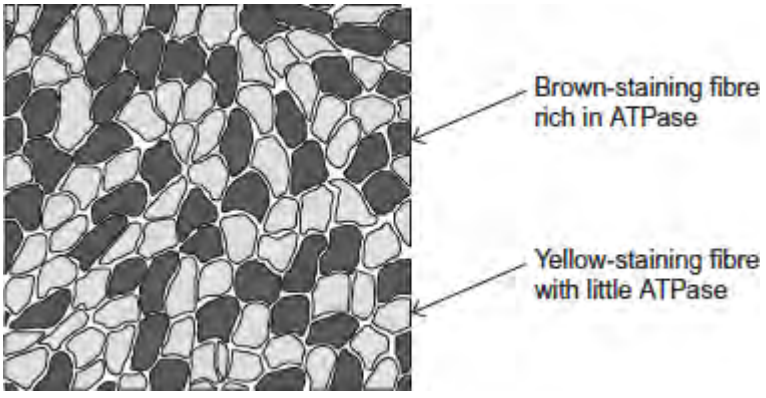
Q1. Slow and fast skeletal muscles both contain slow and fast muscle fibres but in different proportions. The proportion can be determined by observing stained sections of muscle under a microscope. The stain used reacts with an ATPase enzyme. Muscle fibres containing a lot of this ATPase stain brown. Fibres containing little ATPase stain yellow.

The diagram shows stained muscle fibres in a section taken from a muscle.



(a) Both slow and fast muscle fibres contain ATPase.

Explain why.

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(2)

(b) The tissue in the diagram came from muscle with a high proportion of brown-staining fibres. Was the tissue removed from slow or fast skeletal muscle?

Explain your answer.

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(1)

(c) The muscle tissue in the diagram had been stained for viewing with a microscope.

What is the evidence that it had been stained for viewing with an optical (light) microscope? Explain your answer.

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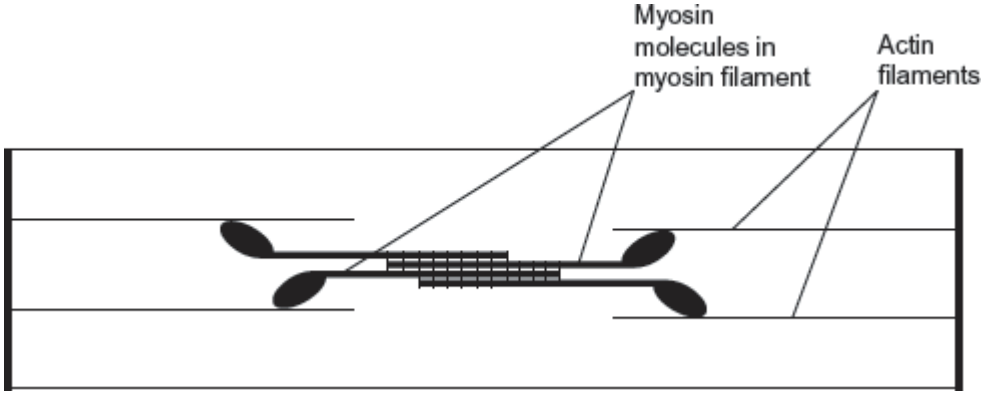
(2)
(Total 5 marks)

Q2.(a) A sarcomere is made up of different molecules.
Complete the table by naming the molecule that carries out the function described.

Function	**Name**
Attaches to Z line at the end of the sarcomere	
Breaks down ATP	
Covers binding site on actin in relaxed myofibril	

(3)

(b) The diagram shows the arrangement of actin and myosin in a sarcomere.



One form of muscle disease is caused by a mutated allele of a gene. This leads to production of myosin molecules that are unable to bind to other myosin molecules.

If myosin molecules are unable to bind to other myosin molecules, this prevents muscle contraction.
Use the diagram and your knowledge of how muscles contract to suggest why.

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(3)
(Total 6 marks)

Q3. Researchers investigated whether the blood supply to slow and fast muscle fibres in a muscle changes with age. They used diaphragms taken from hamsters (*Mesocricetus auratus*). The diaphragm is in constant use for breathing. They took diaphragms from groups of young, adult and old hamsters.

They removed the diaphragm from each animal and took a sample of muscle tissue.They examined it under an optical (light) microscope. For each sample they selected several fields of view at random. In each field of view, they then counted the number of capillaries associated with each type of muscle fibre.

This allowed the researchers to calculate the mean number of capillaries for each type of muscle fibre, for each age group.

The table below shows the researchers' results which include standard deviation (SD).

Hamster age group	**Number of hamsters in**	**Mean number of capillaries associated with each type of muscle fibre**

	group	Slow fibres (± SD)	Fast fibres (± SD)
Young	9	3.4 (±0.8)	4.0 (±0.8)
Adult	10	4.7 (±0.2)	6.3 (±0.4)
Old	8	4.6 (±0.9)	6.8 (±0.6)

(a) Give **four** precautions that the researchers took to make their calculations of mean number of capillaries per fibre reliable.

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2 .....

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3 .....

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4 .....

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(4)

(b) The researchers examined the muscle of an animal in the **old** age group. They found one field of view containing only slow muscle fibres. They counted 69 capillaries in this field of view.

(i) Use a calculation to estimate how many slow muscle fibres were visible in this field of view. Show your working.

Number of slow muscle fibres = ...

(2)

(ii) The actual number of slow muscle fibres in the field of view was **not** the same as the number you calculated in question (i).

Give **one** reason why.

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(1)

(c) A student read the report of the researchers' investigation. She thought that the investigation was unethical but that a conclusion could still be made.

(i) Suggest why she thought the investigation was unethical.

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(1)

(ii) She concluded that age had a significant effect on the mean number of capillaries per fibre.

Evaluate this conclusion.

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(4)
(Total 12 marks)

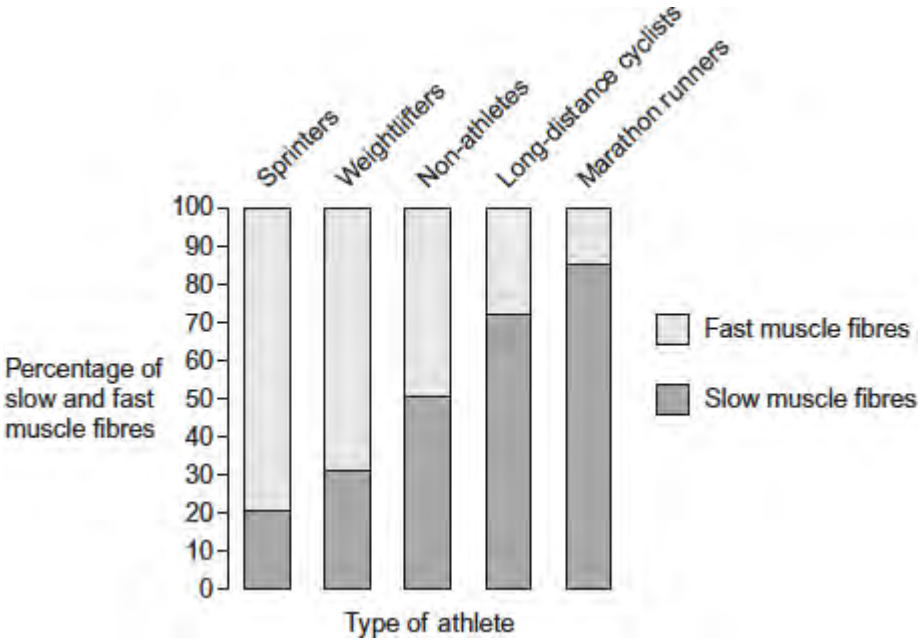
Q4. It is believed that each person is born with a certain percentage of slow and fast muscle fibres in their skeletal muscles. Most people have about 50% slow fibres and 50% fast fibres.

A sports scientist wondered if these percentages could change over time depending on the type of sport in which a person was involved. He knew from previous investigations that:

- the number of mitochondria within a fibre can change
- the diameter of a fibre can change
- the number of muscle fibres in a skeletal muscle remains constant over time.

He determined the mean percentages of slow and fast fibres in skeletal muscles of different types of athletes.

His results are shown in the graph below in the form in which he presented them.



(a) (i) In which type of athlete would the sports scientist expect to find muscle fibres with the highest number of mitochondria?

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(1)

(ii) Explain the reason for your choice of athlete.

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(2)

(b) The leg muscles of long-distance cyclists are usually larger than the leg muscles of non-athletes.

Suggest why.

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(3)

(c) A reader of the sports scientist's results stated that 'the results show that regular weightlifting changes your proportion of slow and fast skeletal muscle fibres.'

Do you agree with this statement? Explain your answer.

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(2)
(Total 8 marks)

Q5.(a) Describe the roles of calcium ions and ATP in the contraction of a myofibril.

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(Extra space) .....

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(5)

(b) ATP is an energy source used in many cell processes. Give **two** ways in which ATP is a suitable energy source for cells to use.

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2 .....

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(2)
(Total 7 marks)

Q6.(a) What is the role of phosphocreatine (PC) in providing energy during muscle contraction?

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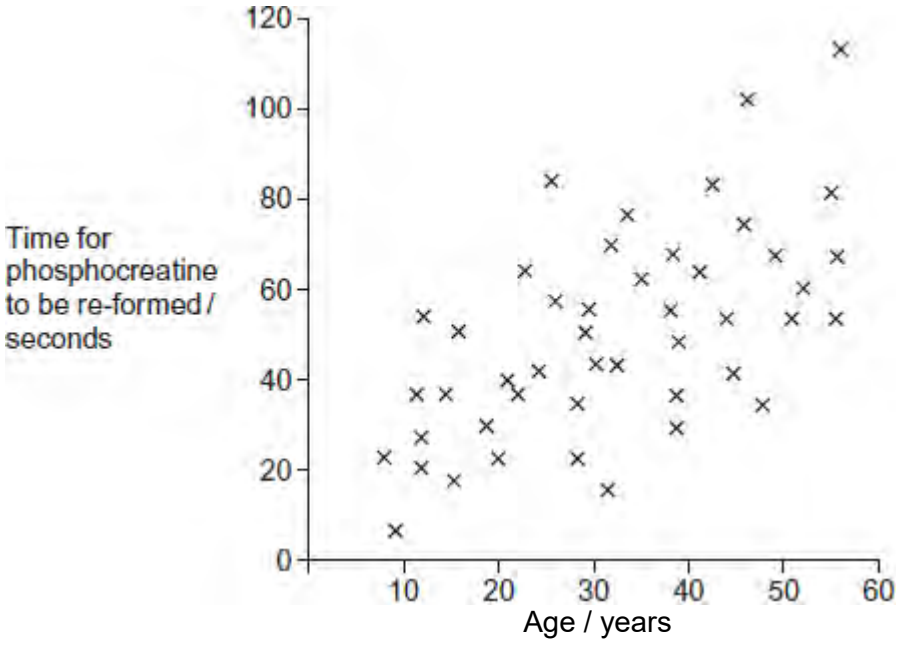
(2)

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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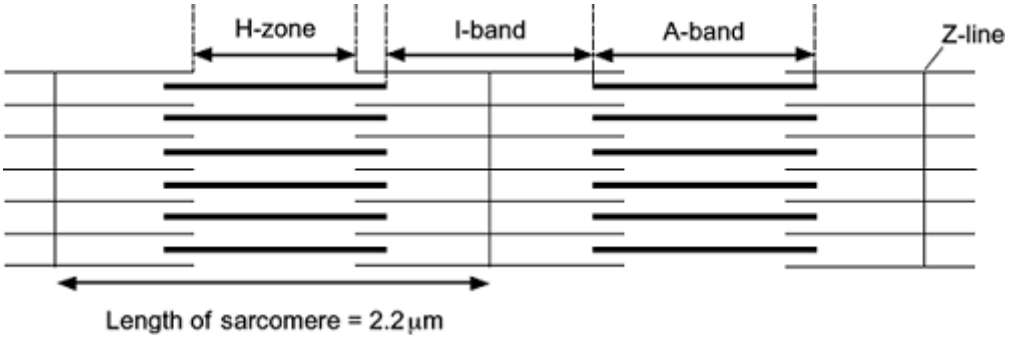
(4)
(Total 7 marks)

Q7. 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)