A-Level Biology

Muscle Contraction

Mark Scheme

Time available: 82 minutes
Marks available: 52 marks

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1.

(a) 1. Light/I band only actin;

2. H zone/band only myosin;

3. Darkest/overlapping region actin **and** myosin;

Accept any suitable descriptions that distinguishes these regions e.g. 'white band' for 1, 'light grey' for 2 and 'dark grey' for 3.

Ignore references to A band.

3

(b) 1. Use (distilled) water and creatinine solution to produce dilutions (series);

Accept description of dilutions (series).

2. Addition of (creatinine-)detecting solution (to each solution);

The addition of a known/specific volume of (creatinine-)detecting solution = 2 marks.

3. Using a known/specified/constant volume of a solution (e.g. diluted creatinine solution);

The addition of a known/specific volume of (creatinine-)detecting solution = 2 marks.

4. Record absorbance/transmission of solution/s using a colorimeter;

Reject calorimeter. Ignore details provided on 'blank'.

Accept description of absorbance or transmission.

5. Plot dilution/concentration of (creatinine) solution against absorbance/transmission;

Accept absorption for 'absorbance'.

Accept description of absorbance or transmission.

4 max

(c) 1. Use same volumes of solutions as used in producing (calibration curve)

OR

Add (creatinine-)detecting solution (to urine);

Ignore 'add indicator' on its own.

Ignore calorimeter in this part of the question.

2. Read off (creatinine) concentration against absorbance/transmission (value) obtained;

Ignore 'line of best fit'.

Accept 'compare' for 'read off'.

2

[9]

2.

(a) C = M line / M disc / myosin filament

D = mitochondrion

E = myofibril

3

(b) Sarcomere

1

(c) Answer in range 1.14–1.18

1

(d) 1. As a store of glucose

Ignore provide energy

OR

To be hydrolysed to glucose;

2. For respiration / to provide ATP;

2

(e) 1. Low pH changes shape of calcium ion receptors

Do not accept tropomyosin does not move

2. Fewer calcium ions bind to tropomyosin;

Accept troponin

3. Fewer tropomyosin molecules move away;

4. Fewer binding sites on actin revealed;

5. Fewer cross-bridges can form

OR

Fewer myosin heads can bind

Must include idea of fewer at least once

3 max

[10]

3.

(a) 1. Calcium ions diffuse into myofibrils from (sarcoplasmic) reticulum;
2. (Calcium ions) cause movement of tropomyosin (on actin);
3. (This movement causes) exposure of the binding sites on the actin;
4. Myosin heads attach to binding sites on actin;
5. Hydrolysis of ATP (on myosin heads) causes myosin heads to bend;
6. (Bending) pulling actin molecules;
7. Attachment of a new ATP molecule to each myosin head causes myosin heads to detach (from actin sites).

5 max

(b) 1. Releases relatively small amount of energy / little energy lost as heat;

Key concept is that little danger of thermal death of cells

2. Releases energy instantaneously;

Key concept is that energy is readily available

3. Phosphorylates other compounds, making them more reactive;
4. Can be rapidly re-synthesised;
5. Is not lost from / does not leave cells.

2 max

[7]

4. (a)

Function	**Name**
Attaches to Z line at the end of the sarcomere	**1. Actin;**
Breaks down ATP	**2. ATPase / myosin (head);**
Covers binding site on actin in relaxed myofibril	**3. Tropomyosin;**

Accept water

Accept troponin

3

(b) 1. Can't form myosin / thick filaments;

Neutral: prevents actin and myosin sliding filament action

2. Can't pull / can't move actin / slide actin past / (myosin) have to be joined / fixed to pull actin;

Accept: myosin can't pull on each other

3. Myosin moves / if attached doesn't move;

4. Can't move actin towards each other / middle of sarcomere / between myosin / can't shorten sarcomere / can't pull Z lines together.

Accept: contract for shorten

3

[6]

5. (a) (i) (Group) 5 / marathon runners.

Must only include this group and no other.

1

(ii) 1. (5 / marathon runners) have highest percentage of slow fibres;

*Maximum of **1** mark if the wrong fibres have been identified.*

2. (Slow fibres) use aerobic respiration / aerobic respiration occurs in mitochondria;

Either approach requires identification of aerobic respiration.

3. (Slow fibres) best for endurance / long periods of exercise / to avoid fatigue.

2 max

(b) 1. No (overall) change in number of fibres;

Reject any suggestion of an increase in number of fibres.

2. Increase in diameter of fibres;

'Size' without qualification is insufficient.

3. (Due to) training / exercise;
4. (Long-distance) cyclists have more / higher percentage of slow fibres (than fast);

A comparison is required to meet this MP.

5. Slow fibres of wider diameter than fast fibres;
6. (Long-distance) cyclists have more mitochondria;
7. (Long-distance) cyclists have more capillaries (in muscles).

Idea of 'more' (than non-athletes) is required to gain credit.

Accept converse (for non-athletes) in MP4, MP6 and MP7.

3 max

(c) 1. Weightlifting favoured by / weightlifters have a high proportion of fast / low proportion of slow fibres
OR
Weightlifters have more fast / fewer slow fibres than non-athletes;
But (cannot tell because):

Reward for general statement or comparison with non-athletes.

For 'proportion', accept percentage (or idea of a ratio).

2. Do not know what 'weightlifters' (tested) were born with / had before started weightlifting / training
OR
Don't know if there has been a change (in proportion due to weightlifting / training);

3. No information about age / gender / number of weightlifters (in sample).

For this MP, accept another relevant factor that might affect 'weightlifter' e.g. weights lifted, sex, diet, ethnicity, country of birth.

Ignore general statements about 'other factors'.

2 max

[8]

6.

(a) 1. Fields of view randomly chosen;
2. Several fields of view;
3. All same <u>species</u> (of animal / hamster);

Reject general statements related to sample size. All mark points relate directly to information provided in Resource A.

Accept 'all (Mesocricetus) auratus'.

4. Same muscle / organ used / only diaphragm used;
5. Used at least 8 (animals) in each (age) group.

4 max

(b) (i) 15

Correct answer = 2 marks.

Allow 1 mark for showing

69 ÷ 4.6

OR

answer of 10 / 10.1 (correct calculation using fast in error.)

2

(ii) 1. (Calculation) used mean (number of capillaries);
2. Variation in number of capillaries per fibre.

*Note: maximum of **1** mark for this question.*

Ignore reference to an anomaly or calculation errors.

1 max

(c) (i) (Removing diaphragm means) animals / hamsters are killed.

1

(ii) 1. (Suggests) significant (difference) between young and adult;

MP1, MP2, MP4 and MP5 can include use of figures but check figures are used correctly.

2. (Suggests) not significant (difference) between adult and old;

Statements related to 'results being significant / not significant' do not meet the marking points. It is the difference that is significant or not. However, only penalise this error once.

3. For slow **and** fast fibres;

This MP can be given in the context of either MP1 or MP2 but only allow once. As well as this context there must be a reference to 'both' types of fibre.

4. (Suggests) significant (difference) between young and old for <u>fast</u> (fibres)
OR
(Suggests) not significant (difference) between young and old for <u>slow</u> (fibres);

All aspects of either approach required to gain credit.

5. (Suggests) significant (difference) where means ± SD do not overlap
OR
(Suggests) not significant (difference) where means ± SD overlap;

All aspects of either approach required to gain credit.

6. Stats test is required (to establish whether significant or not).

4 max

[12]