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# BIOLOGY

## ORGANISMS RESPOND TO CHANGES IN ENVIRONMENT

Level & Board

AQA (A-LEVEL)

TOPIC:

CONTRACTION OF SKELETAL MUSCLES

PAPER TYPE:

QUESTION PAPER - 1

TOTAL QUESTIONS

7

TOTAL MARKS

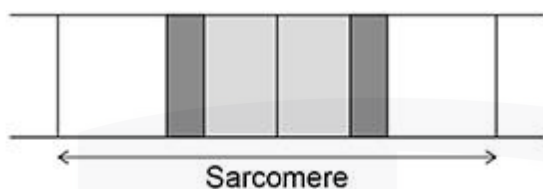
48

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## Contraction of Skeletal Muscles - 1

1.

The banding pattern of a single sarcomere is depicted in the diagram below.



(a) Describe the banding pattern displayed in the preceding diagram. (3)

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## 2.

Researchers looked into how a drop in pH affected the contraction of muscles. The study was conducted using four distinct preparations of isolated muscle tissue, namely A, B, C, and D.

A: Muscle fibers in mice at the normal pH of their muscle tissue (control 1).

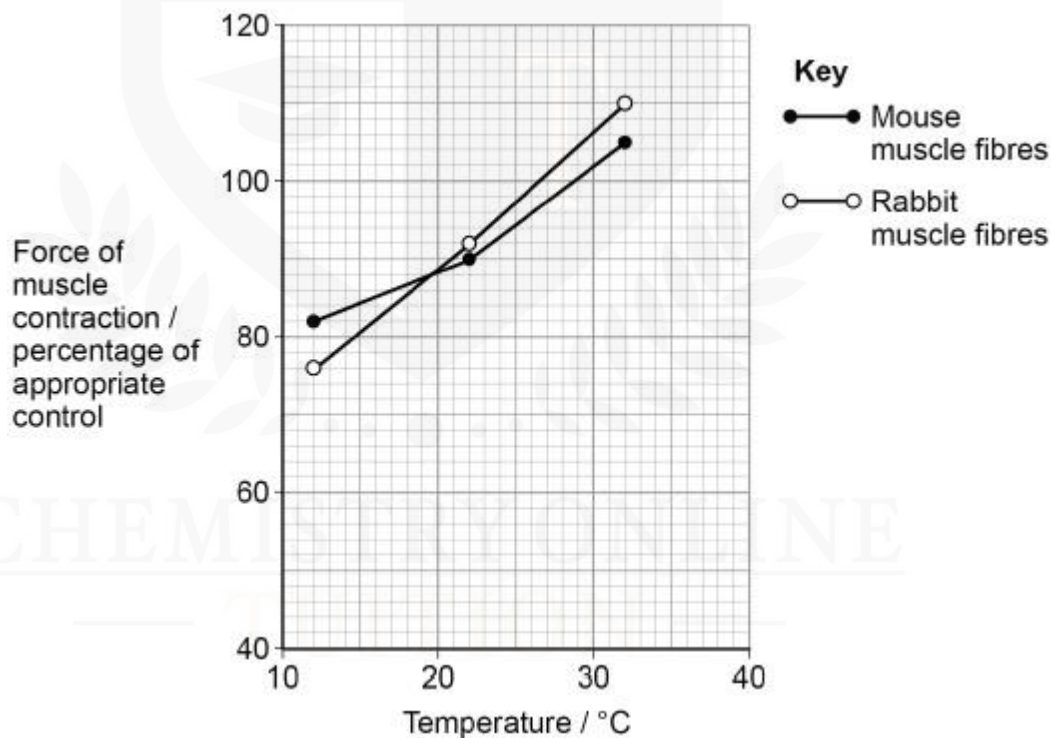
B: Mouse muscle fibers at a pH that is 0.5 units lower than usual.

C: Muscle fibers in rabbits at the normal pH of their muscle tissue (control 2).

D: Muscle fibers from rabbits at a pH 0.5 lower than usual.

At 12, 22, and 32 degrees Celsius, they assessed the force of contraction of the muscle fibers.

The scientists' findings for B and D are displayed in the graph along with a comparison to the suitable control.



(a) After analyzing the data, a student came to the conclusion that a drop in pH does, in fact, result in a drop in the force of muscle contraction.

Examine the above graph to assess this conclusion. (4)



**(b)** Another group of scientists suggested that a decrease in the force of muscle contraction is caused by an increase in the concentration of inorganic phosphate,  $P_i$ , in muscle tissues.

Their hypothesis is that an increase in the concentration of  $P_i$  prevents the

release of calcium ions within muscle tissues.

Explain how a decrease in the concentration of calcium ions within muscle tissues could cause a decrease in the force of muscle contraction. **(3)**



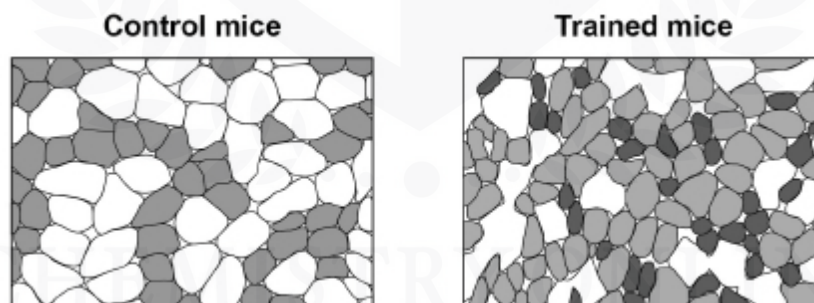
**(c)** During extended activity, pyruvate in muscles is changed into lactate.

Describe how the process of converting pyruvate to lactate permits anaerobic respiration to continue producing ATP. **(2)**

**3.**

Researchers looked into how routine exercise affected the skeletal muscle fibers in mice. The muscle fibers of mice that had been exercised regularly for six weeks (trained mice) and mice that had not exercised (control mice) were compared by the scientists. The muscle fibers of both sets of mice were dyed by the scientists to demonstrate the presence of succinic acid dehydrogenase. The amount of succinic acid dehydrogenase activity increases with stain darkness.

A typical set of results they obtained is depicted in the diagram below.

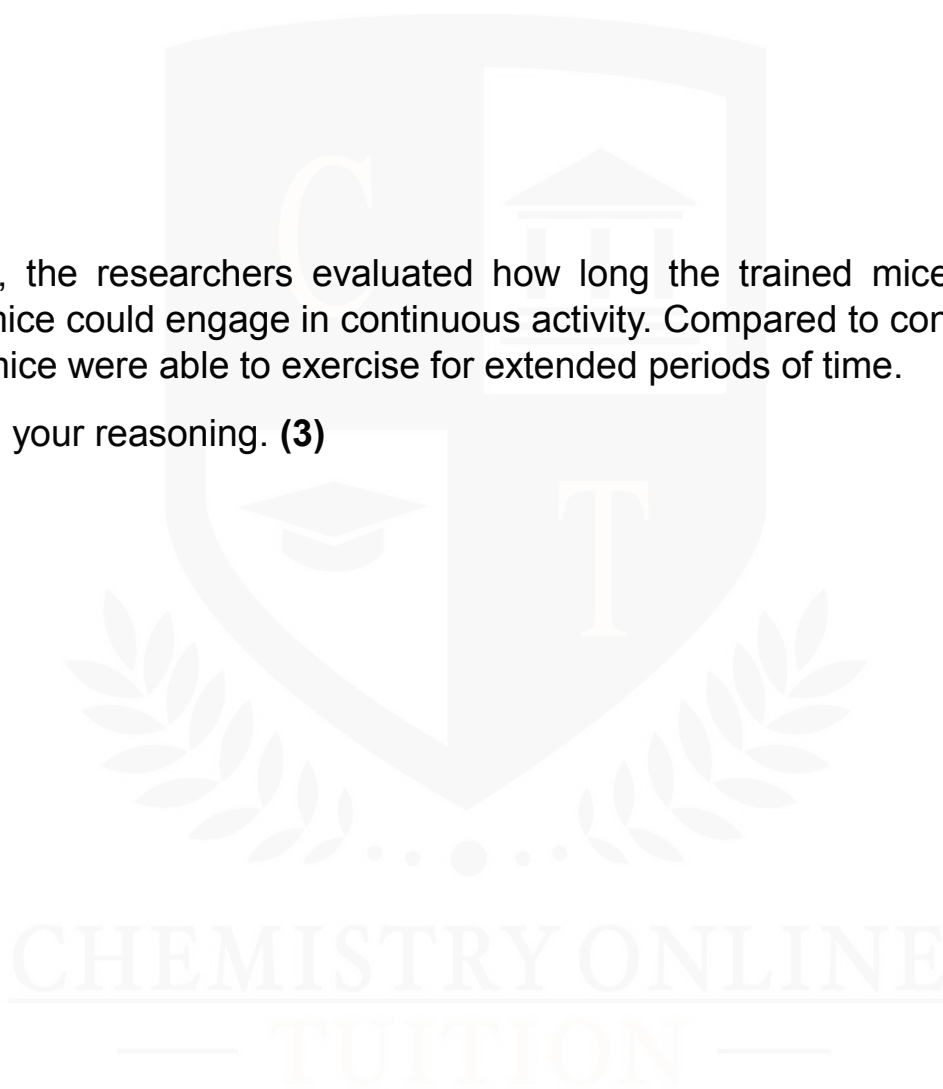


**(a)** The Krebs cycle uses the enzyme succinic acid dehydrogenase.

Provide a plausible explanation for the variation in staining observed in the muscle fibers of the trained and control mice. **(1)**

**(b)** Next, the researchers evaluated how long the trained mice and the control mice could engage in continuous activity. Compared to control mice, trained mice were able to exercise for extended periods of time.

Describe your reasoning. **(3)**



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**(c)** By examining sections of muscle tissue under an optical microscope, the researchers were able to ascertain the mean diameter of the muscle fibers in trained mice.

One field of view circular area ( $\pi r^2$ ) was  $1.25 \text{ mm}^2$ . This region's diameter was equivalent to that of fifteen muscle fibers.

Determine the average muscle fiber diameter in micrometers, or  $\mu\text{m}$ , for the given tissue segment. **(2)**

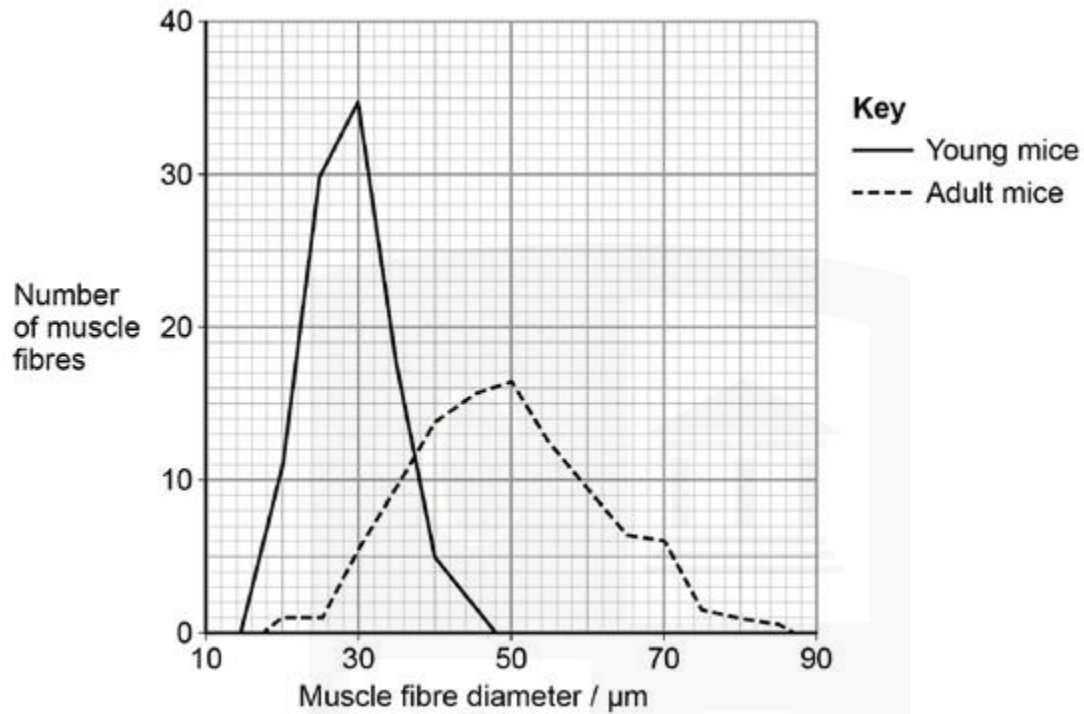


**(d)** The researchers also contrasted the diameter of muscle fiber samples obtained from juvenile and adult mice.

The graph displays a few of their findings. **(2)**

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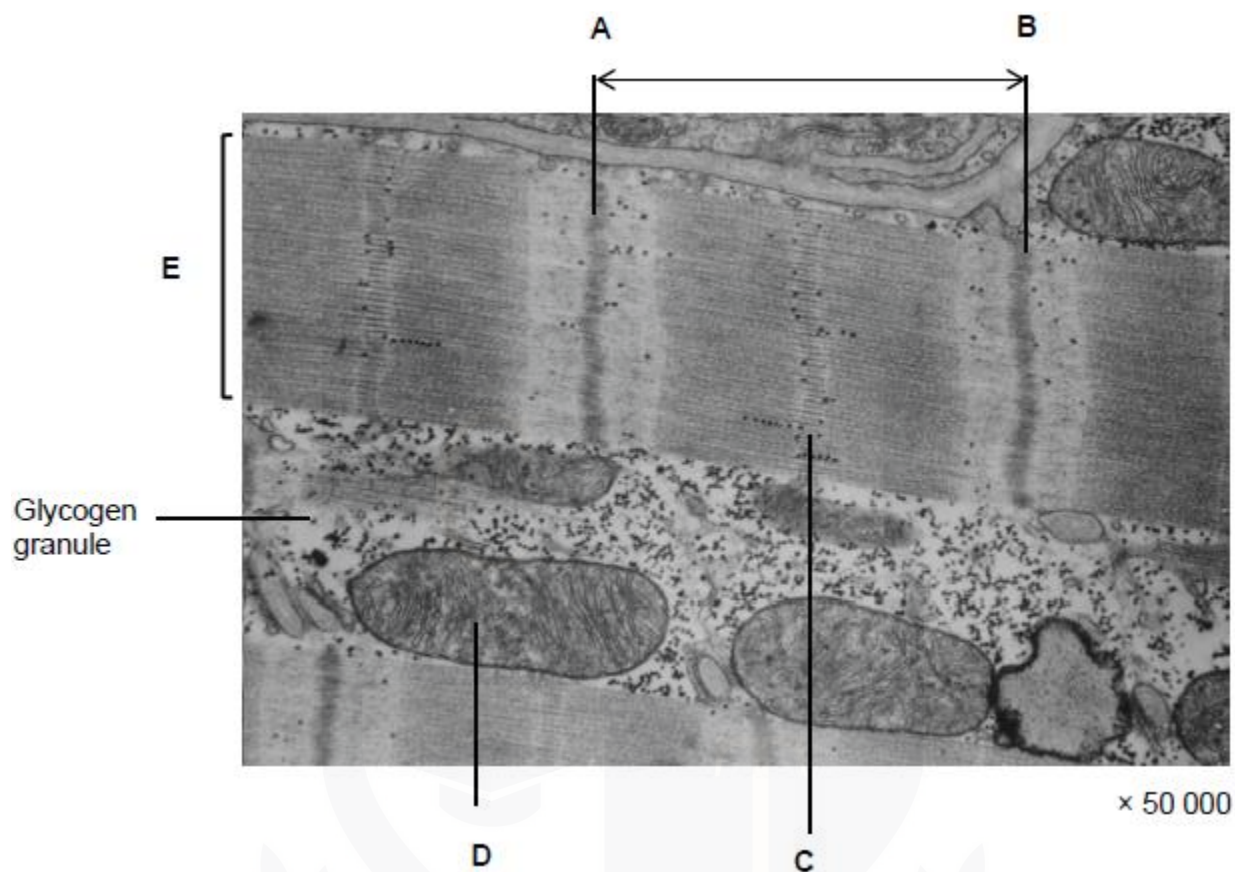


Name two variations present in these muscle fiber samples.

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4.

A transmission electron micrograph of a longitudinal slice of skeletal muscle is displayed in the picture below.



(a) Give C, D, and E structures names. (3)

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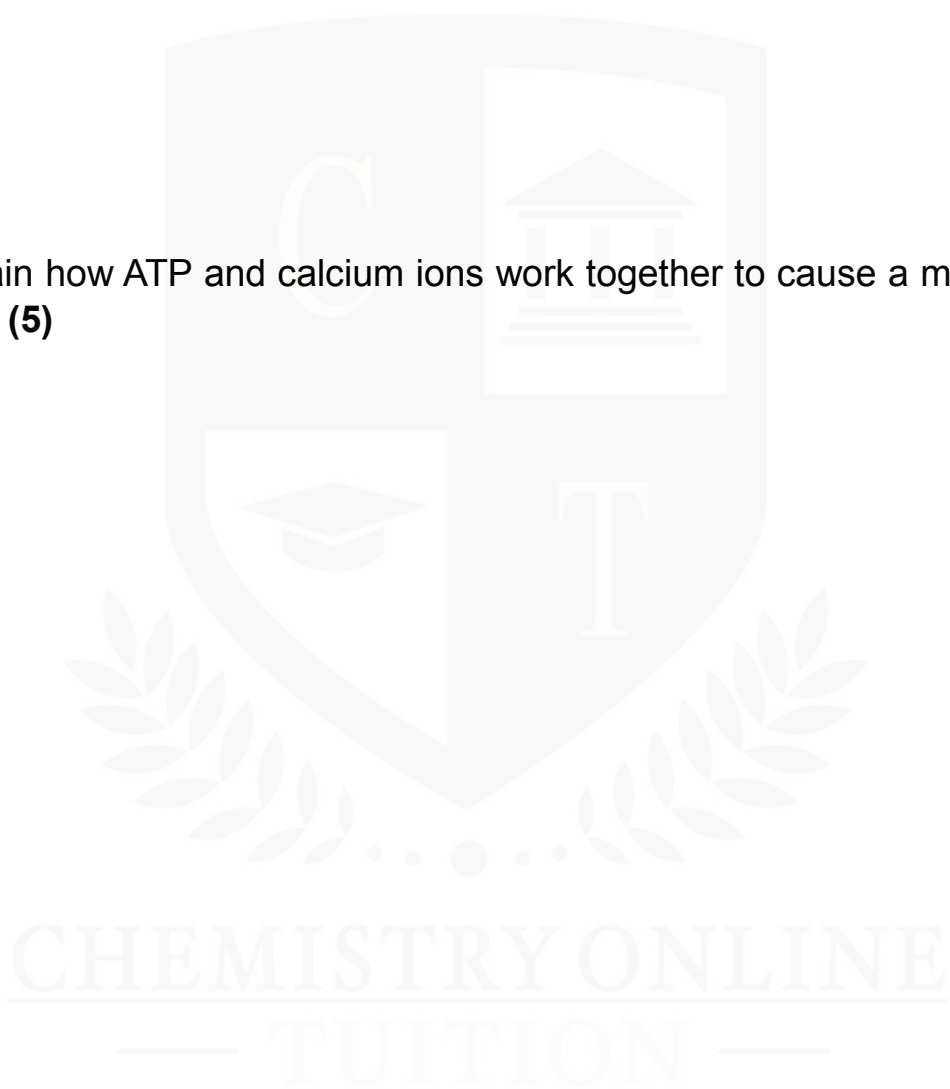
(b) Identify the structure that is visible between positions A and B.(1)

**(c)** Determine how far apart points A and B really are. Please respond in micrometers ( $\mu\text{m}$ ). **(2)**

**(d)** The picture displays the granules of glycogen found in skeletal muscle. Describe their function in the 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)**

**(a)** Explain how ATP and calcium ions work together to cause a myofibril to contract. **(5)**



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**(b)** A variety of cellular functions rely on ATP as an energy source. Describe two reasons why ATP is a good energy source for cells to utilize. **(2)**

**6.**

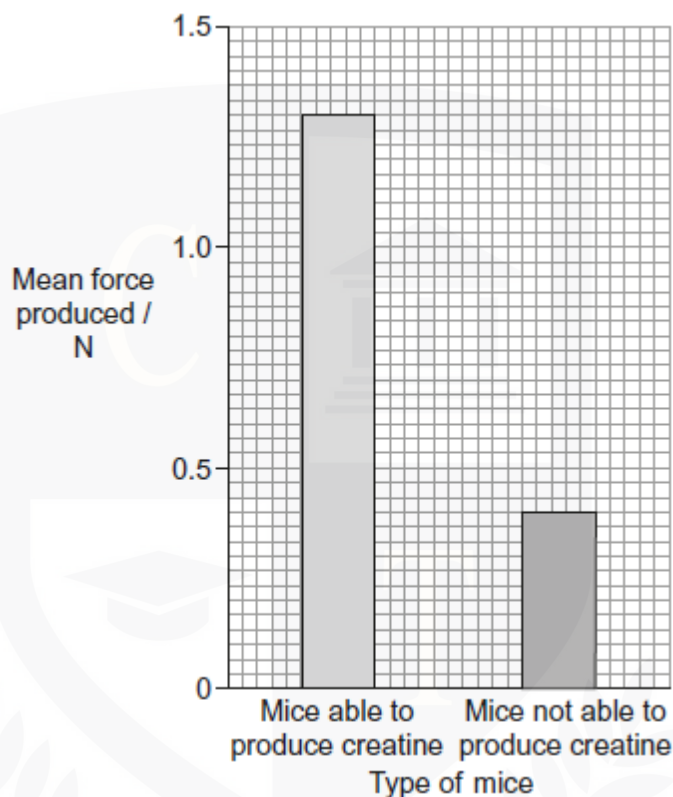
**(a)** How does ATP contribute to the contraction of myofibrils? **(2)**

**7.**

Researchers looked into how a lack of creatine production affected the force generated by muscles. They employed mice that were mutated to prevent them from producing creatine.

The force that these mice produced when they gripped with their paws was compared to the force that regular mice with creatine production capacity produced.

The scientists' findings are displayed on the graph.



**(a)** What was the percentage fall in the mean force produced by mice not able to produce creatine, compared with the normal mice? Show your working. **(2)**

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**(b)** Suggest an explanation for these results. **(2)**

**(c)** A recessive allele of a gene was homozygous in the mice that were unable to synthesize creatine. The forces produced by heterozygous mice for this allele are comparable to those of homozygous normal mice for the dominant allele of the same gene.

Justify the heterozygous mice ability to generate forces akin to those of normal mice. **(2)**

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**(b)** During extended activity, pyruvate in muscles is changed into lactate.

Describe how the process of converting pyruvate to lactate permits anaerobic respiration to continue producing ATP.



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