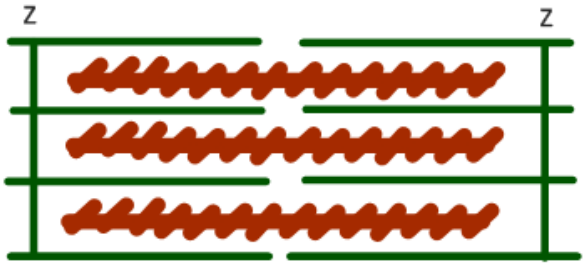


Muscles and Movement (AHL)

Stephen Taylor
Bandung International School

Movement: the human machine

joints
'moment' or pivot for movement

bones
act as levers and structural support

nerves
coordinate & stimulate muscle contractions

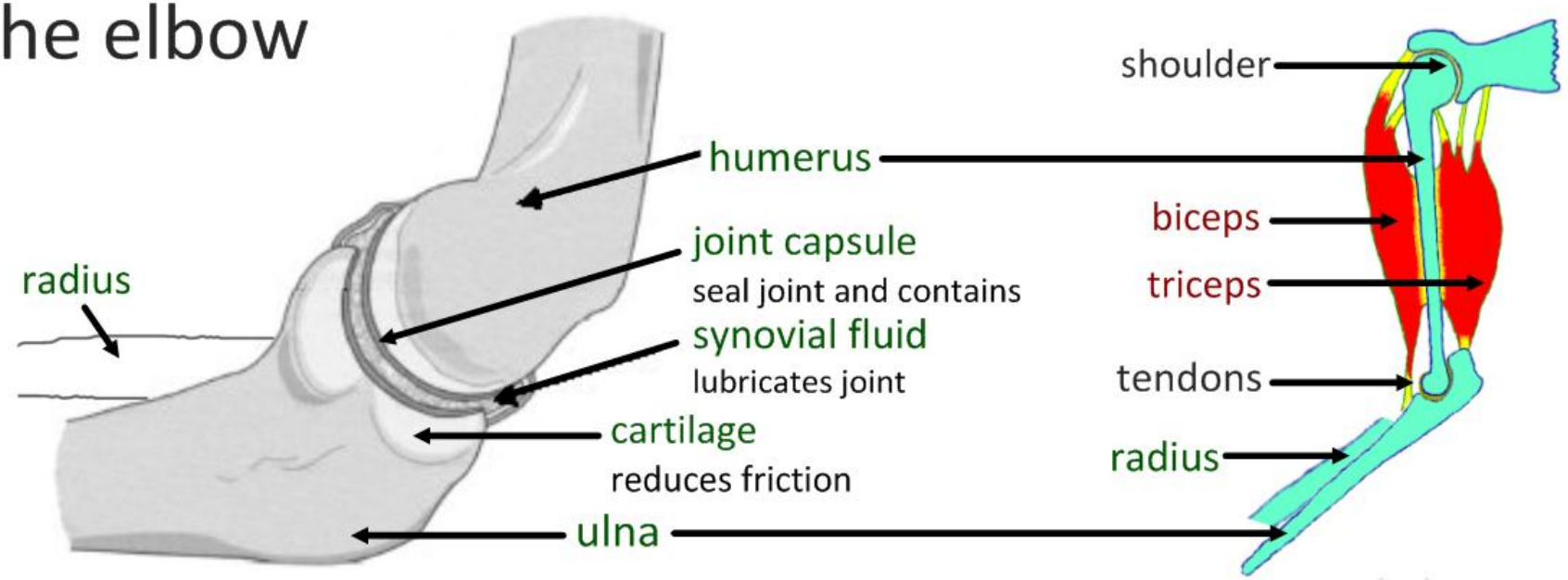
muscles
apply effort or force

tendons
muscle-to-bone

ligaments
bone-to-bone

http://www.bodyworksnc.com/images/skeleton%20to%20muscle%20running.jpg

The elbow



From IB Question Bank

[Source: R. Allen and T Greenwood, (2001) *Advanced Biology 2, Student Resource and Activity Manual*, 3rd edition, Biozone International Limited, page 98]

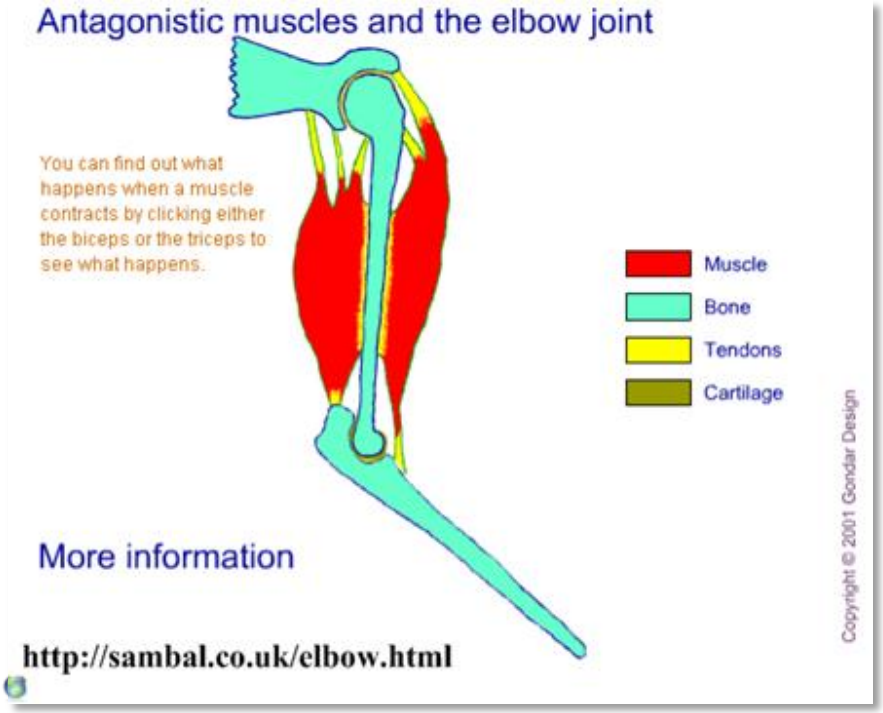
http://content.answers.com/main/content/img/oxford/Oxford_Body/019852403x.elbow.1.jpg

Joint structure reflects function:

http://www.youtube.com/watch?v=SOMFX_83sqk

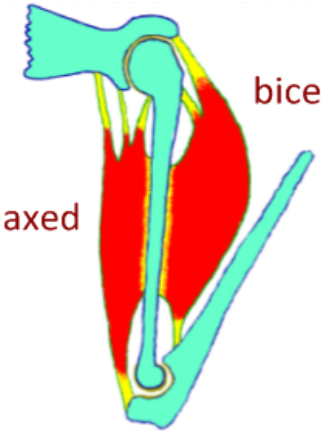
The elbow is a hinge joint

it has a limited range of movement



The biceps and triceps are antagonistic muscles:

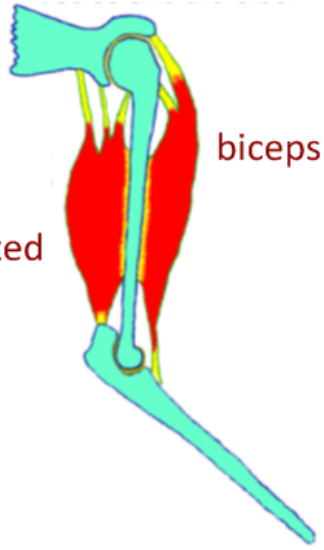
"bend"



biceps contracted

triceps relaxed

"extend"



biceps relaxed

triceps contracted

The knee is a pivotal hinge joint:

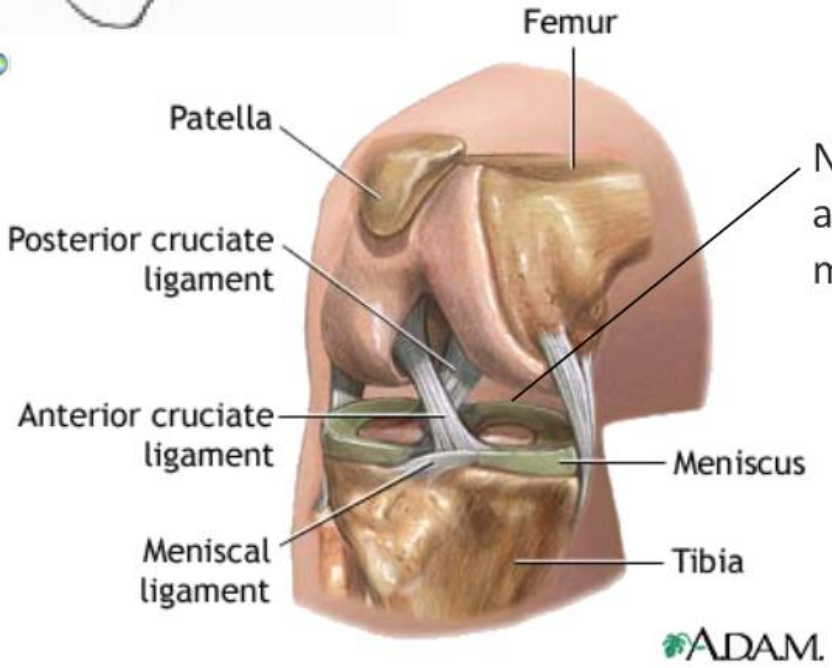
http://www.youtube.com/watch?v=SOMFX_83sqk

It's main range of movement is like a hinge joint, yet it allows some pivotal movement as well.

It is one of the most complex joints in the human body.

Animated X-ray:

http://en.wikipedia.org/wiki/File:Knie_ct.gif



http://medicalimages.allrefer.com/large/knee-arthroscopy-series.jpg

Notice in the diagram and the animated radiograph above that the femur and the tibia do not actually make contact with each other in movement.

Cartilage and synovial fluid protect and lubricate the knee joint, reducing impact harm. Strong ligaments hold the knee in place.

The hip is an example of a ball-and-socket joint

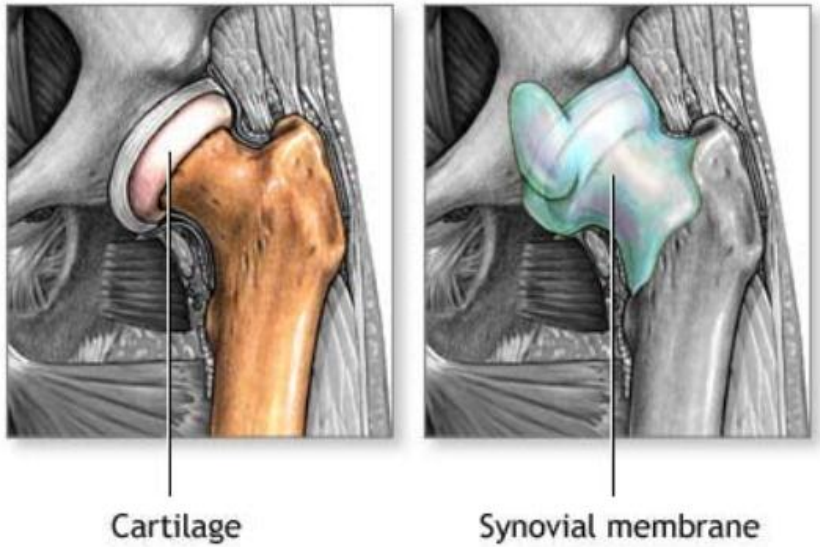
http://www.youtube.com/watch?v=SOMFX_83sqk

Hip X-ray:

http://upload.wikimedia.org/wikipedia/commons/2d/Hueftgelenk-gesund.jpg

It allows movement in all axes and planes. Ball-and-socket joints allow the greatest range of movement.

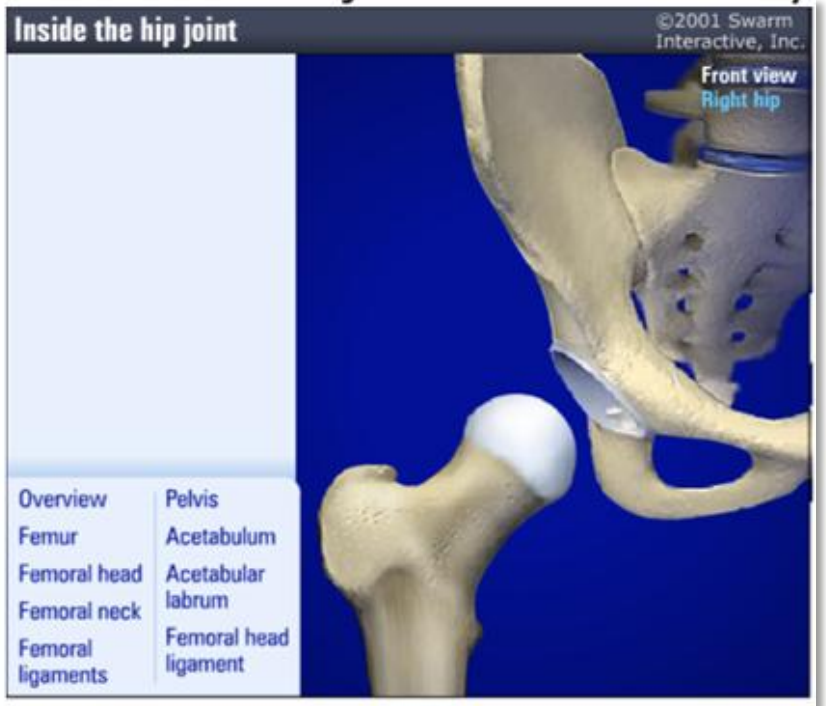
The shoulder is also a ball-and-socket joint.



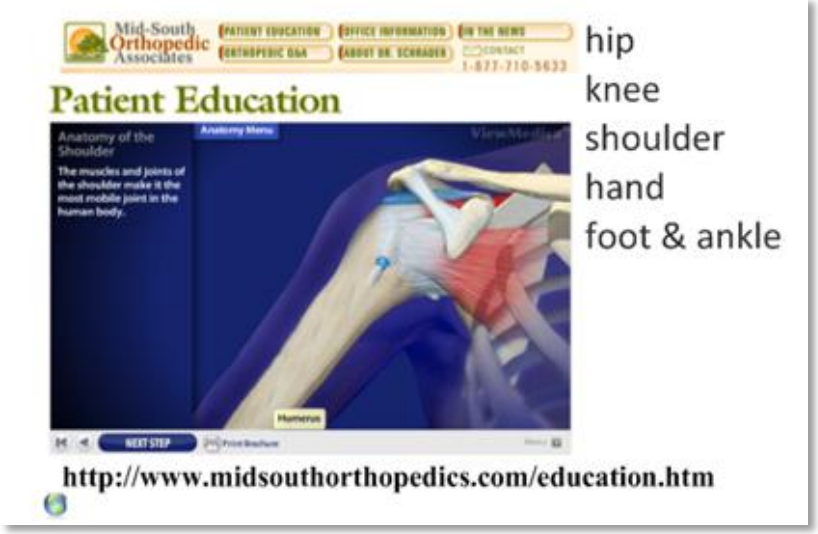
http://assets.aarp.org/external_sites/adam/graphics/images/en/18027.jpg

ADAM.

More about joints in the body:

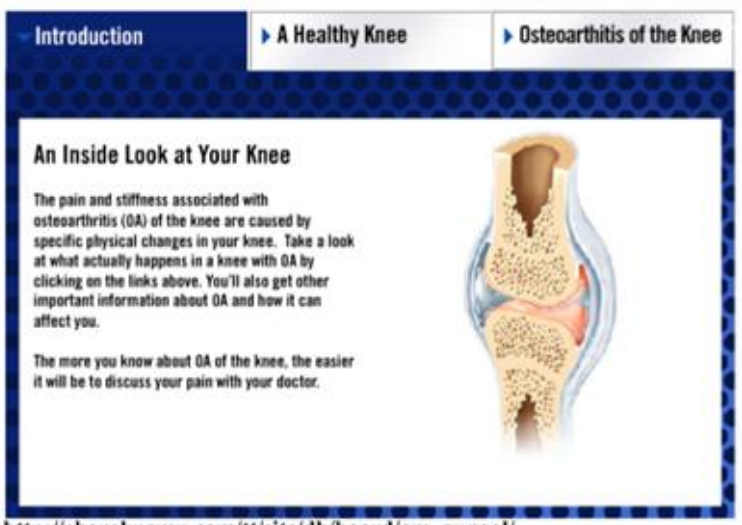


http://www.midsouthorthopedics.com/hipanatomy.htm



hip
knee
shoulder
hand
foot & ankle

http://www.midsouthorthopedics.com/education.htm



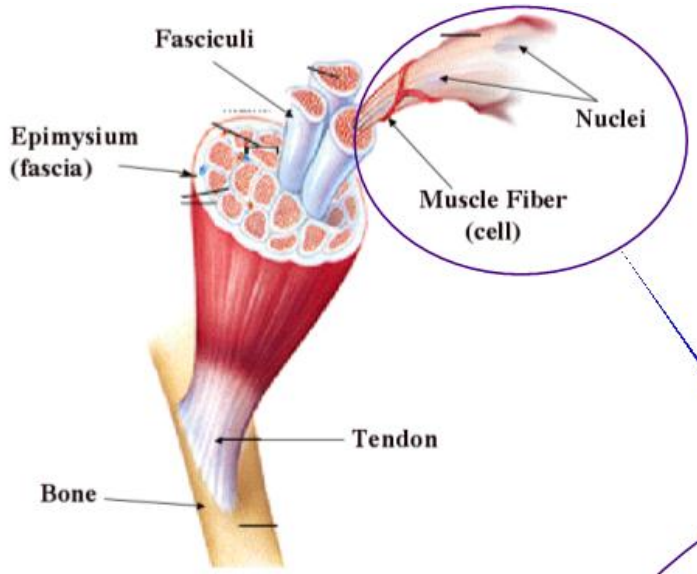
http://choroknamu.com/tt/site/db/board/om_gungol/upload/1_10000/1692/is_en_pt_knee.swf

http://www.midsouthorthopedics.com/kneeanatomy.htm

The Striated Muscle Cell

Skeletal muscle tissue is striated - has dark and light bands - and contracts longitudinally.

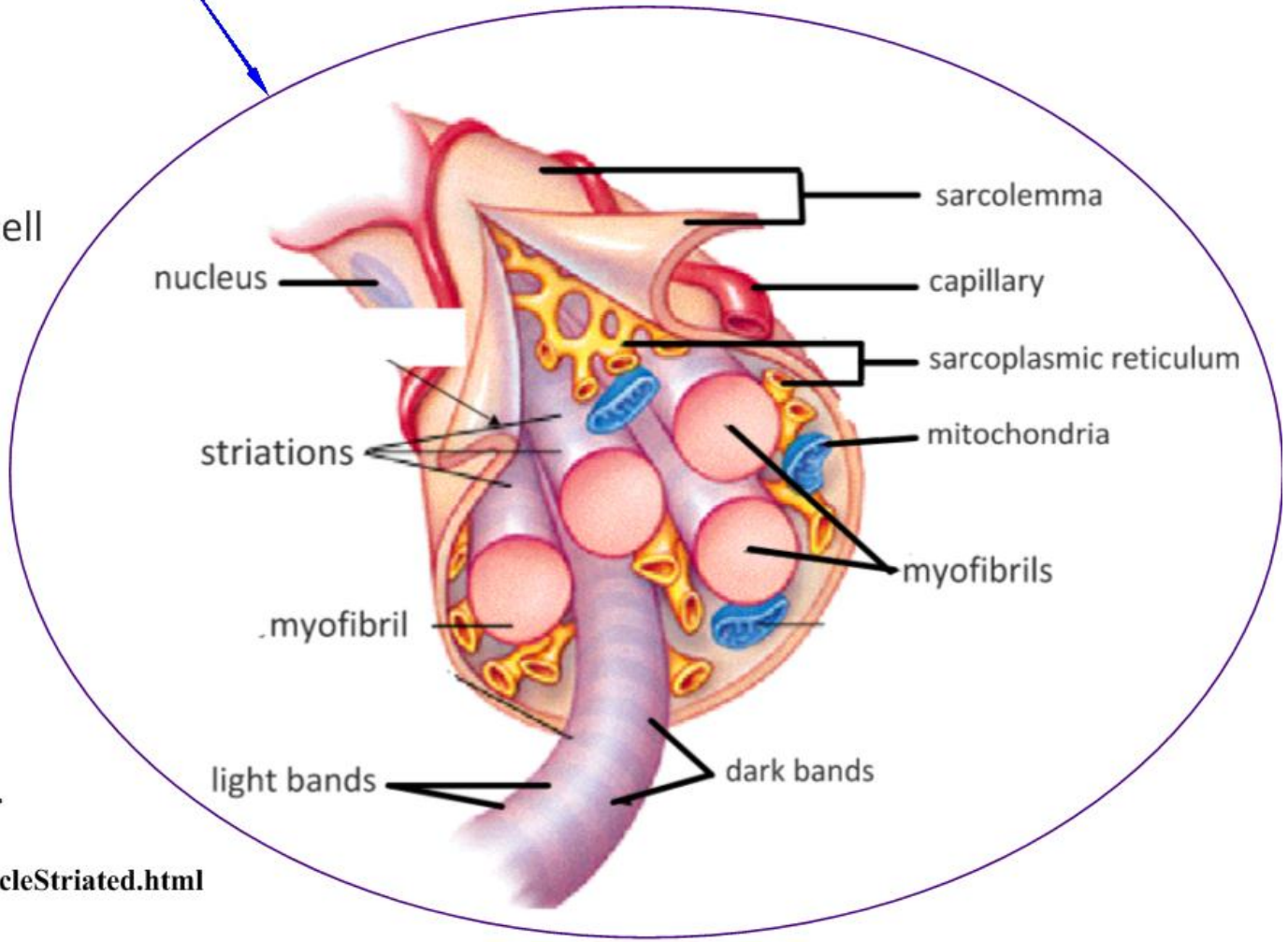
Muscle cells are bundled together in fasciculi, held in place by the sarcolemma (membrane).



A single skeletal muscle cell is multinucleated, with the nuclei arrange along the edges.

Myofibrils are single fibres within the cell.

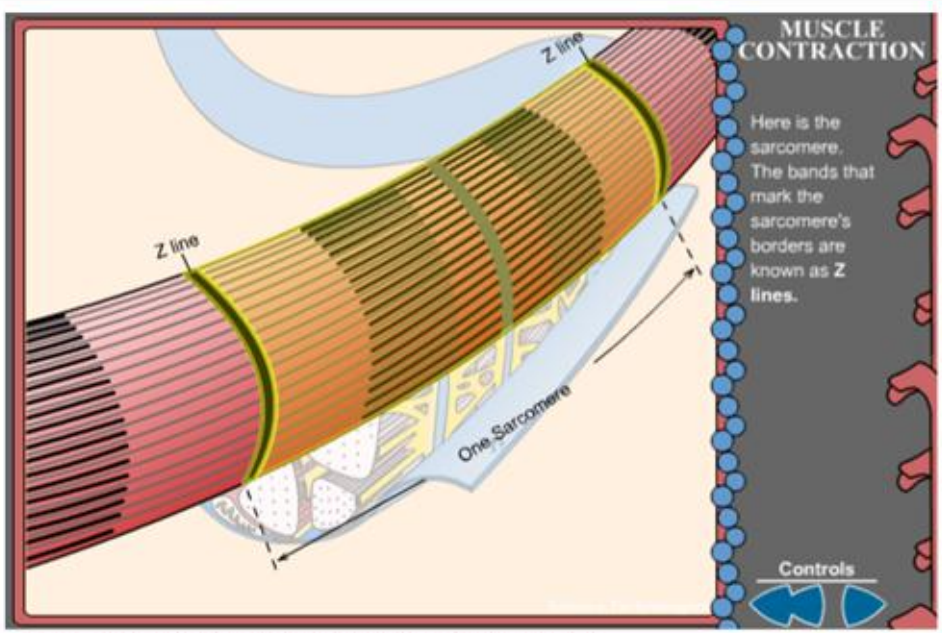
Many mitochondria are also present as there is a high demand for ATP.



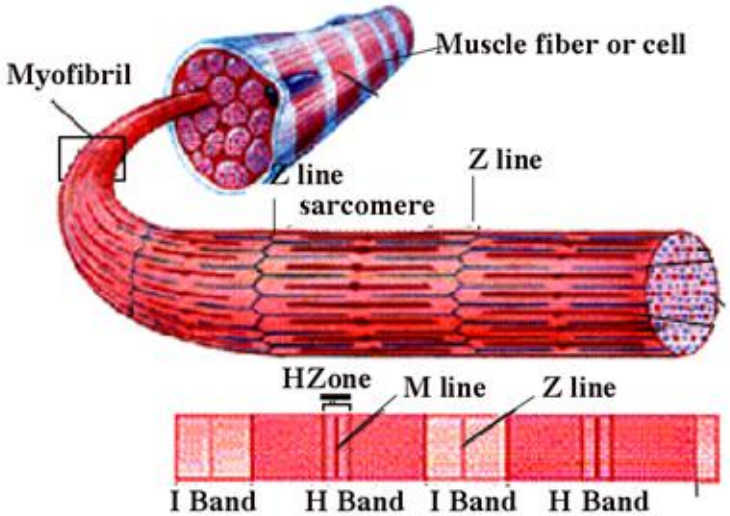
http://www.ucl.ac.uk/~sjjgsca/MuscleStriated.html

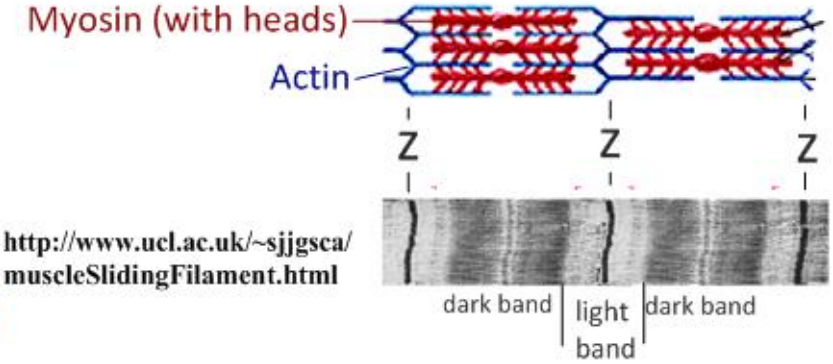
A sarcomere is a repeating unit of a striated muscle cell.

In between two Z-lines, we find overlapping actin and myosin fibres.



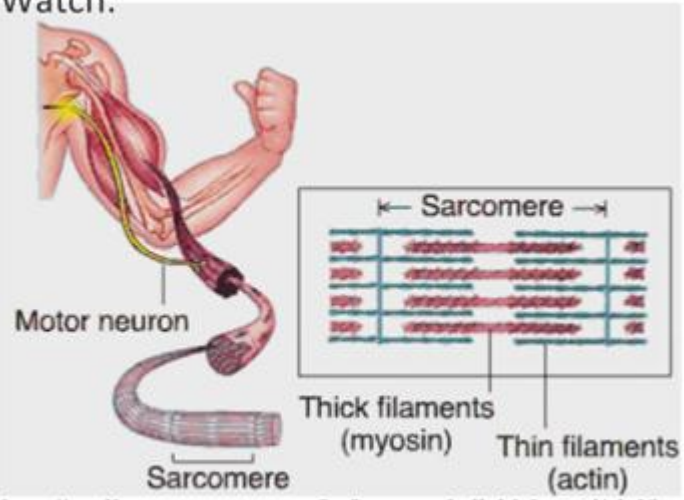
http://www.brookscole.com/chemistry_d/templates/student_resources/shared_resources/animations/muscles/muscles.html





http://www.ucl.ac.uk/~sjjgsca/muscleSlidingFilament.html

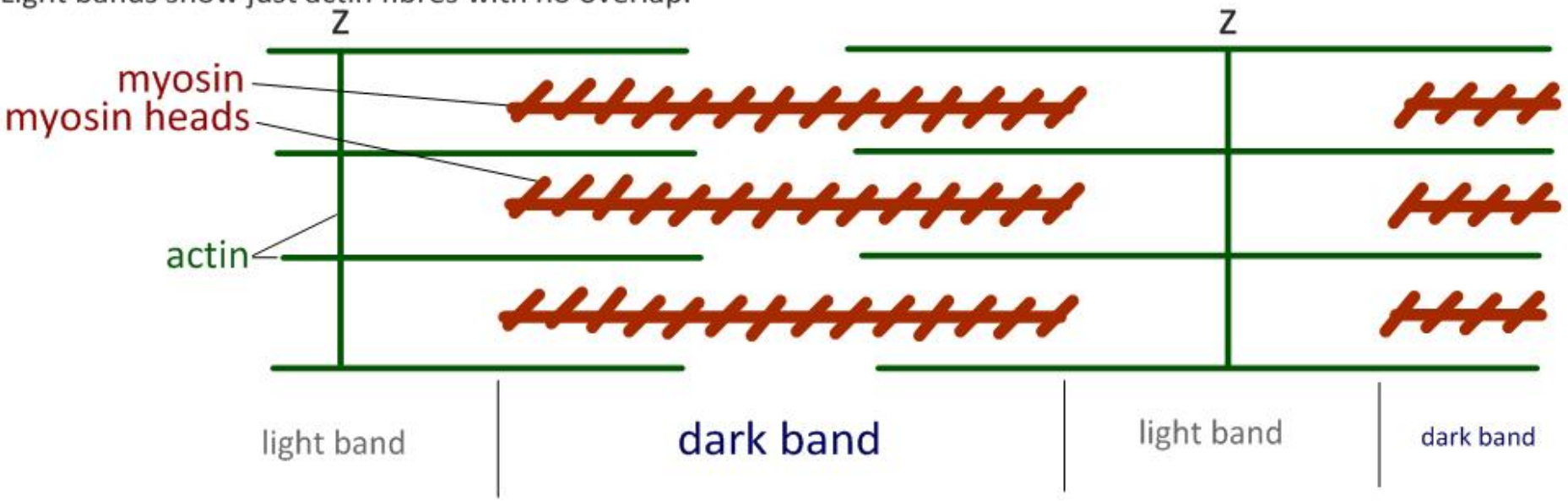
Watch:

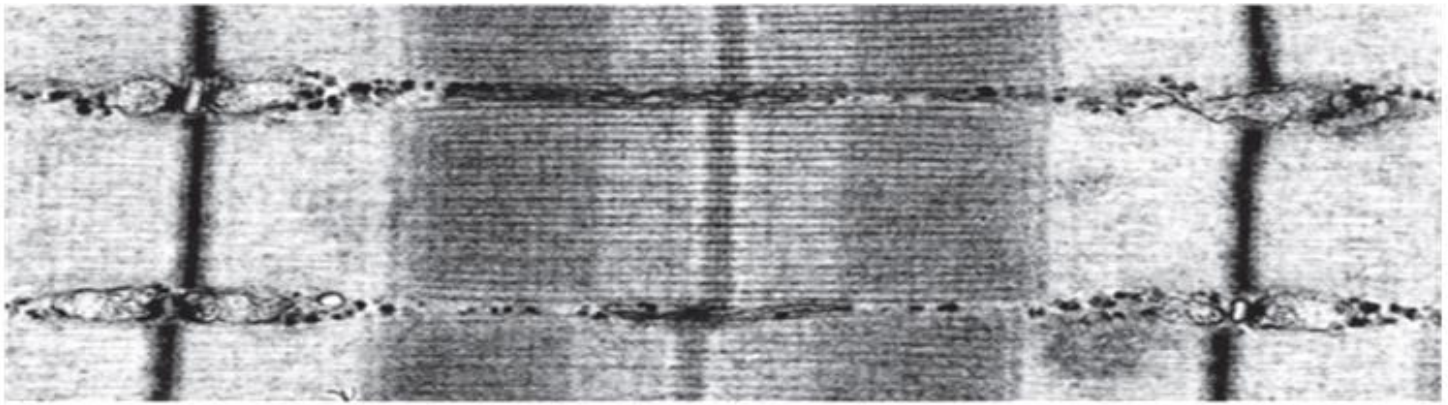


http://media.pearsoncmg.com/bc/bc_campbell_biology_6/cipl/ins/49/HTML/source/71.html

The sarcomere

Where we see dark bands, the actin and myosin are overlapping.
Light bands show just actin fibres with no overlap.

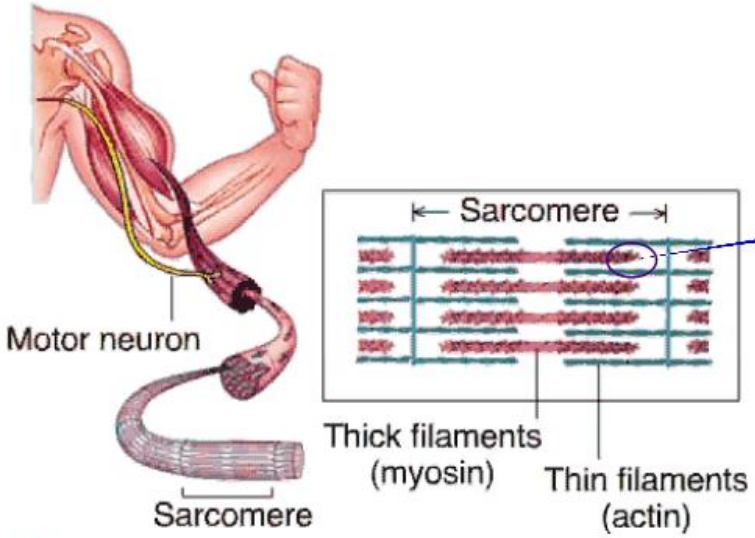


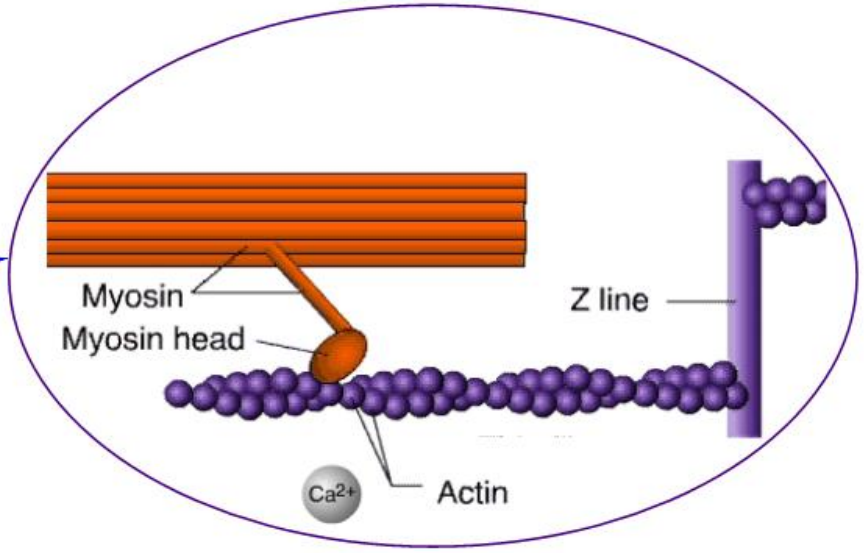


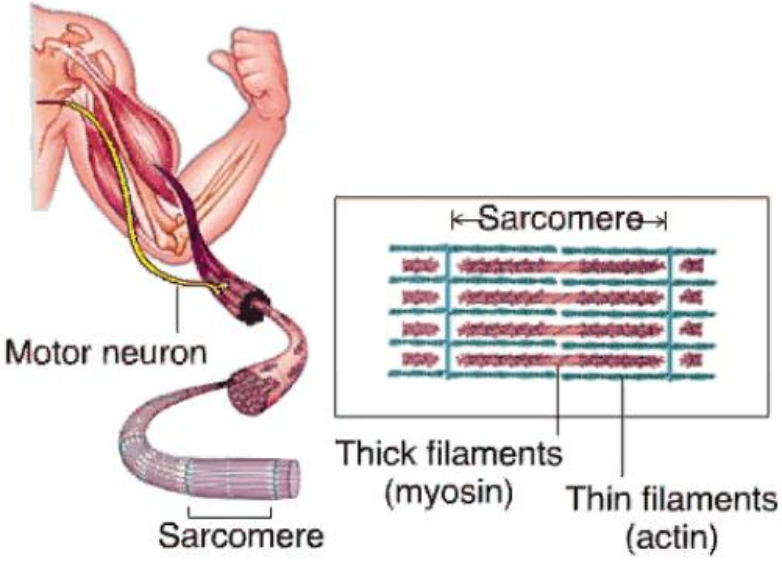
http://www.ks.uiuc.edu/Research/telethonin/MuscleL1.jpg

Electron microscope image

When muscles contract, actin slides over the myosin and causes the sarcomere to shorten:

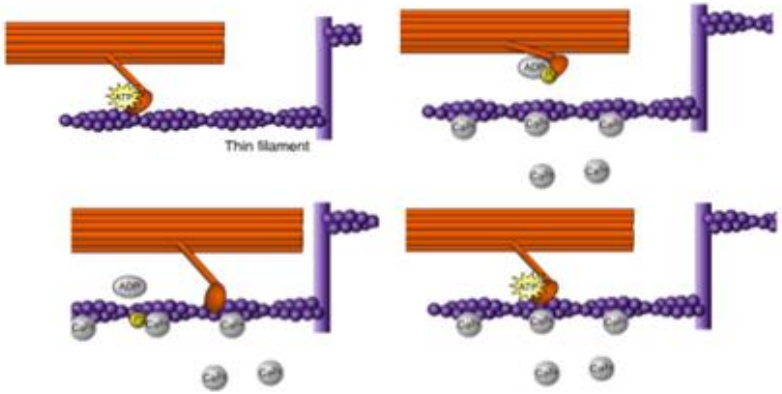






http://media.pearsoncmg.com/bc/bc_campbell_biology_6/cipl/ins/49/HTML/source/71.html

How does it work?
Watch this:



http://media.pearsoncmg.com/bc/bc_campbell_biology_6/cipl/ins/49/HTML/source/71.html

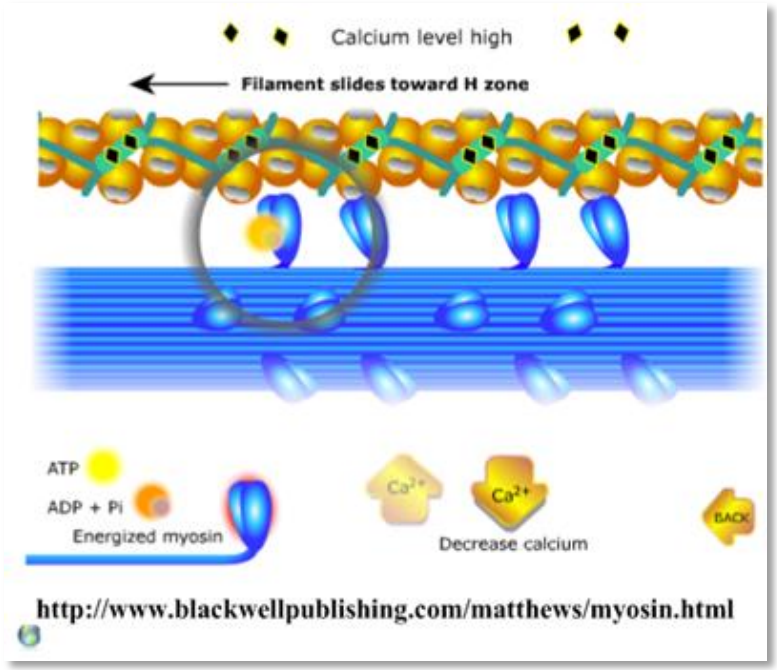
49-31-MuscleContraction.mov

Skeletal muscle contractions:

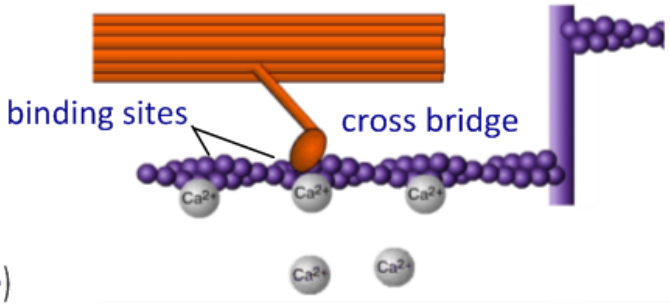
When an action potential (AP) reaches a striated muscle cell, the sarcoplasmic reticulum releases calcium ions Ca^{2+} into the myofibrils. $Ca2^{+}$ opens up binding sites on actin.

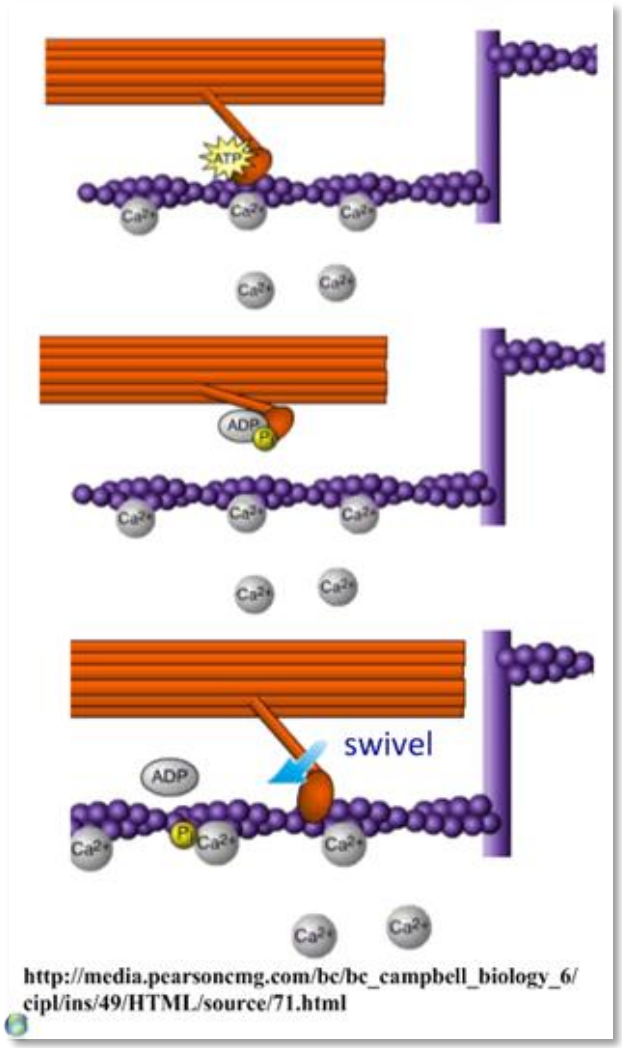
Myosin heads are bound to actin binding sites (making a cross bridge) and are stimulated to move. This causes the actin to slide over myosin, towards the centre of the sarcomere.

ATP releases the myosin head and re-sets it. It forms a new cross bridge with a different actin binding site and continues contraction.



This happens up to 5 times per second and ends when no more Ca^{2+} is released.





Explain how skeletal muscle contracts.

(8 marks)

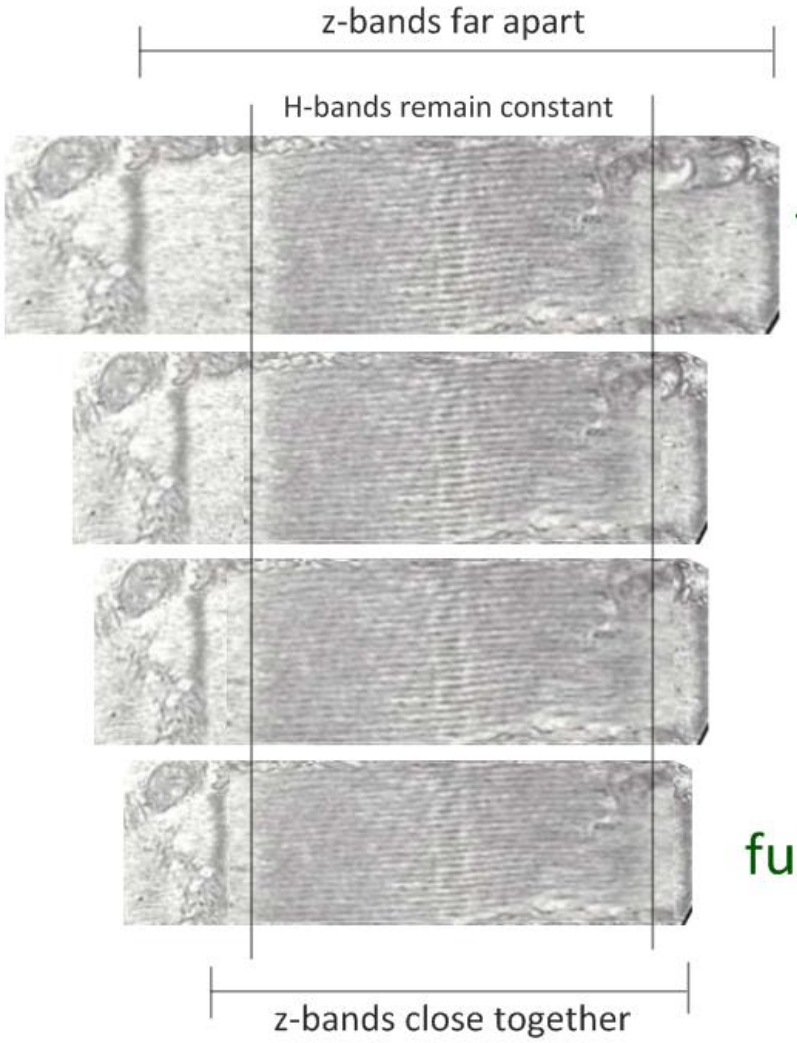
Explain how skeletal muscle contracts.

(8 marks)

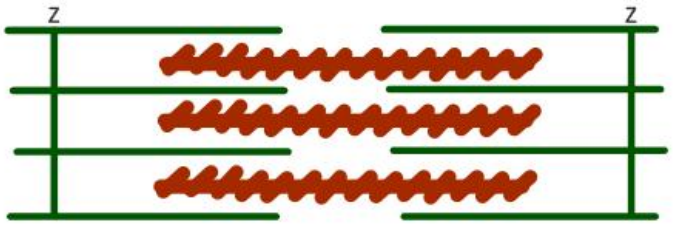
muscles/fibres/myofibrils contain (repeating) units called sarcomeres;
muscle/sarcomeres contain actin filaments and myosin filaments;
actin fibres are thin and myosin fibres are thick;
arriving action potential causes release of Ca^{2+} ;
from sarcoplasmic/endoplasmic reticulum;
Ca^{2+} binds to troponin;
causing troponin and tropomyosin to move (on actin);
exposing binding sites on actin / for myosin;
ATP binds to myosin heads releasing them / breaking cross bridges;
ATP hydrolysed / split into ADP + P_i;
ATP/energy causes myosin heads to change shape / swivel / become cocked;
myosin heads bind / form cross-bridges to (exposed) actin binding sites;
myosin heads swivel / move actin (releasing ADP + P_i);
myosin filaments move actin filaments towards centre of sarcomere;
sliding of filaments / actin and myosin shortens the sarcomere;

(From the QuestionBank CDRom)

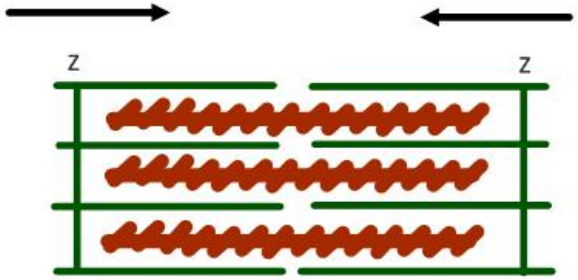
Electron micrographs showing contraction of one sarcomere:



fully relaxed



fully contracted



http://www.indigo.com/software/gphpcd/em37.jpg

Foot cramp?

For more IB Biology resources:

http://sciencevideos.wordpress.com

http://thechurchofbob.com/boblog/?tag=foot-cramp