Exampro A-level Biology

3.5.3 - Effectors

Name:

Class:

Author:

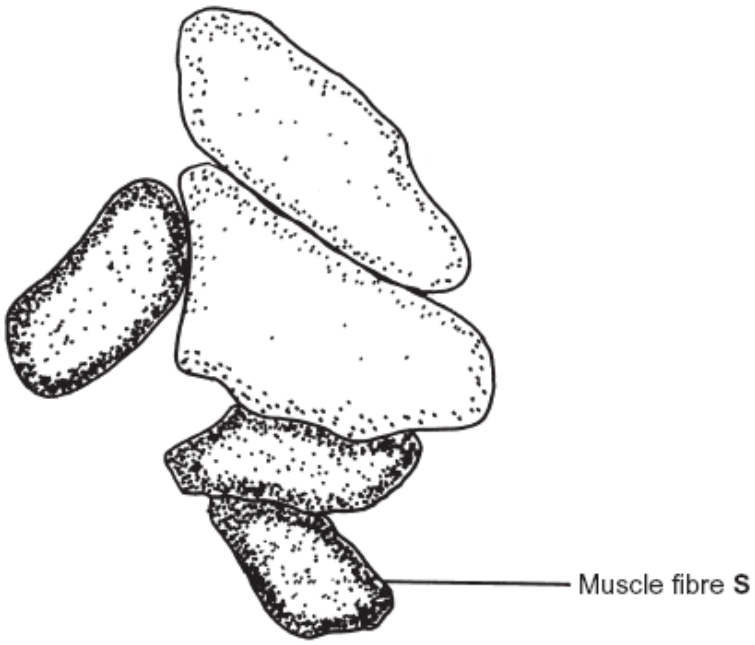
Date:

Time: 95

Marks: 78

Comments:

Q1. The drawing is a tracing of a cross-section through skeletal muscle tissue. This muscle contains fast muscle fibres and slow muscle fibres. The section has been stained to show the distribution of the enzyme succinate dehydrogenase. This enzyme is found in mitochondria.



(a) (i) Succinate dehydrogenase catalyses one of the reactions in the Krebs cycle. What is the evidence from the drawing that muscle fibre **S** is a slow muscle fibre? Explain your answer.

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(2)

(ii) Use evidence from the diagram to describe the distribution of mitochondria inside the slow muscle fibres. Explain the importance of this distribution.

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(3)

(b) (i) You could use an optical microscope and a slide of stained muscle tissue to find the diameter of one of the muscle fibres. Explain how.

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(2)

(ii) A student found the mean diameter for the slow muscle fibres in a section. Give **two** precautions that she should have taken when sampling the fibres. Give a reason for each precaution.

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2 .....

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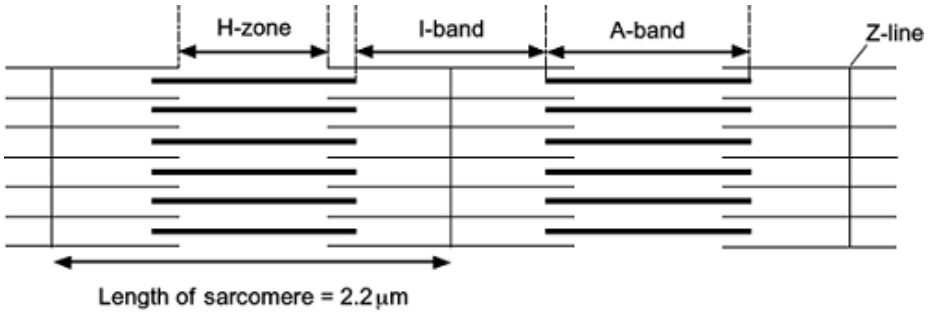
(2)
(Total 9 marks)

Q2. The diagram shows two relaxed sarcomeres from skeletal muscle.



(a) When the sarcomeres contract, what happens to the length of

(i) the I-band

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(1)

(ii) the A-band?

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(1)

(b) The length of each sarcomere in the diagram is 2.2 μm. Use this information to calculate the magnification of the diagram. Show your working.

Magnification .....

(2)

(c) People who have McArdle's disease produce less ATP than healthy people. As a result, they are not able to maintain strong muscle contraction during exercise. Use your knowledge of the sliding filament theory to suggest why.

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(Extra space) .....

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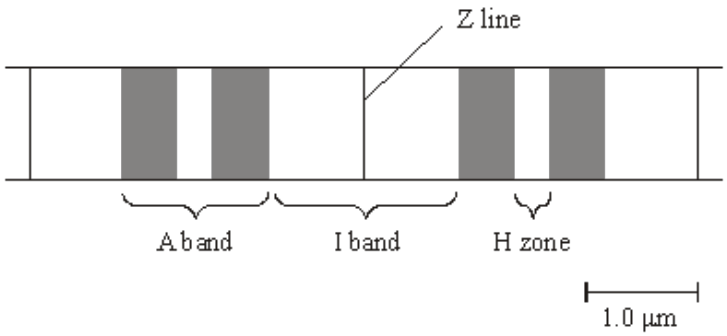
(3)
(Total 7 marks)

Q3. The diagram shows part of a myofibril from a relaxed muscle fibre.



(a) When the muscle fibre contracts, which of the A band, I band and H zone

(i) remain unchanged in length,

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(1)

(ii) decrease in length?

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(1)

(b) Explain what caused the decrease in length in part (a)(ii).

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(2)

(c) The whole muscle fibre is 30 mm long when relaxed. Each sarcomere is 2.25 µm long when contracted. Use the scale given on the diagram to calculate the length of the contracted muscle fibre in millimetres.

Length of contracted fibre = ... mm

(2)

(d) The table gives some properties of the two different types of muscle fibre found in skeletal muscle.

(i) Complete the table by writing the words 'high' or 'low' for the remaining three properties of each type of muscle fibre.

	Type of muscle fibre	
	Type 1	**Type 2**
Speed of contraction	high	low
Force generated	high	low
Activity of the enzymes of glycolysis	high	low
Number of mitochondria		
Activity of Krebs cycle enzymes		
Rate of fatigue		

(3)

(ii) The myosin-ATPase of **type 1** muscle fibres has a faster rate of reaction than that in **type 2** fibres. Use your knowledge of the mechanism of muscle contraction to explain how this will help **type 1** muscle fibres to contract faster than **type 2**.

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(4)

S (iii) The blood leaving an active muscle with a high percentage of **type 1** muscle fibres contained a higher concentration of lactate than that leaving a muscle with a high percentage of **type 2** muscle fibres. Explain why.

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(2)

(Total 15 marks)

Q4. **Figure 1** shows part of a sarcomere.

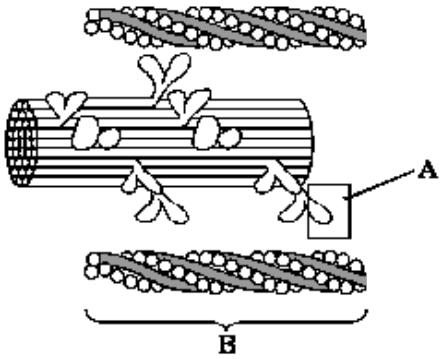

Figure 1

(a) (i) Name the main protein in structure **B**.

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(1)

(ii) Name the structure in box **A**.

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(1)

(b) (i) Describe how calcium ions cause the myofibril to start contracting.

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(2)

(ii) Describe the events that occur within a myofibril which enable it to contract.

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(3)

Slow and fast skeletal muscle fibres differ in a number of ways. Slow fibres get their ATP from aerobic respiration while anaerobic respiration provides fast fibres with their ATP. **Figure 2** shows a bundle of fast and slow fibres seen through an optical microscope. The fibres have been stained with a stain that binds to the enzymes which operate in the electron transport chain.

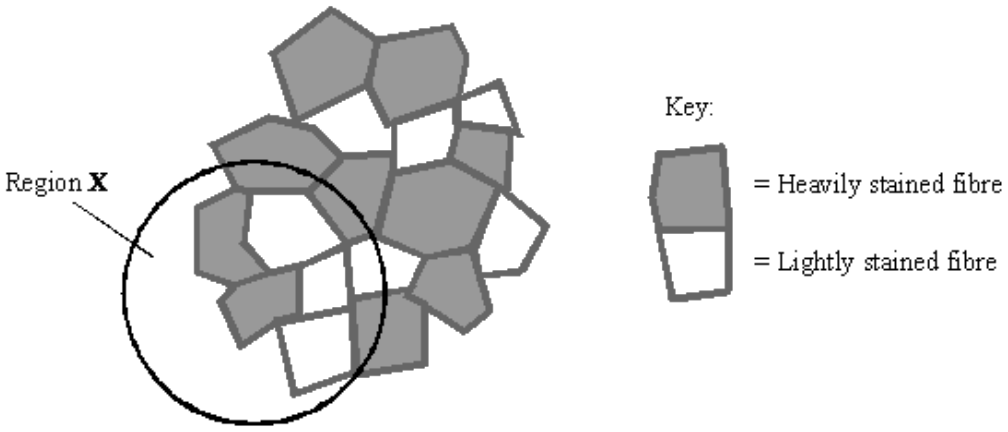

Figure 2

S (c) (i) Describe how you could calculate the percentage of fast fibres in this bundle.

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(1)

(ii) The figure calculated by the method in part (c)(i) may not be true for the muscle as a whole. Explain why.

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(1)

(d) The fibres in **Figure 3** correspond to those in region **X** of **Figure 2**. They were stained with a substance that binds to enzymes involved in glycolysis. Shade **Figure 3** to show the appearance of the fibres. Use the shading shown in the key.

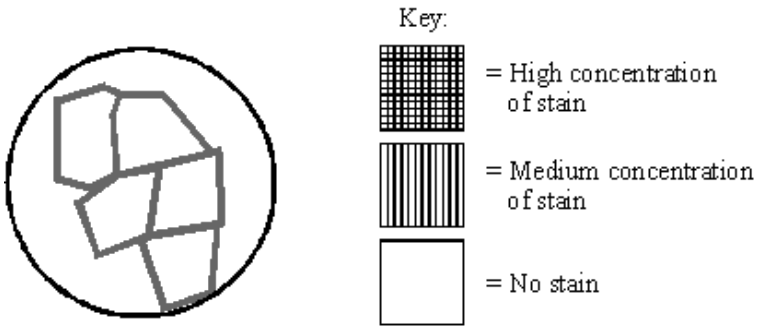

Figure 3

(2)

S (e) Recent research has shown that the difference in fibre types is due in part to the presence of different forms of the protein myosin with different molecular shapes.

Explain how a new form of myosin with different properties could have been produced as a result of mutation.

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(4)
(Total 15 marks)

Q5. **Figure 1** shows a diagram of part of a muscle myofibril.

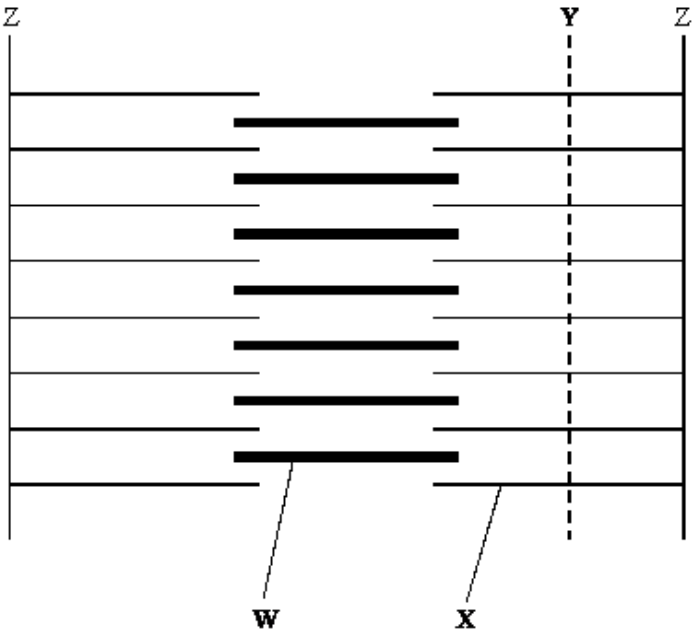

Figure 1

(a) Name the protein present in the filaments labelled **W** and **X**.

W .....

X .....

(1)

(b) **Figure 2** shows the cut ends of the protein filaments when the myofibril was cut at position **Y**. **Figure 3** shows the protein filaments when the myofibril was cut at the same distance from a Z line at a different stage of contraction.

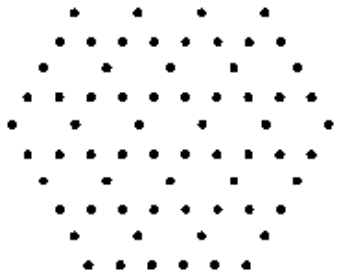

Figure 2

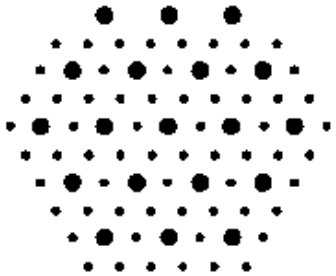

Figure 3

Explain why the pattern of protein filaments differs in **Figure 2** and **Figure 3**.

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(2)

(c) Describe the role of calcium ions in the contraction of a sarcomere.

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(4)
(Total 7 marks)

Q6. (a) Describe the part played by each of the following in myofibril contraction.

(i) Tropomyosin

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(2)

(ii) Myosin

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(2)

(b) The table shows features of fast and slow muscle fibres.

Feature	Fast muscle fibre	Slow muscle fibre
Type of respiration	Mainly anaerobic	Mainly aerobic
Glycogen	High concentration	Low concentration
Capillaries	Few	Many

Use information from the table to suggest and explain **one** advantage of:

(i) the high glycogen content of fast muscle fibres

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(2)

(ii) the number of capillaries supplying slow muscle fibres.

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(2)
(Total 8 marks)

Q7. (a) What is the role of phosphocreatine (PC) in providing energy during muscle contraction?

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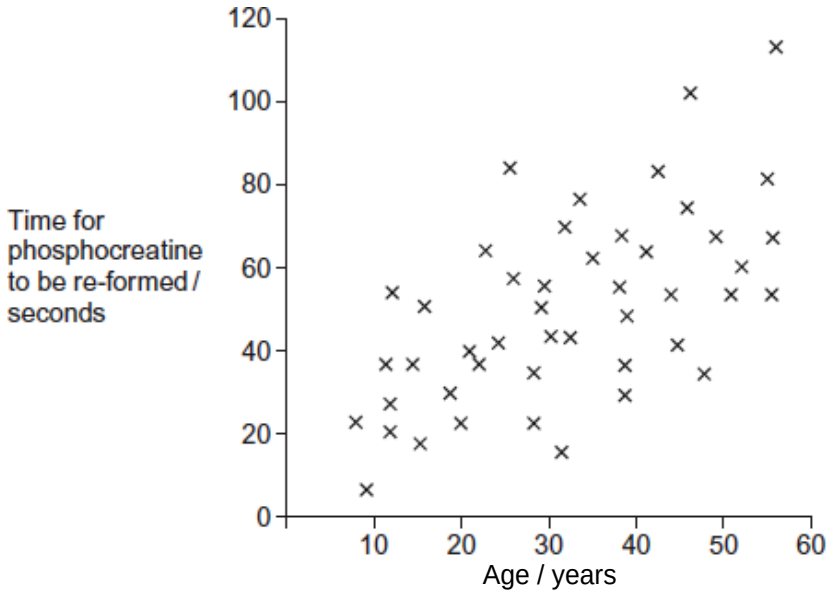
(2)

Scientists investigated the time for phosphocreatine (PC) to be re-formed in arm muscles after the same exercise in healthy people of different ages. The exercise involved brief, rapid contractions of arm muscles.

The figure below shows the scientists' results. Each cross is the result for one person.



(b) There is a lot of variation in the time taken for PC to be re-formed in people of a very similar age.

Suggest **one** reason for this variation.

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(1)

(c) Use your knowledge of fast muscle fibres to explain the data in the figure.

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(Extra space) .....

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(4)

(Total 7 marks)

Q8. The flow chart outlines an investigation to determine from where the calcium ions involved in muscle contraction are released.

Calcium ion transport proteins were isolated from human tissue.

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These proteins were injected into a rabbit.

↓

The rabbit formed antibodies to the proteins. These antibodies were collected and labelled with gold particles.

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Muscle tissue was treated with the labelled antibodies and examined with an electron microscope. High concentrations of gold particles were observed attached to the sarcoplasmic reticulum.

S (a) Labelled antibodies and an electron microscope can be used to produce images locating proteins on the surface of organelles, but cannot be used to observe cross bridge cycling in muscle cells. Explain why.

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(5)

(b) Describe the role of calcium ions and ATP in muscle contraction.

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(5)
(Total 10 marks)