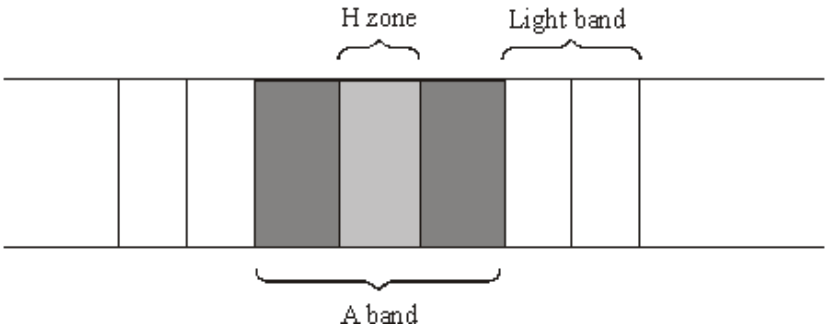
Q1. (a) The diagram shows the banding pattern observed in part of a relaxed muscle fibril.



(i) Describe what causes the different bands seen in the muscle fibril.

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(2)

(ii) Describe how the banding pattern will be different when the muscle fibril is contracted.

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(2)

(b) There is an increase in the activity of the enzyme ATPase during muscle contraction. An investigation into muscle contraction involved measuring the activity of ATPase in solutions containing ATP, myosin and different muscle components. The table shows the results.

Solution	Contents	ATPase activity / arbitrary units
A	ATP, myosin and actin	1.97
B	ATP, myosin, actin and tropomyosin	0.54
C	ATP, myosin, actin, tropomyosin and calcium ions	3.85

(i) Explain the importance of ATPase during muscle contraction.

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(2)

(ii) Using your knowledge of muscle contraction, explain the difference in the results between

A and **B**;

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(2)

B and **C**.

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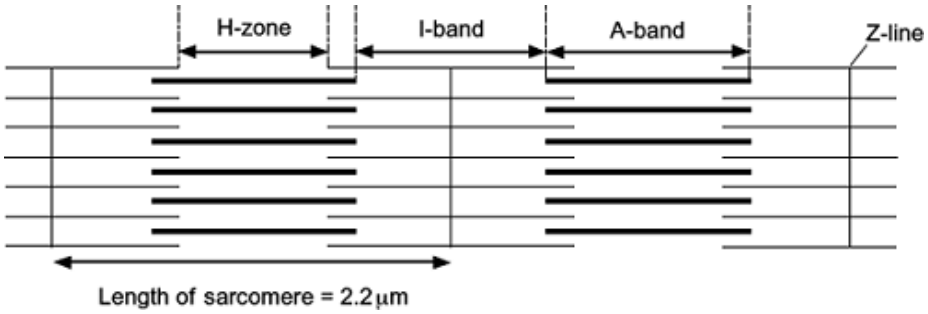
(2)
(Total 10 marks)

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

.....

(1)

(ii) the A-band?

.....

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

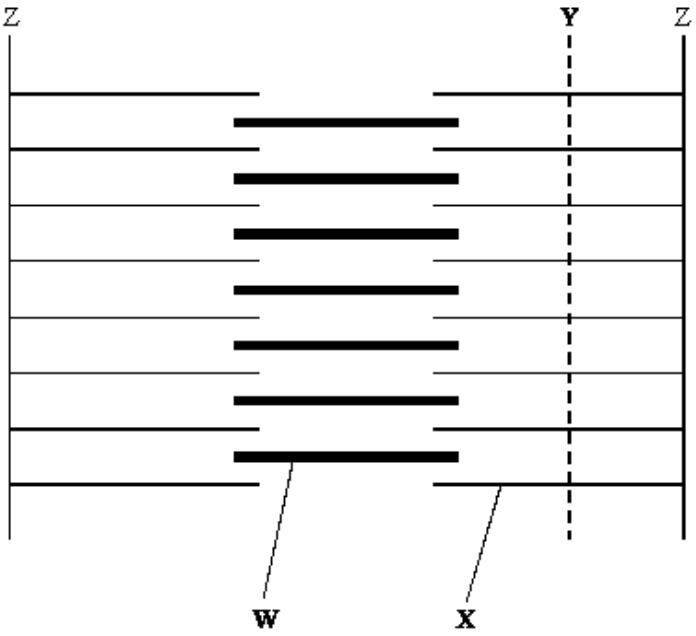

Figure 1

(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.

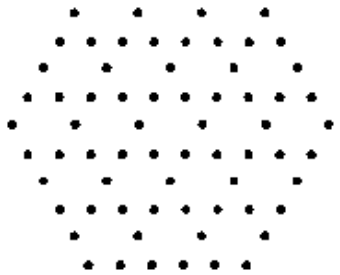

Figure 2

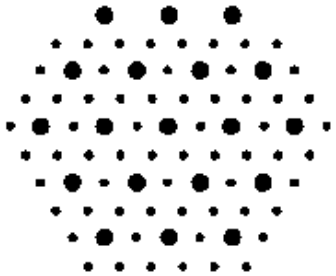

Figure 3

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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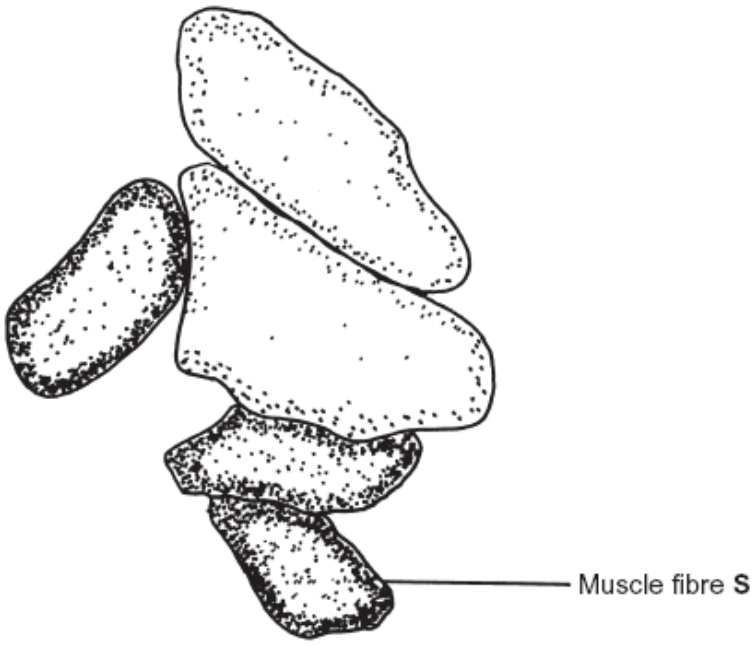
(4)
(Total 7 marks)

Q4. 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.

1 .....

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2 .....

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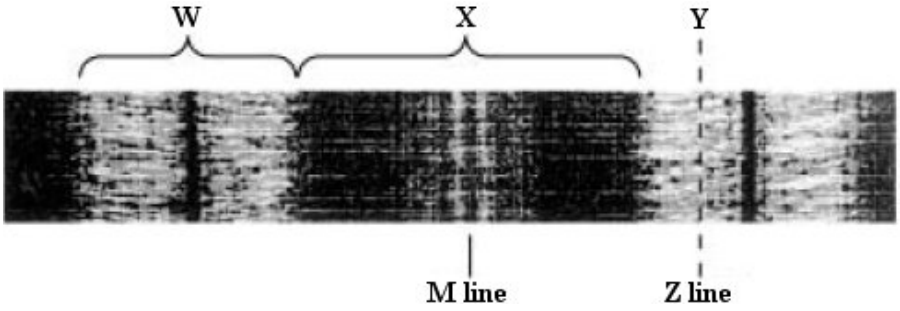
(2)
(Total 9 marks)

Q5. **Figure 1** shows part of a myofibril in a relaxed muscle.

Figure 1



(a) Name the main protein filaments present in

(i) region **W**

.....

(ii) region **X**

.....

(2)

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

Figure 2

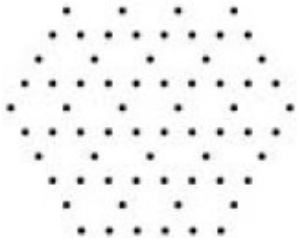
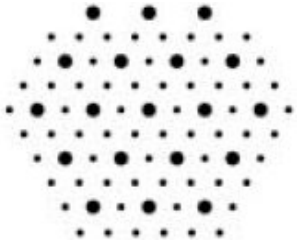


Figure 3



The pattern of protein filaments is different in **Figure 2** and **Figure 3**. Explain why.

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(2)

(c) Describe the roles of ATP and of calcium ions (Ca^{2+}) in bringing about the contraction of a myofibril.

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(4)

(Total 8 marks)

Q6. (a) **Figure 1** shows part of a myofibril from skeletal muscle.

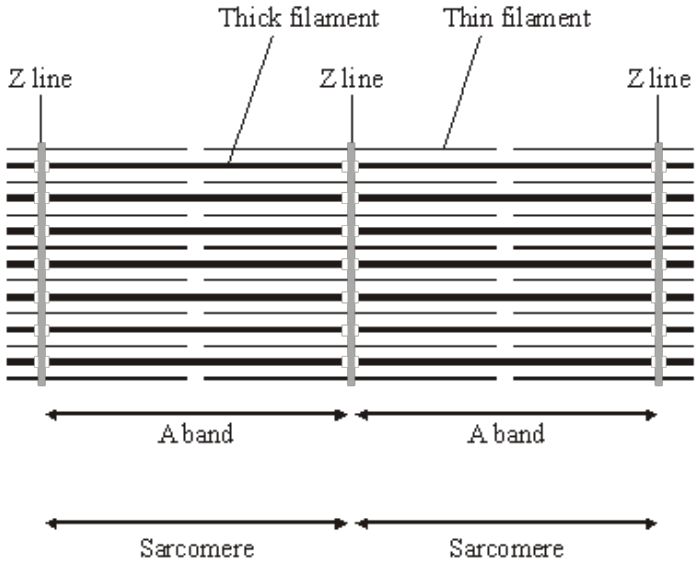

Figure 1

(i) Describe **two** features, visible in the diagram, which show that the myofibril is contracted.

1 .....

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2 .....

.....

(2)

(ii) Explain the role of calcium ions and ATP in bringing about contraction of a muscle fibre.

Calcium ions .....

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ATP .....

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(3)

(b) **Figure 2** shows the structure of a neuromuscular junction. The vesicles contain acetylcholine.

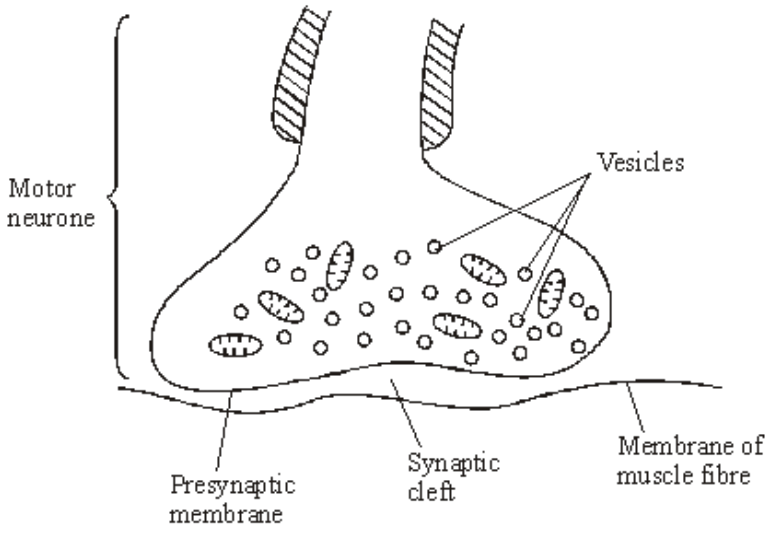

Figure 2

(i) An action potential is generated at the cell body of the motor neurone. Explain how this action potential passes along the motor neurone to the neuromuscular junction.

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(3)

(ii) When the action potential arrives at the neuromuscular junction, it results in the secretion of acetylcholine into the synaptic cleft. Explain how.

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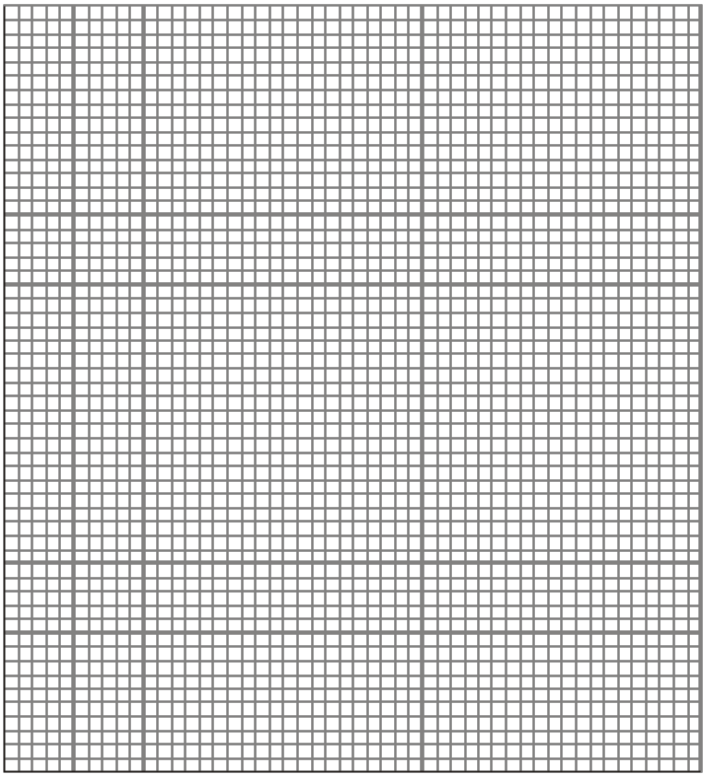
(3)

(c) Between the ages of 20 and 50, 10% of total muscle mass is lost. Between the ages of 50 and 80, a further 40% of the original total muscle mass is lost. Most of the muscle lost consists of fast fibres.

(i) Plot a graph on the grid below to show the percentage of muscle mass remaining between the ages of 20 and 80. Assume that the rate of muscle loss in each age range is constant.



(3)

(ii) Explain why explosive exercises, such as sprinting and weightlifting, will be more affected by this muscle loss than aerobic exercises, such as jogging.

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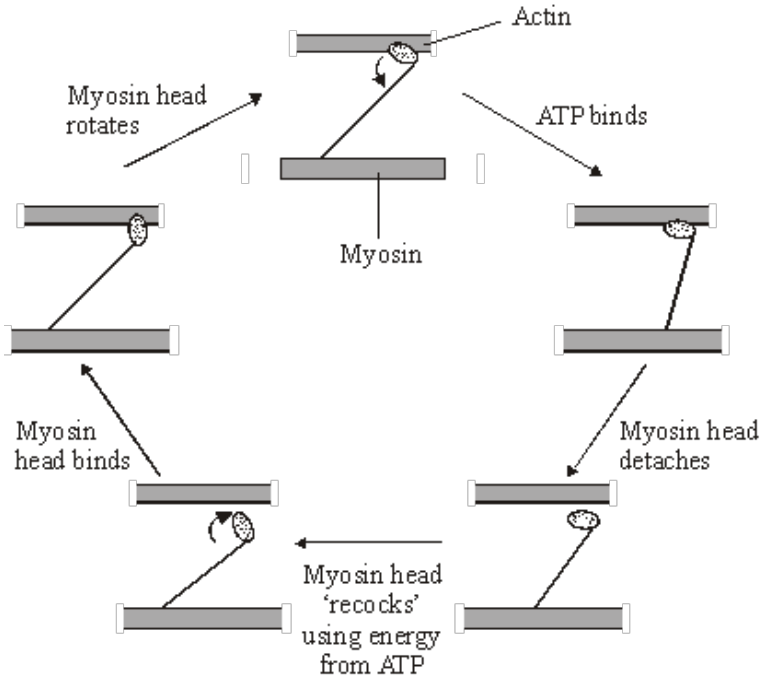
(1)

(Total 15 marks)

Q7. The diagram shows the stages in one cycle that results in movement of an actin filament in a muscle sarcomere.



(a) Describe how stimulation of a muscle by a nerve impulse starts the cycle shown in the diagram.

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(3)

(b) Each cycle requires hydrolysis of one molecule of ATP and moves one actin filament 40 nm. During contraction of a muscle sarcomere, a single actin filament moves 0.6 µm. Calculate how many molecules of ATP are required to produce this movement.

Answer .....

(2)

(c) After death, cross bridges between actin and myosin remain firmly bound resulting in rigor mortis. Using information in the diagram, explain what causes the cross bridges to remain firmly bound.

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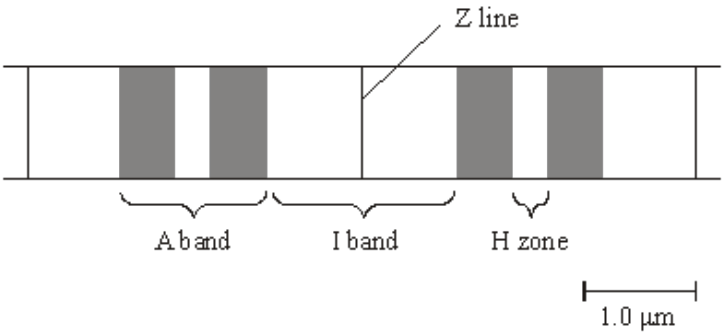
(2)
(Total 7 marks)

Q8. 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)

Q9. 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.

↓

These proteins were injected into a rabbit.

↓

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

↓

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)