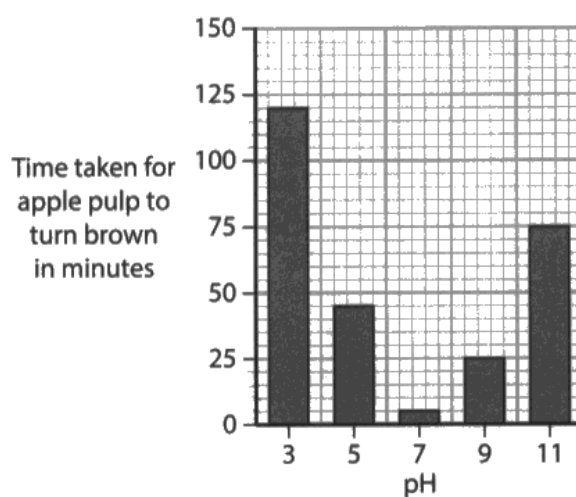
When apple tissue is exposed to oxygen in the air, this enzyme turns the apple tissue brown.

(a) A student uses this method to investigate the effect of pH on the time taken for apple tissue to turn brown.

- mash an apple to produce a pulp
- place 25 g of this pulp into a beaker
- mix a pH 7 buffer with the pulp to maintain the pH
- check the colour of the pulp every five minutes
- record the time when the pulp turns brown

The student repeats this method using pH buffers of 3, 5, 9, and 11.

The graph shows the student's results.



(i) Calculate the percentage increase in time taken for the apple pulp to turn brown at pH 11 compared with the time taken at pH 7.

(2)

$$\frac{75 - 5}{75} \times 100 = 93\%$$

percentage increase = 93 %



This answer gained one mark for calculating the difference in time. The candidate incorrectly divided the difference by the time of 75 minutes.

6 Apples contain an enzyme called phenol oxidase.

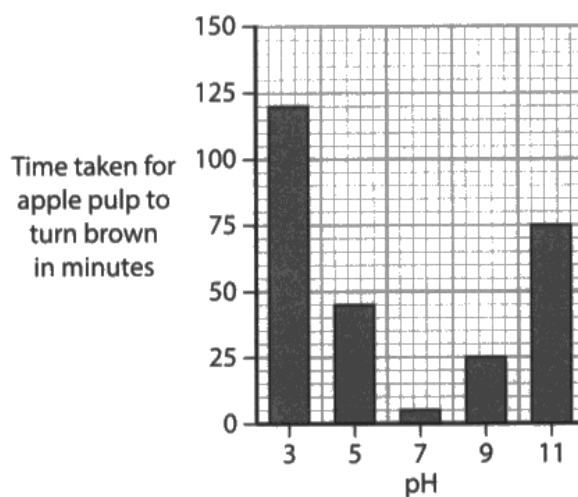
When apple tissue is exposed to oxygen in the air, this enzyme turns the apple tissue brown.

(a) A student uses this method to investigate the effect of pH on the time taken for apple tissue to turn brown.

- mash an apple to produce a pulp
- place 25 g of this pulp into a beaker
- mix a pH 7 buffer with the pulp to maintain the pH
- check the colour of the pulp every five minutes
- record the time when the pulp turns brown

The student repeats this method using pH buffers of 3, 5, 9, and 11.

The graph shows the student's results.



(i) Calculate the percentage increase in time taken for the apple pulp to turn brown at pH 11 compared with the time taken at pH 7.

(2)

$$\frac{75 - 5}{5} \times 100 = 1400$$

percentage increase = 1400 %



This answer gained both marks. The candidate has used the graph to calculate the percentage increase correctly.

6 Apples contain an enzyme called phenol oxidase.

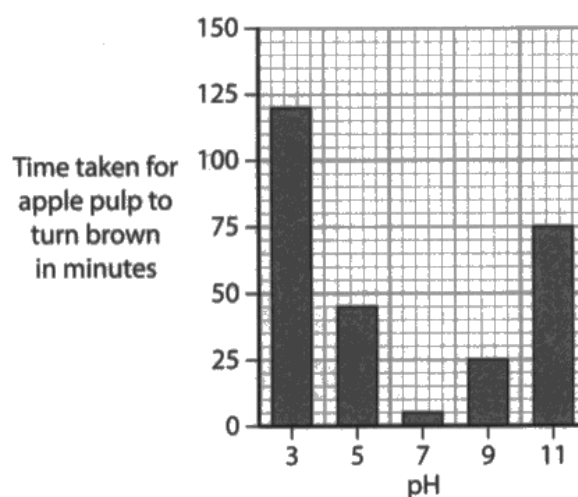
When apple tissue is exposed to oxygen in the air, this enzyme turns the apple tissue brown.

(a) A student uses this method to investigate the effect of pH on the time taken for apple tissue to turn brown.

- mash an apple to produce a pulp
- place 25 g of this pulp into a beaker
- mix a pH 7 buffer with the pulp to maintain the pH
- check the colour of the pulp every five minutes
- record the time when the pulp turns brown

The student repeats this method using pH buffers of 3, 5, 9, and 11.

The graph shows the student's results.



(i) Calculate the percentage increase in time taken for the apple pulp to turn brown at pH 11 compared with the time taken at pH 7.

(2)

7 : 5 min

11 : 75 min

$$\frac{75 - 5}{5}$$

percentage increase = 14 %



This answer gained one mark. The candidate has correctly calculated the increase in time and divided by five but has not converted this into a percentage.

Question 6(a)ii

This question assessed candidates' understanding of the effect of pH on the activity of enzymes. Most candidates gained at least one mark, with many going on to gain all three. Most recognised that enzymes would denature away from the optimum pH and often went on to explain how this would change the shape of the active site so that the substrate no longer binds. Many referred to the optimum pH but fewer stated that the optimum pH for the experiment was 7. Some candidates referred to the optimum temperature rather than pH - candidates should proof read answers once they have written them to avoid these types of error.

- (ii) Explain why the change in pH affects the time taken for the apple pulp to turn brown.

(3)

The phenol oxidase turns the apple brown, and as an enzyme, it has an optimum ^{pH} of 7. Above 7 pH, the enzyme's active site denatures and no more enzyme-substrate complexes are formed, but below 7 pH the ~~enzyme is not enough~~ is also denaturing of enzymes. At the optimum, the phenol oxidase works faster, so the apple takes only 5 minutes to go brown, but the time increases as we move away from 7 pH in either direction. With 4.5 min at pH 5, 120 at pH 3, 25 at pH 9 and 75 at pH 11.



This excellent answer gained all three marks. The candidate identifies seven as the optimum pH and goes on to state that the enzyme denatures and so enzyme-substrate complexes will not form.

- (ii) Explain why the change in pH affects the time taken for the apple pulp to turn brown.

(3)

When the enzyme is not in an optimum pH (7), the enzyme is denatured, and the substrate can no longer bind to the enzyme, since the active site is changed. This reduces the rate of reaction of ^{aerobic} respiration, so it takes longer for the apple pulp to turn brown.



This excellent answer gained three marks. The candidate correctly states that the optimum pH was 7 and then explains that the enzyme denatures at other pHs so that the substrate can not bind due to the change of shape of the active site.

(ii) Explain why the change in pH affects the time taken for the apple pulp to turn brown.

(3)

This is because the pH affects the speed at which the enzyme phenol oxidase works so the optimum pH is 7 as the apple turns brown in the least amount of time, ~~so so~~ ~~so~~



This answer gained one mark for the identification of the optimum pH as being 7. No further explanation was given.

Question 6(a)iii

This challenging question required candidates to explain how the student could modify the method to give a more accurate measure of the time taken. Strong answers recognised that identifying the end point colour is very subjective and so a reference card could be used. Other candidates correctly identified that smaller time increments could be used to identify the exact time more accurately. Many candidates incorrectly simply suggested repeating the experiment which would improve reliability rather than improving accuracy.

- (iii) Explain how the student could modify this method to give a more accurate measure of the time taken for the apple pulp to turn brown. (2)

Have a reference colour or photo
to determine when the apple is brown
and avoid stopping at different shades



This answer gained both marks for the use of a reference colour and the idea that this would avoid getting the shade wrong.

- (iii) Explain how the student could modify this method to give a more accurate measure of the time taken for the apple pulp to turn brown. (2)

- check the colour more often
- Have a set colour so they are all
the same when recorded.



This answer gained two marks for checking the colour more often and the idea of a reference colour.

- (iii) Explain how the student could modify this method to give a more accurate measure of the time taken for the apple pulp to turn brown.

(2)

- Use a colorimeter to measure the colour change.
- Take readings at shorter time intervals to get more precise timing.



This answer gained two marks for use of a colorimeter and taking readings more frequently.

- (iii) Explain how the student could modify this method to give a more accurate measure of the time taken for the apple pulp to turn brown.

(2)

- Check the colour of the pulp more frequently, maybe every minute instead of every 5 minutes to see exactly when the apple turns brown.



This answer gained one mark for the idea of checking the colour more often.

- (iii) Explain how the student could modify this method to give a more accurate measure of the time taken for the apple pulp to turn brown.

(2)

Reduce the interval of checking the colour of the pulp to ~~10~~ 1 minute for example.

Use a colour chart to compare with the pulp so that the results are accurate and not subjective.



This answer gained a mark for checking the colour more frequently and for using a colour chart.

Question 6(b)i

This question was well answered by many candidates with most gaining at least one mark. The question required candidates to state two differences between DNA and RNA. Many correctly stated that DNA has two strands, is a helix and contains thymine rather than uracil. A small number of candidates incorrectly stated that RNA has thymine and DNA uracil.

- (b) A genetically modified (GM) variety of apple has been produced that does not turn brown when exposed to air.

These apples have a gene in their DNA that produces a section of mRNA with a complementary sequence to the mRNA for the phenol oxidase gene.

- (i) State two differences between DNA and mRNA.

(2)

- 1 DNA has a double^{stranded} helix whereas mRNA is only a single strand
- 2 DNA uses the base Thymine paired with Adenosine, whereas mRNA uses the base Uracil paired with Adenosine.



This answer gained two marks. The candidate correctly states that DNA has two strands and is helical by stating the DNA is a double helix. The candidate also correctly states that DNA contains thymine but RNA uracil.

- (b) A genetically modified (GM) variety of apple has been produced that does not turn brown when exposed to air.

These apples have a gene in their DNA that produces a section of mRNA with a complementary sequence to the mRNA for the phenol oxidase gene.

- (i) State two differences between DNA and mRNA.

(2)

- 1 DNA is double string, mRNA is single.
- 2 mRNA use U instead of T



This answer gained two marks for the ideas that DNA is double stranded and it contains thymine but RNA contains uracil.

- (b) A genetically modified (GM) variety of apple has been produced that does not turn brown when exposed to air.

These apples have a gene in their DNA that produces a section of mRNA with a complementary sequence to the mRNA for the phenol oxidase gene.

- (i) State two differences between DNA and mRNA.

(2)

1 DNA contains a thymine base

2 mRNA contains a uracil base



This answer gained one mark. Thymine being present in DNA and uracil in RNA is the same mark point.



Always make sure that you give clearly different points when asked for differences or similarities.

Question 6(b)ii

This challenging final question required candidates to explain why the presence of a piece of RNA complementary to the mRNA for phenol oxidase would prevent apple pulp turning brown. The very best answers explained that the two RNAs would bind together, preventing translation and the binding of tRNA to the mRNA and so the enzyme would not be made. Many excellent descriptions of protein synthesis were seen and the examiners were impressed with how confidently many candidates described transcription and translation. Many candidates did not appreciate that the complementary RNA would bind to the mRNA but still gained three marks for excellent descriptions of protein synthesis. A few candidates suggested that the RNA would cause mutations. Some candidates understood that terms such as transcription, translation, codon, anticodon, ribosomes, and tRNA are involved with protein synthesis but used them inaccurately - candidates often confuse transcription and translation. This topic is a challenging topic that can only be tested on paper two with highly specific vocabulary - candidates should spend time becoming confident with the meaning of all the vocabulary.

- (ii) Explain why these GM apples do not turn brown when the apple tissue is exposed to air.

Use your knowledge of protein synthesis to support your answer.

(4)

~~the~~ ~~m~~ the GM ~~gene~~ DNA unzip and is copied into
a ~~MR~~ mRNA with complementary sequence to mRNA for
the ~~ph~~ phenol oxidase gene during transcription in the nucleus
This ^{mRNA} ~~gene~~ binds with the mRNA of phenol oxidase gene,
as they are complementary
therefore no mRNA ~~binds to~~ of phenol oxidase gene binds to
ribosome, this ~~mrna~~ mRNA codon don't bind with tRNA
anticodon, no tRNA brings amino acids, no chain of
amino acid is made, no phenol oxidase enzyme is made,
as no translation thus no enzyme to turn the apple tissue
brown



This excellent answer gained all four marks. The candidate describes transcription to produce the RNA and its binding to the mRNA for phenol oxidase. The candidate then goes on to describe how the mRNA would not bind to a ribosome and so tRNA would not bind and a chain of amino acids would not form. This is an excellent answer that confidently and accurately uses all the vocabulary.

- (ii) Explain why these GM apples do not turn brown when the apple tissue is exposed to air.

Use your knowledge of protein synthesis to support your answer.

(4)

The complimentary sequence of mRNA produced from ^{the} unzipping of DNA by RNA polymerase can ~~it~~ join with the mRNA responsible for coding the phenol oxidase gene. ~~the~~ Because the two strands are complimentary they will bond before the mRNA can reach the ribosome and produce the protein for phenol oxidase. This means phenol oxidase is not produced, and the apples will not turn brown because the mRNA cannot perform translation as it is bound to a complimentary strand, and there will be no phenol oxidase.



This excellent answer gained all four marks. The candidate describes transcription to produce the RNA, the binding of the two RNAs and how this prevents binding to ribosomes and production of the phenol oxidase enzyme.

- (ii) Explain why these GM apples do not turn brown when the apple tissue is exposed to air.

Use your knowledge of protein synthesis to support your answer.

(4)

When the mRNA to produce phenol oxidase leaves the nucleus, it has to find a complementary tRNA to bind to, to form the correct link of amino acids to form the phenol oxidase polypeptide chain. However, if this phenol oxidase mRNA will bind to the complementary mRNA ~~with~~ produced by the ~~GM~~ ^{modified} gene instead, in the GM apple. This means it will not be able to bind to tRNA in the cytoplasm to form the phenol oxidase protein that turns the apple brown, thus stopping the process.



This answer also gained four marks. The candidate describes how the two RNAs bind together and how this prevents tRNA binding, bringing amino acids and forming an amino acid chain to make phenol oxidase.

- (ii) Explain why these GM apples do not turn brown when the apple tissue is exposed to air.

Use your knowledge of protein synthesis to support your answer.

(4)

The gene carries a strand of mRNA to have a complementary sequence to the mRNA for phenol oxidase, meaning in transcription, a different sequence of bases is copied, therefore in ~~transcription~~ translation, a different polypeptide is produced, which carries out a different function. This means phenol oxidase is not produced and the ~~apple~~ apple does not go brown.



This answer gained one mark for stating that phenol oxidase is not produced. The references to translation and transcription are confused and not accurate.

- (ii) Explain why these GM apples do not turn brown when the apple tissue is exposed to air.

Use your knowledge of protein synthesis to support your answer.

(4)

Because the mRNA sequences are complementary to each other they will bind together with hydrogen bonds. Meaning the mRNA for the enzyme will not be able to make the ~~enzyme~~ bind to a ribosome to make the enzyme as it would already be bonded to the other mRNA. Therefore less enzymes are produced, so there are less enzyme substrate complexes formed, less reaction occur the apple does not turn brown.



This answer gained three marks for correctly stating that the two RNA would bind together, would not bind to a ribosome and so the enzyme is not produced.

Paper Summary

For future series, candidates should:

- ensure that they are fully conversant with practical terminology such as accurate and reliable
- ensure that they understand the differences between the different command words listed in the specification
- explore data fully when answering longer, evaluative questions
- use key scientific terminology with confidence
- have a full understanding of protein synthesis including knowledge of terms such as transcription, translation, codons and anticodons.

Grade boundaries

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