Movement and Locomotion: Muscle in action

[Note: This is the text version of this lecture file. To make the lecture notes downloadable over a slow connection (e.g. modem) the figures have been replaced with figure numbers as found in the textbook. See the full version with complete graphics if you have a faster connection.]

[See Fig. 40.5]

[See Fig. 49.26]

- **Sarcomere contains the basic unit of contractile fibers**
- **I Band contains actin, is isotropic (doesn't polarize light)**
- **A Band contains both actin and myosin, is anisotropic (polarizes light)**
- **Z line marks sarcomere length (*zwischenscheibe* = between disc)**
- **M line represents the midline of the sarcomere**
- **H band (or zone) contains only thick filaments (*helle* = bright)**

[See Fig. 49.26]

Sliding filament model of muscle contraction

[See Fig. 49.27]

Cross-bridge cycle during muscle contraction

- **Each thick filament has about 350 myosin heads. Each head forms about 5 cross-bridge connections every second**

- **There's only enough ATP for a few contractions, so vertebrate muscle contains <u>creatine phosphate</u> and creatine kinase: ADP $\Rightarrow$ ATP**

[See Fig. 49.28]

Calcium ions, troponin and tropomyosin regulate myosin binding and contraction

[See Fig. 49.29]

SR is source of calcium signal. Triggered by nerve input.

[See Fig. 49.30]

Two types of muscle fibers

1) Fast twitch fibers ("white meat") contract quickly and repeatedly. Are used for rapid movements such as flight in birds.

2) Slow twitch fibers ("dark meat") contract more slowly and for longer periods. Are used for posture and to carry weight.

Slow fibers are slower because they have less SR and calcium stays around longer (5X). They require more energy and so contain more mitochondria and have myoglobin to extract more oxygen from blood.

How is muscle contraction controlled?

- **Neurons in the spinal cord called motor neurons innervate different numbers of fibers. More fibers mean stronger contraction.**

- **Stimulation from more neurons leads to recruitment of more fibers**

[See Fig. 49.32]

Faster stimulation of muscle by nerve leads to temporal summation and complete contraction of muscle called tetanus

[See Fig. 49.31]

Because muscle can only contract, muscles work in antagonistic pairs to flex and extend against the skeleton.

[See Fig. 49.25]

- **A skeleton has three purposes:**

1) <u>Support</u> the organism against gravity

2) <u>Protect</u> the internal organs from damage (like the skull protects the brain)

3) <u>allow movement</u> by working with muscles

- **There are three types of skeletons:**

1) <u>Hydrostatic</u> (as in earthworm)

2) <u>Exoskeleton</u> (as in crayfish or grasshopper)

3) <u>Endoskeleton</u> (as in vertebrates)

Hydrostatic skeleton uses pressure of internal fluid with longitudinal and circular muscles to generate movement

[See Fig. 49.23]

- **An Exoskeleton takes the form of a cuticle or shell**

[See Fig. 49.25]

- **An Endoskeleton can be made of cartilage, bone, or other hard connective tissue**

- **In vertebrates, the skeleton can be divided into axial and appendicular components**

[See Fig. 49.24]

• There are three types of joints to direct movement more efficiently

1) ball and socket (as found in shoulder)

[See Fig. 49.24]

2) hinge (as found in elbow and knee)

3) pivot (as used to rotate forearm)