PEARSON EDEXCEL · INTERNATIONAL A-LEVEL · BIOLOGY • EXERCISE SHEET

5.2 Muscles and movement

Name: _____ Class: _____ Date: _____ **Total: 22 marks**

KEY WORDS tendon • ligament • myofibril • sarcomere • sliding filament

Objective

Practise statements 7.9-7.11: how muscles, tendons, ligaments and the skeleton interact, the structure of skeletal muscle fibres, and the sliding-filament theory of contraction.

1 Key knowledge and worked examples

■ Who joins what

Tendon : muscle to bone. **Ligament** : bone to bone, holding joints together. Muscles work in antagonistic pairs across joints – one contracts while its partner relaxes.

■ Inside a fibre

A skeletal muscle fibre is a fused cell with many nuclei, filled with **myofibrils** . Each myofibril is a repeating line of **sarcomeres** : actin (thin) filaments anchored at the Z-lines, myosin (thick) filaments between them with globular heads.

■ The sliding filament cycle

Action potential arrives, Ca2+ is released, calcium binds troponin, tropomyosin moves, actin's binding sites are exposed; the energised myosin head attaches to actin, its stored ADP + Pi released as it pulls (the power stroke); a fresh ATP binds the head and it detaches; ATP is split again to re-cock the head.

■ Worked example: naming what a poison does

A drug that blocks ATP binding to myosin heads: heads cannot detach, actin and myosin stay locked – the muscle stiffens (rigor). An answer that names the step blocked AND the observable outcome earns both marks.

2 Practice

2.1 State two structural differences between a tendon and a ligament's job. [2]

2.2 Name the two protein filaments of a myofibril. [2]

2.3 Describe the role of calcium ions in muscle contraction. [2]

3 Exam-style questions

3.1 Describe the sliding filament mechanism of muscle contraction from the arrival of an action potential at a muscle fibre to the relaxation of the fibre. [6]

3.2 Slow-twitch and fast-twitch fibres differ in mitochondria and blood supply. Compare the two fibre types for endurance and power events, explaining how each structural difference supports its role. [5]

3.3 A weightlifter holds a heavy bar still at arm's length. Both the biceps and triceps of the arm are contracting. Explain why both muscles contract to hold a joint still, and how this differs from the antagonistic action that bent the arm to lift the bar. [5]

Solutions

Original-task marking: M1 method, A1 accuracy, B1 reasoning.

2.1 Tendon joins muscle to bone and transmits the pull; ligament joins bone to bone and stabilises the joint.

2.2 Actin (thin) and myosin (thick).

2.3 Calcium binds troponin, moving tropomyosin off actin's binding sites; this allows myosin heads to attach and begin the cycle.

3.1 Action potential spreads along the fibre's membrane, Ca2+ released from the sarcoplasmic reticulum; Ca2+ binds troponin, exposing binding sites on actin; energised myosin heads attach, pull actin toward the centre, and the sarcomere shortens; ATP detaches the heads and re-cocks them, repeating while stimulation continues; stimulation stops, calcium is pumped back, sites close, and the fibre relaxes passively.

3.2 Slow-twitch: many mitochondria, dense capillaries, myoglobin – support continuous aerobic respiration, so they dominate endurance muscle like marathon runners' calves. Fast-twitch: few mitochondria, thicker fibres, large glycogen store, rapid powerful contraction using anaerobic respiration – sprint and lifting muscle. Each structural difference maps to its energy route.

3.3 Holding still requires both muscles to contract against each other, fixing the joint angle by balancing torques. Lifting used the biceps shortening (concentric) while the triceps lengthened (relaxed), moving the joint. Holding is isometric: both muscles tense without changing length.