

Exercise walk-through

# 17.1

## Muscle contraction: filaments slide

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International Baccalaureate · IB Diploma · Biology · HL

# 17.1 Muscle contraction: filaments slide

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Name: \_\_\_\_\_ Class: \_\_\_\_\_ Date: \_\_\_\_\_ **Total: 10 marks**

**KEY WORDS** sarcomere • cross-bridge

# Objective

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Muscle contraction: filaments slide. Supported HL concept preparation; original classroom practice, not an official IB paper or assessed learner work.

## 1 Key knowledge and worked examples

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### ■ What would explain this observation?

- A **sarcomere** becomes shorter during contraction although its thick and thin filaments keep approximately the same length.
- Start with a prediction. State the quantities or features you would compare, then decide what evidence could distinguish two explanations.

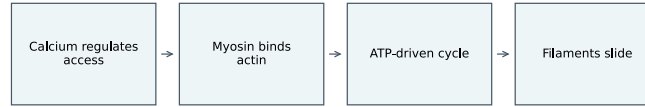
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## ■ Build the model

- 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.





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■ **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.
- 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.

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■ **Work from known quantities**

- State the known values and their units. Choose the relation because its assumptions fit this case, then rearrange before substitution.
- 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%.

**Example:**

A sarcomere shortens from 3.0 to 2.4 micrometres. Calculate percentage shortening. Use the same sequence: known quantities → model → relation → substitution → unit and interpretation.

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■ **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.
- Return to the original observation. Explain what the result supports, which conditions it assumes, and one way to test a competing explanation.

**Warn:**

Contracting muscle shortens by shrinking every actin filament. This claim is false: 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.

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## **Key:**

Muscle contraction: filaments slide: 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.

## Exercises 2.1-2.3

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**2.1** What happens to thick-filament length during normal contraction? Choose one answer.

- **A** It remains approximately constant
- **B** It halves whenever the muscle shortens
- **C** It becomes zero

[1]

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**2.2** A sarcomere shortens from 3.0 to 2.4 micrometres. Calculate percentage shortening. Show the relation, substitution and units.

[2]

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**2.3** Decide whether this claim is true and justify: Contracting muscle shortens by shrinking every actin filament.

[2]

## Exercises 2.1-2.3

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**2.1** What happens to thick-filament length during normal contraction? Choose one answer.

- **A** It remains approximately constant
- **B** It halves whenever the muscle shortens
- **C** It becomes zero

[1]

**2.1 A** 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.

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**2.2** A sarcomere shortens from 3.0 to 2.4 micrometres. Calculate percentage shortening. Show the relation, substitution and units. [2]

**2.2**  $\text{shortening} = (3.0 - 2.4) / 3.0 \times 100 = 20\%$ .

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**2.3** Decide whether this claim is true and justify: Contracting muscle shortens by shrinking every actin filament. [2]

**2.3** False. 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.

## Exercises 2.4·3.1

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**2.4** The repeating contractile unit between two Z lines: write the technical term. [1]

### 3 Exam-style questions

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**3.1** A fictional sarcomere shortens from 2.8 to 2.1 micrometres. Calculate shortening and explain whether the model requires actin filaments to shorten. [4]

## Exercises 2.4·3.1

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**2.4** The repeating contractile unit between two Z lines: write the technical term. [1]

### 3 Exam-style questions

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**2.4** sarcomere. sarcomere means The repeating contractile unit between two Z lines.

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**3.1** A fictional sarcomere shortens from 2.8 to 2.1 micrometres. Calculate shortening and explain whether the model requires actin filaments to shorten. [4]

**3.1** 25% shortening. Sliding-filament reasoning changes overlap and sarcomere length, not filament length. The numerical observation alone does not measure force or diagnose function.