

Muscle and motility

International Baccalaureate · IB Diploma · Biology · HL

Scope and prerequisites

This handout covers selected HL topics for the course first assessed in 2025; it is not the whole syllabus.

Prerequisites: read the stated quantities and units, and use arithmetic and the model conditions below.

The examples are original and fictional: they are not real measurements or real student investigations.

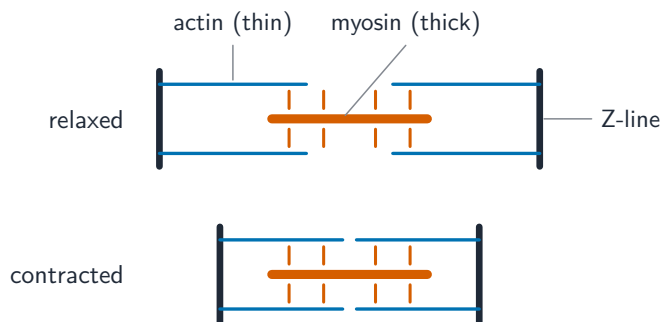
Muscle contraction: filaments slide

■ What would explain this observation?

- A **sarcomere** becomes shorter during contraction although its thick and thin filaments keep approximately the same length.
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■ Build the model

- Actin and myosin interact in a sliding-filament mechanism.
- Calcium permits the interaction through regulatory proteins; ATP binding and hydrolysis support the **cross-bridge** cycle.
- Skeletal muscles pull through tendons and work in coordinated groups.
- sarcomere: The repeating contractile unit between two Z lines.
- cross-bridge: A myosin-actin interaction during the contraction cycle.



the filaments slide over each other, so the sarcomere shortens

Filaments keep their length; they slide, so the sarcomere shortens

■ Choose evidence that can test it

- During shortening, overlap increases.
- The A-band length stays approximately constant while I bands and the H zone become smaller.
- Movement at a joint also depends on tendon insertion, lever geometry and opposing muscle activity.

In the lab: Annotate two sarcomere diagrams at different lengths using the same scale. Track band widths separately from filament length. Use prepared models or existing images, not painful or maximal-exertion tasks.

■ Work from known quantities

- Known: sarcomere length changes from 2.5 to 2.0 micrometres.
- Percentage shortening = $(2.5 - 2.0)/2.5 \times 100 = 20\%$.
- This does not mean either filament shortened by 20%.

Your turn: A sarcomere shortens from 3.0 to 2.4 micrometres. Calculate percentage shortening.

■ Check the conclusion and its limits

- ATP is required for myosin detachment as well as the continuing cycle.
- A muscle pulling harder does not mean all its fibres become shorter under every load.

Not true: Contracting muscle shortens by shrinking every actin filament. Contraction is sliding, not shrinking: actin and myosin filaments keep their length while their overlap increases. A filament that shortened would contradict the sliding-filament evidence.

Key:

- Actin and myosin interact in a sliding-filament mechanism.
- During shortening, overlap increases.
- Watch for: ATP is required for myosin detachment as well as the continuing cycle.

■ Write from a shortening of 25 percent

- A sarcomere shortens from 2.0 to 1.5 micrometres.
- Find the percentage shortening. The filaments themselves do not shorten by that percentage.