Activity 9 – Exemplar question 1

10 A student investigated the light-dependent reactions of photosynthesis in spinach leaves.

The leaves were cut into pieces and ground in a cold solution of sucrose and a buffer.

The mixture was filtered and centrifuged. The liquid in the tube was poured off and kept in an ice water bath.

The pellet at the bottom of the tube was suspended by mixing with fresh sucrose and buffer and stored in an ice water bath.

Four tubes were then set up as follows:

Tube	Liquid poured off after centrifuging / cm^3	Resuspended pellet / cm^3	Sucrose and buffer solution / cm^3
1	–	0.5	–
2	–	–	0.5
3	–	0.5	–
4	0.5	–	–

The tubes had 5 cm^3 of DCPIP added to them. Tube 3 was kept in the dark and the others kept in the light.

After twenty minutes, the colour in each tube was recorded. The results are shown in the table below.

Tube	Colour in tube
1	pale green
2	blue
3	blue
4	blue

(a) (i) Give **two** reasons why a cold solution containing sucrose and a buffer was used in this investigation.

(2)

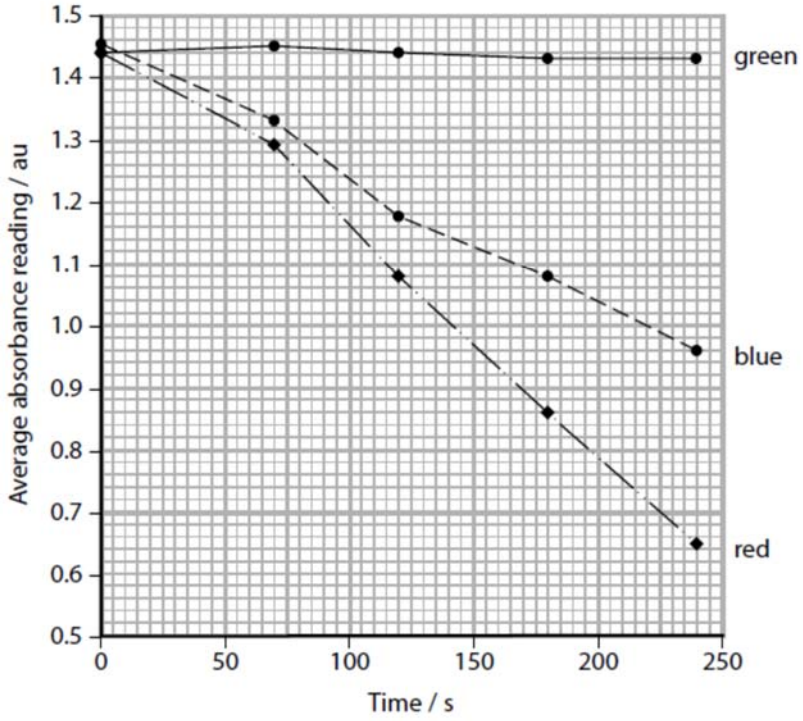
(ii) Give a reason why tube 3 was used in this investigation.

(1)

(iii) In another investigation, the student wanted to determine the effect of different wavelengths of light on the light-dependent stage of photosynthesis.

The student modified her first investigation to obtain results.

The graph shows the results of her modified investigation.



Explain how the student modified the practical procedure of the first investigation to enable these results to be obtained.

(4)

Question Number	Acceptable Answer	Additional guidance	Mark
10(a)(i)	An answer that makes reference to the following: • {cold / buffered} to stop enzyme denaturation (1) • sucrose to stop osmotic loss of water from chloroplasts (1)		**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
10(a)(ii)	• tube 3 is a control to show DCPIP does not change colour over time (1)		**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
10(a)(iii)	An explanation that makes reference to the following: • set up tubes identical to tube 1 so that chloroplasts are available (1) • set up several tubes to ensure data is reliable (1) • tubes exposed to light of different wavelengths for same time because time affects number of electrons released / tubes exposed to light of same intensity because intensity affects number of electrons released (1) • use a colorimeter with a red filter to measure absorbance (1)		**(4)**

Student answers (a)(i)

Student answer A

(a) (i) Give two reasons why a cold solution containing sucrose and a buffer was used in this investigation.

(2)

Sucrose - keep water potential constant

Buffer - keep pH levels 'constant' ; they will change a bit

Student answer B

(a) (i) Give two reasons why a cold solution containing sucrose and a buffer was used in this investigation.

(2)

Cold solution so no enzymes ~~will denature~~.
would denature. Also, the cell membrane
of palisade cells containing the chloroplast
(which contains the chlorophyll) will be broken
down.

Student answer C

(a) (i) Give **two** reasons why a cold solution containing sucrose and a buffer was used in this investigation.

(2)

It needs to be cold to stop denaturation
of enzymes.
& A sucrose solution is needed to stop the
chloroplast from bursting changing shape due to
osmosis.

Student answers (a)(ii)

Student answer A

(ii) Give a reason why tube 3 was used in this investigation.

(1)

To ensure ~~effects~~ results were actually due to light's presence

Student answer B

(ii) Give a reason why tube 3 was used in this investigation.

(1)

As a control

Student answer C

(ii) Give a reason why tube 3 was used in this investigation.

(1)

tube 3 is a control to check that DCPIP does not change on its own.

Student answers (a)(iii)

Student answer A

Explain how the student modified the practical procedure of the first investigation to enable these results to be obtained.

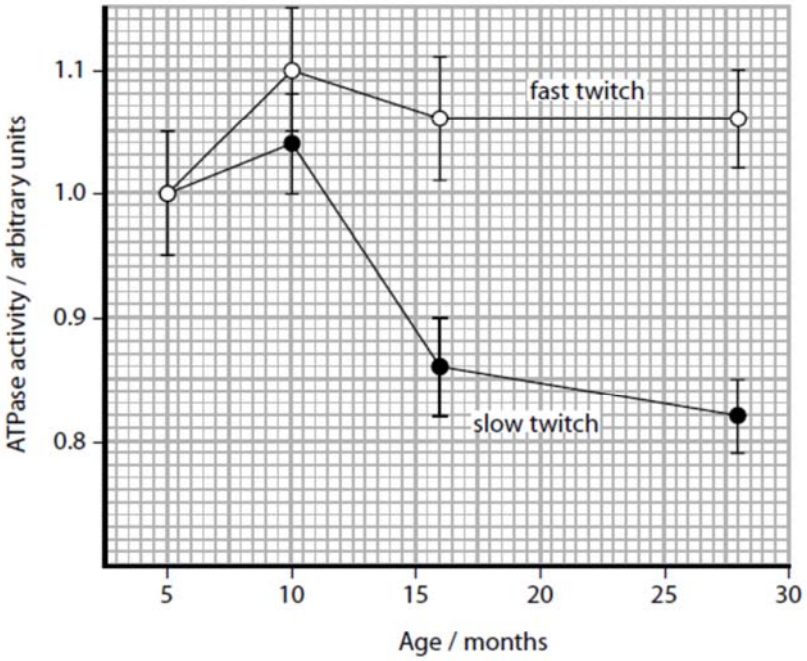
(4)

- Set up lots of tube 1
- Shine green light ~~one~~ on one set of tubes, blue light on another set and blue on another.
- use coloured filters or coloured light bulbs but the same wattage.
- measure the absorbance ~~for~~ every minute for six minutes
- calculate the mean absorbance for each wavelength of light

Activity 9 – Exemplar question 2

(c) A group of scientists investigated the effect of aging on the Ca-ATPase activity in fast and slow twitch muscle fibres obtained from rats.

The results are shown in the graph.



The membranes in these fibres contain the enzyme Ca-ATPase which is involved in the transport of calcium ions.

The scientists concluded that in older muscle it takes longer to restore the calcium ion balance.

Analyse the data to evaluate whether these results support the scientists' conclusion.

(6)

Question Number	Indicative content	
8(c)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. *Supports* • this is true after 10 months because there is a significant decrease for the slow twitch • if muscle is {mainly slow twitch / has fewer fast twitch} • Ca-ATPase will take longer to transport calcium ions into the sarcoplasmic reticulum *Does not support* • ageing has {no / little} effect on fast twitch fibres • there is little difference between the fast and slow twitch up to 10 months • appropriate comment on the difference between the data related to the variation as shown by the error bars	
Level	Mark	Descriptor
	0	No awardable content
Level 1	1-2	Limited scientific judgement made with a focus on one side of the argument only. A conclusion may be attempted, demonstrating isolated elements of biological knowledge and understanding but with limited evidence to support the judgement being made.
Level 2	3-4	A scientific judgement is made through the application of relevant evidence to both sides of the argument. A conclusion is made, demonstrating linkages to elements of biological knowledge and understanding, with occasional evidence to support the judgement being made.
Level 3	5-6	A scientific judgement is made, which is supported throughout by sustained application of relevant evidence from the analysis and interpretation of the scientific information. A conclusion is made, demonstrating sustained linkages to biological knowledge and understanding with evidence to support the judgement being made.

Student answers

Student answer A

Analyse the data to evaluate whether these results support this conclusion. **(6)**

The conclusion is not fully supported by these results. It is supported by the results shown by the slow twitch fibres. The activity of ATPase greatly reduces after a peak at the age of 10 months, falling from 1.04 au to 0.82 au in a space of 18 months. In contrast to this the amount of ATPase activity in fast twitch fibres drops 0.04 au from a peak at 10 months.

Student answer B

overlap. ~~up to~~

The membranes in these fibres contain the enzyme Ca-ATPase which is involved in the transport of calcium ions.

The scientists concluded that in older muscle it takes longer to restore the calcium ion balance.

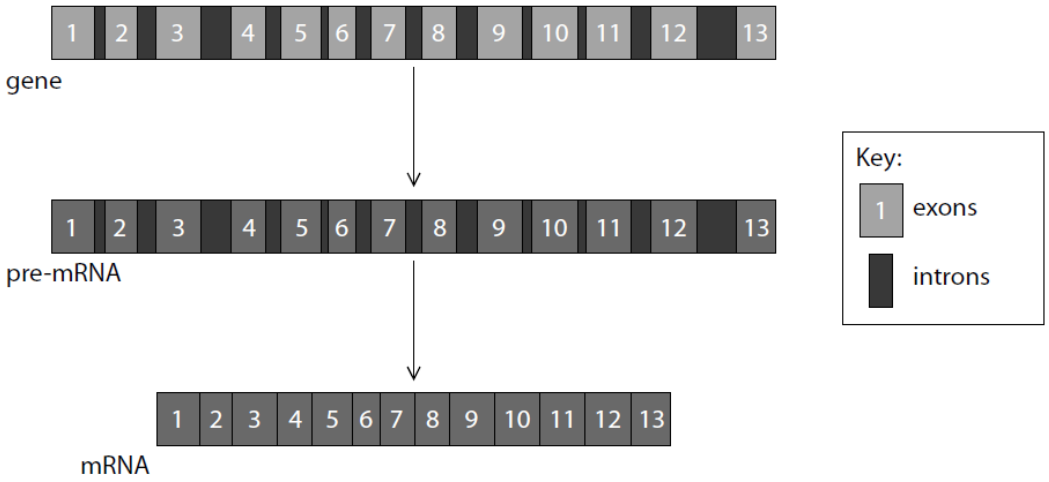
Analyse the data to evaluate whether these results support the scientists' conclusion. **(6)**

~~The data is only about ATPase activity and this doesn't~~ The data doesn't support the conclusion because ~~recessarily effect calcium ions.~~ Also the activity increases from 5 to 10 months in both types of fibre and the error bars overlap. There's no data on the ratio of the two fibres changing. So it doesn't support as there could be fewer slow fibres as it ages. The data does support the statement because although the activity in fast is constant from 16 to 28 months it decreases by 0.04 a.u so with less enzyme activity the calcium ion balance will take longer.

Activity 9 – Exemplar question 3

9 A central idea in biology is that DNA codes for the synthesis of proteins from amino acids. The instructions for making proteins are in the form of mRNA.

The diagram shows two stages in the production of mRNA.



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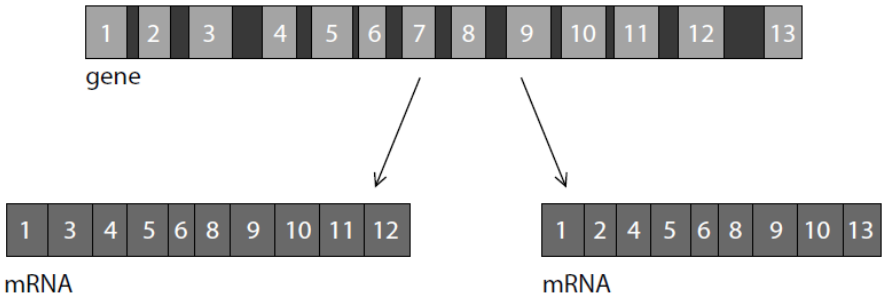
(a) Explain how this molecule of mRNA is produced.

(4)

(b) Sometimes the process is more complicated as shown in the diagram below.



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An initial estimate of the number of genes, based on the number of proteins found in humans, was in the region of 100 000. It is now known that the number of genes is around 25 000.

Explain how the formation of mRNA, shown in the diagram, might account for this.

(5)

Question Number	Acceptable Answer	Additional guidance	Mark
9(a)	An explanation that makes reference to four of the following: • DNA unzips and one strand acts as a template (1) • ribonucleotides pair up with complementary bases (1) • RNA polymerase joins ribonucleotides together to form pre-mRNA (1) • the mRNA has fewer bases than pre-mRNA / gene (1) • as a result of removal of introns / mRNA made up of exons only (1)		**(4)**

Question Number	Acceptable Answer	Additional guidance	Mark
9(b)	An explanation that makes reference to the following: • it was assumed that one gene makes one protein (so there should be 100 000 genes but there are 25 000 genes) (1) • the diagram shows that one gene can make more than one mRNA (1) • one gene can code for several proteins (1) • due to removal of different exons (1) • reference to post-transcriptional change (1)		**(5)**

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Student answers – (a)

Student answer A

(a) Explain how this molecule of mRNA is produced.

(4)

The pre mRNA is spliced, ~~and~~ exons are bonded back together and introns are removed.

Student answer B

(a) Explain how this molecule of mRNA is produced.

(4)

Double stranded DNA will be opened up by helicase and RNA nucleotides will pair themselves with the sequence on the template strand. After pairing, pre-mRNA will detach and double strand of DNA reforms. Pre-mRNA containing ~~with~~ the exons and introns will be modify and introns will be removed and left exons to undergo translation.

Student answer C

(a) Explain how this molecule of mRNA is produced.

(4)

The DNA is unzipped and nucleotides line up on the template strand by complementary pairing of bases. RNA polymerase joins the nucleotides together to produce the pre-mRNA. This molecule is a complementary copy of all the introns and exons in the gene.

Then nucleases remove the bases in the introns and the exons are spliced together. This produces the mRNA by post-transcriptional modification.

Student answers – (b)

Student answer A

Explain how the formation of mRNA, shown in the diagram, might account for this.

(5)

The diagrams shows how 1 gene can code for ~~a~~ and transcribe more than one mRNA and therefore more than one protein can be ~~transcribed~~ translated from a single gene. So there will be fewer genes than proteins

Student answer B

Explain how the formation of mRNA, shown in the diagram, might account for this.

(5)

The early idea that one gene codes for one polypeptide meant that about 100,000 genes would be needed. The human genome project has shown that the number of genes that are needed is fewer. That's because one gene can code for more than one polypeptide. The diagram shows that two different mRNAs can be produced if not only the introns are removed but some of the exons as well. One molecule has 3 exons missing and the other has 4 exons removed. There could be another mRNA with no exons removed. They would all be translated into different polypeptides.

(Total for Question 9 = 9 marks)

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