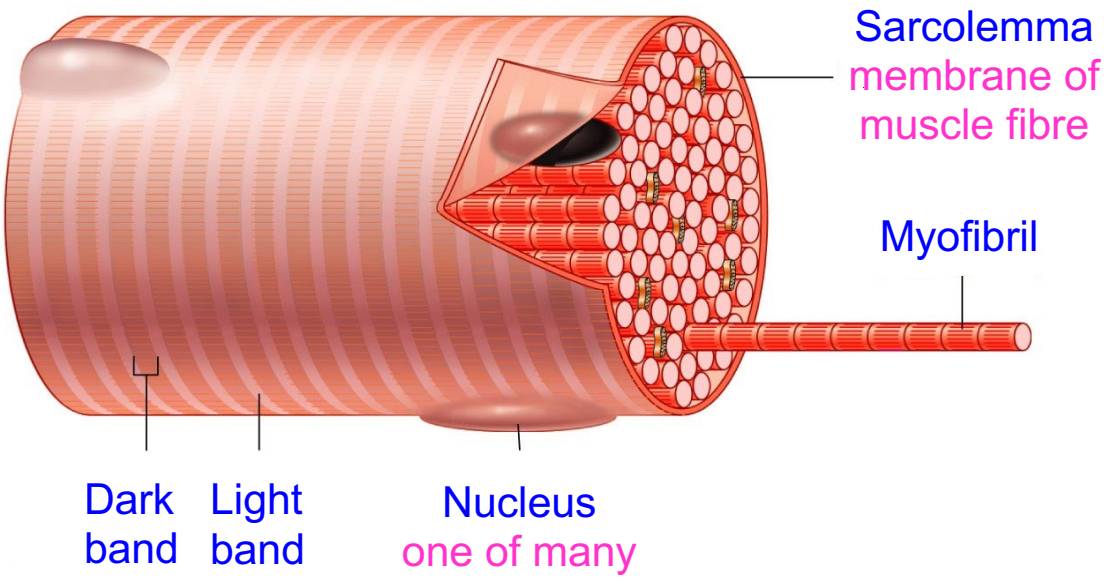
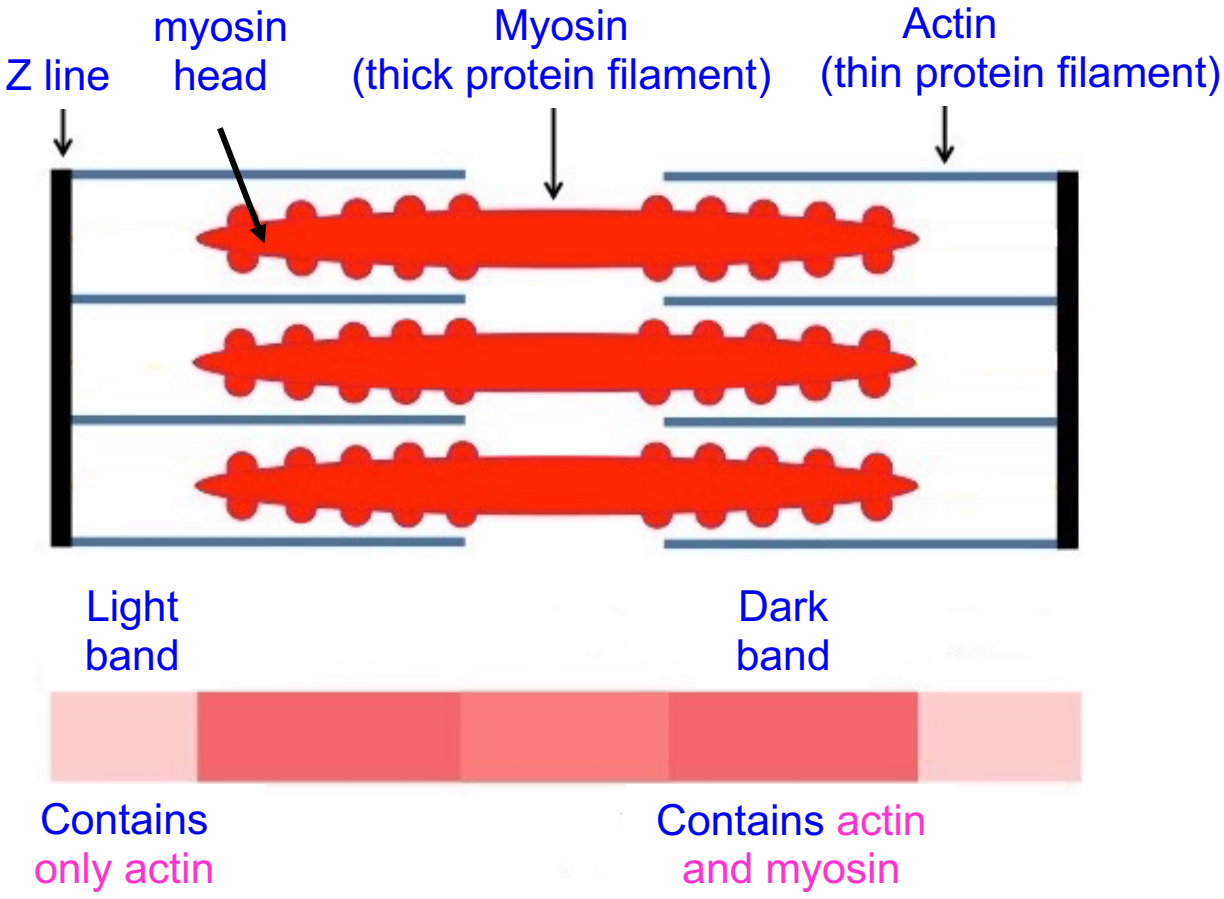
A. STRUCTURE OF SKELETAL MUSCLE



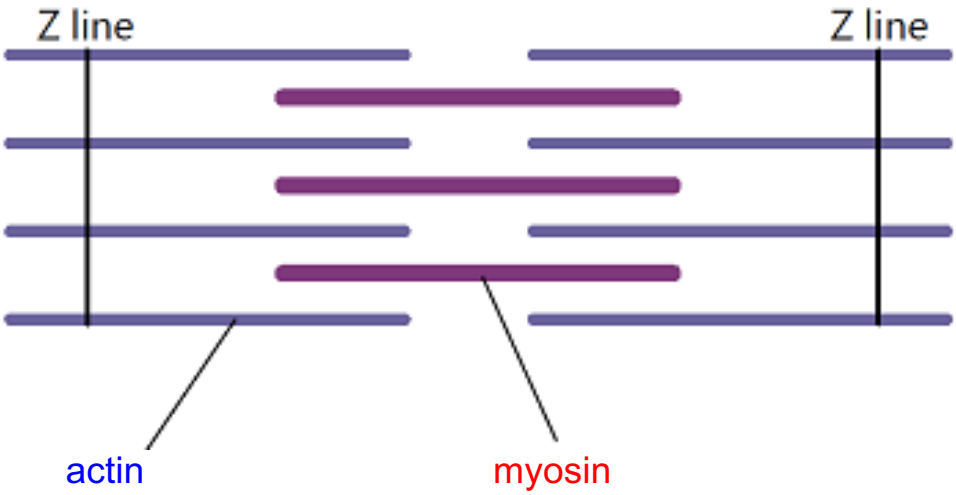
Myofibrils contain repeating units called sarcomeres.
Sarcomeres have light bands and dark bands.
They give muscle a striated (striped) appearance.

B. A SARCOMERE

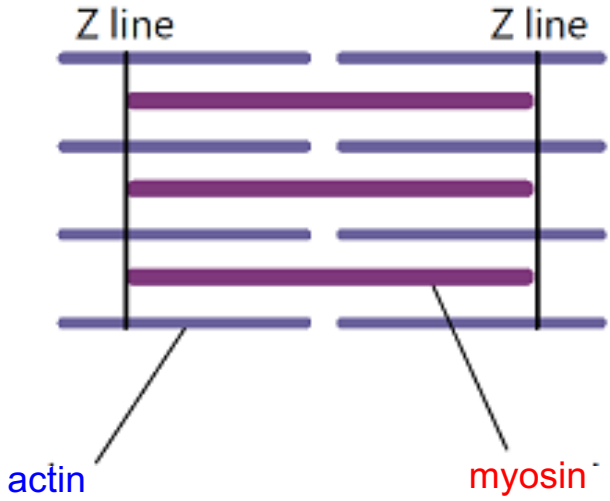


C. HOW THE SARCOMERE CHANGES WHEN A MUSCLE CONTRACTS

MUSCLE RELAXED



MUSCLE CONTRACTED

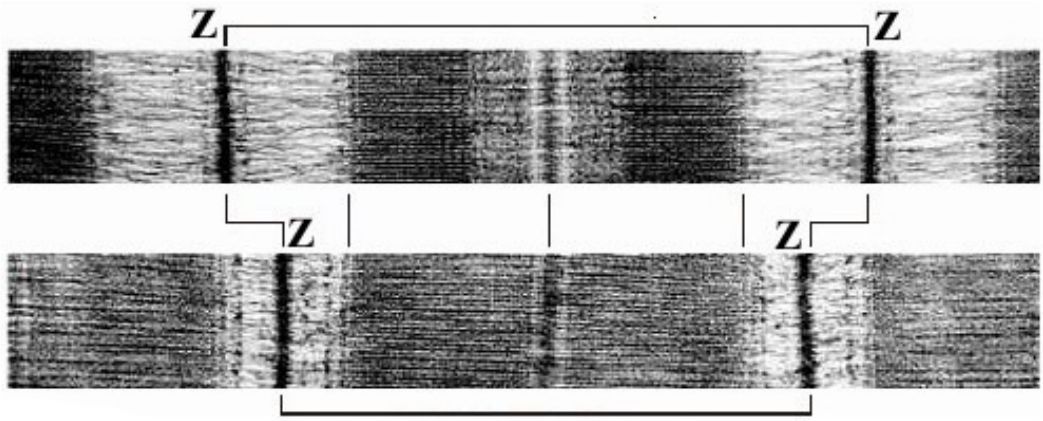


- **sarcomere** gets **shorter**
- **Z-lines** get **closer** together
- **actin** filaments are **pulled inwards** by **myosin heads** (not shown yet)
- **light bands** get **narrower**

D. WHAT THIS ACTUALLY LOOKS LIKE UNDER THE MICROSCOPE

fully relaxed

fully contracted



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E. CALCULATING SARCOMERE LENGTH FROM A MICROGRAPH

Measure the **distance** in **mm**
from the **start of one dark band** and the
start of another dark band that is **10 bands away**

Divide by 10 to find the **length of one sarcomere** in **mm**

Multiply by 1000 to **convert** this length to **µm**

Divide by the **magnification factor**

F. THE SLIDING FILAMENT THEORY OF MUSCLE CONTRACTION

- You need to be able to **picture** this – this diagram "**zooms in**" on **one actin filament** and **one myosin head**.
- **Many myosin heads** do this all at the **same time**, creating a **very strong force** of **contraction**.

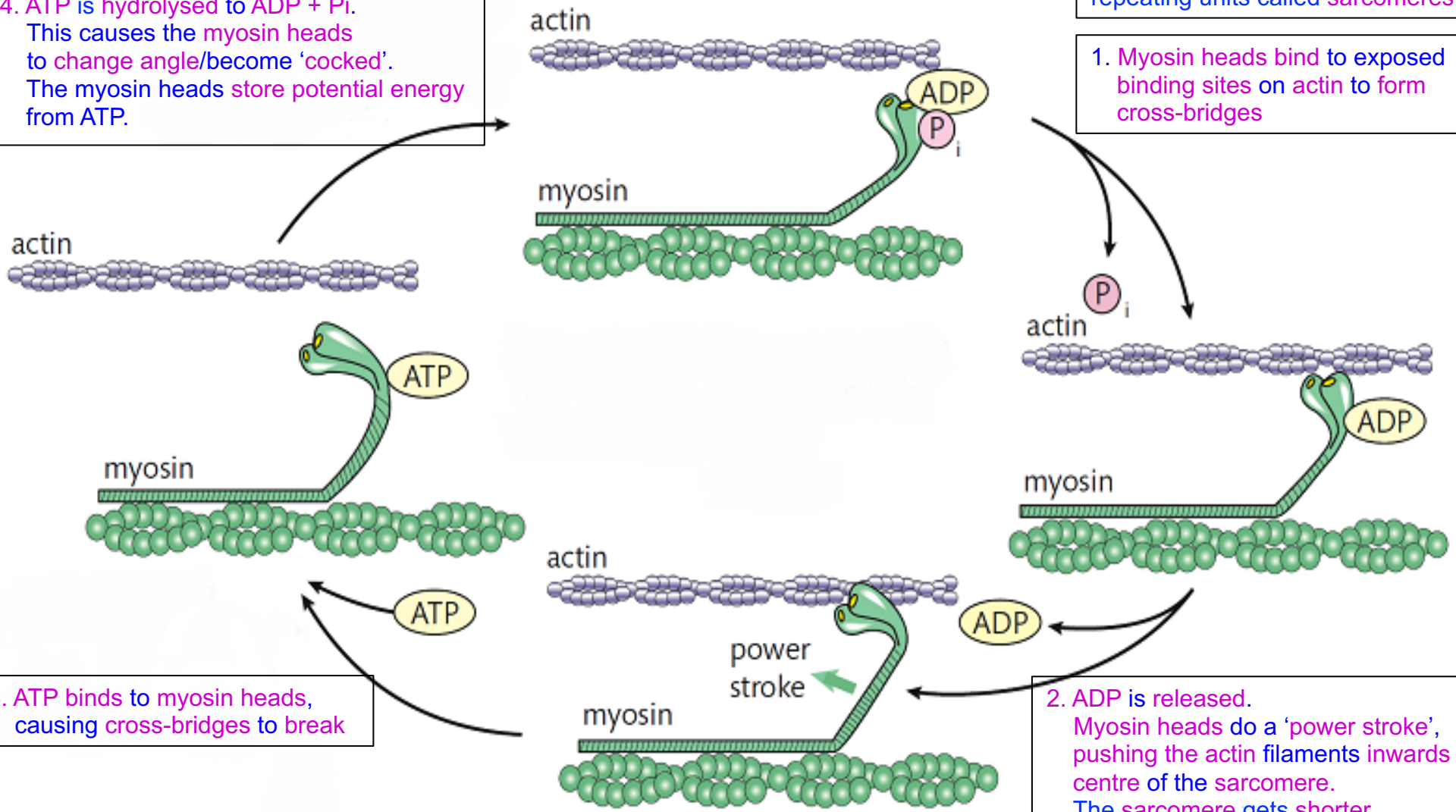
INTRO:
Muscle fibres are made up of myofibrils, which are made up of repeating units called sarcomeres

1. Myosin heads bind to exposed binding sites on actin to form cross-bridges

2. ADP is released.
Myosin heads do a 'power stroke', pushing the actin filaments inwards to the centre of the sarcomere.
The sarcomere gets shorter.
The stored potential energy in the myosin heads has been released.

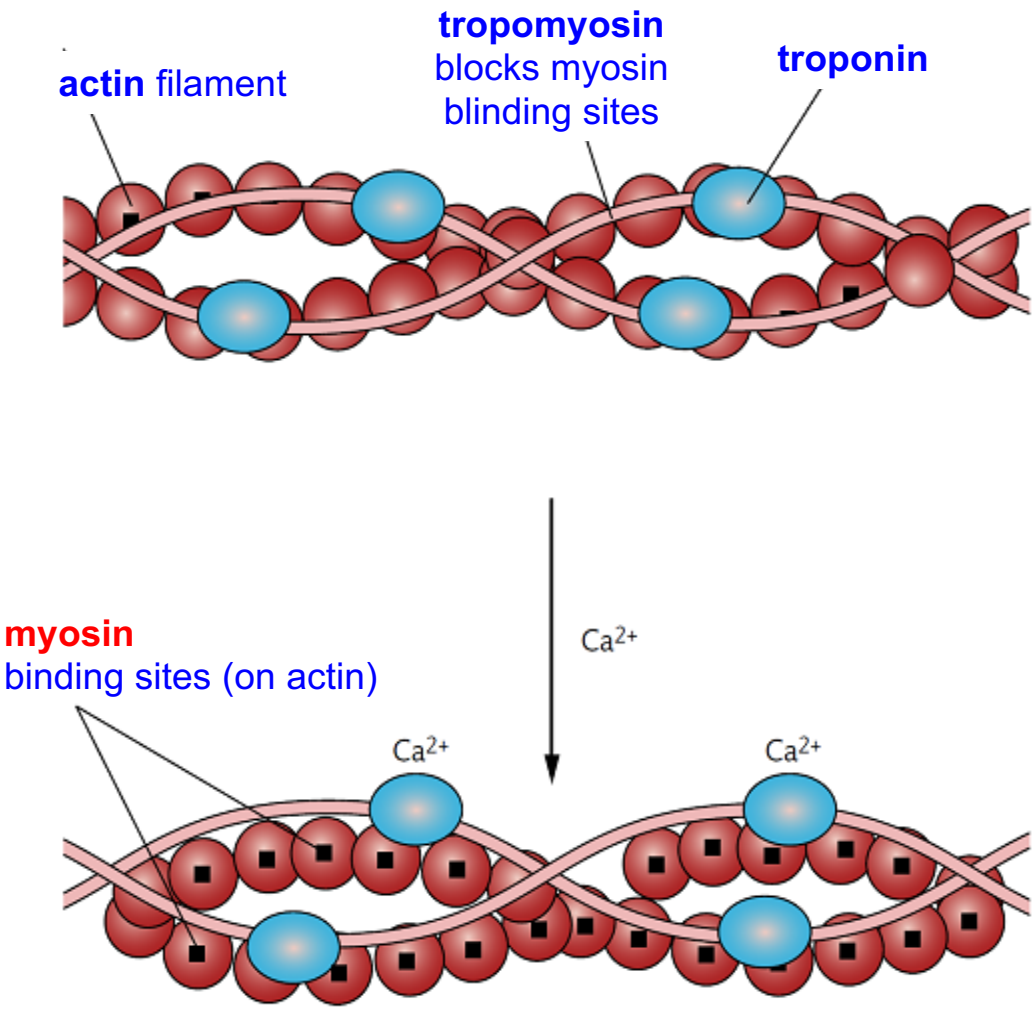
3. ATP binds to myosin heads, causing cross-bridges to break

4. ATP is hydrolysed to ADP + Pi.
This causes the myosin heads to change angle/become 'cocked'.
The myosin heads store potential energy from ATP.



G. CONTROL OF MUSCLE CONTRACTION

- When a muscle is **relaxed**, the **myosin heads** are **prevented** from **binding** to **actin** filaments.
- This is because a protein called **tropomyosin** blocks **myosin binding sites** on the **actin**.



To **cause** muscle **contraction**:

- **Motor neurone** stimulates the **release** of **Ca^{2+}**
- From **sarcoplasmic reticulum**
- **Ca^{2+} bind** to **troponin** and **changes** its **shape**
- This **moves tropomyosin**.
- (Which) **exposes myosin binding sites**
- (So that) the **myosin heads** can **bind** to **actin**

Always refer to **MYOSIN HEADS** in exams, rather than simply 'myosin'

H. APPLYING YOUR KNOWLEDGE

'Rigor mortis' can happen as early as 4-hours after death.

It causes the limbs of the body to become stiff for a long time.

Using your knowledge of the sliding filament theory:

(a) Suggest what causes the limbs to become stiff. [3 marks]

(b) Suggest what causes the limbs to eventually relax again. [3 marks]

(a) no ATP (made);

(so) actin-myosin cross bridges cannot be broken;

(so) muscles stay contracted/cannot relax;

(b) enzymes (in human cells/bacteria);

break actin-myosin cross bridges;

(so) muscles relax;