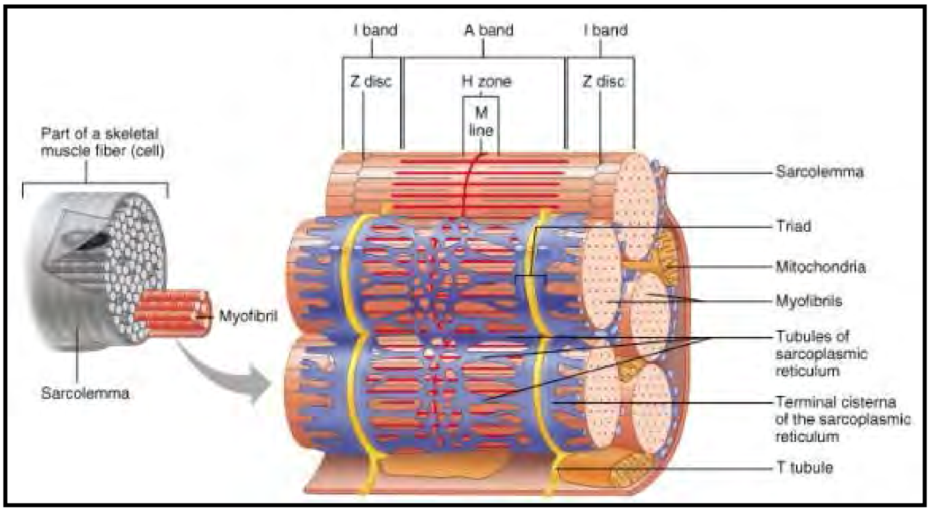
Section 11.1 – Structure of skeletal muscle

There are three types of muscle in the body:
Cardiac muscle which is found only in the heart
Smooth muscle which is found in the walls of blood vessels
Skeletal muscle which is attached to bone and is the only type of muscle under conscious control

Muscles are made up of many muscle fibres called myofibrils
If the cells of muscles were joined together from the end of one cell to another, the point between cells would be a point of weakness
Because of this, the muscle cells are fused together into muscle fibres
Cells of the same myofibrils share the same nuclei as well as cytoplasm (sarcosplasm).
Within the sacroplasm are many mitochondria as well as endoplasmic reticulum

Microscopic structure of skeletal muscle

Myofibrils are made up of two types of protein filament
Actin – thinner, consists of two strands twisted around each other
Myosin – thicker and is made up of long rod shaped fibres with bulbous heads projecting outwards
Myofibrils have coloured bands
The **isotropic (I) bands** appears lighter since it consists only of actin (no overlap)
The **anisotropic (A) bands** are darker since this is where acting and myosin overlap
The **H zone** is the region in the centre of the sarcomere that is lighter in colour since there is only myosin
The **z line** lies at the centre of the I bands



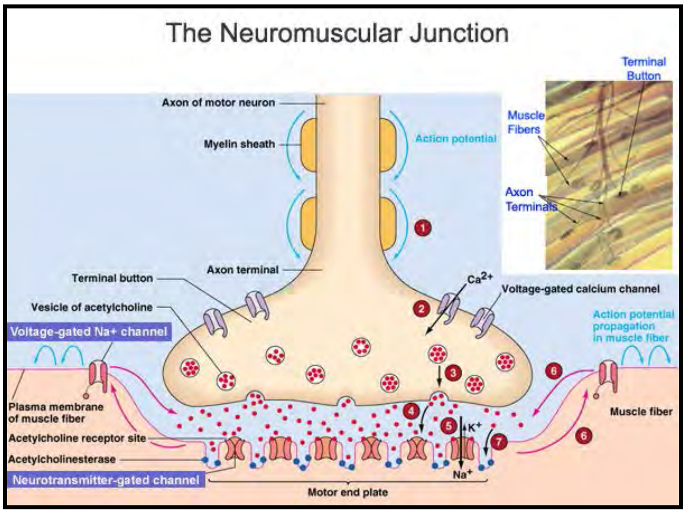
Types of muscle fibre

Slow-twitch fibres – Contract more slowly, less powerful. Adapted for endurance/aerobic respiration so less lactic acid forms
Adaptations include:

Large store of myoglobin, Supply of glycogen, Rich supply of blood vessels, Numerous mitochondria
Fast-twitch – Contracts more rapidly with more power but only for a short period of time. Adapted for intense exercise by:
Having thicker and more numerous myosin filaments, having a high concentration of enzymes used for anaerobic respiration, a large store of phosphocreatine to provide phosphate to make ATP

Neuromuscular junctions

Many neuromuscular junctions are spread through the muscle for simultaneous contraction
Each muscle fibre has one motor neuron associated with it. The muscle fibre and the neuron make up one motor unit
When only a small force is needed only a few motor units are stimulated
When a nerve impulse reaches the neuromuscular junction, the synaptic vesicles join with the presynaptic membrane and release acetylcholine which diffuses across to the postsynaptic membrane and stimulates it to allow sodium ions to enter. The acetylcholine is then broken down by Acetylcholinesterase and then diffuses back into the presynaptic neuron.



Section 11.2 - contraction of skeletal muscle

During muscle contract, actin and myosin slide past each other; hence its name "the sliding filament mechanism

Evidence for the sliding filament mechanism

When a muscle contract, the following changes occur to the sarcomere:
The I band becomes narrower
The z lines move close to one another
The h band becomes narrower
The a band does not change as this band is determined by the width of the myosin

Myosin is made up of two different types of protein

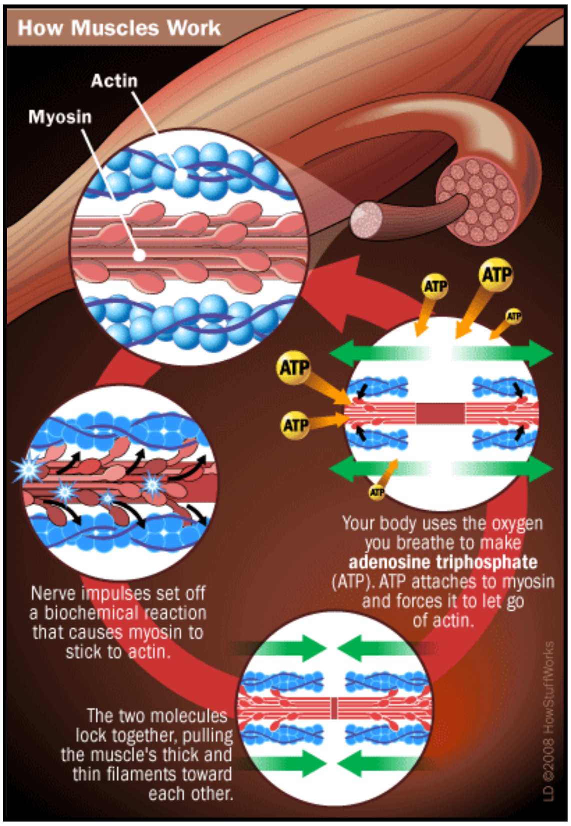
- A fibrous protein arranged into the filament called the tail
- A globular protein that forms a head at each end

Actin is a globular proteins that's molecules are arranged into two chains that twist around each other in a helical manner
Tropomyosin forms long thin stands that s wound around the actin molecule

The process of muscle contraction has a three main stages:
Stimulation, contraction and relaxation

Muscle stimulation

When an action potential reaches the neuromuscular junctions, Calcium ion channels open and calcium ions move into the synaptic knob
The Calcium ions cause the synaptic vesicles to move to the presynaptic membrane and fuse with it releasing acetylcholine
Acetylcholine diffuses across the synaptic cleft and binds with receptors on the sodium voltage gated channels on the postsynaptic membrane causing it to depolarise



Muscle contraction

The action potential movies through the fibres by travelling through T – tubules that branch through the sarcoplasm
The action potential moves through the tubules until it reach the sarcoplasmic reticulum
The action potential opens calcium ions in the sarcoplasmic reticulum
Calcium ions diffuse out into the muscle

Calcium ions cause tropomyosin to change shape and so that the binding sites on the actin filament are exposed
An ADP molecule that is attached to the myosin heads allows it to form a cross bridge with actin by binding with the receptor site
Once the cross bridge is formed, the myosin head changes shape and slides the actin across. In doing so it loses the ADP
An ATP molecule attaches to the myosin head and thus causes it to detach
Calcium ions activate the enzyme ATPase which hydrolyses ATP and releases energy that allows the myosin head to resume its original shape.
The myosin head now has a new ADP molecule that will allow it to bind with a new receptor site somewhere along the actin filament

Muscle relaxation

When the muscle is not being stimulated, the sarcoplasmic reticulum actively transport calcium ions back into it
The lack of calcium ions means that tropomyosin can establish its original position, covering the myosin head binding sites

Energy supply

Energy is needed for the movement of myosin heads and the active transport of calcium ions
ATP often needs to be generated anaerobically
Phosphocreatine provides inorganic phosphate molecules to combine with ADP to form ATP