The Musculo-Skeletal System

Vertebrate Systems
A. Endoskeleton
   1. Muscles attached to internal skeleton made of bone and cartilage
      a. Sharks and rays are completely cartilage
B. Specialization
   1. Skeletons of vertebrates are highly adapted to the functions they
      must perform

Protective Coverings
A. Structure of Skin
   1. Epidermis
      a. Outer layer of skin
   2. Dermis
      a. Inner layer of skin
      b. Fifty to a hundred times thicker than the epidermis
B. Functions of Skin
   1. Conserve moisture
   2. Protection
   3. Cooling

Human Bones
A. Bone as Living Tissue
   1. Bones have a blood supply
   2. Bones have nerves
   3. Bones store and manufacture
   4. Bones grow
B. Bone Marrow
   1. Yellow Marrow
      a. Storage of fat in long bone shafts
   2. Red Marrow
      a. Production of red blood cells in soft bone ends (cancellous)

Bone Composition and Formation
A. Composition (Adult)
   1. Water - 25%
   2. Minerals - 45%
      a. Calcium (with phosphate or carbonate)
B. Mineral Balance in Bone
   1. Calcium can move in and out of bone tissue
      a. Regulated by hormones such as calcitonin and sex hormones
Bone Growth and Development

A. Calcification
   1. Cartilage is converted to bone during fetal development and post-natal growth and development

B. Bone Lengthening
   1. Occurs at the bone ends

C. Red Marrow Sites
   1. Vertebrae, ribs, breastbone (sternum) and pelvis

Joints

A. Immovable Joints
   1. Bones separated by a thin layer of connective tissue
      a. Bones of the skull

B. Slightly Movable Joints
   1. Gaps between bones are held together by cartilage
      a. Vertebrae

C. Freely Movable Joints
   1. Bones are separated by a cavity
   2. Bones are held to other bones by ligaments
      a. Tendons hold muscles to bones
   3. Three types of freely movable joints
      a. Hinge joint
         (1) Knees and elbows
      b. Ball and socket joint
         (1) Hip and shoulder
      c. Gliding joint
         (1) Wrist and ankles

Muscles

A. Tendon Attachments
   1. Origin
      a. Attachment to the bone that doesn't move
   2. Insertion
      a. Attachment to the bone that does move

B. Antagonistic Pairs
   1. Flexor
      a. Flexes the joint (moves toward the body)
   2. Extensor
      a. Extends the joint (away from the body)
Muscle Structure

A. Cardiac Muscle
   1. Striated muscle found only in the heart
   2. Under involuntary control
   3. Only rests between contractions

B. Smooth Muscle
   1. Lack striations
   2. Usually under involuntary control
   3. Contraction is slow and rhythmic
   4. Muscles of internal organs

C. Skeletal Muscle
   1. Striated muscle fibers with no clear separation between cells
   2. Under voluntary control

D. Structure of Striated Muscle
   1. Myofibrils
      a. Made of protein filaments
         (1) Actin
         (2) Myosin
   2. Sarcomere
      a. The smallest unit of muscle contraction
         (1) Contraction is all or nothing

Mechanism of Muscle Contraction

A. Contraction
   1. Heads on myosin filaments attach to actin filaments
   2. Filaments slide by one another then detach
   3. Process repeats itself many times in a single contraction
      a. Energy comes from ATP

B. Rigor
   1. In absence of ATP, myosin heads do not detach and muscle
      becomes rigid

C. Motor Unit
   1. Muscle fibers and the neuron that controls them
      a. Number of fibers per neuron varies
         (1) Few fibers = Capacity for intricate movement
         (2) Many fibers = Simple movements