Movement and locomotion:

Some background:

For movement and locomotion, we need two parts.

1) A skeleton. This provides provide support, protection, and movement.

(It provides a place for muscles to attach to, and something for muscles to move).

There are two main types of skeleton:

i) exoskeleton - a skeleton on the outside, found, for example, in arthropods.

ii) endoskeleton - a skeleton on the inside (what we have).

(There are other types of skeleton (e.g., hydrostatic), but we won't worry about them).

2) Muscles. These move the skeleton, and therefore the entire animal.

Bones are moved against each other by using joints. See fig. 30.3C on p. 607 for some examples.

Muscles only contract, so they are usually arranged in opposing groups **[Fig. 30.7, p. 611]**.

We probably know enough about the skeleton, so we'll concentrate on muscle function (using *skeletal muscles* as an example). Muscles are also the part that interacts with the nervous system **[Fig. 30.8, p. 612]**.

Muscles are composed of bundles of *muscle fibers*.

These bundles are in turn composed of *individual muscle fibers.*

Note: an *individual muscle fiber* = *individual muscle cell*.

Each muscle fiber is, in turn, composed of *myofibrils*.

Finally, myofibrils are, in turn, composed of two types of molecules.

actin - this makes up thin filaments.

myosin - makes up thick filaments (this is the part that will actually cause movement).

These two filaments are arranged in a very regular pattern that allows these filaments to slide past each other as the muscle contracts.

(Don't worry about the names of the different bands (i.e., I band, Z band, etc.).)

Actin and myosin fibers lie next to each other.

Under certain circumstances, the "head" of the myosin fiber will make contact with the actin fiber and cause the actin fiber to slide past the myosin.

Suppose the action potential arrives from a nerve.

Acetylcholine is released, and this excites the muscle cell.

This causes the *sarcoplasmic reticulum* (basically a storage area) to release Ca^{++} ions.

(The sarcoplasmic reticulum actively stores Ca^{++} ions, and releases them in response to an action potential **[Fig. 30.10A, p. 614]**.)

Ca^{++} ions the modify t*ropomyosin*, a fiber that covers up actin**[Fig. 30.10B, p. 614]**.

Ca^{++} ions move tropomyosin out of the way.

Once tropomyosin is out of the way, the heads of the myosin filament can bind to actin.

Myosin heads are always trying to bind to actin, but they can't until the tropomyosin is out of the way

Once the myosin head contacts actin, the head rotates, and this causes the actin fiber to slide past the myosin fibers.

Myosin is then done. It can't do anything else, and needs to be reset.

To reset the myosin fibers (and heads), ATP is needed. ATP restores the myosin head to its original configuration.

ATP actually does two things:

1) It detaches myosin from actin and,

2) It resets the head on the myosin fiber.

[NOTE: the description in the text is confusing. Pay attention to these notes and the **[Fig., not in book, but see fig. 30.9B, p. 613]**.

Incidentally, rigor mortis is due to the fact that the myosin heads can't detach from the actin fibers anymore (muscles freeze up).

This cycle can repeat up to 10/sec, and each myosin fiber can have up to 500 heads.

Muscles are controlled by:

The number of muscle fibers that are triggered **[Fig. 30.10C, p. 614]**.

The number of impulses also control the strength/duration of muscle contractions (discuss the muscle twitcher from lab).

When muscles are moved, this is usually the result of a whole series of impulses.

A smooth sustained muscle contraction (as opposed to a muscle "twitch") needs a whole series of impulses.

When this happens, it is termed "tetanus". A single impulse would just cause "twitches".

So what about the disease “tetanus”? It is named after mucle contractions because it causes uncontrollable muscle contractions.

Finally, a few miscellaneous things about muscles:

Skeletal muscles are arranged into two broad groups:

Fast fibers - these allow for rapid, powerful contractions, but no endurance.

Slow fibers - are slower, but allow for sustained contractions (much more endurance).

For example:

Fast fibers are found in the flight muscles of pheasants and other birds that need to get away quickly (also, light meat in a turkey or chicken).

Slow fibers are found in leg muscles, or posture muscles which are constantly active (also, dark meat in a turkey or chicken).

What about other muscle types?

Smooth muscles work the same way, but are not arranged as regularly.

Contractions are not as powerful; but on the other hand, they can contract over a much greater length.

Cardiac muscles also work in a similar way, and are also highly structured and organized.

Intercalated disks allow for rapid dissemination of electrical signal, and help these muscles to contract almost simultaneously.