Medicine for Managers

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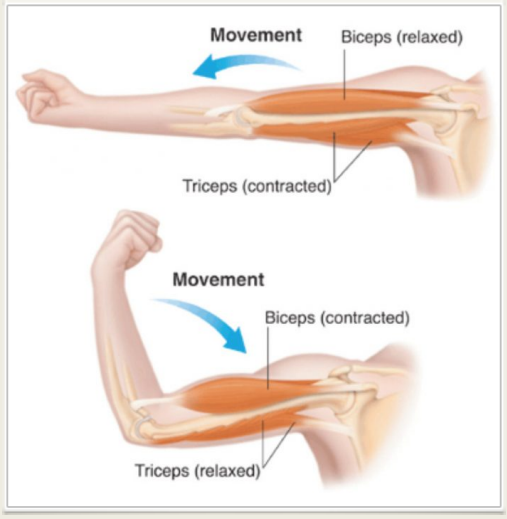
Our Mighty Muscles

Anatomy is a fascinating topic. Much of the understanding of medicine depended on the elucidation of the body's structure. Despite many early legal and religious challenges opposing human dissection, gradually the appreciation of our amazing structure and its function enabled many of the mysteries of diseases and disorders to be understood. High on the list of structural wonders is our musculature and how it works.

About half of the body weight is composed of muscle. Their structure and mechanism enables every muscle cell to ***contract*** so that their length and shape changes. Muscle impacts on every system and every function. It should be remembered that the body can only do two things; it can move and it can secrete. The word muscle derives from the Latin ***musculus***, meaning little mouse, presumably so-called because of the way that muscles move under the skin when contracted.



Muscle movement may be achieved by conscious thought, whilst other muscles are able to function autonomously and involve no conscious control on the part of the individual.

Those muscles which react on command from the body are called ***skeletal muscles***.

Those which act unconsciously are of two types, ***smooth muscle*** found in locations such as the gut and blood vessels, and ***cardiac muscle***, which is found solely in the heart.

Although cardiac and smooth muscle do have nerve supplies to influence their function, they can also respond to external factors such as hormones and other local stimuli, such as being stretched.

Skeletal muscle depends entirely on stimulation by nerves for its function. Essentially, if the nerve supply ceases to function, the skeletal muscle does not work.

How do muscles work?
In simple terms, muscles contain protein filaments of ***actin*** and ***myosin***.

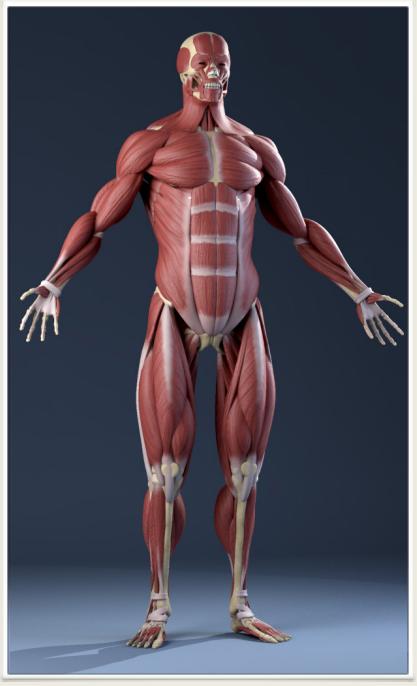
When stimulated they are able to slide past each other. All three types of muscle are covered by membranes that exhibit a property called ***excitability***.

That means that the membranes change their polarity (the electrical state changes from positive to negative when an appropriate stimulation is received) and an electrical wave, called an ***action potential*** extends down the entire length of the

muscle membrane. This stimulates the protein filaments to slide (and shorten) and the muscle as a whole becomes bunched up and shorter.

The biceps contraction illustrates the change. The biceps muscle illustrated is an example of a skeletal muscle.

Muscles are attached at a fixed point at each end. When the muscle contracts, the two points are pulled together creating movement. The biceps is in fact two muscles (*bi* -two) attached together.



At each end of the muscle is a tendon, a tough fibrous cord which attaches it to the shoulder blade and the upper part of the shoulder joint above, and to the radius bone in the lower arm, below the elbow joint.

When the muscle contracts, the elbow flexes and the muscle appears as a bulge in the upper arm. The size of the biceps is a conventional symbol of bodily strength.

Muscles are associated with and attached on both sides of all the bodily joints. In this way, their contraction results in the achievement of movement (locomotion) and the maintenance of posture.

With posture, it is generally maintained as an unconscious reflex but the muscles responsible react to conscious control to keep the individual erect when standing.

The average male adult is composed of 42% of skeletal muscle, as a percentage of body mass.

The average female is composed of 36% of skeletal muscle.
Most authorities suggest that the human body has about 650 skeletal muscles, although the number varies according to how they are counted and some are not present discretely in some people.

Skeletal muscle is sometimes called ***striped muscle***.

This is because the regularly arranged actin and myosin proteins are arranged linearly within the cytoplasm of the muscle cells and the arrangement appears as stripes or ***striations*** when viewed under the light microscope. Cardiac (heart) muscle also displays striations.

Skeletal muscle fibres are ***multinucleated***.

Not all skeletal muscle displays the same functional characteristics.

There are variations in the force which the muscle can exert, the speed with which it reacts to stimulation and the ease with which it tires.

The variation between muscles is the result of variations in blood supply, the relative supply of oxygen, glucose and fat and the cellular structure of the muscle cell.

Some muscles, well supplied with oxygen and nutrients, can sustain repeated contraction over a long period but with relatively little force.

Other muscles are able only to contract rapidly and forcefully for a very short time, without the use of oxygen (***anaerobic***), but tire quickly.

The different types are all important and are exemplified in situations such as walking a long distance where sustained activity is important, or in the flight mechanism where short bursts of speed are necessary.

Smooth or ***Involuntary*** muscle is found within the walls of organs and structures.

These include the blood vessels, the gut, the bronchial tubes, bladder, uterus and the erector pili muscles of the skin (the muscles which cause the hair to stand on end when cold or frightened).

These muscles are not under conscious control. There are billions of smooth muscle fibres in the adult body.

Clearly it is important that smooth muscle operates continuously and reliably when we are awake or asleep to maintain blood pressure, respiration and digestive activity, among many other functions.

Smooth muscle fibres are shaped more like a rugby ball, with a wide middle and tapered at each end. They have a single nucleus and are hundreds of times shorter than skeletal muscle fibres. They do contain actin and myosin and may have thick or thin fibres.

The actin and myosin are not arranged in the regular fashion seen in skeletal muscle and therefore do not have the same striated appearance. However, they are not less efficient than skeletal muscle.

Smooth muscles are present in the walls of blood vessels and internal organs. The smooth muscle in blood vessels maintains the calibre of the vessels and pushes blood along the arteries as required.

The muscle within the internal organs pushes any material contained within them through the organ to point where it is used or excreted.

Cardiac muscle is specifically found in the heart. The heart contracts, rhythmically pushing blood into the circulatory system.

It does have a similar, though less organised, structure than skeletal muscle with striations which are less discrete.

The fibres are branched and connect with other muscle cells. Cardiac muscle fibres are shorter than skeletal muscle fibres and usually have a single nucleus.

The cells have cellular inclusions that enable them to generate energy by producing a chemical compound called ***Adenosine TriPhosphate (ATP)***. Cardiac muscle is truly amazing, contracting rhythmically for seventy or more years. A heart beating eighty times a minute on average will
Contract one hundred and fifteen thousand times a day, over forty million times a year, without fail.

Some bodily muscles are very strong and opinions vary as to the strongest.

Candidates for the strongest muscle include the masseter muscle, which closes the lower jaw and has been estimated to produce a bite strength of quarter of a ton.

The gluteus maximus muscle, the largest of the three extensor muscles of the hip, makes up a large part of the shape of the buttock and is very powerful.

The muscles of the uterus, which weigh about 2½ pounds at the full-term of a pregnancy, can exert a force of between 25 and 100 foot pounds (an awful lot) with each downward contraction.

Horses for courses, but all truly powerful and effective.

Without our muscles we could not have our very existence.

We could do nothing.

In an article to come, we shall look at what happens when disease strikes the muscles.

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