Biology · Structure and Function in Living Organisms · Support and Movement in Living Organisms

Movement in Living Organisms

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Multiple choice questions — 72 questions

1 What is the type of cytoplasmic streaming movement inside a liver cell?

(A) Translational
(B) Whole-body (locomotion)
(C) Local
(D) Continuous

2 During a horse race, what type of movement do the rider and the horse have in common?

(A) Continuous only
(B) Local only
(C) Continuous and local
(D) Continuous and locomotion

3 An insectivorous plant closes its leaf on an insect that lands on the leaf surface and digests it to get its needs of nitrogenous compounds. What type of movement occurs in this plant?

(A) Continuous only
(B) Local only
(C) Continuous and local
(D) Local and locomotion

4 Euglena is a unicellular organism that contains chloroplasts and moves by a flagellum. Which of the following types of movement are found in this organism?

(A) Local only
(B) Continuous only
(C) Continuous, local and locomotion
(D) Local and locomotion

5 Which of the following movements does NOT occur in the pea plant?

(A) Cytoplasmic streaming
(B) Tropism
(C) Pulling by tendrils
(D) Pulling by roots

6 Which of the following movements does NOT occur in the Mimosa (sensitive) plant?

(A) Cytoplasmic streaming movement
(B) Tropism movement
(C) Pulling movement
(D) Movement in response to touch

7 Which of the following movements occurs in all herbaceous plants?

(A) Tropism movement
(B) Pulling movement
(C) Movement in response to touch
(D) Sleep movement

8 Which of the following statements is correct?

(A) Tropism does not depend on the presence of an external stimulus

(B) The movement of the cytoplasm is self-induced

(C) The movement of pulling roots depends on the force of the wind

(D) The movement in response to touch in Mimosa is continuous

9 Which of the following statements is NOT correct about the rotational movement of the cytoplasm in the Elodea plant?

(A) It is detected by the movement of the chloroplasts

(B) It fades away in some plant cells

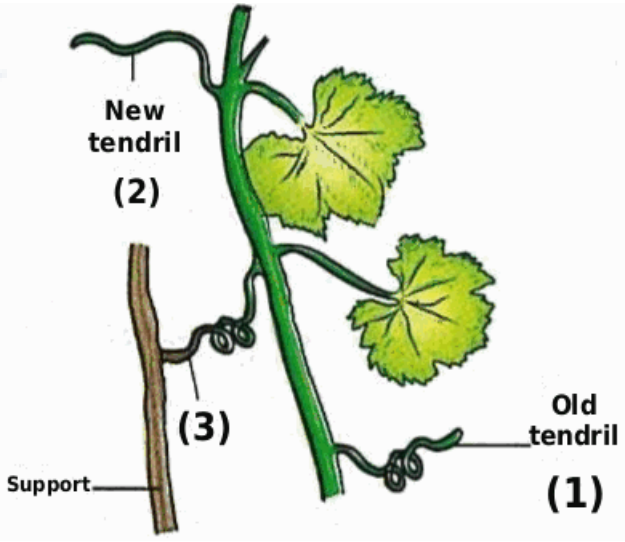
(C) It moves inside the cell in different directions

(D) It is a continuous movement

10 The following figures show some types of plant cells. In which of these cells does the rotational cytoplasmic movement NOT occur?



11 The opposite figure shows three tendrils on part of a climbing plant. Which of the following statements is NOT correct about the figure?



(A) Tendril (2) appeared on the plant after tendril (3)

(B) Tendril (2) is not wall-thickened and tendril (3) is wall-thickened

(C) The cells of tendril (2) are living

(D) The supporting tissues in tendril (2) are more than the supporting tissues in tendril (3)

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12 Which of the following statements is correct about the movement of the cytoplasm in the living cells of onion leaves?

(A) The movement of the cytoplasm is due to the movement of the chloroplasts

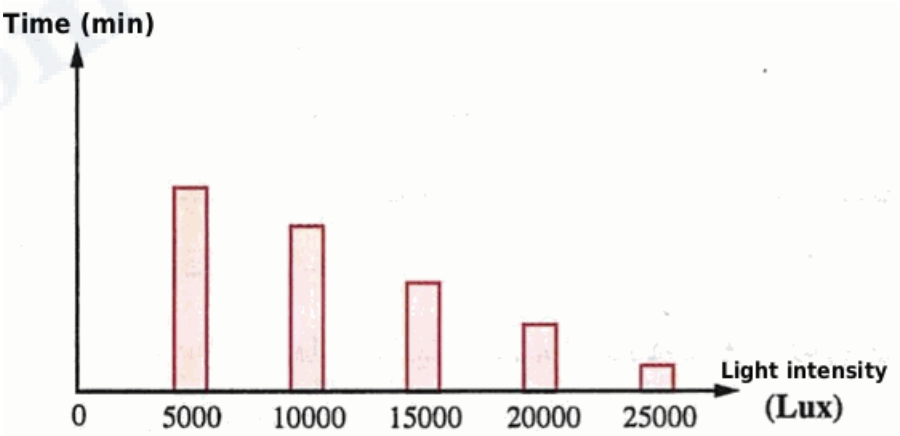
(B) The movement of the chloroplasts is due to the movement of the cytoplasm

(C) There is no relation between the movement of the cytoplasm and the movement of the chloroplasts

(D) The movement of the cytoplasm continues because of the movement of all the cell organelles

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13 The opposite graph shows the relation between light intensity and the time needed for the leaflets of the Mimosa plant to return to their normal position under normal conditions: What do we conclude from the graph?



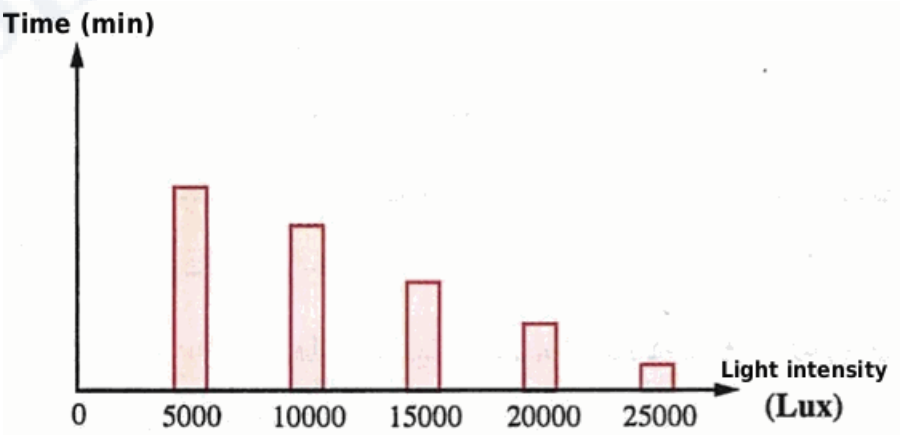
(A) The time needed for the leaflets to return to their normal position increases as the light intensity increases

(B) The light intensity increases as the time needed for the leaflets to return to their normal position increases

(C) The light intensity decreases as the time needed for the leaflets to return to their normal position increases

(D) The time needed for the leaflets to return to their normal position decreases as the light intensity increases

14 The opposite graph shows the relation between light intensity and the time needed for the leaflets of the Mimosa plant to return to their normal position under normal conditions: What happens if it rains for one minute while the experiment is carried out at a light intensity of (25000 Lux)?



(A) The time needed for the leaflets to return to their normal position increases

(B) The time needed for the leaflets to return to their normal position is not affected

(C) The time needed for the leaflets to return to their normal position decreases

(D) The leaflets will not return to their normal position

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15 While the root of a bean plant was growing in the soil, it hit a hard object, which generated a group of signals that stimulated the root to grow away from that object. Which of the following represents the type of movement?

(A) Tropism movement

(B) Movement in response to touch

(C) Pulling movement

(D) Rotational cytoplasmic movement

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16 Which of the following movements is slow and depends mainly on the action of auxins?

(A) Movement in response to touch in the Mimosa plant

(B) Waking movement in the bean plant

(C) Pulling movement by tendrils in the grape plant

(D) Rotational cytoplasmic movement in the Elodea plant

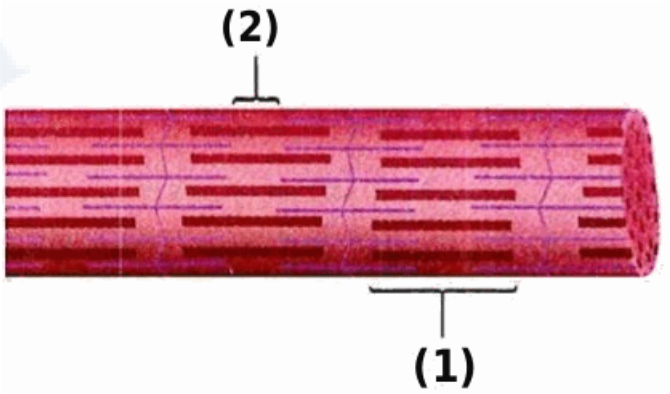
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17 What is the range of the number of myofibrils found in five muscle fibers?

(A) 1000 : 2000 (B) 2000 : 4000 (C) 5000 : 10000 (D) 3000 : 6000

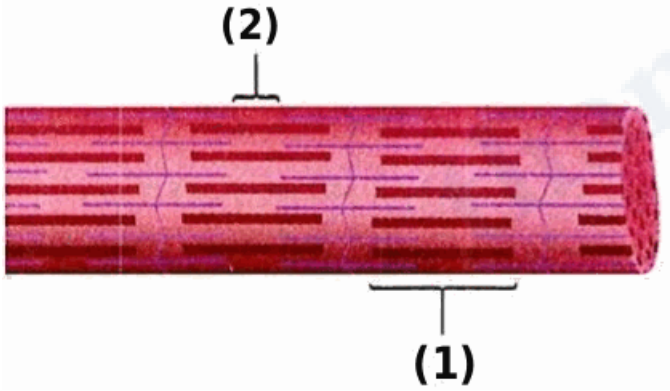
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18 The opposite figure represents part of a myofibril. Study it, then answer:
Which of the following does number (1) represent?



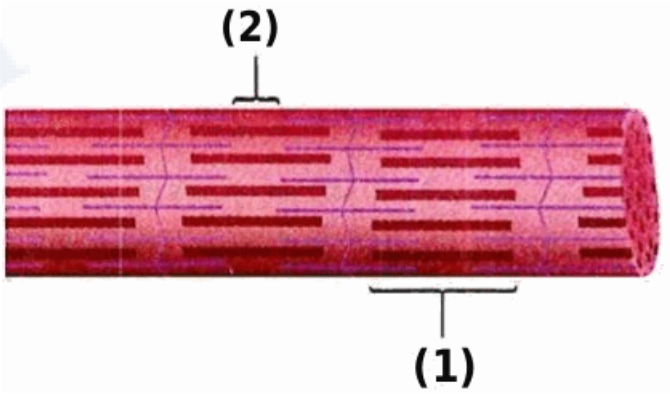
(A) Light band (B) Sarcomere (C) Dark band (D) Semi-light zone

19 The opposite figure represents part of a myofibril. Study it, then answer:
What does part (2) consist of?



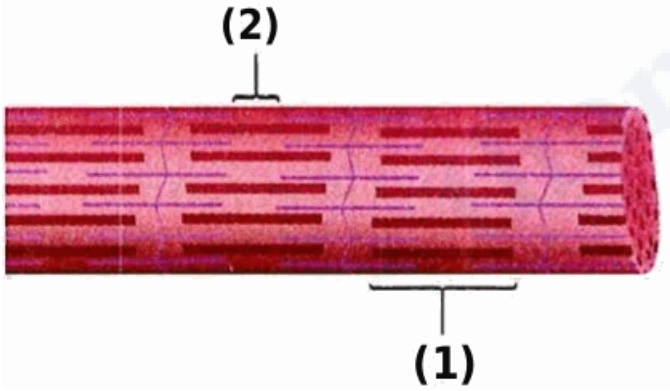
(A) Actin filaments only
(B) Myosin filaments only
(C) Actin and myosin filaments together
(D) It does not contain protein filaments

20 The opposite figure represents part of a myofibril. Study it, then answer:
How many complete sarcomeres are there in this part of the myofibril?



(A) One sarcomere (B) Two sarcomeres (C) Three sarcomeres (D) Four sarcomeres

21 The opposite figure represents part of a myofibril. Study it, then answer:
How many light bands and semi-light zones are there in this part of the myofibril, respectively?

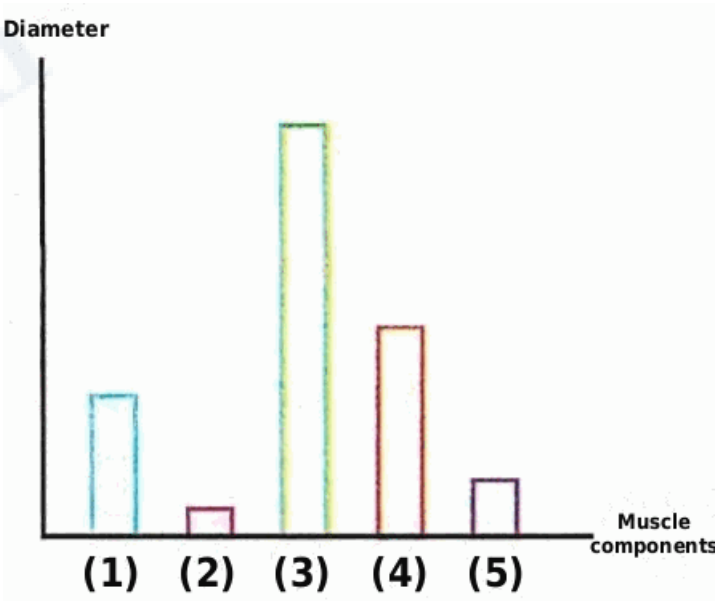


(A) 3 / 3 (B) 3 / 6 (C) 4 / 2 (D) 4 / 6

22 Which of the following is considered the structural unit of the skeletal muscle?

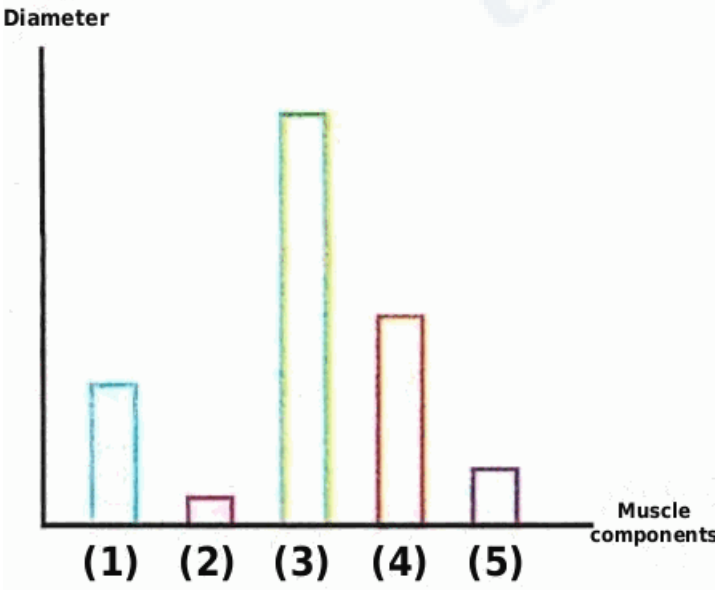
(A) The myofibril (B) The muscle fiber
(C) The sarcomere (D) The muscle bundle

23 The opposite graph represents the diameters of the components of a skeletal muscle:
Which number refers to the muscle fiber?



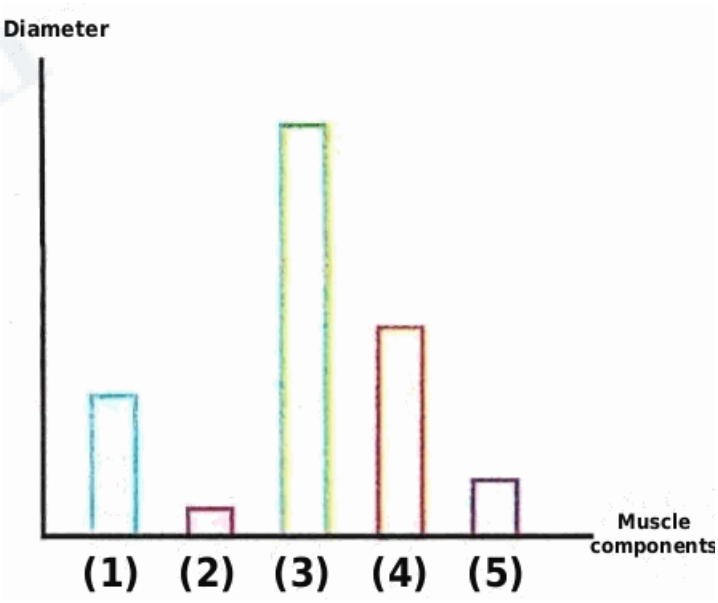
Ⓐ (1) Ⓑ (2) Ⓒ (3) Ⓓ (4)

24 The opposite graph represents the diameters of the components of a skeletal muscle:
Which of the following refers to the myosin filaments and the actin filaments, respectively?



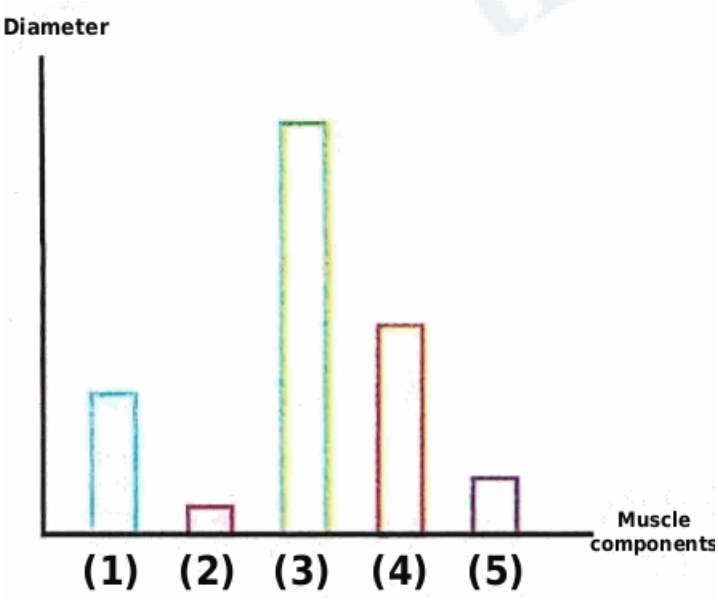
Ⓐ (1) / (2) Ⓑ (3) / (4) Ⓒ (4) / (5) Ⓓ (5) / (2)

25 The opposite graph represents the diameters of the components of a skeletal muscle:
Which number refers to the myofibril?



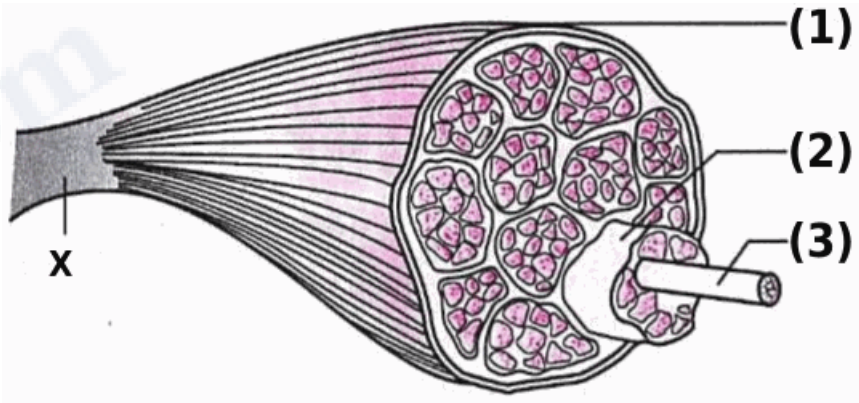
(A) (1) (B) (3) (C) (4) (D) (5)

26 The opposite graph represents the diameters of the components of a skeletal muscle:
Which of the following is surrounded from the outside by a membrane?



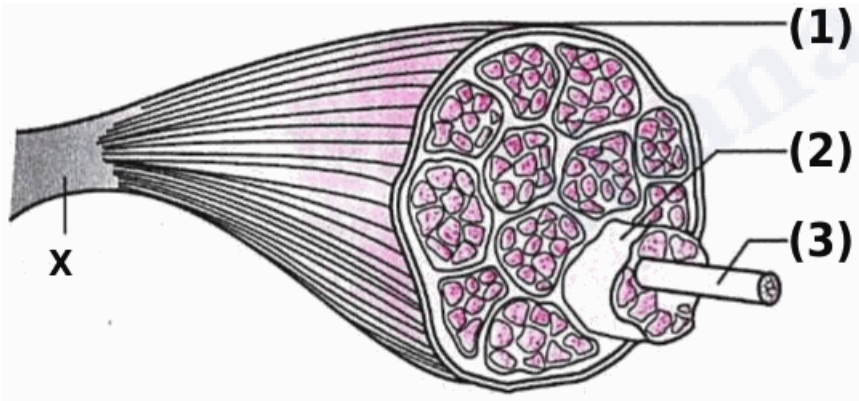
(A) (1), (5) (B) (2), (4) (C) (3), (4) (D) (4), (1)

27 The opposite figure represents a skeletal muscle. Study it, then answer:
What type of tissue makes up structure (X)?



(A) Epithelial (B) Muscular (C) Nervous (D) Connective

28 The opposite figure represents a skeletal muscle. Study it, then answer:
Which of the following structures is surrounded by the sarcolemma?



(A) (2) only (B) (3) only
(C) (1) and (2) together (D) (2) and (3) together

29 A myofibril consists of 5 semi-light zones (H). How many sarcomeres are there in this myofibril?

(A) 7 (B) 6 (C) 5 (D) 4

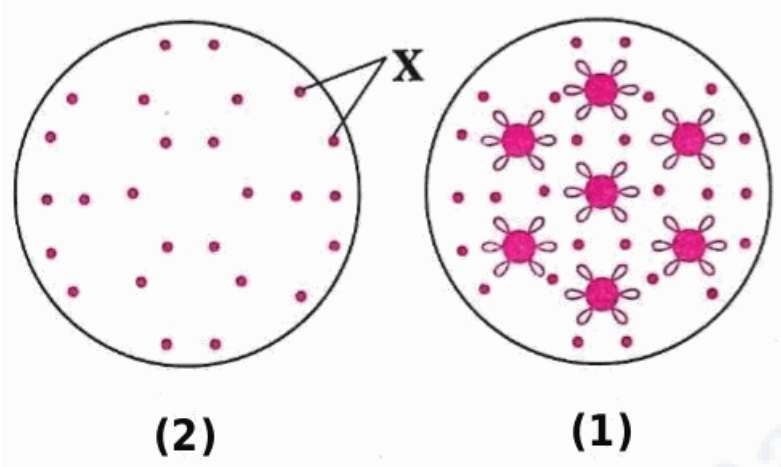
30 If a myofibril consists of (X) number of (A) bands, then the number of (Z) lines = ...

(A) X + 1 (B) X − 1 (C) 2X (D) X^2

31 Which of the following muscles do NOT need tendons in their work?

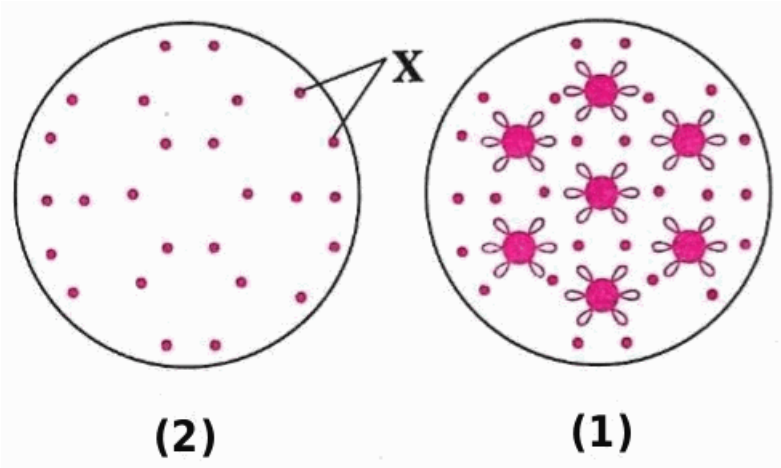
(A) Skeletal and cardiac muscles
(B) Cardiac muscles only
(C) Cardiac and smooth muscles
(D) Smooth muscles only

32 The two opposite diagrams show two cross sections in two different regions of the myofibril: Which of the following regions does figure (1) represent?



(A) A
(B) H
(C) I
(D) Z-Z

33 The two opposite diagrams show two cross sections in two different regions of the myofibril: What does (X) represent in figure (2)?



(A) Myofibrils
(B) (Z) lines
(C) Myosin filaments
(D) Actin filaments

34 How many complete sarcomeres are there between 4 complete light bands?

(A) 2
(B) 3
(C) 4
(D) 5

35 Which system controls the work of the muscles?

(A) Skeletal (B) Nervous (C) Respiratory (D) Circulatory

36 What happens if the motor nerve endings stop secreting acetylcholine?

(A) The cross bridges do not separate from the actin filaments

(B) The charge of the inner surface of the muscle fiber membrane stays negative

(C) The cholinesterase enzyme is absent from the neuromuscular junction

(D) Lactic acid accumulates inside the muscle fiber and acetic acid outside it

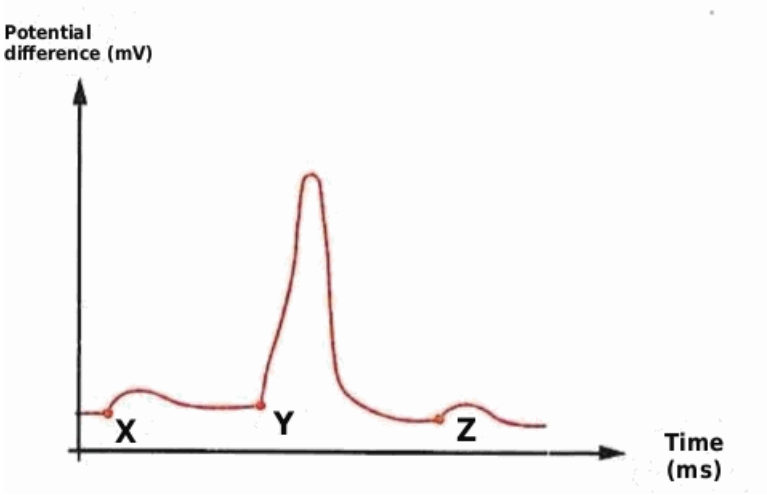
37 Which of the following increases in amount in the muscles during contraction?

(A) Calcium ions (B) ATP (C) Glucose (D) Glycogen

38 Which of the following is directly affected by the conversion of ATP molecules into ADP molecules when bending the arm?

(A) Bones (B) Muscles (C) Ligaments (D) Tendons

39 The opposite graph shows the change in the potential difference when a muscle is exposed to three stimuli (X), (Y), (Z). Which stimuli caused the sliding of the actin filaments?



(A) (X), (Y) (B) (Y) only (C) (Y), (Z) (D) (Z) only

40 The following are processes that take place when a muscle contracts:

(1) Sodium ions enter the muscle fiber.

(2) The muscle fiber membrane changes from the polarized state to the depolarized state.

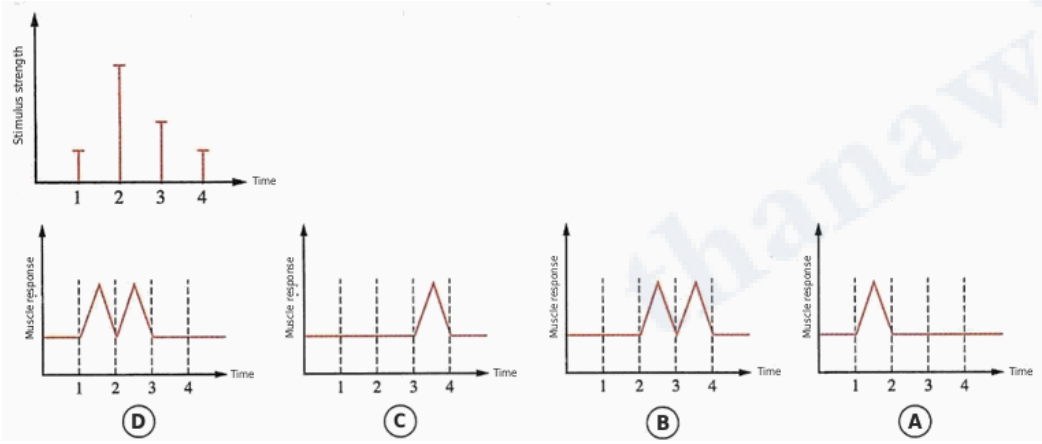
(3) Acetylcholine is released from the vesicles of the neuromuscular junction.

(4) Calcium ions enter the endings of the nerve cell.

Which of the following represents the natural order of these processes for the muscle to contract?

(A) (1) → (2) → (3) → (4)
(B) (2) → (1) → (3) → (4)
(C) (4) → (3) → (2) → (1)
(D) (4) → (3) → (1) → (2)

41 The opposite graph shows the stimuli that reach the muscle. Which of the following graphs represents the response of the muscle to these stimuli?



42 What is the correct order of the work of the following parts when bending the foot?

(A) Muscles → tendons → ligaments → bones
(B) Muscles → bones → tendons → ligaments
(C) Bones → ligaments → muscles → tendons
(D) Muscles → tendons → bones → ligaments

43 What happens if sodium ions do not move into the muscle fiber membrane?

(A) The muscle contracts weakly
(B) The muscle contracts strongly
(C) No muscle contraction occurs
(D) The muscle stays contracted

44 Polarization in the sarcolemma means that .....

(A) The inner surface of the membrane is negative because of the absence of sodium ions

(B) The outer surface of the membrane is positive because of the accumulation of sodium ions

(C) The inner surface of the membrane is negative because of the accumulation of sodium ions

(D) The outer surface of the membrane is positive because of the accumulation of calcium ions

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45 Which regions increase in length when a contracted skeletal muscle relaxes?

(A) I, H (B) A, H (C) I, A (D) I, H, A

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46 Which of the following does NOT apply to the sarcomere?

(A) Its length decreases during muscle contraction

(B) It represents the distance between two successive dark lines

(C) It represents the distance between two successive dark bands

(D) It is the smallest unit of muscle contraction

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47 What happens when the muscle fiber membrane returns to the polarized state?

(A) Cross bridges extend from the myosin filaments to connect with the actin filaments

(B) Cross bridges extend from the actin filaments to connect with the myosin filaments

(C) The cross bridges separate from the actin filaments

(D) The cross bridges separate from the myosin filaments

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48 Which of the following must be available for the skeletal muscle to contract?

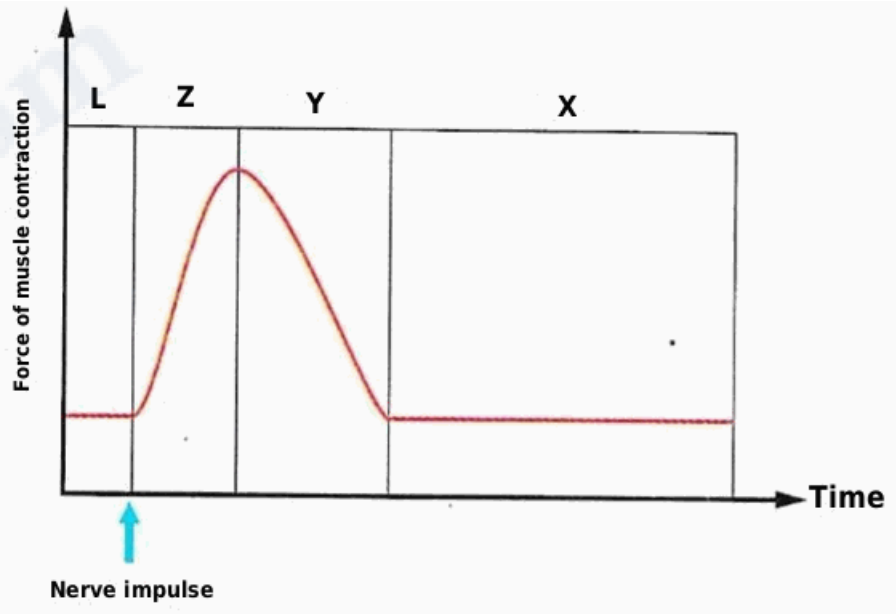
(A) Acetic acid and choline (B) ATP molecules and calcium ions

(C) ATP molecules and choline (D) Acetic acid and sodium ions

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49 The opposite graph shows the contraction of a skeletal muscle:

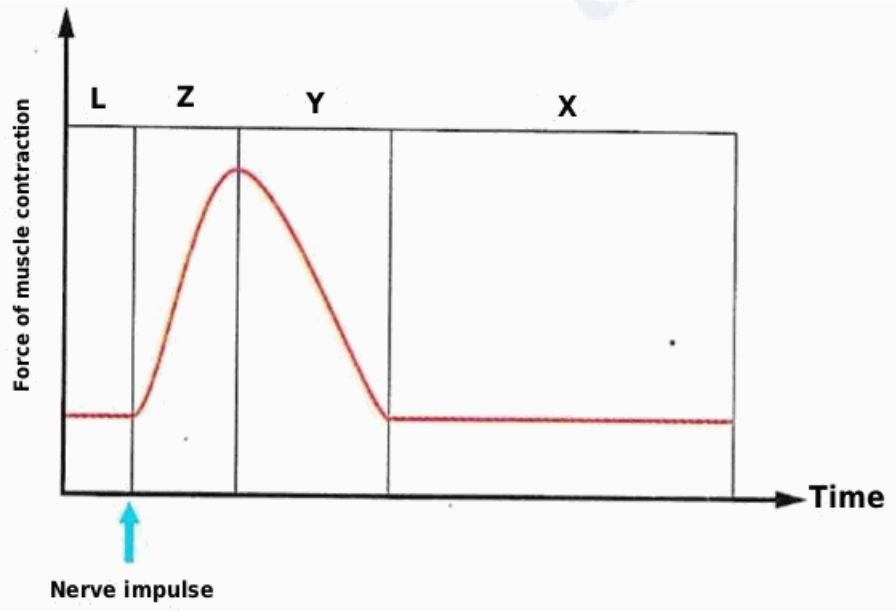
Which of the following shows the (Z) lines moving closer to each other?



(A) Y (B) Z (C) X, Z (D) Y, Z

50 The opposite graph shows the contraction of a skeletal muscle:

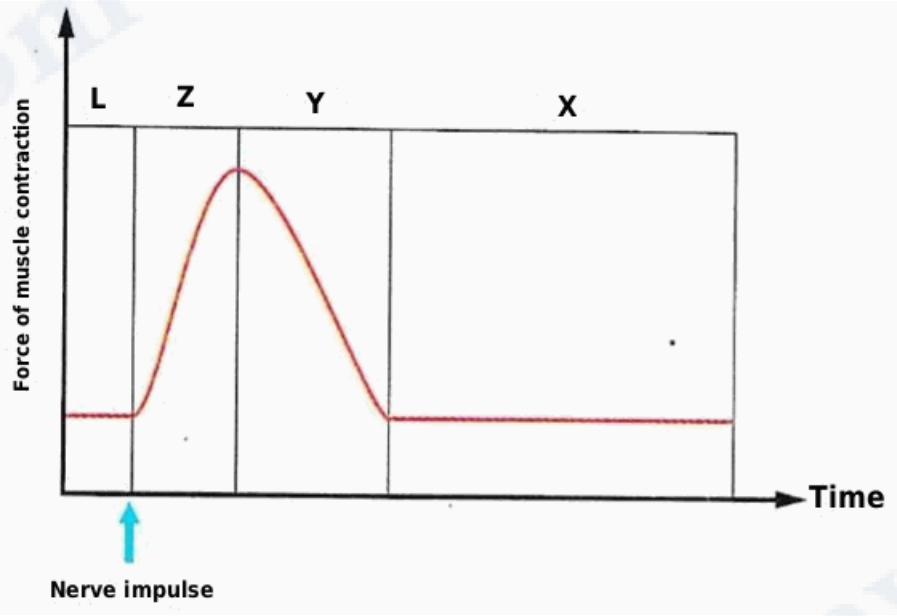
Which of the following shows the polarized state of the muscle fiber membrane?



(A) X, L (B) Y, Z (C) Z, X (D) L, Y

51 The opposite graph shows the contraction of a skeletal muscle:

Which of the following shows the change in the potential difference across the muscle fiber membrane because of the entry of sodium ions?



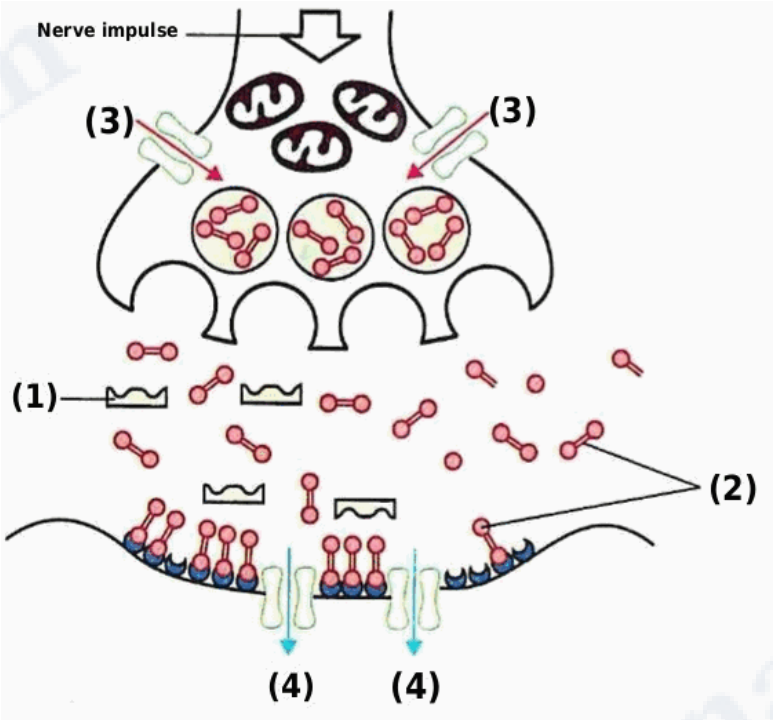
(A) X (B) Y (C) Z (D) L

52 Taking some narcotic substances slows down the response of the muscles. Which of the following is directly affected when these substances are taken, causing this?

(A) The percentage of calcium in the blood
(B) The amount of ATP molecules
(C) The receptors of the muscle fiber
(D) The structure of the muscle fiber

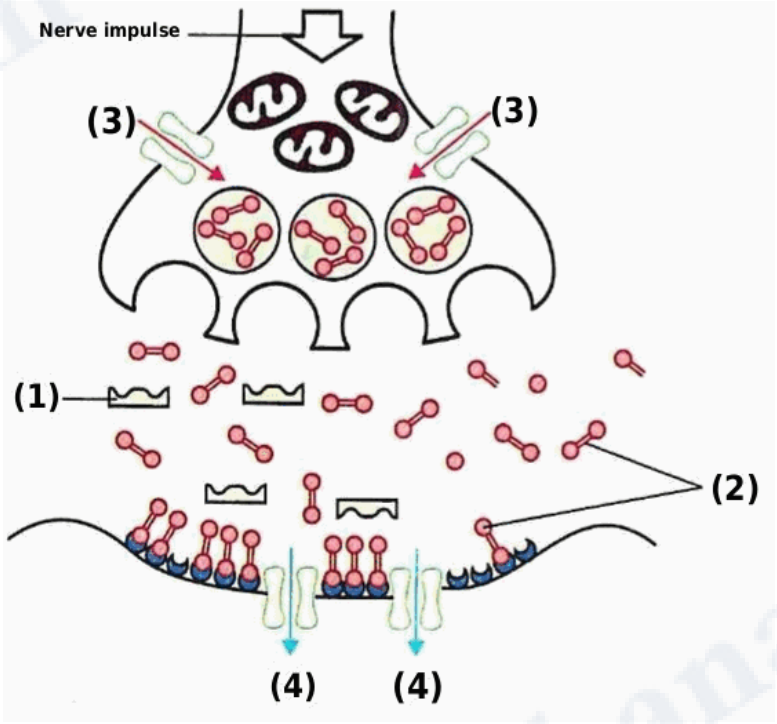
53 From the opposite figure, which shows the neuromuscular junction:

Which numbers refer to the mineral ions?



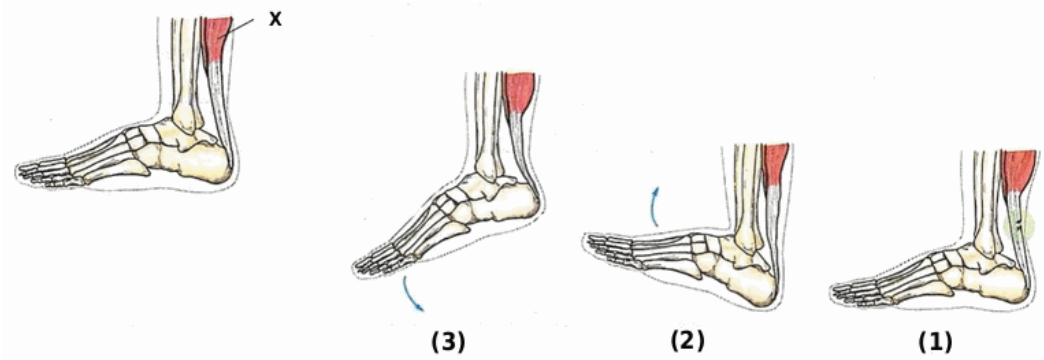
(A) (1), (2) (B) (3), (4) (C) (1), (3) (D) (2), (4)

54 From the opposite figure, which shows the neuromuscular junction:
Which number refers to the neurotransmitter and to the enzyme that breaks it down, respectively?



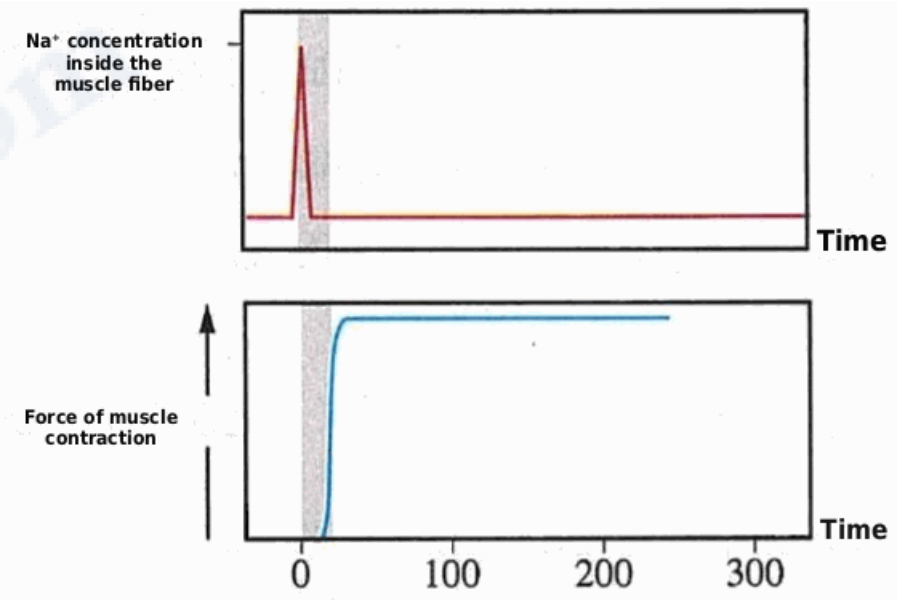
(A) (1) / (2) (B) (2) / (1) (C) (3) / (4) (D) (4) / (3)

55 From the opposite figure, which of the following may happen if structure (X) suffers a muscle cramp?



(A) (1) only (B) (2) only (C) (1) or (2) (D) (1) or (3)

56 From the two opposite graphs, what can be concluded about skeletal neuromuscular coordination?



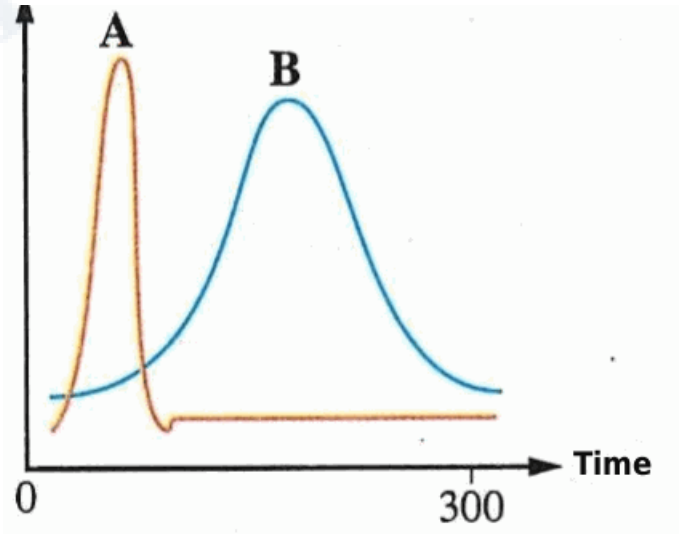
(A) A fracture in one of the bones of the joint

(B) A defect in the transmission of the nerve impulse to the muscle

(C) A muscle cramp because of muscle fatigue

(D) A muscle cramp because of a lack of sodium ions

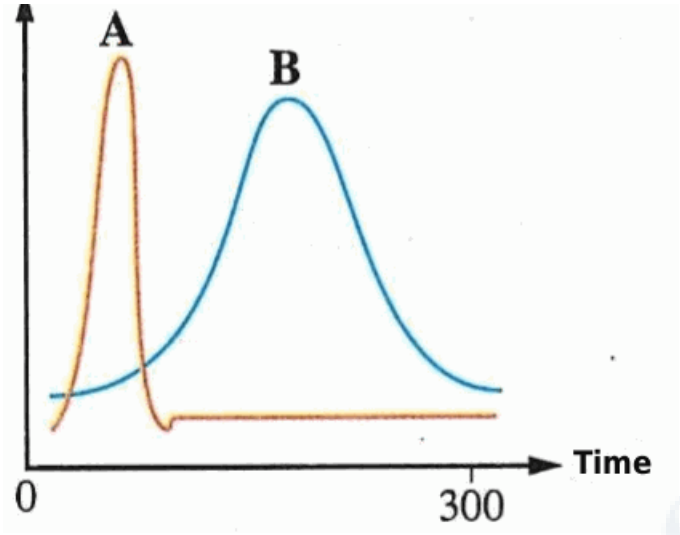
57 In the graph, curve (A) represents a nerve impulse on the axon of a nerve fiber, while curve (B) represents the contraction and relaxation of a skeletal muscle:
What do we conclude from studying the graph?



(A) The nerve impulse takes a longer time than the muscle contraction
(B) No muscle contraction occurs unless a nerve impulse is generated
(C) Muscle contraction has no relation to the nerve impulse
(D) No nerve impulse is generated unless a muscle contraction occurs

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58 In the graph, curve (A) represents a nerve impulse on the axon of a nerve fiber, while curve (B) represents the contraction and relaxation of a skeletal muscle:
When does the role of calcium ions start and end?



(A) Before curve (A)
(B) Between curve (A) and curve (B)
(C) After curve (B)
(D) Before curve (A) and after curve (B)

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59 What happens if a person is exposed to a toxic substance that binds to the neurotransmitter receptors in the membranes of the muscle fibers?

(A) No nerve impulses are generated

(B) The muscles contract and relax normally

(C) The person suffers from a muscle cramp

(D) The muscles will not contract

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60 When is the highest number of free phosphate groups and ADP molecules, produced from breaking down ATP molecules, formed in the skeletal muscle?

(A) During muscle relaxation

(B) At the moment acetylcholine binds to the receptors of the muscle fiber membrane

(C) Directly after the contraction and relaxation of the muscle

(D) Before sodium ions enter the muscle fiber

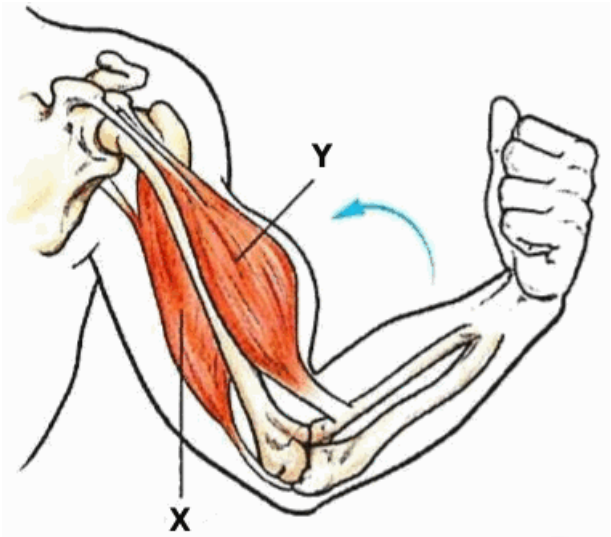
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61 Which ion plays a direct role in changing the electrical state of the muscle fiber during its contraction?

(A) Sodium (B) Potassium (C) Calcium (D) Chloride

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62 From the opposite figure:
Which of the following regions in the myofibril does NOT change in length in the two states (X) and (Y)?

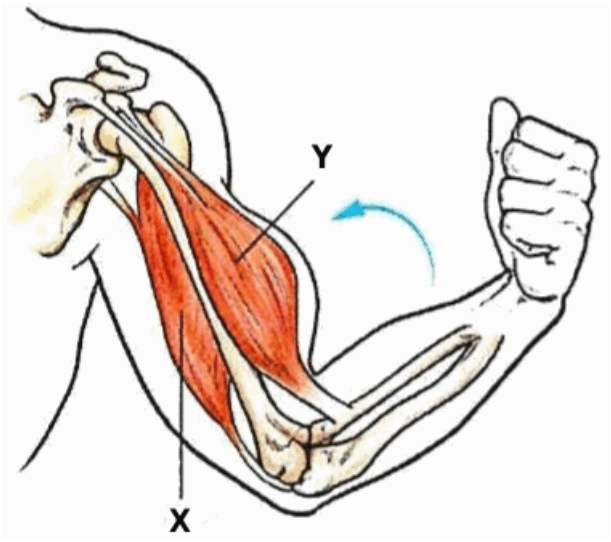


(A) A (B) I (C) H (D) Z-Z

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63 From the opposite figure:

Which of the following must be available for muscle (Y) to return to the state of muscle (X)?



(A) Acetylcholine and calcium ions

(B) Cholinesterase enzyme and calcium ions

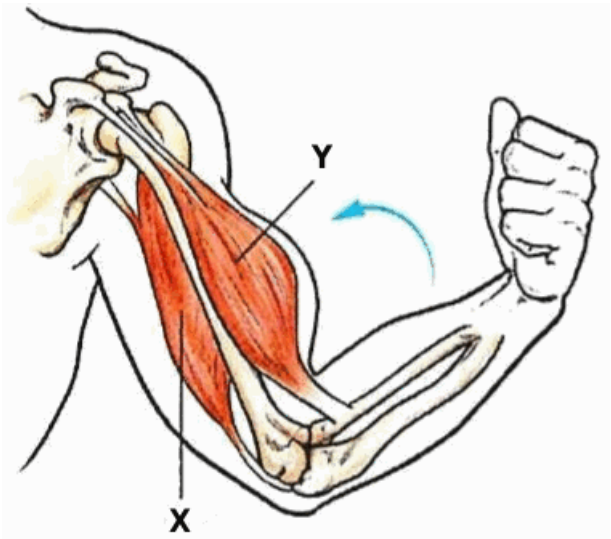
(C) Acetylcholine and ATP molecules

(D) Cholinesterase enzyme and ATP molecules

---

64 From the opposite figure:

For the two forearm bones to move in the direction shown in the figure, which choice in the following table shows the charges on the outer surface of the muscle fiber membrane in muscle (X) and muscle (Y)?



(A) (X): + / (Y): + (B) (X): + / (Y): − (C) (X): − / (Y): + (D) (X): − / (Y): −

---

65 Which ion is responsible for transmitting the nerve impulse from the nerve endings to the muscle fibers?

(A) Potassium (B) Calcium (C) Sodium (D) Chloride

66 Which of the following choices correctly shows the energy source and the type of respiration of a person in three different states?

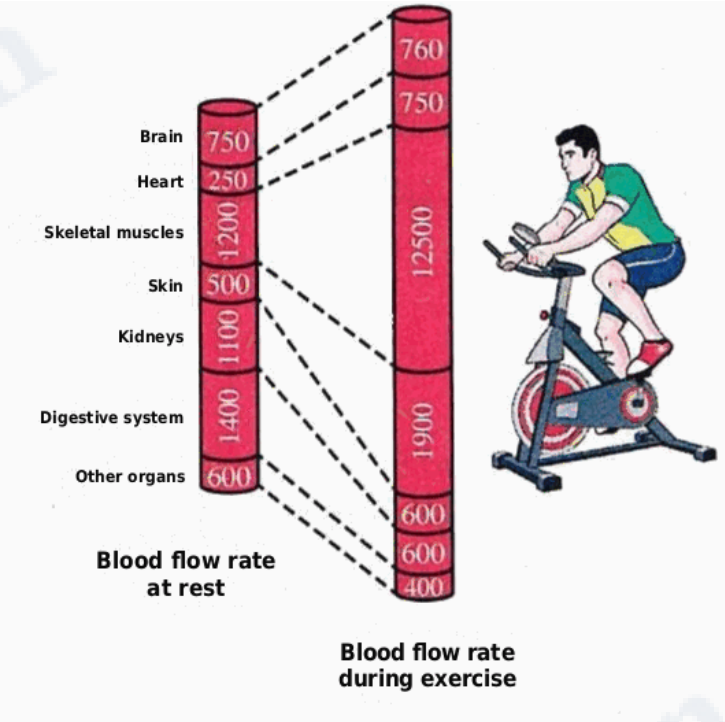
(A) Rest: blood glucose by anaerobic respiration / Light exercise: blood glucose by aerobic respiration / Strenuous exercise: blood glucose by aerobic respiration

(B) Rest: blood glucose by aerobic respiration / Light exercise: muscle glycogen by anaerobic respiration / Strenuous exercise: blood glucose by aerobic respiration

(C) Rest: muscle glycogen by anaerobic respiration / Light exercise: blood glucose by aerobic respiration / Strenuous exercise: blood glucose by anaerobic respiration

(D) Rest: blood glucose by aerobic respiration / Light exercise: blood glucose by aerobic respiration / Strenuous exercise: muscle glycogen by anaerobic respiration

67 The opposite figure shows the rate of blood flow to the body organs at rest and during exercise. Which of the following statements is correct?



(A) At rest, the rate of glucose consumption in the digestive system is greater than its rate during exercise

(B) At rest, the rate of ATP production in the digestive system is less than its rate during exercise

(C) The rate of ATP production by the skeletal muscles decreases during exercise compared to its rate at rest

(D) There is a direct relation between the need of the skeletal muscles and of the digestive system for glucose

---

68 Which of the following is formed during the contraction of a fatigued skeletal muscle?

(A) Lactic acid outside the muscle fibers and acetic acid inside the muscle fibers

(B) Lactic acid inside the muscle fibers and acetic acid outside the muscle fibers

(C) Lactic acid inside and outside the muscle fibers

(D) Acetic acid inside and outside the muscle fibers

---

69 The opposite table shows the concentration of three substances in a skeletal muscle of a person suffering from a muscle cramp:

Blood glucose: 90 mg (normal: 80 to 120 mg)

ATP: 40% (normal: 50% to 90%)

Glycogen: 55% (normal: 40% to 70%)

What is the cause of this muscle cramp?

(A) The neurotransmitters do not leave the vesicles

(B) A large increase in lactic acid inside the muscle

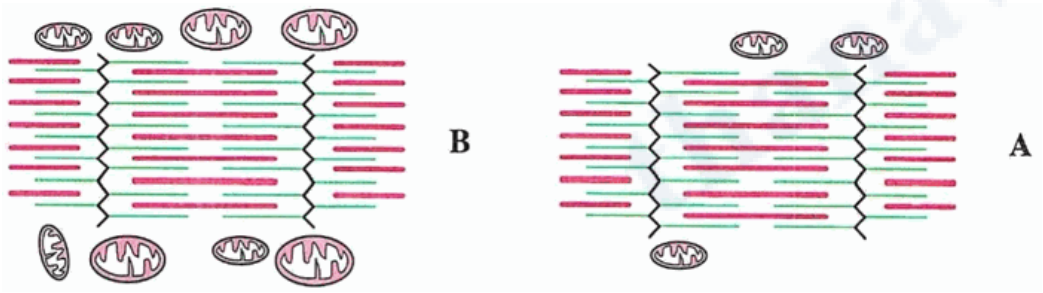
(C) The cross bridges do not separate from the actin filaments

(D) The fast consumption of glycogen in the muscle

---

70 The two figures represent two muscle fibers (A) and (B) in two different muscles of the human body:

Which of the following is correct about (A) and (B)?



(A) (A) is more active than (B)

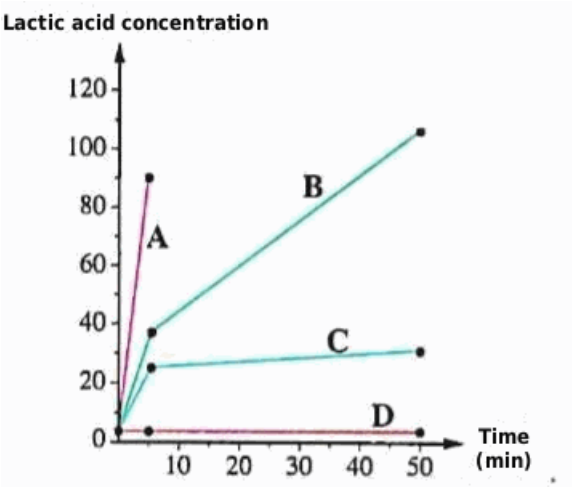
(B) (A) is found in one of the finger muscles and (B) is found in the gastrocnemius (twin) muscle

(C) (A) and (B) release equal amounts of energy

(D) (B) consumes less glucose than (A)

---

71 The opposite graph shows the concentration of lactic acid in the muscles of four runners. Which runner is practicing this sport for the first time?



72 What happens in muscle fatigue?

(A) The oxidation of glucose by oxygen increases

(B) The production of ATP molecules increases

(C) The consumption of glucose increases

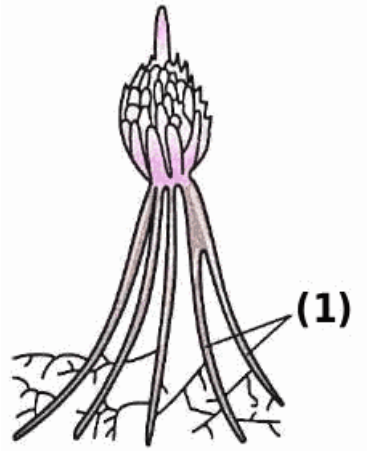
(D) The percentage of CO_2 gas increases

Essay questions — 13 questions

1 The opposite figure shows a type of plant:

(1) State the forms of movement in this type of plant.

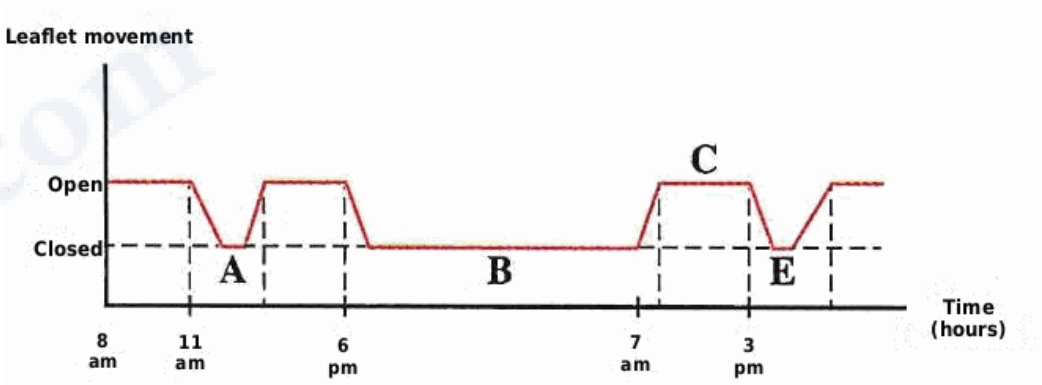
(2) What happens if structure (1) is absent?



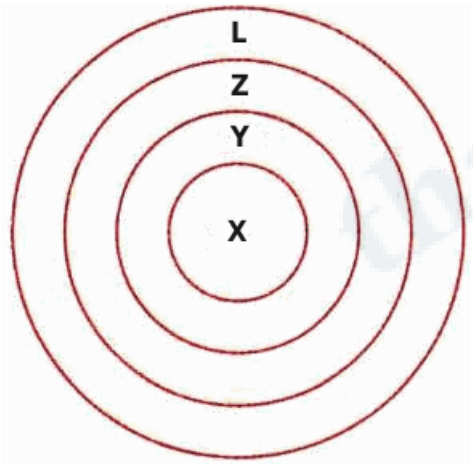
2 From the two opposite figures, what is the cause of the change of this plant from position (X) to position (Y)?



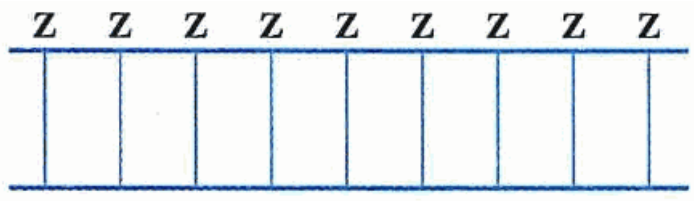
3 From the opposite graph, which periods show the sleep and waking movements and the movement in response to touch in the Mimosa plant?



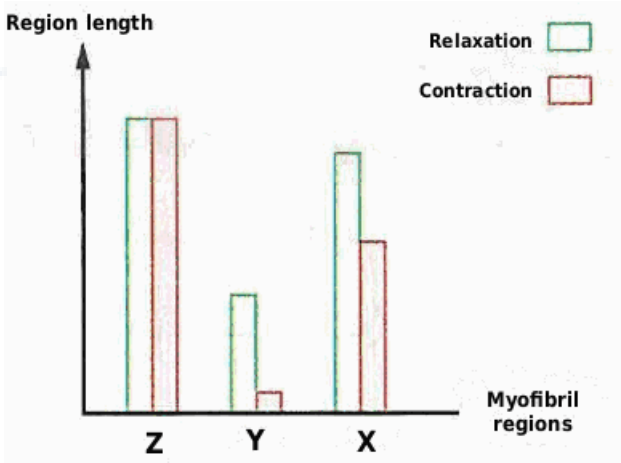
4 The opposite figure represents diameters in one of the components of the muscular system in humans. If (L) represents the structural unit of the muscular system, where are the mitochondria found? Explain your answer.



5 From the opposite diagram, which represents one of the myofibrils of the skeletal muscle, how many sarcomeres, dark bands and semi-light zones are there when complete muscle contraction occurs?



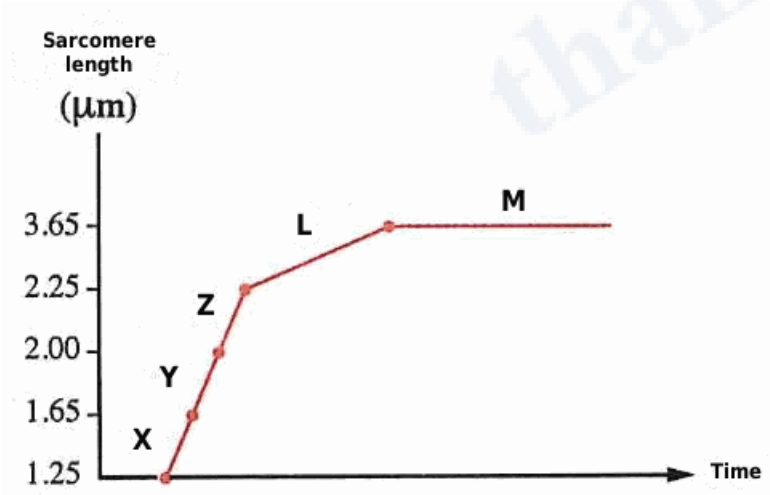
6 The opposite graph shows the change in the length of the regions of the myofibril during contraction and relaxation. What do regions (X), (Y), (Z) represent?



7 The opposite graph shows the change in the length of the sarcomere during the relaxation of a skeletal muscle:

(1) In which stage do the cross bridges start to separate from the actin filaments?

(2) In which stage is the semi-light zone at its largest?

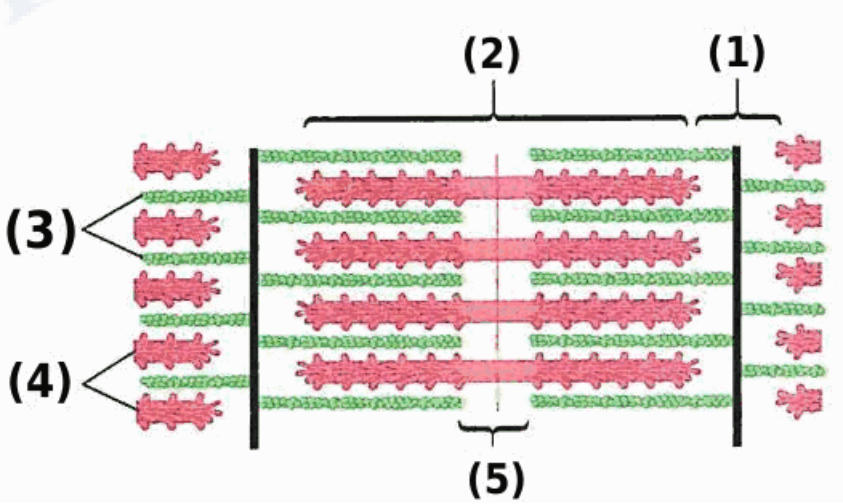


8 The opposite figure shows part of a muscle fiber of a skeletal muscle:

(1) Is this muscle contracted or relaxed? Why?

(2) Explain the changes that happen to parts (1) to (5) when the muscle contracts.

(3) What is the relation between part number (4) and muscle contraction?

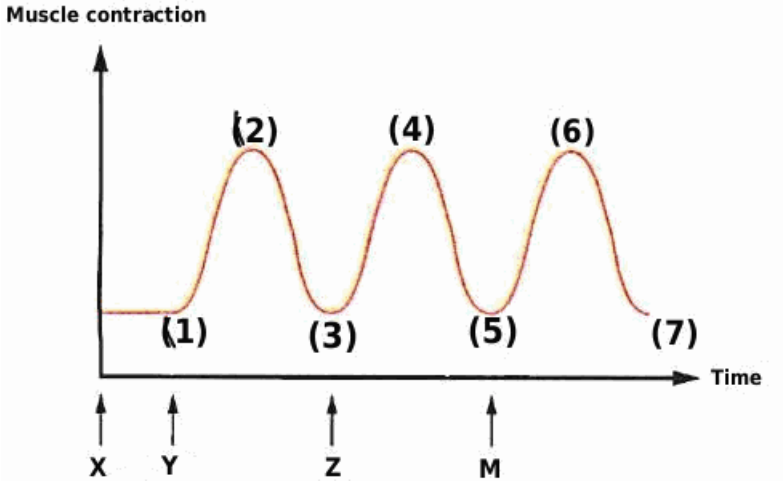


9 The opposite graph shows the contraction and relaxation of a skeletal muscle over a period of time:

(1) How many nerve stimuli caused the muscle contractions shown? What are they?

(2) Which stages need both calcium ions and ATP molecules?

(3) In which stages is the action of the cholinesterase enzyme shown?

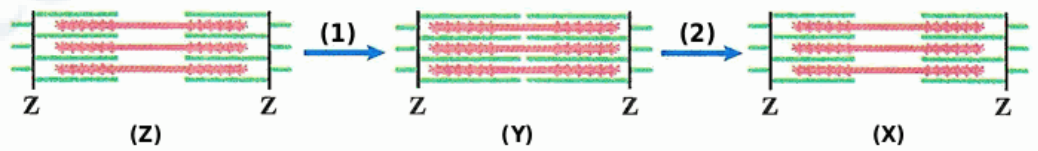


10 Study the following figure, then answer:

(1) ATP molecules play a double role in both process (1) and process (2). Explain.

(2) What are the reasons that prevent process (1) from happening even though there is a nerve impulse?

(3) What must be available to move from state (Y) to state (X)?



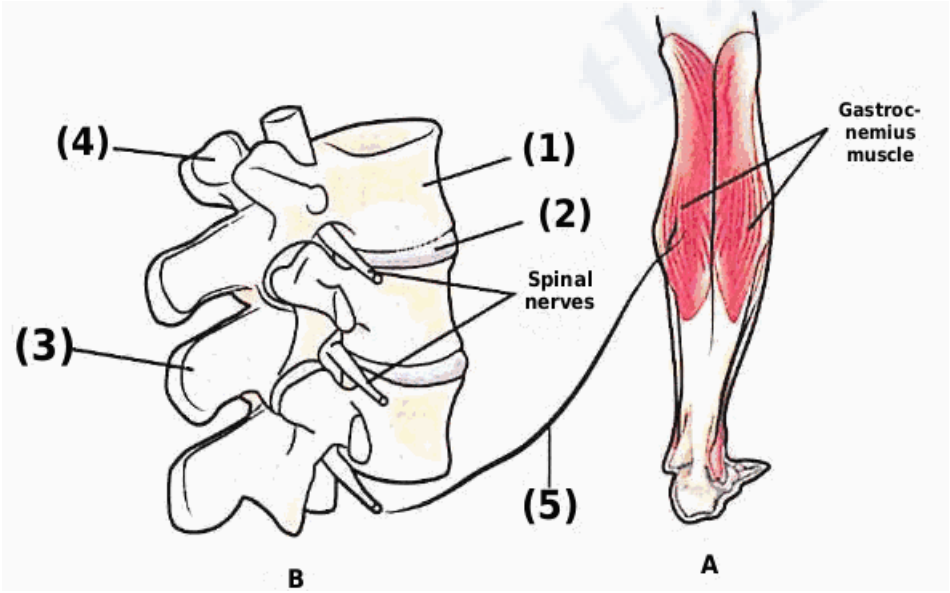
11 The opposite figure shows the coordination of three systems in the human body to produce movement. Study it, then answer the following:

(1) Figure (B) has a role in protecting an important structure in the body. Explain this.

(2) Write what the numbers (1) to (4) refer to.

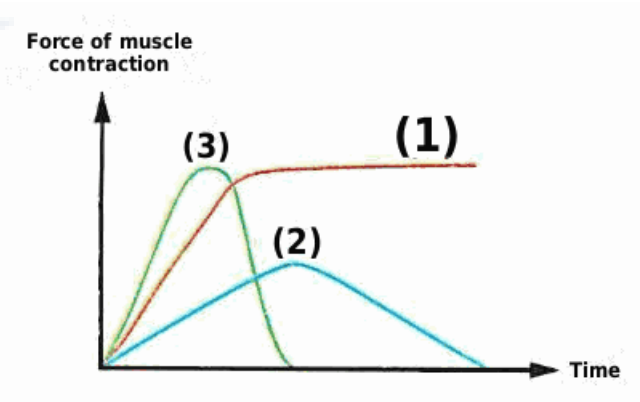
(3) When the gastrocnemius (twin) muscle is stimulated, one of the bones moves. Name it, then state how this bone is connected to the muscle.

(4) What happens if structure (5) is damaged?



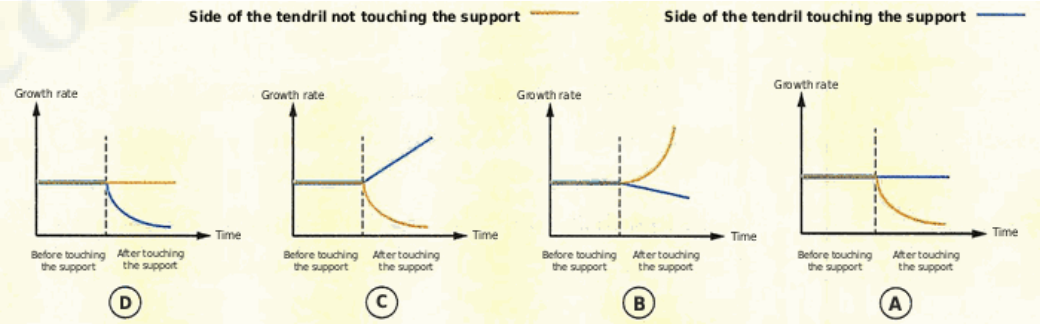
12 If a muscle bundle contains 400 muscle fibers, what is the average number of myofibrils in this bundle?

13 The opposite graph represents the force of contraction of three muscles (1), (2), (3). If muscle (3) contracts and relaxes normally, what condition does each of muscle (1) and muscle (2) show? What is the cause of each condition?

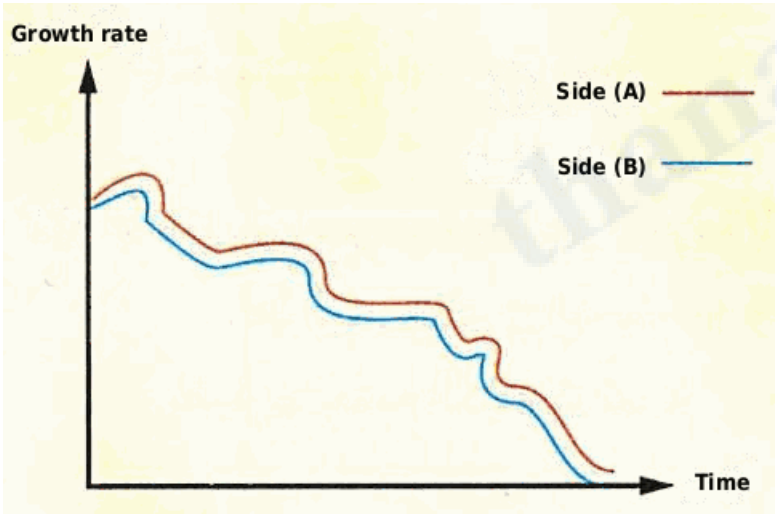


Past exam questions — 53 questions

1 Which of the following graphs represents the growth of the two sides of a tendril if it touches an external support? (Trial exam / May 2021)



2 Study the opposite graph, which shows the growth rate of the two sides of a tendril of a climbing plant, then state what you can conclude from the graph. (Trial exam / June 2021)



(A) The tendril is in the stage of searching for a support

(B) The tendril is coiled around the support

(C) The tendril did not find a suitable support

(D) The plant grows vertically upwards

3 What is the result of the tendril coiling around the support? (1st session 2023)

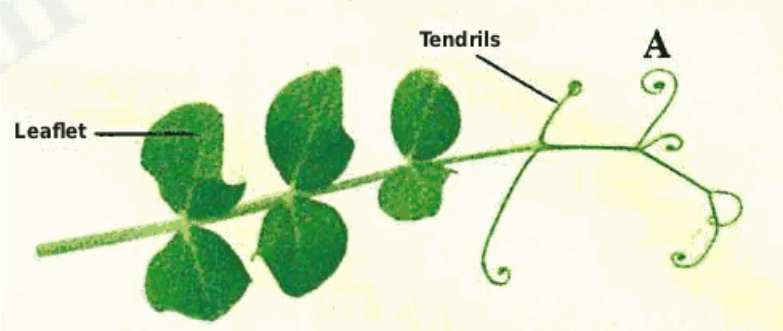
(A) Photosynthesis takes place efficiently in the plant

(B) The plant loses its ability to show tropism under the effect of light

(C) Cytoplasmic movement stops inside the plant cells

(D) The transport of substances inside the plant speeds up

4 The opposite figure shows the pinnate compound leaf of a leguminous plant in which some leaflets change into tendrils. What type of stimulus / stimuli can this leaf respond to? (2nd session 2023)



(A) A wooden stem only
(B) Light and darkness only
(C) A metal rod, and light and darkness
(D) Touching the leaflets, and light and darkness

---

5 What is the purpose of the movement that occurs in the cells and in the contractile (pulling) roots of bulbs, respectively? (1st session 2024)

(A) Transporting nutrients / supporting the stems and leaves
(B) Storing food / photosynthesis
(C) Photosynthesis / storing food
(D) Supporting the stem and leaves / transporting nutrients

---

6 Which of the following has a structure that shows the rotational movement of the cytoplasm in the plant? (2nd session 2024)

(A) The cells that make food in the leaves of the bean plant
(B) The sclerenchyma cells in a young dicot stem
(C) The root cells of the Mimosa plant
(D) The xylem vessels in the pea plant

---

7 What type of movement involves the continuous internal activity inside the cells? (Sample exam 2025)

(A) Tropism movement
(B) Movement of contractile roots
(C) Cytoplasmic streaming
(D) Tendril movement

---

8 What type of movement is the response of plant parts to light, moisture and gravity? (Sample exam 2025)

(A) Cytoplasmic movement
(B) Tropism
(C) Pulling movement
(D) Sleep movement

9 What is the similarity between the pulling movement in pea and the pulling movement in corms? (Sample exam 2025)

(A) Providing protection and support for the plant
(B) The direction of movement of the plant stem in both
(C) Forming supporting tissues
(D) The mechanism by which the pulling takes place

10 Which of the following is NOT correct about locomotion? (Sample exam 2026)

(A) It helps the organism search for food
(B) It helps the organism escape from dangers
(C) All living organisms perform it
(D) Some unicellular organisms perform it

11 All of the following are correct about local movement EXCEPT ..... (Sample exam 2026)

(A) It has a role in digestion
(B) Its occurrence is shown by the movement of the chloroplasts
(C) Tropism and pulling movement in plants are examples of it
(D) Most living organisms perform it

12 During inhalation and exhalation in humans, the diaphragm muscle and the ribs move. What is the correct description of the type of this movement? (Sample exam 2026)

(A) Continuous
(B) Cytoplasmic
(C) Local
(D) Locomotion

13 In the leaves of which of the following plants does the sleep movement occur? (2nd session 2025)

(A) The Mimosa plant only

(B) Some leguminous plants only

(C) The Mimosa plant and some leguminous plants

(D) All plants with pinnate compound leaves

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14 Which vital activity matches the function of the skeletal muscle in the human body? (2nd session 2021)

(A) Moving the arm

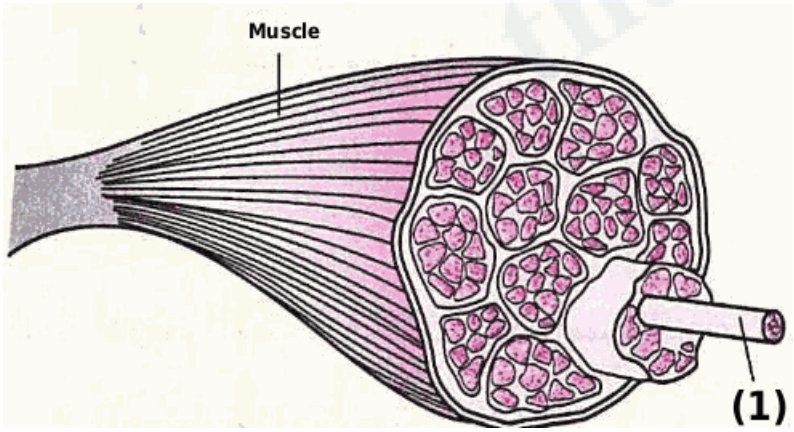
(B) The heart pumping blood

(C) Moving the baby from the mother's uterus to the vagina

(D) Kneading food and mixing it with the juice in the stomach

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15 The opposite figure shows the structure of a skeletal muscle. What is the most important feature of structure (1)? (2nd session 2021)



(A) Its ability to contract and relax by itself

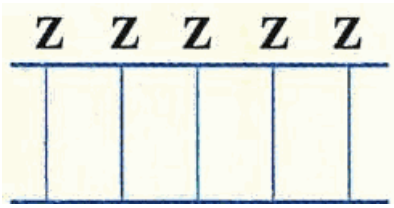
(B) It is surrounded by a membrane

(C) It contains more than one nucleus

(D) It is made of proteins

---

16 The opposite diagram represents one of the skeletal myofibrils. How many complete light bands appear in the figure? (Trial exam 2023)

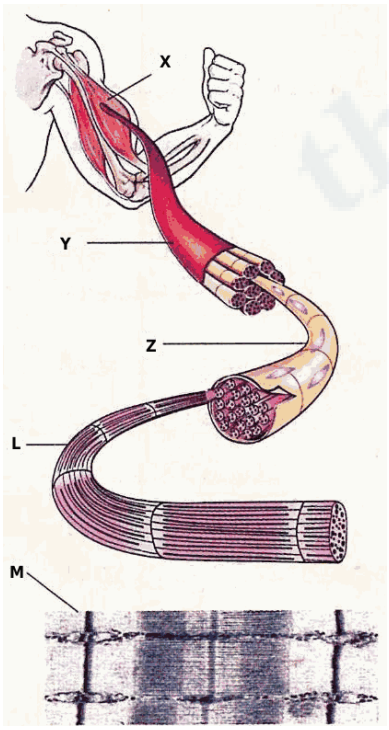


(A) 3 (B) 4 (C) 5 (D) 6

17 In skeletal muscles, the nuclei are usually found ..... (Sample exam 2026)

(A) in the center of the muscle fiber
(B) in the middle of the sarcomere
(C) near the sarcolemma
(D) next to the myosin filaments

18 Which of the following represents the order of the parts of the skeletal muscle in descending order of size? (Sample exam 2026)



(A) Y - Z - L - X (B) L - Z - Y - X (C) X - Z - Y - M (D) X - Y - Z - M

19 Which region / regions of the myofibril do not contain cross bridges? (1st session 2025)

(A) The dark band only

(B) The light band only

(C) The light bands and the semi-light zones

(D) The dark bands and the semi-light zones

20 Where are the binding sites of the cross bridges extending from myosin in the structure of the sarcomere? (1st session 2023, Sample exam 2025)

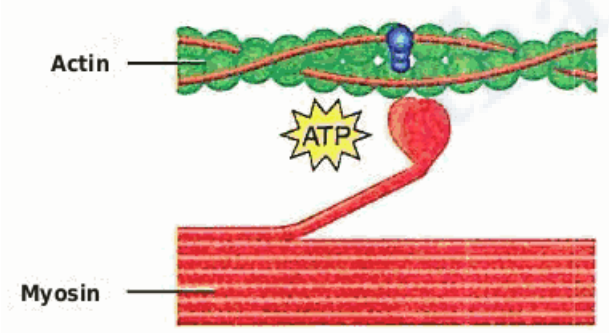
(A) The semi-light zone

(B) The actin filaments

(C) The actin filaments and the semi-light zone

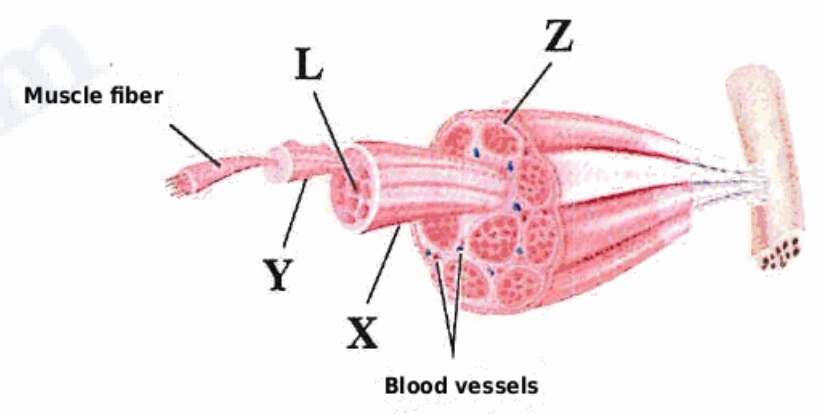
(D) The actin filaments and the dark line (Z)

21 Study the opposite figure, then deduce which region of the sarcomere is shown in the figure. (2nd session 2023)



(A) H (B) A (C) I (D) Line (Z)

22 Study the opposite figure, which shows the structure of a skeletal muscle, then state which letter / letters refer to the membrane of the muscle bundle. (1st session 2024)



(A) (X) or (Y) (B) (Z) only (C) (X) only (D) (L) or (X)

23 In the structure of the muscle fiber, which parts contain myosin filaments only, parallel to the longitudinal axis of the muscle fiber? (2nd session 2024)

(A) The dark bands
(B) The semi-light zones
(C) The sarcomeres
(D) The light bands

24 In the elbow joint, when the arm is bent, there is coordination between the antagonistic muscles that leads to the movement of the joint. Which part / component is responsible for this coordination? (Sample exam 2026)

(A) The antagonistic muscles
(B) The ligaments
(C) The joint
(D) The nervous system

25 The position of the body changes automatically when balance is lost, and this depends on ..... (Sample exam 2026)

(A) a skeletal-muscular reflex
(B) a neuromuscular reflex
(C) a muscular-skeletal reflex
(D) the reaction of the ligaments at the joints and their stretching

26 The all-or-none law is the law that governs muscle contraction. It means that the muscle does not contract unless the stimulus is enough to make it contract, and then the muscle contracts with its maximum force. If two identical muscles are exposed to two stimuli that are enough to stimulate them, but the first stimulus is twice as strong as the second, what is the result? (Trial exam / May 2021)

(A) The first muscle contracts and the second muscle does not contract

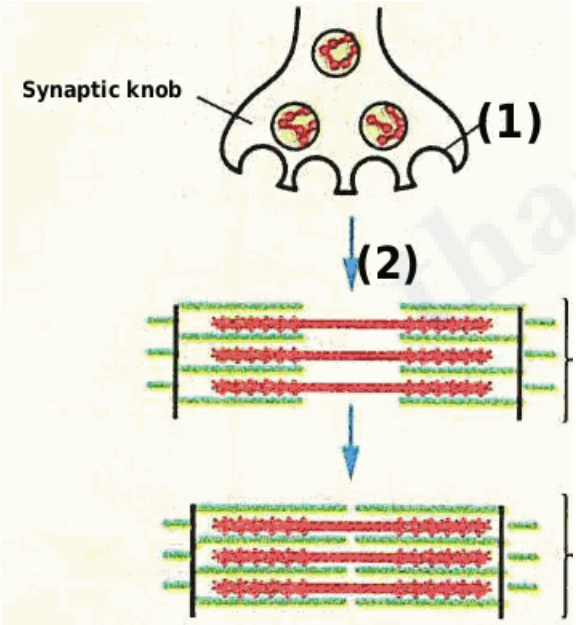
(B) The contraction of the first muscle is twice the contraction of the second muscle

(C) The contraction of the second muscle is twice the contraction of the first muscle

(D) The two muscles contract to the same degree

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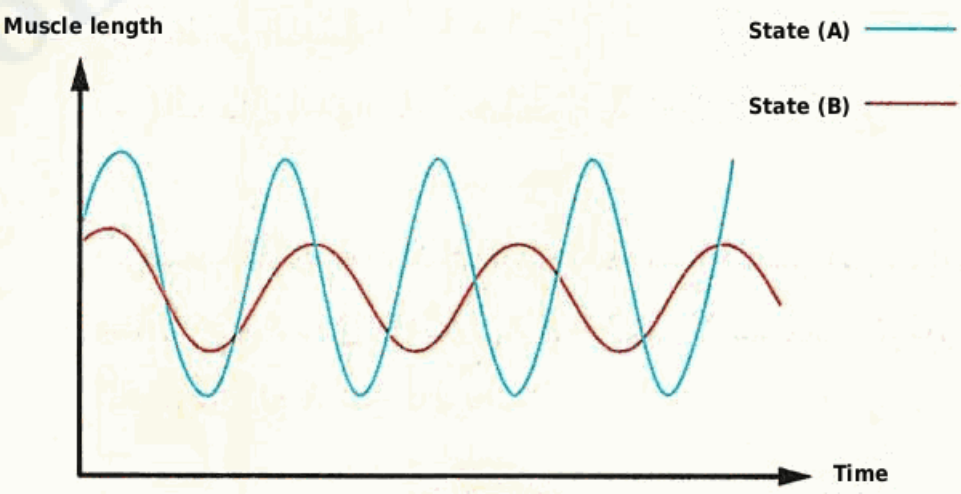
27 The opposite figure represents a neuromuscular junction. Which number / numbers refer to the role of calcium ions in this figure? (Trial exam / June 2021)



(A) (1), (4) (B) (3), (4) (C) (1) only (D) (4) only

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28 Study the opposite graph, which shows the change in the length of the gastrocnemius (twin) muscle during walking for the same person, where (A) and (B) are two different states of this muscle. What can be expected about the distance the person will cover in each state? (Trial exam / June 2021)



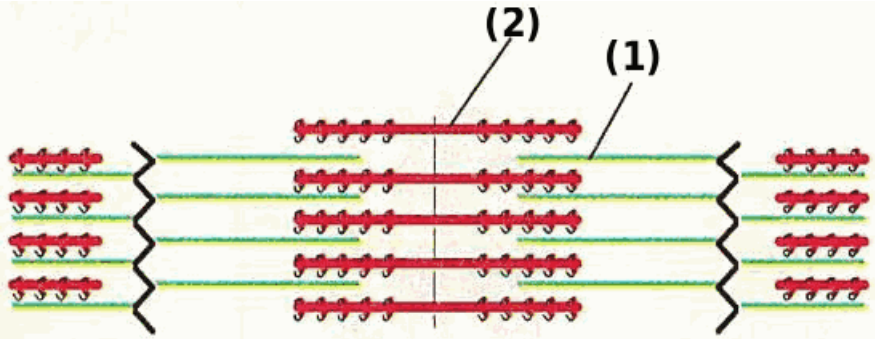
(A) The distance in state (A) is less than in state (B)

(B) The distance in state (A) is greater than in state (B)

(C) The distances in states (A) and (B) are equal

(D) There is no relation between the change in muscle length and the distance covered

29 The opposite figure shows the structure of a sarcomere in a skeletal muscle. What is the similarity between structures (1) and (2)? (1st session 2021)



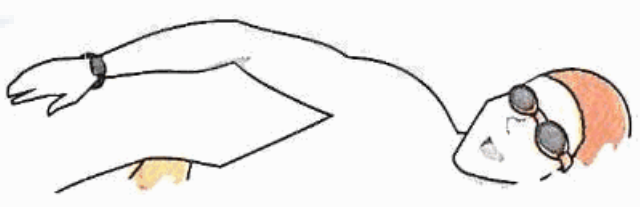
(A) Their ability to move during contraction and relaxation

(B) Their presence in all types of muscles

(C) They are made of the same building unit

(D) Their ability to form cross bridges

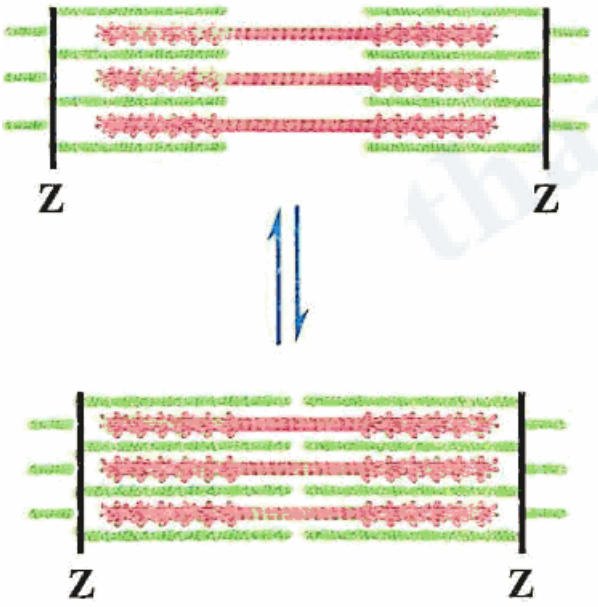
30 The picture in front of you shows the integration of all the body muscles when performing this type of physical activity. Which muscles need the most energy to complete this activity? (1st session 2021)



(A) The trunk and foot muscles
(B) The intercostal muscles
(C) The arm and shoulder muscles
(D) The neck muscles

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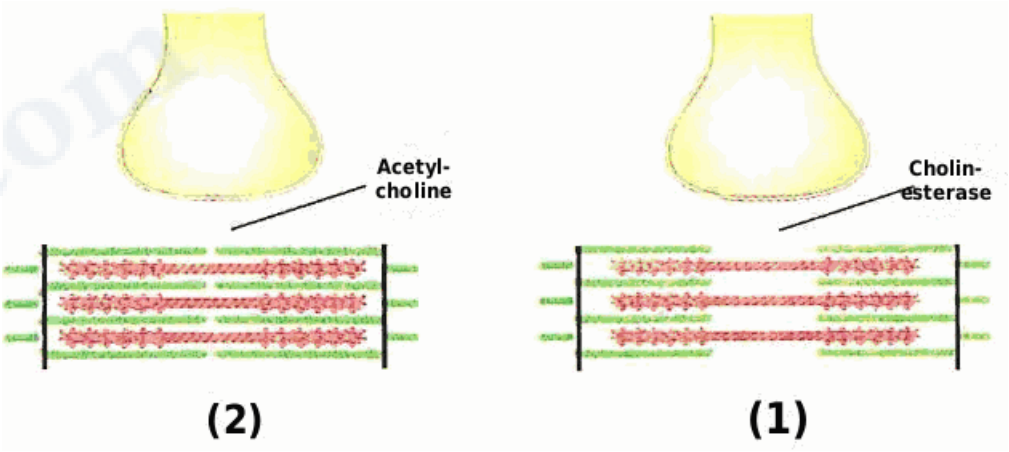
31 The two opposite figures show the state of a sarcomere during its usual activity. What is the scientific explanation for the loss of control over the direction of movement of the joint whose movement is controlled by the muscle this sarcomere is part of? (2nd session 2021)



(A) A torn ligament
(B) A torn tendon
(C) A muscle cramp
(D) Muscle fatigue

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32 Study the figure in front of you, then answer: what is the similarity between (1) and (2)? (2nd session 2022)



(A) The distance between the actin filaments

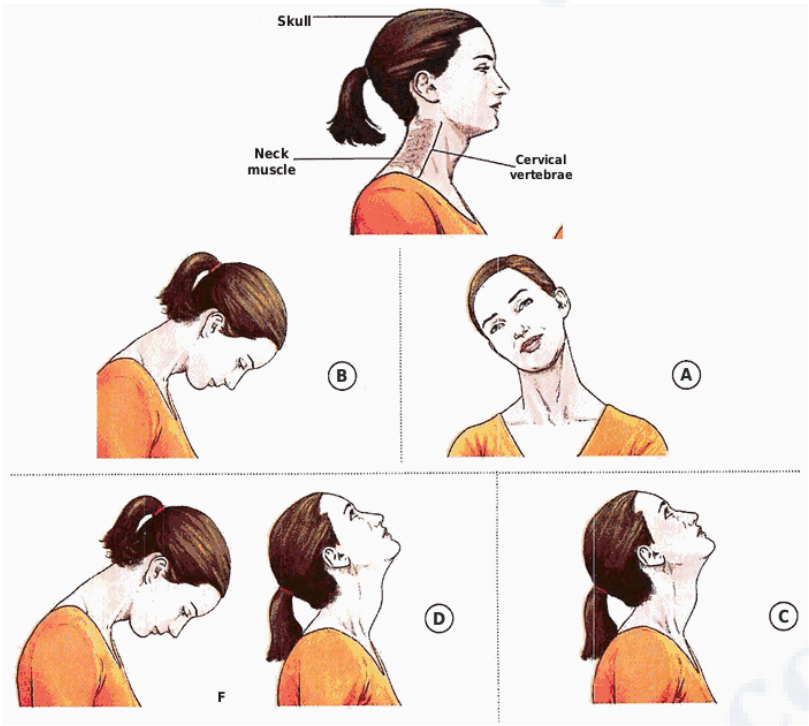
(B) The length of the myosin filaments

(C) The length of the muscle fiber

(D) The connection of the cross bridges to the actin filaments

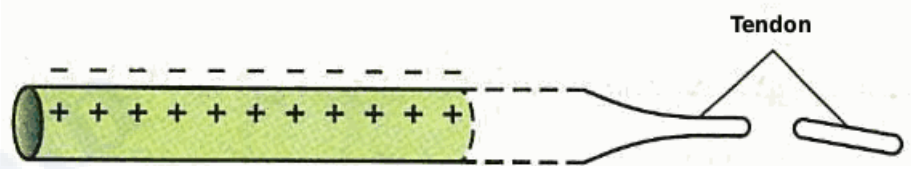
---

33 The drawing in front of you shows the normal position of the head. What happens if acetylcholine is not broken down in the muscle shown in the drawing? (2nd session 2022)



---

34 The opposite figure shows a muscle fiber. What does the figure indicate? (Trial exam 2023)



(A) Contraction without movement at the joint

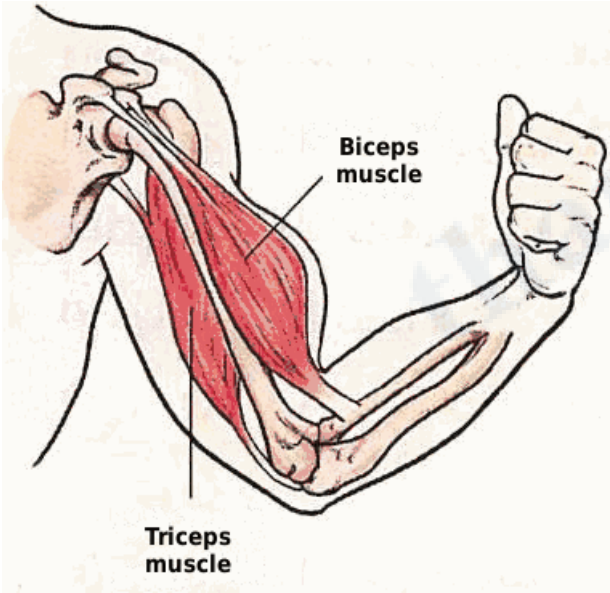
(B) Relaxation without movement at the joint

(C) Contraction with normal movement at the joint

(D) A polarized state without movement at the joint

---

35 Study the figure in front of you, then deduce which of the following muscle cell membranes shown in the figure has a lower permeability to sodium ions. (2nd session 2023)



(A) Both muscles

(B) The biceps muscle

(C) The triceps muscle

(D) The muscle that has a cramp

---

36 Which of the following substances is always present at the neuromuscular junction? (1st session 2024)

(A) Cholinesterase and acetylcholine

(B) Calcium ions and cholinesterase

(C) Calcium ions and calcium pumps

(D) Neurotransmitters and their receptors

---

37 Which of the following muscles needs a nerve impulse in order to contract? (2nd session 2024)

(A) All types of muscles
(B) The muscles of the artery wall
(C) The muscles of the heart wall
(D) The neck muscles

---

38 Which of the following stimuli increases the permeability of the sarcolemma to sodium ions? (2nd session 2025)

(A) The chemical neurotransmitter
(B) Cholinesterase
(C) Calcium ions
(D) The nerve impulse

---

39 Where do calcium ions act inside the muscle fiber during muscle contraction? (2nd session 2025)

(A) At the myosin filaments in the light band
(B) At the actin filaments in the light band
(C) At the myosin filaments in the semi-light zone
(D) At the actin filaments in the dark band

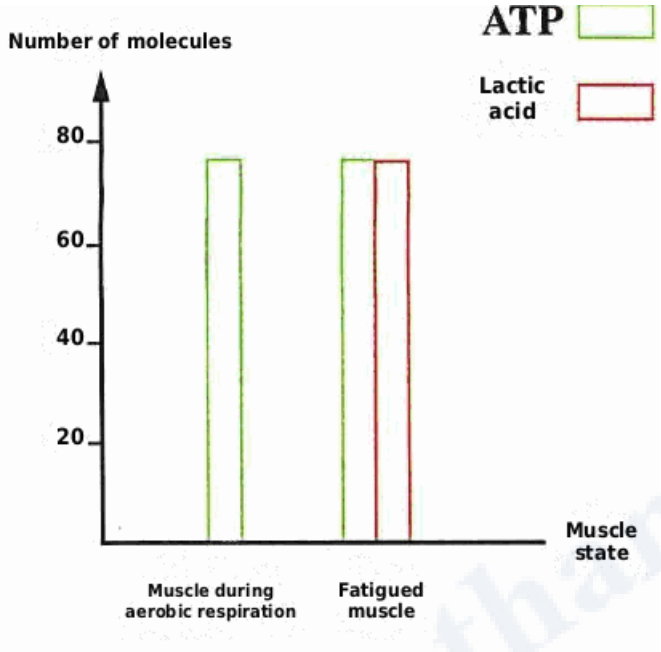
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40 Which of the following can the sarcomere include? (Sample exam 2026)

(A) 2 actin regions / 2 regions of actin and myosin together / one myosin region (at full contraction)
(B) 2 actin regions / one region of actin and myosin together / 2 myosin regions (at full contraction)
(C) 2 actin regions / 2 regions of actin and myosin together / 2 myosin regions (at rest)
(D) 2 actin regions / 2 regions of actin and myosin together / one myosin region (at rest)

---

41 In aerobic respiration of the skeletal muscle, the energy produced from breaking down one glucose molecule is only 38 ATP molecules, while in fermentation one glucose molecule produces two ATP molecules and two lactic acid molecules. The opposite graph shows the amount of ATP and lactic acid produced during the activity of a skeletal muscle. What is the ratio between the amount of glucose the muscle consumes during its normal activity and the amount it consumes during fatigue, respectively? (Trial exam / May 2021)



(A) 1 : 12 (B) 1 : 2 (C) 1 : 19 (D) 19 : 1

42 Which of the following indicates that a skeletal muscle is fatigued? (Trial exam / June 2021)

(A) A decrease in the consumption of the blood glucose that feeds the muscle

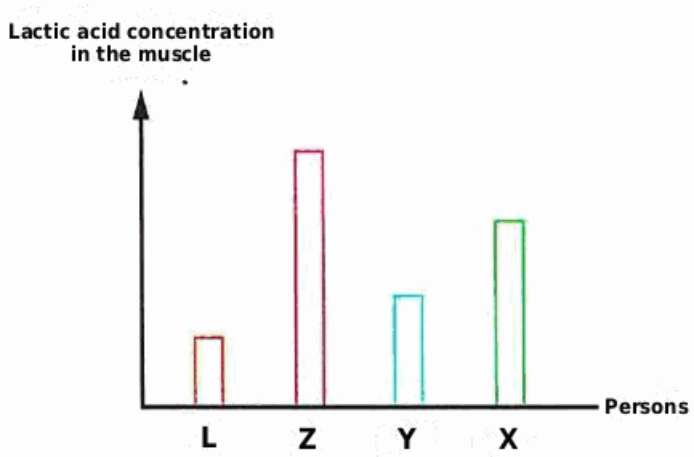
(B) Fast oxidation of the lactic acid accumulated in the muscle

(C) Fast consumption of the glycogen stored in the muscle

(D) An increase in the amount of ATP molecules inside the muscle

43 The opposite graph shows the concentration of lactic acid formed in the body muscles of four persons:

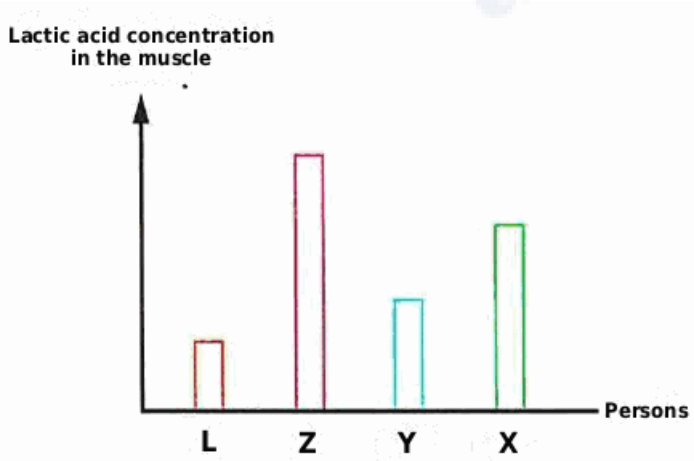
(1) If the four persons raced several times up the stairs of a five-floor building, which person did not do the necessary regular exercise before the race? (1st session 2021)



(A) X (B) Y (C) Z (D) L

44 The opposite graph shows the concentration of lactic acid formed in the body muscles of four persons:

(2) Which person consumes the least amount of glycogen? (2nd session 2021)



(A) X (B) Y (C) Z (D) L

45 (RICE) is a term made of abbreviations meaning (Rest - Ice - Compression - Elevation), which are ways of treating muscle fatigue. What is the effect of rest on fatigued muscles? (1st session 2022)

(A) A decrease in the level of glycogen in the muscles

(B) An increase in the level of acetylcholine

(C) An increase in the level of cholinesterase

(D) A decrease in the level of lactic acid in the muscle

---

46 A person felt fatigue in the gastrocnemius (twin) muscle even though he was sitting and not moving for a long time. What is the scientific explanation for this case? (2nd session 2022)

(A) Narrowing of the artery that supplies this muscle

(B) A decrease in acetylcholine

(C) A decrease in calcium in the muscle

(D) The absence of the cholinesterase enzyme

---

47 Which of the following describes the changes that can happen in the arm muscle of a person carrying a heavy bag and climbing the stairs? (Trial exam 2023)

(A) An increase in the amount of ATP molecules in the muscle cells

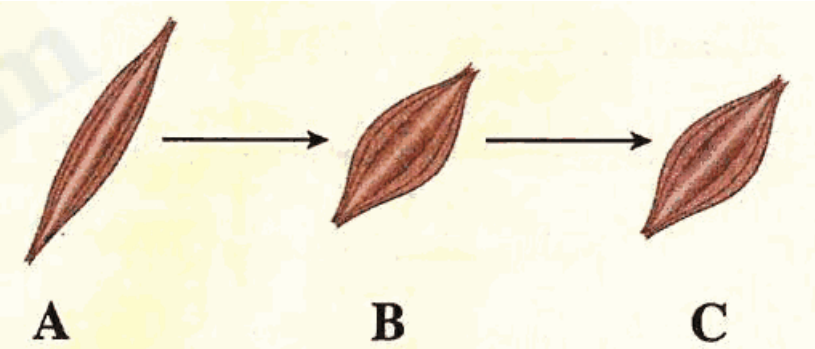
(B) A decrease in the amount of glycogen stored in the muscle cells

(C) A decrease in the calcium ions needed for the cross bridges to work

(D) A decrease in the amount of the chemical neurotransmitter

---

48 In front of you are three pictures of a muscle during an activity. What is the cause of the muscle state not changing in the period from (B) to (C)? (Trial exam 2023)



(A) The separation of the cross bridges from the actin filaments

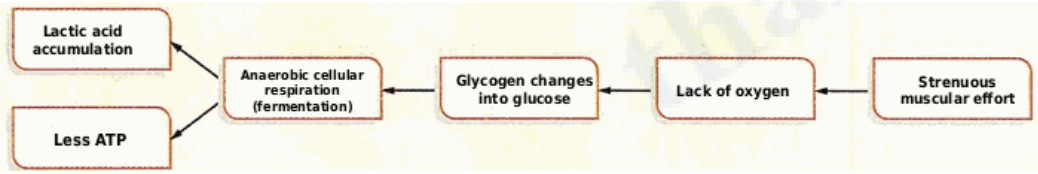
(B) The accumulation of lactic acid

(C) An increase in the production of ATP molecules

(D) Not enough O_2 reaching the muscle

---

49 Study the following diagram, then deduce: why is glycogen converted into glucose before anaerobic respiration starts? (1st session 2023)



(A) Because the oxidation of glucose does not need respiratory enzymes

(B) Because glucose releases more energy than glycogen when oxidized

(C) Because the consumption of glucose increases during anaerobic respiration

(D) Because glycogen cannot be oxidized in the absence of oxygen

---

50 What is the common cause of both muscle fatigue and muscle cramp? (2nd session 2023)

(A) Lack of oxygen

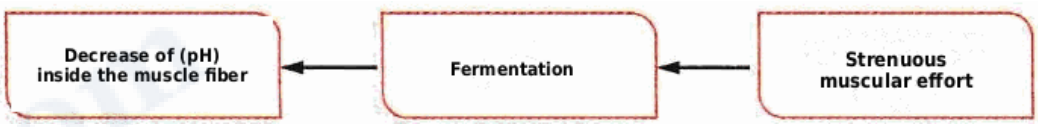
(B) Absence of ATP molecules

(C) Lack of glucose

(D) Absence of cholinesterase

---

51 Study the opposite diagram, then deduce: what is the result of the decrease in (pH) inside the muscle fiber? (1st session 2024)



(A) Inhibition of the neurotransmitter receptors
(B) An increase in the permeability of the muscle fiber membrane to sodium
(C) A decrease in the activity of the respiratory enzymes
(D) The cholinesterase enzyme is not secreted

---

52 Which of the following is a way to relieve muscle fatigue? (2nd session 2024)

(A) Nerve impulses reaching the muscle
(B) Increasing the conversion of glycogen into glucose
(C) Increasing the blood supply to the muscle
(D) Increasing the glucose supply to the muscle

---

53 What is the cause of a construction worker feeling pain in the muscles of the hand? (Sample exam 2025)

(A) The conversion of glycogen molecules into glucose
(B) An increase in the rate of anaerobic respiration in the muscles
(C) Plenty of ATP molecules produced by aerobic respiration
(D) A lack of ATP molecules produced by aerobic respiration

Answer key and solutions

Multiple choice questions

1 D	2 C	3 C	4 C	5 D	6 C	7 A	8 B	9 C	10 B
11 D	12 B	13 D	14 A	15 B	16 C	17 C	18 C	19 B	20 B
21 A	22 B	23 D	24 D	25 A	26 C	27 D	28 B	29 C	30 A
31 C	32 A	33 D	34 B	35 B	36 B	37 A	38 B	39 B	40 D
41 B	42 D	43 C	44 B	45 A	46 C	47 C	48 B	49 B	50 A
51 C	52 C	53 B	54 B	55 D	56 C	57 B	58 B	59 D	60 C
61 A	62 A	63 D	64 B	65 B	66 D	67 A	68 B	69 C	70 B
71 A	72 C								

1 **Answer (D)**

Cytoplasmic streaming (the movement of the cytoplasm) goes on in all living cells.

It is a continuous movement.

2 **Answer (C)**

The movement of body parts is local, and the movement of the cytoplasm in their cells is continuous.

The rider does not move by himself, so his movement is not locomotion.

3 **Answer (C)**

Closing the leaf on the insect is a local movement.

The movement of the cytoplasm in its cells is continuous.

4 **Answer (C)**

The movement of the cytoplasm is continuous, and the movement of the flagellum is local.

The movement of the organism in water from place to place is locomotion.

5 **Answer (D)**

Pulling by roots occurs in plants that have bulbs and corms.

The pea plant does not have this type.

6 **Answer (C)**

Pulling movement by roots occurs in plants that have contractile (pulling) roots.

Mimosa does not have this movement.

7 **Answer (A)**

Tropism (the bending of the plant towards a stimulus) occurs in all plants.

8 **Answer (B)**

The movement of the cytoplasm is continuous and self-induced; it does not need an external stimulus.

Tropism depends on an external stimulus, and the response to touch is local.

9 **Answer (C)**

The rotational movement of the cytoplasm is in one direction inside the cell.

So statement (C) is not correct.

10 **Answer (B)**

The rotational movement occurs in living cells only.

Cell (B) has a thick wall and is dead (sclerenchyma).

11 **Answer (D)**

Tendril (3) is coiled around the support and wall-thickened, so it has more supporting tissues.

Tendril (2) is new and is still not wall-thickened.

12 **Answer (B)**

The chloroplasts are carried with the cytoplasm as it moves.

So their movement is a result of the movement of the cytoplasm.

13 **Answer (D)**

The higher the light intensity, the shorter the bars in the graph.

So the time needed for the leaflets to return decreases.

14 **Answer (A)**

Rain is a touch stimulus that closes the leaflets again.

So the time needed for them to return to their normal position increases.

15 **Answer (B)**

The root hitting a hard object is touch.

So the movement is a response to touch.

16 **Answer (C)**

The slow movement that depends on auxins is the pulling movement by tendrils.

The movement of Mimosa is fast and does not depend on auxins.

17 **Answer (C)**

One muscle fiber contains 1000 to 2000 myofibrils.

So five fibers contain 5000 to 10000 myofibrils.

18 **Answer (C)**

(1) extends along the length of the myosin filaments, so it is a dark band (A).

19 **Answer (B)**

(2) is in the middle of the dark band, so it is the semi-light zone (H).

It contains myosin filaments only.

20 **Answer (B)**

The sarcomere is the distance between two successive (Z) lines.

There are 3 (Z) lines, so there are two sarcomeres.

21 **Answer (A)**

The light bands (I) around the three (Z) lines = 3.

The number of semi-light zones (H) = 3 as well.

22 **Answer (B)**

The structural unit of the skeletal muscle is the muscle fiber (the cell).

The myofibril is part of the fiber.

23 **Answer (D)**

The order from the largest diameter: the muscle, the bundle (3), the fiber (4), the myofibril (1).

Then the myosin filaments (5) and the actin filaments (2).

24 **Answer (D)**

Myosin filaments are thicker than actin filaments.

So myosin is (5) and actin is (2).

25 **Answer (A)**

The myofibril (1) is larger than the filaments (5) and (2) and smaller than the fiber (4).

26 **Answer (C)**

The bundle (3) is surrounded by a connective membrane.

The fiber (4) is surrounded by the sarcolemma.

27 **Answer (D)**

(X) is the tendon of the muscle, and it is made of connective tissue.

28 **Answer (B)**

The sarcolemma is the membrane of the muscle fiber (3).

The bundle (2) and the muscle (1) are surrounded by connective tissue.

29 **Answer (C)**

Each sarcomere has one semi-light zone (H).

5 (H) zones mean 5 sarcomeres.

30 **Answer (A)**

Each sarcomere has one (A) band, so the number of sarcomeres = X.

The number of (Z) lines = the number of sarcomeres + 1.

31 **Answer (C)**

Tendons connect the skeletal muscles to the bones.

Cardiac and smooth muscles are not attached to bones.

32 **Answer (A)**

Figure (1) shows both types of filaments: thick myosin and thin actin.

This is the structure of the dark band (A).

33 **Answer (D)**

Figure (2) has thin filaments only, so it is a light band (I).

The thin filaments are actin (X).

34 **Answer (B)**

The sarcomere is the distance between two (Z) lines.

Between 4 complete light bands there are 3 sarcomeres.

35 **Answer (B)**

The nervous system controls the work of the muscles.

36 **Answer (B)**

Without acetylcholine the potential difference does not change.

So the charge of the inner surface of the membrane stays negative (polarization).

37 **Answer (A)**

When the impulse arrives, calcium enters the muscle fiber, so its amount increases.

Glucose, glycogen and ATP decrease or are converted.

38 **Answer (B)**

ATP is the energy source of contraction, and the muscles are what do the work when bending the arm.

39 **Answer (B)**

Only stimulus (Y) caused a large change in the potential difference, that is, a full impulse.

It is followed by the sliding of the actin filaments.

40 **Answer (D)**

First (4): calcium enters the nerve endings.

Then (3) acetylcholine is released, then (1) sodium enters, then (2) depolarization.

41 **Answer (B)**

The muscle responds only to strong stimuli and ignores weak ones.

Stimuli 2 and 3 give two responses, and there is no response to stimuli 1 and 4.

42 **Answer (D)**

The muscles contract and pull the tendons, and the tendons move the bones.

The ligaments hold the joint in place at the end.

43 **Answer (C)**

The entry of sodium changes the potential difference across the membrane (depolarization).

Without it no muscle contraction occurs.

44 **Answer (B)**

In polarization, sodium accumulates outside the membrane.

So the outer surface is positive and the inner surface is negative.

45 **Answer (A)**

On relaxation the (Z) lines move away from each other.

The light band (I) and the semi-light zone (H) increase, and the length of (A) does not change.

46 **Answer (C)**

The sarcomere is the distance between two successive (Z) lines, not between two dark bands.

47 **Answer (C)**

Returning to polarization means the end of contraction.

The cross bridges separate from the actin filaments.

48 **Answer (B)**

Contraction needs ATP molecules to move the cross bridges,

and calcium ions, which uncover the binding sites on actin.

49 **Answer (B)**

The (Z) lines moving closer means contraction, which is region (Z), the stage in which the force of contraction increases.

50 **Answer (A)**

Polarization is the resting state before the nerve impulse (L) and after relaxation ends (X).

51 **Answer (C)**

The entry of sodium changes the potential difference just before the contraction, so it is region (Z).

52 **Answer (C)**

The response starts when the neurotransmitter binds to the receptors of the muscle fiber.

Narcotic substances slow the response by acting on these receptors.

53 **Answer (B)**

The mineral ions are the calcium entering (3) and the sodium entering (4).

54 **Answer (B)**

(2) is the neurotransmitter (acetylcholine).

(1) is the enzyme that breaks it down (cholinesterase).

55 **Answer (D)**

A muscle cramp is a continuous contraction of muscle (X).

Its contraction moves the foot downwards as in (3), and the pull shows at the tendon as in (1).

56 **Answer (C)**

The Na+ concentration rises for a moment and then returns to its level, so the nerve impulse arrives normally.

The force of contraction stays high and the muscle does not relax: this cramp is caused by fatigue.

57 **Answer (B)**

Curve (A), the nerve impulse, comes before curve (B), the contraction.

No contraction occurs unless a nerve impulse is generated.

58 **Answer (B)**

Calcium enters when the impulse (A) reaches the nerve endings,

and its role ends at the start of contraction (B), that is, between the two curves.

59 **Answer (D)**

The toxic substance blocks the neurotransmitter receptors, so the neurotransmitter cannot bind to them.

So the permeability of the membrane is not affected and the muscles will not contract.

60 **Answer (C)**

During contraction and relaxation, ATP molecules are broken down into ADP and free phosphate groups.

Their highest number is directly after contraction and relaxation.

61 **Answer (A)**

The increased permeability of the fiber membrane to positive sodium ions changes the electrical state of the membrane.

So the muscle contracts.

62 **Answer (A)**

Muscle (Y) is contracted and muscle (X) is relaxed.

The dark band (A) does not change in length in the two states.

63 **Answer (D)**

Muscle relaxation needs the cholinesterase enzyme, which breaks down acetylcholine, and ATP molecules to separate the cross bridges.

64 **Answer (B)**

The contracted muscle (Y) has a negative outer surface.

The relaxed muscle (X) has a positive outer surface.

65 **Answer (B)**

When the impulse arrives, calcium ions enter the nerve endings,

so they release the neurotransmitters, which reach the muscle fiber membrane.

66 **Answer (D)**

At rest and in light exercise, the source is blood glucose by aerobic respiration.

In strenuous exercise, it is muscle glycogen by anaerobic respiration.

67 **Answer (A)**

At rest the blood flow to the digestive system is 1400, and during exercise it is 600.

So its glucose consumption is greater at rest.

68 **Answer (B)**

In muscle fatigue, lactic acid is formed inside the fibers,

and acetic acid is formed outside them after acetylcholine is broken down.

69 **Answer (C)**

ATP in the muscle is 40%, which is less than the normal level.

The lack of ATP prevents the cross bridges from separating from actin.

70 **Answer (B)**

Fiber (B) has more mitochondria, so it produces more energy and is more active.

(A) is in the finger muscles and (B) is in the gastrocnemius muscle.

71 **Answer (A)**

The lactic acid concentration in (A) rose quickly in a short time.

This is a sign of fatigue in someone not used to running.

72 **Answer (C)**

Fatigue happens because too little oxygen reaches the muscle.

So the consumption of glucose in anaerobic respiration increases.

Essay questions

1 **Model answer**

(1) Tropism movement, pulling movement, rotational cytoplasmic movement.

(2) If structure (1), "the contractile (pulling) roots", is absent, the bulb (the narcissus bulb) will not go down to its normal suitable level in the soil. This affects its aerial parts, which are affected by the wind, so it is easily uprooted.

2 **Model answer**

The cause of the change from (X) to (Y) is the movement of the plant leaflets (closing together) in response to touch.

3 **Model answer**

Period (B) represents the sleep period, in which the leaflets close together for a long time when darkness falls (from 6 p.m. to 7 a.m.).

Period (C) represents a waking period, in which the leaflets spread apart.

Periods (A) and (E) represent periods of touching the plant leaflets, so the leaflets close together for a short time, because the closing happened during the day.

4 **Model answer**

Y / where (L) represents the muscle, (Z) the muscle bundle, (Y) the muscle fiber (cell) and (X) the myofibril. The muscle fiber (cell) contains the living matter (protoplasm), which includes the cytoplasm that contains the cell organelles, among them the mitochondria.

5 **Model answer**

When complete muscle contraction occurs in the myofibril shown in the figure:

Number of sarcomeres = 8, number of dark bands (A) = 8, number of semi-light zones (H) = zero

6 **Model answer**

(X) light band (I), (Y) semi-light zone (H), (Z) dark band (A).

7 **Model answer**

(1) Stage (X).

(2) Stage (M).

8 **Model answer**

(1) The muscle is relaxed / because the actin filaments are far apart, the light band I (1) is longer and the semi-light zone H (5) is longer, that is, the muscle is in its normal state.

(2) When the muscle contracts: number (1) "the light band": its length decreases; number (2) "the dark band": its length does not change; number (3) "the actin filaments": they move closer to each other; number (4) "the myosin filaments": cross bridges arise from them; number (5) "the semi-light zone": its length decreases or disappears depending on the force of contraction.

(3) Cross bridges extend from the myosin filaments to connect with the actin filaments. This connection takes place with the help of calcium ions and ATP molecules: the cross bridges act as hooks that, using the energy stored in ATP molecules, pull the neighbouring groups of actin filaments towards each other, so the muscle contracts. The muscle relaxes when the cross bridges separate from the actin filaments, using part of the energy stored in ATP molecules.

9 **Model answer**

(1) 3 nerve stimuli / (Y), (Z), (M).

(2) The stages: (1) → (2), (3) → (4), (5) → (6).

(3) The stages: (2) → (3), (4) → (5), (6) → (7).

10 **Model answer**

(1) Process (1) is the contraction of the muscle fiber (contraction of the muscle): the cross bridges act as hooks that pull the neighbouring groups of actin filaments towards each other with the help of the energy stored in ATP molecules, so the muscle fiber contracts.

Process (2) is the relaxation of the muscle fiber (relaxation of the muscle): the muscle uses part of the energy stored in ATP molecules to separate the cross bridges from the actin filaments, so the muscle fiber returns to its normal position.

(2) Lack of calcium ions, lack of neurotransmitters such as acetylcholine, lack of sodium ions, lack of ATP molecules.

(3) The presence of the cholinesterase enzyme and of ATP molecules.

11 **Model answer**

(1) Figure (B), "the vertebral column", protects the spinal cord.

(2) (1) body of the vertebra, (2) cartilage, (3) spinous process, (4) upper articular process.

(3) The heel bone / The heel bone is connected to the gastrocnemius muscle by the Achilles tendon.

(4) Damage to structure (5), "the motor nerve", makes the gastrocnemius muscle unable to contract or relax, so the person cannot raise the heel of the foot, because the nerve impulses that stimulate the contraction of the gastrocnemius muscle do not arrive.

12 **Model answer**

The number of myofibrils in a muscle fiber ranges from 1000 to 2000 myofibrils, so the average number of myofibrils in a muscle fiber = 1500 myofibrils.

The average number of myofibrils in a muscle bundle that contains 400 fibers = number of muscle fibers × 1500 = 400 × 1500 = 600000 myofibrils.

13 **Model answer**

Muscle (1): a muscle cramp (the muscle stays in continuous contraction without returning to the resting position). This may be caused by a decrease in ATP molecules, or by the lack of the cholinesterase enzyme at the (neuromuscular) junctions.

Muscle (2): muscle fatigue (the muscle takes longer than normal to contract and relax). This is caused by the accumulation of lactic acid produced by the oxidation of glucose by fermentation (anaerobic respiration).

Past exam questions

1	2	3	4	5	6	7	8	9	10
B	C	A	C	A	A	C	B	A	C
11	12	13	14	15	16	17	18	19	20
B	C	C	A	C	C	C	D	C	B
21	22	23	24	25	26	27	28	29	30
B	C	B	D	B	D	A	B	C	C
31	32	33	34	35	36	37	38	39	40
A	B	C	A	D	C	B	A	A	D
41	42	43	44	45	46	47	48	49	50
C	C	C	D	D	A	B	D	C	A
51	52	53							
C	C	B							

1 **Answer (B)**

After touching the support, the growth of the side touching it decreases and the growth of the other side increases, so the tendril coils around the support.

2 **Answer (C)**

The growth rates of the two sides are equal and decreasing, so there is no difference in growth to cause coiling, that is, the tendril did not find a suitable support.

3 **Answer (A)**

The tendril coiling around the support raises the plant upwards, so it is exposed to sunlight and photosynthesis takes place efficiently.

4 **Answer (C)**

The tendrils coil around supports (such as a metal rod), and the leaflets perform the sleep movement in response to light and darkness.

5 **Answer (A)**

The movement inside the cells (rotational cytoplasmic movement) transports nutrients, and the contractile roots pull the bulbs down to fix them and support the stems and leaves.

6 **Answer (A)**

The cells of bean leaves contain chloroplasts, and their movement is evidence of the rotational movement of the cytoplasm.

7 **Answer (C)**

Cytoplasmic streaming is a continuous internal activity inside the cells.

8 **Answer (B)**

Tropism is the response of plant parts to light, moisture and gravity.

9 **Answer (A)**

The pulling movement in pea (tendrils) and in corms (contractile roots) both provide protection and support for the plant.

10 **Answer (C)**

Not all living organisms perform locomotion; plants, for example, do not move from their place.

11 **Answer (B)**

The movement of the chloroplasts is evidence of the rotational movement of the cytoplasm, not of local movement.

12 **Answer (C)**

The movement of the diaphragm and the ribs is a movement of body parts without moving the body, so it is a local movement.

13 **Answer (C)**

The sleep movement occurs in the leaves of the Mimosa plant and some leguminous plants.

14 **Answer (A)**

Skeletal muscles move the skeleton, such as moving the arm; the heart is cardiac muscle, and the uterus and stomach are smooth muscles.

15 **Answer (C)**

Structure (1) is a muscle fiber (cell) that contains more than one nucleus.

16 **Answer (C)**

The Z lines lie in the middle of the light bands; the figure has 5 Z lines, so 5 light bands appear.

17 **Answer (C)**

The nuclei of skeletal muscle fibers are found near the sarcolemma (the membrane of the fiber).

18 **Answer (D)**

The order from the largest: the muscle (X), then the bundle (Y), then the fiber (Z), then the myofibril (L), then the sarcomere (M).

19 **Answer (C)**

The cross bridges extend from myosin and connect to actin in the overlap region, so they are not found in the light band (actin only) or in the semi-light zone (myosin only).

20 **Answer (B)**

The cross bridges extending from myosin bind to the actin filaments.

21 **Answer (B)**

The figure shows actin and myosin overlapping, which is found in the dark band A.

22 **Answer (C)**

(X) surrounds a group of muscle fibers, so it is the membrane of the muscle bundle.

23 **Answer (B)**

The semi-light zone H contains myosin filaments only.

24 **Answer (D)**

The nervous system coordinates the antagonistic muscles when the joint moves.

25 **Answer (B)**

Changing the body position automatically when balance is lost depends on a neuromuscular reflex.

26 **Answer (D)**

According to the all-or-none law, as long as both stimuli are enough, each muscle contracts with its maximum force, so the contraction is the same.

27 **Answer (A)**

Calcium ions help release the neurotransmitters from the nerve terminal (knob) (1) and help the cross bridges connect to actin during contraction (4).

28 **Answer (B)**

In state (A) the length of the muscle changes over a larger range and more times, so the person covers a greater distance.

29 **Answer (C)**

Actin and myosin filaments are both proteins made of the same building unit (amino acids).

30 **Answer (C)**

In swimming, movement depends mainly on the arm and shoulder muscles, so they need more energy.

31 **Answer (A)**

The sarcomere contracts and relaxes normally, so the loss of control over the direction of joint movement is caused by torn ligaments, which determine the direction of movement.

32 **Answer (B)**

In both states (contraction and relaxation) the length of the myosin filaments (the dark band) does not change.

33 **Answer (C)**

If acetylcholine is not broken down, the neck (nuchal) muscle stays continuously contracted and pulls the head backwards.

34 **Answer (A)**

The positive charges are on the outer surface of the membrane (polarization), and the tendon is not attached to the bone, so no movement occurs at the joint.

35 **Answer (D)**

36 **Answer (C)**

37 **Answer (B)**

38 **Answer (A)**

The chemical neurotransmitter (acetylcholine) increases the permeability of the sarcolemma to sodium ions.

39 **Answer (A)**

40 **Answer (D)**

At rest the sarcomere includes: two halves of a light band (actin) at its two ends, two regions where actin and myosin overlap, and one semi-light zone (myosin).

41 **Answer (C)**

Normal activity: ATP = 76 from aerobic respiration, so glucose = 76 ÷ 38 = 2 molecules.
Fatigue: lactic acid = 76, so glucose = 76 ÷ 2 = 38 molecules.
The ratio: normal activity 1, fatigue 19

42 **Answer (C)**

In fatigue the muscle quickly consumes the stored glycogen to produce energy by fermentation.

43 **Answer (C)**

Person (Z) has the highest concentration of lactic acid, so he is the least trained.

44 **Answer (D)**

Person (L) has the lowest concentration of lactic acid, so he consumes the least glycogen by fermentation.

45 **Answer (D)**

Rest allows oxygen to arrive and oxidize the lactic acid, so its level in the muscle decreases.

46 **Answer (A)**

Narrowing of the artery that supplies the muscle reduces the oxygen reaching it, so lactic acid accumulates even without movement.

47 **Answer (B)**

Strenuous effort increases the consumption of the glycogen stored in the muscle cells, so its amount decreases.

48 **Answer (D)**

The muscle does not return to its state because not enough oxygen reaches it, so lactic acid accumulates (fatigue).

49 **Answer (C)**

The model answer: the consumption of glucose increases during anaerobic respiration, so the stored glycogen is converted into glucose.

50 **Answer (A)**

Lack of oxygen is a common cause of muscle fatigue (accumulation of lactic acid) and muscle cramp.

51 **Answer (C)**

A decrease in pH (increased acidity) reduces the activity of enzymes, including the respiratory enzymes.

52 **Answer (C)**

Increasing the blood supply to the muscle provides the oxygen needed to oxidize the lactic acid.

53 **Answer (B)**

Continuous effort increases anaerobic respiration, so lactic acid accumulates and causes pain.