

Types of **Skeletal** Muscle fibres.

Muscle can be classified into two major categories:

- (1) small diameter, red or slow or Type I muscle fibres;
- (2) large diameter, fast (white) or Type II fibres.

But category (2) is further subdivided into Type IIa (fast oxidative muscle) and Type IIb (fast glycolytic muscle). In recent times, other classes of skeletal muscle fibres have been discovered, but it is sufficient to know about the three classes of skeletal muscle fibres, slow fibres, slow twitch fibres and fast twitch fibres. These have characteristics which can be summarised:

Muscle categories	Type I Slow fibres	Type IIa slow twitch fibres	Type IIb fast twitch fibres
Colour	red	red	white
Shortening speed	slow	fast	fast
Myosin ATPase	slow	intermediate	fast
Fatigue	resistant	intermediate	easily
Metabolism	oxidative	oxidative	glycolytic
<i>Diameter</i>	small	intermediate	large
Volume of SR	small	medium	well developed
Mitochondria	many	intermediate	few
Lipid droplets	many	intermediate	few
Glycogen	low	intermediate	high
Capillaries	lots	intermediate	few
Myoglobin	lots	lots	low

A Comparison of Different Muscle Fibre

SKELETAL	CARDIAC	SMOOTH
striated	striated	non -striated
tubes	branching tubes	spindle-shaped
hexagonal array of filaments	hexagonal array of filaments	filaments disordered
peripheral nucleus	central nucleus	central nucleus
A & I bands , Z discs	A & I bands , Z discs	no bands, dense bodies
Ca regulation is based on thin filaments	Ca regulation is based on thin filaments	Ca regulation is based on the myosin thick filaments
Moderately vascular	Highly vascular	not vascular
voluntary control	autonomic control	autonomic control
Terminally differentiated	Terminally differentiated	capable of proliferation

Cardiac muscle fibres are smaller (20 μ) in diameter and much shorter (80 μ) than skeletal fibres and they branch. They also have a centrally placed nucleus. The connection between contiguous fibres is via the **intercalated disks**. Electrical continuity is via the peripheral *tight junctions*. The thin filaments at ends of the fibrils insert into the *fasciae adherens*. A desmosomal-like structure, the *macula adherens*, enables adjacent cells to adhere to each other. Ventricular fibres resemble **slow** skeletal muscle fibres whereas atrial fibres are **relatively fast**. **Purkinje** fibres are modified cardiac muscle fibres, specialised for fast conduction of action potentials. They are large in diameter (therefore faster) and have few myofibrils which tend to be located at the periphery of the fibres. They contain large amounts of glycogen. In your class you will see human cardiac muscle. The Purkinje fibres are recognisable because they are large, pale-staining and are usually near the surface of the heart tissue. Many Purkinje fibres form a Bundle of His. The Purkinje fibres rapidly conduct APs from the AV node to the apex of the heart where they directly join papillary muscles.

Smooth muscle fibres

Smooth muscle fibres are small, spindle-shaped non-striated cells with a single centrally-placed nucleus. They contain disorganised thin (actin-containing) and thick (myosin-containing) filaments. The former are attached to *dense bodies* which are the equivalent to the Z disks. The Ca-control of smooth muscle is by the myosin (using a phosphorylation mechanism) rather than via the thin filament regulation found in striated muscles.

The Cytoskeleton

All cells have a cytoskeleton which give cells their shape, enable them to divide and stir up the cytoplasm. This cytoskeleton consists of a system of MICROFILAMENTS which are principally composed of actin (the same protein that is located in the thin filaments of skeletal muscle). Molecular motors run along these microfilaments and carry various "loads". For example, in nerve cells, new proteins, chemical transmitters (acetyl choline, glutamate) and other important

molecules are made in the cell body (soma) of the nerve cell and have to be transmitted down to the end of the axon.

Molecular Motors

Most textbooks do not tell us about important new facts concerning molecule motors. We now know from the crystallographic structures of all of these motor proteins (myosin heads, kinesin and ncd) are very similar. In fact, the central structural core of these proteins can be almost perfectly superimposed. This is true despite the fact that there is very little amino acid sequence homology. Furthermore, a major protein involved in cell signalling (G-protein) has essentially the same structure as these motor proteins.

Molecular motors come in two “flavours” (1) conventional two-headed myosin and unconventional single-headed myosins which run along the microfilaments system, always travelling in the same direction; and (2) microtubules which are large (relative to actin filaments) tubes consisting of two proteins called α - and β -tubulin along which runs at least two kinds of motors, kinesin (120kDa) which is an anterograde (forward propelling) motor, and ncd which is retrograde (moves in the opposite direction to kinesin). Thus, the microfilaments and microtubules can act as railway lines for motor proteins moving in *both* directions.