A-Level Biology

Muscle Contraction

Question Paper

Time available: 82 minutes
Marks available: 52 marks

1. The diagram below shows the banding pattern of a single sarcomere.

(a) Explain the banding pattern shown in the diagram above.

(3)

Creatinine is produced in muscle tissues. Creatinine diffuses into the blood. The kidneys then excrete creatinine.

A calibration curve can be used to determine the concentration of creatinine in urine. One method of producing a calibration curve needs:

- creatinine solution of known concentration
- distilled water
- creatinine-detecting solution
- a colorimeter.

Creatinine-detecting solution reacts with creatinine to produce an orange colour.

(b) Use the information provided to describe how you could produce a calibration curve for creatinine.

Do **not** include details on the use of glassware in your answer.

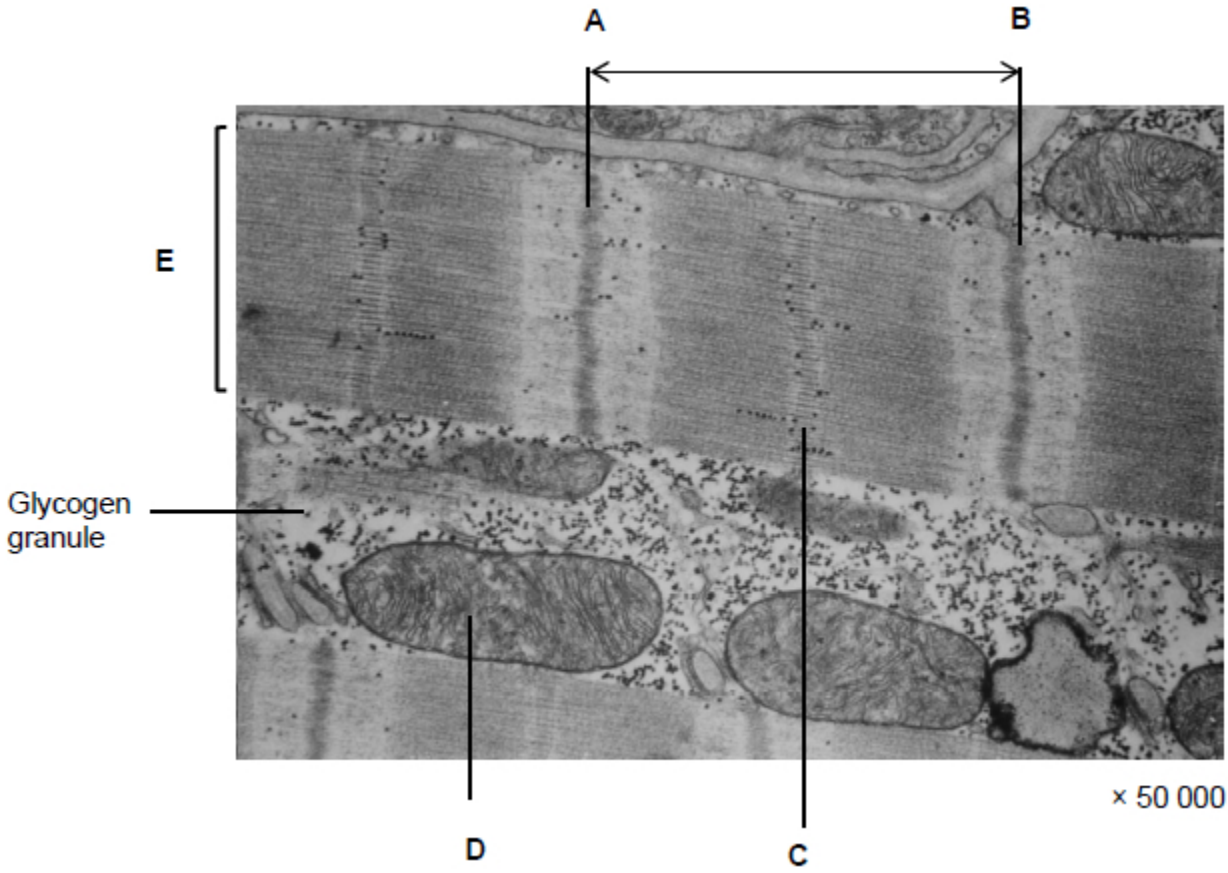
(4)

(c) Describe how you would determine the concentration of creatinine in a urine sample using your calibration curve.

(2)

(Total 9 marks)

2. The image below shows a transmission electron micrograph of a longitudinal section of skeletal muscle.



(a) Name structures **C**, **D** and **E**.

C _____

D _____

E _____

(3)

(b) Give the name of the structure shown between points **A** and **B**.

_____

(1)

(c) Calculate the actual distance between points **A** and **B**. Give your answer in micrometres (µm).

Answer = _____ µm

(1)

(d) The image shows glycogen granules present in skeletal muscle.

Explain their role in skeletal muscle.

(2)

(e) During vigorous exercise, the pH of skeletal muscle tissue falls. This fall in pH leads to a reduction in the ability of calcium ions to stimulate muscle contraction.

Suggest how.

(3)

(Total 10 marks)

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

(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.

1. _____

2. _____

(2)

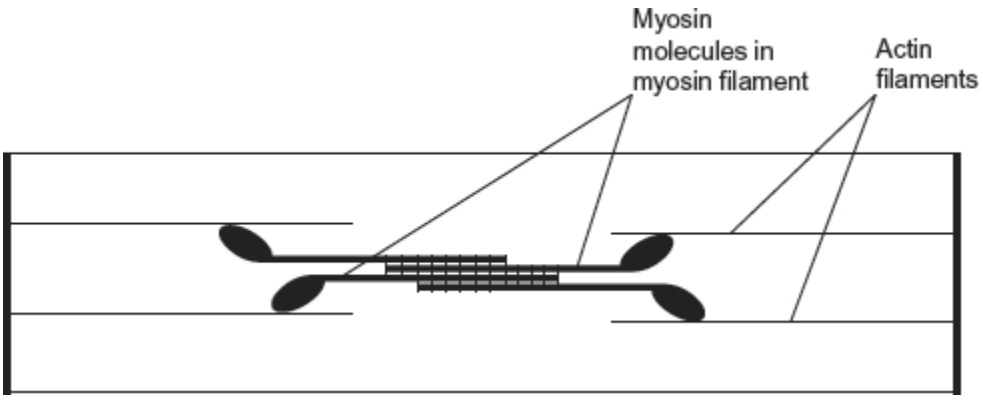
(Total 7 marks)

4. (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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_____

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_____

(3)

(Total 6 marks)

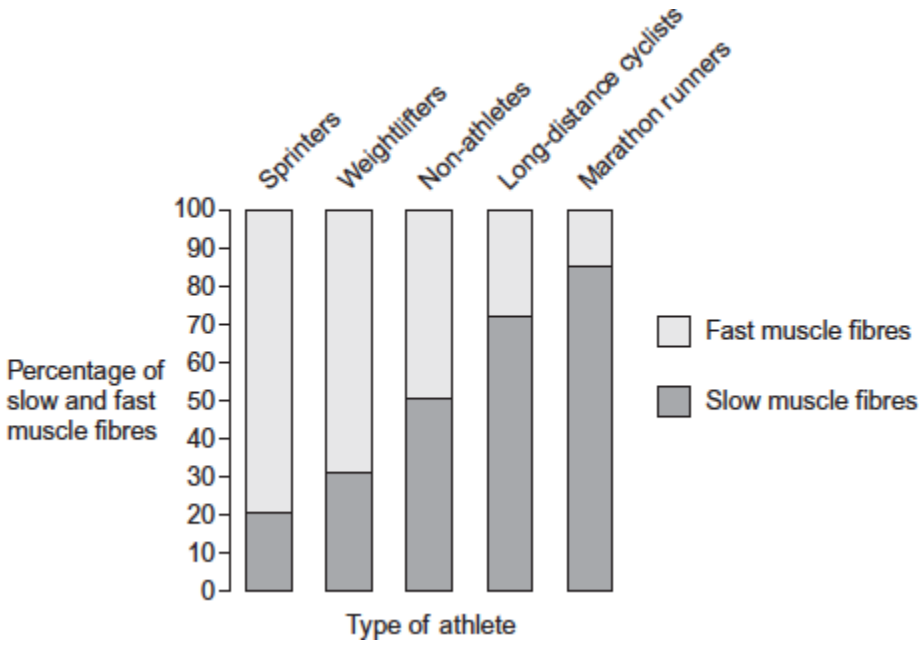
5. It is believed that each person is born with a certain percentage of slow and fast muscle fibres in their skeletal muscles. Most people have about 50% slow fibres and 50% fast fibres.

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?

_____

(1)

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

_____

_____

_____

_____

(2)

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

Suggest why.

_____

_____

_____

_____

_____

_____

(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.

_____

_____

_____

_____

_____

(2)

(Total 8 marks)

6. 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 group**	**Mean number of capillaries associated with each type of muscle fibre**	
		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.

1. _____

_____

2. _____

_____

3. _____

_____

4. _____

_____

(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.

_____

_____

_____

(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.

_____

_____

_____

(1)

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

Evaluate this conclusion.

(4)

(Total 12 marks)