

# Edexcel (A) Biology A-level

## 7.1 to 7.2 + 7.10 + 7.13 to 7.15 - Muscles and Movement

### Flashcards

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What does the phrase 'antagonistic pair of muscles' mean?



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Muscles can only pull, so they work in pairs to move bones around joints.

Pairs of flexors & extensors pull in opposite directions: agonist contracts while antagonist is relaxed.



Describe the gross structure of the skeletal muscle system.



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Tendons (inelastic tissue) connect muscles to incompressible skeleton.

Ligaments (elastic tissue) join bones at joints (cartilage & fibrous connective tissue).



Describe the gross structure of skeletal muscle.



Describe the gross structure of skeletal muscle.

Muscle cells are fused together to form bundles of parallel muscle fibres (**myofibrils**).

Arrangement ensures there is no point of weakness between cells.

Each bundle is surrounded by **endomysium**: loose connective tissue with many capillaries.



Describe the microscopic structure of skeletal muscle.





Describe the microscopic structure of skeletal muscle.

**Myofibrils:** site of contraction.

**Sarcoplasm:** shared nuclei and cytoplasm with lots of mitochondria & endoplasmic reticulum.

**Sarcolemma:** folds inwards towards sarcoplasm to form transverse (T) tubules.



Draw a diagram to show the ultrastructure of a myofibril.



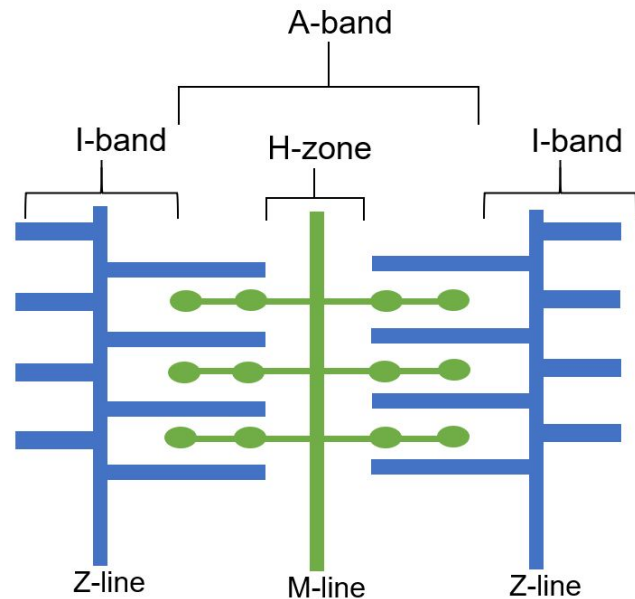
Draw a diagram to show the ultrastructure of a myofibril.

**Z-line:** boundary between sarcomeres

**I-band:** only actin

**A-band:** overlap of actin & myosin

**H-zone:** only myosin



# How is muscle contraction stimulated?



# How is muscle contraction stimulated?

1. Neuromuscular junction: action potential = voltage-gated  $\text{Ca}^{2+}$  channels open.
2. Vesicles move towards & fuse with presynaptic membrane.
3. Exocytosis of acetylcholine (ACh), which diffuses across synaptic cleft.
4. ACh binds to receptors on  $\text{Na}^+$  channel proteins on skeletal muscle cell membrane.
5. Influx of  $\text{Na}^+$  = depolarisation.



Explain the role of  $\text{Ca}^{2+}$  ions in muscle contraction.



Explain the role of  $\text{Ca}^{2+}$  ions in muscle contraction.

1. Action potential moves through T-tubules in sarcoplasm =  $\text{Ca}^{2+}$  channels in sarcoplasmic reticulum open.
2.  $\text{Ca}^{2+}$  binds to troponin, triggering conformational change in tropomyosin.
3. Exposes binding sites on actin filaments so actin/myosin cross bridges can form.



Outline the 'sliding filament theory'.





## Outline the 'sliding filament theory'.

1. Myosin head with ADP attached forms cross bridge with actin.
2. Power stroke: myosin head changes shape & loses ADP, pulling actin over myosin.
3. ATP attaches to myosin head, causing it to detach from actin.
4. ATPase hydrolyses  $\text{ATP} \rightarrow \text{ADP} + \text{P}_i$  so myosin head can return to original position.
5. Myosin head re-attaches to actin further along filament and the cycle repeats.



How does sliding filament action cause a myofibril to shorten?



# How does sliding filament action cause a myofibril to shorten?

Myosin heads flex in opposite directions = actin filaments are pulled towards each other.

Distance between adjacent sarcomere Z lines shortens.

Sliding filament action occurs up to 100 times per second in multiple sarcomeres.



# What happens during muscle relaxation?



## What happens during muscle relaxation?

1.  $\text{Ca}^{2+}$  is actively transported back into endoplasmic reticulum.
2. Tropomyosin once again blocks actin binding site.



Where are slow and fast-twitch muscle fibres found in the body?



Where are slow and fast-twitch muscle fibres found in the body?

**Slow-twitch:** sites of sustained contraction e.g. calf muscle.

**Fast-twitch:** sites of short-term, rapid, powerful contraction e.g. biceps.



Explain the role of slow and fast-twitch muscle fibres.





Explain the role of slow and fast-twitch muscle fibres.

**Slow-twitch:** long-duration contraction; well-adapted to aerobic respiration to prevent lactate buildup.

**Fast-twitch:** powerful short-term contraction; well-adapted to anaerobic respiration.



Explain the structure and properties of slow-twitch muscle fibres.



## Explain the structure and properties of slow-twitch muscle fibres.

- **Glycogen** store: many terminal ends can be hydrolysed to release glucose for respiration.
- Contain **myoglobin**: higher affinity for oxygen than haemoglobin at lower partial pressures.
- Many mitochondria: aerobic respiration produces more ATP.
- Surrounded by many blood vessels: high supply of oxygen & glucose.



Explain the structure and properties of fast-twitch muscle fibres.



# Explain the structure and properties of fast-twitch muscle fibres.

- Large store of **phosphocreatine**
- More myosin filaments
- Thicker myosin filaments
- High concentration of enzymes involved in anaerobic respiration.
- Extensive sarcoplasmic reticulum: rapid uptake & release of  $\text{Ca}^{2+}$ .



Suggest the disadvantages of exercising too much.



Suggest the disadvantages of exercising too much.

- Suppression of immune system: higher cortisol levels, lower levels of white blood cells.
- Strain on muscles, joints & ligaments.
- Bursitis (swelling in the region of the joints).



Suggest the disadvantages of exercising too little.





Suggest the disadvantages of exercising too little.

- Increases risk of cardiovascular disease, diabetes & Type 2 diabetes.
- Increases level of low density lipoproteins (LDLs) which are associated with atherosclerosis.



What is the difference between correlation and causation?



# What is the difference between correlation and causation?

Correlation indicates that there is a relationship between the pattern of two variables.

Causation indicates that the pattern of one variable is a direct consequence of another variable.



Name 2 medical technologies that enable those with injuries or disabilities to participate in sport.



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- Keyhole surgery to repair damaged joints (uses fibre optics so incision can be smaller).
- Prostheses (artificial body parts).



# What are the advantages of keyhole surgery?



## What are the advantages of keyhole surgery?

- Smaller incision = shorter recovery time, less risk of infection, less blood lost.
- Fewer staff required = cheaper.



Suggest the ethical issues surrounding the use of performance-enhancing drugs by athletes.





Suggest the ethical issues surrounding the use of performance-enhancing drugs by athletes.

- Legality
- Health risks
- Fairness: some argue that competition is always unfair due to different access to training resources
- Financial advantages
- Autonomy

