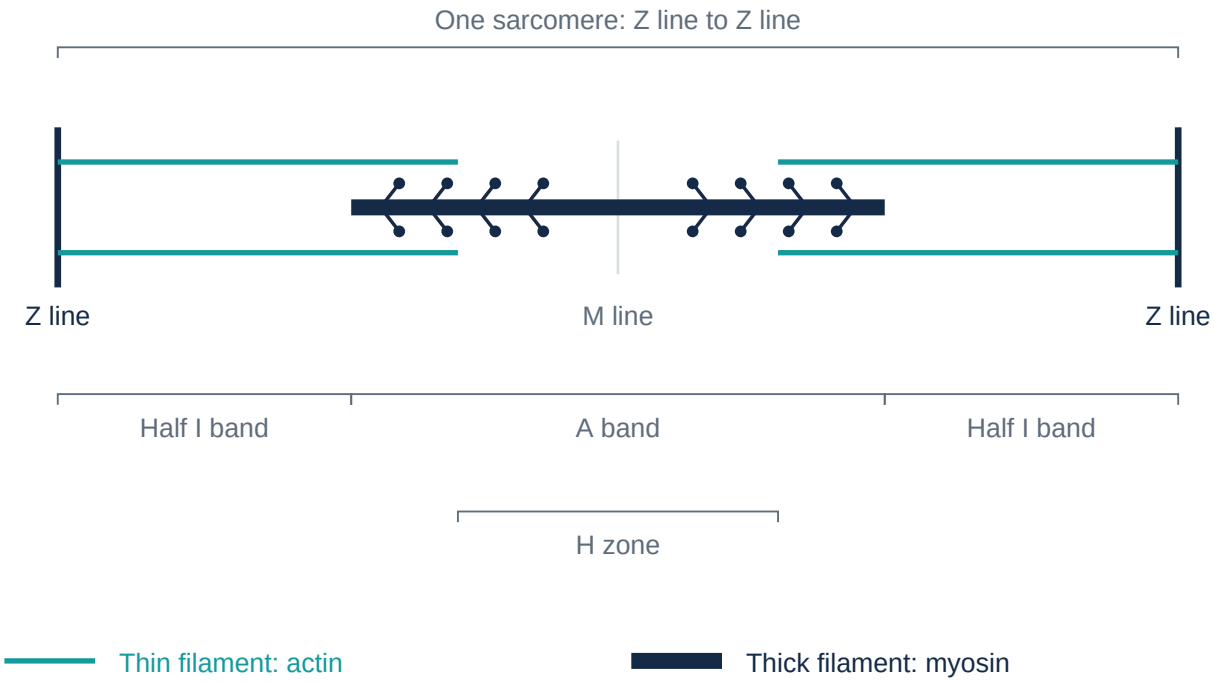
The sarcomere is the working unit

Skeletal muscle fibres are long, multinucleate cells. Each contains parallel myofibrils made of repeating sarcomeres, whose aligned bands produce striations.

1. MAP ONE SARCOMERE



Schematic, not an electron micrograph; lengths are illustrative.

2. MATCH STRUCTURE TO LOCATION

Thin filaments attach to Z lines and contain actin, troponin and tropomyosin. Thick filaments contain myosin, whose projecting heads bind actin and hydrolyse ATP. The M line lies at the sarcomere centre.

3. READ A LONGITUDINAL ELECTRON MICROGRAPH

Locate repeating Z lines first. The darker A band spans the thick filaments; its paler central H zone has no thin filaments. The lighter I band contains thin filaments but no thick filaments. A full I band straddles a Z line.

Muscle organisation and sarcomeres: OpenStax, A&P 2e 10.2.
Band identities and filament composition: OpenStax, Biology 2e 38.4.

Scope: Cambridge Biology 9700, section 15.1, outcomes 11-12, p. 39.

Filaments slide; they do not shrink

During sarcomere shortening, thin filaments move towards the M line. Their overlap with thick filaments increases while each filament keeps its length.

1. COMPARE THE SAME SARCOMERE

More relaxed



Shortened



Both drawings use the same scale. Navy = myosin; teal = actin.

2. WHAT CHANGES DURING SHORTENING?

Z-to-Z distance	Decreases
I band and H zone	Narrow; the H zone may disappear
A band	Unchanged: thick filament length is constant
Thin and thick filaments	Unchanged length; greater overlap

A contracting muscle can generate tension without shortening overall. The changes above describe a sarcomere that is actually shortening.

Sliding model and band changes: OpenStax, Biology 2e 38.4.
Filament movement and force: OpenStax, A&P 2e 10.3.

Scope: Cambridge Biology 9700, section 15.1, outcomes 11-12, p. 39.

Calcium permits; ATP powers cycling

Calcium regulates access to actin. ATP has distinct roles in myosin detachment, re-energising the head and returning calcium to storage.

1. EXPOSE THE BINDING SITES

A muscle action potential triggers Ca^{2+} release from the sarcoplasmic reticulum (SR). Calcium binds troponin, changing its shape and moving tropomyosin away from myosin-binding sites on actin. Myosin can now attach.

2. REPEAT THE CROSS-BRIDGE CYCLE

A. Attach	An energised myosin head carrying ADP and P_i binds an exposed actin site.
B. Pull	P_i release is associated with the power stroke. The head pivots, pulling actin inward; ADP leaves.
C. Detach	A new ATP binds to myosin, causing the head to release actin.
D. Reset	Myosin ATPase hydrolyses ATP to ADP + P_i, re-cocking the head. It can attach again.

3. RELAXATION ALSO USES ATP

When stimulation stops, ATP-driven pumps return Ca^{2+} to the SR. Calcium dissociates from troponin, so tropomyosin covers the sites again. New cross-bridges are prevented; remaining attached heads need ATP to detach.

No ATP does not mean normal relaxation: myosin cannot detach, explaining rigor. P_i means inorganic phosphate. Calcium binds troponin, not tropomyosin.

ATP cycle and relaxation: OpenStax, A&P 2e 10.3.
Troponin and regulatory proteins: OpenStax, Biology 2e 38.4.

Scope: Cambridge Biology 9700, section 15.1, outcomes 11-12, p. 39.