InkBiology

ANSWER BOOK

Sliding filaments: shortening a muscle without shortening anything

Nervous coordination, receptors, muscles and behaviour · Unit B14

AQA 3.6.3 · OCR A 5.1.5 · Edexcel A Topic 7.13–7.16 · CAIE 15.2

6 questions · 24 marks

NAVY EDITION

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SECTION B · Standard, 3 to 5 marks

B1 **B1** calcium ions bind to troponin, which changes shape. **B1** troponin pulls tropomyosin aside, exposing the myosin binding sites on the actin, which were covered before. **B1** a myosin head carrying ADP and phosphate attaches to an exposed binding site and forms a cross-bridge. **B1** the head bends in a power stroke, releasing the ADP and phosphate and pulling the thin filament about 10 nm towards the centre of the sarcomere. **A1** ATP binds to the head so that it detaches, and hydrolysis of that ATP returns it to its upright position to attach further along; heads work out of step so the filament is never released. [5]

B2 **B1** ATP binding to the myosin head causes it to detach from the actin at the end of a power stroke. **B1** hydrolysis of that ATP by the head's own ATPase activity returns the head to its upright position, ready to attach further along the thin filament. **B1** ATP is used to pump calcium ions back into the sarcoplasmic reticulum during relaxation, so tropomyosin can slide back over the binding sites. **A1** after death respiration stops and ATP runs out, so the heads cannot detach and calcium cannot be pumped back, and the cross-bridges stay formed until the proteins themselves break down. [4]

B3 **B1** slow twitch fibres contract more slowly but in a sustained way, whereas fast twitch fibres contract rapidly and powerfully for a short time. **B1** slow twitch fibres have many mitochondria and respire aerobically, whereas fast twitch fibres have few and rely on anaerobic glycolysis with a large glycogen store. **B1** slow twitch fibres have a dense capillary supply and much myoglobin, so oxygen is delivered and stored, whereas fast twitch fibres have a sparse supply and little myoglobin and are paler. **A1** slow twitch fibres therefore resist fatigue and dominate postural muscles and the calf muscles of distance runners, whereas fast twitch fibres accumulate lactate and tire quickly, and dominate the leg muscles of sprinters. [4]

B4 **M1** convert to the same unit: 3.0 cm is 30 000 micrometres. **M1** number of sarcomeres is the fibre length divided by the length of one sarcomere, so 30 000 ÷ 2.4. **A1** 12 500 sarcomeres in series. **A1** 12 500 × 2.0 = 25 000 micrometres, which is 2.5 cm. [4]

B5 **B1** the ATP already in the fibres lasts only about two seconds, so a muscle working for 40 seconds must be regenerating ATP throughout rather than running on a store of it. **B1** phosphocreatine in the sarcoplasm transfers its phosphate group directly to ADP to regenerate ATP anaerobically, but it is spent within about ten seconds. **B1** most of the rest of the effort is supplied by anaerobic glycolysis, because oxygen cannot be delivered fast enough for aerobic respiration to meet the demand. **A1** anaerobic glycolysis yields only two ATP per glucose and the lactate it produces accumulates, so what fails is the rate at which ATP can be resupplied rather than the quantity of ATP present. [4]

B6 **B1** the A band is unchanged. **B1** the I band gets shorter. **B1** the H zone gets shorter, and in a strong contraction it can disappear altogether. [3]