

The Science of Health, Nutrition and Fitness

Physiology and Characteristics of the Slow Twitch Muscle Fibre

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Within the human body not all muscle fibres are born equal. The muscle fibres within skeletal muscle have distinct physiological characteristics which dictate their functionality and location within the working muscles. For example, postural muscles located in the back and legs have a greater requirement for 'sustained' energy and so require a muscle fibre type that can facilitate that requirement. This is the domain of the slow twitch muscle fibre.

Slow twitch muscle fibres are also known as red fibres, oxidative fibres and type I fibres. Some of their names are related to the characteristics they possess. These are the main 'aerobic' fibre type found within skeletal muscular system. They are associated with activities such as running and long distance based events. An outline of the slow twitch fibres characteristics is outlined below:

Slow Twitch Muscle Fibre Characteristics

Characteristic	Slow Twitch (Type I)
Contraction Velocity	Low
Motor Neuron Size	Small
Relaxation Velocity	Low
Capillarization	High
Myoglobin Content	High
Mitochondrial Content	High
Fatigue	Slow
Speed and Power Generation	Low
Energy Sources	Fats, Carbohydrates, Amino Acids
Fibre Diameter	Small
Oxidative Capacity	High
Glycolytic Capacity	Medium
Maximum Duration of Use	Hours
Main Storage Fuel	Triglycerides
ATPase Activity	Low
Fibre Colour	Red

The above table highlights the fact that the slow twitch fibre is not associated with high force production and is a more sustainable 'long term' muscle fibre. This muscle fibre relies heavily on oxygen as this is required to break down fats and carbohydrates in the metabolic processes. Oxygen is also one of the fundamental reasons why aerobic energy production in the slow twitch fibres does not produce lactic acid.

Physiological Construction of the Slow Twitch Fibres

Physiologically the slow twitch muscle fibre has several elements that distinguish it from the other fibre types. These physiological constituents also give the fibre its oxidative component. In terms of structure the slow twitch fibre is much like any other muscle fibre, in that it consists of myofibrils, sarcomeres and actin and myosin contractile proteins. Where it differs is in its organelle and cardiovascular physiology. For example, slow twitch fibres have a denser capillary bed than fast twitch fibres. This allows greater blood delivery and therefore substrates such as fats and carbohydrates are more abundant as a fuel source. Oxygen delivery is also enhanced which is highly advantageous to the aerobic metabolic processes. Aerobic training has the potential to increase the capillary supply. (Hepple, R.T. *et al*, 1997; Gute, D. *et al*, 1996)

Another 'oxidative' advantage is the presence of large amounts of myoglobin; an oxygen binding pigment that gives the slow twitch fibre its 'red' appearance. This increased myoglobin content; compared to fast

twitch fibres, allows the slow twitch fibres to be provided with more oxygen as myoglobin's role is to shuttle oxygen from the cell membrane to the mitochondria. This myoglobin content can be increased significantly with an effective aerobic training regimen from anywhere between 13 – 45%. (Hickson, R.C., 1981)

The mitochondria are an organelle found in abundance in the slow twitch fibres. Mitochondria are known as the 'aerobic powerhouse of a cell'. Aerobic training has the potential to increase this mitochondrial component in terms of size and number (Holloszy, J.O., 1984); so increasing the ability of slow twitch fibres to work aerobically.

Slow twitch fibres carry out their metabolic function using a number of different aerobic enzymatic components. Enzymes involved in aerobic metabolism include; succinate dehydrogenase, malate dehydrogenase and carnitine palmityl transferase. Research has illustrated that aerobic training can increase the availability and activity of key enzymes required for aerobic metabolism (Fink W.J. *et al*, 1977; Gollnick, P.D., and B. Saltin, 1982 and McAllister R.M. *et al*, 1997)

Slow Twitch Fibres and Sport Specifics

In bodybuilding the slow twitch fibres have very little influence except in the pre-competition cutting phases when use of oxidative systems and slow twitch fibres might be used to burn fat as an energy source and thus reduce body fat levels. Slow twitch fibres have a small cross sectional area and do not have great potential for hypertrophy using traditional high intensity training (S. J. Baker and L. Hardy, 1989). However, with respect to the bodybuilder, some caution must be used in the employment of aerobic training where body mass increases and strength are of significance. Research has illustrated that if endurance training is utilised over a long period, fast twitch fibres may take on slow twitch properties and thus would detract from strength or mass gains. (Thayer R. *et al*, 2000, Wilson J.M. *et al*, 2012).

As has already been identified, aerobic training results in various adaptations in slow twitch fibres which can include increased capillarization, increased myoglobin content, increased mitochondrial content, potential increases in cross sectional area and greater aerobic enzyme activity. All of these adaptations would increase the ability of the ST fibres to work aerobically and therefore have a positive effect on endurance potential. (Wang N. *et al*, 1993).

Highly aerobic activity could be involved in the reduction or *atrophy* of slow twitch fibre cross sectional area. (Trappe S. *et al*, 2006). This diminution of cross sectional area, taking place, despite a maintained or improved aerobic capacity of the slow twitch fibres. For an endurance athlete or a light weight combatant based sports person, this adaptation would have optimisation advantageousness.

Slow Twitch Fibre Summary

- Terms ST Fibres, Red Fibres, Type I or Oxidative Fibres
- Used in long and ultra-distance events such as the marathon
- Contain a high number of mitochondria, number can be increased with training (Holloszy, J.O., 1984)
- High myoglobin content which can be increased with training (Hickson, R.C., 1981)
- Fibres have a vast capillary supply which can be increased with aerobic training (Hepple, R.T, 1997)
- Aerobic enzyme content and activity can be increased with aerobic training (Fink W.J. 1977)
- Aerobic training can atrophy ST fibres why increasing functionality (Thayer R. 2000)

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