Skeletal System

Introduction
1. Functions:
   a. Support
   b. Movement
   c. Protection
   d. Mineral storage of Ca++ and PO4
   e. Blood cell production called hemopoiesis
   f. Fat storage
2. Key roots:
   a. Osteo = bone as in osteocyte
   b. Chondro = cartilage as in chondroblast
   c. Arthro = joint as in arthritis
3. Orthopedics-branch of medicine that deals with preservation and restoration of the skeletal system, joints, and associated structures

Cartilage
1. Composition:
   a. Glycosaminoglycans
      1) Chondroitin sulfate
      2) Hyaluronic acid
   b. Fibers = collagen and elastin
   c. Cells: Chondrocytes and chondroblasts
      1) An active chondroblast secretes cartilage matrix and encloses itself in a pocket called a lacuna
2. Perichondrium
   a. Outer fibrous layer composed of dense irregular CT; anchors cartilage to surrounding structures
   b. An inner chondrogenic layer next to the cartilage matrix that houses chondroblasts and allows for growth
3. Types of cartilage
   a. Hyaline cartilage
      1) Most abundant cartilage
      2) Matrix is blue/purple and translucent because collagen fibers not visible
      3) Chondrocytes in lacunae
      4) Gives firm support with pliability
      5) Locations: articular & costal cartilages, nose, trachea, larynx, embryonic skeleton, and epiphyseal plates
   b. Fibrocartilage
      1) Thick & densely interwoven collagen fibers with chondrocytes (in lacunae) squeezed between
2) Looks much like dense irregular CT
3) Gives very strong support and withstands heavy pressure
4) Locations: pubic symphysis, intervertebral discs, and menisci at some joints
c. Elastic cartilage
   1) Chondrocytes, in lacunae, in a network rich in elastic fibers
   2) Looks darker than other cartilages
   3) Great flexibility for stretching
   4) Locations: epiglottis, pinna, Eustachian tubes

Bone
1. General description:
   a. Dry wt is 1/3 organic & 2/3 inorganic matter
   b. Organic matter
      1) Collagen, GAGs, proteoglycans, & glycoproteins
      2) Cells
   c. Inorganic matter
      1) 85% hydroxyapatite (crystallized calcium phosphate salt)
      2) 10% calcium carbonate
      3) Other minerals calcium hydroxide
   d. Combination provides for strength & resilience
      1) Minerals resist compression; collagen resists tension
2. Cells
   a. Osteogenic cells reside in endosteum or periosteum; multiple continuously & differentiate into osteoblasts
   b. Osteoblasts form organic matter of matrix & help to mineralize it in response to stress or fractures
   c. Osteocytes are osteoblasts that have become trapped and less active
      1) Reside in lacunae & are connected to each other via canalculi
      2) Signal osteoclasts & osteoblasts about mechanical stresses
   d. Osteoclasts develop in bone marrow by the fusion of the same stem cells that give rise to monocytes (a WBC) in the blood
      1) Reside in pits called resorption bays that they have eaten into the surface of the bone
      2) Cytoplasmic extensions secrete proteolytic Ez’s to break down collagen and acids to dissolve Ca++
      3) Osteoclasts phagocytize dissolved organics and Ca++ and release these into blood
3. Bone macrostructure-terms
   a. Diaphysis-shaft or long portion of bone
   b. Epiphysis (pl = ses) expanded ends of bone
   c. Metaphysis-narrow zone where epiphysis connects to diaphysis
   d. Epiphyseal line-remnant of epiphyseal plate present in an adult
e. Epiphyseal plate-growth zone in subadults composed mostly of cartilage and found between epiphyses and diaphysis
f. Articular cartilage-thin layer of hyaline cartilage covering the epiphyses; cushions bones at joint
g. Periosteum (peri = around)-layer of CT that surrounds diaphysis; double-layered:
   1) Fibrous layer-outer layer composed of dense irregular CT and serves as insertion/origin points for tendons/ligaments
   2) Osteogenic layer-houses osteogenic cells & osteoblasts for adding cells & bone matrix
h. Medullary canal-space within diaphysis filled with yellow (fatty) marrow
i. Endosteum-(Endo = inside/within)-layer of osteoblasts and osteoclasts that line medullary cavity
j. Compact bone-high density bone matrix without visible spaces
   1) Looks smooth and homogeneous
   2) Mostly in shaft and outer layers of bone
k. Spongy bone-low density bone with many visible spaces
   1) Composed of bony struts called trabeculae
   2) Mostly in epiphyses, short, flat, and irregular bones
   3) Storage area for red marrow

4. Bone microstructure of compact bone
   a. Compact bone is built from units called Haversian systems (= osteons)
   b. Each osteon has:
      1) Haversian canal (= central canal)-runs parallel to longitudinal axis of bone; filled with blood vessels & nerves
      2) Lamellae-concentric rings of bone matrix surrounding central canal
      3) Lacunae-pockets or spaces between lamellae housing osteocytes
      4) Osteocytes-bone cells that maintain matrix
      5) Canaliculi-hair-like canals filled with cytoplasmic extensions of osteocytes radiating out from each lacuna
c. Interstitial lamellae-remnant osteons that fill spaces between complete osteons
d. Volkmann’s (=perforating) canals-run transversely to shaft axis and connect Haversian canals

5. Spongy bone microstructure
   a. Spongelike appearance formed by rods and plates of bone called trabeculae; spaces filled with red marrow
   b. Trabeculae have few, if any osteons
      1) No osteocyte is far from blood of bone marrow
c. Provides strength with little weight; trabeculae develop along bone’s line of stress
d. Osteocytes still found in lacuna
e. Lamellae still present

6. Ossification
a. Process by which bone is formed  
b. Begins about the 5th/6th week of fetal development  
c. Templates for bone formation are derived from mesenchymal CT  
d. Two kinds:  
  1) Intramembranous (intra = within)  
  2) Endochondral  
e. Bone composition is the same from both processes  
f. Blood supply invading area is key bringing in chemicals that trigger mesenchymal stem cells to turn into other cells  
g. Intramembranous ossification  
  1) Locations: most skull bones, mandibles, and clavicles  
  2) Steps:  
     a) Blood vessel invades mesenchymal CT template  
     b) Mesenchymal cells cluster in center of plate-called center of ossification  
     c) Mesenchymal cells differentiate into osteoblasts and begin bone formation  
     d) Osteoblasts release Ez alkaline phosphatase making Ca++ insoluble and causes it to crystallize on collagen fibers  
     e) Calcified fibers form a latticework of trabeculae-spongy bone  
     f) Some osteoblasts become trapped in lacunae and are now called osteocytes  
     g) Spaces fill with red marrow  
     h) Original CT becomes periosteum  
     i) Surface layers reconstructed into compact bone  
     j) Outer layer compact bone + spongy bone + inner layer of compact bone = diploe  
h. Endochondral ossification  
  1) Locations: all ‘other’ bones  
  2) Steps:  
     a) Cartilage (chondral) template laid down early in embryological development  
        i. Covered with a fibrous CT membrane called the perichondrium  
     b) Blood vessel penetration of perichondrium along diaphysis  
        i. Causes inner chondrocytes to become osteoblasts  
        ii. Some earlier death of chondrocytes in matrix  
     c) Osteoblasts secrete bony collar along shaft  
        i. Perichondrium now called the periosteum  
        ii. Fibroblasts migrate in and some differentiate into osteoblasts  
     d) Primary center of ossification formed in center of template  
        i. Inner chondrocytes enlarge, burst, and release Ez, alkaline phosphatase
ii. interior calcifies eventually forming spongy
e) Thickened matrix prevents oxygen and nutrients from
reaching interior chondrocytes-cartilage matrix disintegrates
creating cavities, a process called cavitation
   i. Smaller cavities fuse and form larger medullary cavity
f) Invasion of the periosteal bud-a collection of blood vessels,
nerves, lymphatics, red marrow, adipocytes, osteoblasts, and
osteoclasts
g) Medullary cavity lengthens by osteoclasts
h) Collar thickened into compact bone
i) Cartilage template lengthens at ends because of chondroblast
divisions
j) Osteoblasts secrete bone that replaces cartilage
   i. This all happens in metaphysis zone
k) Blood vessels invade epiphyses forming secondary centers
   of ossification
l) Bone complete replaces cartilage except in two areas:
   i. Articular cartilages
   ii. Epiphyseal plate
   iii. Epiphyseal plate replaced with bone in adults leaving
       an epiphyseal line
m) Grow stops by ages 18 in females and 21 in males
   i. The metaphysis
      1) Transitional zone between head and shaft of a developing long
         bone
      2) 5 zones:
         a) Zone of reserve cartilage is layer of ‘resting’ cartilage;
            i. Anchors plate to epiphysis
            ii. Have a single chondrocyte per lacunae
         b) Zone of cell proliferation is layer that has:
            i. Chondroblasts divide and as they divide they form
               stacks of many chondroblasts in elongate lacunae
            ii. Provides new chondroblasts to build cartilage
               component of plate at epiphyseal end
         c) Zone of cell hypertrophy
            i. chondroblasts enlarge; still in stacks of multiple cells in
               elongate lacunae
         d) Zone of calcification shows mineralization between columns
            of lacunae
            i. Chondroblasts rupture causing calcification of collagen
               fibers
            ii. Helps cement epiphysis to diaphysis
         e) Zone of bone deposition (ossification)-
i. Chondrocytes die and each channel is filled with osteoblasts and blood vessels to eventually form a haversian canal & osteon
ii. Invaded by osteoblasts secreting spongy bone
iii. Marrow elements also arrive

3) Lengthwise Bone growth-The race
   a) At epiphyseal end, zone of proliferation adds new chondroblasts influenced by growth hormone and others; the plate thickens with fresh cartilage here
   b) At diaphyseal end, zones of calcification and ossification destroy cartilage component and add bone
   c) Diameter remains relatively constant until adult status

4) Diameter bone growth
   a) On periosteal surface, osteoblasts secrete bone thickening outer collar by adding bone matrix
   b) Along endosteal surface, osteoclasts reabsorb bone to widen medullary canal
   c) Delicate balance between two processes: bone thickness versus bone density (mass)

7. Remodeling
   a. Replacement of old bone tissue by new bone tissue
   b. Homeostasis = steady state; examples are:
      1) Control of body temperature
      2) Control of blood glucose
      3) Control of blood calcium
      4) Regulation of bone composition
   c. Most parts of skeleton are remodeled
      1) Distal femur every 4 months
      2) Bones under less stress much longer (yrs)
   d. Remodeling allows:
      1) Repair of injured bone
      2) Body systems access to calcium (and phosphorus)
      3) Adjustments to muscle stress on bones
   e. Normal bone growth factors:
      1) Sufficient access to Ca++ and PO4; these make bone hard
      2) Vitamin D-aides in Ca++ absorption from gut, removal from bone, and kidney reabsorption
      3) Hormones:
          a) Growth hormone accelerates bone growth at epiphyseal plate; increases chondroblast divisions
          b) Thyroid hormones-increases metabolism and osteoblast activity
c) Calcitonin from thyroid gland; released in response to high blood Ca++ and works by inhibiting osteoclasts and accelerates Ca++ absorption by bones
d) Parathyroid hormone from parathyroid glands; released in response to low blood Ca++ and works by stimulating osteoclasts to digest bone and then release Ca++ into blood; also increases reabsorption of Ca++ in kidneys
e) Sex hormones (estrogen & testosterone) enhance bone deposition and stimulate osteoblast activity

f. Mechanical stress on Bone
   1) Bone grows or remolds in response to the forces or stresses placed upon it = Wolf’s Law
   2) Evidence:
      a) Long bones are thickest midway along shaft
      b) Large bone projections (tuberosities, tubercles, ridges, etc) occur where heavy, active muscles are attached
      c) Featureless bones of fetuses and bedridden people
d) Appendages in casts
e) Orthodontics

8. Aging
   a. Ca++ loss from bones increases and quality of collagen decreases
   b. Begins after age 40 in females to as much as 30% by age 70
   c. Males begin loss after age 60
d. With loss of collagen, bones become brittle and break easily

9. Fractures
   a. A break in a bone
   b. Kinds:
      1) Stress fracture is a break caused by abnormal trauma to a bone as in car accidents, falls, athletics, etc
      2) Pathological fracture is a break in a bone weakened by a disease such as bone cancer or osteoporosis
      3) Fractures are classified by their structural characteristics, if they cause a break in the skin, they break into multiple pieces, or after the physician who first described it (Figure 7.16)
         a) Open
         b) Compound
         c) Greenstick
         d) Comminuted
         e) Colles
         f) Potts
c. Normal healing takes 8 to 12 weeks (longer in elderly)
   1) Stages of healing:
      a) Fracture hematoma
i. Trauma causes broken blood vessels that form a blood clot in damaged area
ii. Cellular debris & bone fragments present
iii. Macrophages enter & clean up debris

b) Granulation tissue
   i. Blood vessel invasion brings in fibroblasts
   ii. Fibrous tissue (of collagen) formed by fibroblasts connects bone ends

c) Callus formation
   i. Granulation tissue leads to formation of soft callus of fibrocartilage chondroblasts in vade
   ii. Soft callus is replaced by hard callus when osteoblasts secrete bone
   iii. Usually about 6 weeks

d) Remodeling
   i. Occurs over next 6 months as spongy bone is replaced with compact bone
   ii. Thickened area is trimmed by osteoclasts

d. Treatment of fractures
   1) Closed reduction-fragments are aligned with manipulation & casted
   2) Open reduction-surgical exposure & repair with plates & screws
   3) Traction is not used in elderly due to risks of long-term confinement to bed
      a) Hip fractures are pinned & early walking is encouraged
   4) Electrical stimulation is used on fractures that take longer than 2 months to heal
   5) Artificial/crushed bone-ceramics, human cadavers, shark cartilage are used to make a paste for non-weight bearing bones
   6) Free vascular fibular graft
      a) Section of fibula with blood supply removed and inserted into damaged site
      b) Used for replacing cancerous long bones, especially in children, or for accidents that crush a long bone diaphysis
   7) Bone stretching
      a) For bones that are shorter than the other in a pair
      b) Or expanding length of jaw for implants

10. Bone diseases
    a. Osteoporosis-group of diseases where bone reabsorption on endosteal surface outpaces bone deposition on periosteal surface
       1) Chemical composition normal
       2) Bones thinner and more vulnerable to fracture
       3) Risk factors:
          a) Sex: females are more likely than males
          b) Body build: thin and short most likely
c) Smoking: decreases estrogen levels
d) Ca++ deficiency
e) Vitamin D deficiency
f) Lack of exercise
g) Drugs: alcohol and cortisone
h) Premature menopause
i) Repeated pregnancies
j) Race??
   i. Dark-skinned more likely because of lower Vitamin D synthesis
   ii. Dark-skinned less likely because of higher average bone density

4) Treatments:
   a) Supplements of Ca++ and Vitamin D
   b) Biphosphonates
   c) Increase exercise
   d) Stop smoking
   e) PTH and Calcitonin treatments

b. Osteomalacia-soft bone disorder where bones are not properly mineralized
   1) Structurally weak leading to fracture, bowing, or deformities
   2) Known as Rickets in children
   3) Causes: lack of Ca++ or Vitamin D
   4) Treatment: Supplements of Ca+ and Vitamin D

c. Spinal bifida-congenital defect where lamina of vertebrae fail to fuse
   1) Often exposes meninges or spinal cord at birth

d. Paget’s Disease—progressive bone disease where a pattern of excessive bone destruction is followed by deposition which causes excessive thickening
   1) Results in skull, pelvis, lower appendage deformities
   2) Unknown cause
   3) Usually after age 40

**Joints**

1. Arthrology is the study of the joints
2. Kinesiology is the study of musculoskeletal movement
3. Joints are classified by their degree of mobility:
   a. Diarthrosis-freely movable
   b. Amphiarthrosis-slightly movable
   c. Synarthrosis-little to no movement
4. Joints are classified by the kind of CT joining the bones together:
   a. Fibrous
      1) Sutures
      2) Gomphoses
3) Syndesmoses
b. Cartilaginous
   1) Synchondrosis
   2) Symphysis
c. Bony
d. Synovial
5. Fibrous Joints-have collagen fibers (fibrous CT) spanning the space between bones; there is no joint cavity
a. Sutures
   1) A synarthrotic fibrous joint that bind the bones of the skull to each other
   2) Bone edges interlock like pieces of a puzzle giving added strength
   3) No joint cavity that encloses bone ends
b. Gomphoses
   1) Attachment of a tooth to its socket is a joint called a gomphosis
   2) Cone-shaped peg fits into socket
   3) Tooth held in place by fibrous periodontal ligament
   4) Collagen fibers that extend from bone of jaw to tooth
   5) Allows tooth to move a little while chewing; mostly synarthrotic
   6) No joint cavity
c. Syndesmoses
   1) Joint in which two bone shafts (diaphyses) are bound by a ligament only (interosseous membrane)
   2) Most movable of fibrous joints-amphiarthrotic
   3) Interosseous membranes unite radius to ulna & tibia to fibula
6. Cartilaginous Joints-have some type of cartilage connecting bones; no joint cavity
a. Synchondroses
   1) Bones united by hyaline cartilage
   2) No joint cavity encloses bone ends
   3) Mostly synarthrotic
   4) Examples:
      a) Rib attachment to sternum by costal cartilages
      b) Epiphyseal plate in children binds epiphysis and diaphysis
b. Symphyses
   1) 2 bones joined by fibrocartilage
   2) Only slight movement (synarthrotic/amphiarthrotic) is possible
   3) Pubic symphysis and intervertebral discs
7. Synostoses (Bony) joints
a. 2 bones, once separate, fused by osseous tissue
b. No joint cavity
c. Ossification occurs with age:
   1) L & R mandible present at birth
   2) L & R frontal bones present at birth
3) Epiphyses and diaphysis of long bones

8. Synovial joints
   a. Joint in which two bones are separated by a space called a joint (synovial) cavity
   b. Most are freely movable-diarthrotic
   c. Have articular cartilages and some with articular discs (menisci)
   d. Surrounded by a sleeve-like articular capsule
      1) Articular capsule has 2 layers:
         a) Fibrous (layer) capsule (#1) lined by synovial membrane (#2)
         b) Fibrous layer continuous with perisoteum
         c) Fibrous layer is ligaments
      2) Synovial fluid-viscous slippery fluid rich in albumin & hyaluronic acid (similar to raw egg white); lubricates joint and nutrient distribution
   e. Articular cartilage
      1) Hyaline cartilage covering and cushioning the bone surfaces
   f. Menisci is pad of fibrocartilage in jaw, wrist, knee, and sternoclavicular joints
      1) Pads of fibrocartilage lying between articular surfaces of bone
      2) Anchored to fibrous capsule
      3) Subdivides synovial cavity and channels synovial fluid
      4) Allows bones to fit together more precisely and restrict movement to a specific plane
      5) Only in most complex joints such as knee
      6) A ‘torn’ cartilage usually refers to a meniscus
   g. Tendon attaches muscle to bone
   h. Ligament attaches bone to bone
   i. Arthroscopic surgery
      1) Slat solution injected through first ¼ in incision to expand joint
      2) Arthroscope-a pencil thin camera enters through 2nd incision that allows physician to view internal synovial cavity
      3) Surgical instruments enter through a third ¼ in incision to remove damaged cartilage
   j. Tendon sheaths and bursae
      1) Bursa is saclike, fluid-filled extension of joint capsule that extends between nearby structures allowing them to slide more easily past each other
         a) Bursitis is an inflammation of the bursae
      2) Tendon sheaths are elongated cylinders of connective lined with synovial membrane & wrapped around a tendon
         a) Tendinitis is an inflammation of the tendon sheaths
         b) Numerous in hand & feet
   k. Movements of synovial joints
      1) Flexion, extension, & hyperextension
a) Flexion decreases the angle of a joint; e.g. bending elbow or wrist; Angle becomes less than 180 degrees
b) Extension straighteneds a joint and returns a body part to natural anatomical position; angle increases towards 180 degrees
c) Hyperextension is extension of a joint beyond 180 degrees

2) Abduction & adduction
   a) Abduction is movement of a part away from the midsagittal line; e.g. raising the arm to the side and away from body midline
   b) Adduction is movement towards the midsagittal line

3) Elevation & depression
   a) Elevation is a movement that raises a bone vertically; e.g. mandibles are elevated during biting & clavicles during a shrug
   b) Depression is lowering the mandible or the shoulders

4) Protraction & retraction
   a) Protraction is movement of a bone anteriorly (forward) on a horizontal plane; e.g. thrusting the jaws, shoulders, or pelvis forward
   b) Retraction is movement of a bone posteriorly

5) Circumduction
   a) Movement in which one end of an appendage remains stationary while the other makes a circular motion
   b) Sequence of flexion, abduction, extension, & adduction movements
   c) Baseball player winding up for a pitch

6) Lateral & medial rotation
   a) Movement of a bone turning on its longitudinal axis; e.g. rotation of trunk, thigh, head, or arm
   b) Medial rotation turns bone inwards
   c) Lateral rotation turns the bone outwards

7) Supination & pronation
   a) Supination is rotation of the forearm so that the palm faces forward or upward; as in asking for supper to hold a plate
   b) Pronation is rotation of the forearm so the palm faces rear or downward
   c) Movements used during turning a doorknob or turning a screw with a screwdriver

8) Dorsiflexion & plantar flexion
   a) Dorsiflexion is raising of the toes as when you swing the foot forward to take a step (heel strike)
   b) Plantar flexion is extension of the foot so that the toes point downward as in standing on tiptoe

9) Inversion & eversion
   a) Inversion is a movement in which soles are turned medially
b) Eversion is a turning of the soles to face laterally

I. Types of synovial joints

1) Gliding
   a) Flat articular surfaces in which bones ‘glide’ over each other
   b) Limited monoaxial (one plane) or nonaxial (no plane) joint
   c) Consider amphiarthrotic
   d) Also found between superior & inferior articulating surfaces of vertebrate

2) Hinge
   a) One bone with convex surface that fits into a concave depression on the other bone
   b) Uniaxial joint
   c) Examples:
      i. ulna & humerus at elbow
      ii. femur & tibia at knee
      iii. finger & toe joints

3) Pivot
   a) One bone has a rounded, pointed, or conical projection that fits into a ring-like ligament of another bone
   b) First bone rotates on its longitudinal axis relative to the other bone
   c) Uniaxial rotation
   d) Examples:
      i. atlantoaxial joint (dens & atlas)
      ii. proximal radioulnar joint allows the radius to move during pronation & supination

4) Condyloid (Ellipsoidal)
   a) Oval convex (condyloid) surface of one bone fits into a similarly-shaped (elliptical cavity) depression on the next bone
   b) Biaxial joint
   c) Examples:
      i. radiocarpal joint of the wrist
      ii. metacarpophalangeal joints at the bases of the fingers

5) Saddle
   a) Each articular surface is shaped like a saddle; concave in one direction and convex in the other
   b) Multiaxial joint
   c) More movable than a condyloid or hinge forming the primate opposable thumb

6) Ball & Socket joint
   a) Smooth hemispherical (ball-like) head fits within a concave depression created by one or more bones and other CT
   b) Multiaxial joint
   c) Examples:
i. Head of humerus into glenoid cavity of scapula
ii. head of femur into acetabulum of hip (os coxa) bone

m. Other joints
   1) Temporomandibular joint (TMJ)-TMJ syndrome caused by malocclusion & stress
      a) Clicking sounds, headaches, vertigo, pain, tinnitus
   2) Humeroscapular joint (shoulder joint)
      a) Rotator cuff-tendons of 4 muscles form rotator cuff that fuses to joint capsule & strengthens it
      b) 4 muscles: subscapularis, supraspinatus, infraspinatus, and teres minor
   3) Elbow joint
   4) Hip Joint
   5) Knee joint
      a) Most complex diarthrosis of the body
      b) Joint capsule anteriorly consists of patella & extensions of quadriceps femoris tendon
      c) Rest of capsule strengthened by both extracapsular (medial & lateral collaterals) & intracapsular (anterior & posterior cruciates) ligaments
      d) Medial & lateral menisci absorb shock & shape joint
      e) Anterior & posterior cruciate ligaments limit anterior & posterior sliding movements
      f) Medial & lateral collateral ligaments prevent rotation of extended knee
      g) 3 ‘C’s in a knee injury are: cartilages, collaterals, cruciates

9. Arthritis
   a. Arthritis is a broad term for pain & inflammation associated with the joints
   b. All forms of arthritis have pain, swelling (inflammation), and reduced mobility
   c. Rheumatism is an even broader term that refers to any painful state associated with supporting structures such as bones, ligaments, joints, muscle, or tendons
   d. 3 basic kinds, but dozens of variations: osteoarthritis, rheumatoid arthritis, & gouty arthritis
   e. Osteoarthritis results from years of joint wear
      1) Articular cartilage softens and degenerates
      2) Accompanied by crackling sounds called crepitus
      3) Bone spurs develop on exposed bone tissue causing pain
   f. Rheumatoid arthritis is an autoimmune attack on joint
      1) Antibodies attack synovial membrane, EZ’s in synovial fluid degrade the cartilage, bones ossify
      2) If untreated, restricted mobility allows joint to ossify in a fracture=repair like process
3) Remissions occur, steroids & aspirin control inflammation
4) Generally affects people 30-40 yrs old; about 2.5% of adults
5) Arthroplasty is replacement of diseased joint with artificial device called a prosthesis
6) A variety of immunosuppressant drugs help control

g. Gouty arthritis is caused by buildup of uric acid; uric acid converted to sodium urate salt that is deposited in tissues of joints
   1) Crystals irritate and eventually destroy cartilage
   2) Often affects big toe
   3) Rich man’s disease due to foods rich in nucleic acids
   4) Treatment: drugs that inhibit uric acid production and diet with foods low in nucleic acids

10. Sprains & strains
   a. Sprain—forcible wrenching & twisting of a joint
      1) Ligament & tendon damage likely
      2) Blood vessels rupture & extreme swelling
   b. Strain—overstretching of a muscle; less serious than a sprain