Anterior and posterior view of superficial muscles

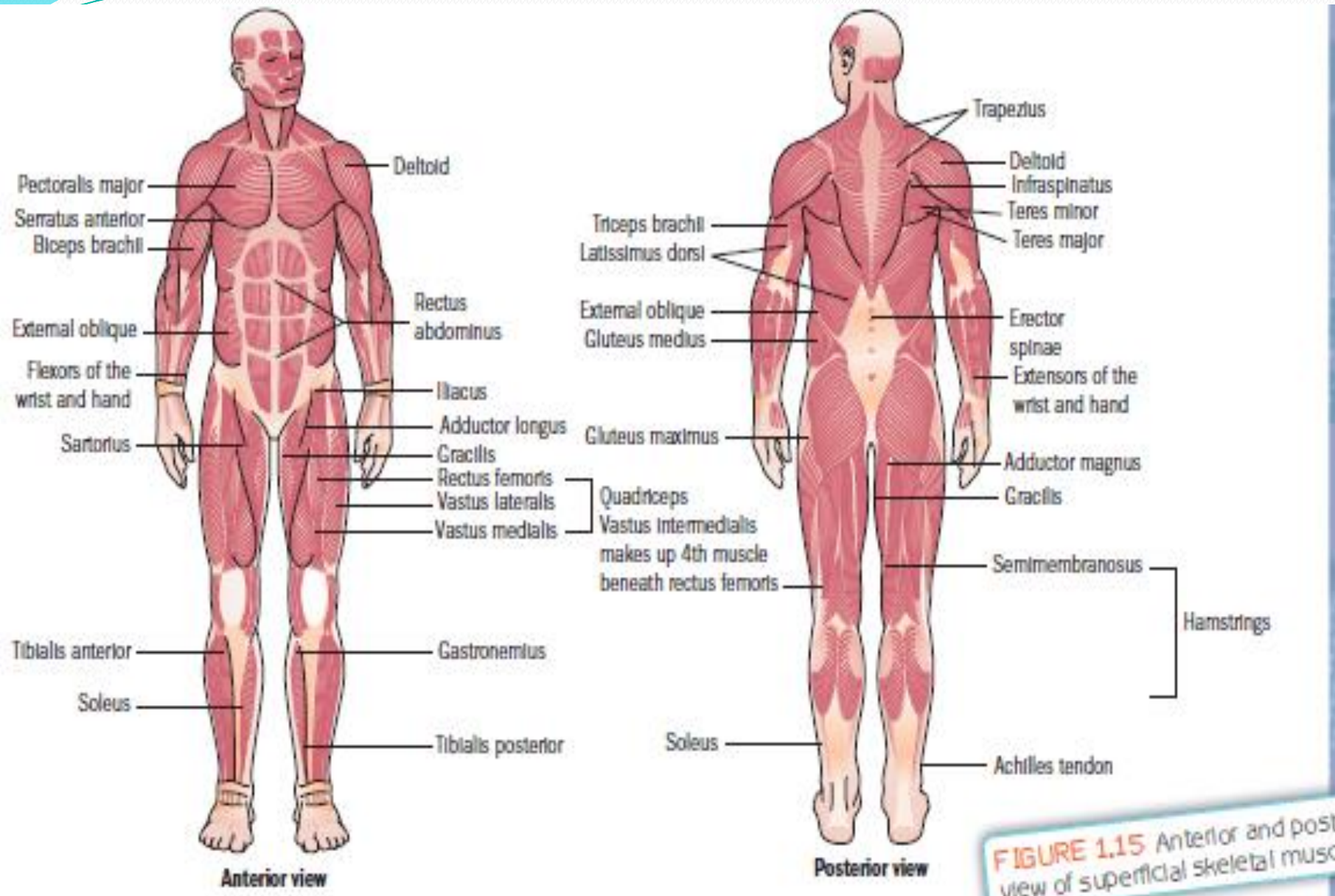


FIGURE 1.15 Anterior and posterior view of superficial skeletal muscles

Types of contraction

There are basically three types of muscular contraction, classified by the movement they cause. These are listed below in order of occurrence in everyday activity, from most common to least common:

- **isotonic** (concentric and eccentric)
- **isometric**
- **isokinetic**

Isotonic contraction
Occurs whenever the muscle length changes through a range of motion or action. When a constant load (weight) is being moved, differences exist in the amount of force applied at various joint angles.

Isometric contraction
Occur when tension is developed but no change results in the length of the muscle. Isometric contractions hence involve little, if any, change in muscle length while tension is developed.

Isokinetic contraction
Tension developed is maximal throughout the entire range of motion and is common on hydraulic fitness equipment. The amount of force applied by the machine always equals the amount of force applied by the muscle.

How muscles work

•A **muscle origin** occurs where it is attached to a stable bone.
•A muscle insertion occurs where it attached to a bone that it pulls on and moves.
•Muscles work in pairs or groups. The **prime mover** is the **agonist** whilst the opposite muscle is the **antagonist.**

Reciprocal inhibition occurs when one muscle contracts and its opposite relaxes, to allow movements to occur.

Muscles that **stabilise** a joint are also known as **fixator muscles** because they provide additional support at the origin to allow more forceful contractions to occur.

3 types of muscles?

Microscopic structure of muscles

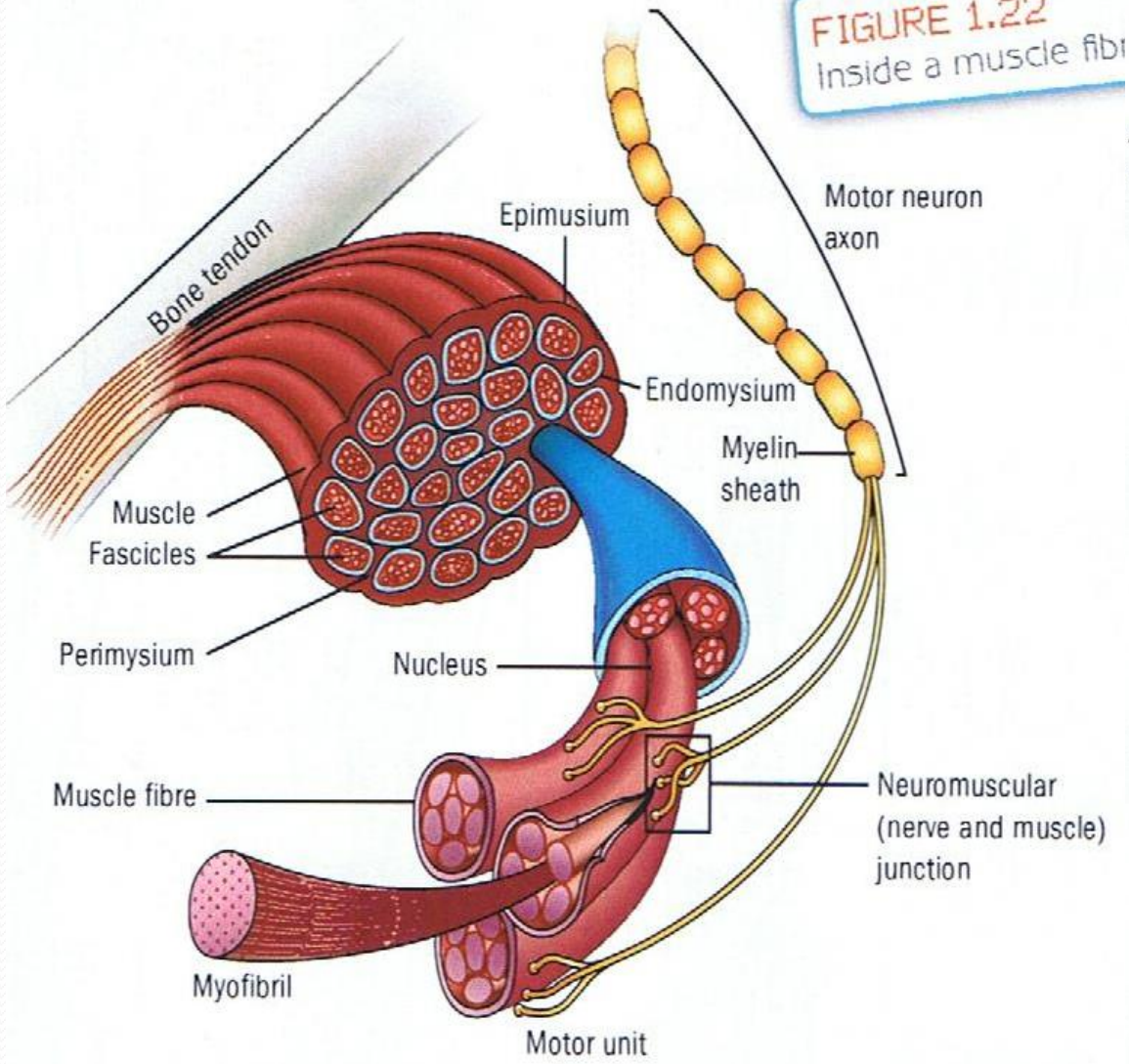


FIGURE 1.22 Inside a muscle fibr

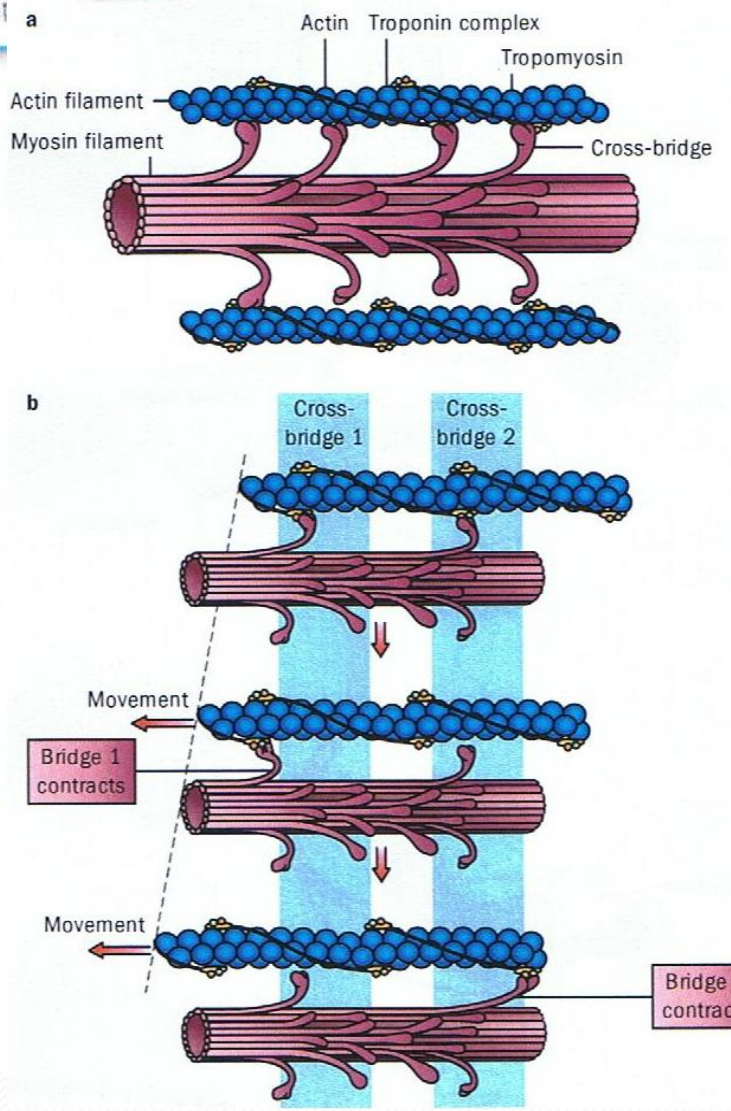
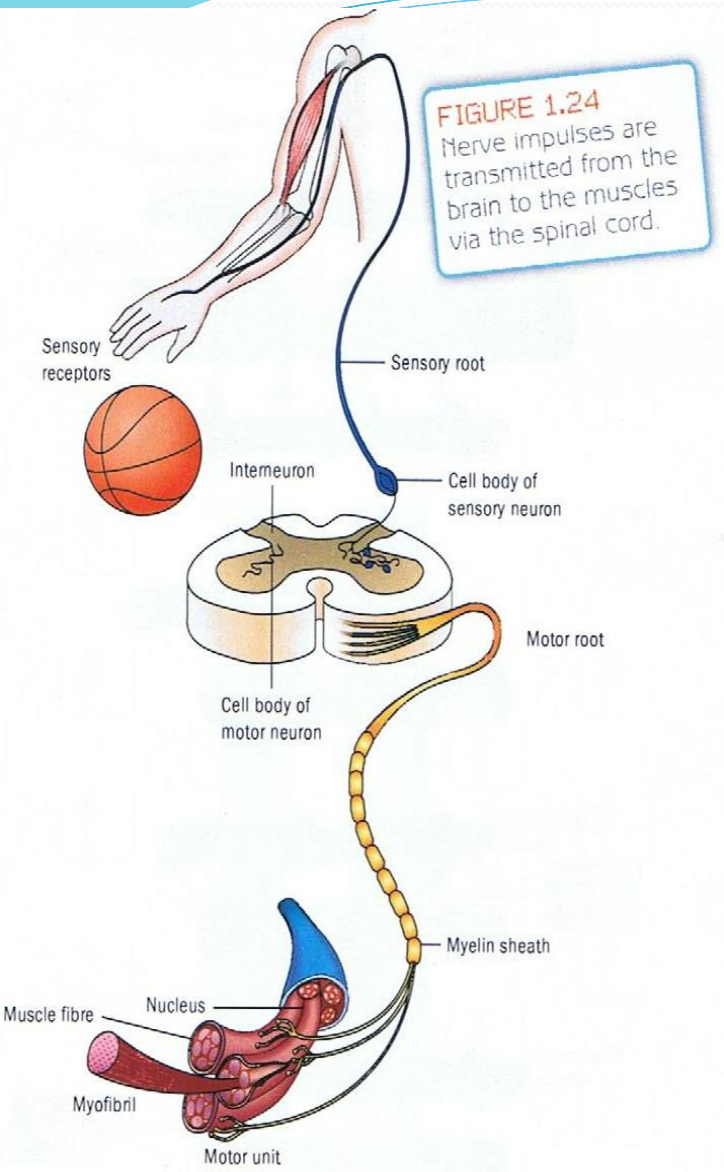


FIGURE 1.23 Structural arrangement of actin and myosin filaments in a sarcomere

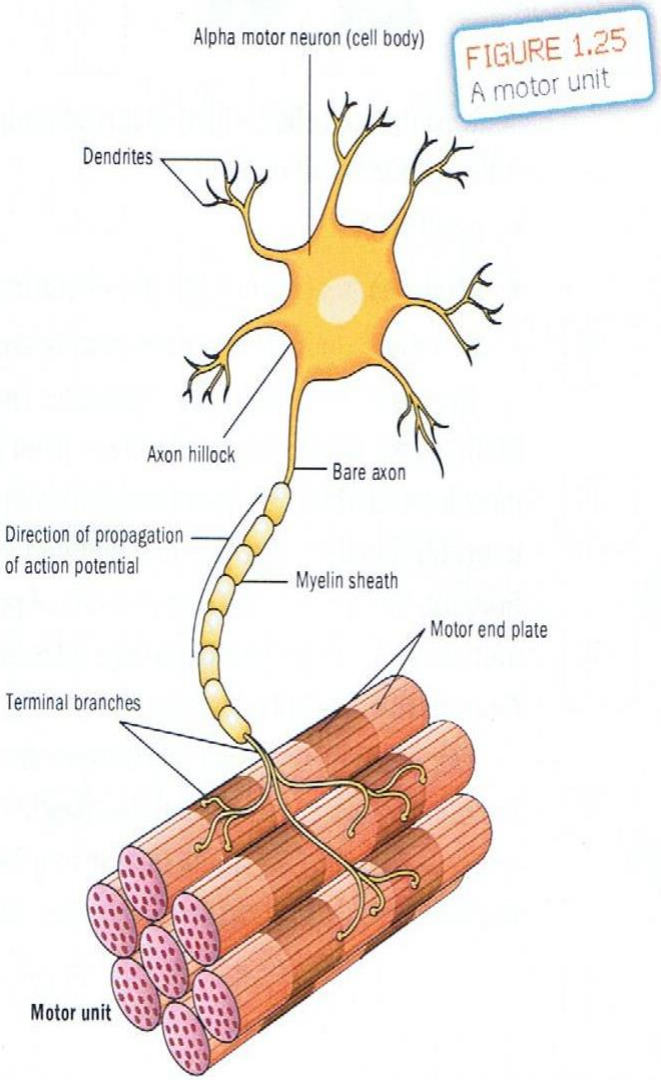
Nervous control of muscular contractions



Motor neurons convey nerve impulses form the brain to muscles

A motor neuron and the fibres it controls/stimulates are known as the **motor unit**

Sensory neurons convey nerve impulses from muscles, organs and cells to the brain



The **all or nothing principle** states:

It is not until an electrical threshold is surpassed that all of the fibres linked to a motor unit will fire together and maximally.

Gross movements requiring major muscle involvement require more motor units than precise/ fine movements.

Fibres will be recruited according to the activity demand and this is known as **preferential recruitment.**

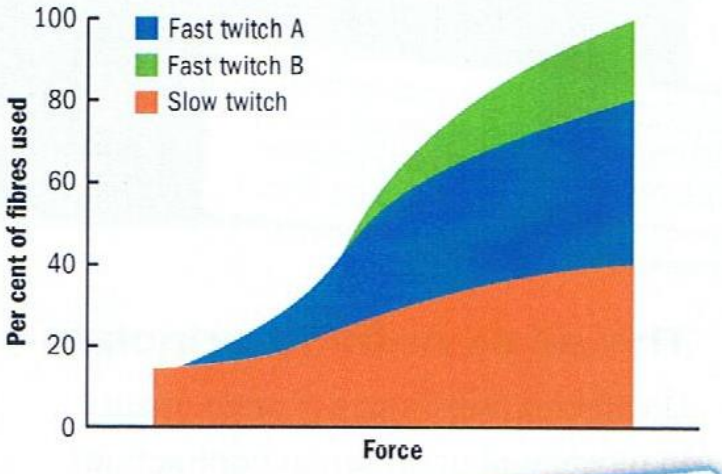


FIGURE 1.28 The recruitment of fibres increases as muscular force increases.

How muscles contract

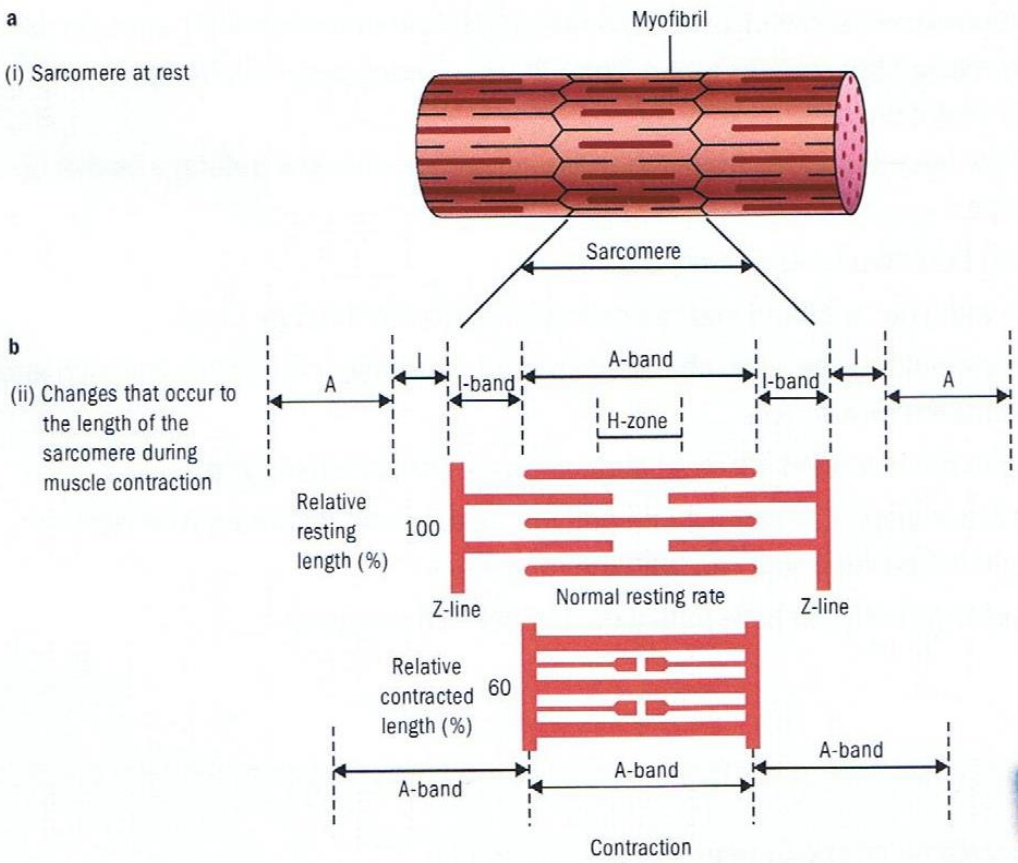
Muscle contraction and relaxation summary

In resting muscle:

- there are few or no electrical impulses reaching muscle
- there are Ca^{2+} ions within sarcoplasmic reticulum
- ATP is stored, not broken down.

During a contraction:

- nerve impulses travel along axons to the axon end plate
- acetylcholine travels across the synaptic cleft to myofibril
- sarcoplasmic reticulum releases Ca^{2+}
- myosin cross-bridges attach to actin
- ATP is broken down and energy is released, causing cross-bridges to shorten
- actin is pulled and slides over myosin and the muscle shortens or contracts.



Fast & slow twitch fibres

Muscles are made up of two different types of fibres:

• Red, type I, slow-twitch fibres (ST), best suited to aerobic, endurance work such as triathlons.

• White, type II, fast-twitch fibres (FT), best suited to short-duration, high intensity anaerobic work, for example the bursts of power and speed required to sprint.

Table 1.4

Characteristics of fast-twitch and slow-twitch fibres

Characteristic	Fast-twitch		Slow-twitch
	B	A	
Performance conditions	Purely anaerobic	Partially	Aerobic
Colour	White	White/red	Red
Oxidative enzymes	Low	Medium	High
Myoglobin content	Low	Medium	High
Glycolytic capacity	high	High	Low
Mitochondria density	Low	Medium	High
Capillary density	Low	Medium	High
Calcium capacity	High	Medium/low	Low
Myosin ATPase	High	High	Low
Phosphocreatine stores	High	Medium/low	Low
Triglyceride stores	Low	Medium/low	High
Fibre diameter	Large	Intermediate	Small
Contraction speed	High	Moderate	Slow
Force capacity	High	Intermediate	Low
Fatigue resistance	Low	Medium/low	High