

# AQA Biology A-level

## 6.3 - Skeletal muscles

### Flashcards

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Name the 3 types of muscle in the body and where they are located.



Name the 3 types of muscle in the body and where they are located.

- **Cardiac:** exclusively found in heart.
- **Smooth:** walls of blood vessels and intestines.
- **Skeletal:** attached to incompressible skeleton by tendons.



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



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

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

Pairs pull in opposite directions: agonist contracts while antagonist is relaxed.



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.



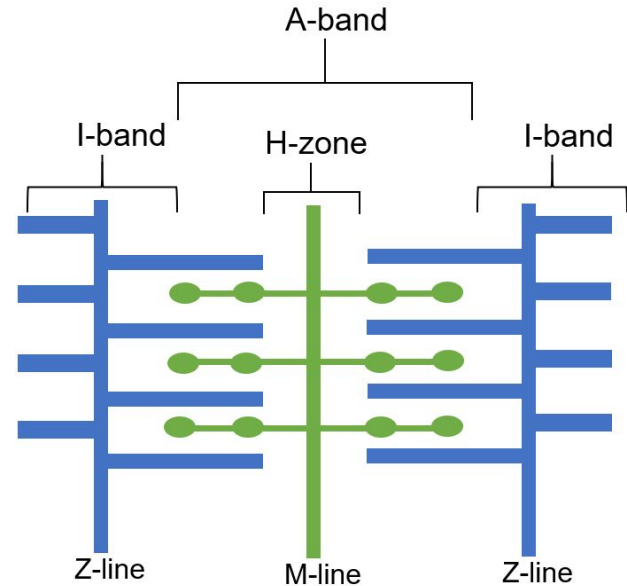
Draw a diagram to show the ultrastructure of a myofibril.

**Z-line:** boundary between sarcomeres

**I-band:** only actin

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

**H-zone:** only myosin



How does each band appear under an optical microscope?



How does each band appear under an optical microscope?

**I-band:** light

**A-band:** dark



# 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 the 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 actinomyosin 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.



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.



State 4 pieces of evidence that support the sliding filament theory.



State 4 pieces of evidence that support the sliding filament theory.

- H-zone narrows
- I-band narrows
- Z-lines get closer (sarcomere shortens)
- A-zone remains same width (proves that myosin filaments do not shorten)



# 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.



Explain the role of phosphocreatine in muscle contraction.



Explain the role of phosphocreatine in muscle contraction.

Phosphorylates ADP directly to ATP when oxygen for aerobic respiration is limited e.g. during vigorous exercise.



How could a student calculate the length of one sarcomere?



How could a student calculate the length of one sarcomere?

1. View thin slice of muscle under optical microscope.
2. Calibrate eyepiece graticule.
3. Measure distance from middle of one light band to middle of another.



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  $\text{Ca}^{2+}$ .



# What is a motor unit?



# What is a motor unit?

One motor neuron supplies several muscle fibres, which act simultaneously as one functional unit.

