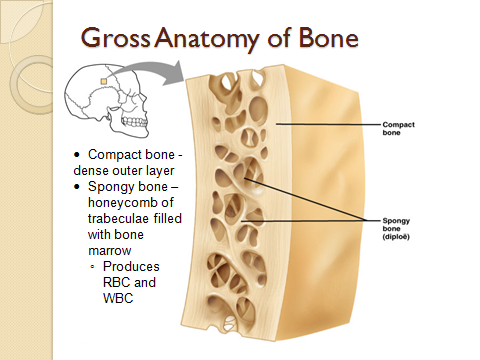
**Bone Tissue**

**Dr. Gary Mumaugh**

**Function of Bones**

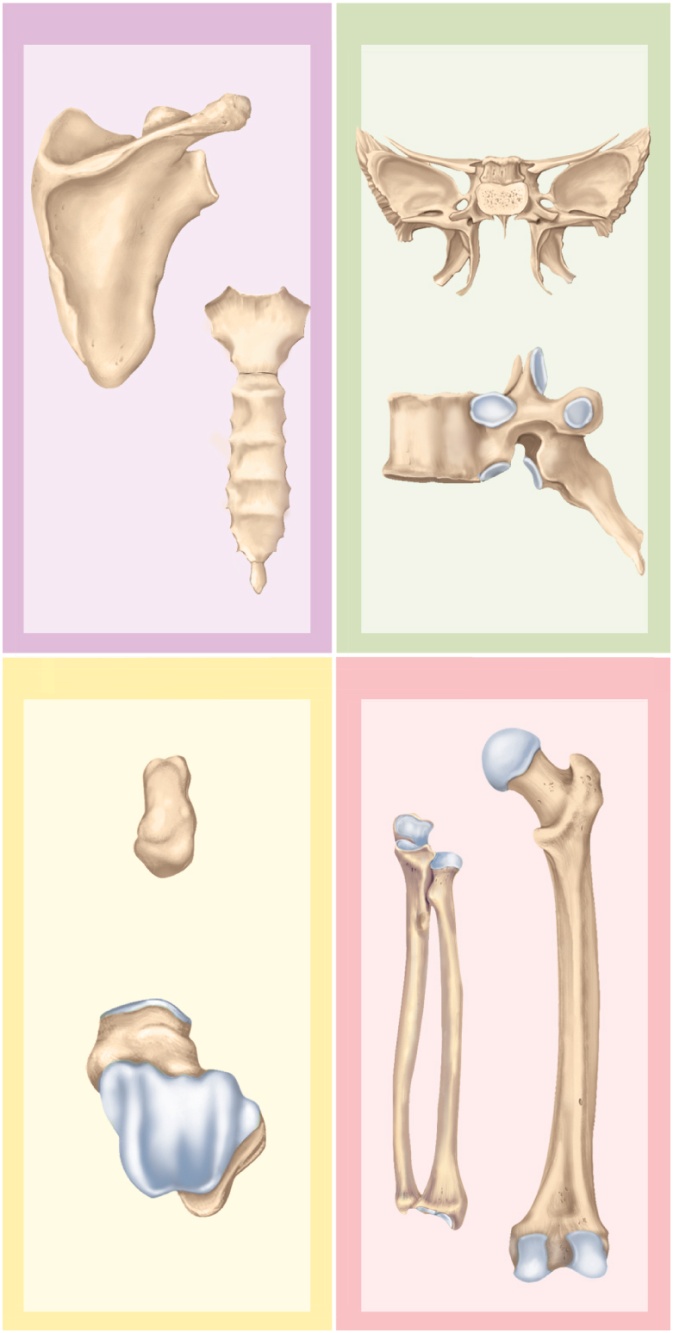
* Support – form the framework that supports the body and cradles soft organs
* Protection – provide a protective case for the brain, spinal cord, and vital organs
* Movement – provide levers for muscles
* Mineral storage – reservoir for minerals, especially calcium and phosphorus
* Blood cell formation– hematopoiesis occurs within the marrow cavities of bones

**Gross Anatomy of Bone**

**

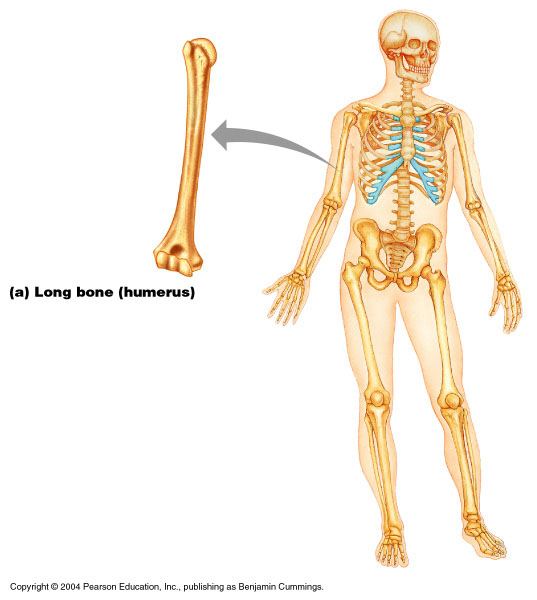
**Classification of Bones**

* Axial skeleton – bones of the skull, vertebral column, and rib cage
* Appendicular skeleton– bones of the upper and lower limbs, shoulder, and hip



**Shape of Bones**

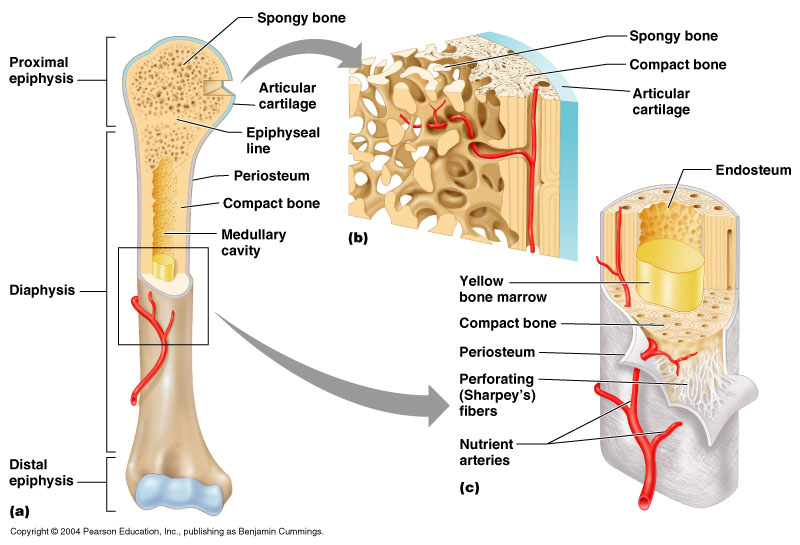
* Long bones
* Short bones
* Flat bones
* Irregular bones

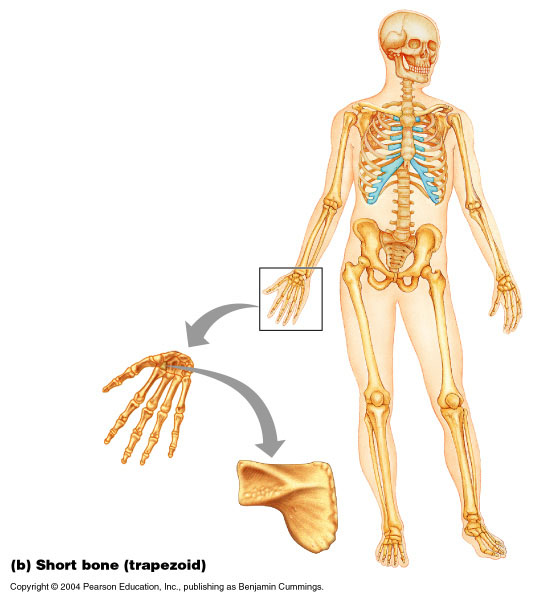
**Long Bones**

* Long bones – longer than they are wide
* Humerus, radius, ulna
* Femur, tibia, fibula

**Structure of Long Bones**

* Diaphysis
  + Tubular shaft that forms the axis of long bones
* Epiphyses
  + Expanded ends of long bones
  + Joint surface is covered with articular (hyaline) cartilage
  + Epiphyseal line separates the diaphysis from the epiphyses



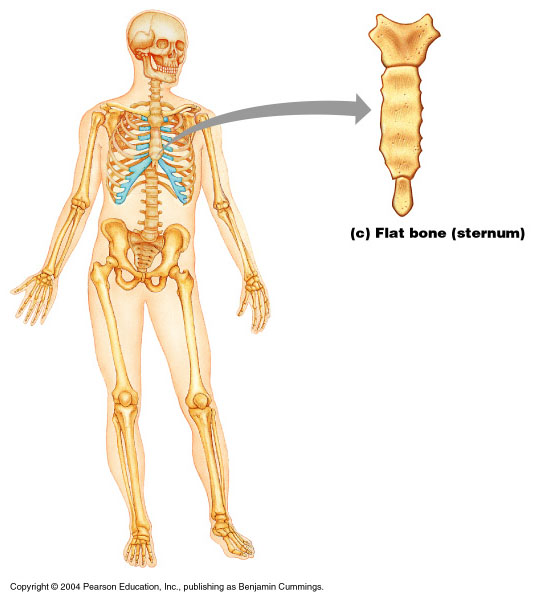
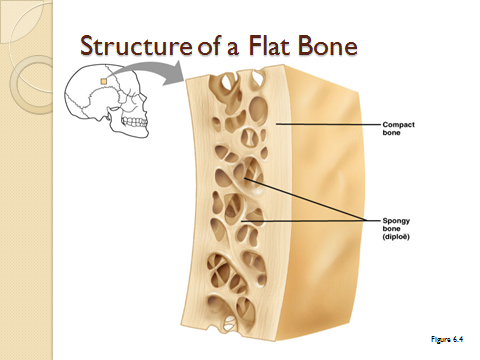


**Short Bones**

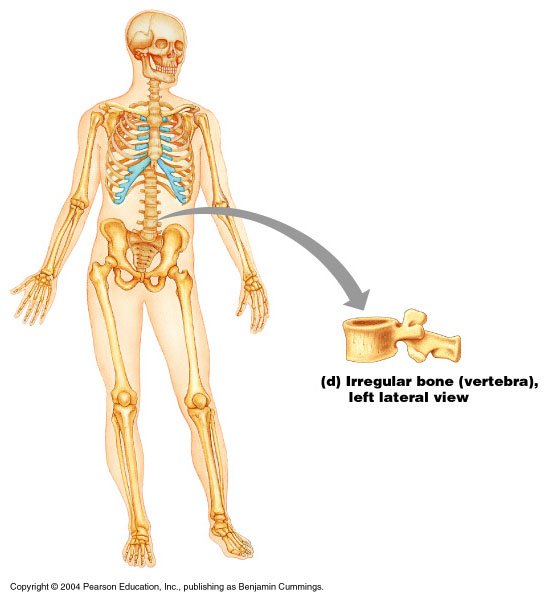
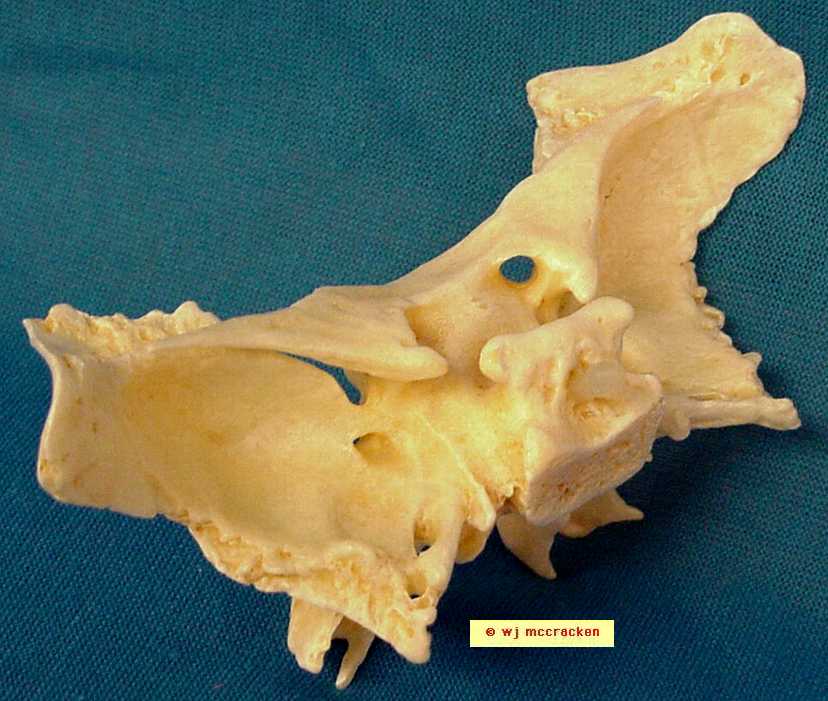
* Short bones
  + Bones of the wrist and ankle
  + Bones that form within tendons (e.g., patella)

**Flat Bones**

* Flat bones – thin, flattened, and a bit curved (e.g., sternum, and most skull bones)

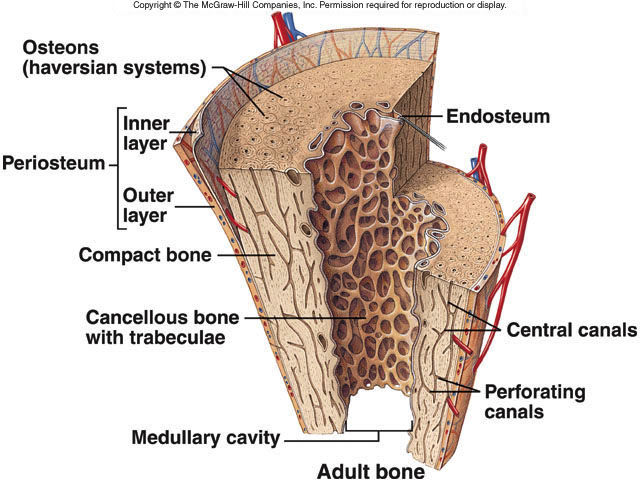
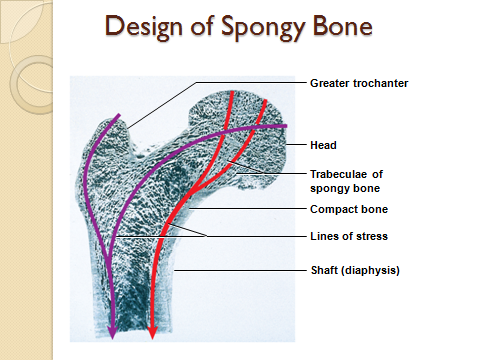
**Irregular Bones**

* Irregular bones – bones with complicated shapes (e.g., vertebrae and hip bones)

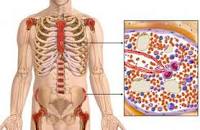


**Bone Membranes**

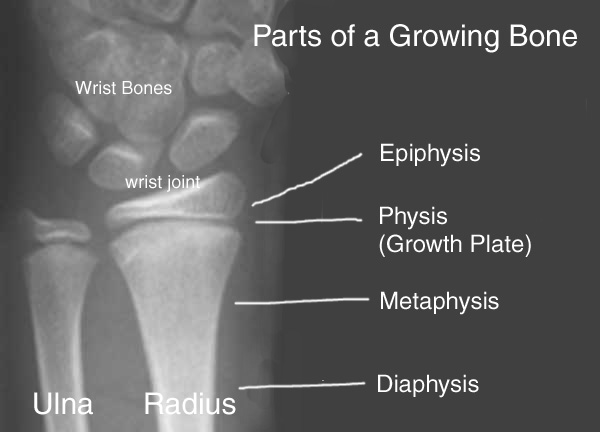
* Periosteum – double-layered protective membrane
  + Outer fibrous layer is dense regular connective tissue
  + Richly supplied with nerve fibers, blood, and lymphatic vessels, which enter the bone via nutrient foramina
* Endosteum – delicate membrane covering internal surfaces of bone



**Bone Marrow**

* bone marrow – general term for soft tissue that occupies the marrow cavity of a long bone and small spaces amid the trabeculae of spongy bone
* red marrow
  + in nearly every bone in a child
  + hemopoietic tissue - produces blood cells
  + in adults, found in skull, vertebrae, ribs, sternum, part of pelvic girdle, and proximal heads of humerus and femur
* yellow marrow found in adults
  + most red marrow turns into fatty yellow marrow
  + no longer produces blood

**Bone Development**

* ossification or osteogenesis – the formation of bone
* in the human fetus and infant, bone develops by two methods:
* intramembranous ossification
* endochondral ossification

**Bone Growth and Remodeling**

* ossification continues throughout life with the growth and remodeling of bones
* bones grow in two directions: length and width
* bone elongation
  + epiphyseal plate – a region of transition from cartilage to bone
    - functions as growth zone where the bones elongate
    - consists of typical hyaline cartilage in the middle
    - with a transition zone on each side where cartilage is being replaced by bone

**Factors Affecting Bone Growth**

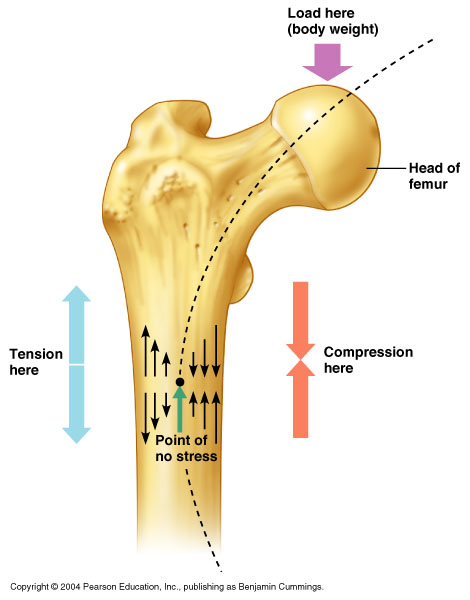
* Heredity
* Nutrition
  + Calcium, phosphorus, protein, Vitamin D, A, C
* Hormones
* Exercise or “stress”

Without bones becoming weight bearing, they lose calcium

**Hormonal Regulation of Bone Growth During Youth**

* During infancy and childhood, epiphyseal plate activity is stimulated by growth hormone
* During puberty, testosterone and estrogens:
  + Initially promote adolescent growth spurts
  + Cause masculinization and feminization of specific parts of the skeleton
  + Later induce epiphyseal plate closure, ending longitudinal bone growth

**Importance of Ionic Calcium in the Body**

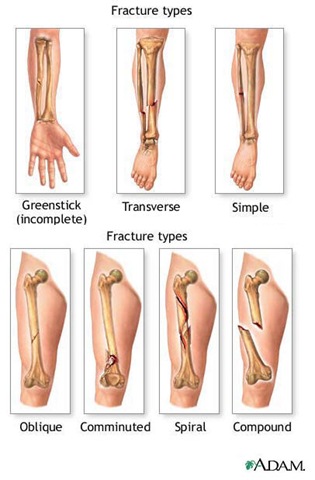
* Calcium is necessary for:
  + Transmission of nerve impulses
  + Muscle contraction
  + Blood coagulation
  + Secretion by glands and nerve cells
  + Cell division

**Response to Mechanical Stress**

* Wolff’s law – a bone grows or remodels in response to the forces or demands placed upon it
* Observations supporting Wolff’s law include
  + Long bones are thickest midway along the shaft (where bending stress is greatest)
  + Curved bones are thickest where they are most likely to buckle

**Bone Fractures (Breaks)**

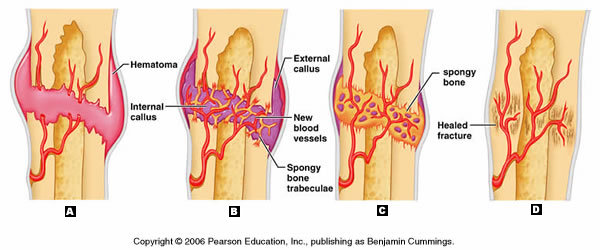
* Bone fractures are classified by:
  + The position of the bone ends after fracture
  + The completeness of the break
  + The orientation of the bone to the long axis
  + Whether or not the bones ends penetrate the skin
* Types of Bone Fractures
  + Compound (open) – bone ends penetrate the skin
  + Simple (closed) – bone ends do not penetrate the skin
  + Greenstick – incomplete fracture where one side of the bone breaks and the other side bends; common in children
  + Comminuted – bone fragments into three or more pieces; common in the elderly
  + Compression – bone is crushed; common in porous bones

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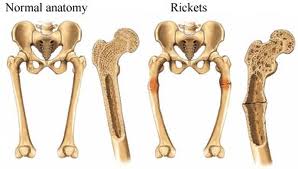
**Stages in the Healing of a Bone Fracture**

* Hematoma formation A
  + Torn blood vessels hemorrhage
  + A mass of clotted blood (hematoma) forms at the fracture site
  + Site becomes swollen, painful, and inflamed
* Fibrocartilaginous callus forms B
* Bony callus formation C
  + Bone callus begins 3-4 weeks after injury, and continues until firm union is formed 2-3 months later
* Bone remodeling D
  + Excess material on the bone shaft exterior and in the medullary canal is removed
  + Compact bone is laid down to reconstruct shaft walls

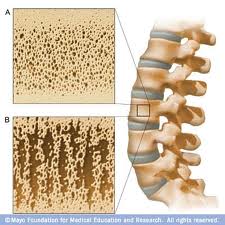
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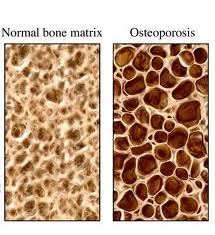
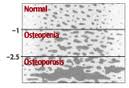
**Homeostatic Imbalances**

* Osteomalacia
  + Bones are inadequately mineralized causing softened, weakened bones
  + Main symptom is pain when weight is put on the affected bone
  + Caused by insufficient calcium in the diet, or by vitamin D deficiency
* Rickets
  + Bones of children are inadequately mineralized causing softened, weakened bones
  + Bowed legs and deformities of the pelvis, skull, and rib cage are common
  + Caused by insufficient calcium in the diet, or by vitamin D deficiency





* Osteopenia
  + Normal bone demineralization seen after 35-40 years old
* Osteoporosis
  + Spongy bone of the spine is most vulnerable
  + Occurs most often in postmenopausal women
  + Bones become so fragile that sneezing or stepping off a curb can cause fractures
  + Osteoporosis Treatment
    - Calcium and vitamin D supplements
      * 1200 mg. of calcium per day
      * Increased weight-bearing exercise
      * Hormone (estrogen) replacement therapy (HRT) slows bone loss
      * Natural progesterone cream prompts new bone growth

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