

Muscle fibre types

PE REVIEW examines the characteristics of different muscle fibre types

Types I and II

Three main types of muscle fibre can be identified:

- Type I (slow oxidative)
- Type IIa (fast oxidative glycolytic)
- Type IIb/IIx (fast glycolytic).

Our skeletal muscles contain a mixture of all three types of fibre but not in equal proportions. This mix is mainly determined by genetics. The relative proportion of each fibre type varies in the same muscles of different people. For example, in an elite endurance athlete there will be a greater proportion of slow-twitch fibres in the quadriceps and gastrocnemius muscles in the legs and in an elite sprinter a greater proportion of fast-twitch fibres in these muscles. Postural muscles tend to have a greater proportion of slow-twitch fibres as they are involved in maintaining body position over a long period of time so require endurance.

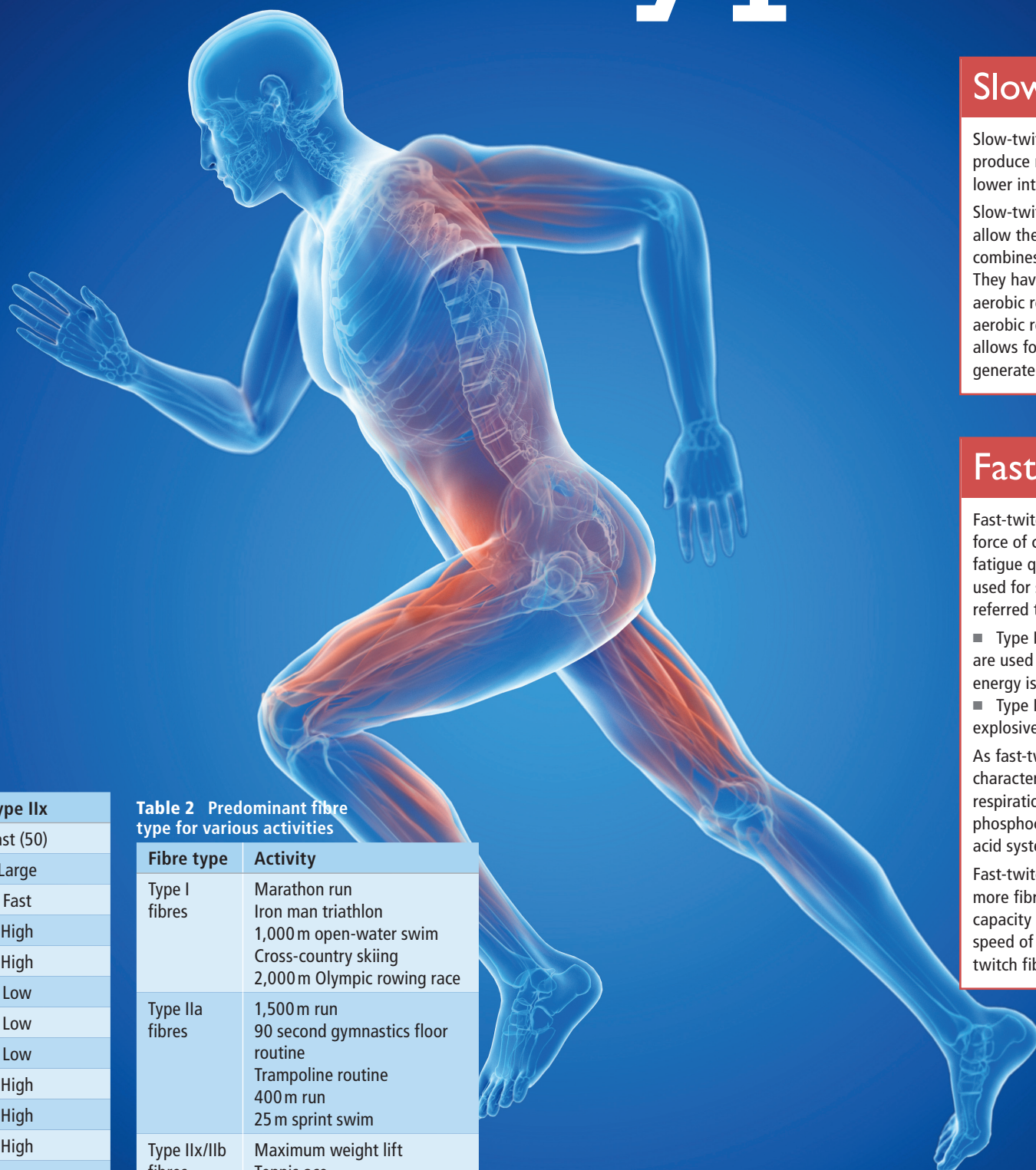


Table 1 Muscle fibre characteristics

Characteristic	Type I	Type IIa	Type IIx
Contraction speed (ms)	Slow (110)	Fast (50)	Fast (50)
Motor neurone size	Small	Large	Large
Motor neurone conduction	Slow	Fast	Fast
Force produced	Low	High	High
Fatiguability	Low	Medium	High
Mitochondrial density	High	Medium	Low
Myoglobin content	High	Medium	Low
Capillary density	High	Medium	Low
Elasticity	Low	High	High
Phosphocreatine store	Low	High	High
Glycogen store	Low	High	High
Aerobic capacity	Very high	Medium	Low
Anaerobic capacity	Low	High	Very high
Myosin ATPase/glycolytic enzyme activity	Low	High	Very high

Table 2 Predominant fibre type for various activities

Fibre type	Activity
Type I fibres	Marathon run Iron man triathlon 1,000 m open-water swim Cross-country skiing 2,000 m Olympic rowing race
Type IIa fibres	1,500 m run 90 second gymnastics floor routine Trampoline routine 400 m run 25 m sprint swim
Type IIx/IIb fibres	Maximum weight lift Tennis ace Spike in volleyball Hammer throw Yurchenko layout vault in gymnastics

Slow-twitch fibres

Slow-twitch fibres (Type I) have a slower contraction speed than fast-twitch fibres and they produce most of their energy aerobically (using oxygen). As a result, they are better adapted to lower intensity exercise such as long distance running.

Slow-twitch fibres have a high aerobic capacity and therefore have specific characteristics that allow them to use oxygen more effectively. They have more myoglobin, the red pigment that combines with oxygen in the muscle, and for this reason they can also be called red fibres. They have more mitochondria, which are the microscopic structures in the muscle where aerobic respiration takes place. More mitochondria also means more oxidative enzymes for aerobic respiration. Slow-twitch fibres also have a greater number of capillaries per fibre, which allows for a better blood supply, enabling greater gaseous exchange. However, they are slow to generate a lot of force and are smaller in size than fast-twitch fibres.

Fast-twitch fibres

Fast-twitch fibres (Type II) have a much faster contraction speed and can generate a greater force of contraction. However, they have a relatively poor aerobic endurance and therefore fatigue quickly. They produce most of their energy anaerobically (without oxygen) and are used for short, intense bursts of effort such as sprinting. With fewer myoglobin they are often referred to as white fibres. There are two types of fast-twitch fibre:

- Type IIa fast oxidative glycolytic: these are more resistant to fatigue than type IIx/IIb and are used for events such as the 1,500 m in athletics or a 400 m swim where a longer burst of energy is needed.
- Type IIx/IIb fast glycolytic: these fatigue much quicker than type IIa and are used for highly explosive events such as the 100 m in athletics where a quick, short burst of energy is needed.

As fast-twitch fibres contract more rapidly than slow-twitch fibres, they have specific characteristics that allow them to produce these rapid contractions. They rely on anaerobic respiration and have a much larger anaerobic capacity, and so have larger stores of phosphocreatine and glycogen (fuels for the ATP/PC system and the anaerobic glycolytic/lactic acid system).

Fast-twitch motor neurones are larger than slow-twitch motor neurones, which means that more fibres are stimulated, increasing the force of contraction. Motor neurone conduction capacity refers to the speed of the impulse along the motor neurone. In fast-twitch fibres the speed of the impulse is much higher. Myosin ATPase releases energy from ATP and in fast-twitch fibres myosin ATPase activity is higher so energy is released faster.

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