

The image is a composite. The top left features the University of Manchester logo, which consists of the word 'MANCHESTER' in white serif font and '1824' in yellow serif font, both on a purple rectangular background. Below the logo, the text 'The University of Manchester' is written in a white serif font. The background of the entire slide is a photograph of a university campus. It shows a wide, paved path curving through a green lawn. There are many large, leafy trees on the left and right. In the distance, a modern building with large glass windows and a red roof is visible, along with a traditional stone building. The sun is shining from the top right, creating a bright glow and long shadows.

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BIOL21332 Motor Systems

Sliding filaments theory

Huxley AF (1917-2012)



http://www.nobelprize.org/nobel_prizes/medicine/laureates/1963/huxley-photo.html

Brave New World

- The Doors of Perception



Sliding Filament Mechanism of Contraction

- Myosin (thick) and actin (thin) filaments = contractile proteins
- Contractile force is produced by cross bridges between thick and thin filaments

Sliding Filament Mechanism of Contraction

5 steps

Step 1: Rest.

Step 2: Activation.

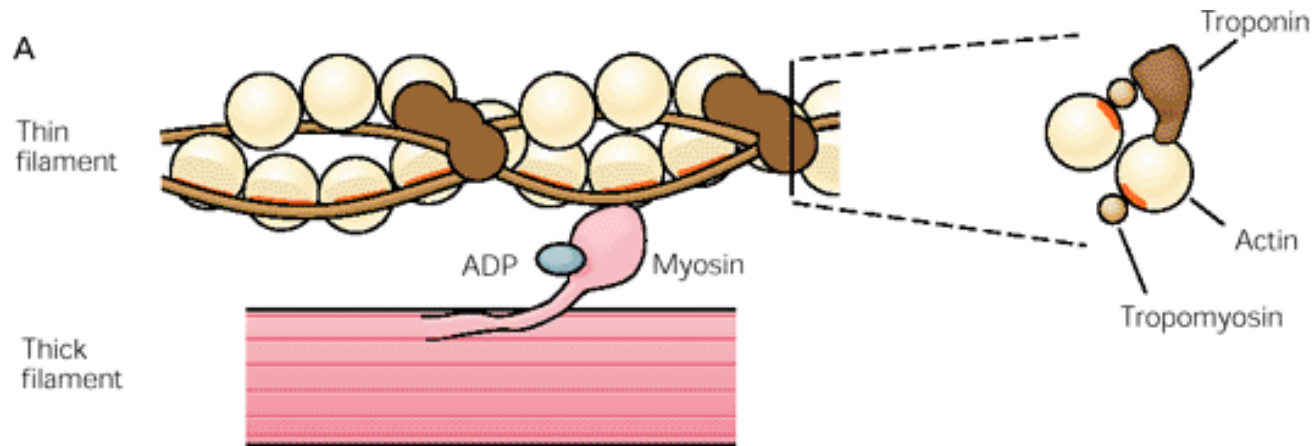
Step 3: Sliding of filaments.

Step 4: Myosin detachment.

Step 5: Reactivation of myosin.

Step 1: Rest.

Troponin-tropomyosin complexes on thin filaments block the binding sites on the actin.



Myosin heads are ADP-bound → “cocked” position

[Ca²⁺] in sarcoplasm: low ($\sim 10^{-7}$ - 10^{-8} M).

There are no cross-bridges between thin and thick filaments

Sliding Filament Mechanism of Contraction

5 steps

Step 1: Rest.

Step 2: Activation.

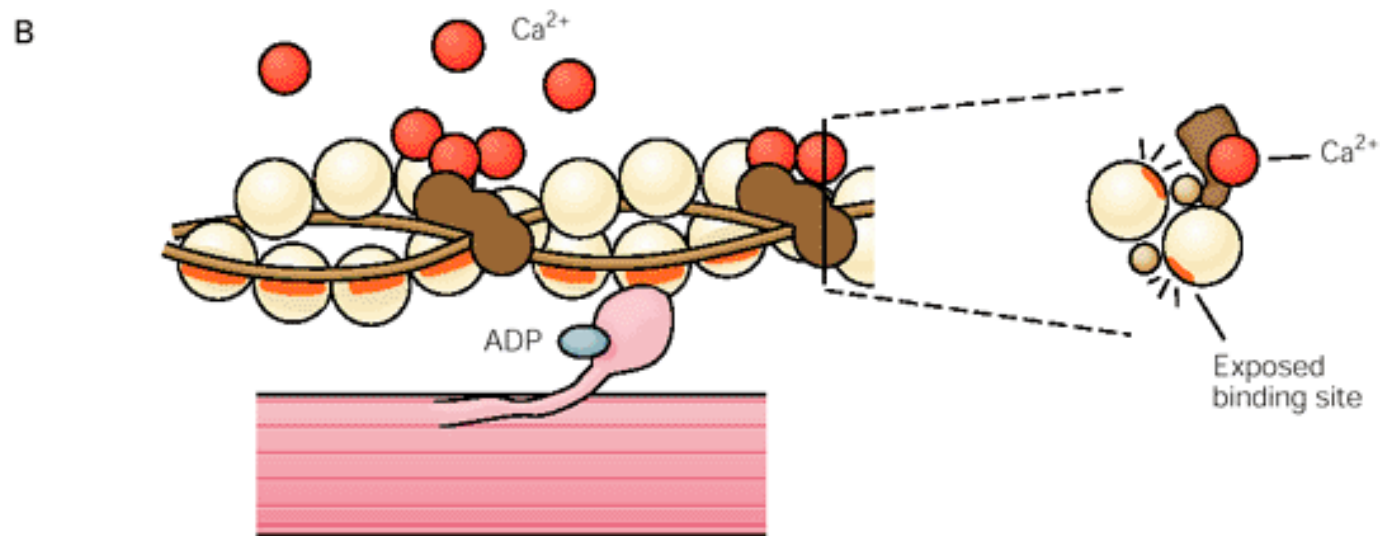
Step 3: Sliding of filaments.

Step 4: Myosin detachment.

Step 5: Reactivation of myosin.

Step 2: Activation.

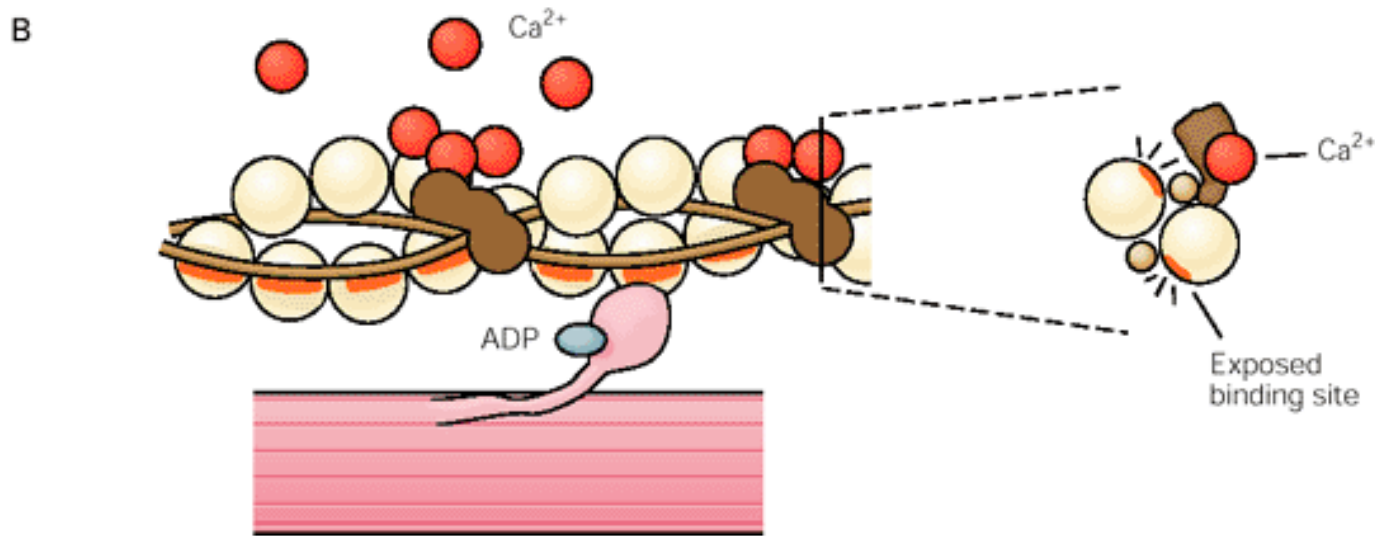
Muscle fibre is activated (action potential travels down T-tubules).



Ca^{2+} is released from the cisternae of the sarcoplasmic reticulum (SPR)

Step 2: Activation.

Ca^{2+} binds to troponin.



Conformational change in thin filament exposes actin binding sites.

Attachment of cocked myosin heads = cross-bridge formation.

Sliding Filament Mechanism of Contraction

5 steps

Step 1: Rest.

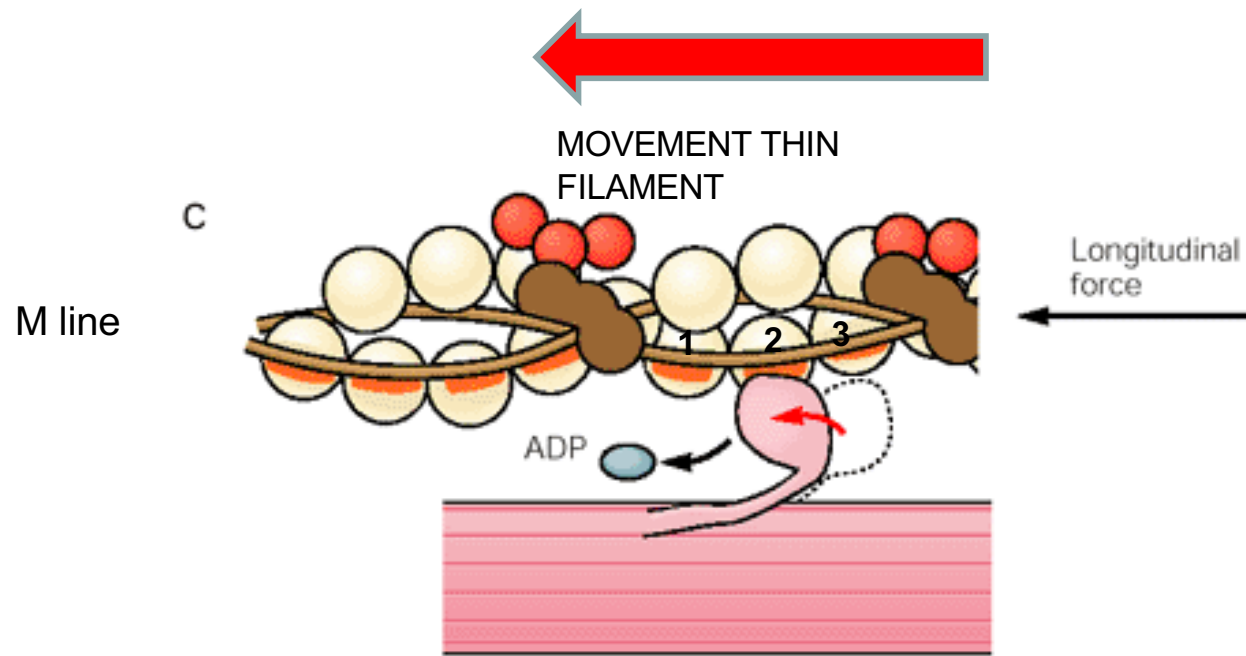
Step 2: Activation.

Step 3: Sliding of filaments.

Step 4: Myosin detachment.

Step 5: Reactivation of myosin.

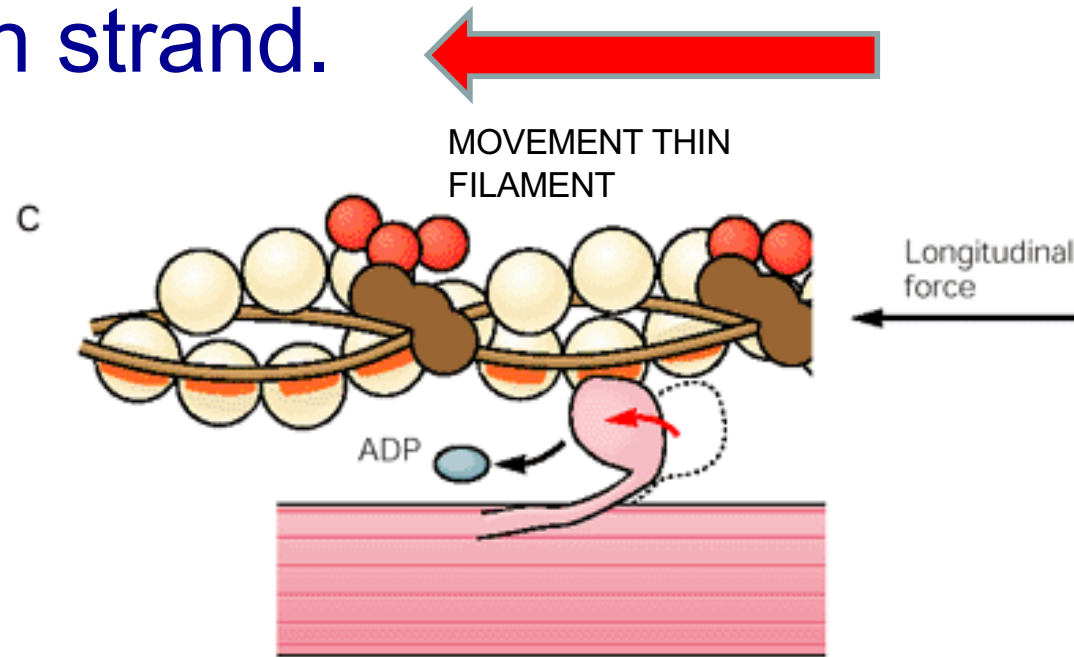
Step 3: Sliding of filaments.



Upon formation of cross-bridges, mechanical energy (from ATP dephosphorylation) stored in “cocked” myosin heads is released → POWER STROKE.

Step 3: Sliding of filaments.

- Myosin heads have shed bound ADP: resume relaxed / native state while remaining cross-linked to thin strand.



- Longitudinal force pulls the thin and thick filaments into greater overlap ($\sim 0.06 \mu\text{m}$) \rightarrow shortens the muscle fibre.

Sliding Filament Mechanism of Contraction

5 steps

Step 1: Rest.

Step 2: Activation.

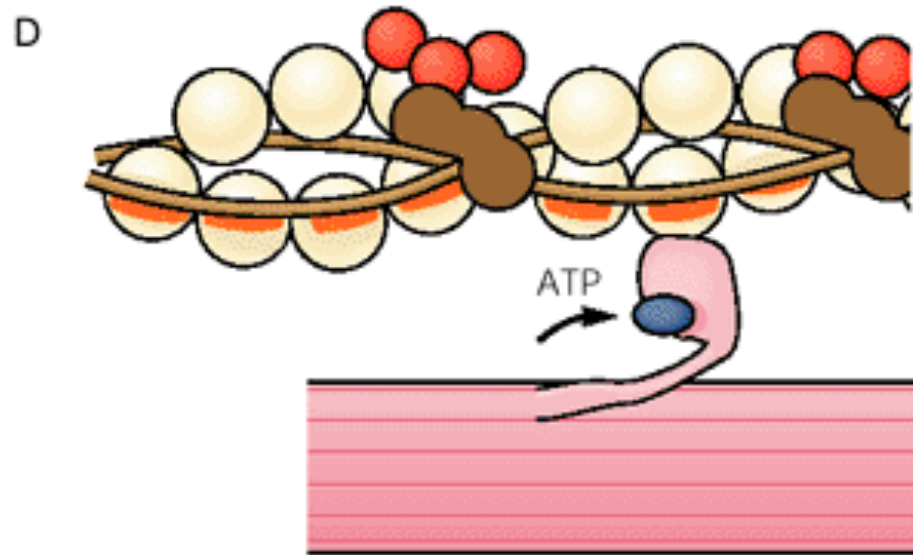
Step 3: Sliding of filaments.

Step 4: Myosin detachment.

Step 5: Reactivation of myosin.

Step 4: Myosin detachment.

ATP binds to Myosin heads which then detaches from its actin binding site.



Actin-binding site is released and can form another cross-bridge to sustain muscle contraction.

Sliding Filament Mechanism of Contraction

5 steps

Step 1: Rest.

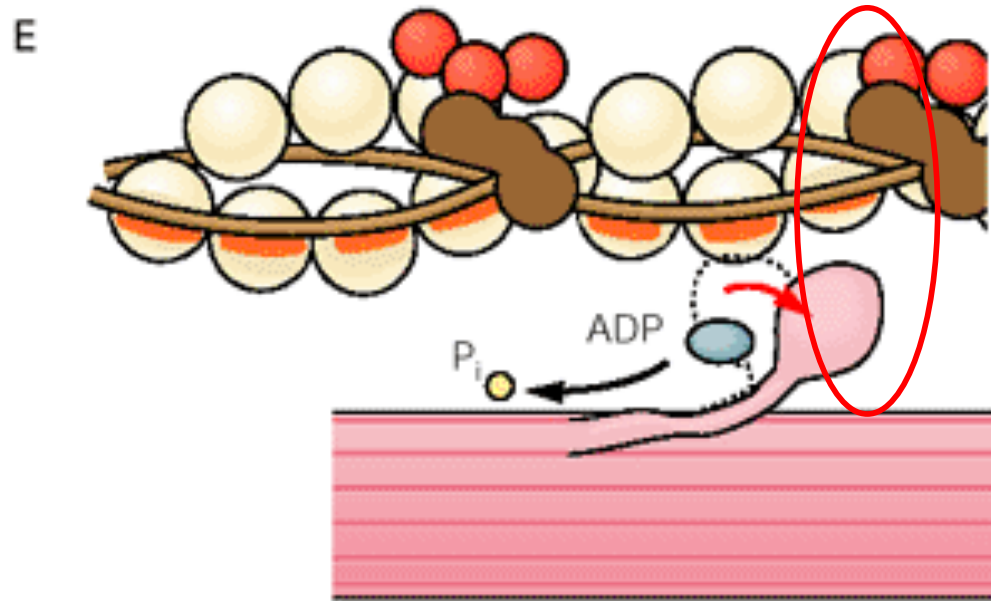
Step 2: Activation.

Step 3: Sliding of filaments.

Step 4: Myosin detachment.

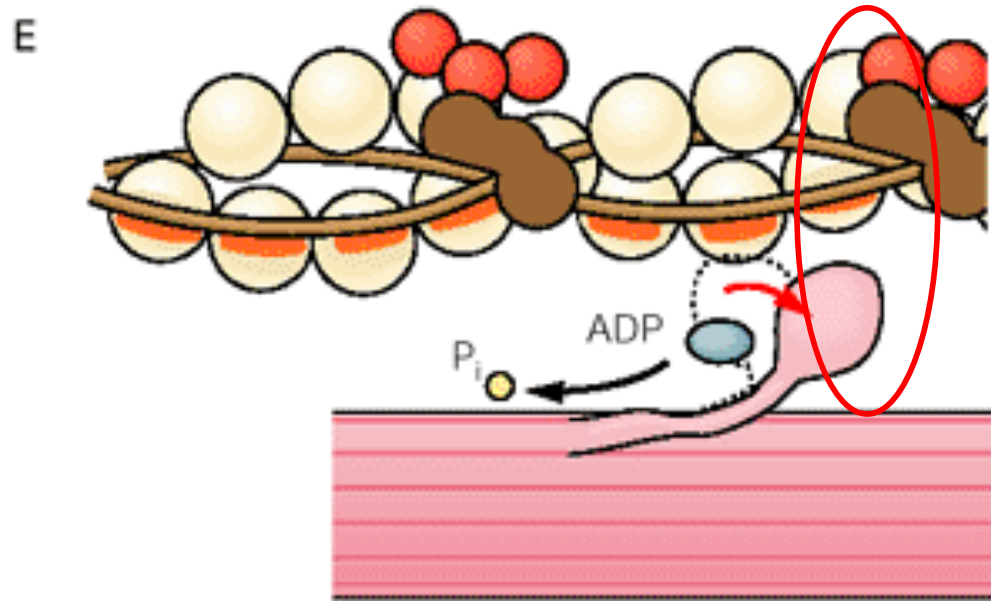
Step 5: Reactivation of myosin.

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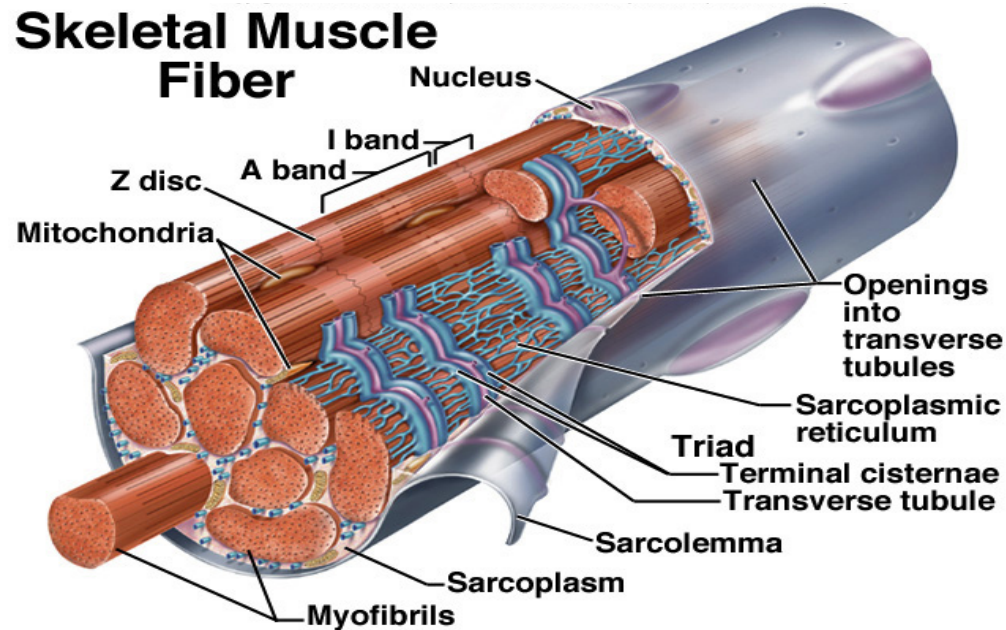


Thick filament: Energy released by dephosphorylation of ATP to bound ADP is stored in myosin heads → myosin heads are “re-cocked”.

Step 5: Reactivation of myosin.



Thin filament: High $[Ca^{2+}]$: system remains activated (step 2), muscle contraction persists. Low $[Ca^{2+}]$: return to resting state (step 1): myosin heads are cocked but unable to form cross-bridge.



Muscle fibres contain network of longitudinal tubules and chambers (sarcoplasmic reticulum, SPR)

Sequester, store and release Ca^{2+}

At rest intracellular $[\text{Ca}^{2+}]$ low, actively pumped into SPR.

Role of Ca^{2+} in excitation-contraction coupling

- Action potential initiated at the NMJ
- Travels across surface of the muscle fibre
- Depolarisation of transverse tubules within the muscle fibre
- Ca^{2+} is released from cisternae of SPR
- Ca^{2+} diffuses along myofibrils
- Ca^{2+} binds to troponin enabling cross-bridges to form
- Release of Ca^{2+} is very rapid (20-50ms to activate the thin filaments fully)
- Reuptake of Ca^{2+} is also rapid → decrease in cross-bridges (80-200 ms)

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