

PowerLecture:
Chapter 37
Structural Support and Movement
Section 37.0: Weblinks and InfoTrac

See the latest Weblinks and InfoTrac articles for this chapter online or click highlighted articles below (articles subject to change)

- Section 37.0: NCAA—Choices in Sports
- Section 37.0: Steroid Law—Sports Nutrition
- Section 37.0: Creatine for Muscle Building. Jule Klotter. *Townsend Letter for Doctors and Patients*, July 2003.
- Section 37.0: Looking for a Boost. Liz Applegate. *Runner's World*, Sept. 1998.

How Would You Vote?

The following is the question for this chapter. See national results below.

Should dietary supplements be more carefully regulated?

Impacts, Issues: Pumping Up Muscles

- Dietary supplements for body builders are extremely popular, but tests for effectiveness are rarely performed
- Androstenedione – an intermediate in the synthesis of testosterone and estrogen
- Studies show andro is not an effective supplement for muscle gain

Impacts, Issues: Pumping Up Muscles

- Andro has health risks for both sexes; in 2004 distribution was halted after the FDA demonstrated negative side effects
- Creatine, another muscle-building supplement, has been effective in controlled studies - it may have applications for muscular dystrophy and other muscular disorders
- Too much creatine strains the kidneys, and its long-term effects are unknown

Section 37.1: Weblinks and InfoTrac

See the **latest Weblinks** and **InfoTrac articles** for this chapter online or click highlighted articles below (articles subject to change)

- Section 37.1: The Skeleton Space: A Finite Set of Organic Designs. R.D.K. Thomas et al. *Evolution*, Apr. 1993.

Evolution of Movement

- “Epitheliomuscular” cells
 - Actin and myosin
- Bundled contractile cells form muscle
- Movement requires support structure: skeleton
 - Hydrostatic skeleton
 - Exoskeleton
 - Endoskeleton

Section 37.2

Hydrostatic Skeleton

- Muscles work against an internal body fluid and redistribute it within a confined space

Exoskeleton

- Rigid, external body parts receive the applied force of muscle contraction

Echinoderms

- Echinoderms have endoskeletons located within their dermis

Section 37.3: Weblinks and InfoTrac

See the **latest Weblinks** and **InfoTrac articles** for this chapter online or click highlighted articles below (articles subject to change)

- Section 37.3: Paleontology & Fossils Resources
- Section 37.3: Building to Code. Jared Diamond. *Discover*, May 1993.

Endoskeleton

- All vertebrates
- Fins or limbs attach to skeleton at pectoral and pelvic girdles

Evolution of Vertebrate Skeletons

Husky Adaptations

- Huskies are adapted to load pulling and long distance running in cold climates
- Their integument, musculature, and skeleton are specialized for this way of life

Section 37.4: Weblinks and InfoTrac

See the **latest Weblinks and InfoTrac articles** for this chapter online or click **highlighted articles below (articles subject to change)**

- Section 37.4: [American Academy of Orthopedic Surgeons](#)
- Section 37.4: [National Osteoporosis Foundation](#)
- Section 37.4: [Osteoporosis and Soy Products. Lynn Keegan. *Alternative Therapies in Women's Health*, Apr. 1, 2005.](#)

Long Bone Structure

- Compact bone
- Spongy bone
- Central cavity contains yellow marrow

Compact Bone Structure

- Mature compact bone consists of many cylindrical Haversian systems

Functions of Bone

- Interact with muscle to enable movement
- Support and anchor muscles
- Enclose and protect internal organs
- Store calcium and phosphorus
- Produce blood cells

Bone Marrow

- Yellow marrow
 - Fills the cavities of adult long bones
 - Is largely fat
- Red marrow
 - Occurs in spongy bone of some bones
 - Produces blood cells

Bone Remodeling

- In adults, bone building and bone breakdown continue constantly
- Osteoblasts deposit bone
- Osteoclasts secrete enzymes that degrade it
- Remodeling adjusts bone strength and helps maintain blood calcium levels

Bone Density

- Exercise can increase bone density
- Osteoporosis is a decrease in bone density
 - May occur when the action of osteoclasts outpaces that of osteoblasts
 - May also occur as a result of inability to absorb calcium

Joints

- Areas of contact or near contact between bones
- Fibrous joints
 - Short connecting fibers join bones
- Synovial joints
 - Move freely; ligaments connect bones
- Cartilaginous joints
 - Straps of cartilage allow slight movement

Tendons Attach
Muscle to Bone

Section 37.5: Weblinks and InfoTrac

See the latest Weblinks and InfoTrac articles for this chapter online or click highlighted articles below (articles subject to change)

- Section 37.5: Gray's Anatomy—Mechanics of Muscle
- Section 37.5: Flexibility: Dynamic Range of Motion for Life. Chuck Wolf. *IDEA Personal Trainer*, July–Aug. 2002.

Skeletal Muscle

- Bundles of striped muscle cells
- Attaches to bone
- Often works in opposition

Section 37.6: Weblinks and InfoTrac

See the latest Weblinks and InfoTrac articles for this chapter online or click highlighted articles below (articles subject to change)

- Section 37.6: Muscle Biochemistry
- Section 37.6: Overview of Muscle Cells
- Section 37.6: Minimizing Molecular Motor Mysteries: Physics and Biology Work Together to Unravel the Basis of Movement. Gabrielle Strobel. *Science News*, Nov. 13, 1993.

Skeletal Muscle Structure

- A muscle is made up of muscle cells
- A muscle fiber is a single muscle cell
- Each fiber contains many myofibrils

Sarcomere

Muscle Microfilaments

Thin filaments

- Like two strands of pearls twisted together
- Pearls are actin
- Other proteins in grooves in filament

Sliding-Filament Model

- Myosin heads attach to actin filaments
- Myosin heads tilt toward sarcomere center, pulling actin with them

Sliding-Filament Model

Sarcomere shortens because the actin filaments are pulled inward, toward the sarcomere center

Section 37.7

Nervous System

Controls Contraction

- Signals from nervous system travel along spinal cord, down a motor neuron
- Endings of motor neuron synapse on a muscle cell at a neuromuscular junction

Role of Calcium in Contraction

- T tubules in the sarcoplasmic reticulum relay signal
- Calcium ions are released

Troponin and Tropomyosin

- Lie in groove in actin filament
- When muscle is relaxed, tropomyosin blocks myosin binding site

Troponin and Tropomyosin

- When troponin binds calcium ions, it changes shape and moves tropomyosin
- Cross-bridge formation and contraction can now proceed

Section 37.8: Weblinks and InfoTrac

See the **latest Weblinks and InfoTrac articles** for this chapter online or click **highlighted articles below (articles subject to change)**

- Section 37.8: How Exercise Works

Contraction Requires Energy

- Muscle cells require huge amounts of ATP energy to power contraction
- The cells have only a very small store of ATP
- Three pathways supply ATP to power muscle contraction

ATP for Contraction

Muscle Tension

- Mechanical force a contracting muscle exerts on an object
- For a muscle to shorten, muscle tension must exceed the load that opposes it
- The load may be the weight of an object or gravity's pull on the muscle

Section 37.9: Weblinks and InfoTrac

See the **latest Weblinks** and **InfoTrac articles** for this chapter online or click **highlighted articles below (articles subject to change)**

- Section 37.9: Muscle Physiology and Design
- Section 37.9: Muscular Dystrophy Association
- Section 37.9: Muscle Fatigue: The Cellular Aspects. Robert Fitts. *The American Journal of Sports Medicine*, Nov.–Dec. 1996.

Two Types of Contraction

Motor Unit

- One neuron and all the muscle cells that form junctions with its endings
- When a motor neuron is stimulated, all the muscle cells it supplies are activated to contract simultaneously
- Each muscle consists of many motor units

Twitches and Tetanus

Muscle Fatigue

- An inability to maintain muscle tension
- Occurs after a period of tetanic contraction
- Different types of muscle show different fatigue patterns

Section 37.10: Weblinks and InfoTrac

See the **latest Weblinks** and **InfoTrac articles** for this chapter online or click **highlighted articles below (articles subject to change)**

- Section 37.10: Centers for Disease Control—Botulism Resources
- Section 37.10: Blindsided by Tetanus. Claire Panosian Dunavan. *Discover*, Jan. 2000.

Tetanus

 - *C. tetani* bacterial toxin - delivered to spinal cord and brain - blocks neurotransmitters that control motor neurons
 - Loss of control over muscle contraction results in symptoms of disease *tetanus*
 - Overstimulated muscles stiffen and lock - when cardiac muscles are paralyzed, death is almost certain