

7

SKELETAL SYSTEM

Chapter 7
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Unit Two



SOME AMAZING BONE FACTS

- *at birth humans have 300 bones; several fuse together = 206 in adults
- *half of your bones are in your hands and feet
- *one person in 20 has an extra rib; this is more common in males
- *older people often develop a slight curve in the spine, right-handed people curve right, and left-handed people curve left
- *each bone is beautifully fitted and shaped for its own particular place
- *the last bone to close is the collarbone, between the ages of 18 & 25
- *bones carry on all life's function, they do so more slowly
- *30% of bone is living tissue, cells, & blood vessels
- *45% is mineral deposits, mostly calcium phosphate, forms layers of crystals on the surface of a bone & gives bone hardness
- *25% of bone is water

I. Introduction

A. Bones are very physiologically active tissues.

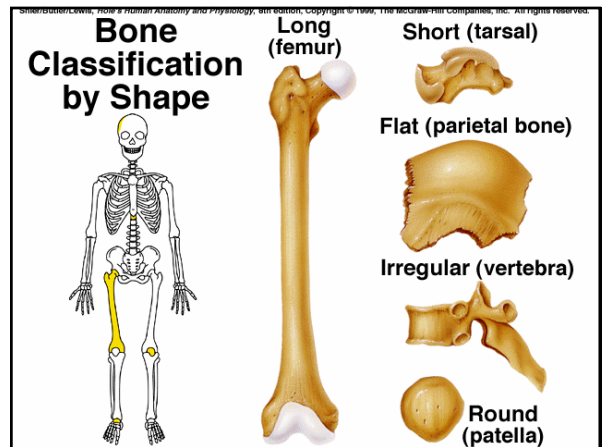
B. Each bone is made up of several types of tissues: bone tissue, cartilage, dense connective tissue, blood, & nervous tissue

Each bone is an organ.

II. Bone Structure

A. Bone Classification

- *long bones – long longitudinal axes & expanded ends = forearm & thigh bones
- *short bones – cubelike = wrists & ankles
- *flat bones – broad surface = ribs, scapulae, skull bones
- *irregular bones – different shapes = vertebrae & facial bones
- *sesamoid bones – round, small, & nodular = tendons & joints; kneecap

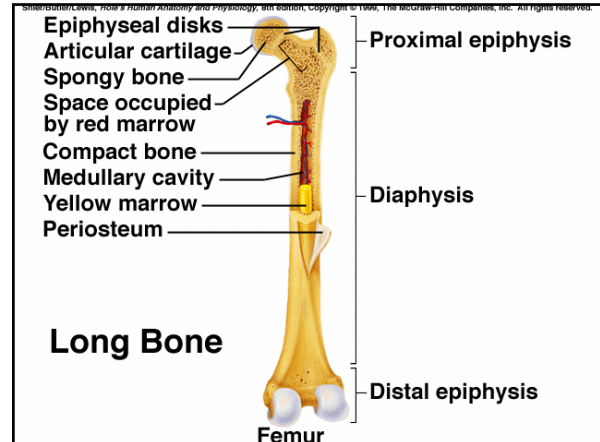


B. Parts of a Long Bone

long bone example = femur

- *epiphysis – expanded portion of a long bone that forms a joint (articulation) with another bone
- *articular cartilage – area of hyaline cartilage that covers the articulating surface of the epiphysis
- *diaphysis – shaft of the bone located between the epiphyses
- *periosteum – tough, vascular covering of fibrous tissue that covers the length of the diaphysis; attaches to bones & is continuous with tendons & ligaments; also functions in the formation & repair of bone tissue
- *processes – bony projections provide sites for ligament & tendon attachments
- *grooves, openings & depressions – allow passageways for blood vessels, nerves and articulations with other bones

(continued next slide)



- *compact bone – composes the wall of the diaphysis; has a continuous matrix with no gaps
- *spongy bone (cancellous bone) – composes the epiphyses; consists of trabeculae = branching bony plates which help reduce the bone's weight
- *medullary cavity – hollow chamber in the diaphysis
- *endosteum – squamous epithelial cells that line the medullary cavity
- *marrow – a specialized type of soft connective tissue that fills the medullary cavity, 2 forms: red & yellow

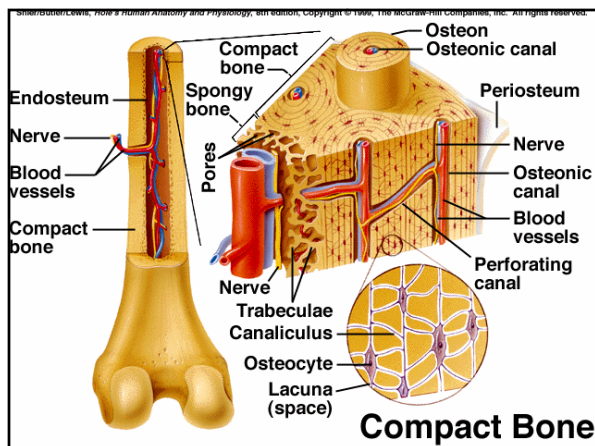
C. Microscopic Structure

**osteocytes are located in lacunae which form osteonic canals; they communicate with nearby cells by canaliculi; matrix is collagen & salts which gives bone strength & resilience

*compact bone:

osteon - a cylinder-shaped unit containing osteocytes that surround an osteonic (Haversian) canal; the orientation of the osteons resists compressive forces; osteonic canals have blood vessels & nerve fibers; perforating canals or Volkman's canals connect osteonic canals

*spongy bone: bone cells do not aggregate around osteonic canals, the cells lie within the trabeculae & receive substances diffusing into the canaliculi that lead to the surface of these thin, bony plates



III. Bone Development and Growth

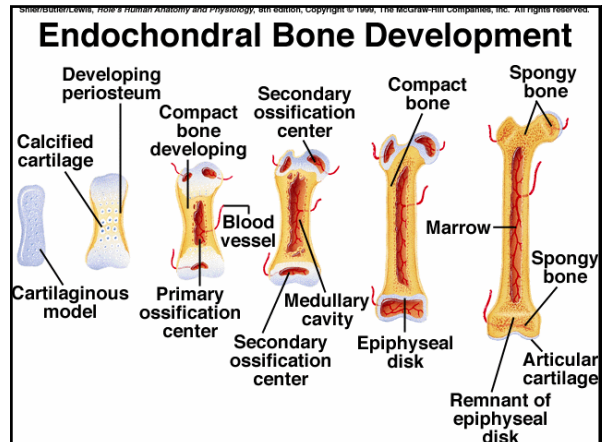
- Bones form by replacing connective tissue/cartilage in the fetus.
- Some form with sheetlike layers of connective tissue (intramembranous bones), while others replace masses of cartilage (endochondral bones).
- Intramembranous Bones
 - *certain flat, broad bones of the skull
 - *osteogenesis – the development of bone:
 - primitive connective tissues appear at the sites of future bones
 - blood vessels supply these tissues
 - these cells enlarge & form osteoblasts which deposit bony matrix around themselves
 - spongy bone forms & later some becomes compact bone
 - osteoblasts become surrounded by matrix & secluded within lacunae > canaliculi > osteocytes
 - cells outside the developing bone > periosteum & osteoblasts on inside form compact bone over newly formed spongy bone
 - *intramembranous ossification – process of replacing connective tissue to form bone

D. Endochondral Bones

*most bones are endochondral bones

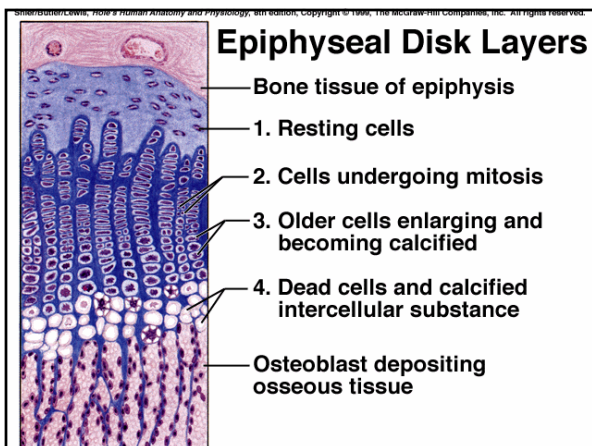
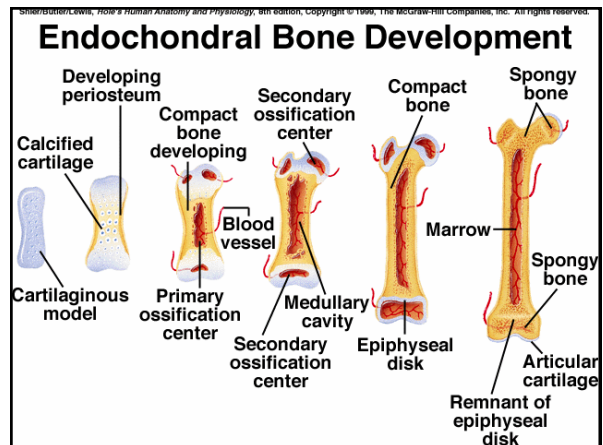
endochondral ossification:

- 1) develop from masses of hyaline cartilage shaped like future bony structure
- 2) cartilage tissue breaks down & periosteum develops
- 3) blood vessels and differentiating osteoblasts invade area
- 4) osteoblasts form spongy bone in space where cartilage was
- 5) when bony matrix surrounds osteoblasts > osteocytes
- 6) osteoblasts beneath periosteum deposit compact bone around spongy bone



E. Growth of an Endochondral Bone

- 1) primary ossification center – area in center of diaphysis where bony tissue begins to replace hyaline cartilage
- 2) secondary ossification center – appears in the epiphyses & spongy bone forms in all directions
- 3) epiphyseal plate remains between the 2 ossification centers - consists of resting cells, young reproducing cells, older enlarging cells, & dying cells; *responsible for lengthening bones*
- 4) osteoclasts break down the calcified matrix by secreting an acid that dissolves it, bone building osteoblasts then deposit bone tissue
- 5) long bones continue lengthening until epiphyseal plate is ossified
- 6) Bone growth thickness is due to intramembranous ossification beneath the periosteum

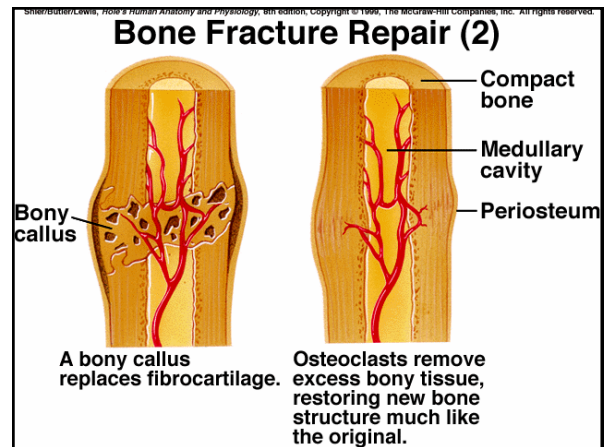
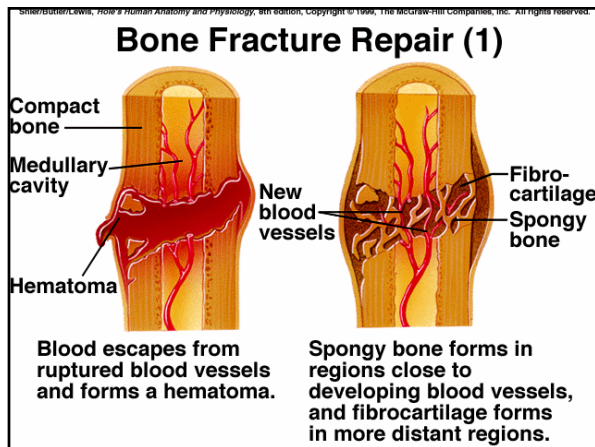
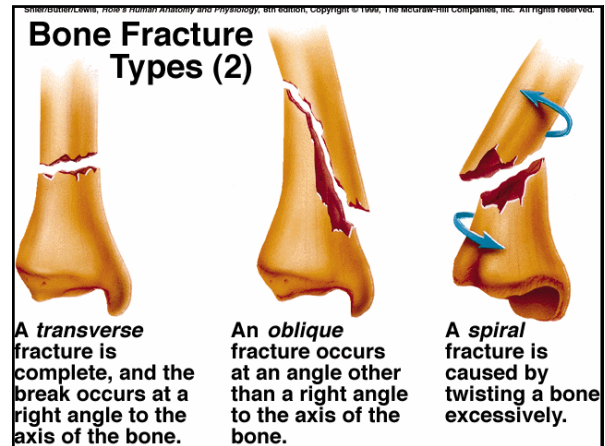
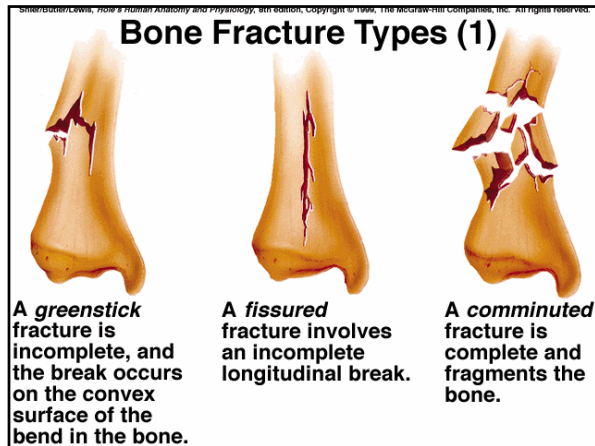


F. Homeostasis of Bone Tissue

- *osteoblasts and osteoclasts constantly remodel bone
- * total mass of bone remains nearly constant
- *resorption & absorption are opposing forces that regulate total bone mass

G. Factors Affecting Bone Development, Growth, and Repair

- *influential factors: nutrition, exposure to sunlight, hormonal secretions, & physical exercise
- *vitamin D – necessary for good absorption of Ca for good bone formation (absence causes rickets in children & osteomalacia in adults – in both bones are deformed)
- *vitamin A – necessary for bone resorption
- *vitamin C – for collagen synthesis (bones are thin & fragile)
- *pituitary growth hormone – deficiency results in dwarfism; excess results in gigantism or acromegaly
- *thyroid hormone – deficiency delays bone growth
- *sex hormones promote bone formation & help ossify disk



IV. Bone Function

A. Support and Protection
*shape, support, protect internal organs & tissues, house tissues that produce blood cells, & store inorganic salts

B. Body Movement
*bones of lower limbs, pelvis, & vertebral column - support body's weight
*skull bones - protect eyes, ears, & brain
*rib cage & shoulder girdle - protect heart & lungs
*pelvic girdle - protect lower abdominal & internal reproductive organs

***When limbs or other body parts move, bones & muscles interact. (levers)

C. Blood Cell Formation

***hematopoiesis** - process of blood formation, begins in the yolk sac which is outside the human embryo; later they are manufactured in the liver & spleen; still later in bone marrow

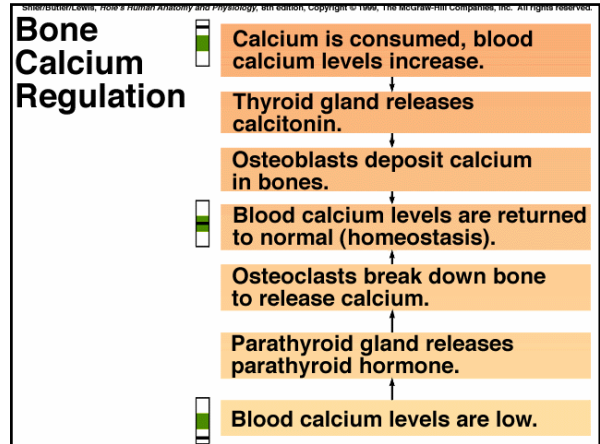
*marrow - netlike mass of connective tissue in medullary cavities of long bones, irregular spaces of spongy bone, & in larger osteonic canals of compact bone tissue (2 kinds):
***red marrow** - forms **erythrocytes** (red), **leukocytes** (white), and **thrombocytes** (blood platelets)
hemoglobin - red oxygen-carrying protein in red blood cells gives red marrow its color
***yellow marrow** - stores fat & helps in immunity & injured tissue repair (no blood cell formation)

If blood cell supply is deficient yellow marrow can change back into red marrow & produce blood cells

D. Inorganic Salt Storage

- *salts make up 70% of bone matrix – hydroxyapatite - CaPO_4
- *body needs Ca for blood clot formation, nerve impulse conduction, & muscle cell contraction
- *when blood Ca is low, osteoclasts resorb bone releasing Ca salts; when blood Ca is high, osteoblasts form bone tissue & store calcium
- *P is also stored by bone tissue
- *bone stores small amounts of Na, Mg, K, and CO_3 ions
- *bone tissue may accumulate Pb, Ra, or Sr which are harmful

LOOK AT CHART NEXT SLIDE.



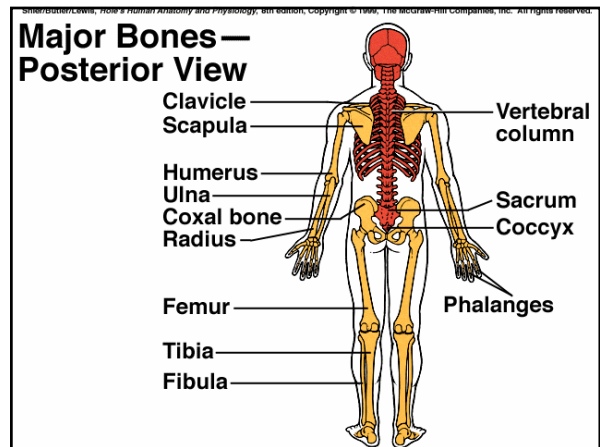
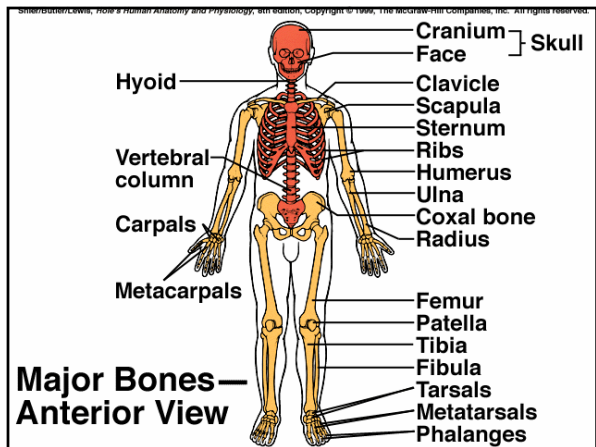
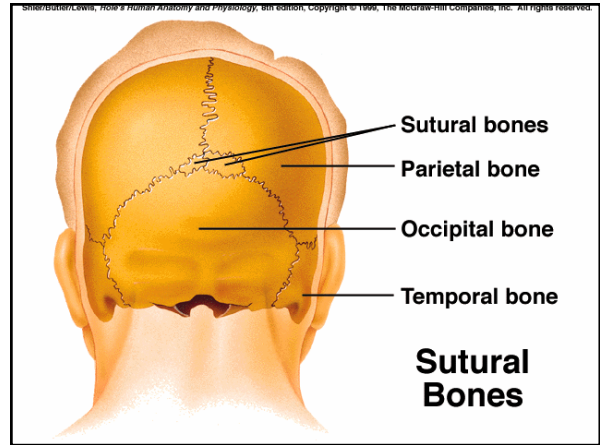
V. Skeletal Organization

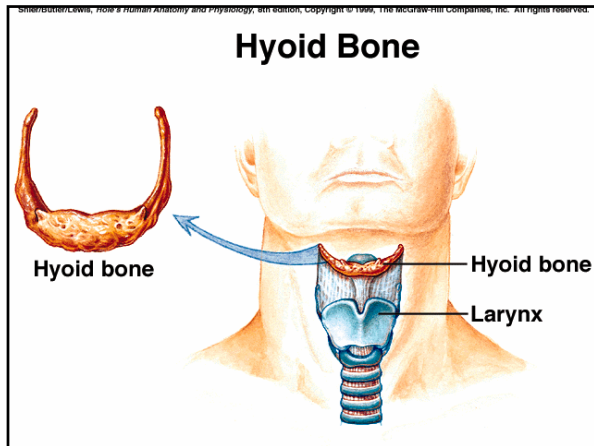
A. Number of Bones

- *usual # is 206; some have more or less due to sutural bones that grow in sutures – area where 2 bones grow together (ie. Flat bones in skull); OR sesamoid bones may develop in tendons to help reduce friction in places where tendons have to pass over bony prominences

B. Divisions of the Skeleton

- *skeleton is divided in axial & appendicular portions
- *axial skeleton – skull, hyoid bone, vertebral column, & thoracic cage
- *appendicular skeleton – pectoral girdle, upper limbs, pelvic girdle, & lower limbs

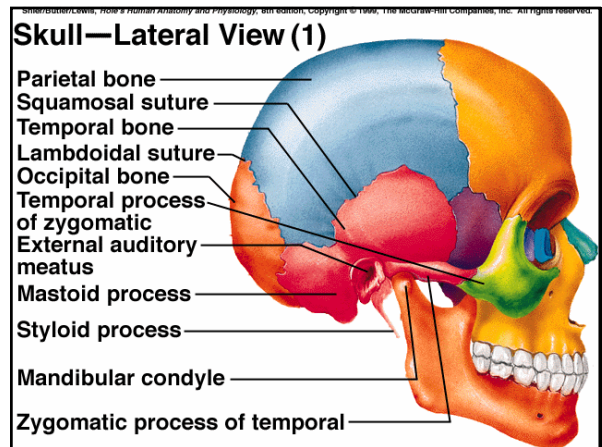
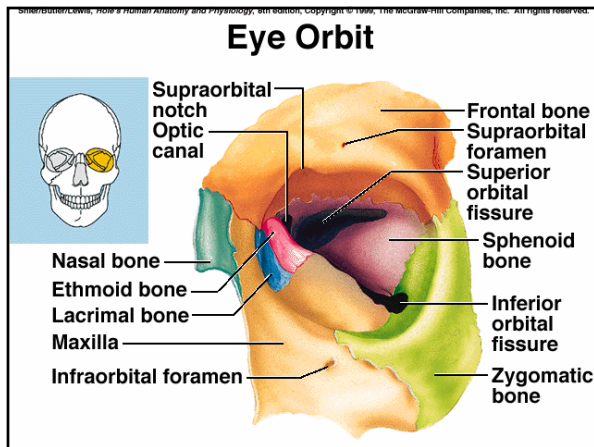
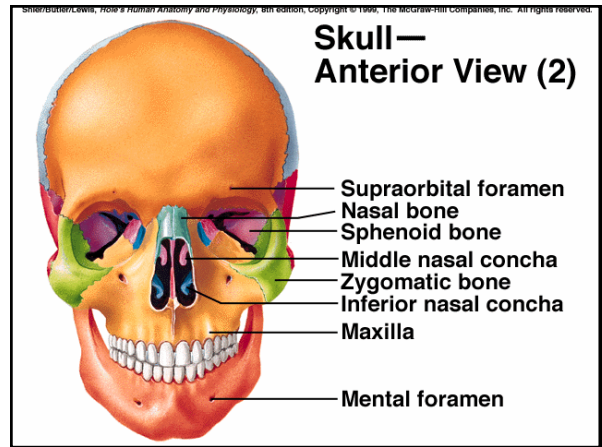
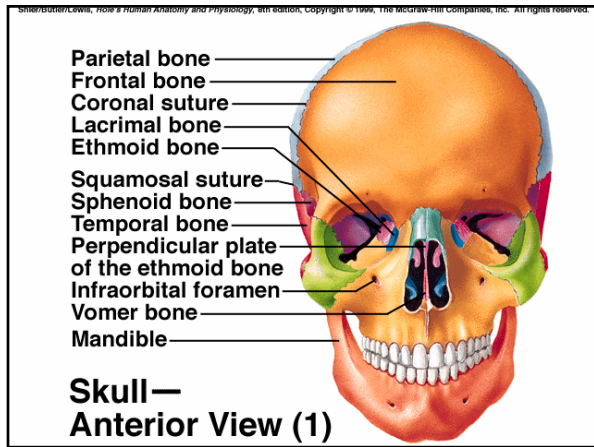


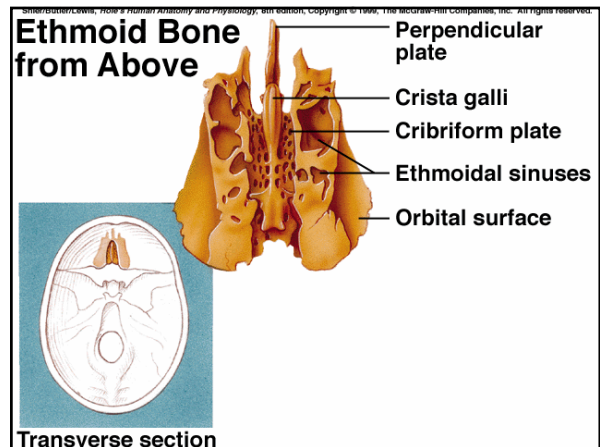
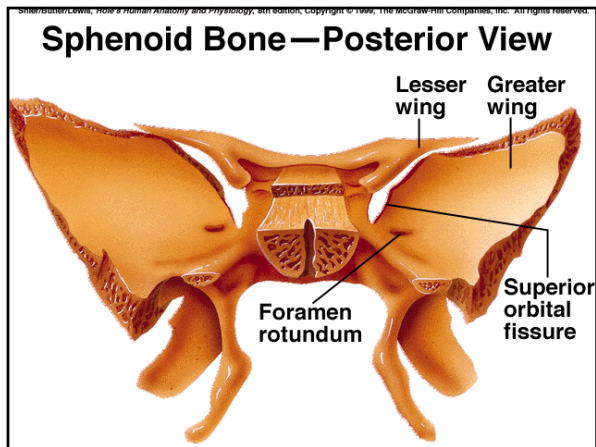
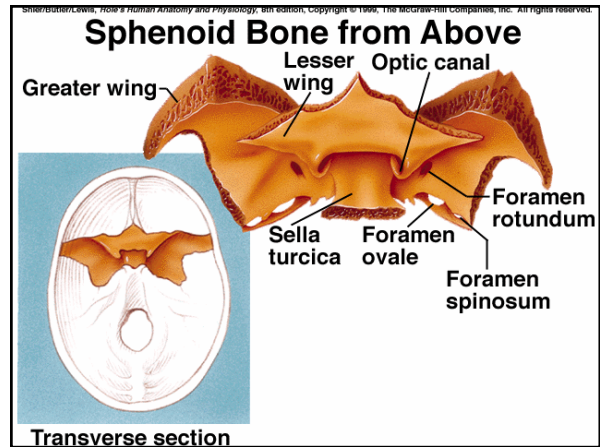
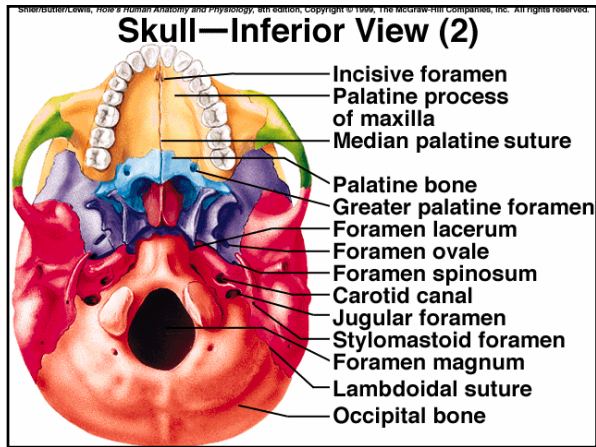
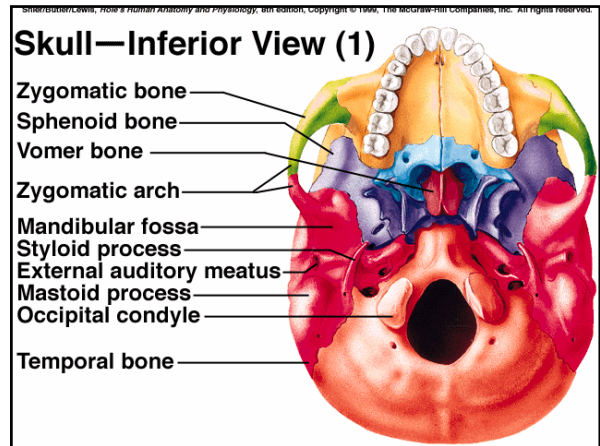
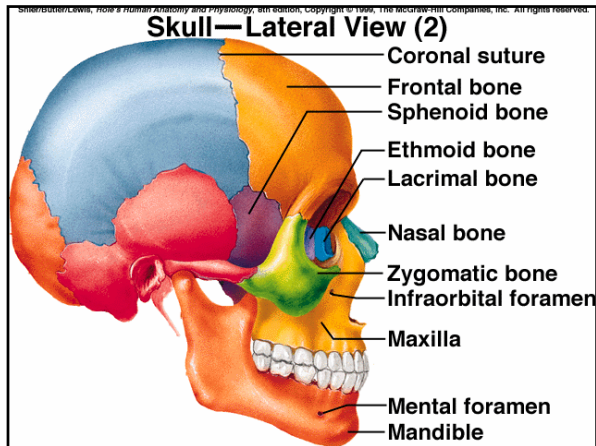


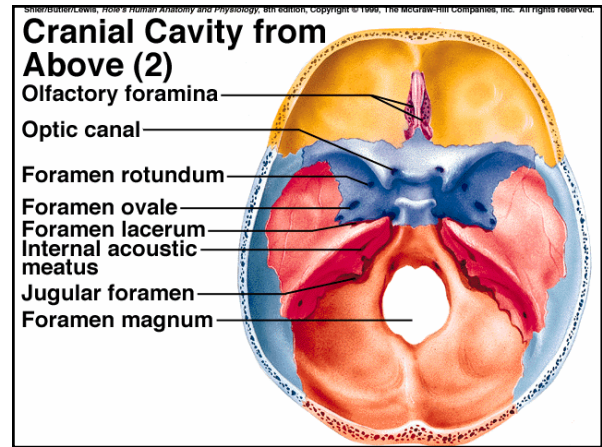
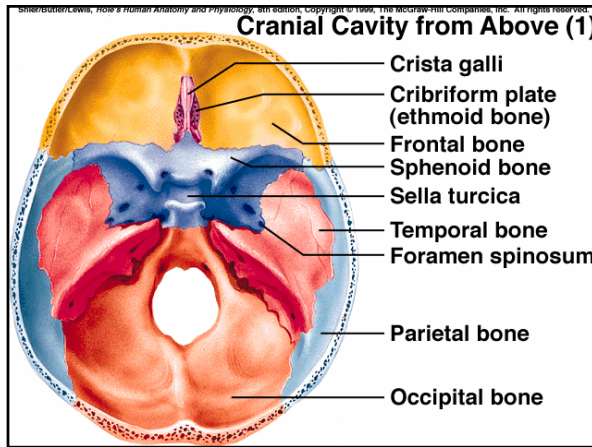
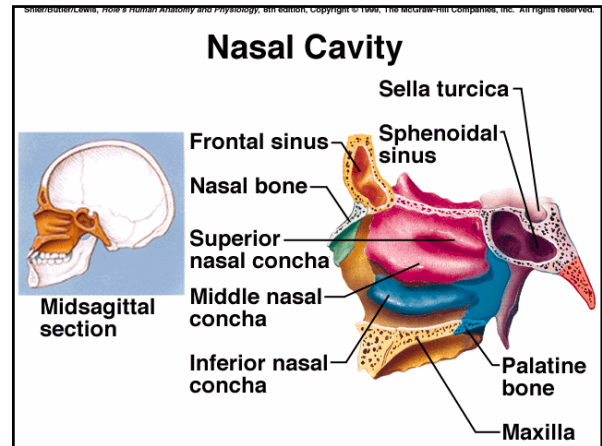
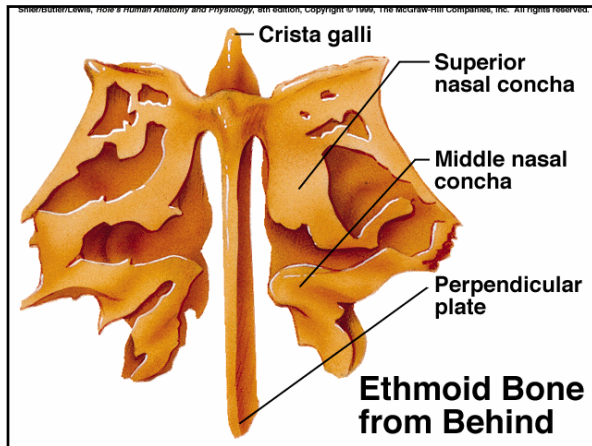
VI. Skull

A. The skull is made up of 22 bones, including 8 cranial bones, 13 facial bones, and the mandible (lower jaw bone).
 *all bones of the skull are joined by sutures except the mandible

B. Cranium – 8 bones
 *encloses & protects brain, provides attachments for muscles that aid in chewing & head movement
 *sinuses – air-filled cavities lined with mucous membranes, & are connected to nasal cavity; they reduce weight of skull and allow for voice intensity
 *frontal bone, parietal bones (2), occipital bone, temporal bones(2), sphenoid bone, ethmoid bone





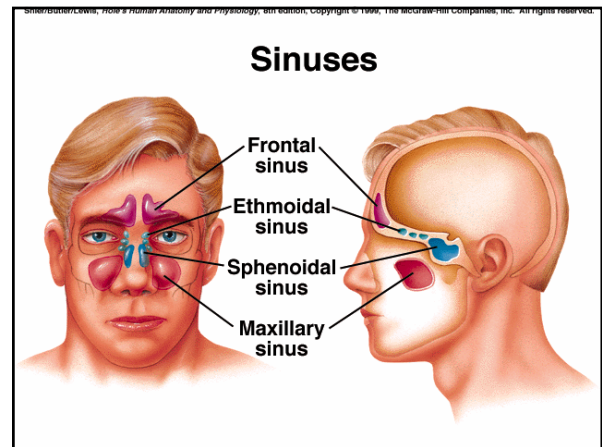


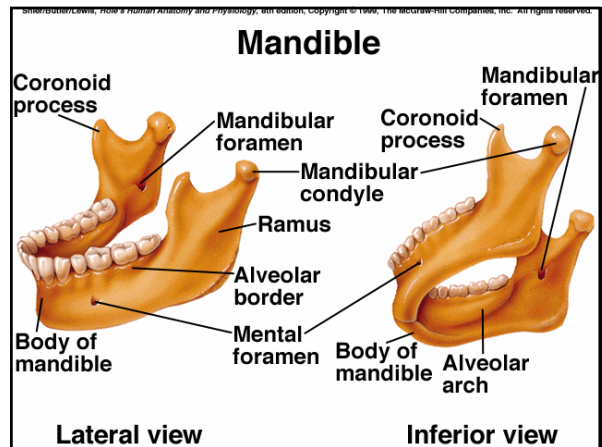
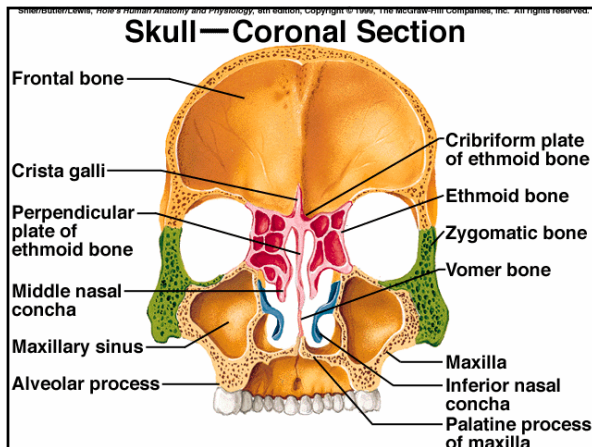
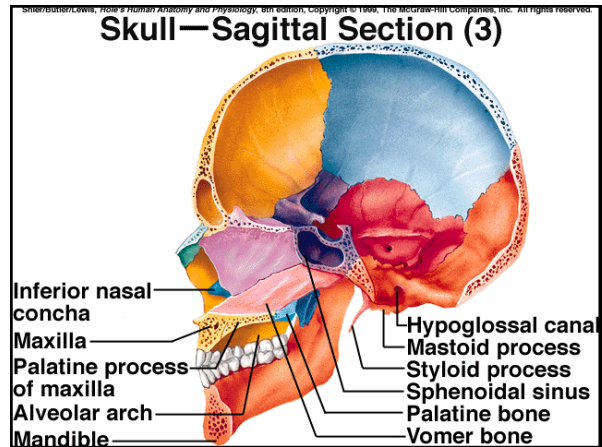
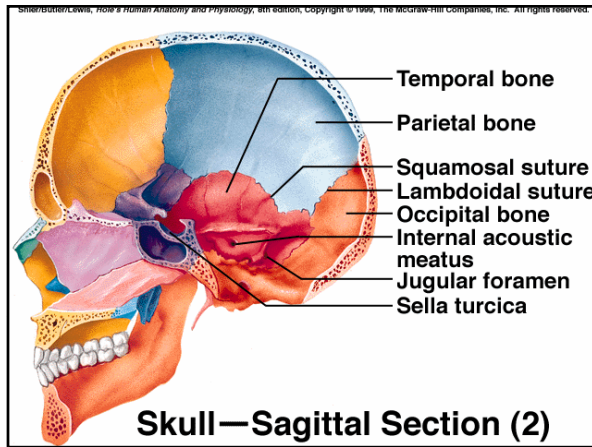
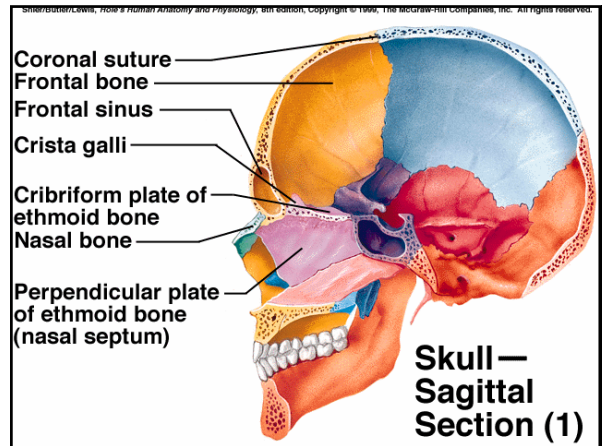
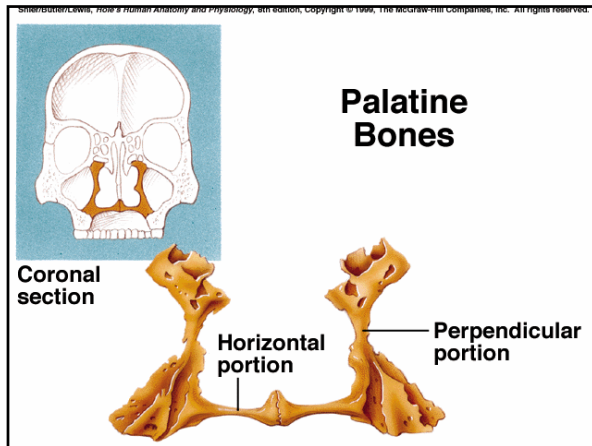
C. Facial Skeleton – 13 bones

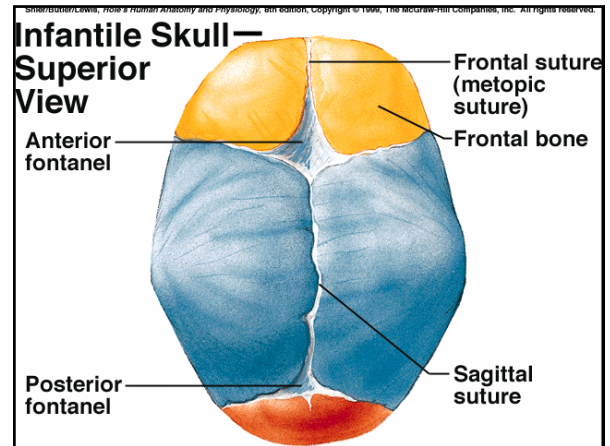
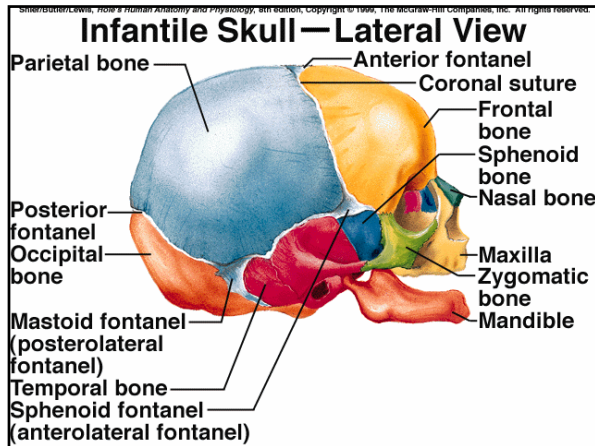
- *immovable bones, form shape of face, and provide attachments for muscles that move jaw & control facial expressions
- *maxillary bones (2), palatine bones (2), zygomatic bones (2), lacrimal bones (2), nasal bones (2), vomer bone, inferior nasal conchae, & mandible

D. Infantile Skull

- *skull is not completely developed at birth
- *fontanels (soft spots) – membranous areas connect cranial bones, enables infant's skull to move more easily through birth canal
- *as cranial bones grow together, fontanel closes by 2nd year
- *skull proportions are different than the adult skull, bones are less easily fractured

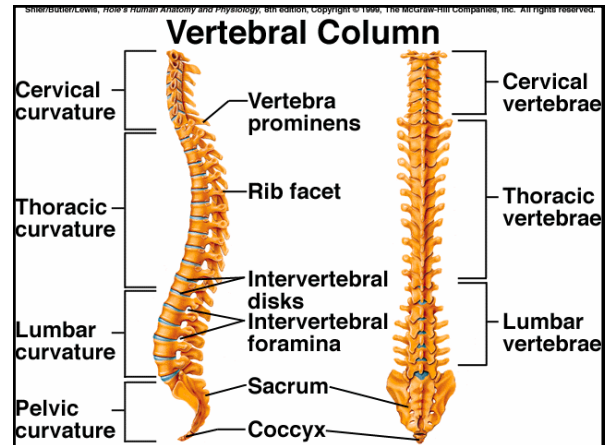






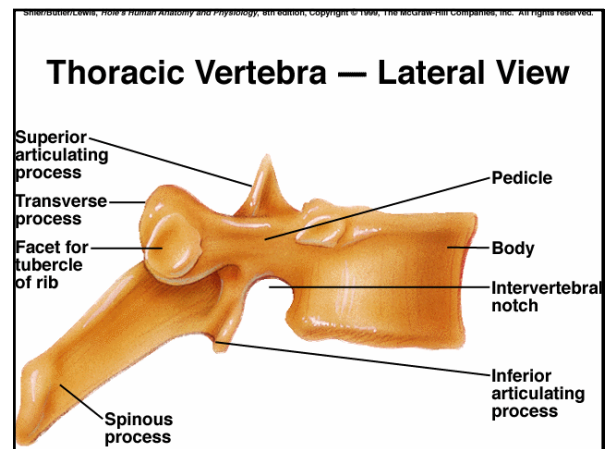
VII. Vertebral Column

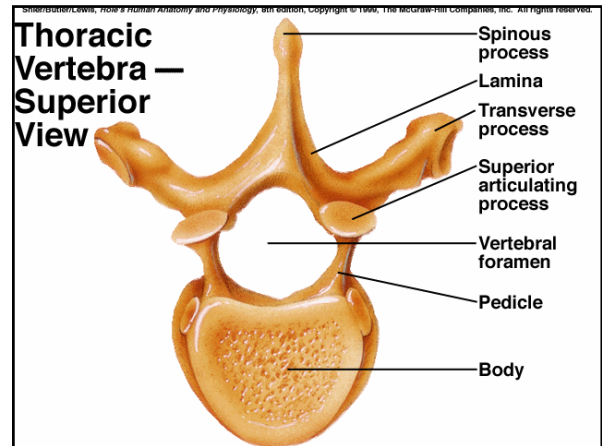
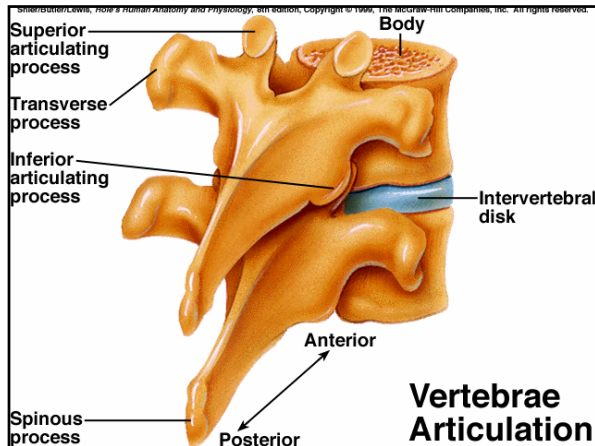
- A. The vertebral column, from skull to pelvis, forms the vertical axis of the skeleton.
- B. It is composed of bony parts called vertebrae separated by masses of fibrocartilage called intervertebral disks & are connected by ligaments; supports head & trunk; openings in vertebrae form vertebral canal which allows spinal cord to pass through
- C. An infant has 33 bones in its vertebral column; an adult has 26. 5 fuse to form sacrum & 4 join to form coccyx
- D. The vertebral column has four curvatures that give resiliency: cervical, thoracic, lumbar, and pelvic.
 - *cervical curvature – develops when baby holds head up
 - *lumbar curvature – develops when child begins to stand



E. A Typical Vertebra

- *body or centrum – drum-shaped, anterior; support weight of head & trunk; intervertebral disks separate adjacent vertebrae & are joined by anterior & posterior ligaments
- *pedicles – 2 short stalks that project from the body & form sides of vertebral foramen
- *laminae – 2 plates that arise from the pedicles & fuse to form spinous process
- *vertebral arch – composed of pedicles, laminae, & spinous process
- *transverse process – between pedicles & laminae
- *various muscles and ligaments are attached to processes
- *superior & inferior articulating processes – cartilage covered facets that join vertebrae
- *intervertebral foramina – provide passageways for spinal nerves (notches)





VII. Vertebral Column

F. Cervical Vertebrae
 *7 cervical vertebrae; bony axis of neck, smallest, bone tissue is densest

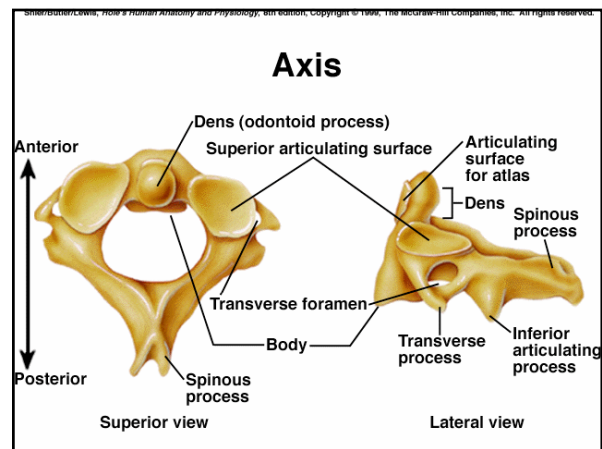
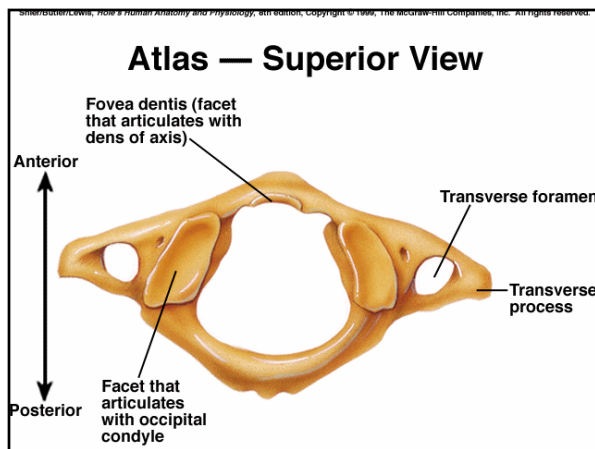
- *transverse processes have transverse foramina which are passageways for arteries leading to the brain
- *spinous processes are forked (bifid) for attachment of muscles
- *vertebra prominens – spinous process of 7th vertebrae, can feel
- *atlas (1st vertebra) – supports head, has 2 facets that articulate with occipital condyles
- *axis (2nd vertebra) – toothlike dens (odontoid process) that lies in the ring of the atlas; atlas pivots around the dens to move the head

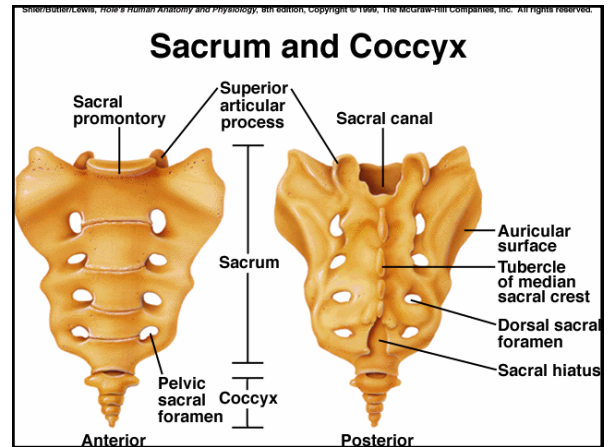
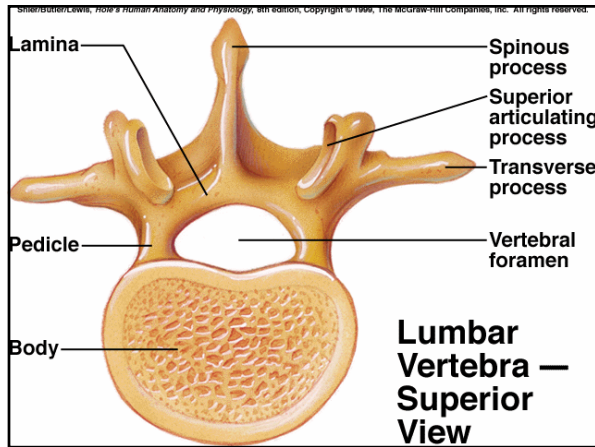
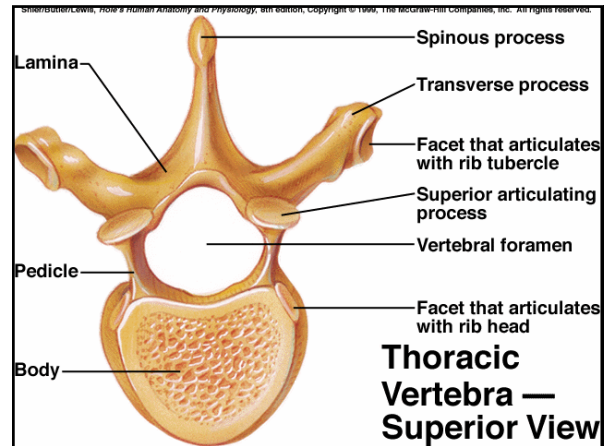
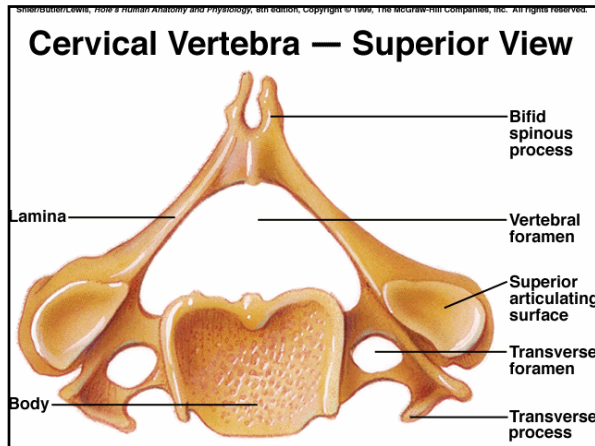
G. Thoracic Vertebrae
 *12 thoracic vertebrae, larger than cervical vertebrae
 *long spinous processes slope downward, & facets on the sides of bodies articulate with the ribs

H. Lumbar Vertebrae
 *5 lumbar vertebrae, are large & strong
 *transverse processes project posteriorly at sharp angles
 *spinous processes are horizontal

I. Sacrum
 *5 fused vertebrae, triangular at base of vertebral column
 *vertebrae fuse at ages 18-30
 *is united with coxal bones at sacroiliac joints
 *sacral promontory provides a guide for determining the size of the pelvis

J. Coccyx (tailbone)
 *4 vertebrae that fuse by age 25
 *acts as a shock absorber





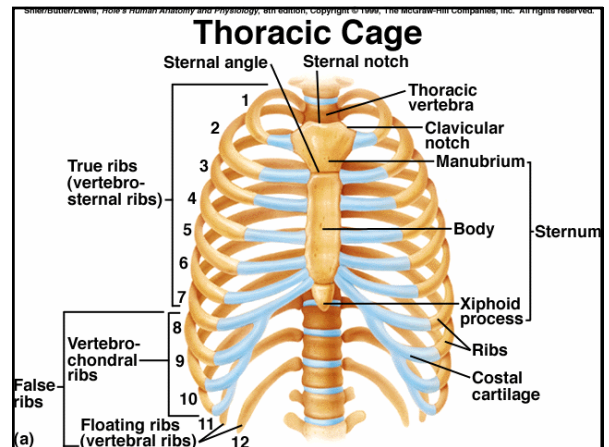
VIII. Thoracic Cage

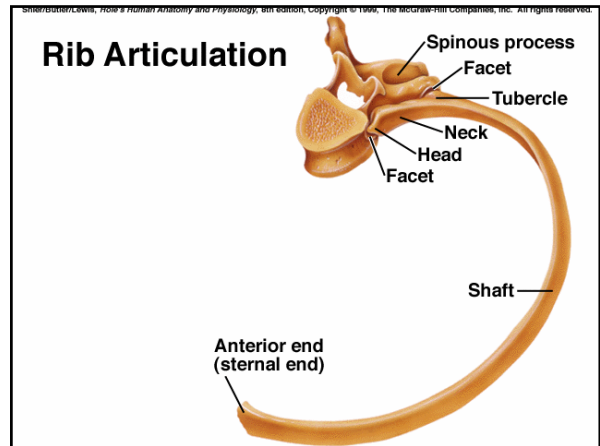
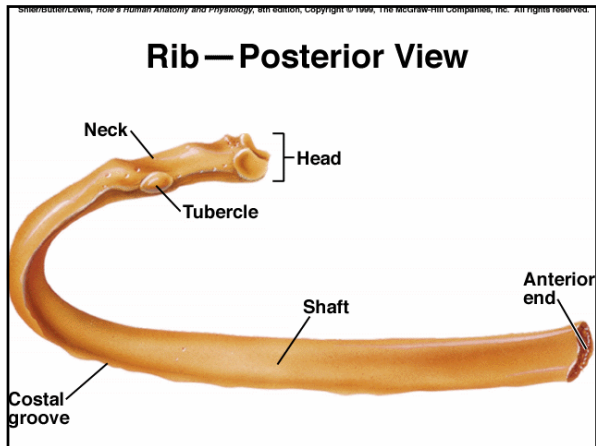
A. The thoracic cage includes the ribs, thoracic vertebrae, sternum, & costal cartilages that attach ribs to sternum.

B. It supports the pectoral girdle & upper limbs, functions in breathing, & protects thoracic & upper abdominal organs.

C. **Ribs**
 *12 pairs of ribs, attached to 12 thoracic vertebrae
 *costal cartilages (hyaline cartilage) of true ribs join the sternum directly; those of the false ribs (floating ribs) join indirectly or not at all
 *ribs have shaft, head, & tubercles that articulate with the vertebrae

D. **Sternum (breastbone)**
 *consists of 3 parts – **manubrium** (upper), **body** (middle), & **xiphoid process** that projects downward
 *articulates with costal cartilages & clavicles





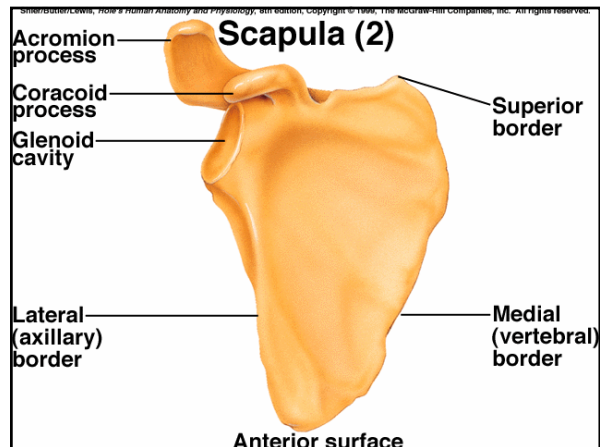
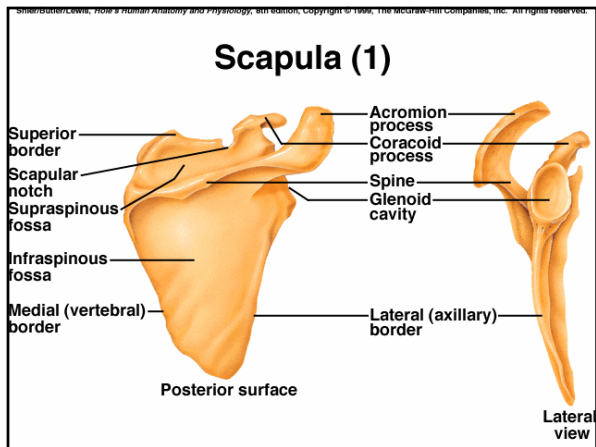
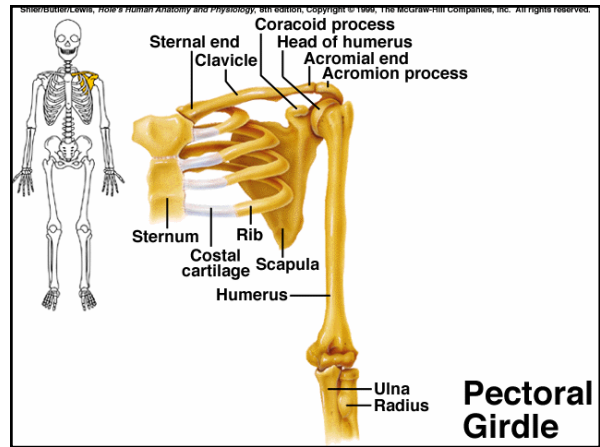
IX. Pectoral Girdle

A. The pectoral girdle makes an incomplete ring that supports the upper limbs.

B. It is made up of two scapulae (shoulder blades) and two clavicles (collarbones).

C. **Clavicles** (collarbones)
 *slender, rod-like bones (S-shaped), run horizontally between sternum & shoulders
 *hold shoulders in place & provide attachments for muscles

D. **Scapulae** (shoulders)
 *broad triangular bones located on either side of upper back
 *articulate with humerus of each upper limb
 *provide attachments for muscles of the upper limbs & chest



X. Upper Limb

A. Bones of the upper limb form the framework for the arm, forearm, & hand, provide attachments for muscles, function in levers that move limb parts; includes humerus, radius, ulna, carpals, metacarpals, & phalanges

B. **Humerus** – heavy bone that extends from the scapula to the elbow

***head** – fits into **glenoid cavity** of the scapula

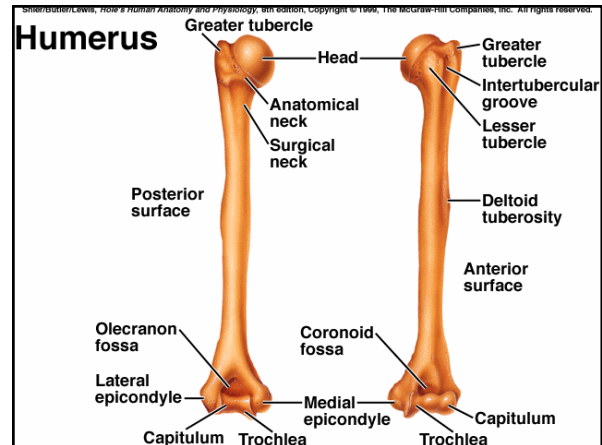
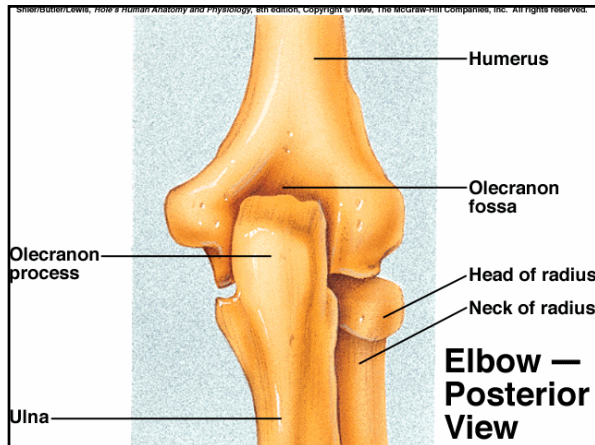
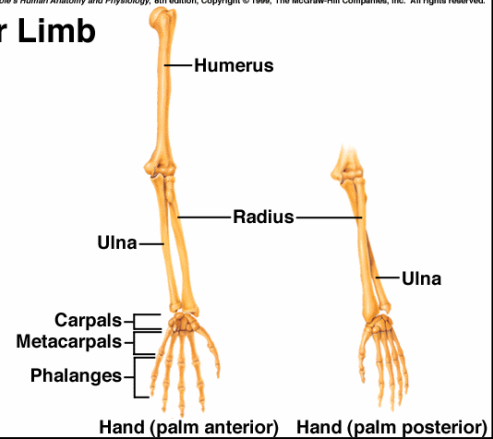
***greater & lesser tubercles** – below head & provide attachments for muscles that move the arms at the shoulders

***intertubercular groove** – narrow furrow through which a tendon passes

***anatomical neck** – depression that separates head from tubercles

* **others** - surgical neck, deltoid tuberosity, capitulum, trochlea, epicondyles, coronoid fossa, & olecranon fossa

Upper Limb



C. Radius

*located on thumb side of forearm between elbow & wrist,
*has head, radial tuberosity, styloid process, & ulnar notch

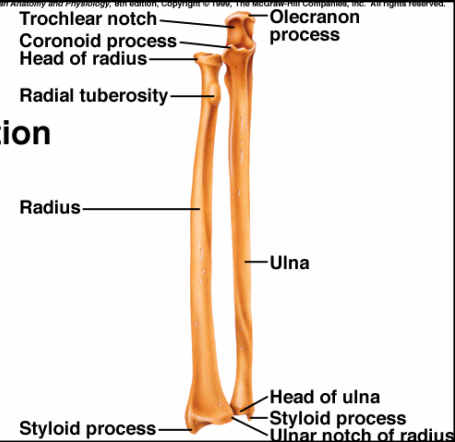
D. Ulna

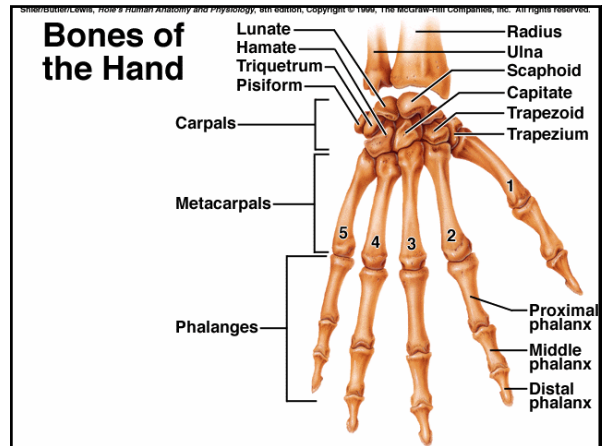
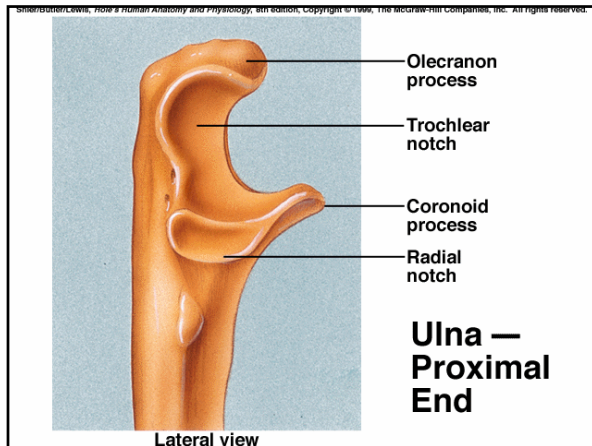
*longer than radius
*articulates with radius laterally & with a disk of fibrocartilage inferiorly
*has trochlear notch, olecranon process, coronoid process, head, styloid process, & radial notch

E. Hand

*composed of wrist, palm, & 5 fingers
*includes 8 carpals that form a carpus, 5 metacarpals, & 14 phalanges (finger bones)

Radial and Ulnar Articulation



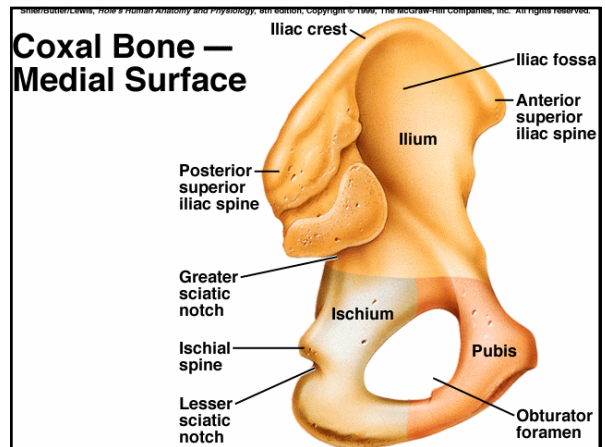
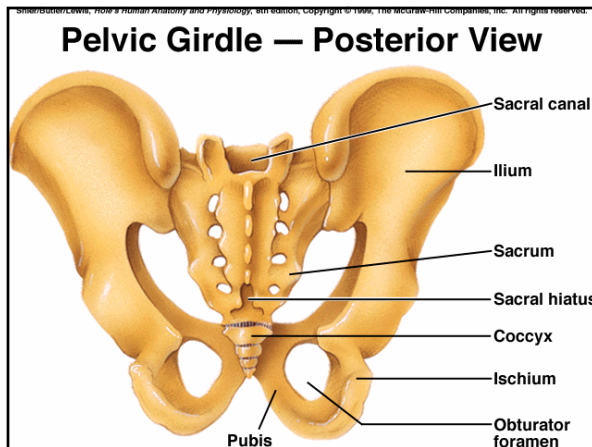
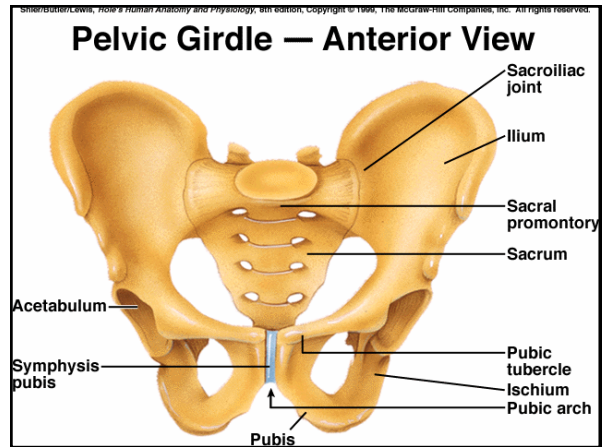


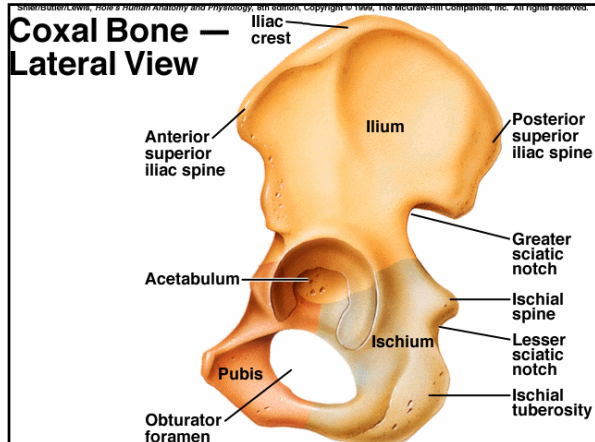
XI. Pelvic Girdle

A. The pelvic girdle consists of the two coxal bones (hipbones) & the sacrum; it supports the trunk of the body on the lower limbs.

B. The pelvic girdle supports the trunk, provides attachments for legs, protects urinary bladder, distal end of large intestine, & internal reproductive organs

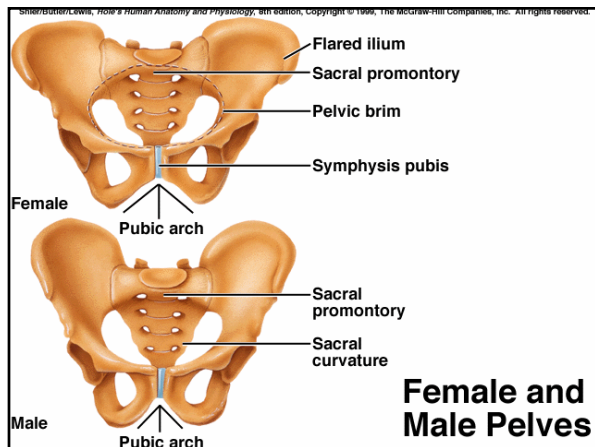
C. **Coxal Bones**
 *each coxal bone develops from 3 parts – an ilium, an ischium & a pubis
ilium – largest portion of coxal bone, joins sacrum at sacroiliac joint
ischium – lowest portion of coxal bone
pubis – anterior portion of coxal bone; forms symphysis pubis (joint); angle formed is pubic arch





D. Greater and Lesser Pelves
 *lesser pelvis – is below pelvic brim; functions as a birth canal
 *greater pelvis – is above pelvic brim; helps support abdominal organs

E. Differences between Male and Female Pelves
 *differences due to function of female pelvis as a birth canal
 *female pelvis is more flared, pubic arch is broader, distance between ischial spines & ischial tuberosities is greater, sacral curvature is shorter

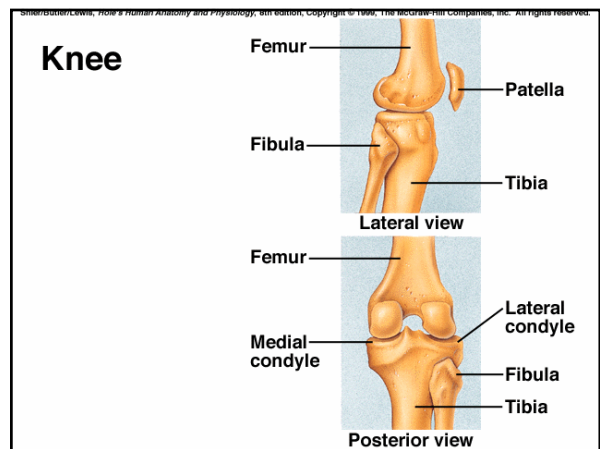
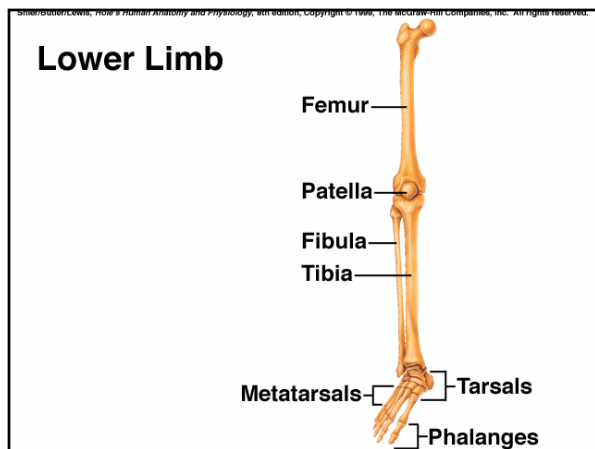


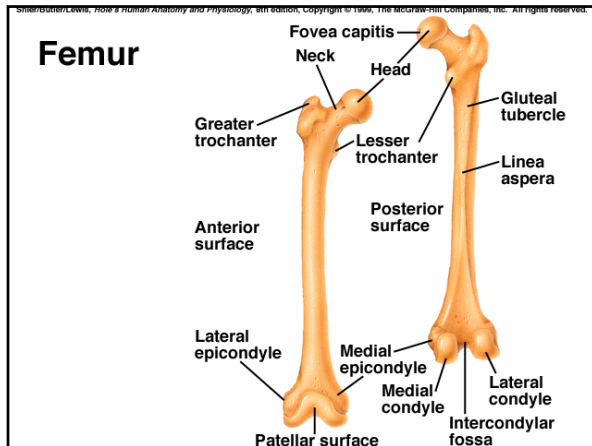
XII. Lower Limb

A. The bones of the lower limb provide the framework for the thigh, lower leg, and foot.

B. Femur
 *thighbone, longest bone in body, extends from hip to knee
 *head projects (articulates) into the acetabulum of the coxal bone

C. Patella
 *kneecap, flat sesamoid bone in the tendon that passes anteriorly over the knee
 *controls angle of the tendon & functions in lever actions associated with lower limb movements

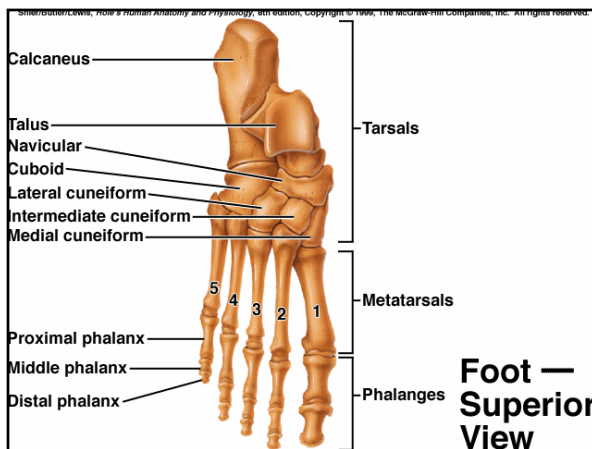
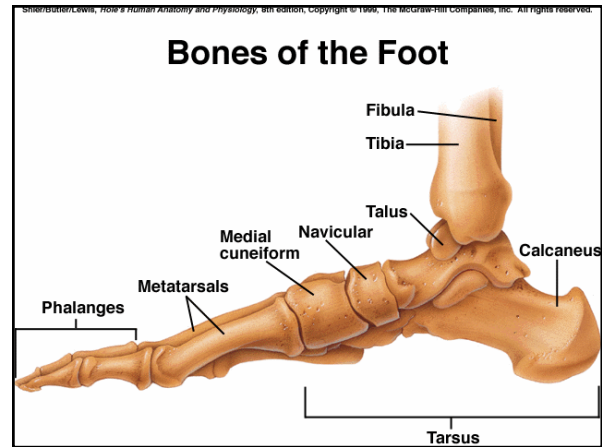
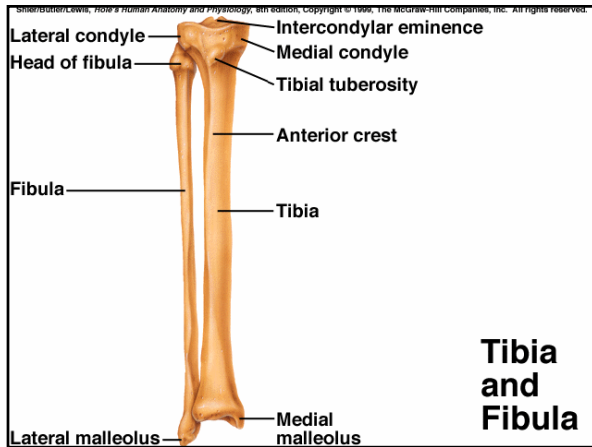




D. Tibia
 *shinbone, largest of 2 leg bones, located on medial side
 *articulates with talus of ankle

E. Fibula
 *long slender bone of lateral side of the tibia,
 *does not bear body weight
 *head and lateral malleolus articulate with the ankle

F. Foot
 *ankle, instep, & 5 toes
 *7 tarsals that form the tarsus, 5 metatarsals, & 14 phalanges
 *talus – can move freely
 *calcaneus – heel bone, largest ankle bone



Arrivederci

Remember – At the end of the chapter is a Chapter Summary that is your Study Guide for the Chapter 7 test.