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**Answer ALL questions.**

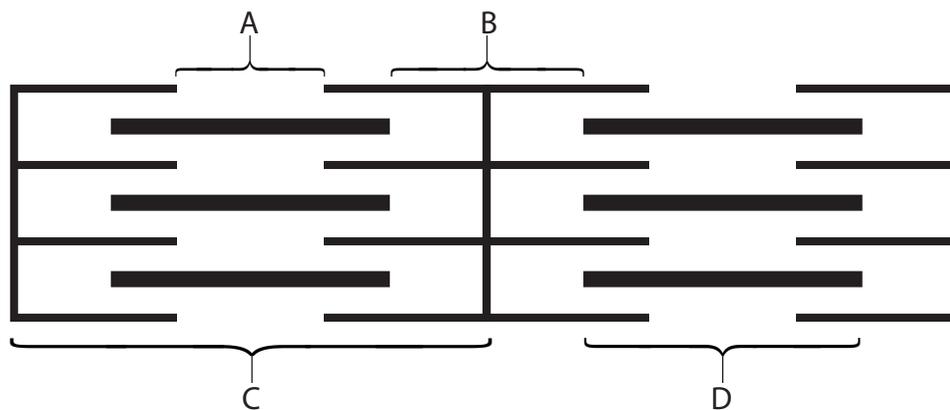
**Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.**

**1** Muscles, tendons and the skeleton all interact when the leg of a human moves.

(a) Place a cross in the box ☒ that completes each statement about skeletal muscles.

(i) The diagram below shows part of a muscle fibre.

(1)



The label that shows a sarcomere is

- A**  
 **B**  
 **C**  
 **D**

(ii) When a muscle contracts, the length of a sarcomere

(1)

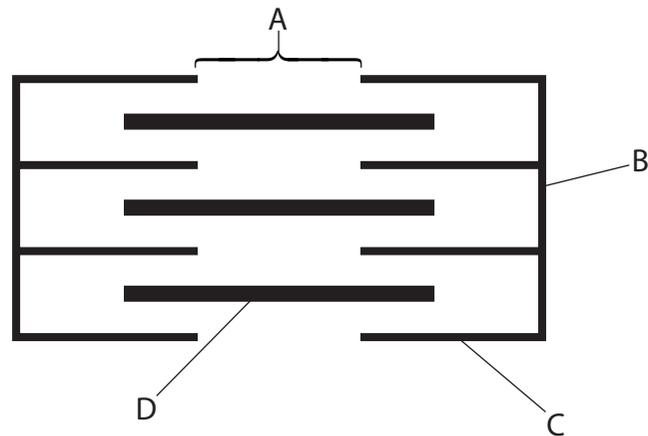
- A** becomes zero  
 **B** decreases  
 **C** increases  
 **D** stays the same



P 4 2 9 1 9 A 0 3 2 8

(iii) In the diagram below, tropomyosin is found in

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- A
- B
- C
- D

(iv) The sarcoplasmic reticulum releases ions that bind to troponin. These ions are

(1)

- A calcium
- B phosphate
- C potassium
- D sodium

(v) The thin filament in a muscle fibre is

(1)

- A actin
- B ATP
- C ATPase
- D myosin

(vi) Slow twitch muscle fibres have

(1)

- A less myoglobin than fast twitch fibres
- B more myoglobin than fast twitch fibres
- C no myoglobin
- D the same quantity of myoglobin as fast twitch fibres



(b) Explain why tendons need to be inelastic.

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**(Total for Question 1 = 9 marks)**





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- 2 The zebrafish is a tropical freshwater fish that has been genetically modified.  
The photograph below shows a zebrafish.



Magnification  $\times 1$

- (a) The transcription factor known as Sp2 has been studied. In this study, a gene from red coral cells was added to the genome of the zebrafish.

The gene from red coral cells produces a red protein when the synthesis of Sp2 also occurs.

- (i) Explain what is meant by the term **transcription factor**.

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(ii) Suggest how this gene is removed from the red coral cells and then added to the zebrafish genome.

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(b) Genetically modified zebrafish, in a variety of bright colours, can be bought from some pet shops.

The colour of the zebrafish depends on which gene has been added to its genome.

Suggest **one** potential risk to other organisms in a river ecosystem if a genetically modified zebrafish escaped into this river.

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(c) The optimum temperature range for zebrafish to survive is 17–29°C.

An investigation was carried out to study the effect of water temperature on the survival of both genetically modified zebrafish and non-genetically modified zebrafish.

The results are shown in the table below.

Type of zebrafish	Lowest temperature for survival / °C	
	Mean	Standard deviation
Non-genetically modified	5.3	1.3
With gene for red protein	9.2	1.9
With gene for green protein	6.4	1.3

(i) These results suggest that there would be less risk to the environment if zebrafish with the gene for the red protein escaped into a cold water river compared with non-genetically modified zebrafish.

Using the information in the table, give the evidence for this.

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(ii) These results also suggest that there may be no difference in the lowest temperature for survival of the zebrafish with the gene for the green protein and the non-genetically modified zebrafish.

Using the information in the table, give the evidence for this.

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**(Total for Question 2 = 9 marks)**





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**3** Activities such as exercise can affect both the heart rate and breathing rate of humans.

(a) Heart rate can be measured using an electrocardiogram (ECG).

Explain what is meant by the term **electrocardiogram**.

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(b) A spirometer trace can be used to find the resting breathing rate in humans.

Explain how a spirometer trace can be used to calculate the mean resting breathing rate of a person.

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(ii) Suggest how an increase in breathing rate can help to reduce the concentration of carbon dioxide in a person walking away from a volcano.

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**(Total for Question 3 = 13 marks)**



**4** Weisel and Hubel studied the development of vision during the critical window (critical period) of various mammals.

(a) In one investigation, kittens were used.

(i) Suggest why kittens were used to study the development of vision in humans.

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(ii) Suggest why the kittens used were all from one set of parents.

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(b) A kitten had its right eye covered for the first seven weeks after birth. The right eye was then uncovered. The left eye was not covered.

After seven weeks the visual cortex of this kitten was studied.

(i) Describe what happens to the visual pigment in a rod cell when stimulated by light.

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(ii) Explain what happens to the visual cortex when the right eye of this kitten is covered for the first seven weeks after birth.

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(c) Give **one** reason why some people believe that it is ethically unacceptable to use kittens in medical research.

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**(Total for Question 4 = 8 marks)**



5 A neurone is a cell that has a potential difference across its cell surface membrane. This potential difference changes when a neurone is stimulated.

(a) The potential difference across the membrane of a neurone was investigated before and after stimulation.

The table below shows the results of this investigation.

Time / ms	Potential difference / mV
0.00	-70
1.00	-70
1.25	0
1.50	+30
1.75	0
2.00	-80

(i) Place a cross in the box  that completes the following statement.

The resting potential for this neurone is

(1)

- A - 80 mV
- B - 70 mV
- C 0 mV
- D + 30 mV

(ii) Using the information in the table, describe the changes in the potential difference from 1.00 ms to 1.50 ms.

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(iii) Suggest an explanation for the change in potential difference across the membrane between 1.00 ms and 1.50 ms.

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(b) This neurone was given a second stimulus at 1.50 ms.  
This had no effect on the changes in the potential difference shown in the table.

Suggest reasons why the second stimulus had no effect on the changes in the potential difference.

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**(Total for Question 5 = 10 marks)**





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6 Serotonin is a neurotransmitter found in the human brain.  
A reduced level of this neurotransmitter has been linked to depression.

(a) Explain what is meant by the term **neurotransmitter**.

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(b) A serotonin selective reabsorption inhibitor (SSRI) may be given to patients to reduce depression.

Suggest how this helps to reduce depression.

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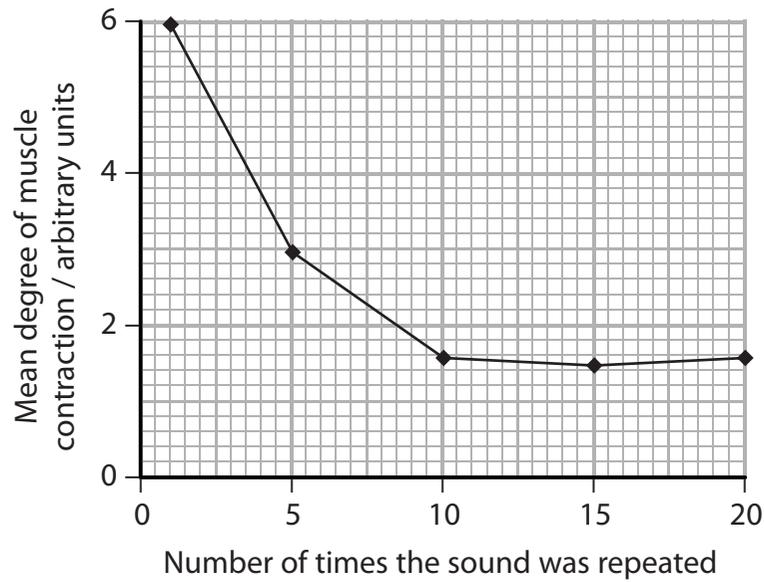
(c) An investigation was carried out to study habituation in a group of people.

Each person wore a pair of headphones through which a short sound was played once. This sound made each person blink their eyes.

The degree of contraction of one muscle involved in blinking was recorded. The mean degree of muscle contraction was calculated for the group.

This was repeated with the sound played 5 times, 10 times, 15 times and 20 times. The mean results for the group were recorded.

The results are shown in the graph below.



(i) Suggest an explanation for the change in the mean degree of muscle contraction.

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(ii) Describe how this investigation could be extended to obtain valid and reliable data on how the volume of the sound could affect habituation.

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**(Total for Question 6 = 11 marks)**





(c) Explain what is meant by the term **mutation** 'of mitochondrial genes' (paragraph 7).

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(d) In 2011 there were 723,913 children born in England and Wales.

Using information from paragraph 9, calculate the number of children born with Leigh syndrome in England and Wales in 2011. Show your working.

(2)

Answer .....

(e) Using information from paragraph 22, explain how cells in the pancreas would detect an increase in blood glucose concentration.

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(h) Preimplantation genetic diagnosis cannot 'help women whose mitochondria are all mutant' (paragraph 46).

(i) Give a reason why people may wish to use preimplantation genetic diagnosis.

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(ii) Give an ethical reason why people may **not** wish to use preimplantation genetic diagnosis.

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(i) Using information from paragraph 52 and your own knowledge, suggest which climate-related mitochondrial variant may boost athleticism. Give reasons for your answer.

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(j) Using paragraphs 53 and 54, suggest why mitochondrial genes may 'play the dominant role in natural speciation' of copepods.

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**(Total for Question 7 = 30 marks)**

**TOTAL FOR PAPER = 90 MARKS**

