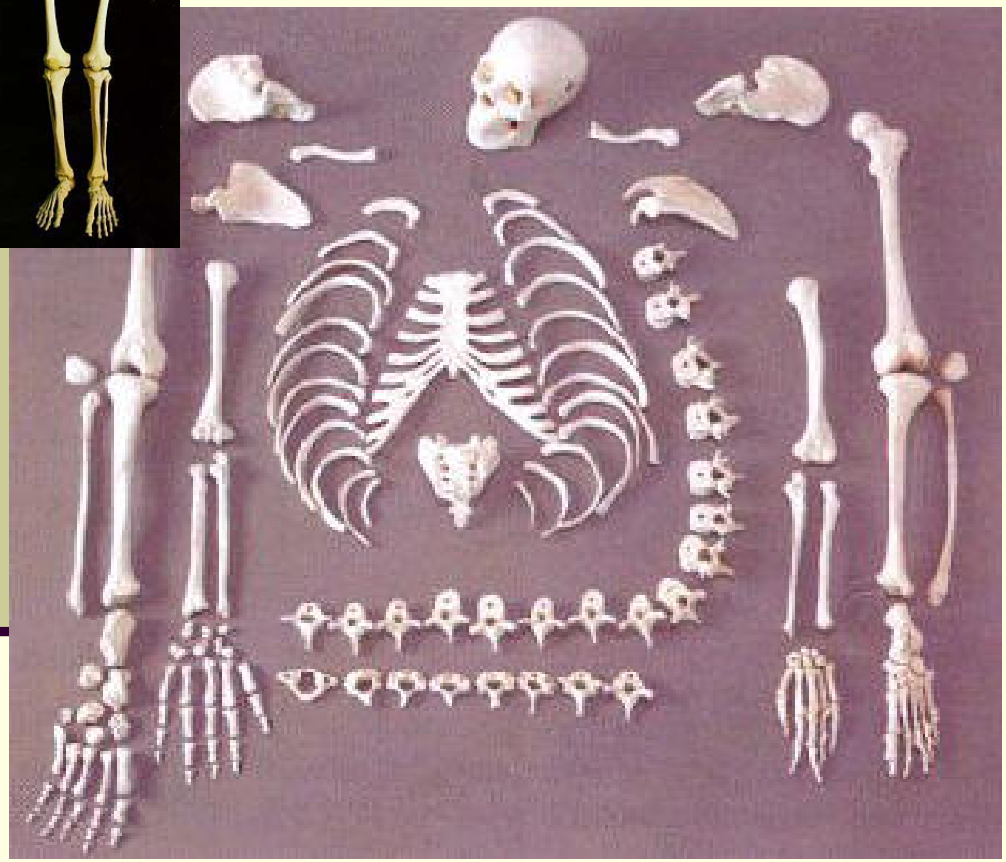
# UNDERSTANDING WORDS

- For Chapters 6 and 7 check out pages 157 and 181.  For example:
  - Ax-, axis: axial skeleton – upright portion of the skeleton that supports the head, neck, and trunk.
  - -blast, bud or offshoot, a growing organism in early stages:  osteoblast – cell that will form bone tissue.
  - Fove-, pit: fovea capitis – pit in the head of a femur

# Chapter 7 – The Skeletal System



- Classification of Bones – 2 Groups
  - Axial Skeleton – forms the long axis of the body, Includes: bones of the skull, vertebral column, and rib cage
  - Appendicular Skeleton – relating to an appendage, Includes: bones of the upper and lower limbs, shoulder girdle, and hip girdle
  - A total of 206 bones in the human body. See page 196 in the textbook for breakdown.

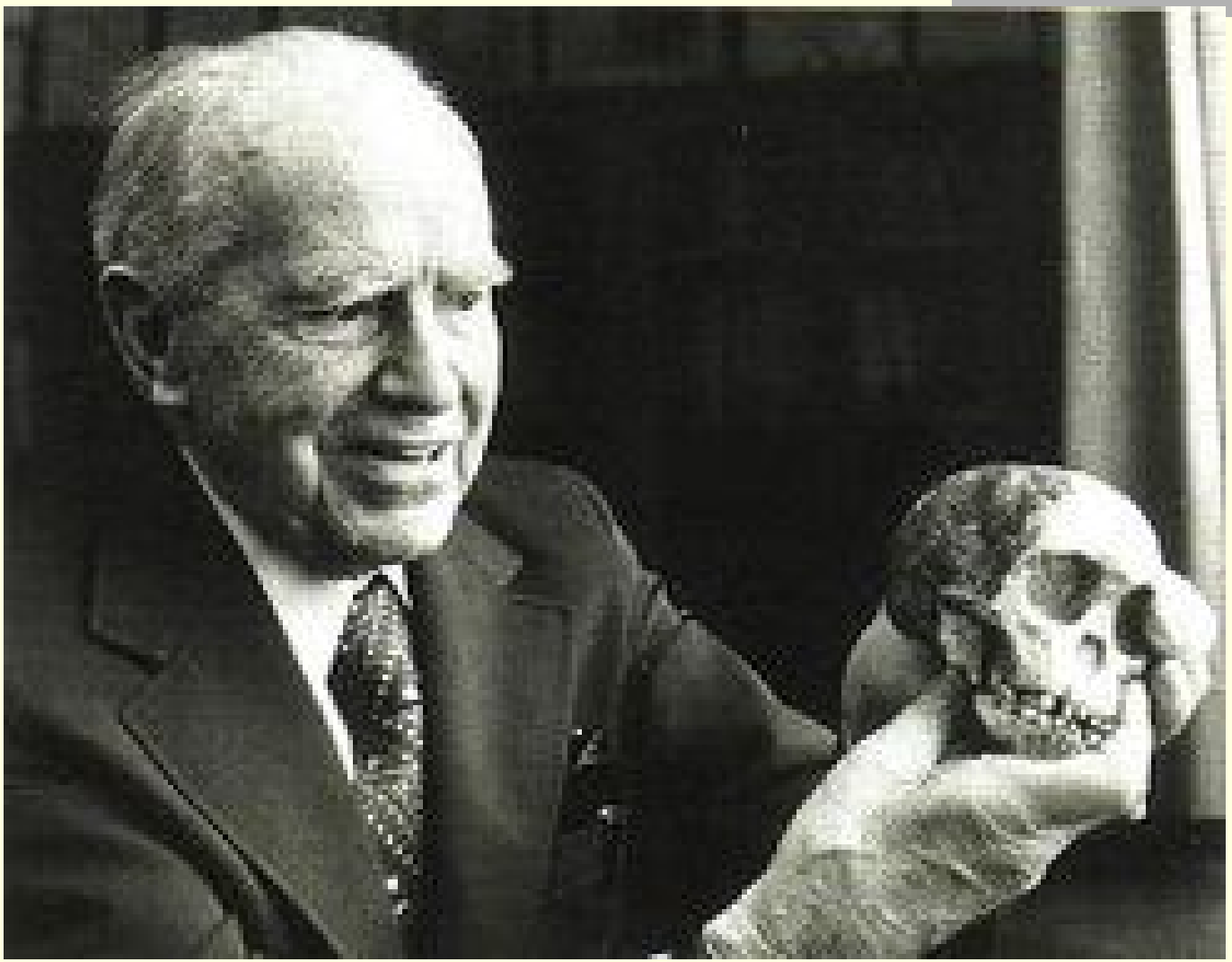
# Parts of the skeleton often persist in decomposed remains of human bodies

- Useful in Forensic Science especially in the resolution of cases dealing with missing persons and criminal investigations
- Useful in studies of archeology and anthropology (e.g., longevity, quality of diet)
- Useful in studies of paleontology, especially when bones are preserved by process of fossilization. Bones can assist scientist in answering questions regarding human origins

# The Biological Origins of *Homo sapiens* (wise man)

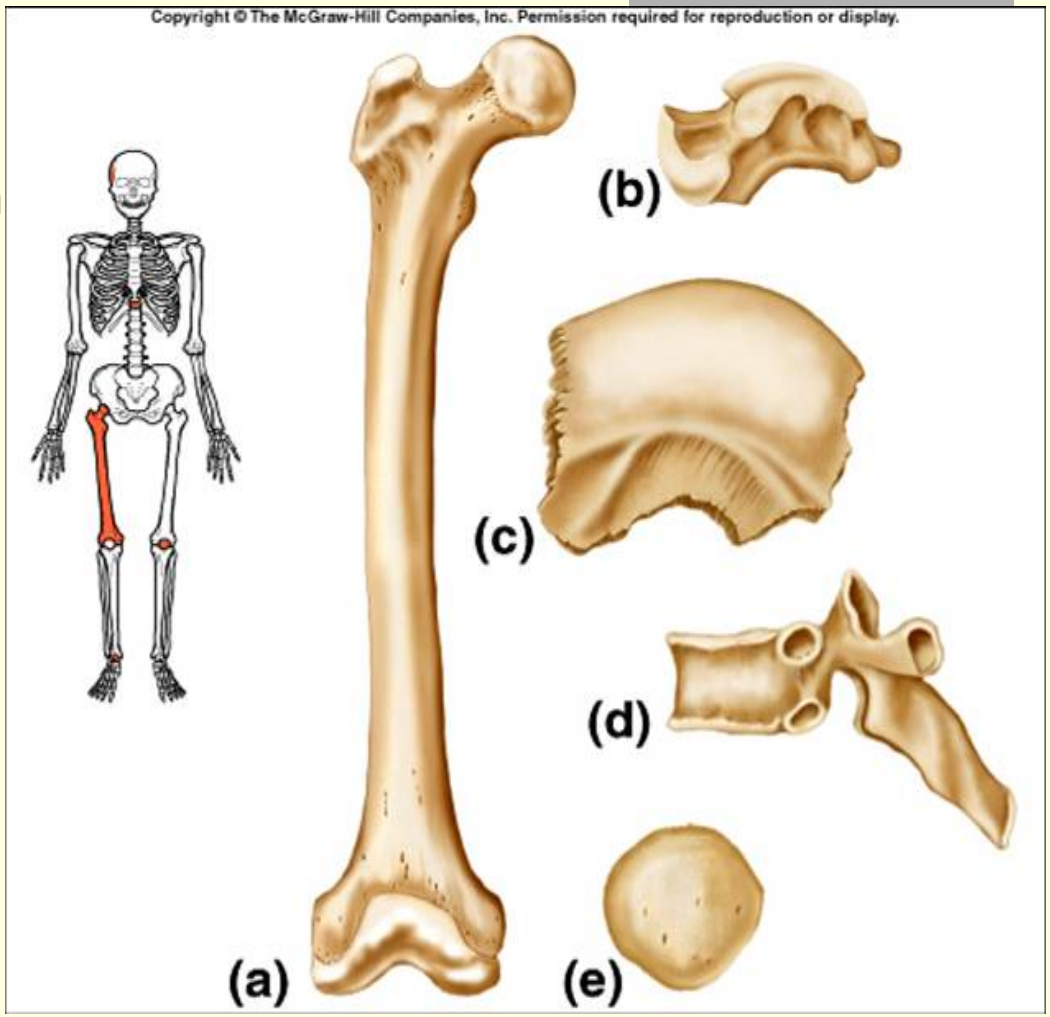
- Charles Darwin predicted in ***The Descent of Man, and Selection in Relation to Sex*** (1871) that the earliest human ancestors probably originated in Africa.
  - Large-brained fossil humans in Europe swung scientific opinion in favor of Eurasia during the first third of the 20th century.
  - Raymond Dart and Robert Broom found fossil evidence to the contrary to the prevailing idea of the time during the 1920s and 1930s.
  - Dart's Taung Child is *Australopithecus africanus* and lived about 2.5 million years ago.
- During hominid evolution which came first, a large brain or the ability to walk upright? Fossilized skeletal remains give some insight into this question.
  - The ancestors of later hominid lineages had small brains but could walk upright. This notion when initially introduced was met with skepticism by the "experts" of the day, much to Dart's dismay. Later studies confirmed that the first "human-like" animals were bipedal, then later developed larger brains.
- http://www.press.uchicago.edu/Misc/Chicago/284158_brain.html, http://en.wikipedia.org/wiki/Taung_Child, & http://en.wikipedia.org/wiki/Raymond_Dart

# Raymond Dart Holding Skull of Taung Child Discovered in 1924 at Taung in South Africa



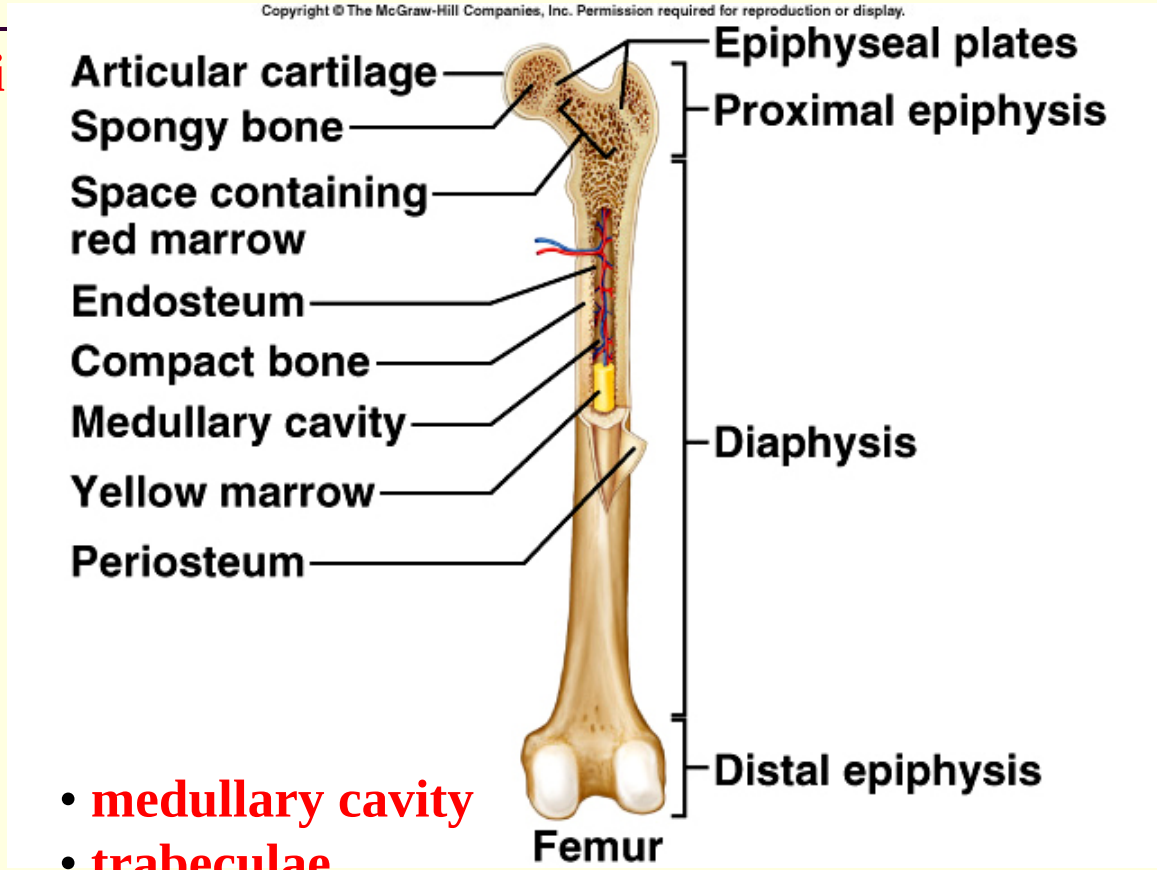
# Bone Classification

- **Long** Bones – long longitudinal axes and expanded ends (examples include the forearm and thigh bones)
- **Short** Bones – somewhat cube-like (examples include the wrist and ankle bones)
- **Flat** Bones – plate-like (examples include some bones in the skull, rib bones)
- **Irregular** Bones (many facial bones and vertebrate)
- **Sesamoid** Bones – bones embedded in the tendons next to joints (e.g., patella)



# Parts of Long Bone

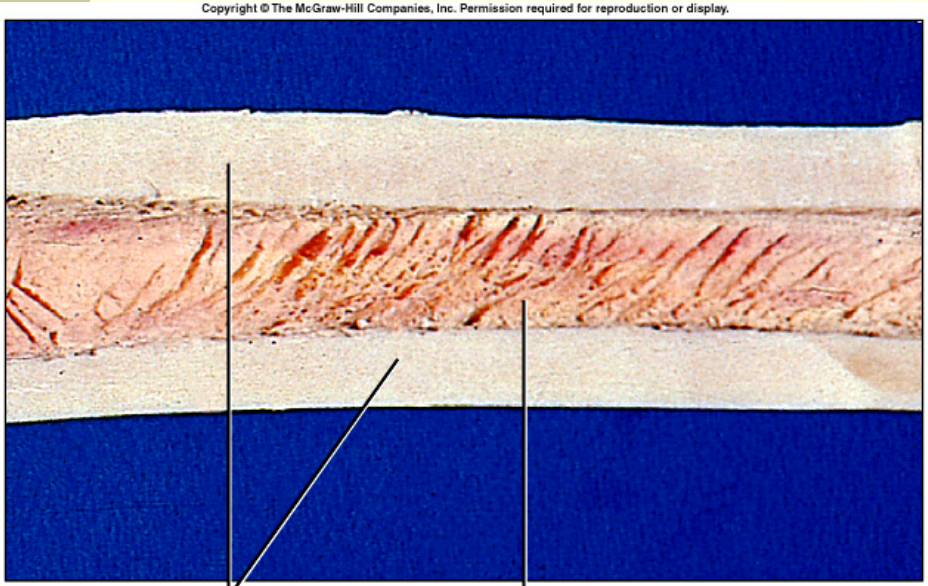
- epiphysis (expanded porti
  - distal
  - proximal
- diaphysis (bone shaft)
- compact bone
- spongy bone
- articular cartilage
  - (hyaline cartilage)
- periosteum
  - (fibrous tissue attached to bone surface)
- endosteum (mebrane of bone-foming cells)



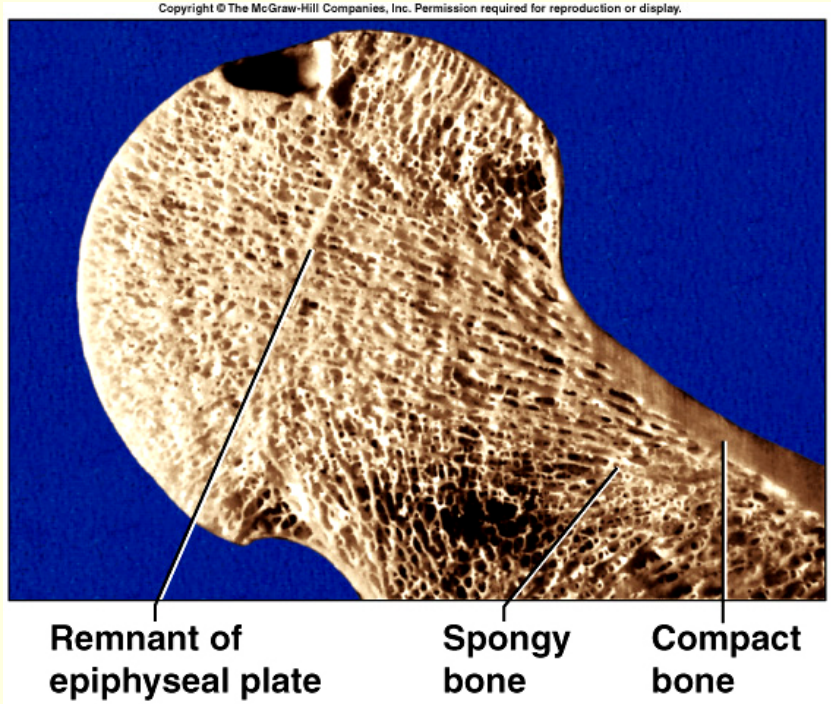

- medullary cavity
- trabeculae
- marrow
  - red
  - yellow

# Compact and Spongy Bone



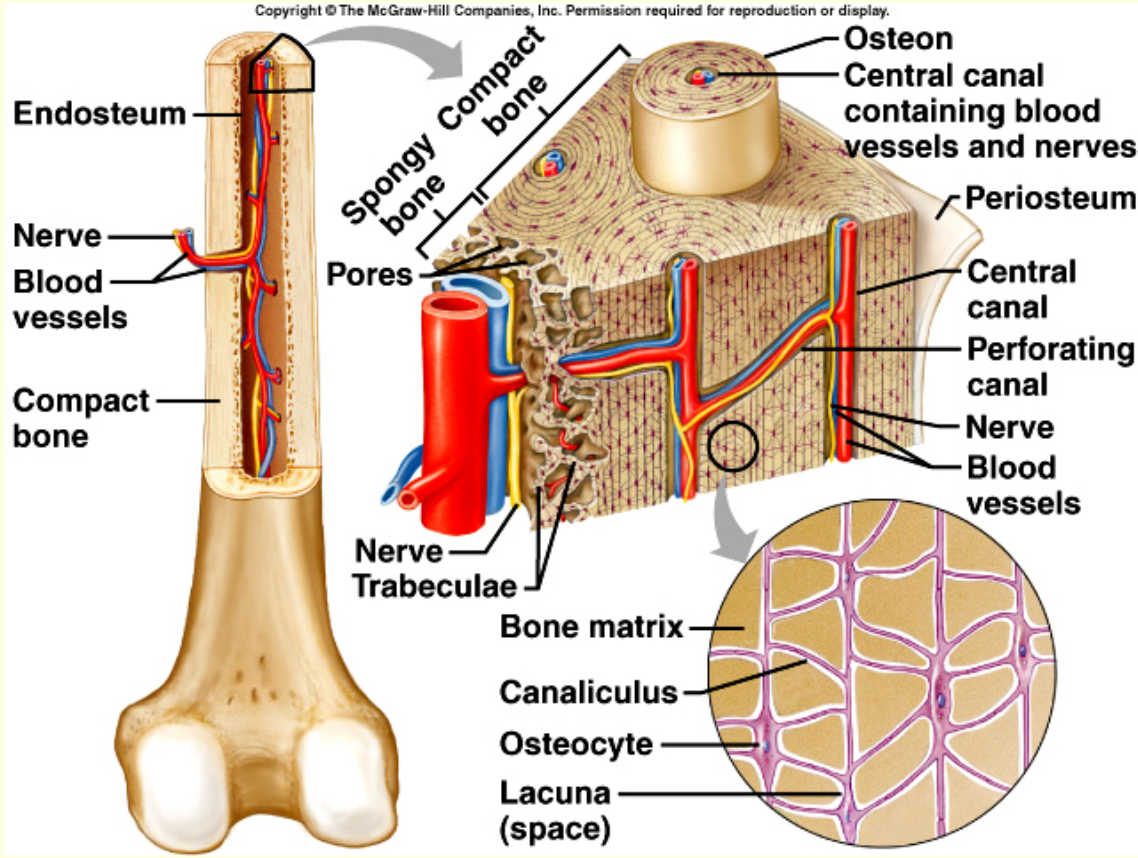




# Microscopic Structure of Compact Bone

- **osteon (Haversian System)**
- **central canal**
- **perforating canal**
- **osteocytes (originate from osteoblasts)**
- **lacuna**
- **bone matrix**
- **canaliculus (canals that allow transport of nutrients and wastes between osteocytes)**



# Bone Development

**Intramembranous Ossification** (process of replacing connective tissue to form bone)

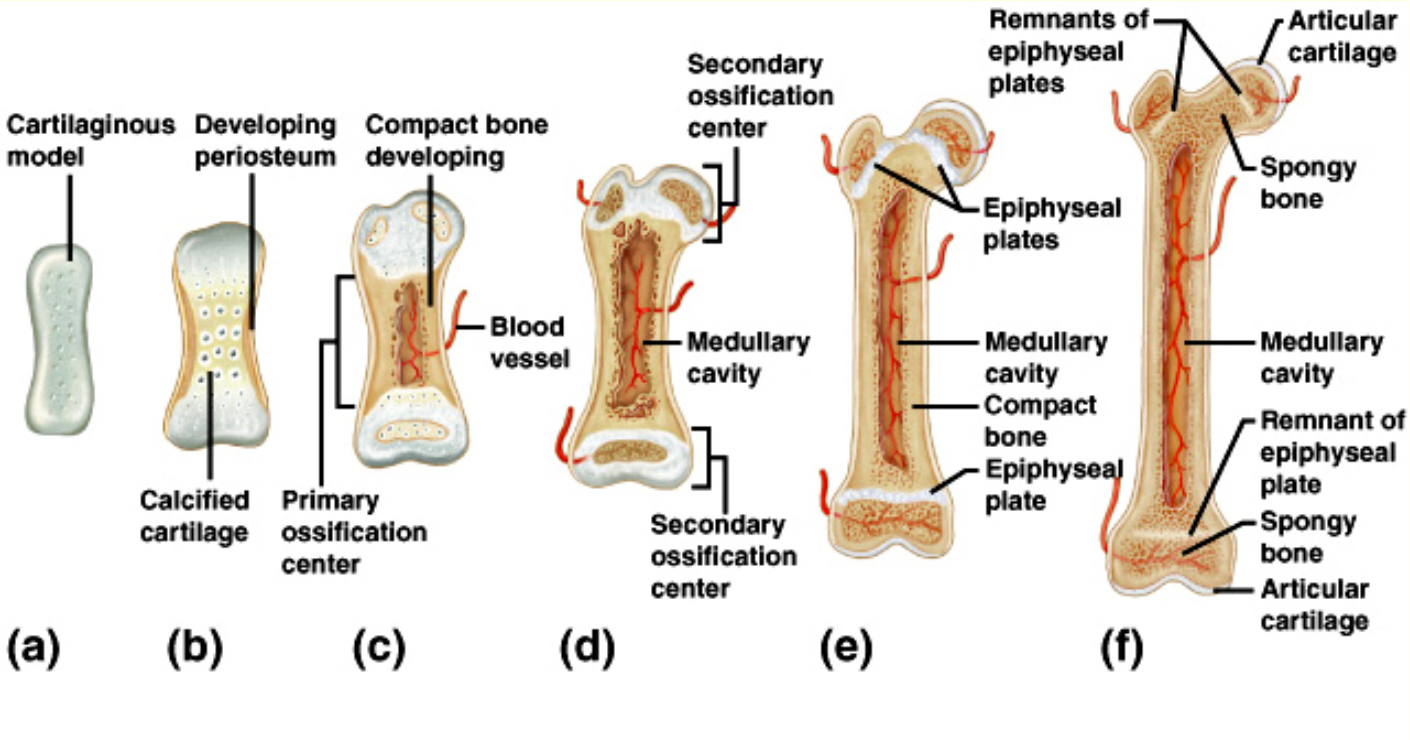
- **bones originate within sheetlike layers of connective tissues**
- **broad, flat bones**
- **skull bones (except mandible)**
- **intramembranous bones**

**Endochondral Ossification** (process of replacing cartilage to form bone)

- **bones begin as hyaline cartilage**
- **most bones of the skeleton**
- **endochondral bones**

# Endochondral Ossification

- hyaline cartilage model
- primary ossification center
- secondary ossification centers
- epiphyseal plate
- osteoblasts (cells that become osteocytes) vs. osteoclasts (cells that erode bone)



## TABLE 7.1 Major Steps in Bone Development

| Intramembranous Ossification | Endochondral Ossification |
|---|---|
| 1. Sheets of primitive connective tissue appear at sites of future bones. | 1. Masses of hyaline cartilage form models of future bones. |
| 2. Primitive connective tissue cells collect around blood vessels in these layers. | 2. Cartilage tissue breaks down. Periosteum develops. |
| 3. Connective tissue cells differentiate into osteoblasts, which deposit spongy bone. | 3. Blood vessels and differentiating osteoblasts from the periosteum invade the disintegrating tissue. |
| 4. Osteoblasts become osteocytes when bony matrix completely surrounds them. | 4. Osteoblasts form spongy bone in the space occupied by cartilage. |
| 5. Connective tissue on the surface of each developing structure forms a periosteum. | 5. Osteoblasts become osteocytes when bony matrix completely surrounds them. |
| 6. Osteoblasts on the inside of the periosteum deposit compact bone over the spongy bone. | 6. Osteoblasts beneath the periosteum deposit compact bone around spongy bone. |

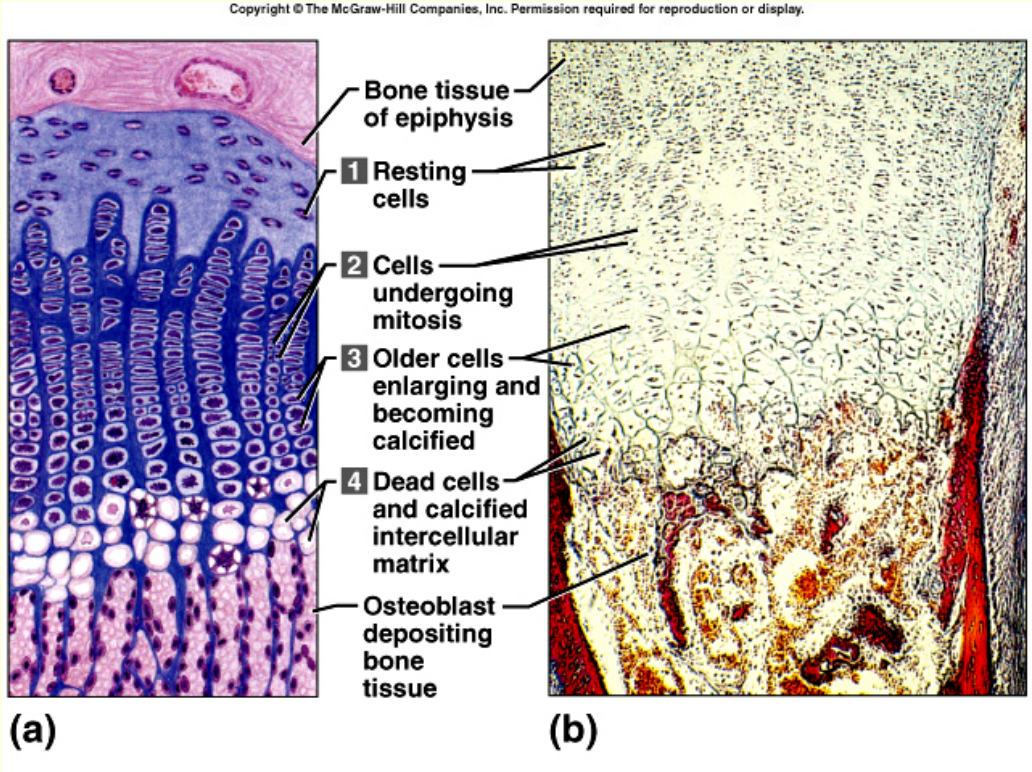
# Growth at the Epiphyseal Plate

**First layer of cells**

- **closest to the end of epiphysis**
- **resting cells**
- **anchors epiphyseal plate to epiphysis**

**Second layer of cells**

- **many rows of young cells**
- **undergoing mitosis**



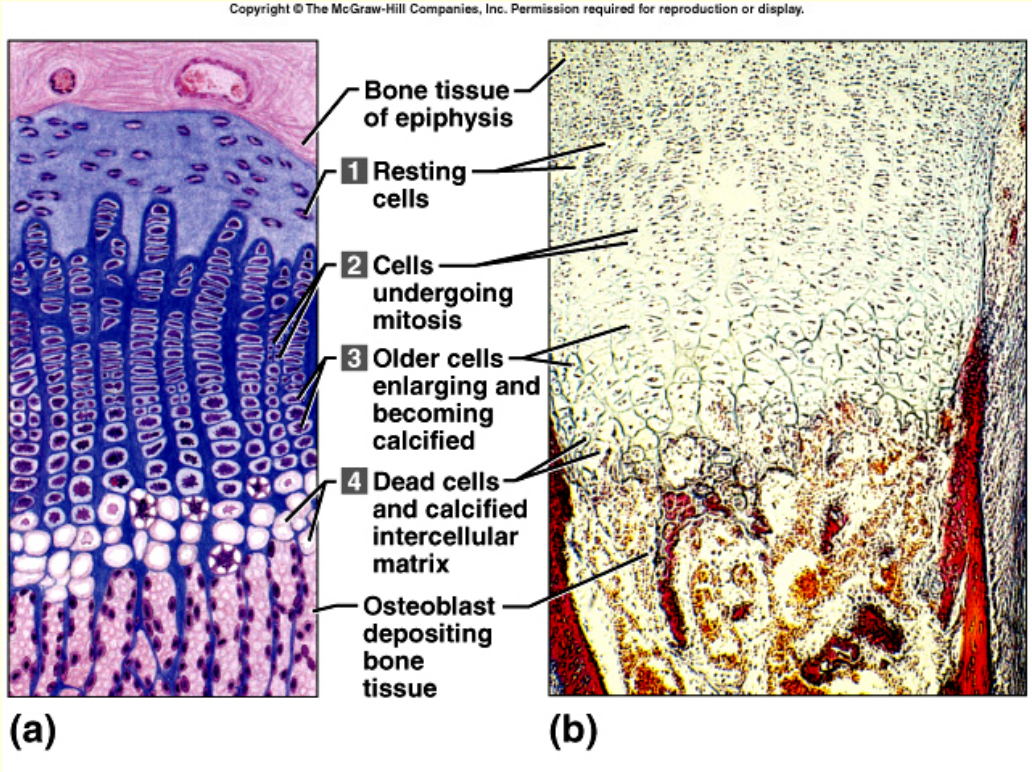
# Growth at the Epiphyseal Plate

**Third layer of cells**

- older cells
- left behind when new cells appear
- cells enlarging and becoming calcified

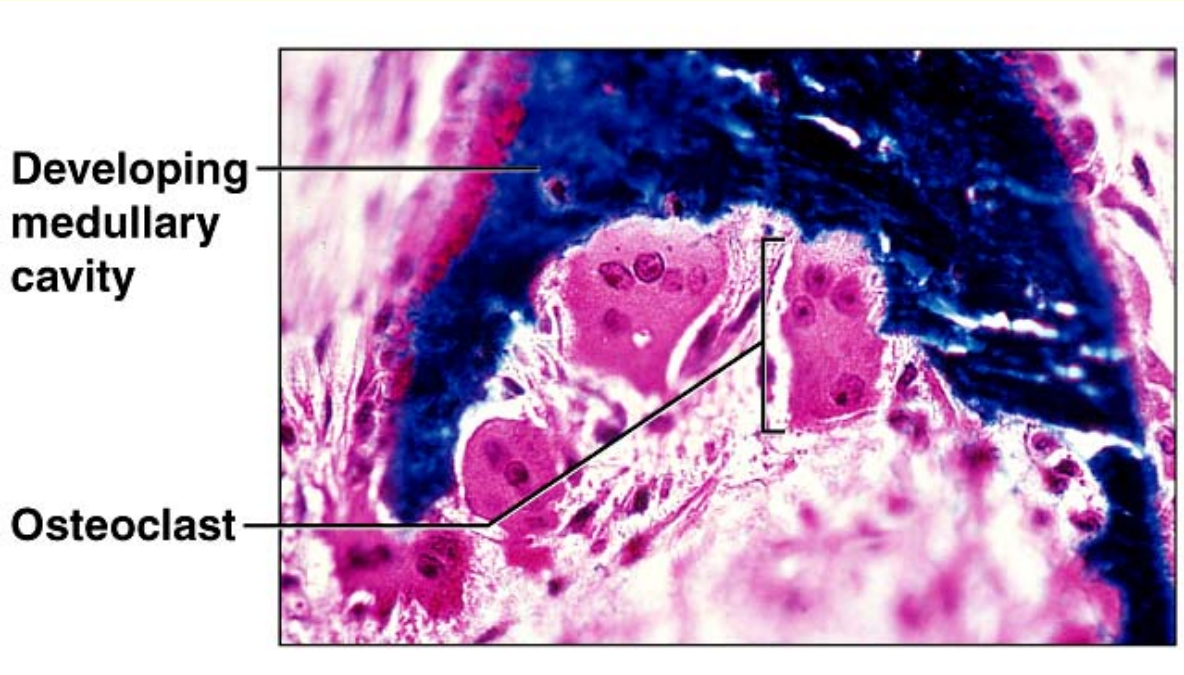
**Fourth layer of cells**

- thin
- dead cells
- calcified intercellular substance



# Homeostasis of Bone Tissue

- **Bone Resorption – action of osteoclasts and parathyroid hormone**
- **Bone Deposition – action of osteoblasts and calcitonin**
  - Resorption and Deposition are Opposing Processes
  - Total mass of bone tissue in and adult skeleton remains nearly constant, even though 3-5% of bone calcium is exchanged each year.

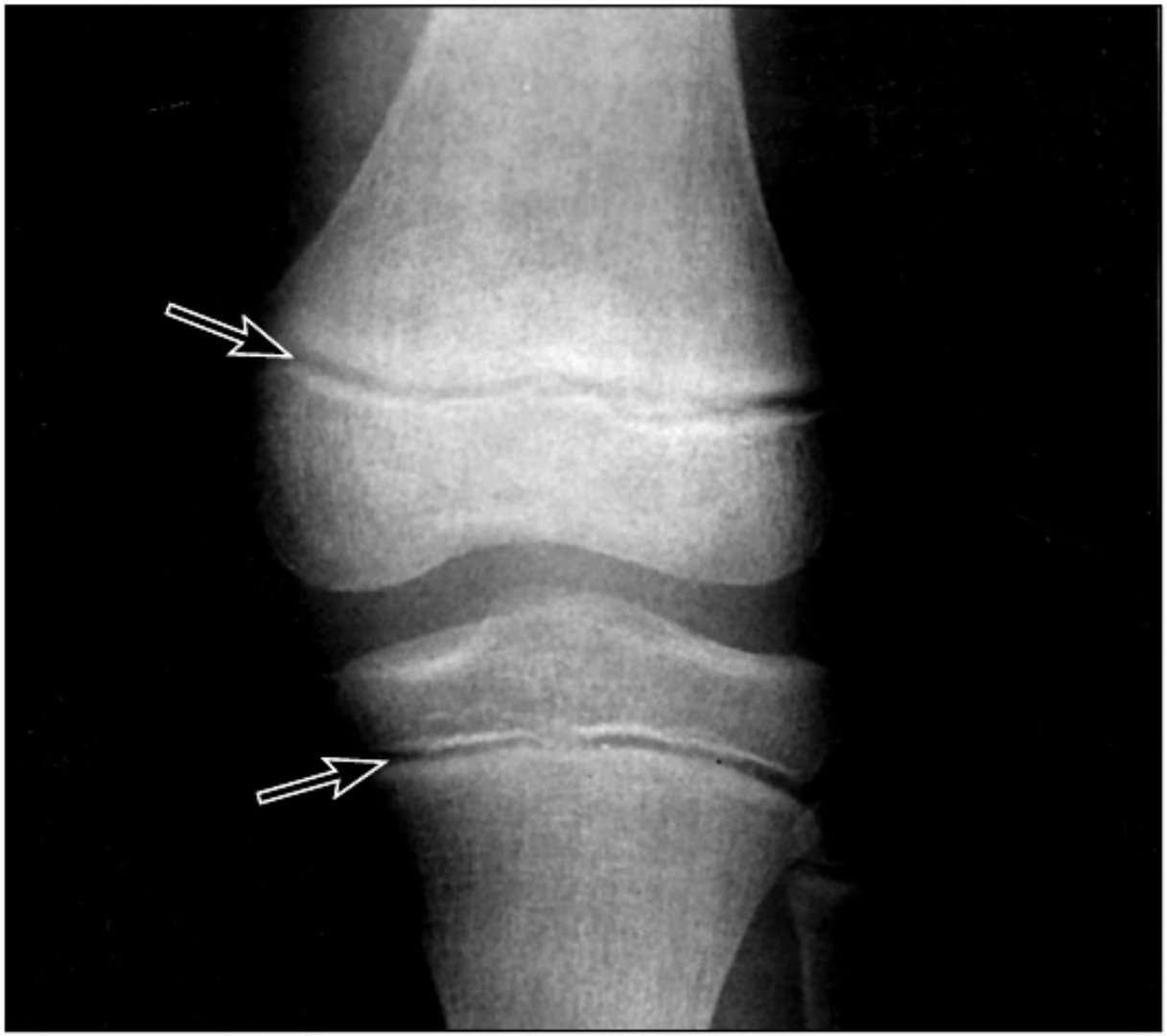


## TABLE 7.2 Ossification Timetable

| Age | Occurrence | Age | Occurrence |
|---|---|---|---|
| Third month of prenatal development | Ossification in long bones begins. | 15 to 18 years (females)<br>17 to 20 years (males) | Bones of the upper limbs and scapulae completely ossify. |
| Fourth month of prenatal development | Most primary ossification centers have appeared in the diaphyses of bones. | 16 to 21 years (females)<br>18 to 23 years (males) | Bones of the lower limbs and coxal bones completely ossify. |
| Birth to 5 years | Secondary ossification centers appear in the epiphyses. | 21 to 23 years (females)<br>23 to 25 years (males) | Bones of the sternum, clavicles, and vertebrae completely ossify. |
| 5 to 12 years in females, or 5 to 14 years in males | Ossification rapidly spreads from the ossification centers, and certain bones are ossifying. | By 23 years (females)<br>By 25 years (males) | Nearly all bones completely ossify. |

Radiograph showing the presence of epiphyseal plates in a child's bones indicates the the bones are still lengthening.





# Factors Affecting Bone Development, Growth, and Repair

- **Deficiency of Vitamin A – retards bone development**
- **Deficiency of Vitamin C – results in fragile bones**
- **Deficiency of Vitamin D – rickets (children), osteomalacia (adults)**
- **Insufficient Growth Hormone – dwarfism**
- **Excessive Growth Hormone – gigantism, acromegaly**
- **Insufficient Thyroid Hormone – delays bone growth**
- **Sex Hormones – promote bone formation; stimulate ossification of epiphyseal plates**
- **Physical Stress – stimulates bone growth**

# 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, etc.

# Homeostatic Imbalances

- 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
  - Figure on right is an X-ray of a child with bowed legs due to rickets

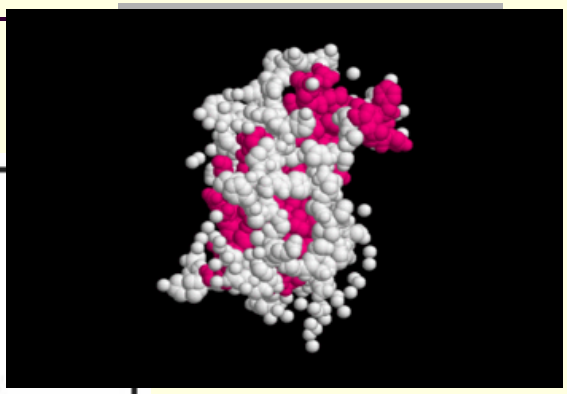
# Homeostatic Imbalances

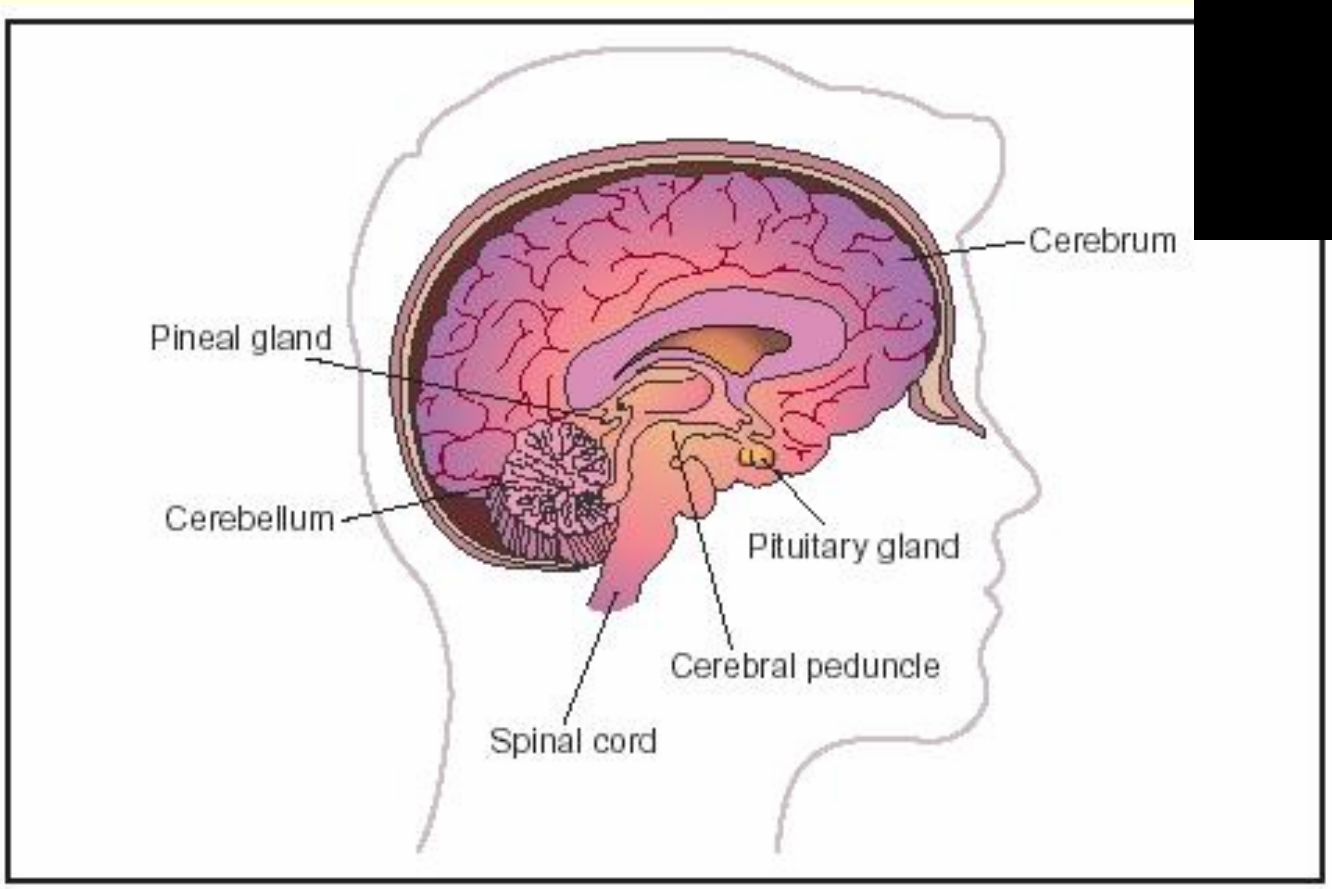
- Osteoporosis
  - Group of diseases in which bone resorption outpaces bone deposit
  - Spongy bone of the spine is most vulnerable
  - Occurs most often in postmenopausal women
- Treatment
  - Calcium and vitamin D supplements
  - Increased weight bearing exercise
  - Hormone (estrogen) replacement therapy (HRT)
- Prevented or delayed by sufficient calcium intake and weight-bearing exercise

# Paget's Disease -malfunction in the normal process of bone remodelling

- Characterized by excessive bone formation and breakdown
- Pagetic bone has a higher ratio of spongy bone to compact bone
- Pagetic bone, along with reduced mineralization, causes spotty weakening of bone
- Osteoclast activity wanes, but osteoblast activity continues and may form irregular bone thickenings or fill the marrow cavity
- Cause is unknown

# Human Growth Hormone - Polypeptide Hormone Secreted by the Anterior Pituitary Gland





# Human Growth Hormone – Too much or Too little of a good thing

- **Human Growth Hormone**
  - **Polypeptide Hormone Secreted by the Anterior Pituitary Gland**
- **Hormone Imbalance**
  - **Too much HGH**
    - **Pituitary gigantism**
    - **Acromegaly** (from Greek *akros* "high" and *megas* "large" - extremities enlargement)
  - **Too little HGH**
    - When severe GH deficiency is present from birth and never treated, adult heights can be as short as 48-58 inches (122-147 cm).
    - Also called pituitary dwarfism.
    - Other conditions can lead to dwarfism.

# Bone Function

- Support and Protection
  - gives shape to head, etc.
  - supports body's weight
  - protects lungs, etc.

- Body Movement
  - interacts with muscles
  - bones act as rigid bar of a lever

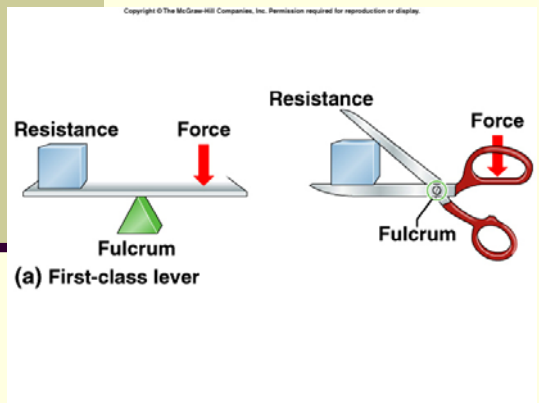
- Blood Cell Formation
  - hematopoiesis
  - red marrow (active)
  - Yellow marrow (fat storage and inactive)

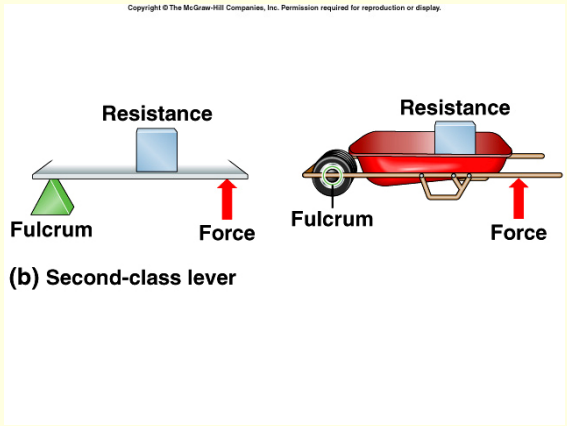
- Inorganic Salt Storage
  - calcium
  - phosphate
  - magnesium
  - sodium
  - potassium

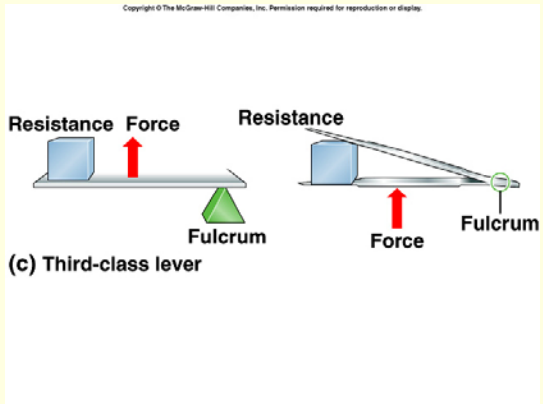
# Levers

**Four Basic Components**

1. **rigid bar – bones**
2. **fulcrum – point on which bar moves;joint**
3. **object moved against resistance**
4. **force – supplies energy for movement; muscles**

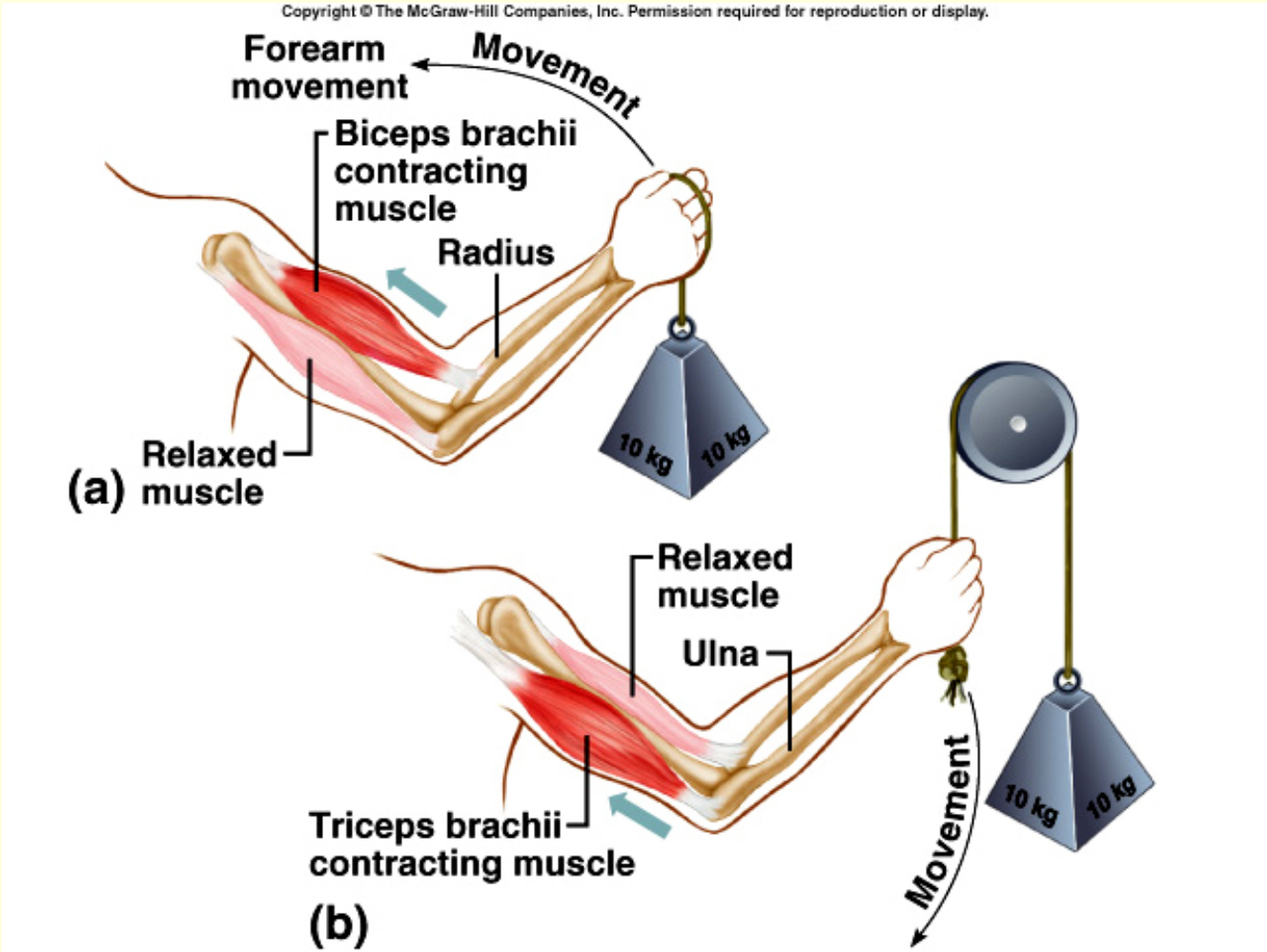


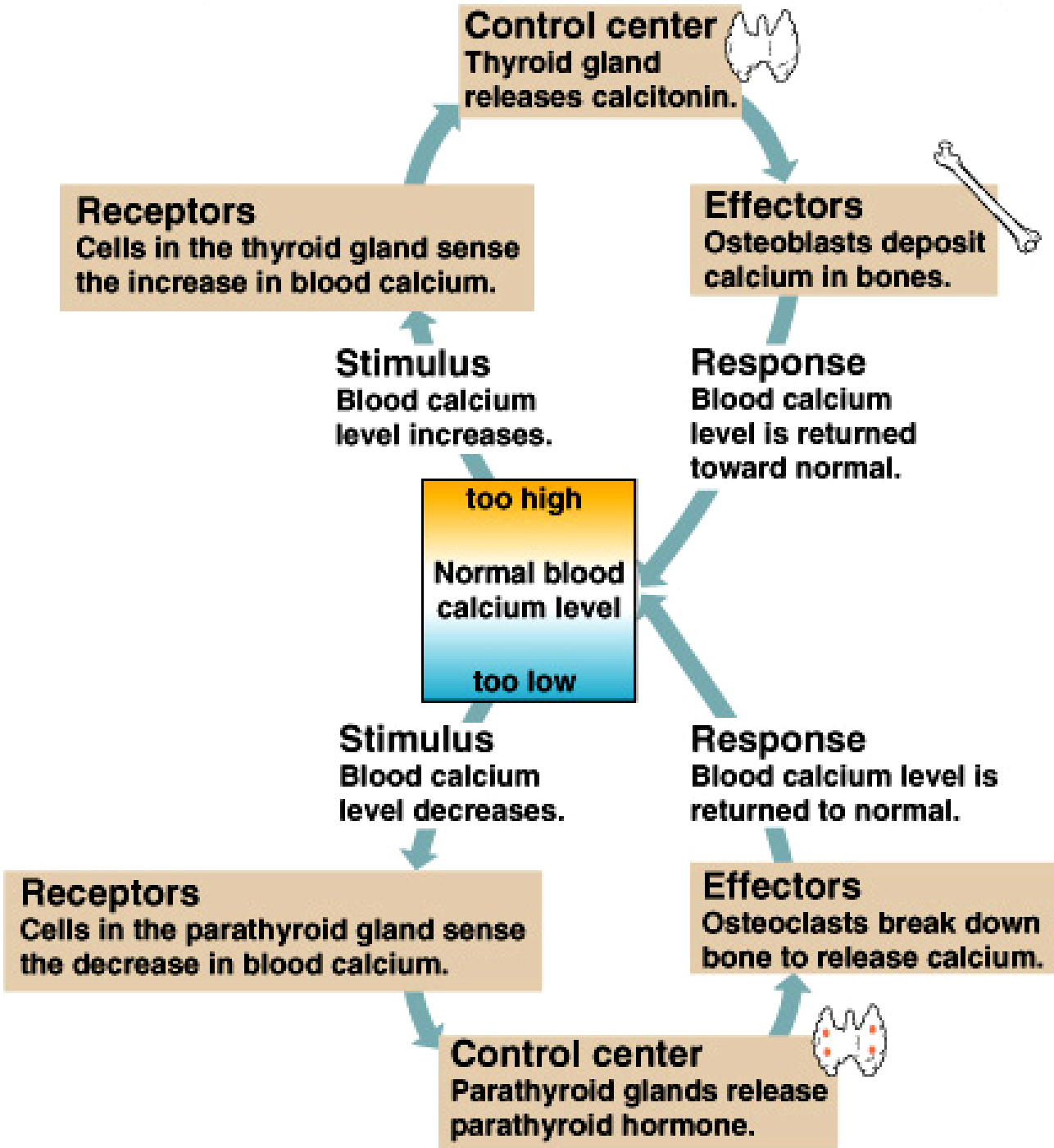



FEMUR:
posterior surface of left femur (left); anterior surface of right femur (right)

# Levers and Movement





## TABLE 7.3 Bones of the Adult Skeleton

| | |
|---|---|
| **1. Axial Skeleton** | |
| **a. Skull** | 22 bones |
| 8 cranial bones | |
| frontal 1 | |
| parietal 2 | |
| occipital 1 | |
| temporal 2 | |
| sphenoid 1 | |
| ethmoid 1 | |
| 14 facial bones | |
| maxilla 2 | |
| palatine 2 | |
| zygomatic 2 | |
| lacrimal 2 | |
| nasal 2 | |
| vomer 1 | |
| inferior nasal concha 2 | |
| mandible 1 | |
| **b. Middle ear bones** | 6 bones |
| malleus 2 | |
| incus 2 | |
| stapes 2 | |
| **c. Hyoid** | 1 bone |
| hyoid bone 1 | |
| **d. Vertebral column** | 26 bones |
| cervical vertebra 7 | |
| thoracic vertebra 12 | |
| lumbar vertebra 5 | |
| sacrum 1 | |
| coccyx 1 | |
| **e. Thoracic cage** | 25 bones |
| rib 24 | |
| sternum 1 | |

| | | |
|---|---|---|
| **2. Appendicular Skeleton** | | |
| **a. Pectoral girdle** | | 4 bones |
| scapula 2 | | |
| clavicle 2 | | |
| **b. Upper limbs** | | 60 bones |
| humerus 2 | | |
| radius 2 | | |
| ulna 2 | | |
| carpal 16 | | |
| metacarpal 10 | | |
| phalanx 28 | | |
| **c. Pelvic girdle** | | 2 bones |
| coxa 2 | | |
| **d. Lower limbs** | | 60 bones |
| femur 2 | | |
| tibia 2 | | |
| fibula 2 | | |
| patella 2 | | |
| tarsal 14 | | |
| metatarsal 10 | | |
| phalanx 28 | | |
| | **Total** | 206 bones |

# Bone Markings

- Bulges, depressions, and holes that serve as:
  - Sites of attachment for muscles, ligaments, and tendons
  - Joint surfaces
  - Conduits for blood vessels and nerves

# Bone Markings:

## Projections –
## Sites of Muscle and Ligament Attachment

- Tuberosity – rounded projection
- Crest – narrow, prominent ridge of bone
- Trochanter – large, blunt, irregular surface
- Line – narrow ridge of bone

- Tubercle – small rounded projection
- Epicondyle – raised area above a condyle
- Spine – sharp, slender projection
- Process – any bony prominence

# Bone Markings:

## Projections That Help Form Joints

- Head – bony expansion carried on a narrow neck
- Facet – smooth, nearly flat articular surface
- Condyle – rounded articular projection
- Ramus – armlike bar of bone

# Bone Markings: Depressions and Openings

- Meatus – canal-like passageway
- Sinus – cavity within a bone
- Fossa – shallow, basinlike depression
- Groove – furrow
- Fissure – narrow, slitlike opening
- Foramen – round or oval opening through a bone

## TABLE 7.4 Terms Used to Describe Skeletal Structures

| Term | Definition | Example |
|---|---|---|
| condyle (kon′dīl) | A rounded process that usually articulates with another bone | Occipital condyle of the occipital bone (fig. 7.22) |
| crest (krest) | A narrow, ridgelike projection | Iliac crest of the ilium (fig. 7.50) |
| epicondyle (ep″ĭ-kon′dīl) | A projection situated above a condyle | Medial epicondyle of the humerus (fig. 7.45) |
| facet (fas′et) | A small, nearly flat surface | Facet of a thoracic vertebra (fig. 7.38) |
| fissure (fish′ūr) | A cleft or groove | Inferior orbital fissure in the orbit of the eye (fig. 7.20) |
| fontanel (fon″tah-nel′) | A soft spot in the skull where membranes cover the space between bones | Anterior fontanel between the frontal and parietal bones (fig. 7.33) |
| foramen (fo-ra′men) | An opening through a bone that usually serves as a passageway for blood vessels, nerves, or ligaments | Foramen magnum of the occipital bone (fig. 7.22) |
| fossa (fos′ah) | A relatively deep pit or depression | Olecranon fossa of the humerus (fig. 7.45) |
| fovea (fo′ve-ah) | A tiny pit or depression | Fovea capitis of the femur (fig. 7.53) |
| head (hed) | An enlargement on the end of a bone | Head of the humerus (fig. 7.45) |
| linea (lin′e-ah) | A narrow ridge | Linea aspera of the femur (fig. 7.53) |
| meatus (me-a′tus) | A tubelike passageway within a bone | External acoustic meatus of the ear (fig. 7.21) |
| process (pros′es) | A prominent projection on a bone | Mastoid process of the temporal bone (fig. 7.21) |
| ramus (ra′mus) | A branch or similar extension | Ramus of the mandible (fig. 7.31) |
| sinus (si′nus) | A cavity within a bone | Frontal sinus of the frontal bone (fig. 7.27) |
| spine (spīn) | A thornlike projection | Spine of the scapula (fig. 7.43) |
| suture (soo′cher) | An interlocking line of union between bones | Lambdoidal suture between the occipital and parietal bones (fig. 7.21) |
| trochanter (tro-kan′ter) | A relatively large process | Greater trochanter of the femur (fig. 7.53) |
| tubercle (tu′ber-kl) | A small, knoblike process | Tubercle of a rib (fig. 7.41) |
| tuberosity (tu″bĕ-ros′ĭ-te) | A knoblike process usually larger than a tubercle | Radial tuberosity of the radius (fig. 7.46) |

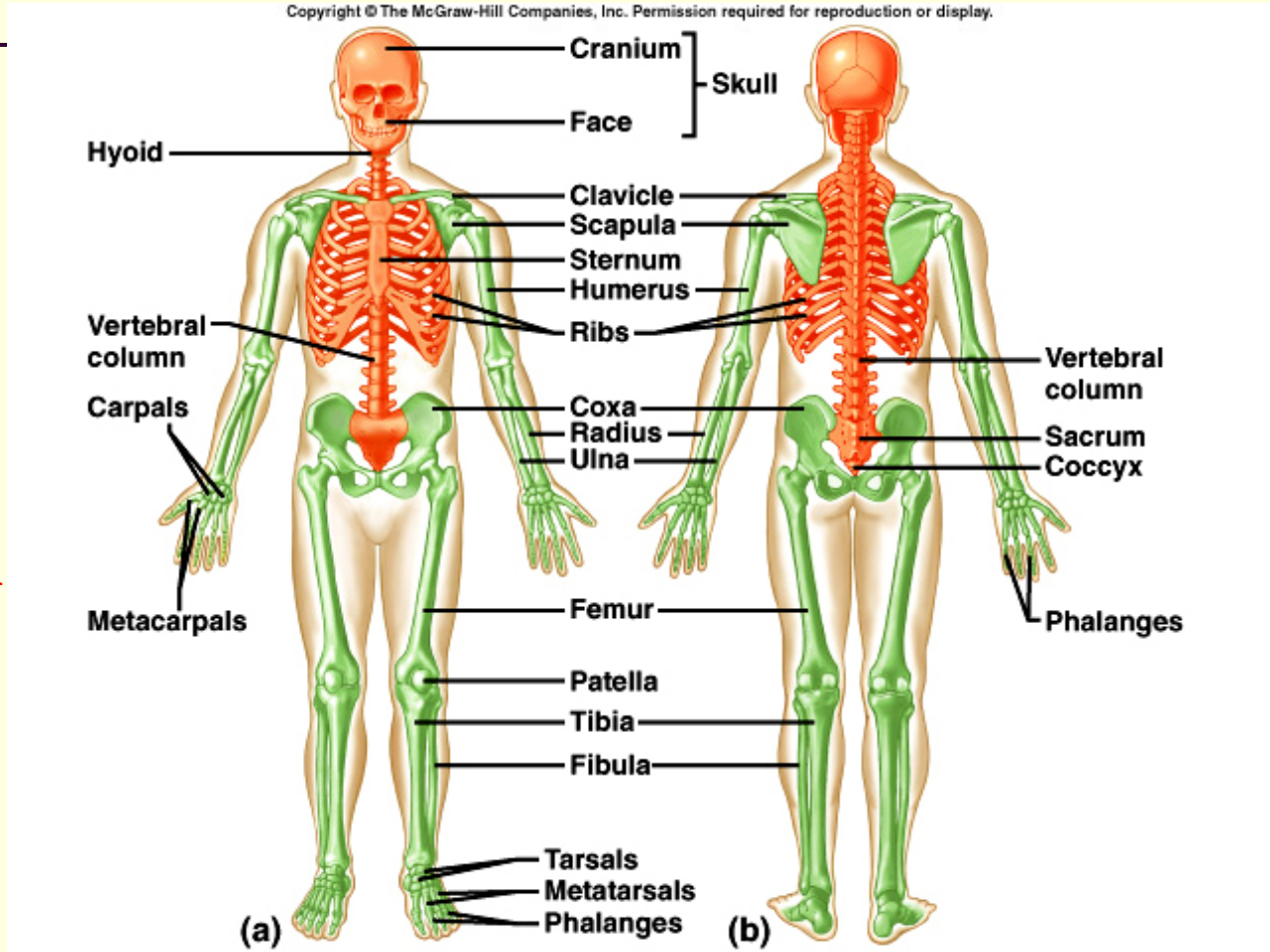
# Skeletal Organization

## Axial Skeleton

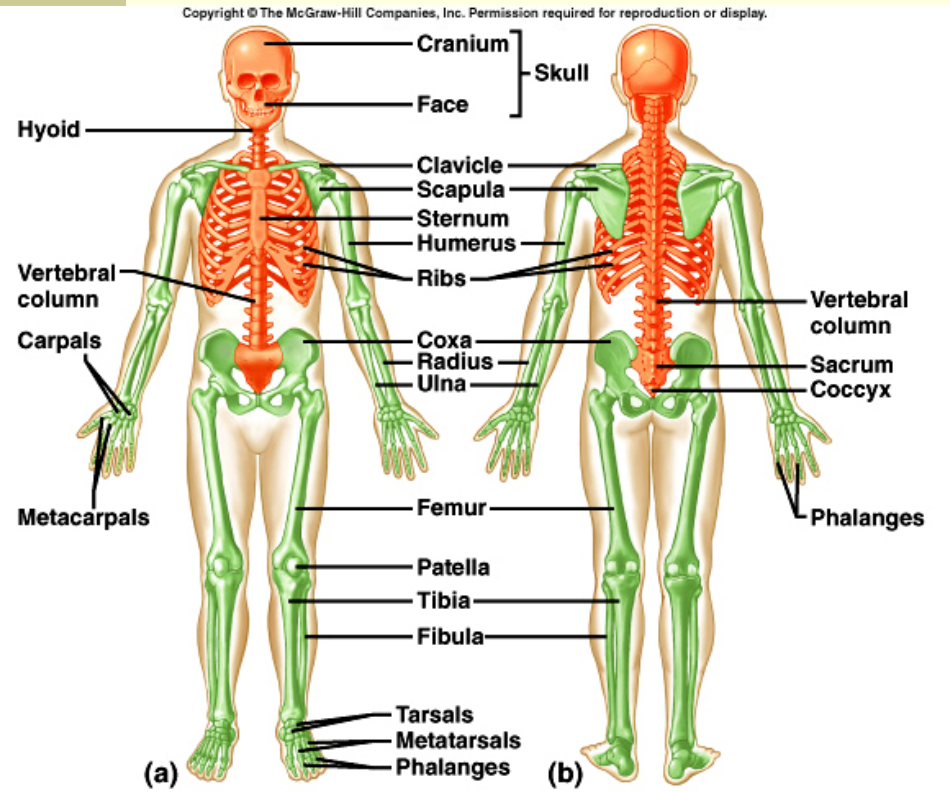
- head
- neck
- trunk

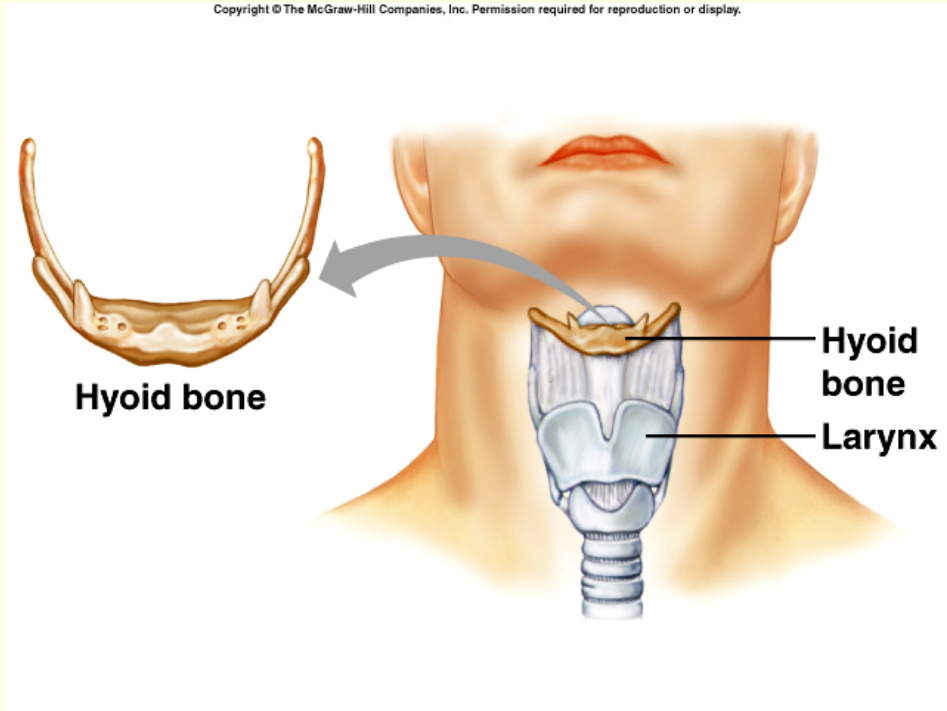
## Appendicular Skeleton

- upper limbs
- lower limbs
- pectoral girdle
- pelvic girdle



# Skeletal Organization



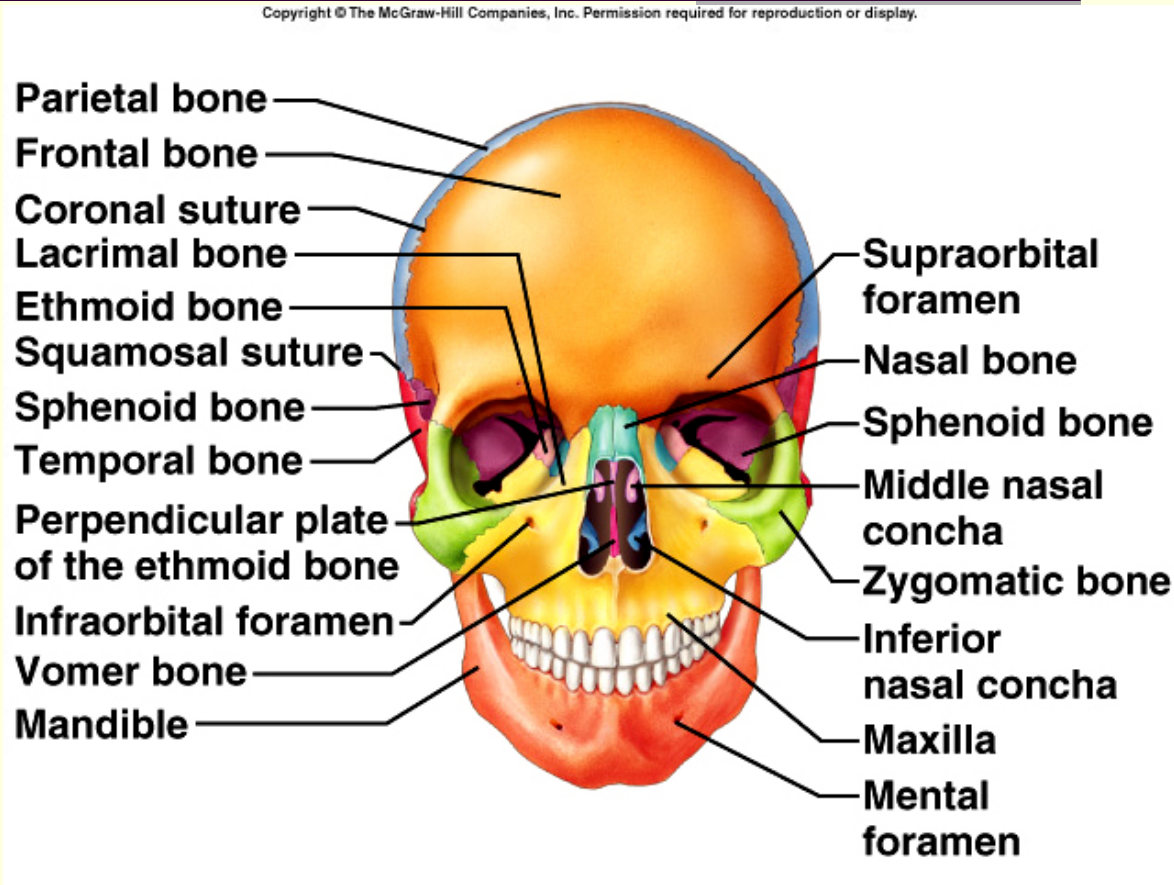
## TABLE 7.5 Cranial Bones

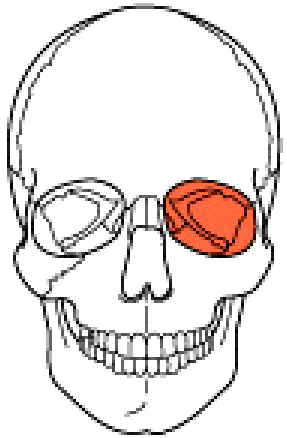
| Name and Number | Description | Special Features |
|---|---|---|
| Frontal (1) | Forms forehead, roof of nasal cavity, and roofs of orbits | Supraorbital foramen, frontal sinuses |
| Parietal (2) | Form side walls and roof of cranium | Fused at midline along sagittal suture |
| Occipital (1) | Forms back of skull and base of cranium | Foramen magnum, occipital condyles |
| Temporal (2) | Form side walls and floor of cranium | External acoustic meatus, mandibular fossa, mastoid process, styloid process, zygomatic process |
| Sphenoid (1) | Forms parts of base of cranium, sides of skull, and floors and sides of orbits | Sella turcica, sphenoidal sinuses |
| Ethmoid (1) | Forms parts of roof and walls of nasal cavity, floor of cranium, and walls of orbits | Cribriform plates, perpendicular plate, superior and middle nasal conchae, ethmoidal sinuses, crista galli |

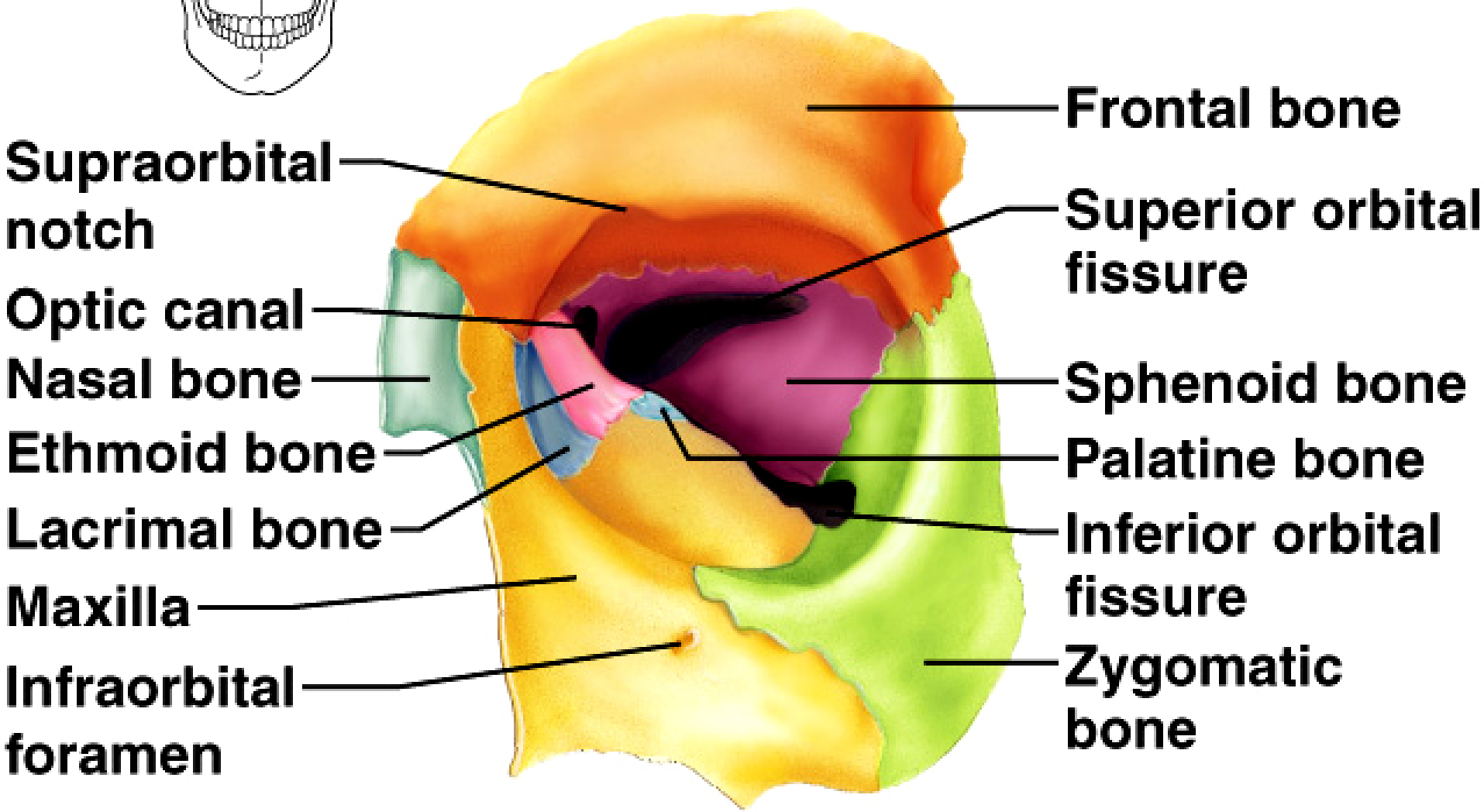
# Skull

**Frontal (1)**

- forehead
- roof of nasal cavity
- roofs of orbits
- frontal sinuses
- supraorbital foramen
- coronal suture



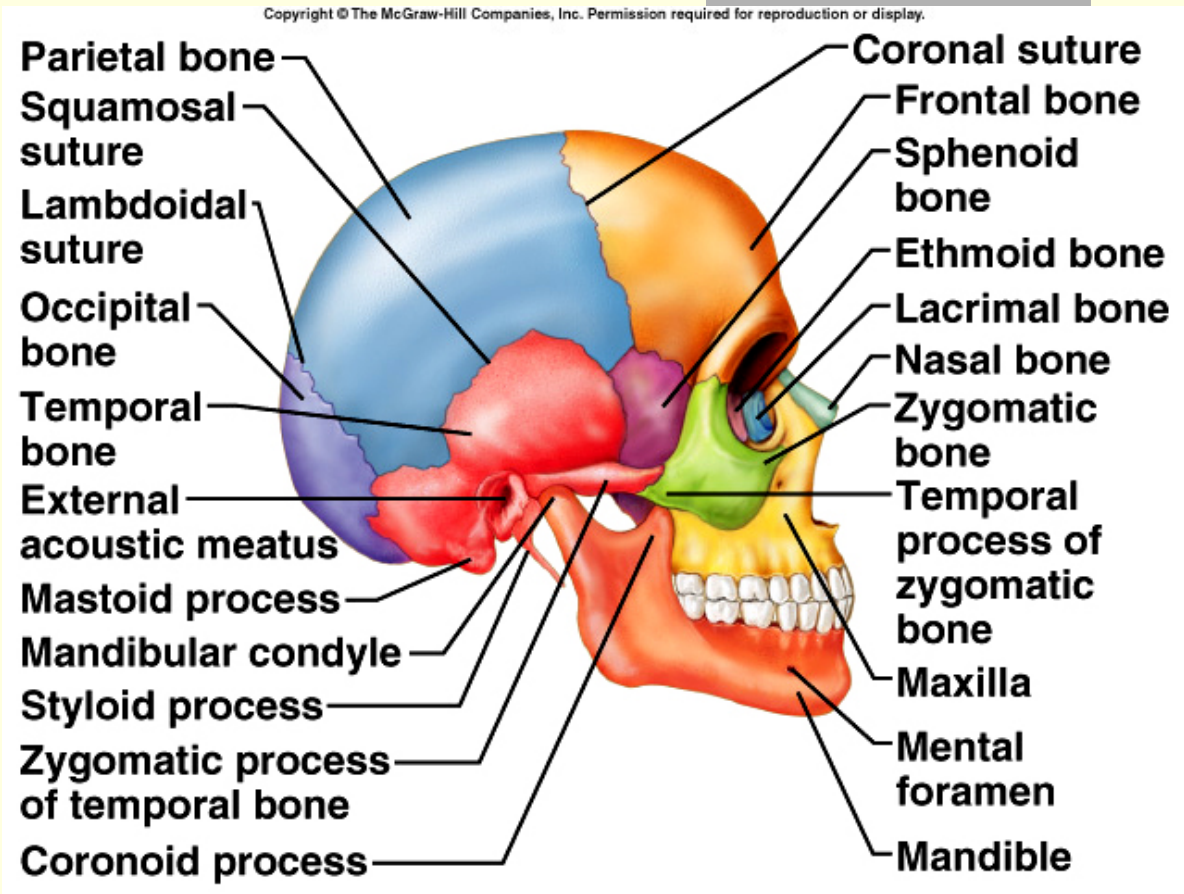




# Skull

**Temporal (2)**

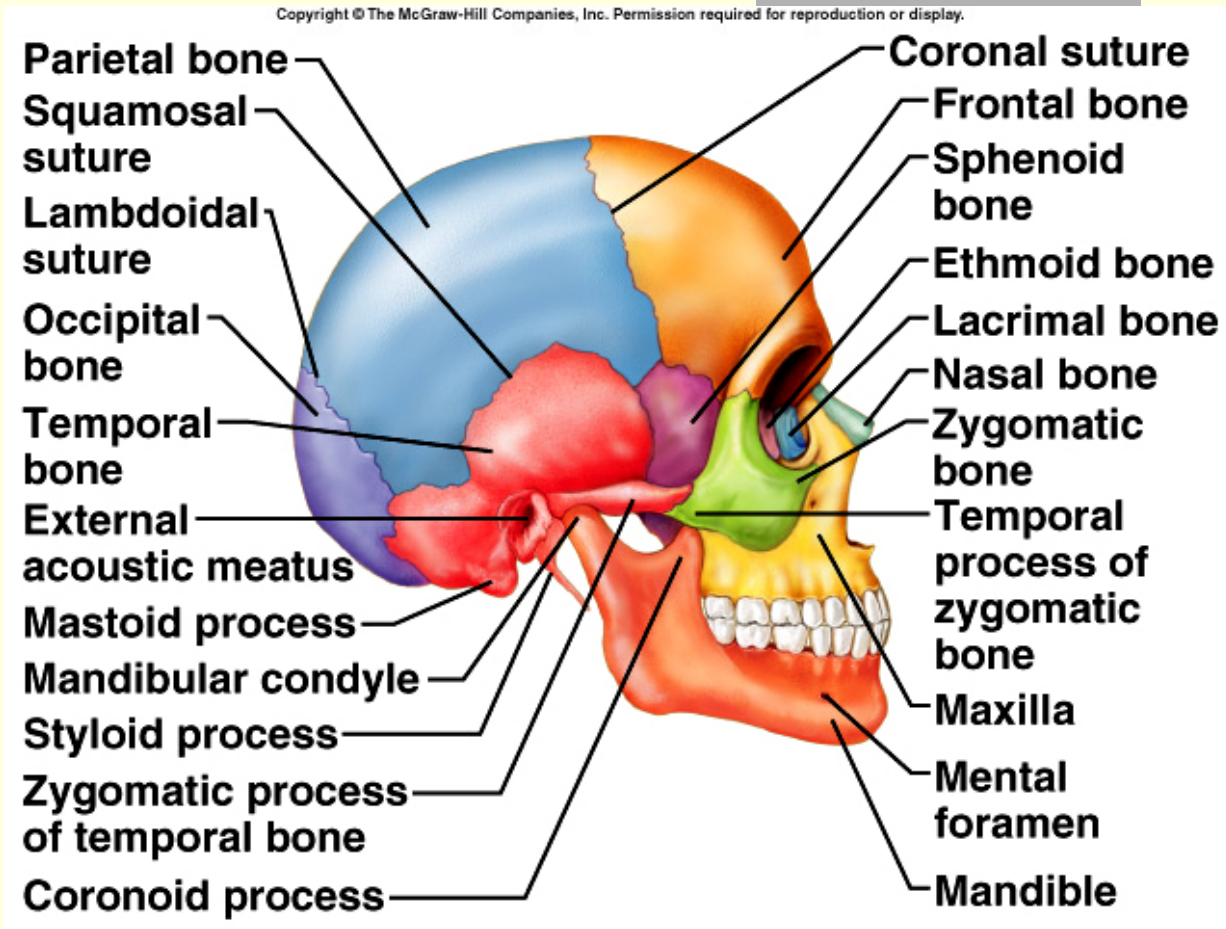
- wall of cranium
- floor of cranium
- floors and sides of orbits
- squamosal suture
- external acoustic meatus
- mandibular fossa
- mastoid process
- styloid process
- zygomatic process



# Skull

**Parietal (2)**

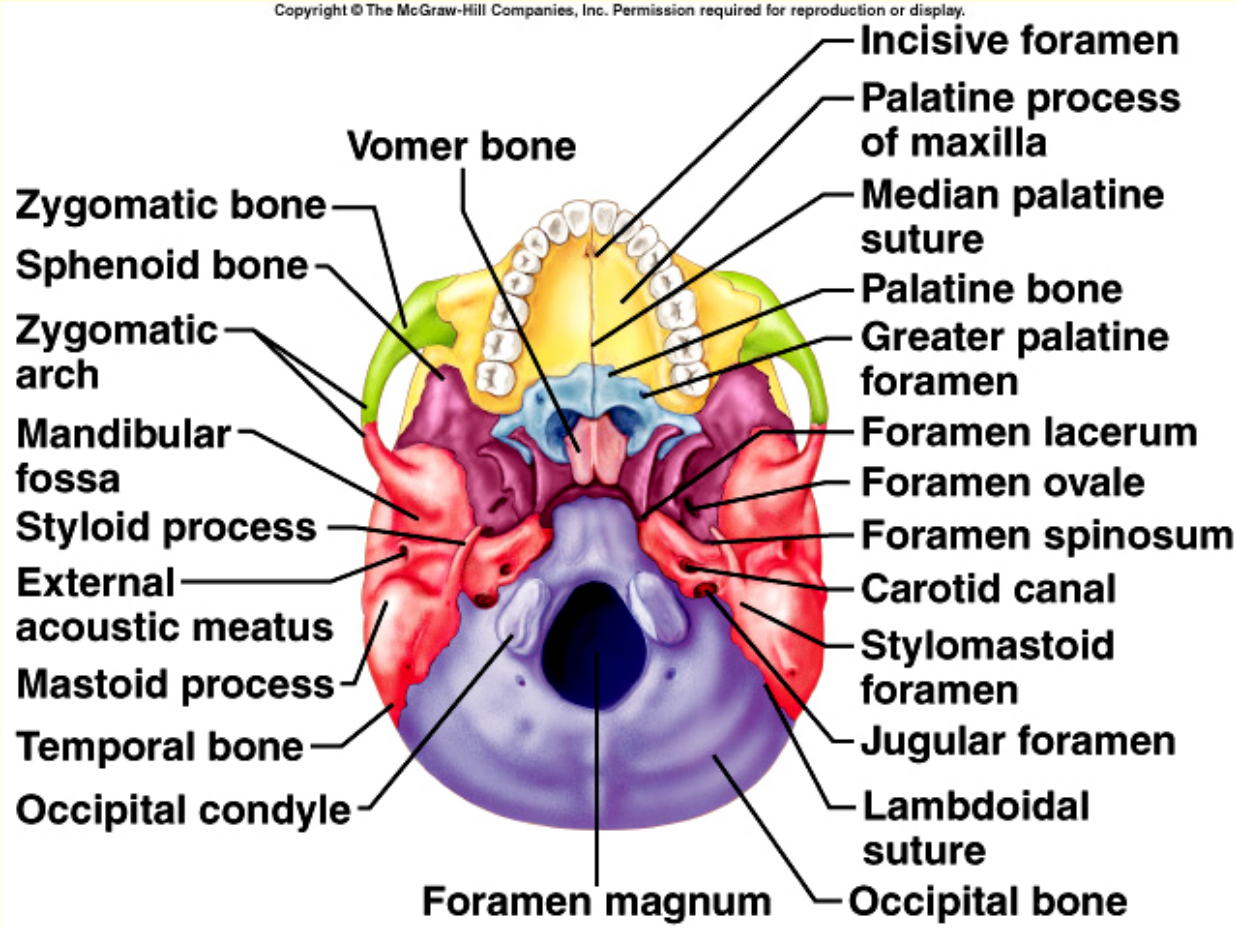
- side walls of cranium
- roof of cranium
- sagittal suture

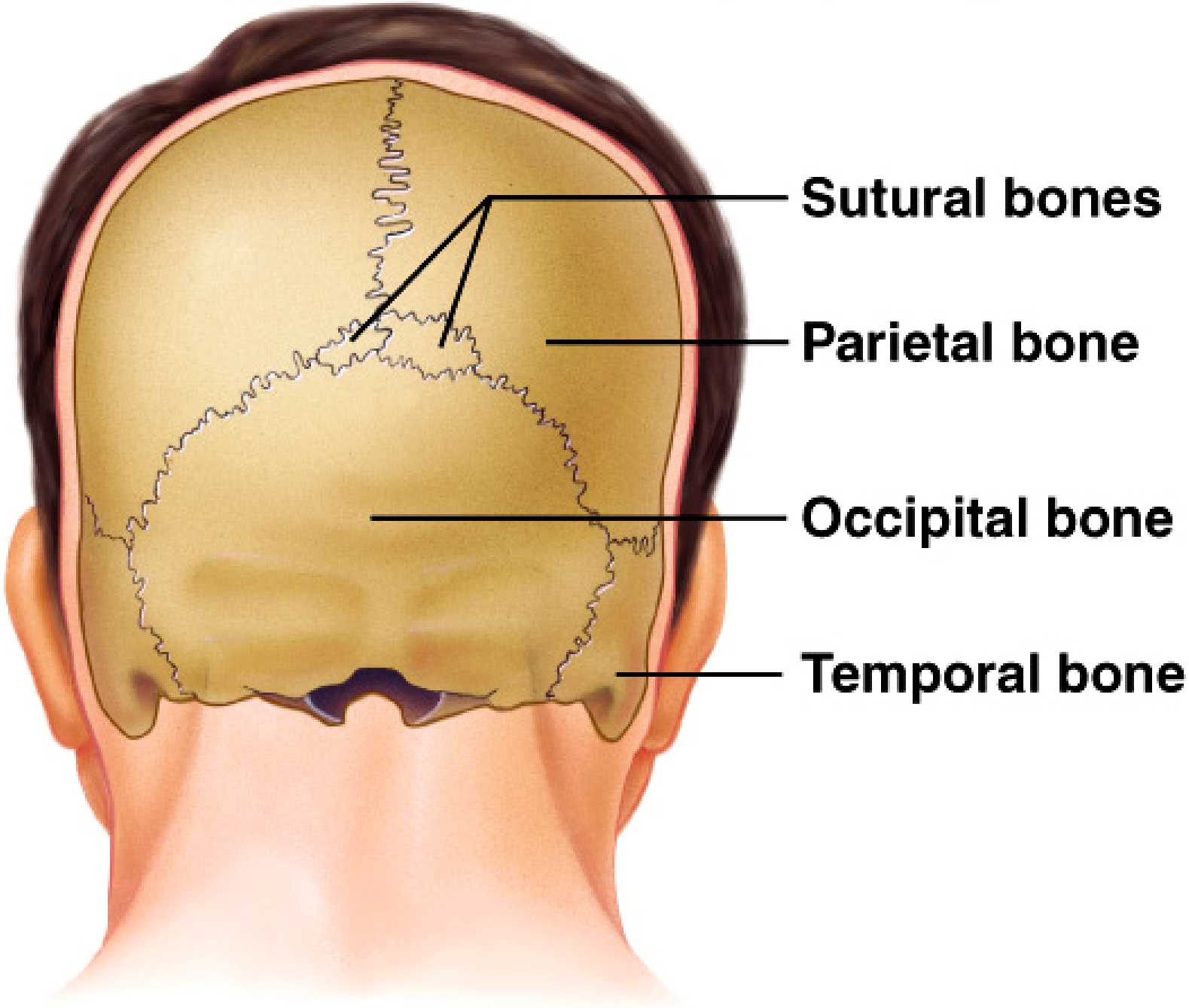


# Skull

**Occipital (1)**

- back of skull
- base of cranium
- foramen magnum
- occipital condyles
- lambdoidal suture

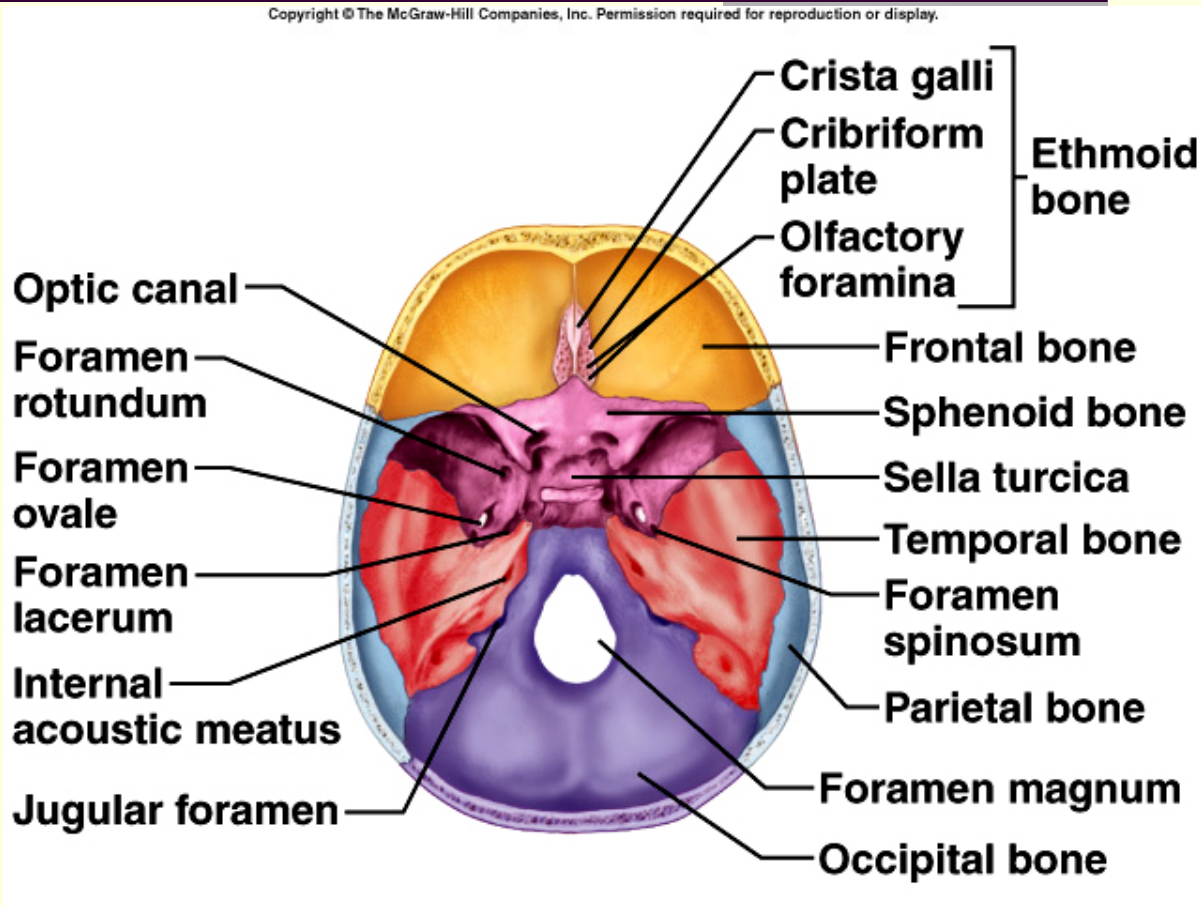


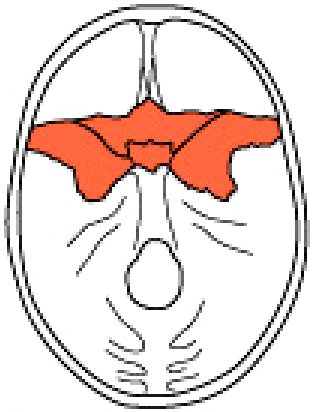


# Skull

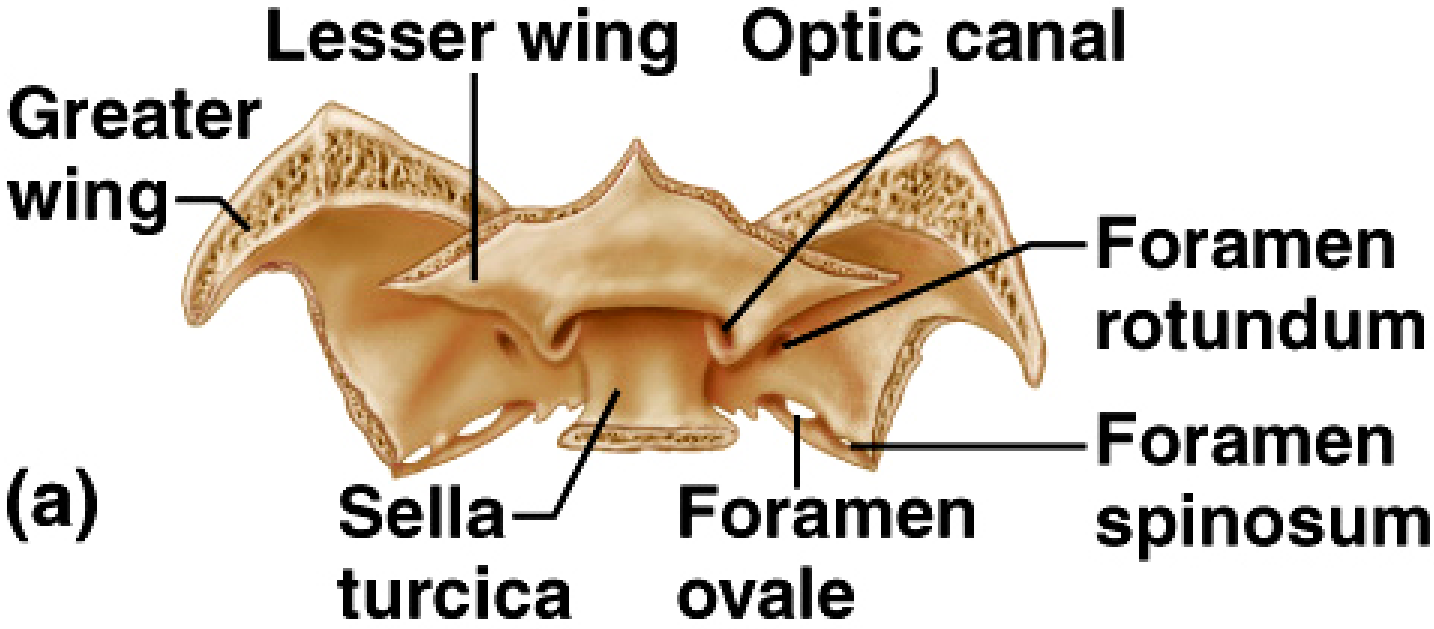
**Sphenoid (1)**

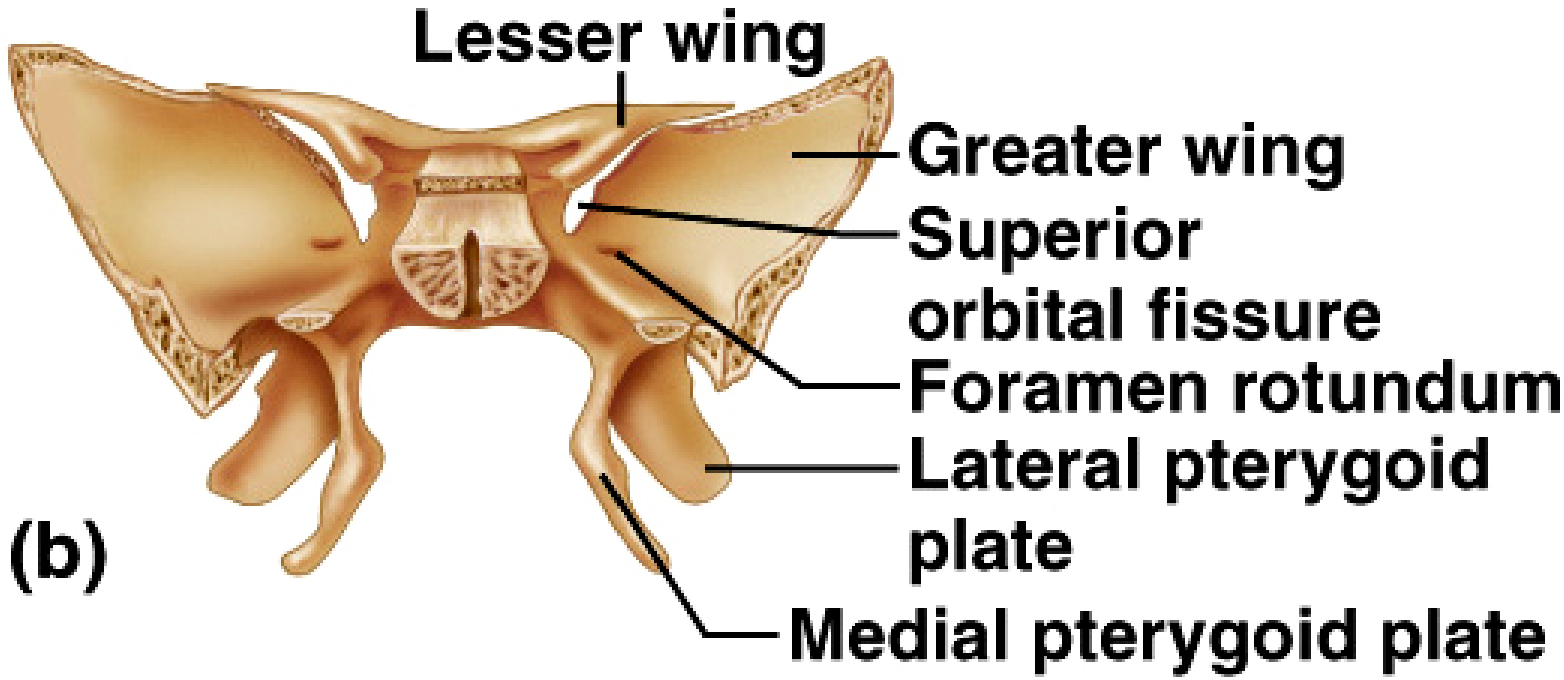
- base of cranium
- sides of skull
- floors and sides of orbits
- sella turcica
- sphenoidal sinuses





Transverse section

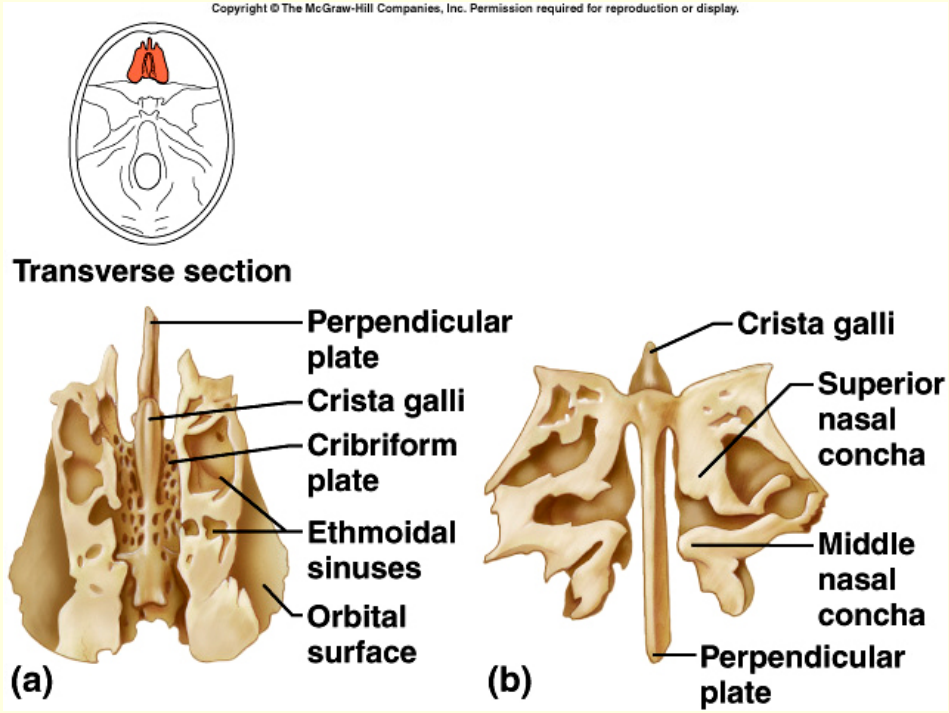


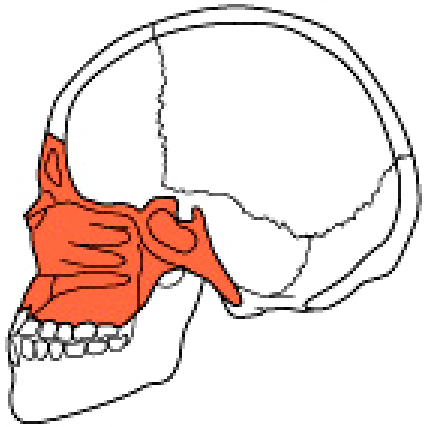



# Skull

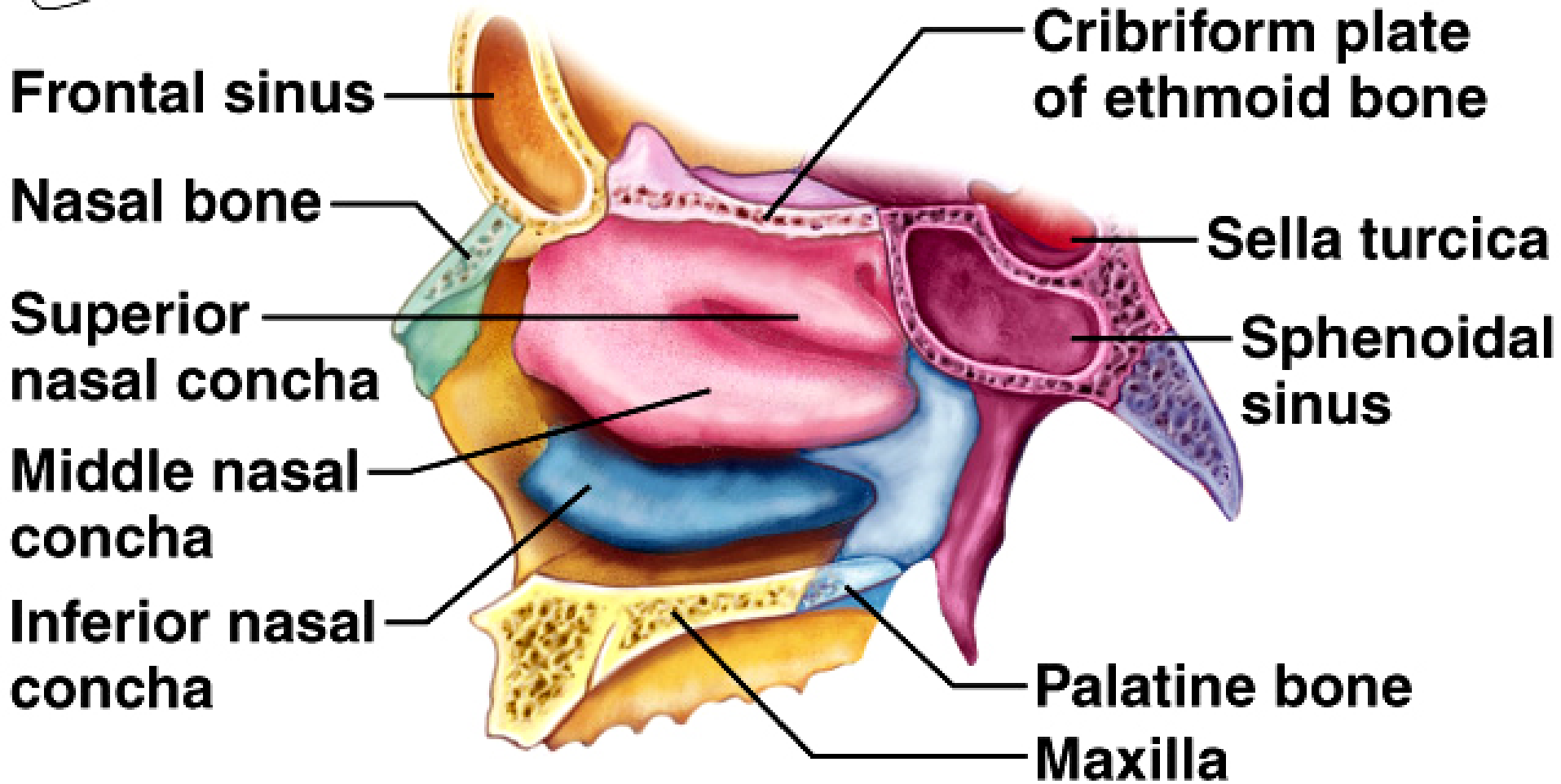
**Ethmoid (1)**

- roof and walls of nasal cavity
- floor of cranium
- wall of orbits
- cribiform plates
- perpendicular plate
- superior and middle nasal conchae
- ethmoidal sinuses
- crista gallis





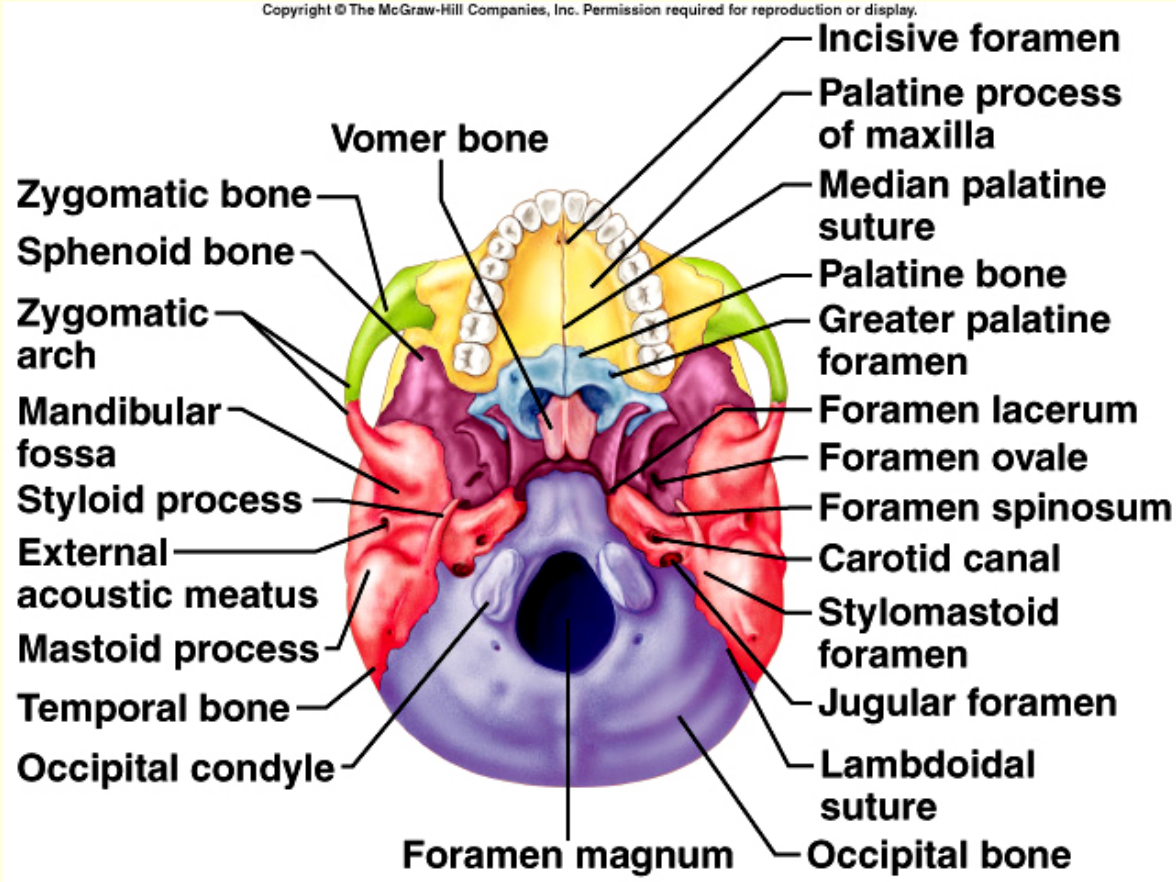
# Midsagittal section



# Facial Skeleton

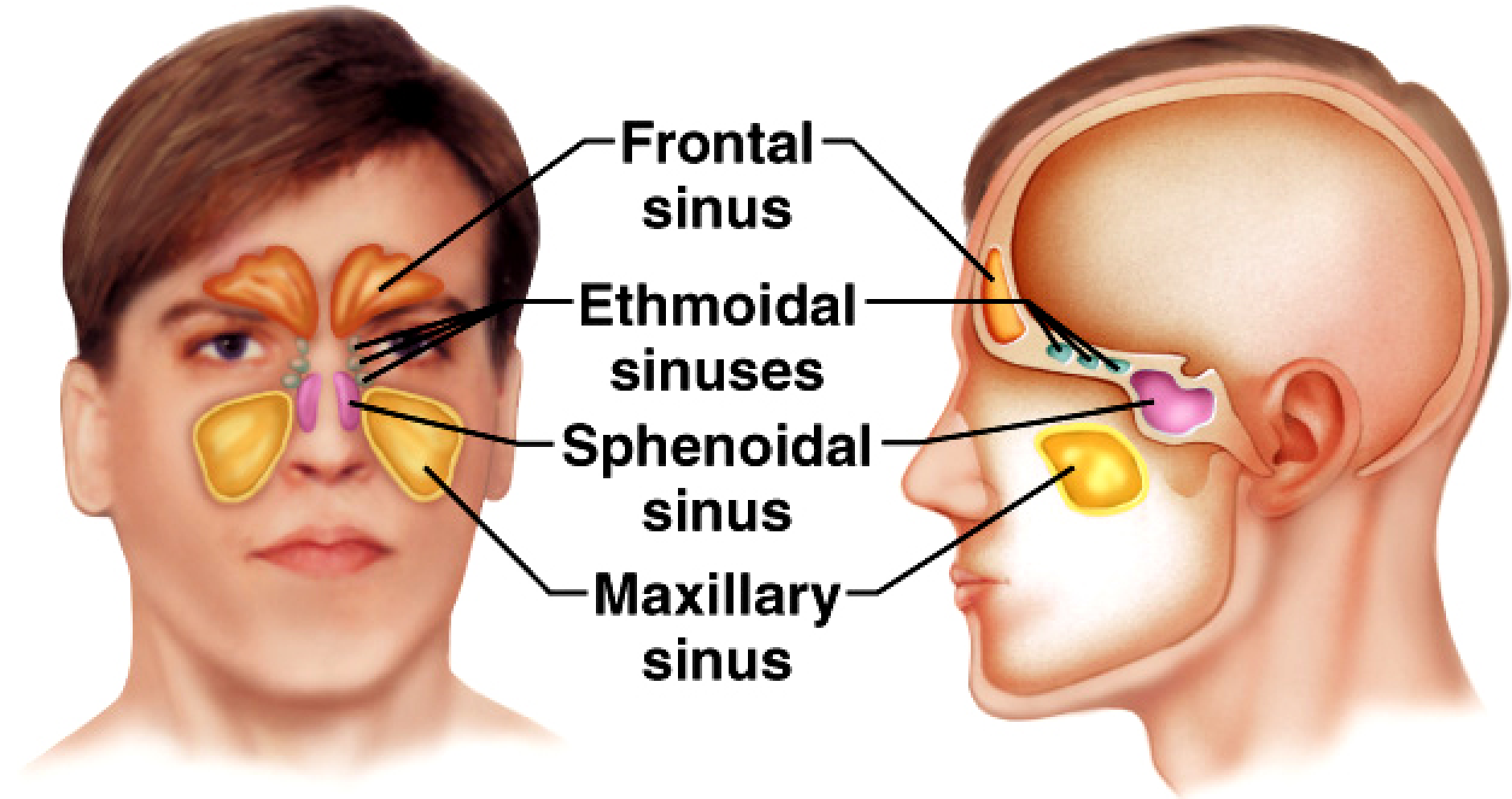
**Maxillary (2)**

- upper jaw
- anterior roof of mouth
- floors of orbits
- sides of nasal cavity
- floors of nasal cavity
- alveolar processes
- maxillary sinuses
- palatine process



# TABLE 7.6 Sinuses of the Cranial and Facial Bones

| Sinuses | Number | Location |
|---|---|---|
| Frontal sinuses | 2 | Frontal bone above each eye and near the midline |
| Sphenoidal sinuses | 2 | Sphenoid bone above the posterior portion of the nasal cavity |
| Ethmoidal sinuses | 2 groups of small spaces | Ethmoid bone on either side of the upper portion of the nasal cavity |
| Maxillary sinuses | 2 | Maxillary bones lateral to the nasal cavity and extending from the floor of the orbits to the roots of the upper teeth |



# Bones of the Facial Skeleton



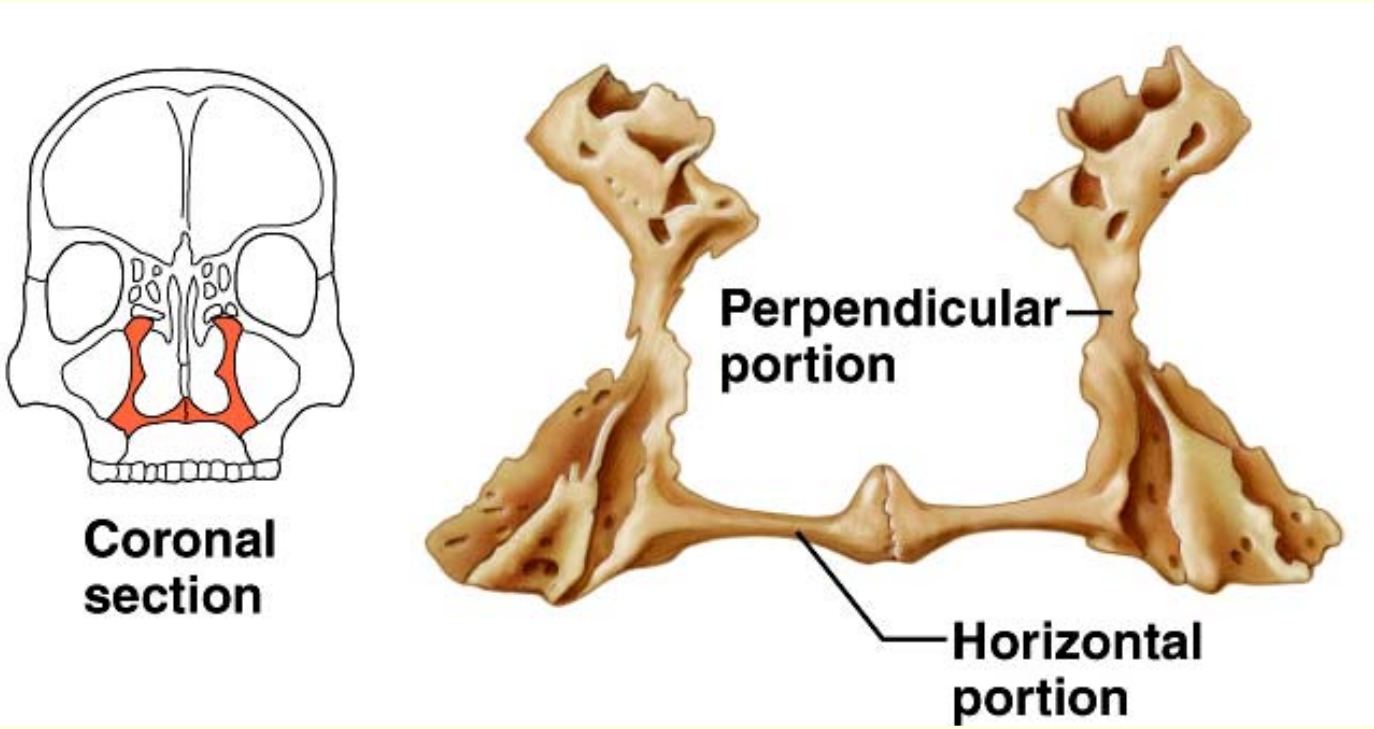
TABLE 7.7 Bones of the Facial Skeleton

| Name and Number | Description | Special Features |
|---|---|---|
| Maxillary (2) | Form upper jaw, anterior roof of mouth, floors of orbits, and sides and floor of nasal cavity | Alveolar processes, maxillary sinuses, palatine process |
| Palatine (2) | Form posterior roof of mouth, and floor and lateral walls of nasal cavity | |
| Zygomatic (2) | Form prominences of cheeks, and lateral walls and floors of orbits | Temporal process |
| Lacrimal (2) | Form part of medial walls of orbits | Groove that leads from orbit to nasal cavity |
| Nasal (2) | Form bridge of nose | |
| Vomer (1) | Forms inferior portion of nasal septum | |
| Inferior nasal conchae (2) | Extend into nasal cavity from its lateral walls | |
| Mandible (1) | Forms lower jaw | Body, ramus, mandibular condyle, coronoid process, alveolar process, mandibular foramen, mental foramen |

# Facial Skeleton

**Palatine (2)**

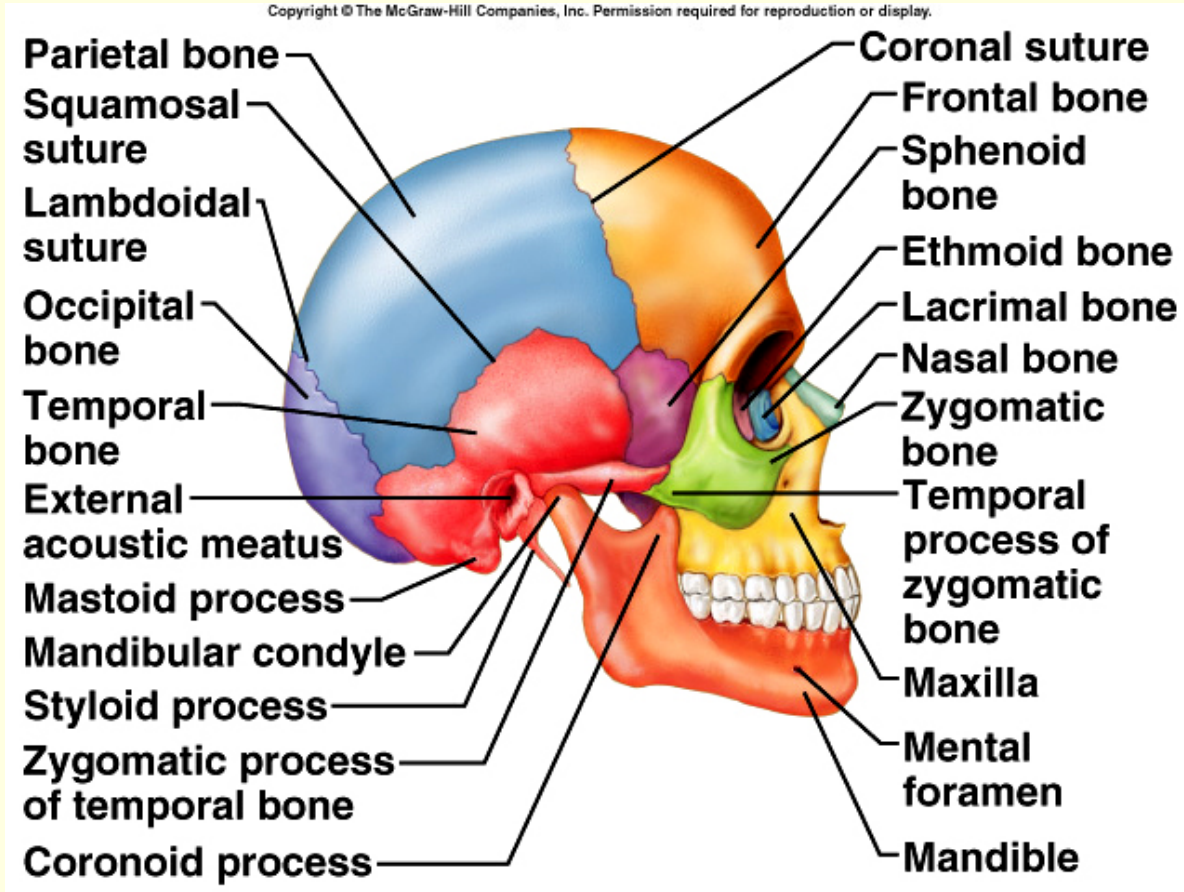
- **posterior roof of mouth**
- **floor of nasal cavity**
- **lateral walls of nasal cavity**



# Facial Skeleton

**Zygomatic (2)**

- prominences of cheeks
- lateral walls of orbits
- floors of orbits
- temporal process



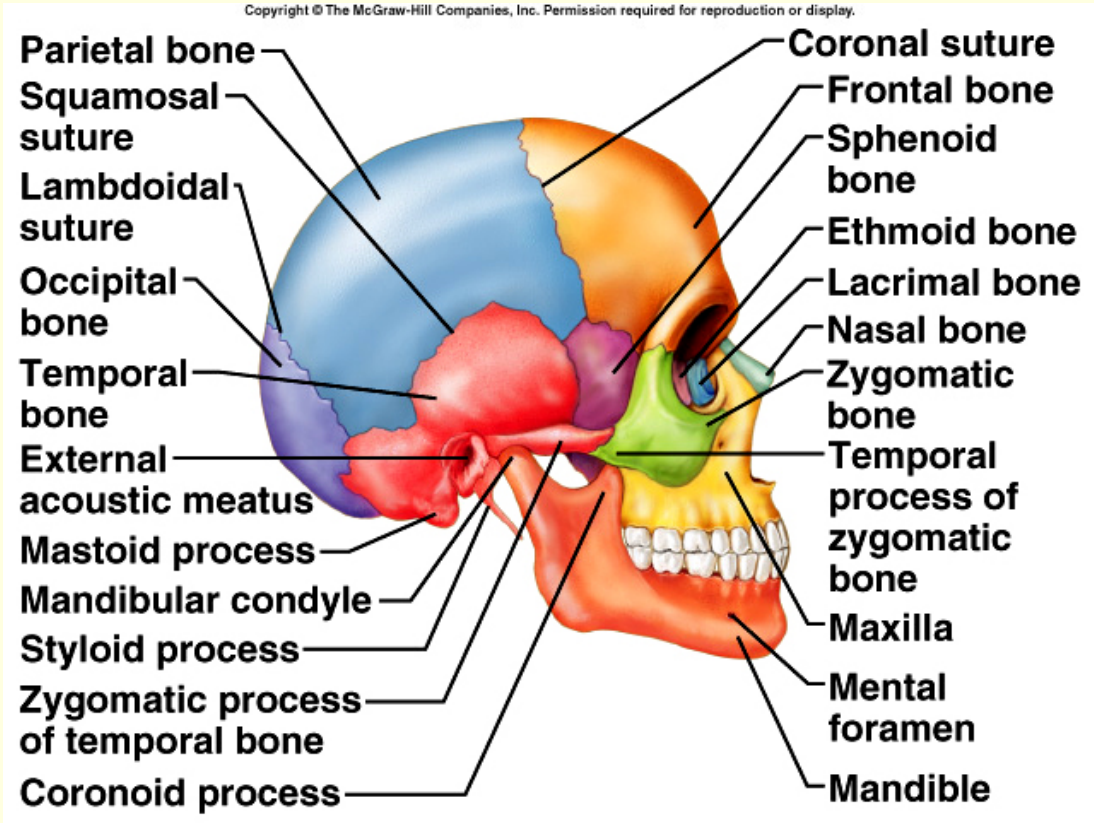
# Facial Skeleton

**Lacrimal (2)**

- **medial walls of orbits**
- **groove from orbit to nasal cavity**

**Nasal (2)**

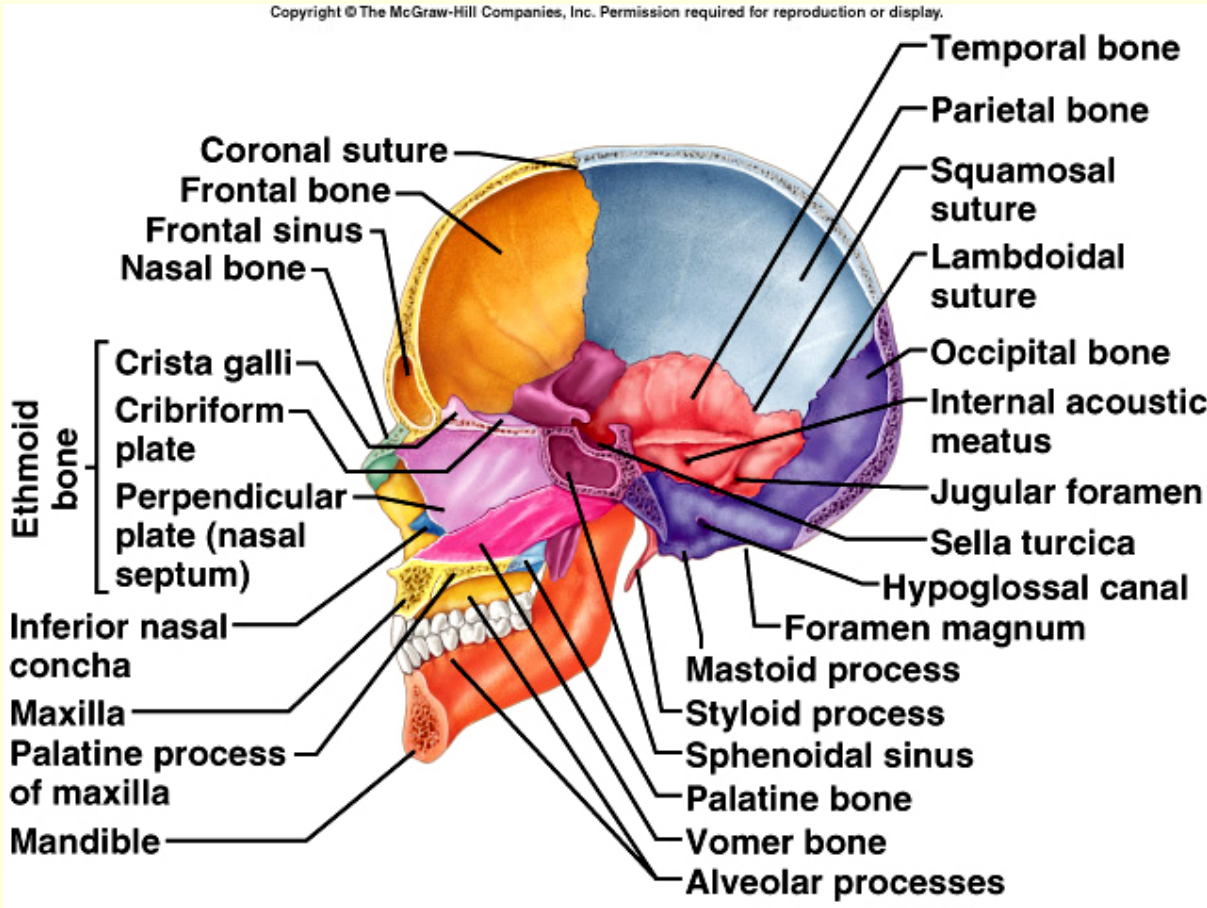
- **bridge of nose**

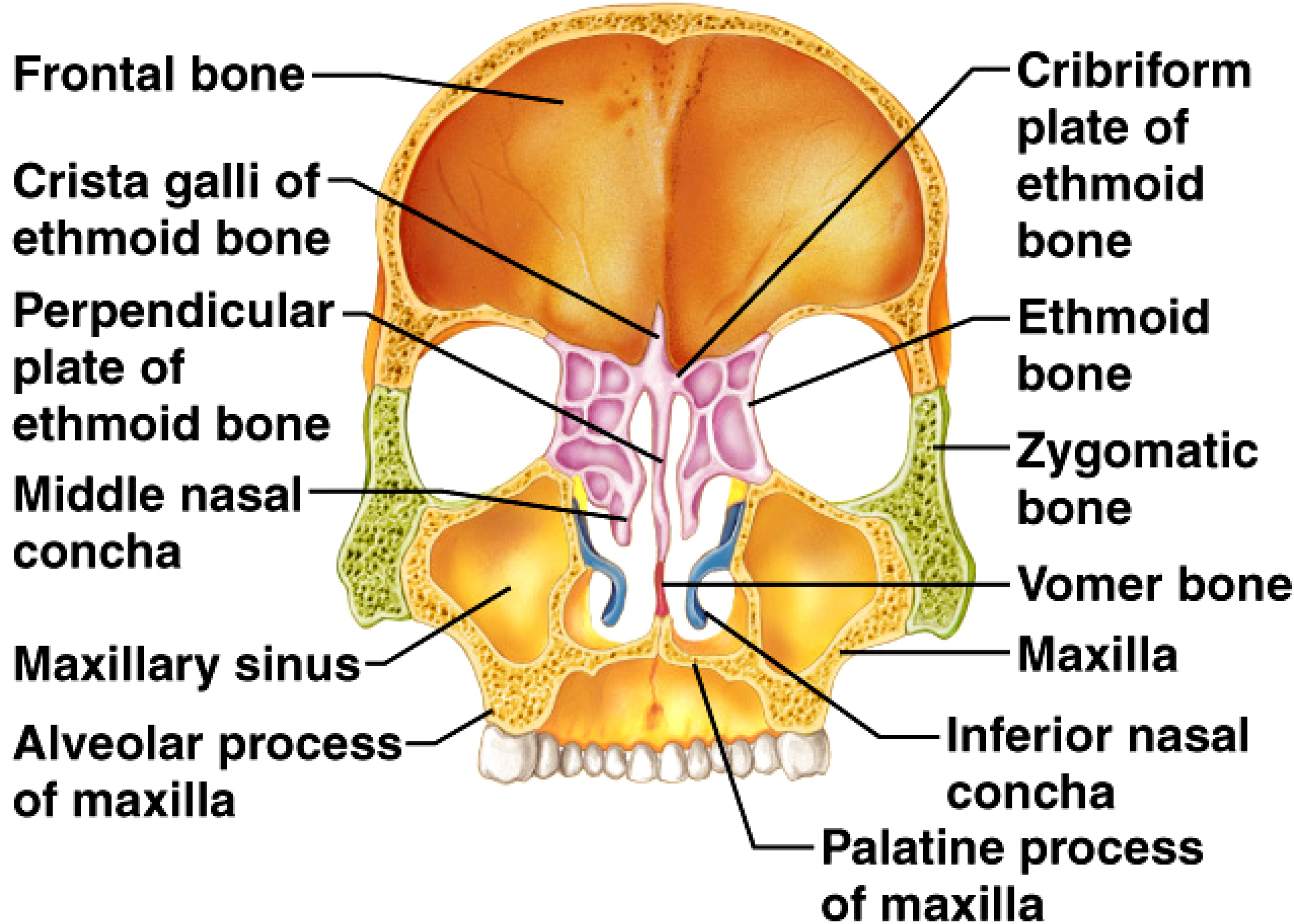


# Facial Skeleton

**Vomer (1)**

- **inferior portion of nasal septum**

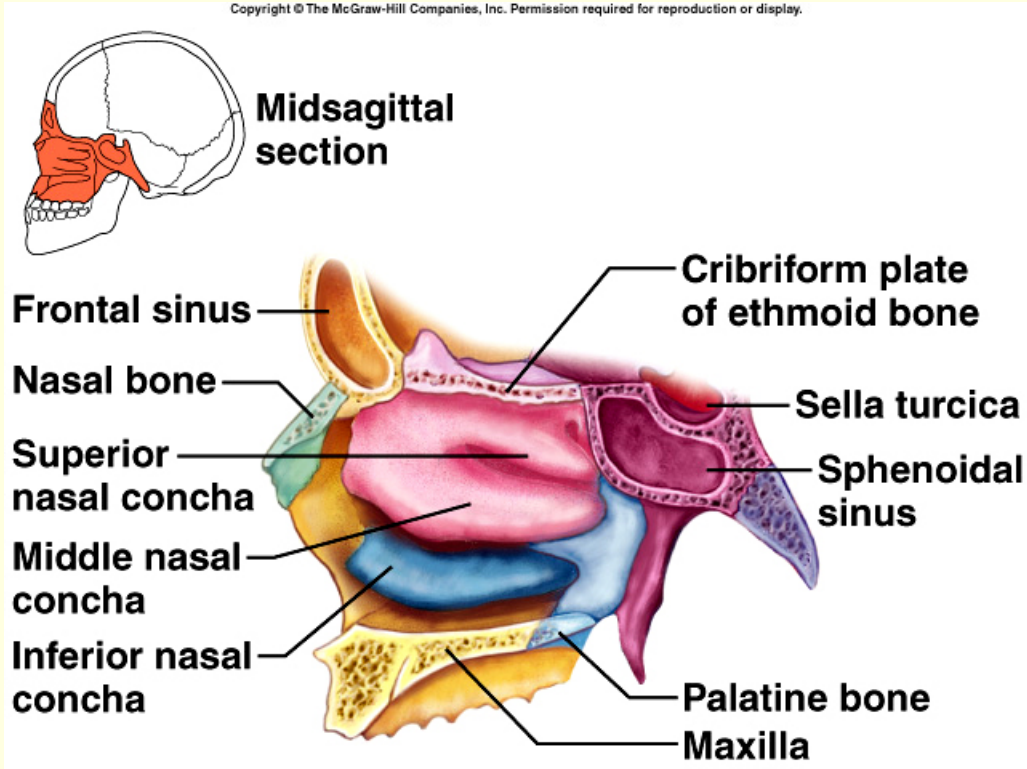




# Facial Skeleton

**Inferior Nasal Conchae (2)**

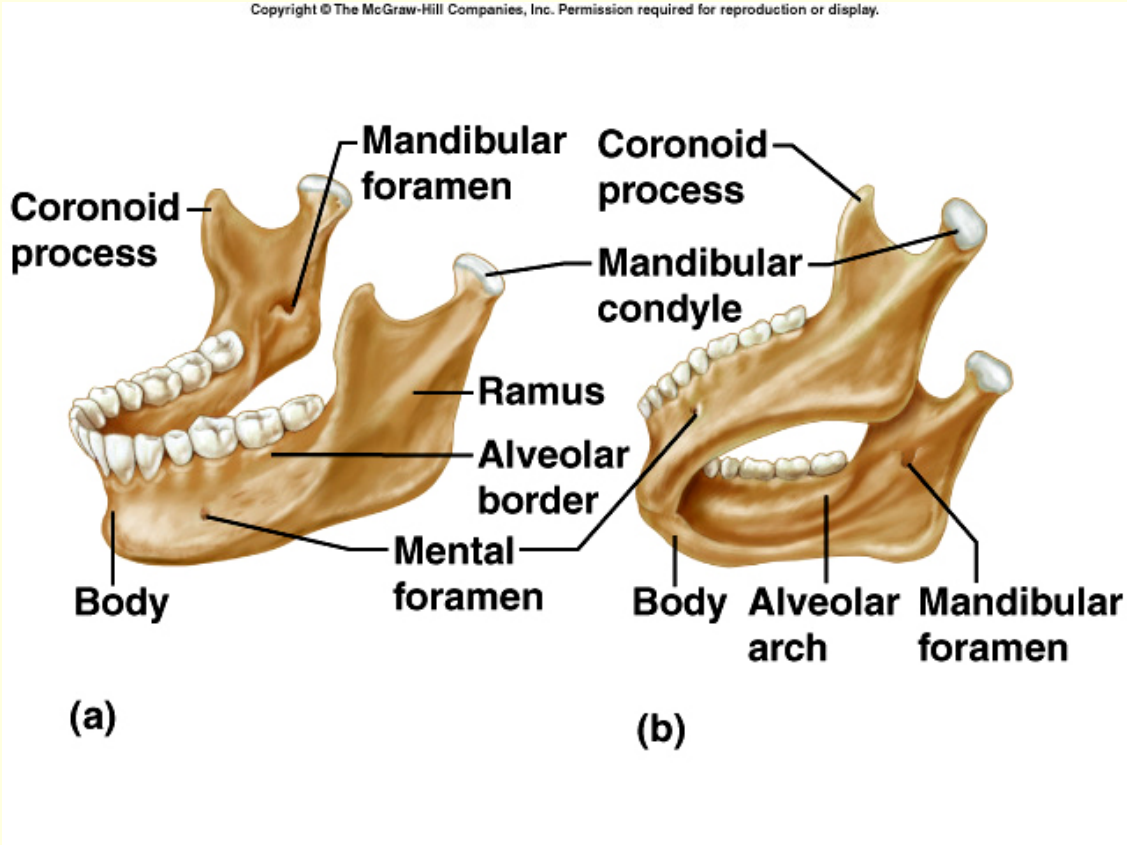
- **extend from lateral walls of nasal cavity**



# Facial Skeleton

**Mandible (1)**

- lower jaw
- body
- ramus
- mandibular condyle
- coronoid process
- alveolar process
- mandibular foramen
- mental foramen

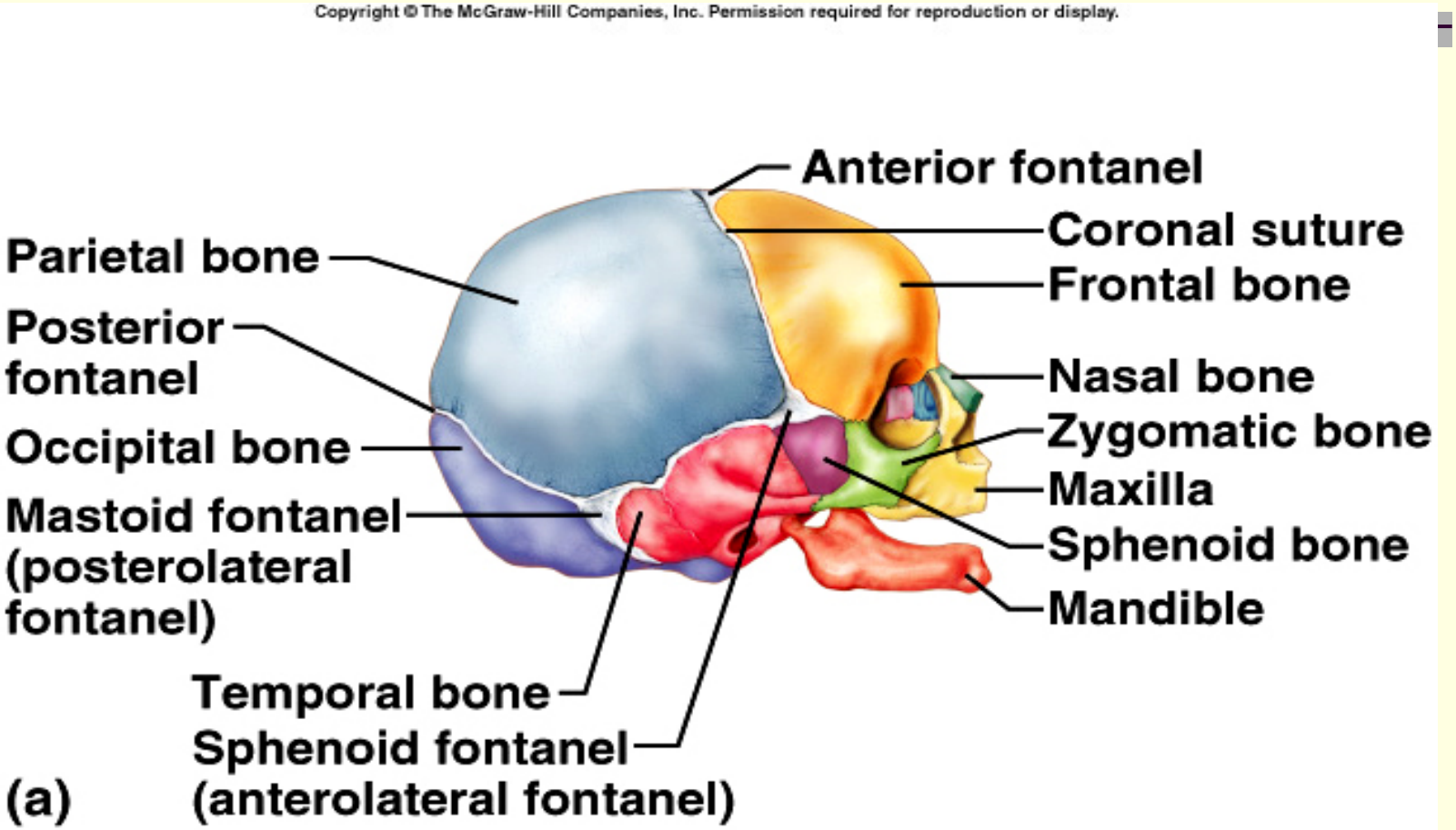


## TABLE 7.8 Passageways Through Bones of the Skull

| Passageway | Location | Major Stuctures Transmitted |
|---|---|---|
| Carotid canal (fig. 7.22) | Inferior surface of the temporal bone | Internal carotid artery, veins, and nerves |
| Foramen lacerum (fig. 7.22) | Floor of cranial cavity between temporal and sphenoid bones | Branch of pharyngeal artery (in life, opening is largely covered by fibrocartilage) |
| Foramen magnum (fig. 7.26) | Base of skull in occipital bone | Nerve fibers passing between the brain and spinal cord as it exits from the base of the brain, also certain arteries |
| Foramen ovale (fig. 7.22) | Floor of cranial cavity in sphenoid bone | Mandibular division of trigeminal nerve and veins |
| Foramen rotundum (fig. 7.26) | Floor of cranial cavity in sphenoid bone | Maxillary division of trigeminal nerve |
| Foramen spinosum (fig. 7.26) | Floor of cranial cavity in sphenoid bone | Middle meningeal blood vessels and branch of mandibular nerve |
| Greater palatine foramen (fig. 7.22) | Posterior portion of hard palate in palatine bone | Palatine blood vessels and nerves |
| Hypoglossal canal (fig. 7.29) | Near margin of foramen magnum in occipital bone | Hypoglossal nerve |
| Incisive foramen (fig. 7.22) | Incisive fossa in anterior portion of hard palate | Nasopalatine nerves, openings of vomeronasal organ |
| Inferior orbital fissure (fig. 7.20) | Floor of the orbit | Maxillary nerve and blood vessels |
| Infraorbital foramen (fig. 7.20) | Below the orbit in maxillary bone | Infraorbital blood vessels and nerves |
| Internal acoustic meatus (fig. 7.26) | Floor of cranial cavity in temporal bone | Branches of facial and vestibulocochlear nerves, and blood vessels |
| Jugular foramen (fig. 7.26) | Base of the skull between temporal and occipital bones | Glossopharyngeal, vagus and accessory nerves, and blood vessels |
| Mandibular foramen (fig. 7.31) | Inner surface of ramus of mandible | Inferior alveolar blood vessels and nerves |
| Mental foramen (fig. 7.31) | Near point of jaw in mandible | Mental nerve and blood vessels |
| Optic canal (fig. 7.20) | Posterior portion of orbit in sphenoid bone | Optic nerve and ophthalmic artery |
| Stylomastoid foramen (fig. 7.22) | Between styloid and mastoid processes | Facial nerve and blood vessels |
| Superior orbital fissure (fig. 7.20) | Lateral wall of orbit | Oculomotor, trochlear, and abducens nerves, and ophthalmic division of trigeminal nerve |
| Supraorbital foramen (fig. 7.19) | Upper margin or orbit in frontal bone | Supraorbital blood vessels and nerves |

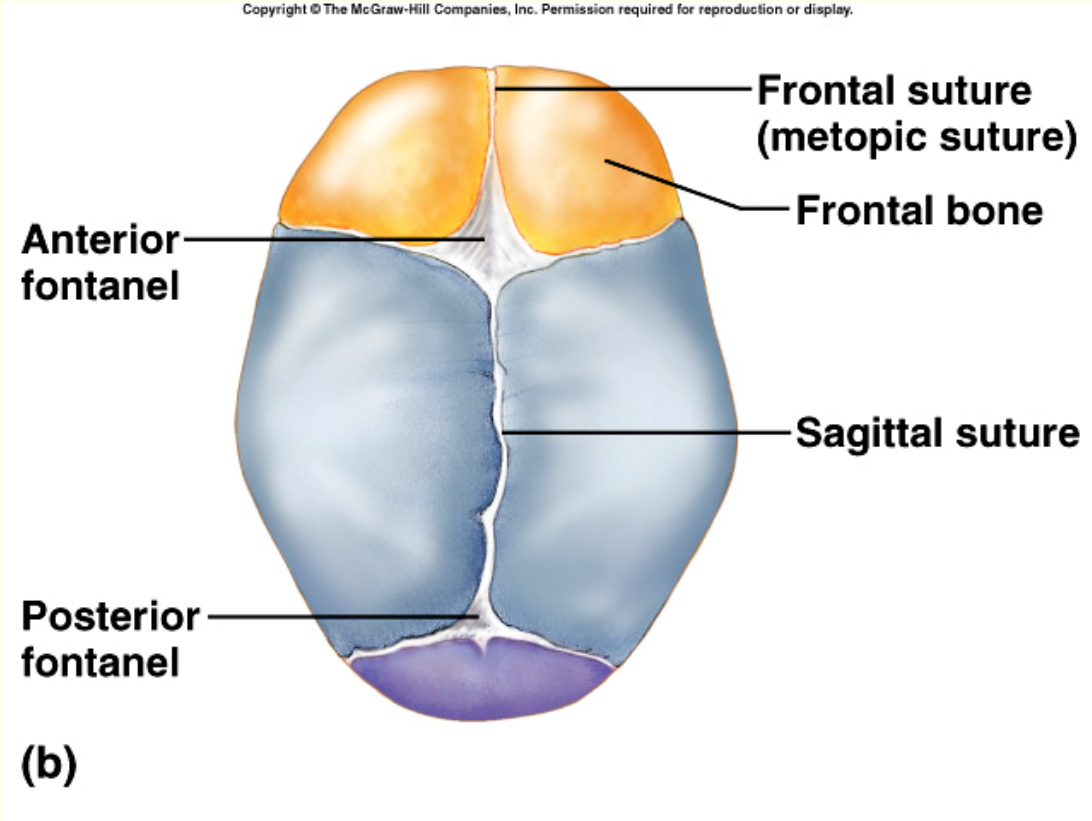
# Infantile Skull





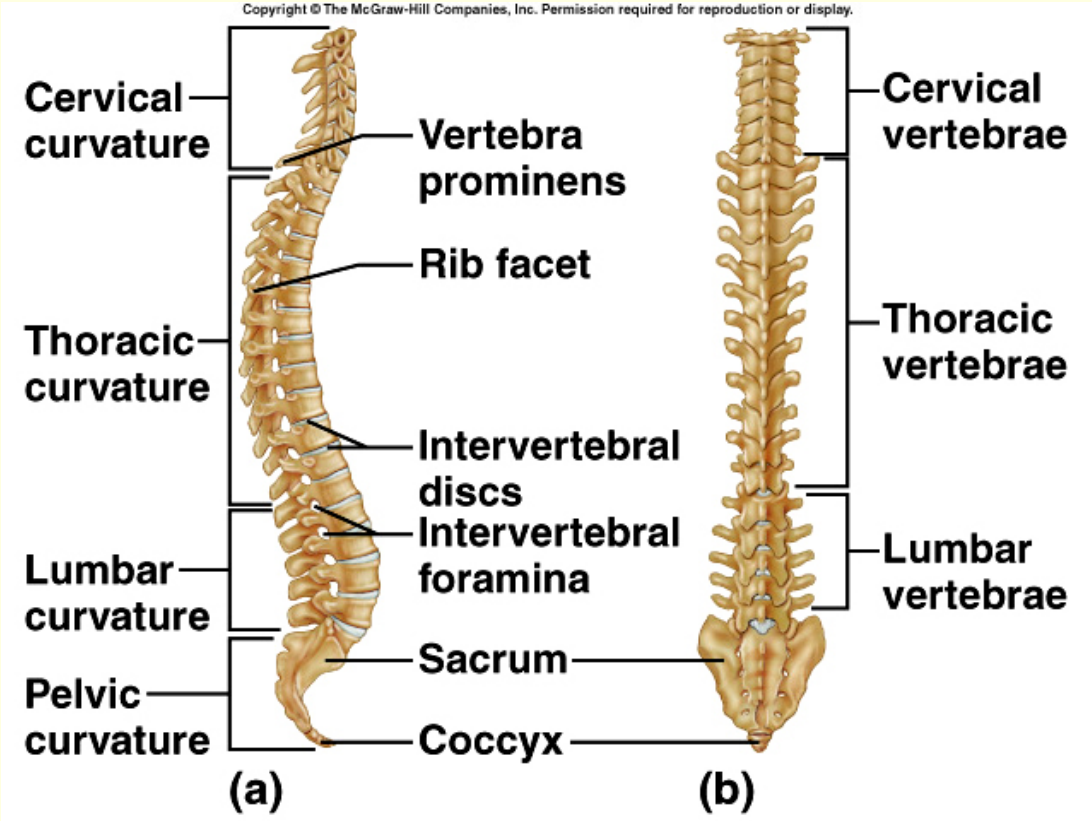
# Infantile Skull

**Fontanels – fibrous membranes**



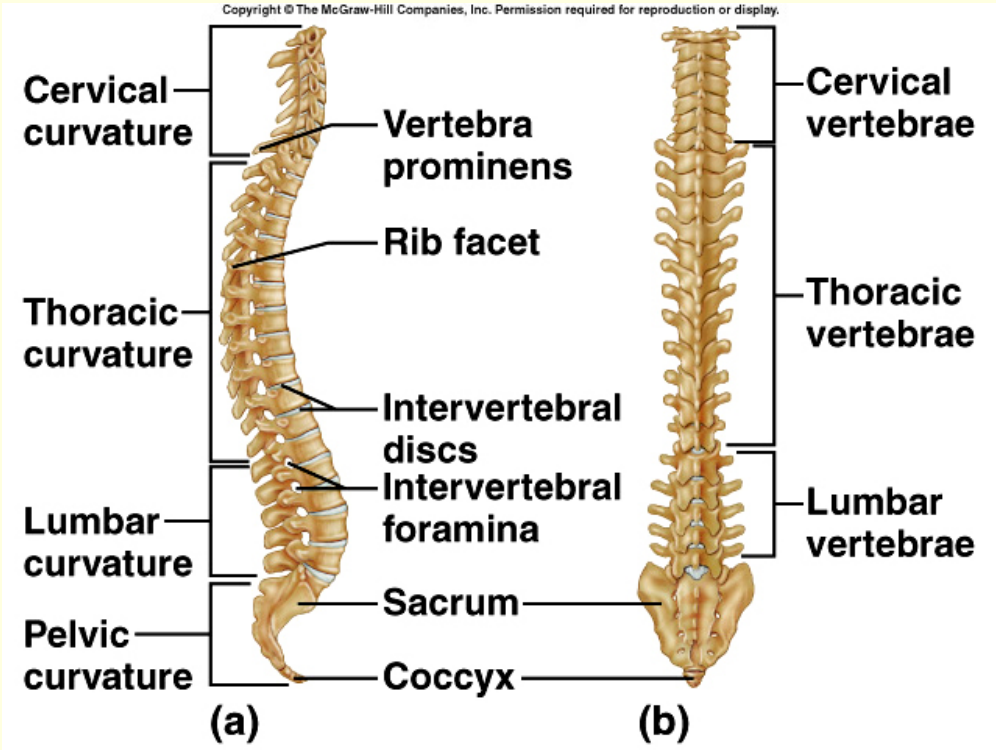
# Vertebral Column: Parts

- **cervical vertebrae** (7)
- **thoracic vertebrae** (12)
- **lumbar vertebrae** (5)
- **sacrum**
- **coccyx**



# Vertebral Column: Features

- cervical curvature
- thoracic curvature
- lumbar curvature
- pelvic curvature
- rib facets
- vertebra prominens
- intervertebral discs
- intervertebral foramina



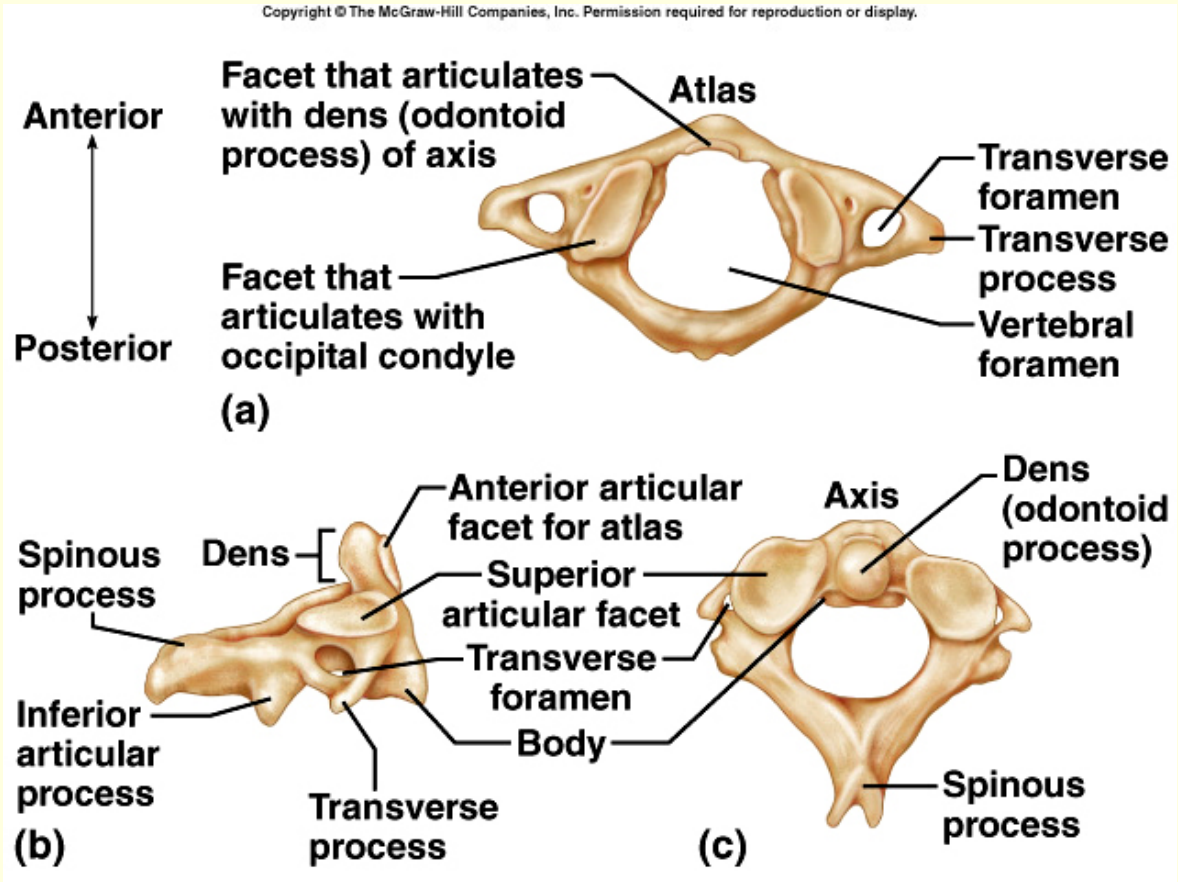
## TABLE 7.9 Bones of the Vertebral Column

| Bones | Number | Special Features |
|---|---|---|
| Cervical vertebrae | 7 | Transverse foramina; facets of atlas articulate with occipital condyles of skull; dens of axis articulates with atlas; spinous processes of second through sixth vertebrae are bifid |
| Thoracic vertebrae | 12 | Pointed spinous processes that slope downward; facets that articulate with ribs |
| Lumbar vertebrae | 5 | Large bodies; transverse processes that project posteriorly at sharp angles; short, thick spinous processes directed nearly horizontally |
| Sacrum | 5 vertebrae fused into 1 bone | Dorsal sacral foramina, auricular surfaces, sacral promontory, sacral canal, sacral hiatus, anterior sacral foramina |
| Coccyx | 4 vertebrae fused into 1 bone | Attached by ligaments to the margins of the sacral hiatus |

# Cervical Vertebrae

- **Atlas – 1st; supports head**
- **Axis – 2nd; dens pivots to turn head**
- **transverse foramina**
- **bifid spinous processes**
- **vertebral prominens – useful landmark**

In Greek Mythology, the Titan, Atlas, was punished by Zeus to stand at the edge of the world & hold up the heavens on his shoulders.



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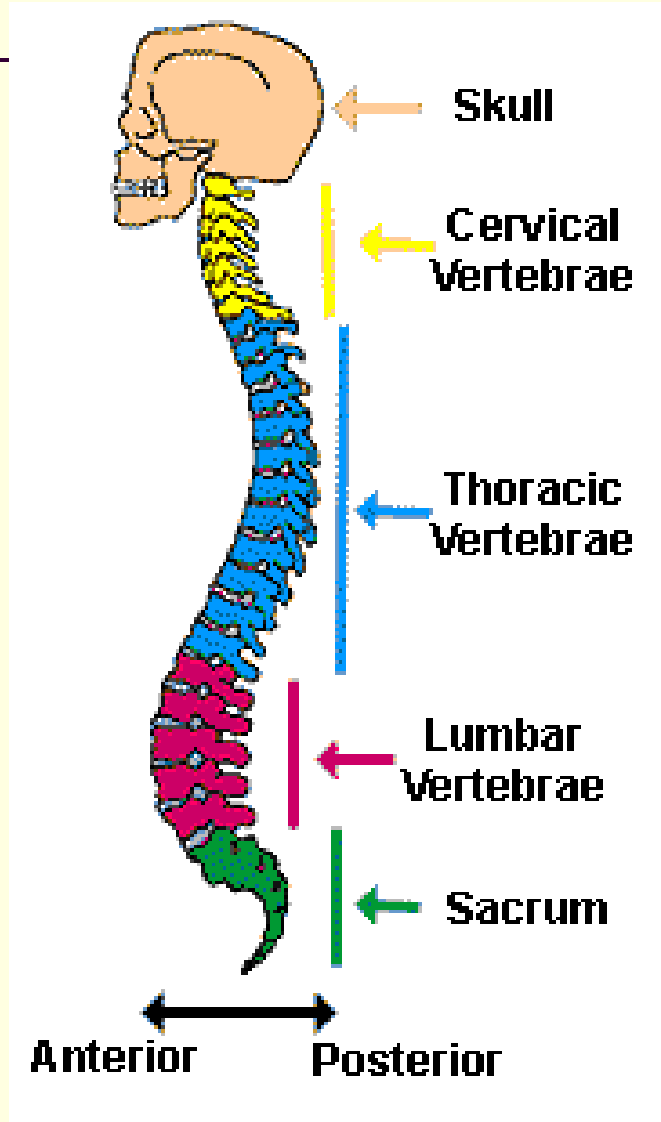
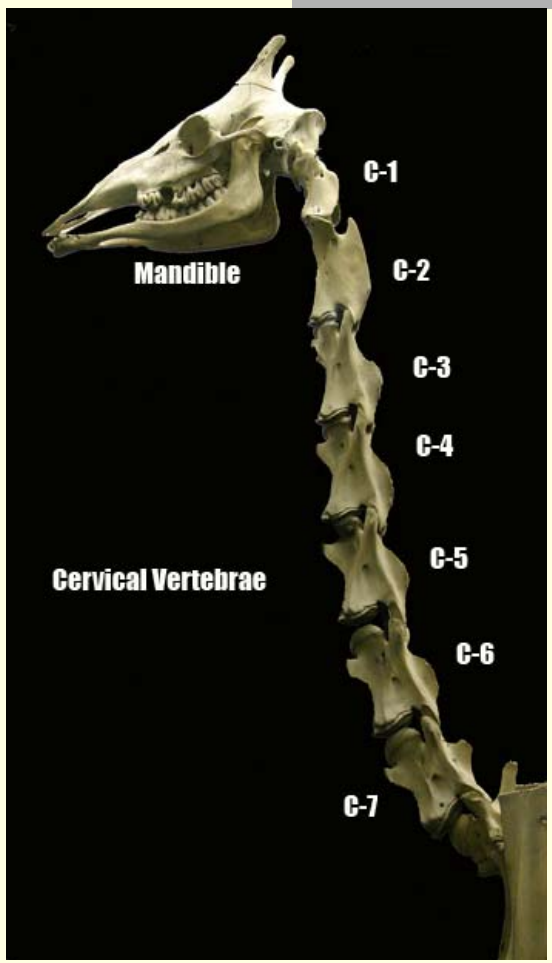
# Human Vertebral Column



# Comparison of Cervical Vertebrate of in Humans with Giraffes

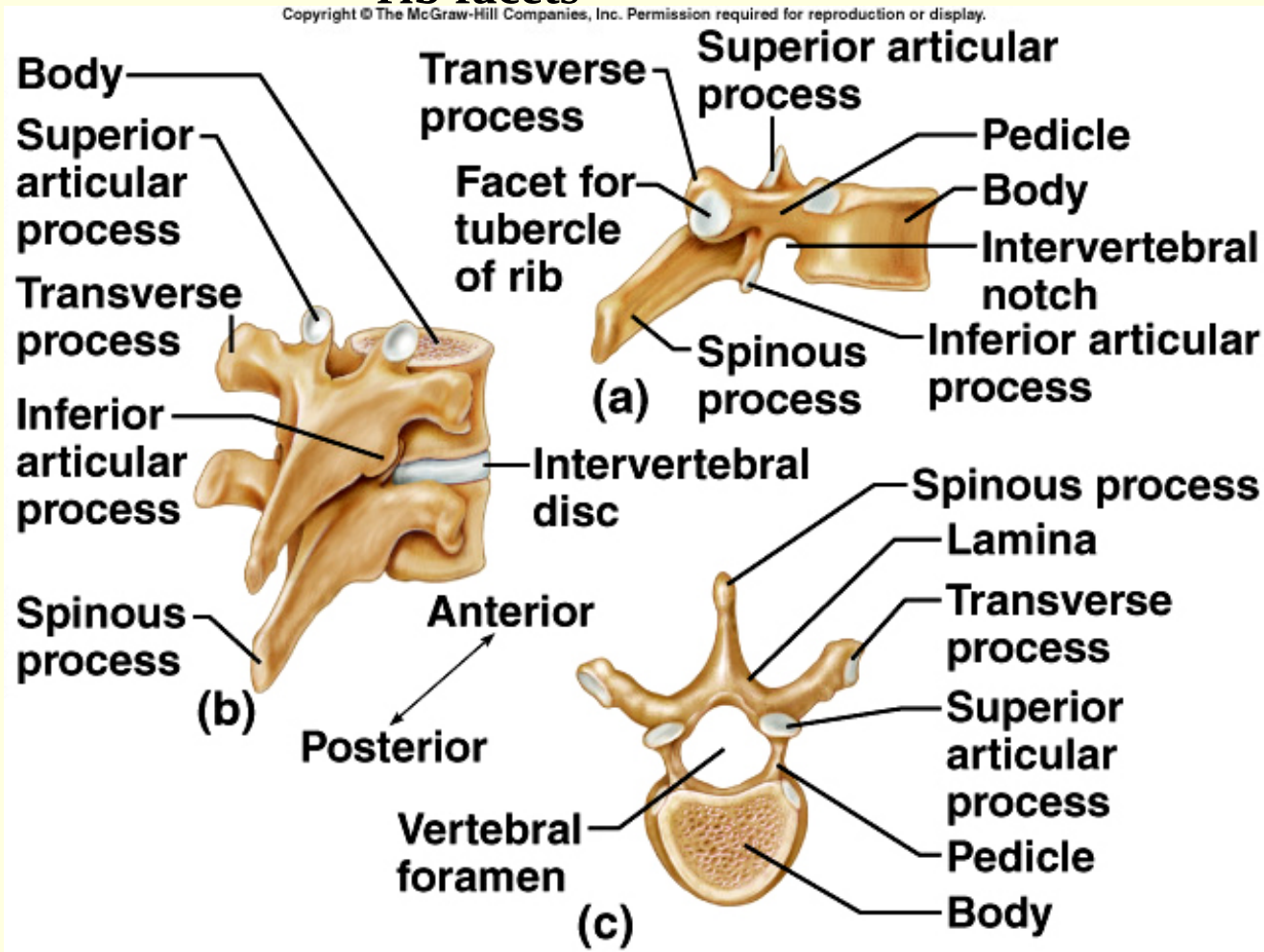
- **The giraffe neck has the same number of cervical vertebrae as a human 7.**
- **Each vertebrae is approximately 11 inches long.**





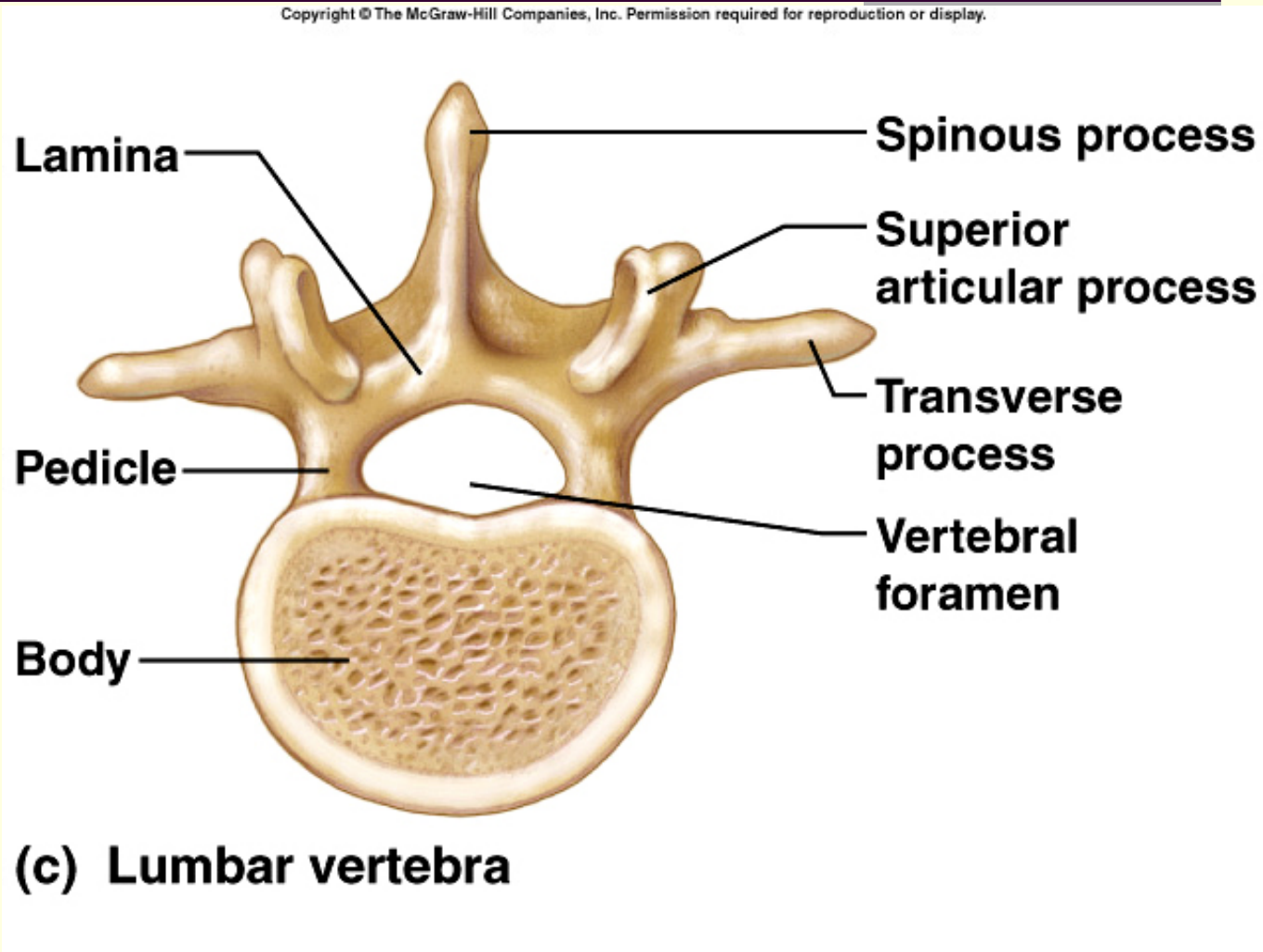
# Thoracic Vertebrae

- long spinous processes
- rib facets



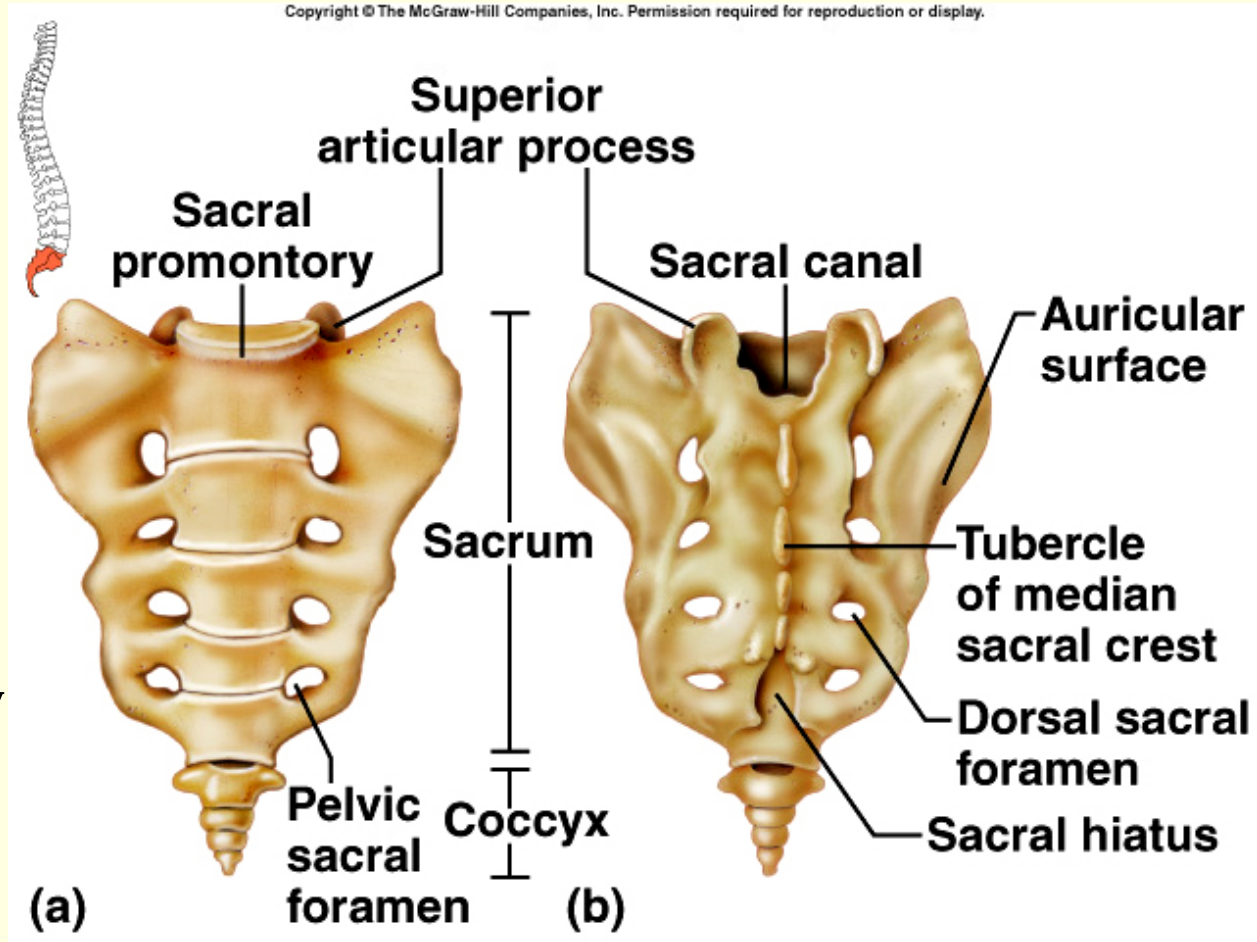
# Lumbar Vertebrae

- large bodies
- thick, short spinous processes



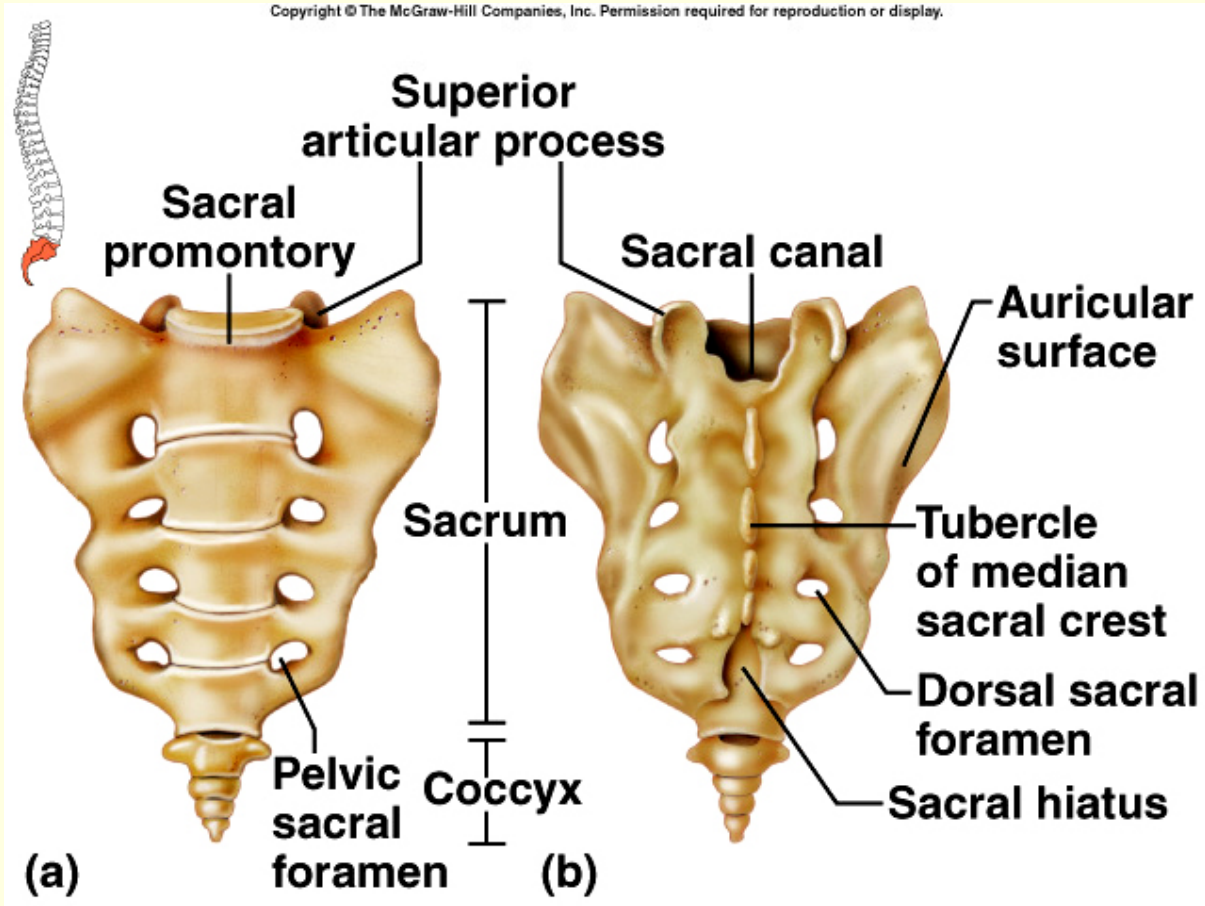
# Sacrum

- five fused vertebrae
- median sacral crest
- dorsal sacral foramina
- posterior wall of pelvic cavity
- sacral promontory



# Coccyx

- tailbone
- four fused vertebrae

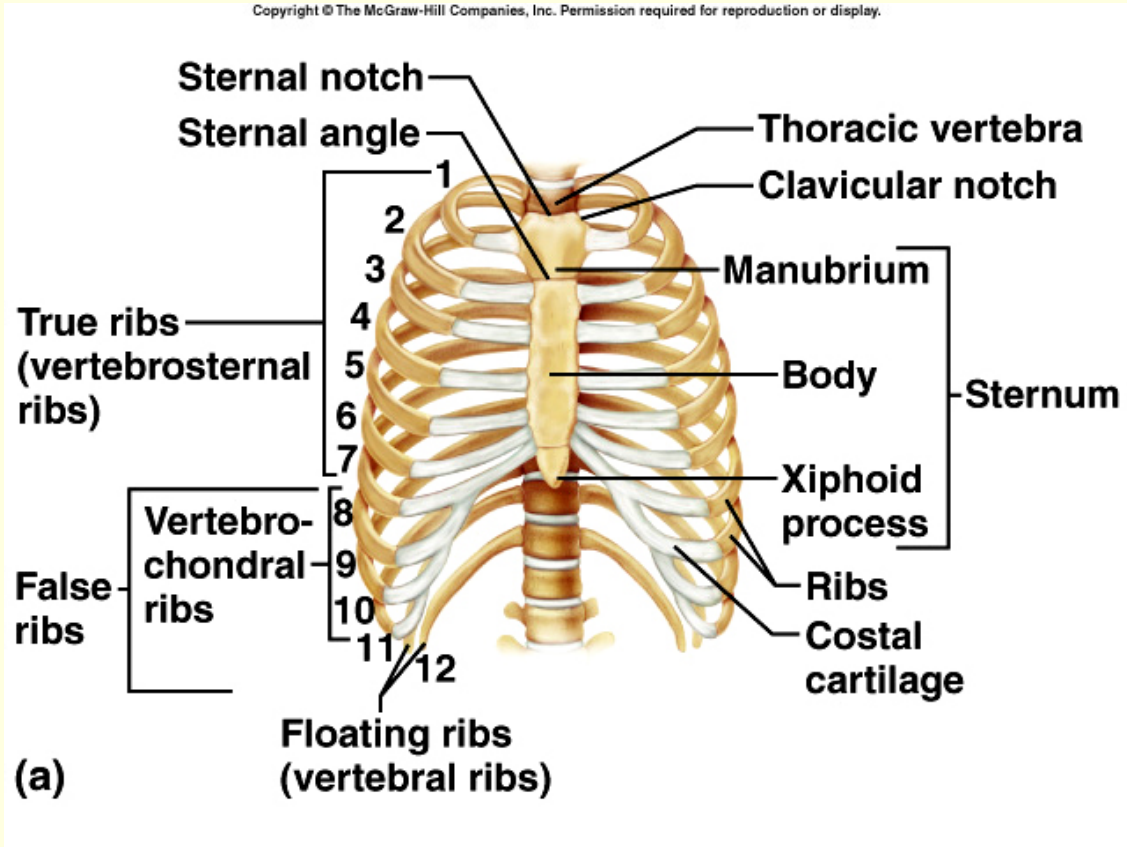


## TABLE 7.10 Bones of the Pectoral Girdle and Upper Limbs

| Name and Number | Location | Special Features |
|---|---|---|
| Clavicle (2) | Base of neck between sternum and scapula | Sternal end, acromial end |
| Scapula (2) | Upper back, forming part of shoulder | Body, spine, head, acromion process, coracoid process, glenoid cavity |
| Humerus (2) | Arm, between scapula and elbow | Head, greater tubercle, lesser tubercle, intertubercular groove, surgical neck, deltoid tuberosity, capitulum, trochlea, medial epicondyle, lateral epicondyle, coronoid fossa, olecranon fossa |
| Radius (2) | Lateral side of forearm, between elbow and wrist | Head, radial tuberosity, styloid process, ulnar notch |
| Ulna (2) | Medial side of forearm, between elbow and wrist | Trochlear notch, olecranon process, head, styloid process, radial notch |
| Carpal (16) | Wrist | Arranged in two rows of four bones each |
| Metacarpal (10) | Palm | One in line with each finger and thumb |
| Phalanx (28) | Finger | Three in each finger; two in each thumb |

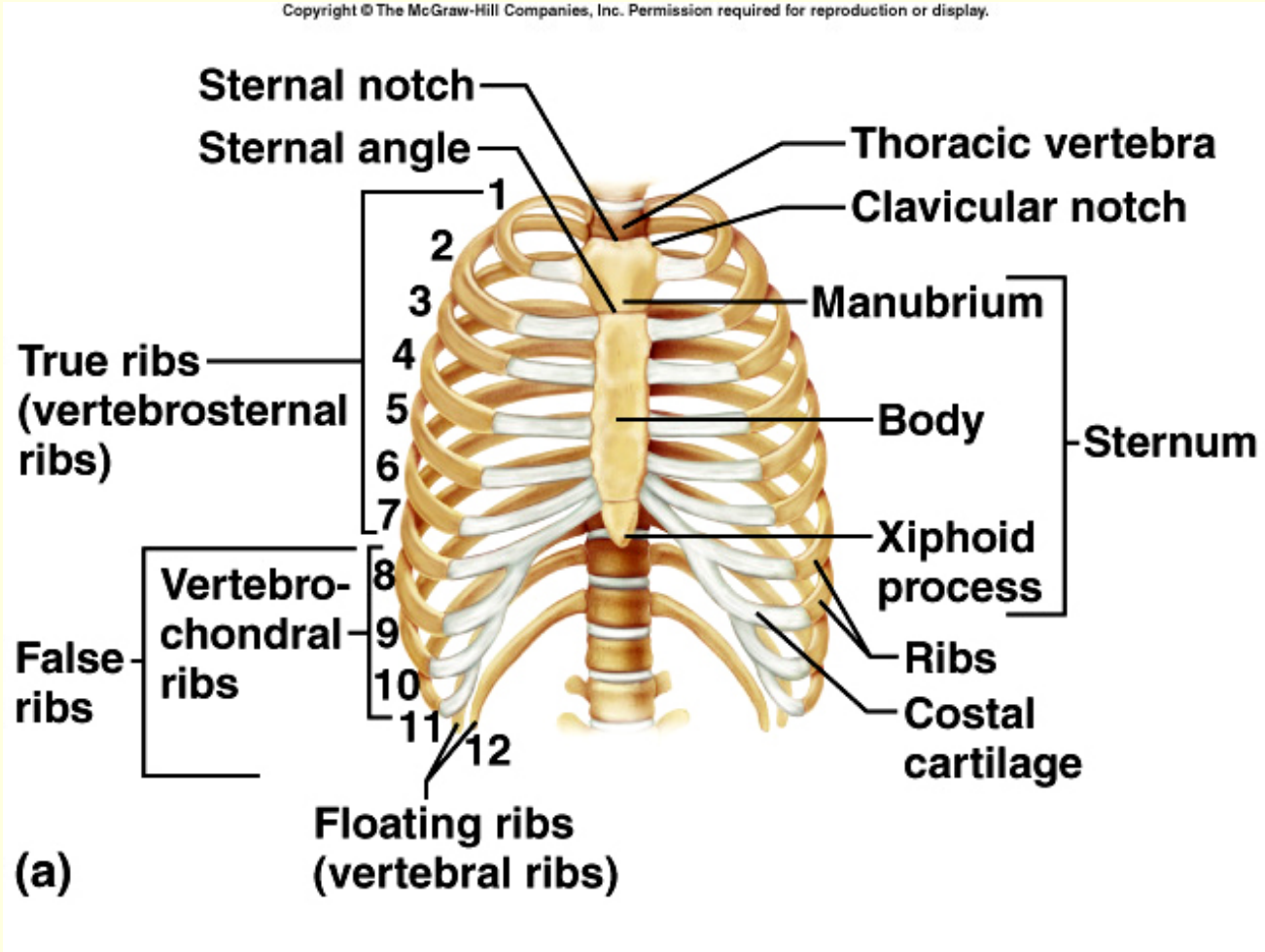
# Thoracic Cage

- Ribs
- Sternum
- Thoracic vertebrae
- Costal cartilages
- Supports shoulder girdle
- Protects viscera
- Role in breathing



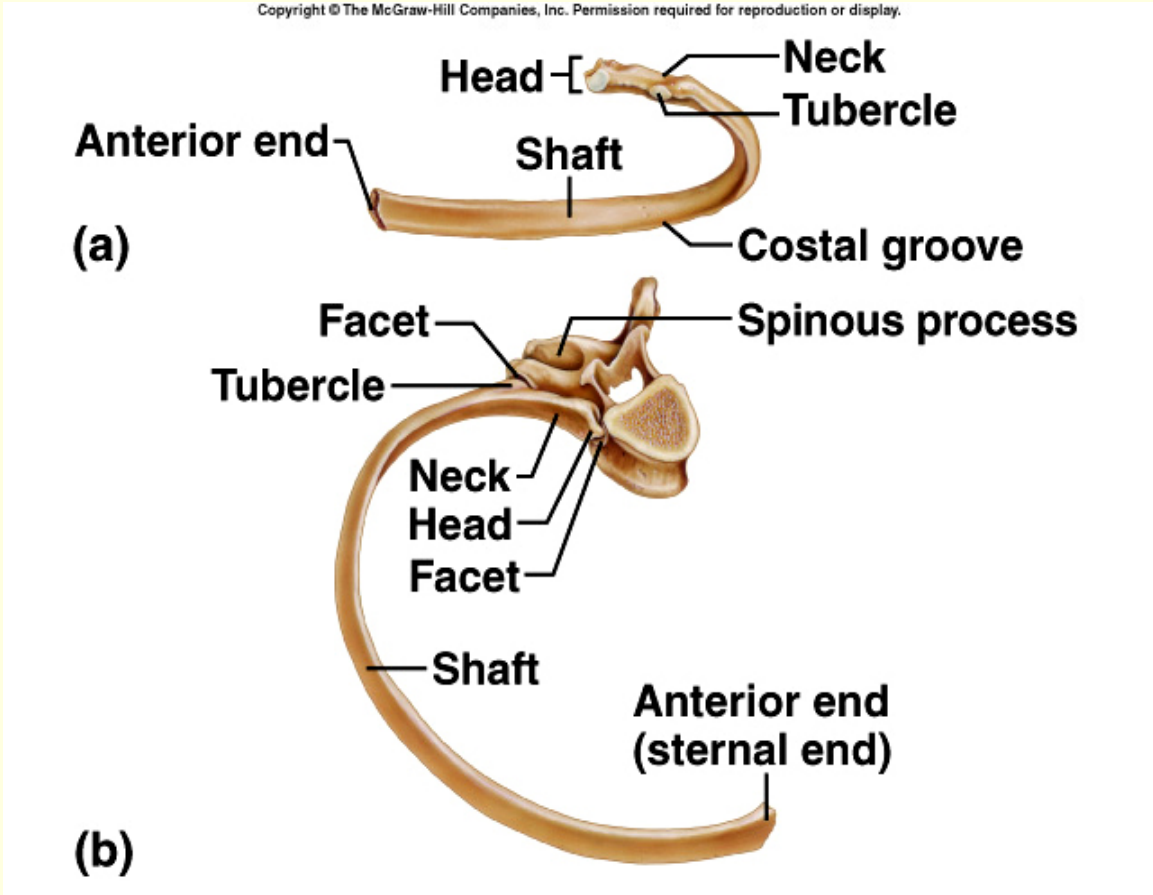
# Ribs

- True ribs (7)
- False ribs (5)
  - floating (2)



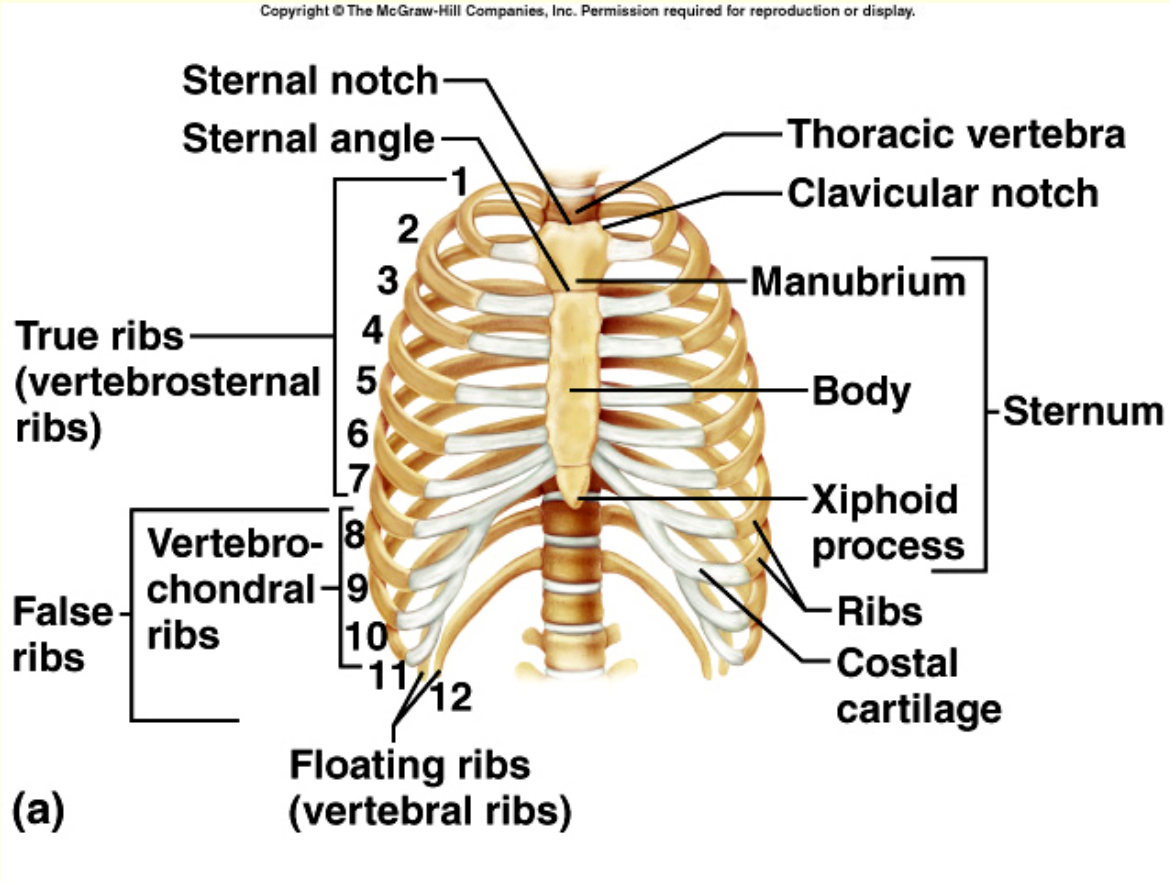
# Rib Structure

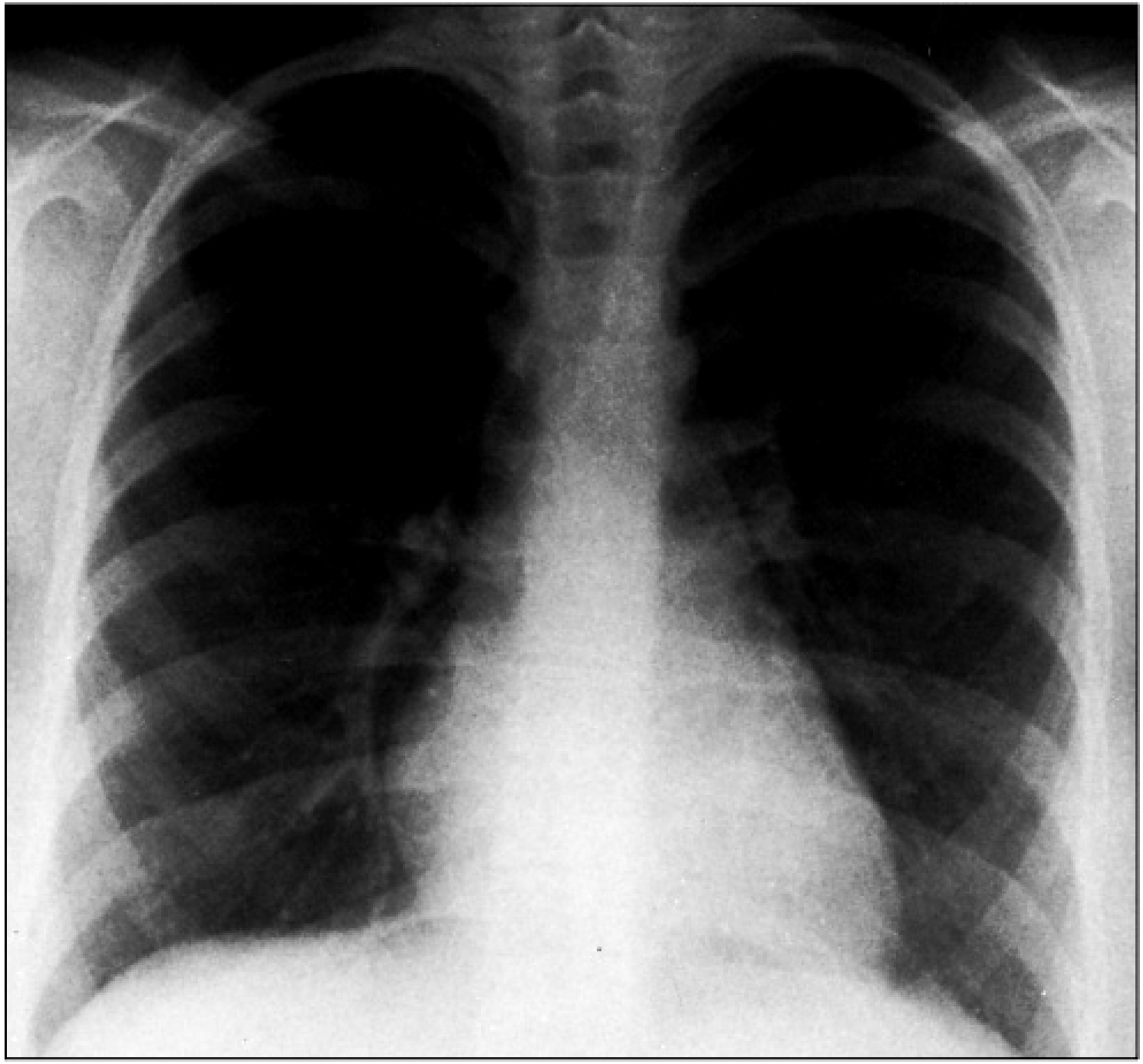
- **Shaft**
- **Head – posterior end; articulates with vertebrae**
- **Tubercle – articulates with vertebrae**
- **Costal cartilage – hyaline cartilage**



# Sternum

- Manubrium
- Body
- Xiphoid process

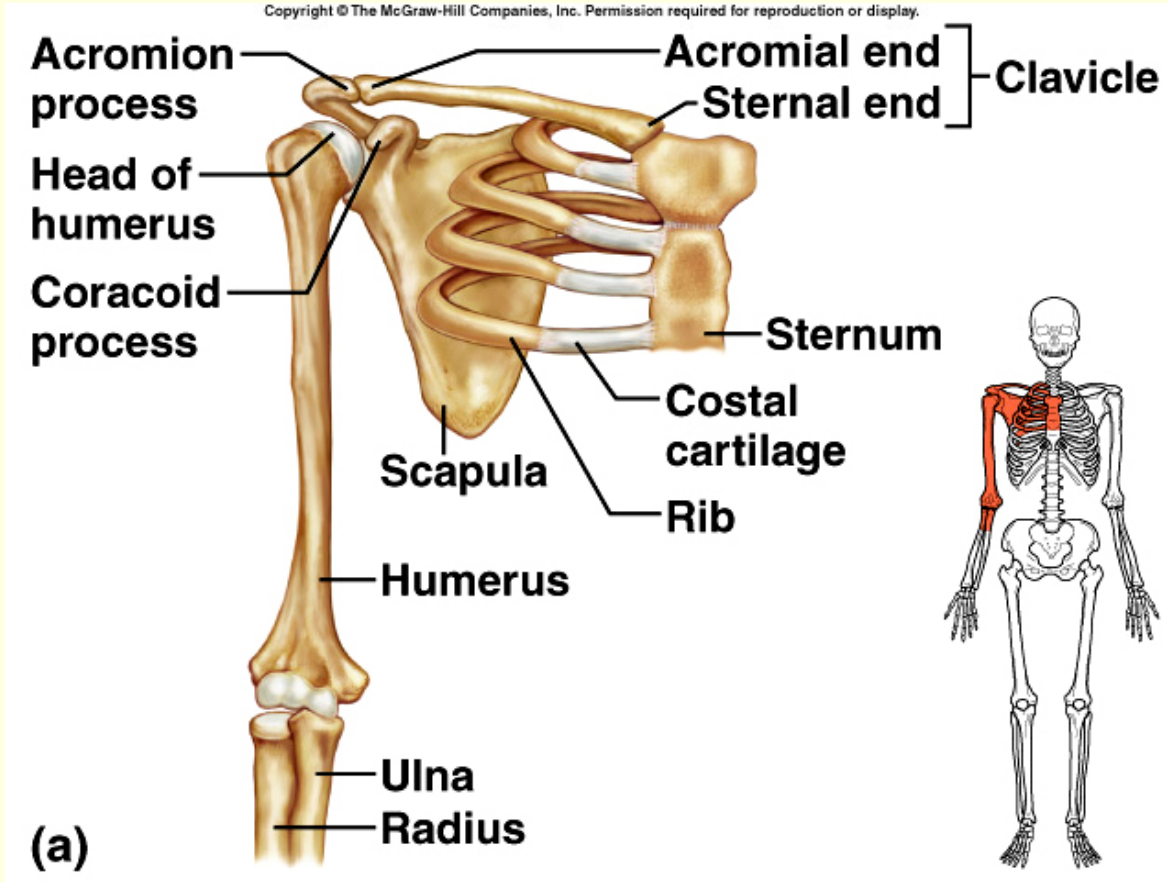




(b)

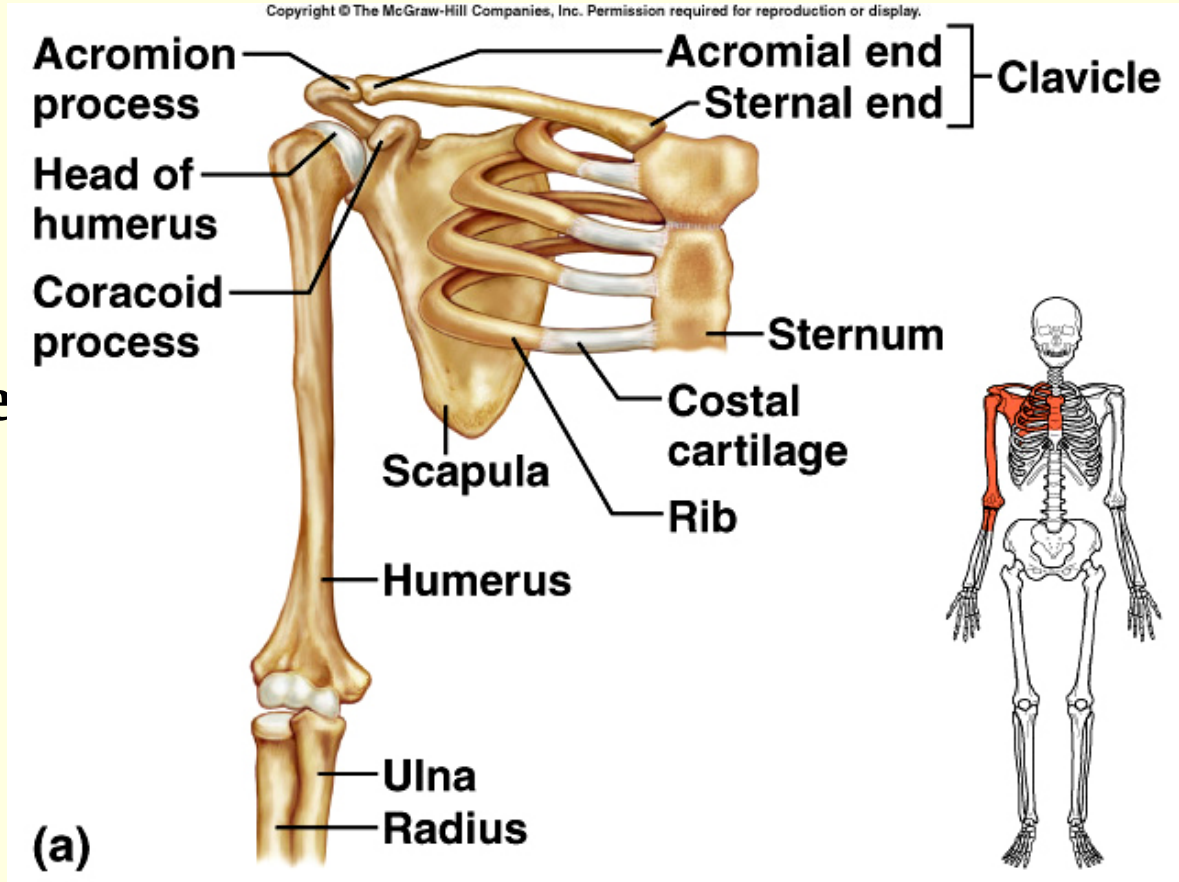
# Pectoral Girdle

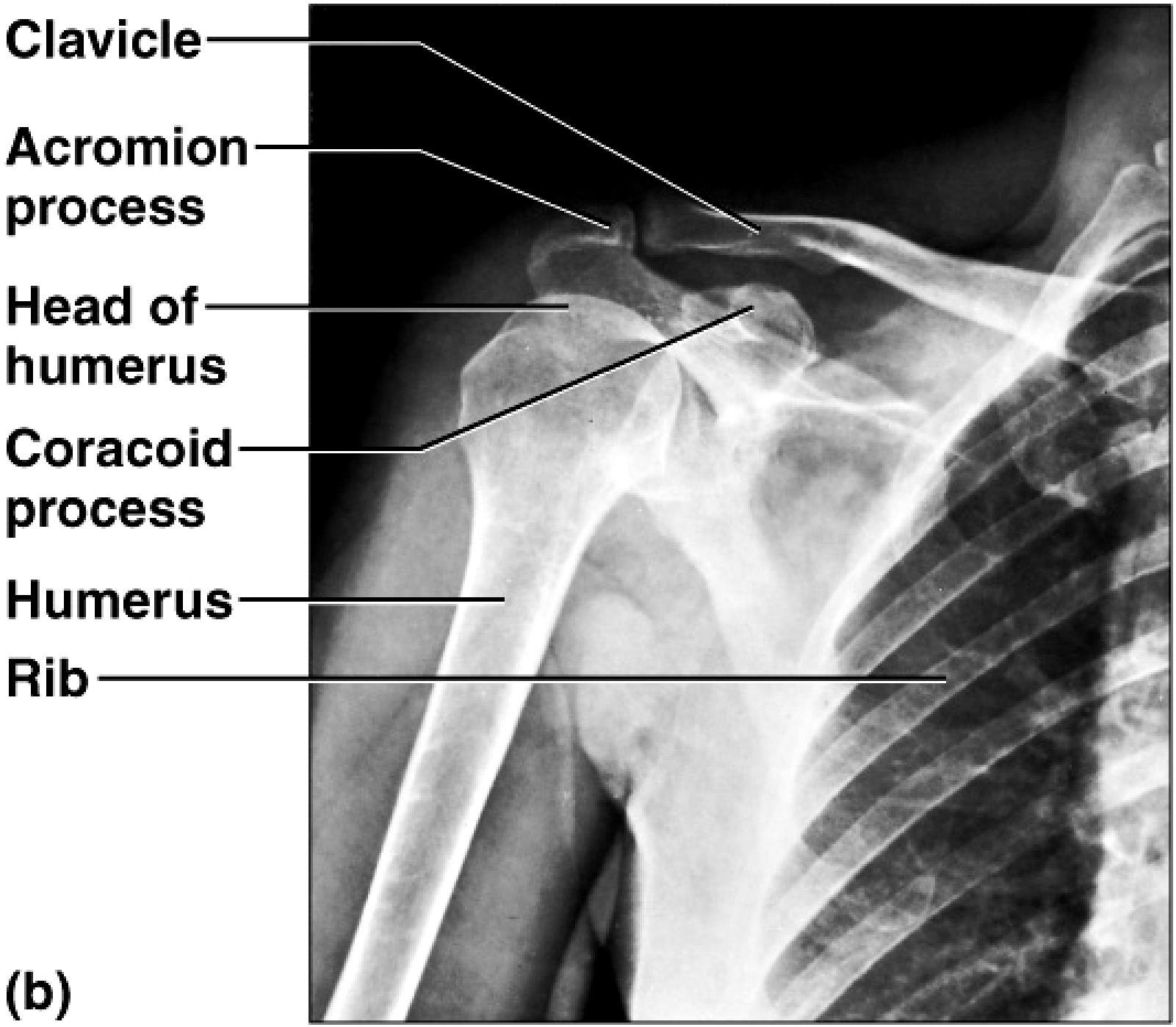
- shoulder girdle
- clavicles
- scapulae
- supports upper limbs



# Clavicles

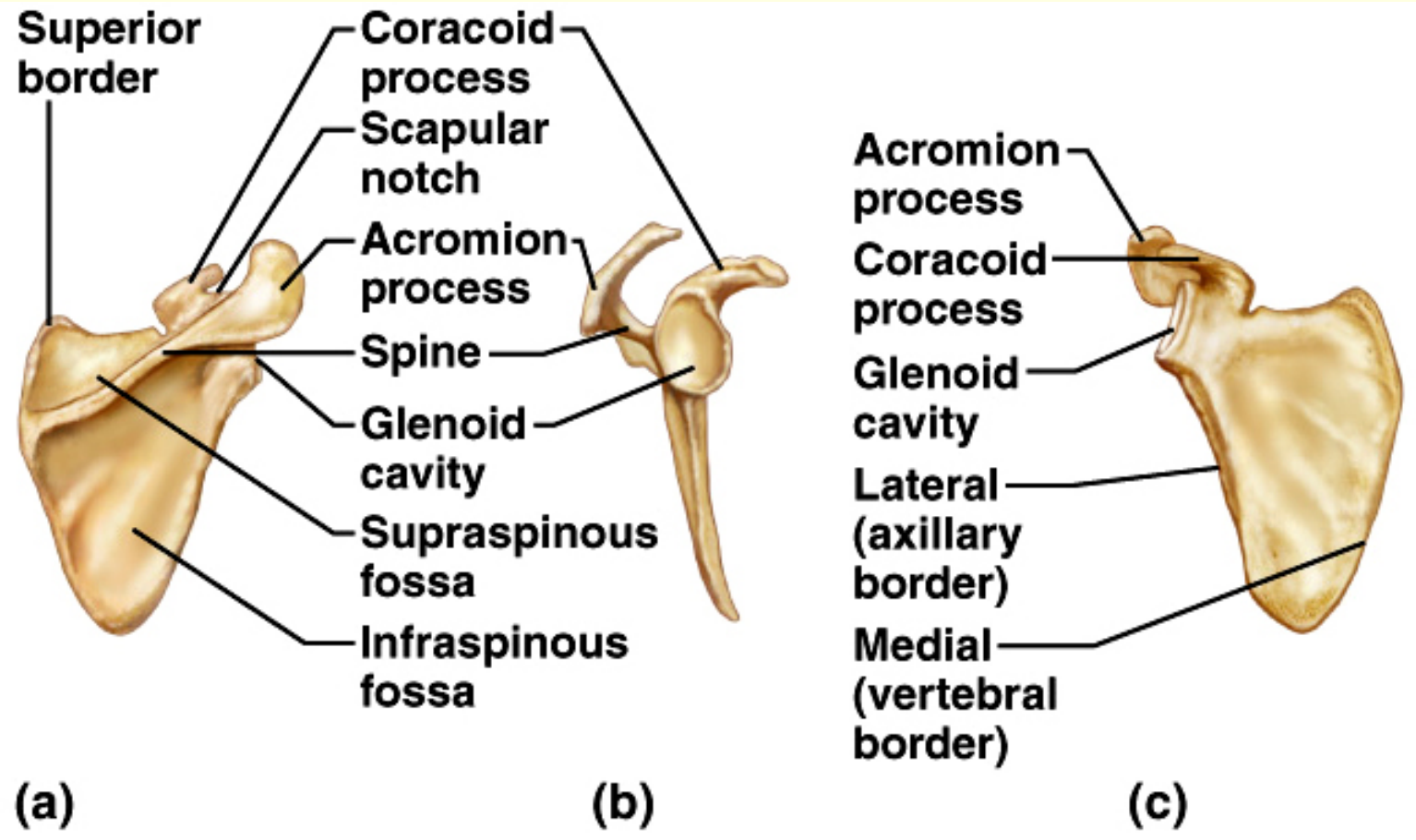
- articulate with manubrium
- articulate with scapulae (acromion process)





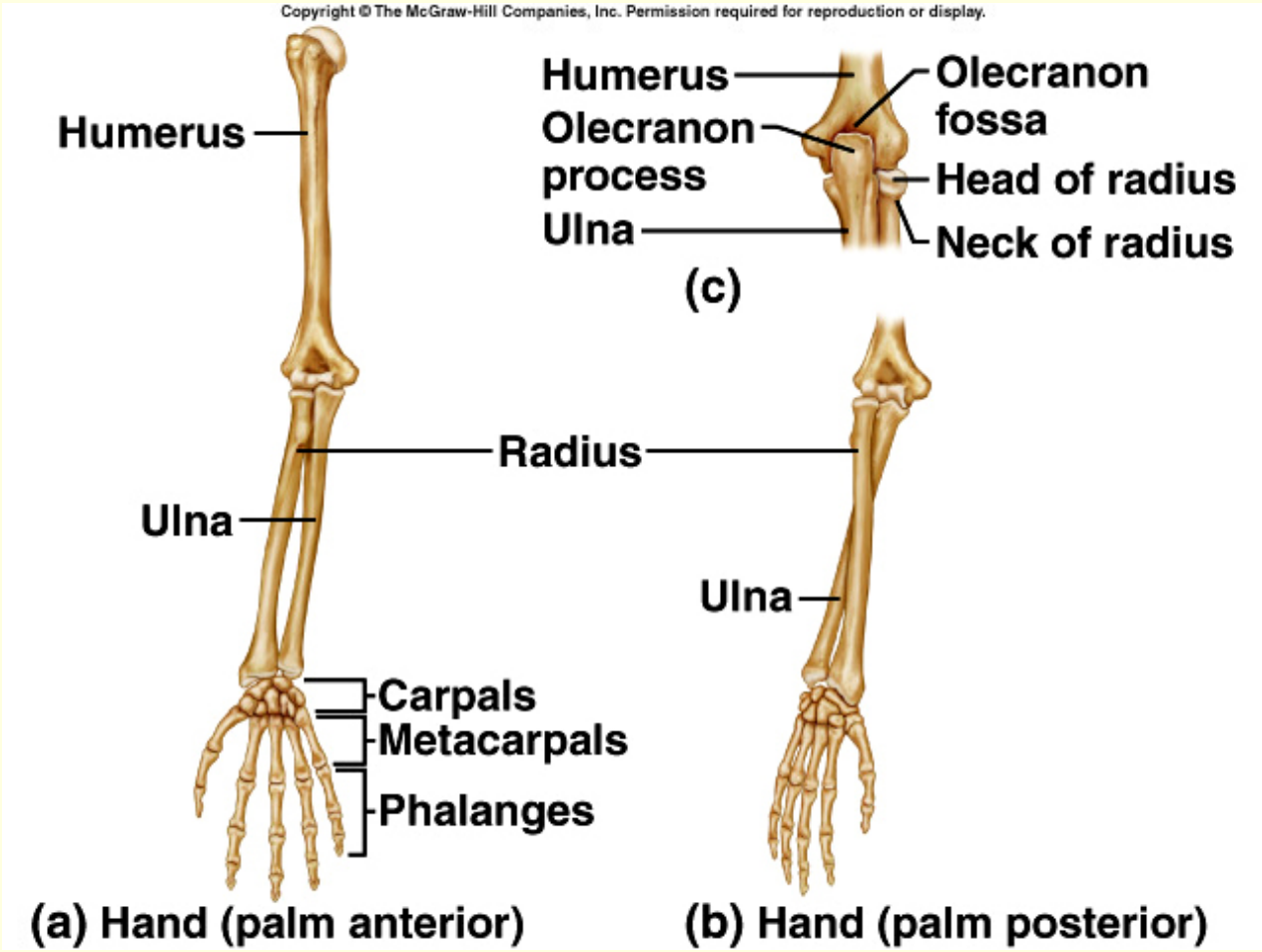
# Scapulae

- spine
- supraspinous fossa
- infraspinous fossa
- acromion process
- coracoid process
- glenoid cavity

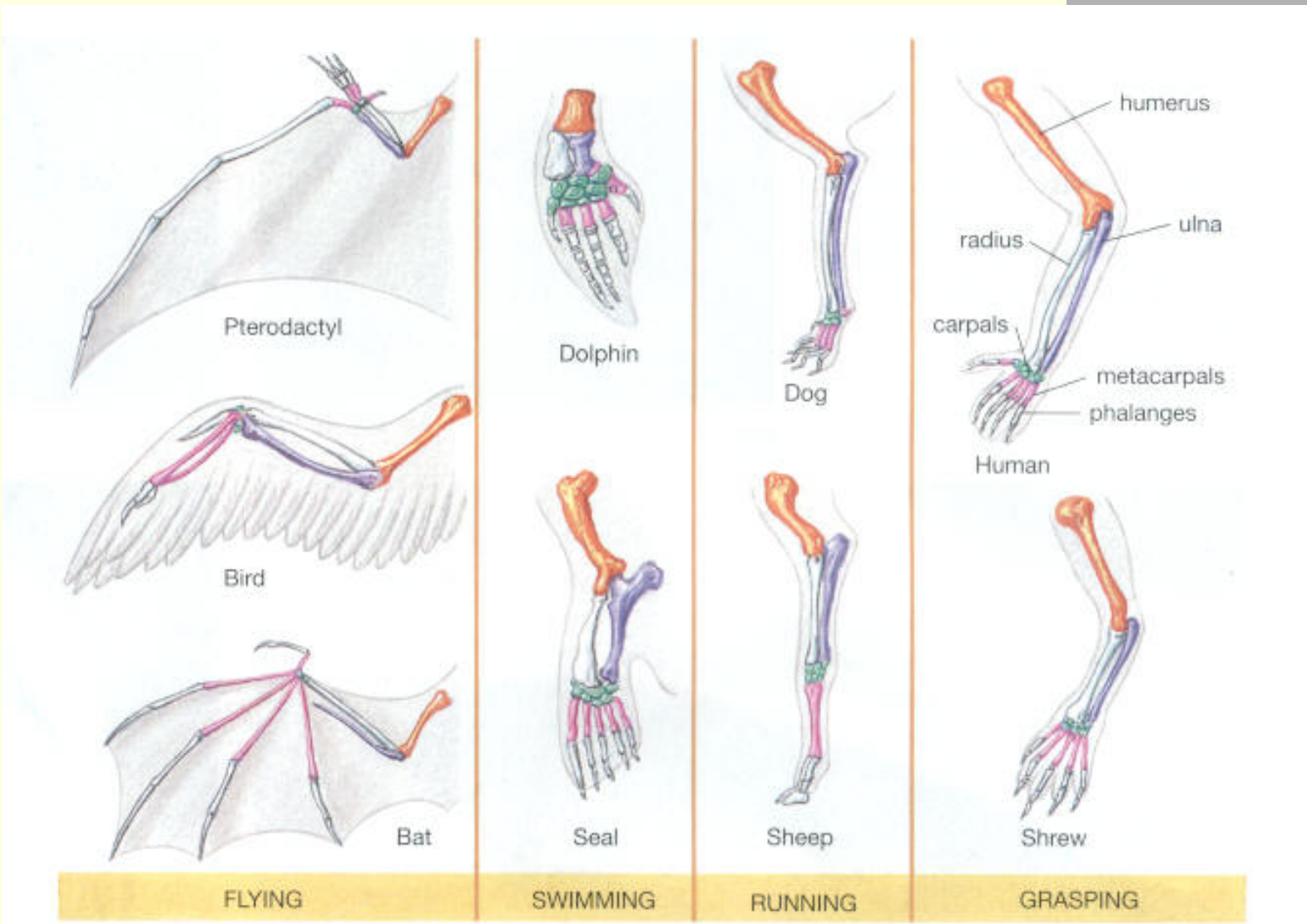


# Upper Limb

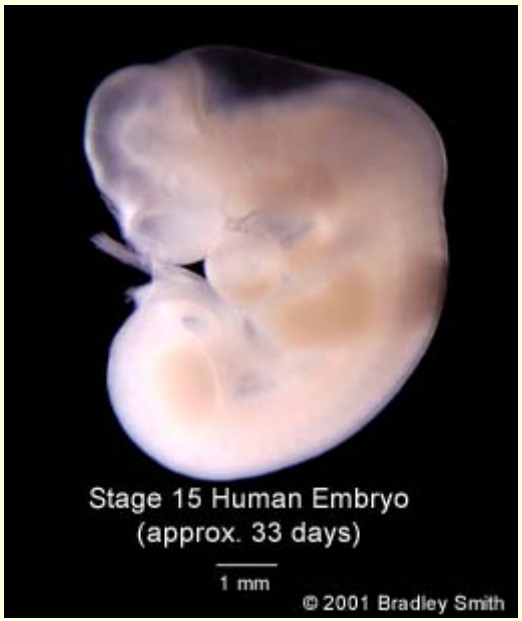
- Humerus
- Radius
- Ulna
- Carpals
- Metacarpals
- Phalanges



# Homologous Anatomical Structures

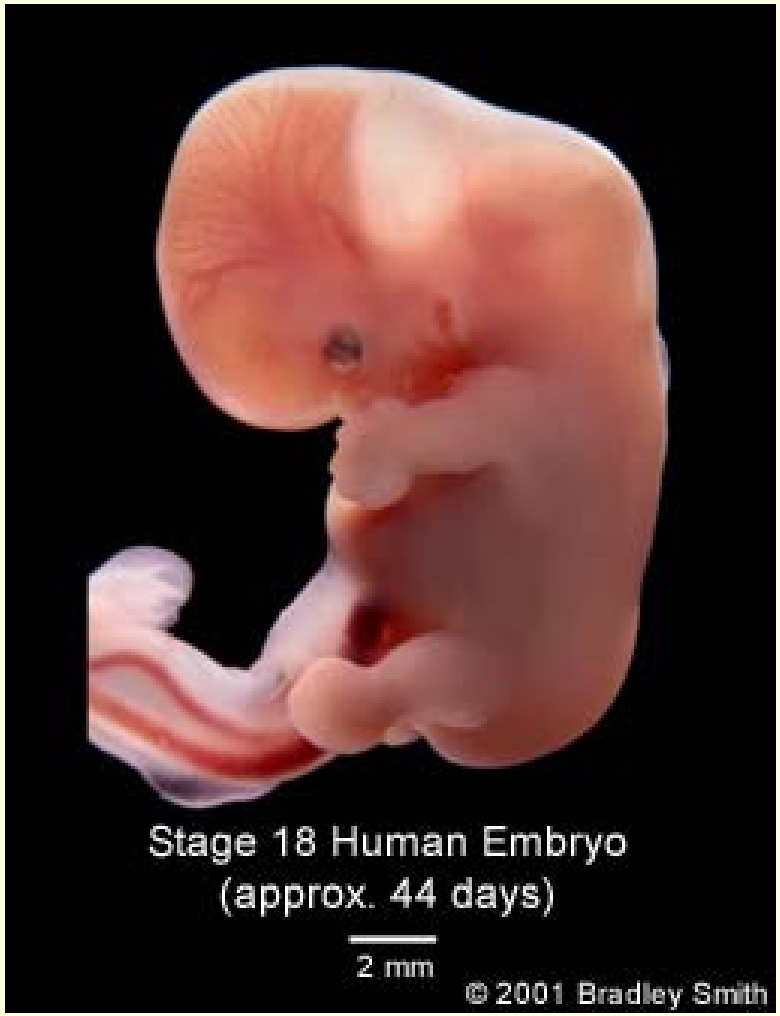


# Limb buds of a young Human Embryo



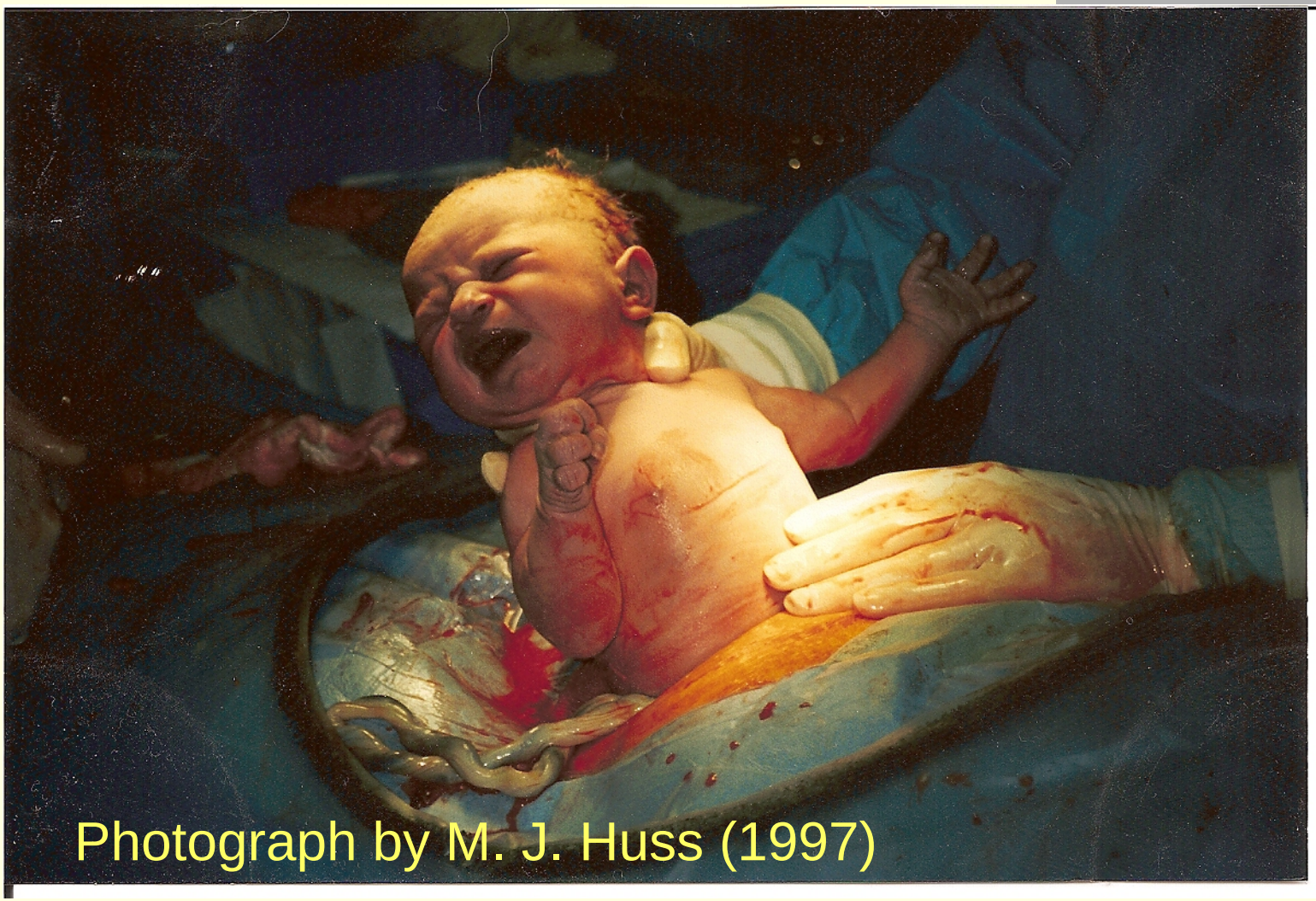

- A 28 day old embryo (upper photograph) and a 33 day old embryo (lower photograph) has a head, tail, backbone and limb buds - which will eventually become arms and legs. The beginnings of ears and eyes are also visible. The heart is already beating, and the other organs are forming fast. An umbilical cord starts to grow between the embryo and the placenta.

# Forelimbs & Hindlimbs of an Embryo




- Most embryos that are 44 postovulatory days old measure 13-17 mm in length. Note evidence of distinct notching in the hand plate of the forelimbs.

# Full term baby born via Caesarian-Section (note presence of two fully developed forelimbs)

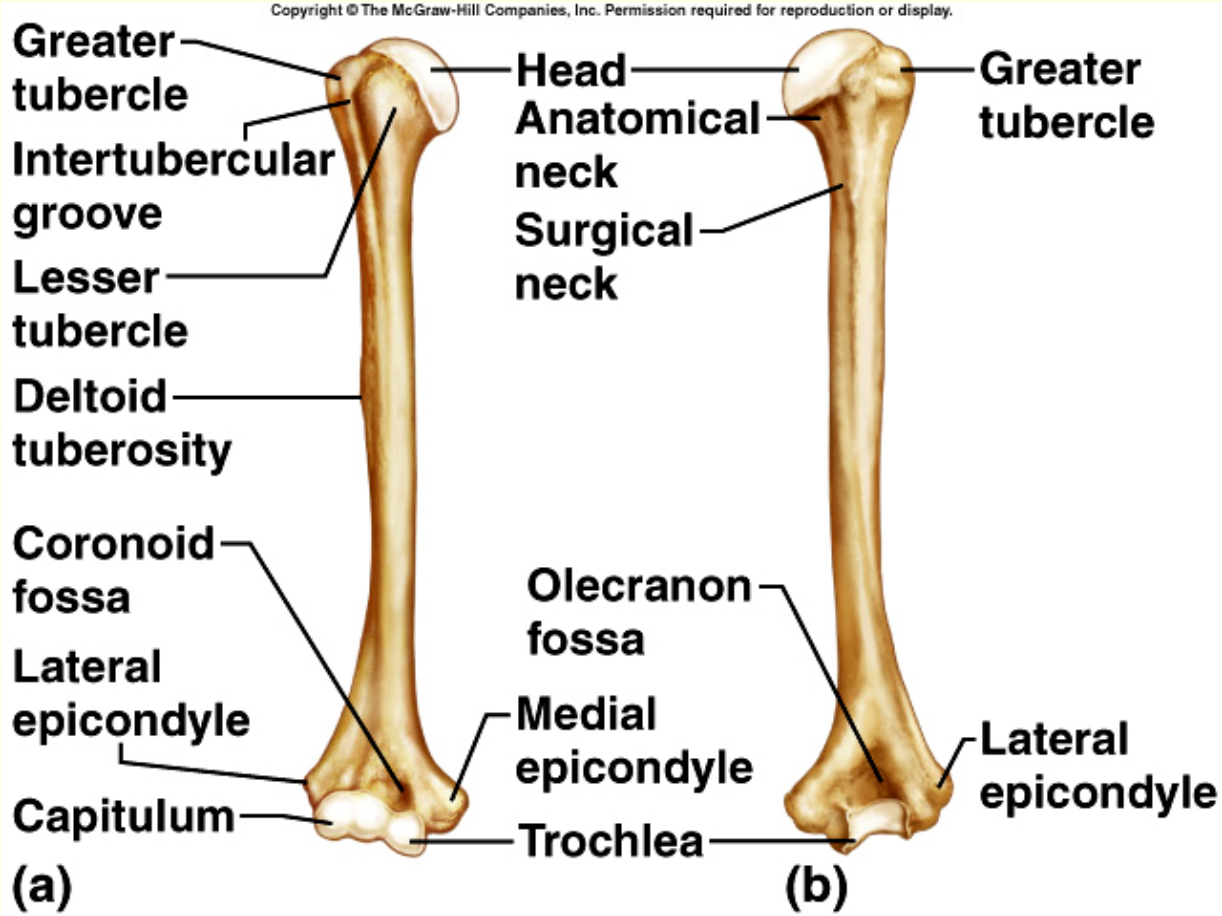


# Child born with extra Forelimb

- Chinese baby born with three Arms: The child pictured is shown at 2 months of age. The extra appendage was removed surgically)
- **See story available online at http://edition.cnn.com/2006/WORLD/asiapcf/06/06/third.arm/**

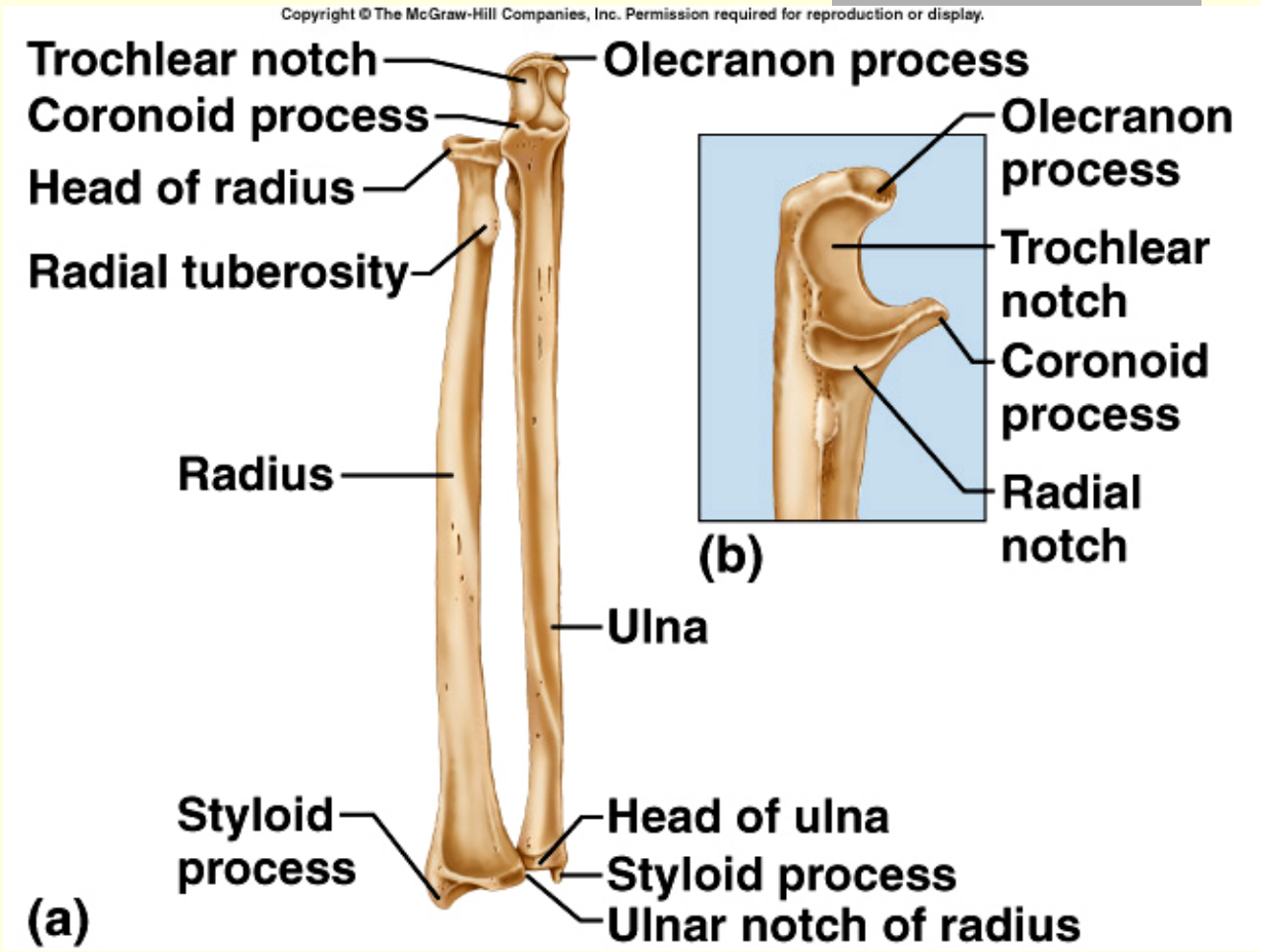
# Humerus

- head
- greater tubercle
- lesser tubercle
- anatomical neck
- surgical neck
- deltoid tuberosity
- capitulum
- trochlea
- coronoid fossa
- olecranon fossa



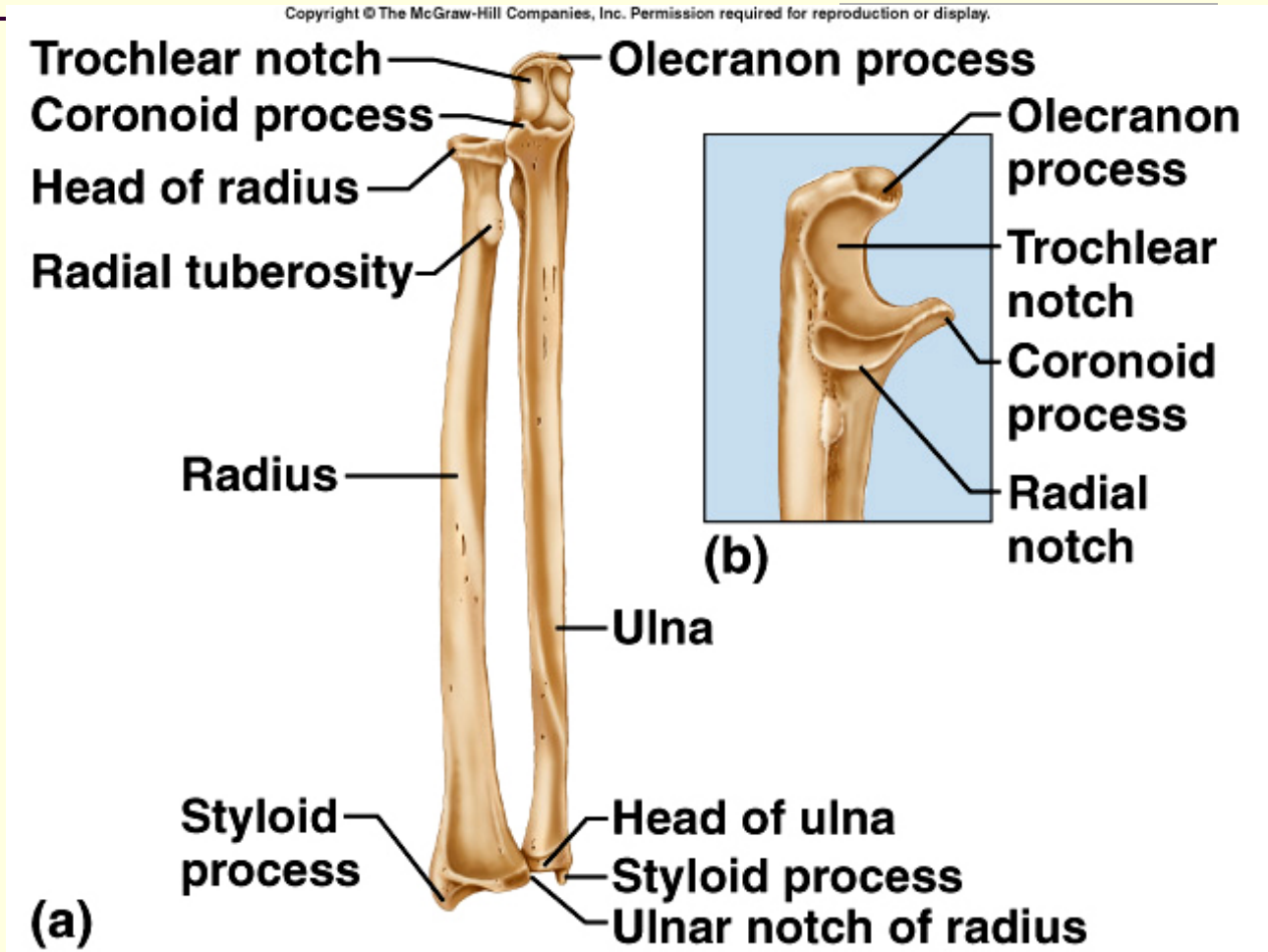
# Radius

- lateral forearm bone
- head
- radial tuberosity
- styloid process



# Ulna

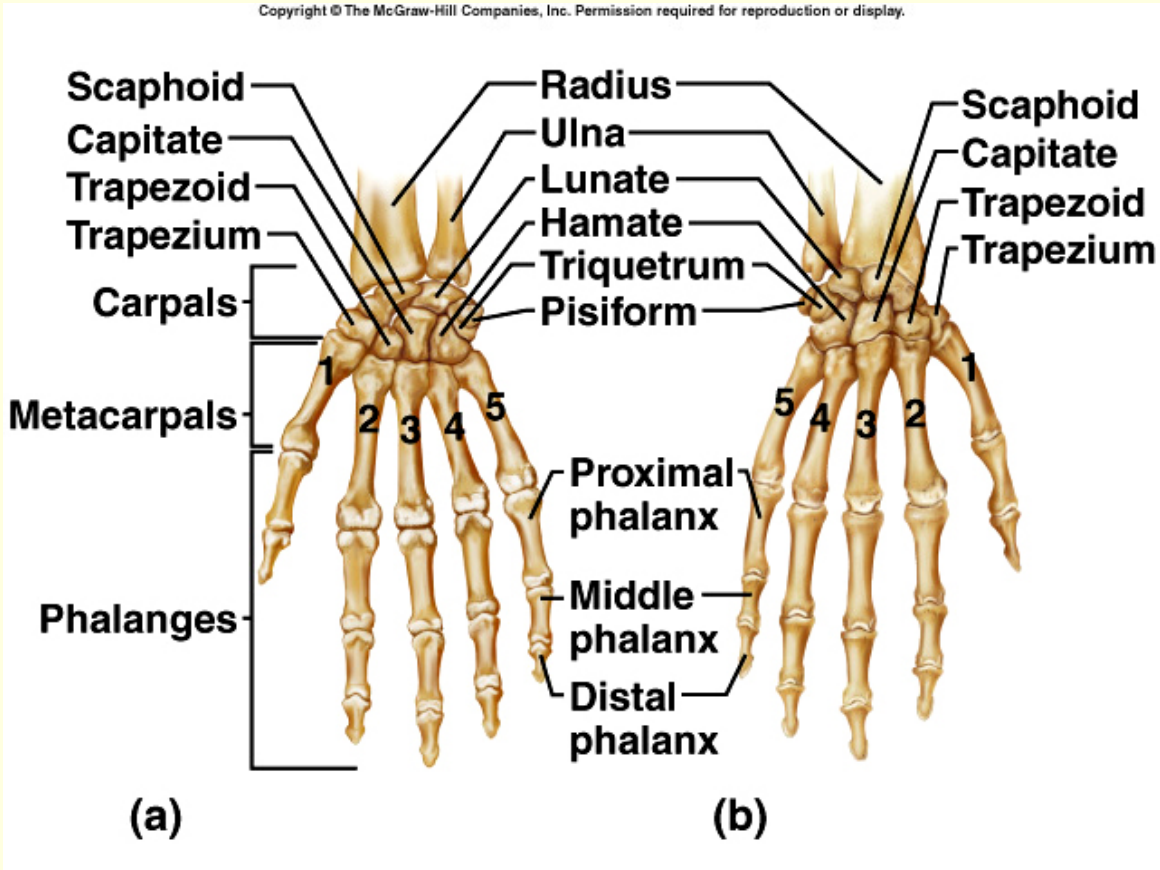
- medial forearm bone
- trochlear notch
- olecranon process
- coronoid process
- styloid process



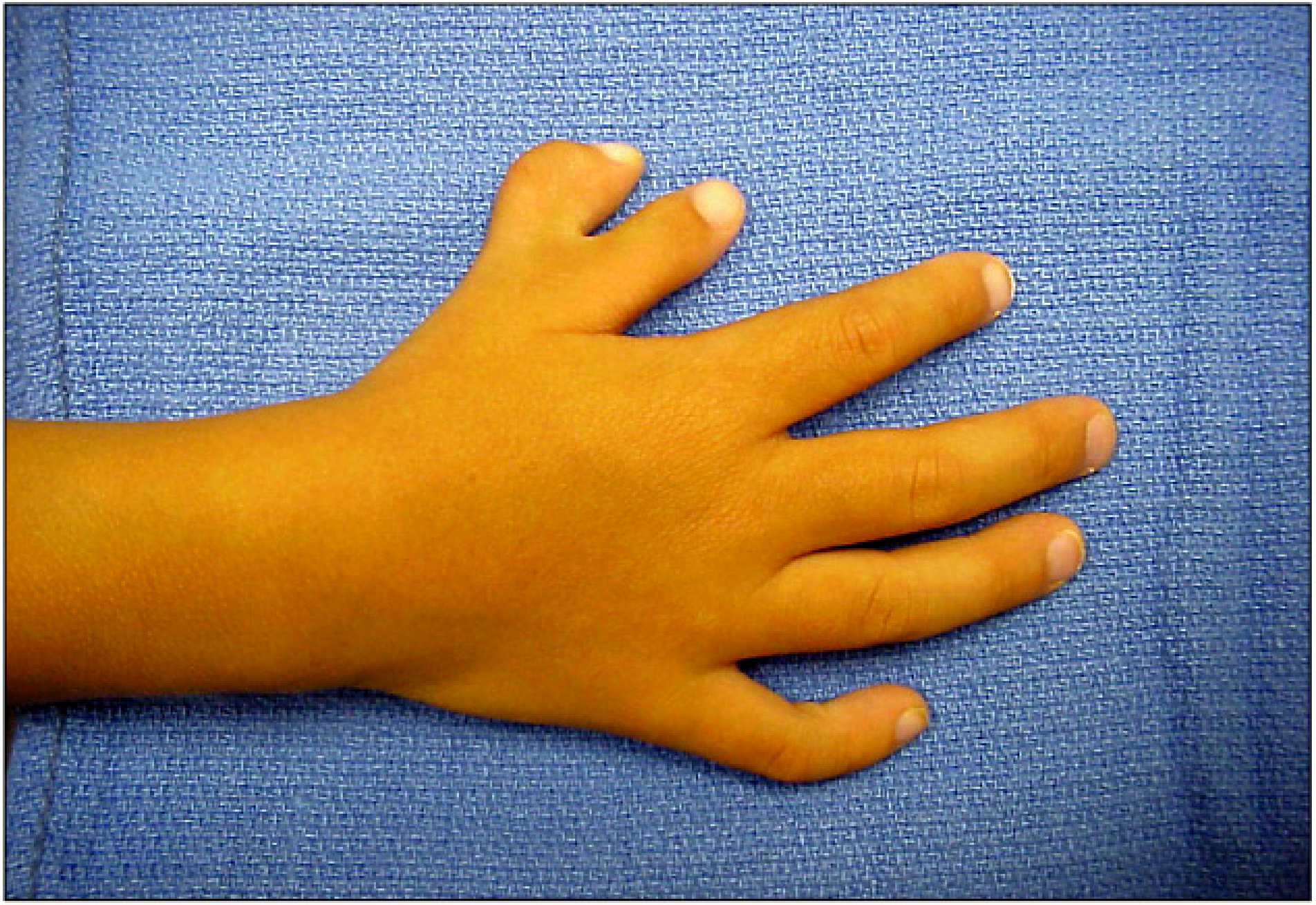
(d)

# Wrist and Hand

- **Carpals** (16)
  - trapezium
  - trapezoid
  - capitate
  - scaphoid
  - pisiform
  - triquetrum
  - hamate
  - lunate
- **Metacarpals** (10)
- **Phalanges** (28)
  - proximal phalanx
  - middle phalanx
  - distal phalanx



(c)

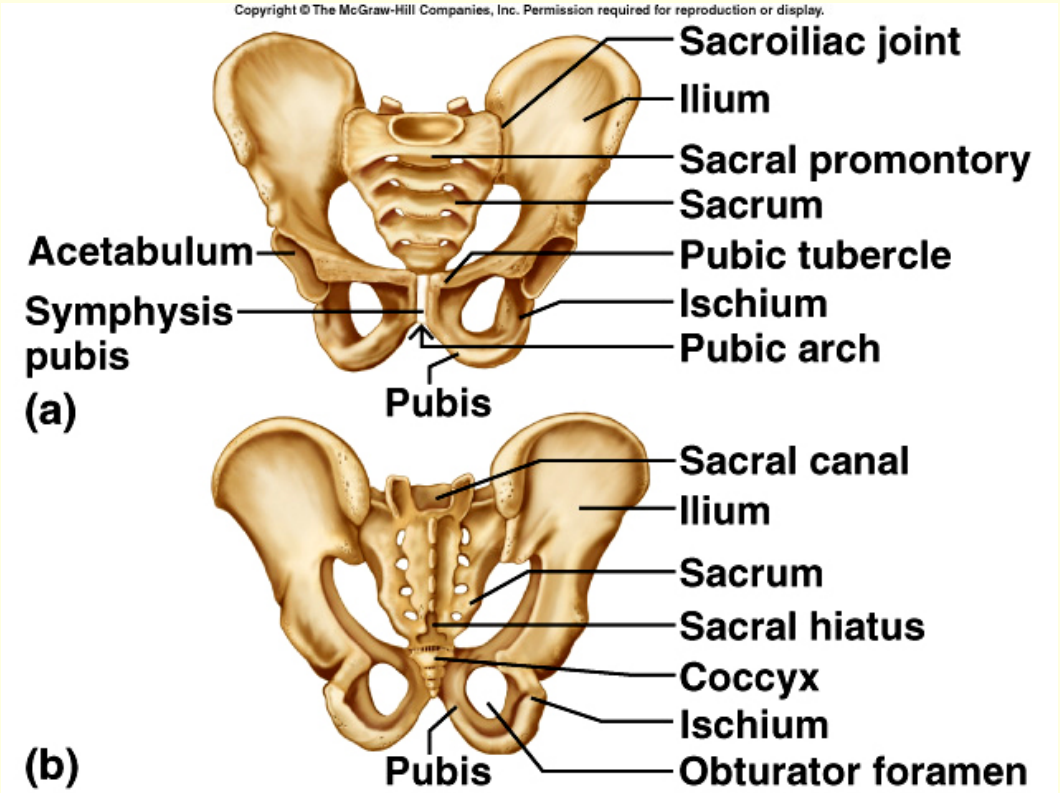


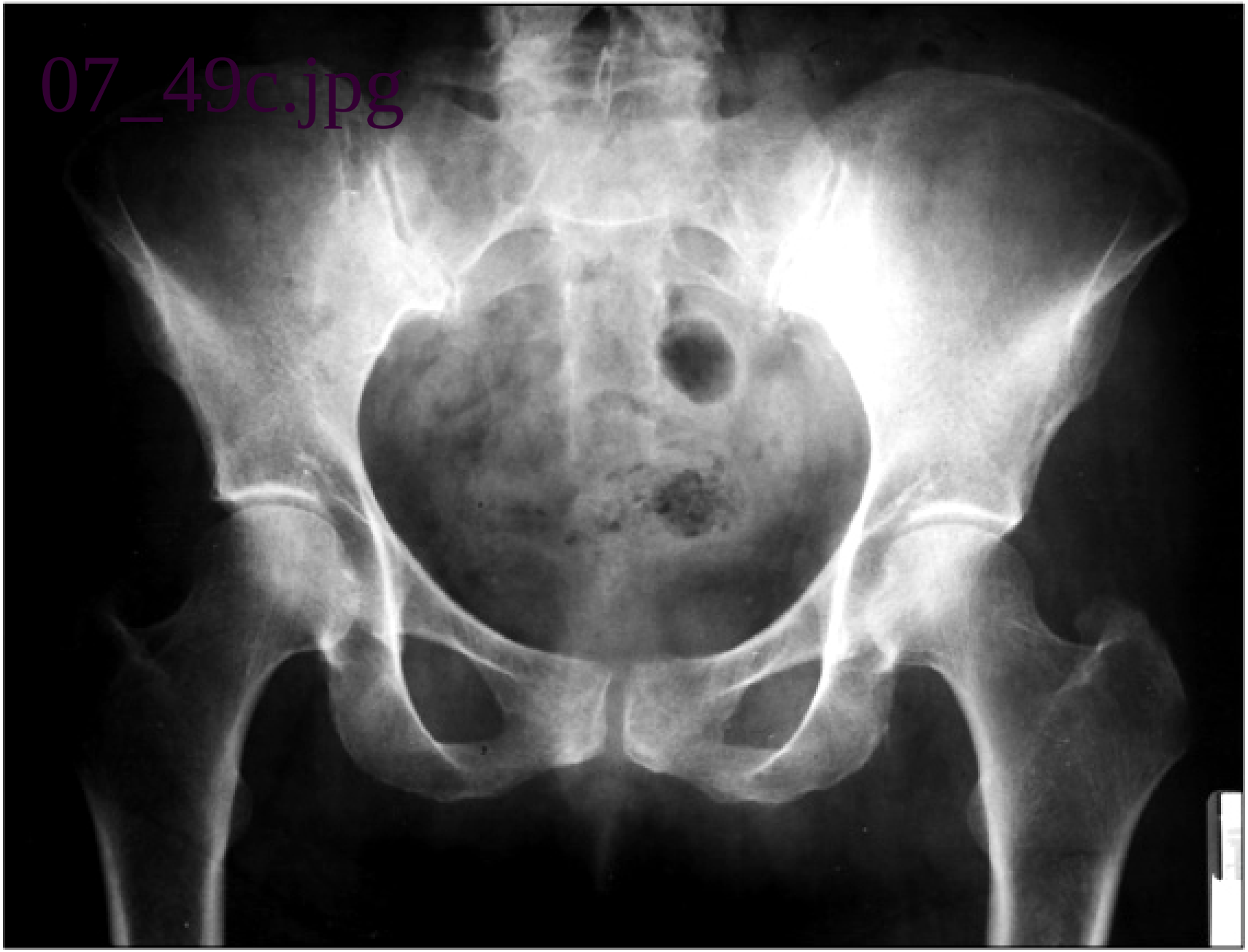
## TABLE 7.12 Bones of the Pelvic Girdle and Lower Limbs

| Name and Number | Location | Special Features |
|---|---|---|
| Coxa (2) | Hip, articulating with the other coxa anteriorly and with the sacrum posteriorly | Ilium, iliac crest, anterior superior iliac spine, ischium, ischial tuberosity, ischial spine, obturator foramen, acetabulum, pubis |
| Femur (2) | Thigh, between hip and knee | Head, fovea capitis, neck, greater trochanter, lesser trochanter, linea aspera, lateral condyle, medial condyle, gluteal tuberosity, intercondylar fossa |
| Patella (2) | Anterior surface of knee | A flat sesamoid bone located within a tendon |
| Tibia (2) | Medial side of leg, between knee and ankle | Medial condyle, lateral condyle, tibial tuberosity, anterior crest, medial malleolus, intercondylar eminence |
| Fibula (2) | Lateral side of leg, between knee and ankle | Head, lateral malleolus |
| Tarsal (14) | Ankle | Freely movable talus that articulates with leg bones; calcaneus that forms the base of the heel; five other tarsal bones bound firmly together |
| Metatarsal (10) | Instep | One in line with each toe, arranged and bound by ligaments to form arches |
| Phalanx (28) | Toe | Three in each toe, two in great toe |

# Pelvic Girdle

- Coxae (2)
- supports trunk of body
- protects viscera






(c)

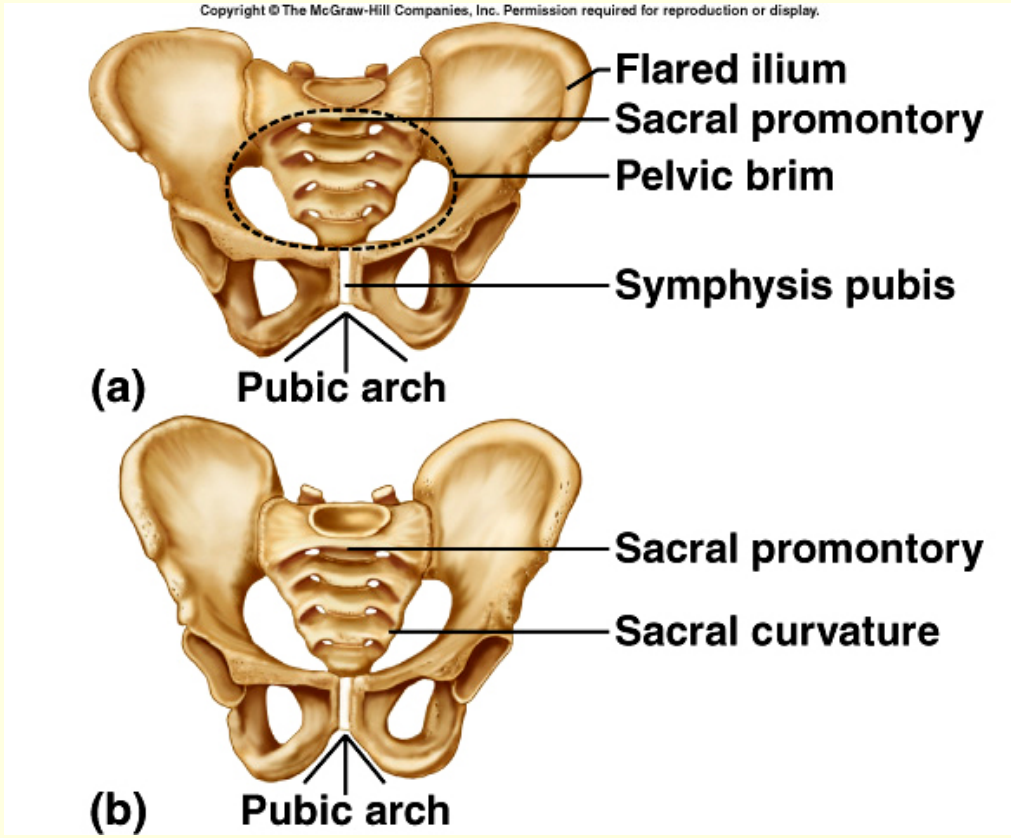
# Greater and Lesser Pelvis

**Greater Pelvis**

- lumbar vertebrae posteriorly
- iliac bones laterally
- abdominal wall anteriorly

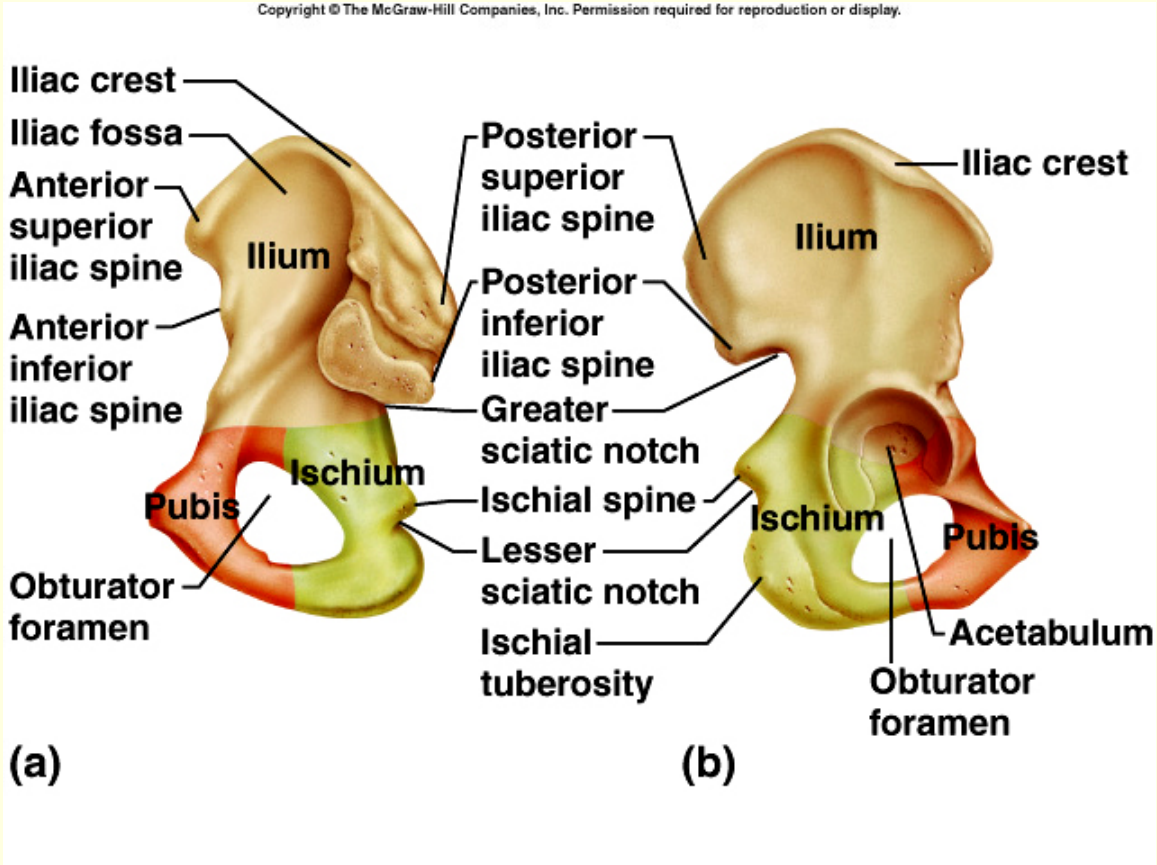
**Lesser Pelvis**

- sacrum and coccyx posteriorly
- lower ilium, ischium, and pubis bones laterally and anteriorly



# Coxae

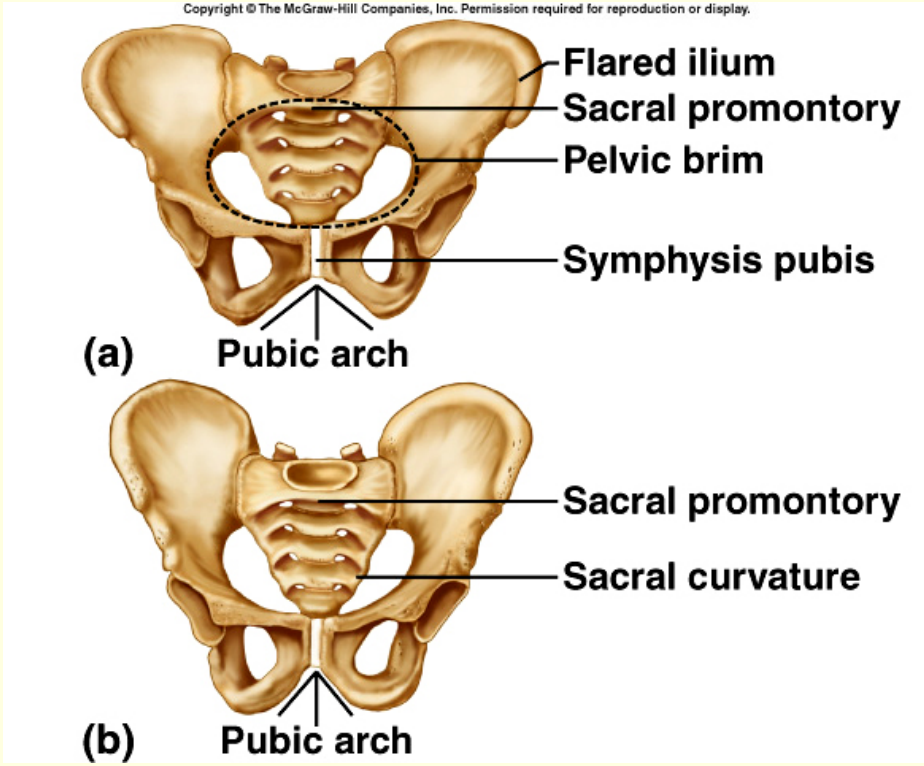
- hip bones
- ilium
  - iliac crest
  - iliac spines
  - greater sciatic notch
- ischium
  - ischial spines
  - lesser sciatic notch
  - ischial tuberosity
- pubis
- obturator foramen
- acetabulum



# Male and Female Pelvis

**Female**

- **iliac bones more flared**
- **broader hips**
- **pubic arch angle greater**
- **more distance between ischial spine and ischial tuberosity**
- **sacral curvature shorter and flatter**
- **lighter bones**



## TABLE 7.11 Differences Between the Male and Female Skeletons

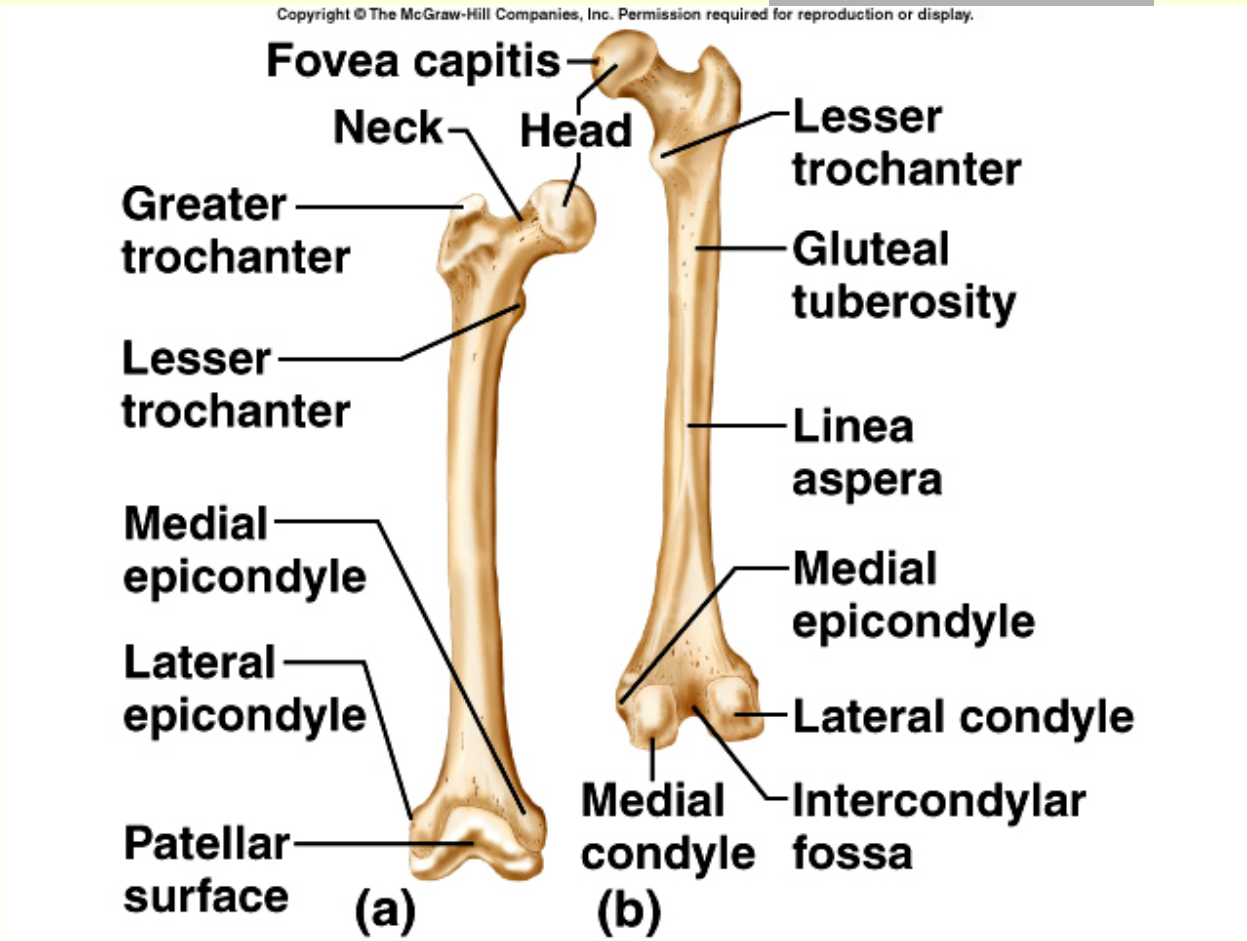
| Part | Differences |
|---|---|
| Skull | Male skull is larger and heavier, with more conspicuous muscular attachments. Male forehead is shorter, facial area is less round, jaw larger, and mastoid processes and supraorbital ridges more prominent than those of a female. |
| Pelvis | Male pelvic bones are heavier, thicker, and have more obvious muscular attachments. The obturator foramina and the acetabula are larger and closer together than those of a female. |
| Pelvic cavity | Male pelvic cavity is narrower in all diameters and is longer, less roomy, and more funnel-shaped. The distances between the ischial spines and between the ischial tuberosities are less than in a female. |
| Sacrum | Male sacrum is narrower, sacral promontory projects forward to a greater degree, and sacral curvature is bent less sharply posteriorly than in a female. |
| Coccyx | Male coccyx is less movable than that of a female. |

# Lower Limb

- Femur
- Patella
- Tibia
- Fibula
- Tarsals
- Metatarsals
- Phalanges

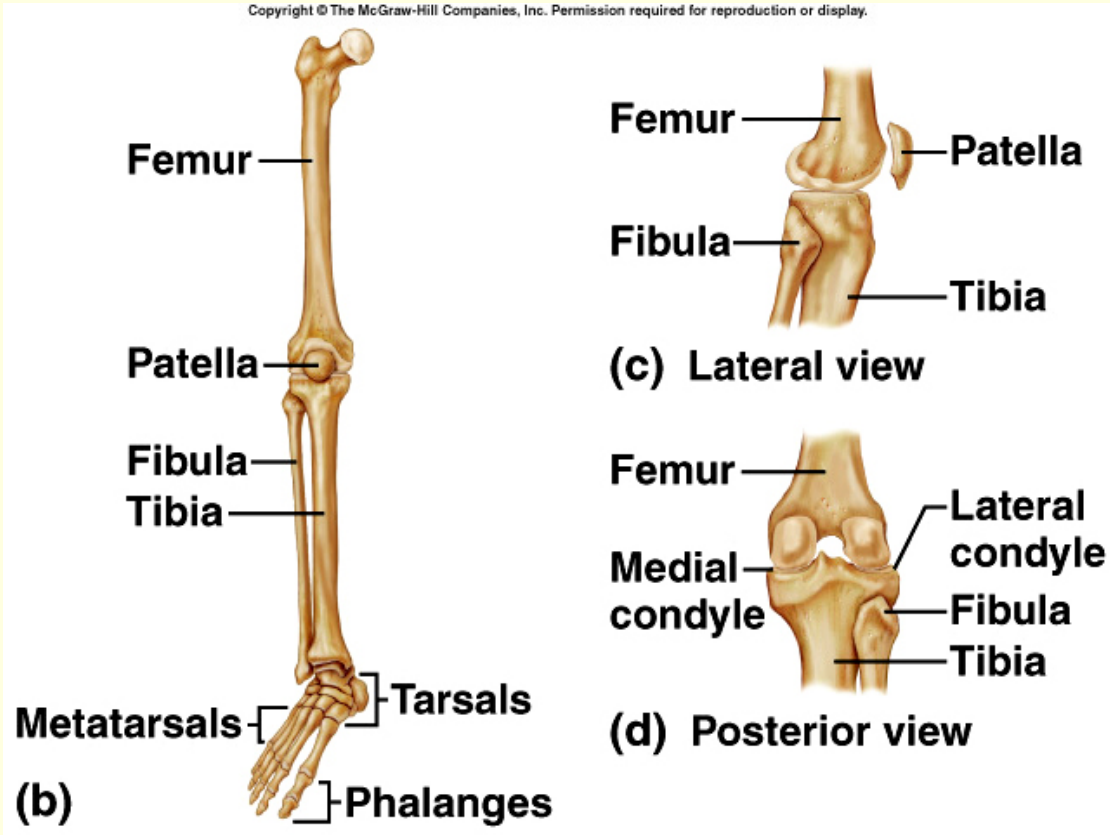
# Femur

- longest bone of body
- head
- fovea capitis
- neck
- greater trochanter
- lesser trochanter
- linea aspera
- condyles
- epicondyles



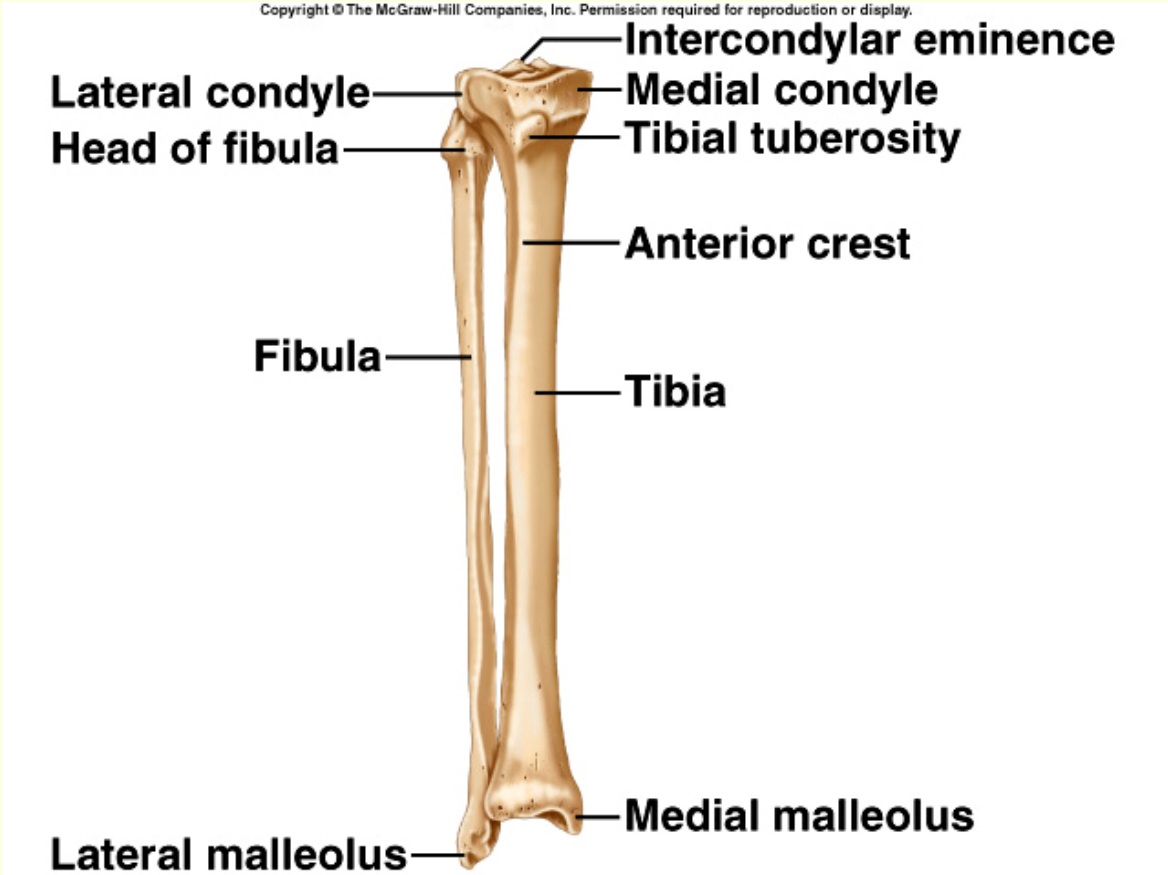
# Patella

- kneecap
- anterior surface of knee
- flat sesmoid bone located in a tendon



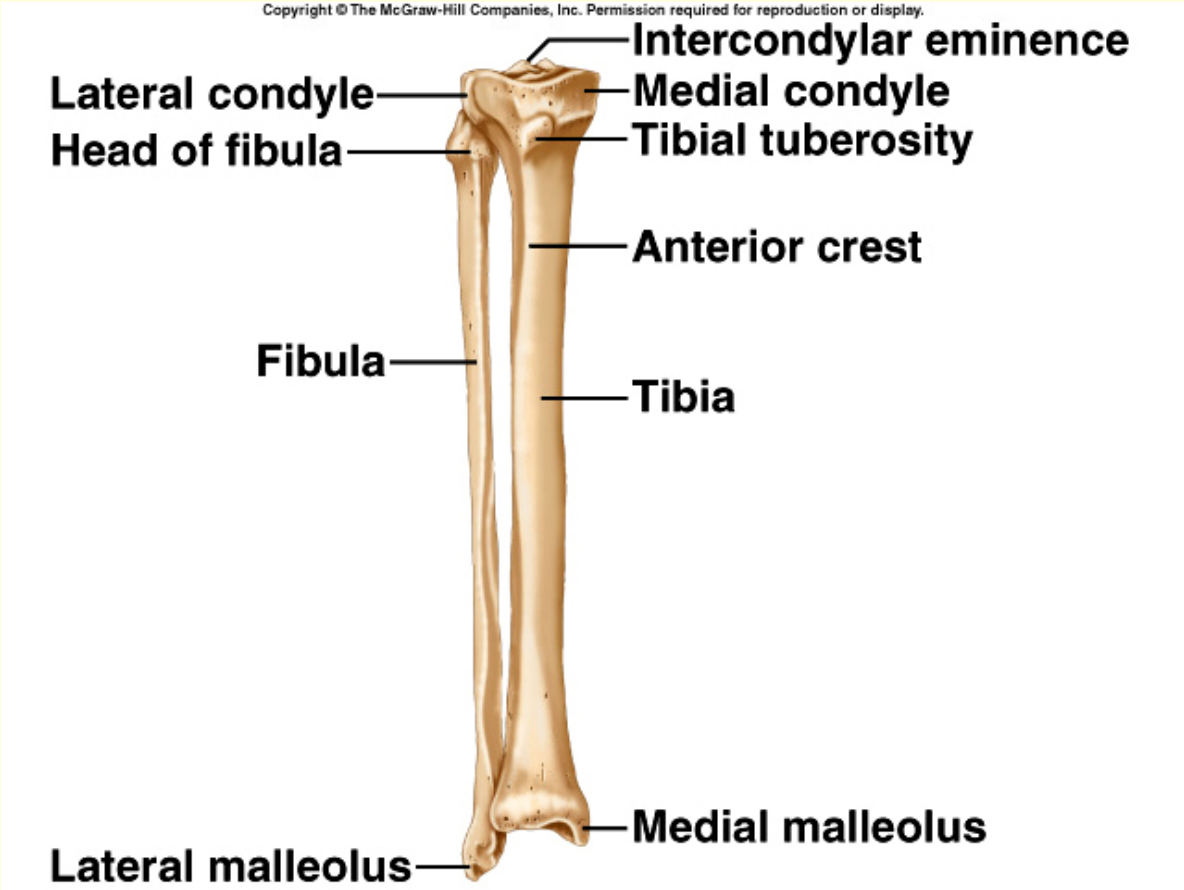
# Tibia

- shin bone
- medial to fibula
- condyles
- tibial tuberosity
- anterior crest
- medial malleolus



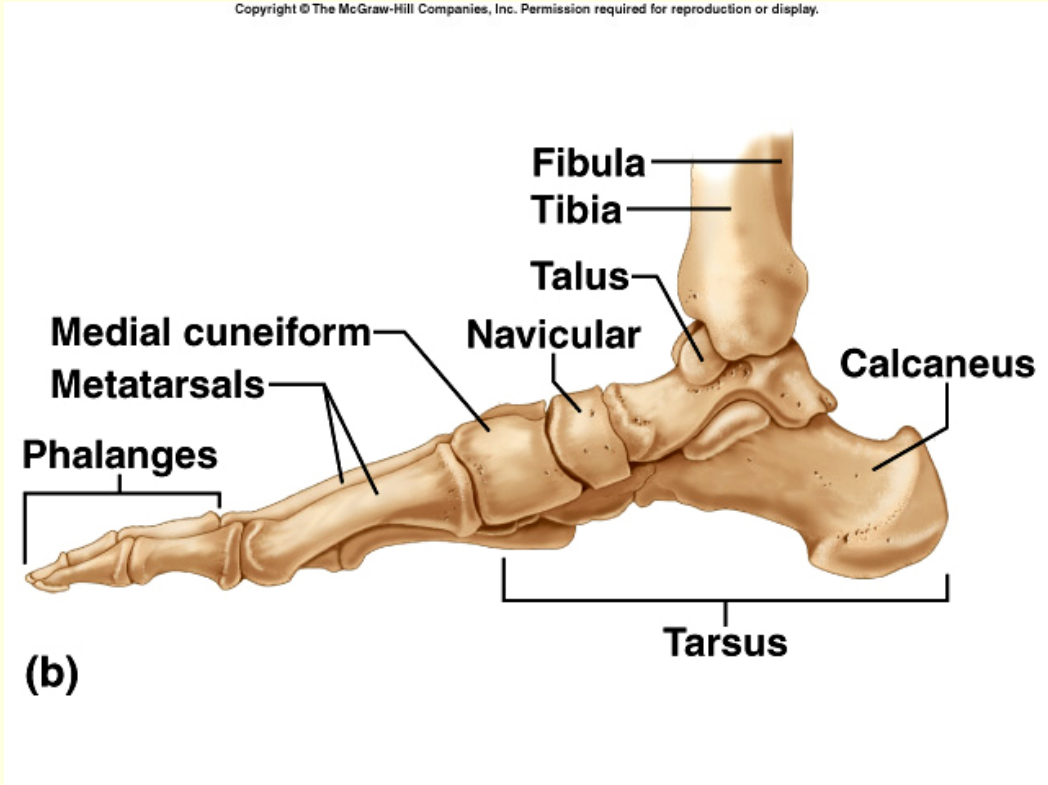
# Fibula

- lateral to tibia
- long, slender
- head
- lateral malleolus
- does not bear any body weight



# Ankle and Foot

- **Tarsals** (14)
  - calcaneus
  - talus
  - navicular
  - cuboid
  - lateral cuneiform
  - intermediate cuneiform
  - medial cuneiform
- **Metatarsals** (10)
- **Phalanges** (28)
  - proximal
  - middle
  - distal

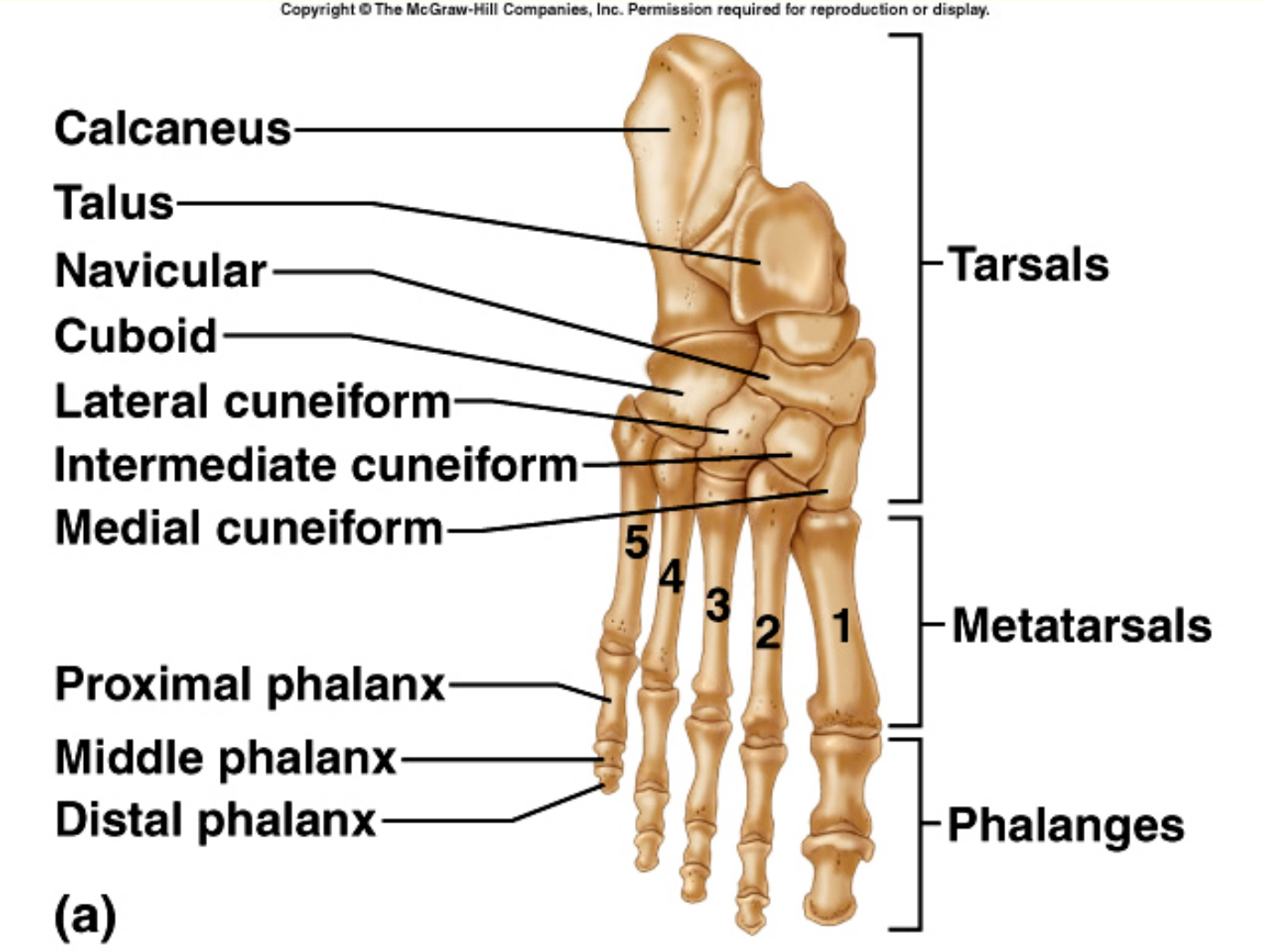


# X-ray photograph of the foot



(a)

# Ankle and Foot



# X-ray photograph of the foot



(b)

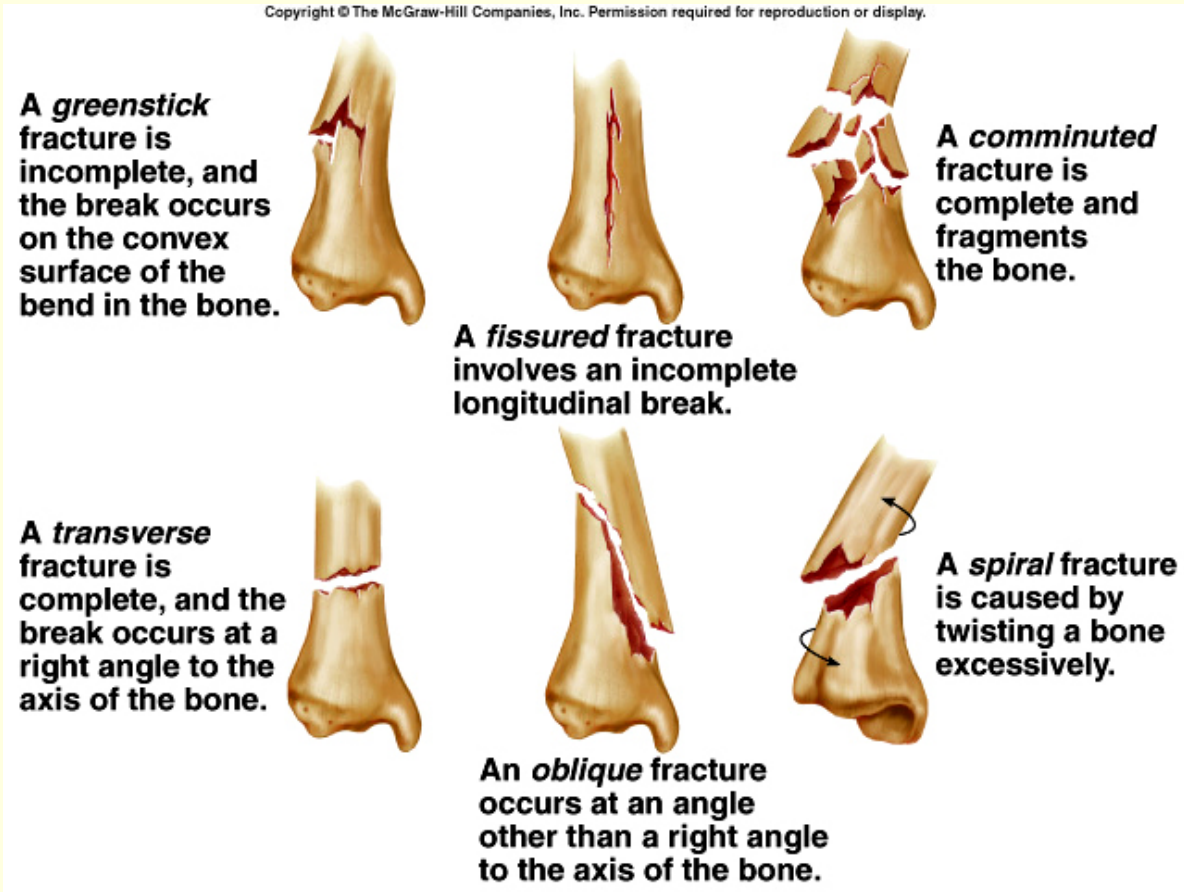
# Life-Span Changes

- decrease in height at about age 30
- calcium levels fall
- bones become brittle
- osteoclasts outnumber osteoblasts
- spongy bone weakens before compact bone
- bone loss rapid in menopausal women
- hip fractures common
- vertebral compression fractures common

# Clinical Application

## Types of Fractures

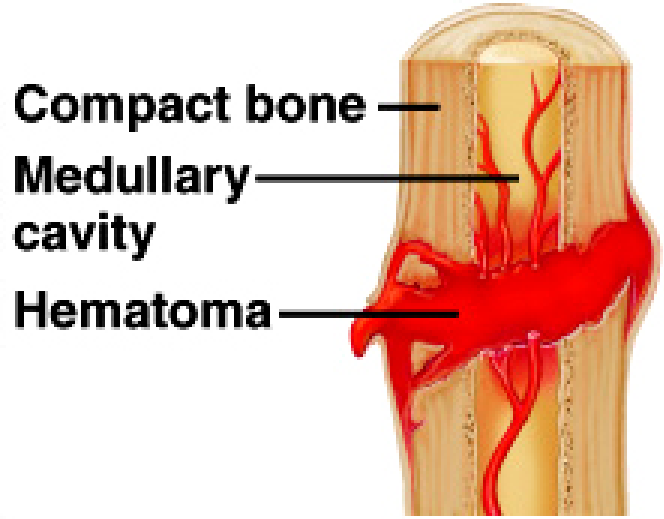
- green stick
- fissured
- comminuted
- transverse
- oblique
- spiral



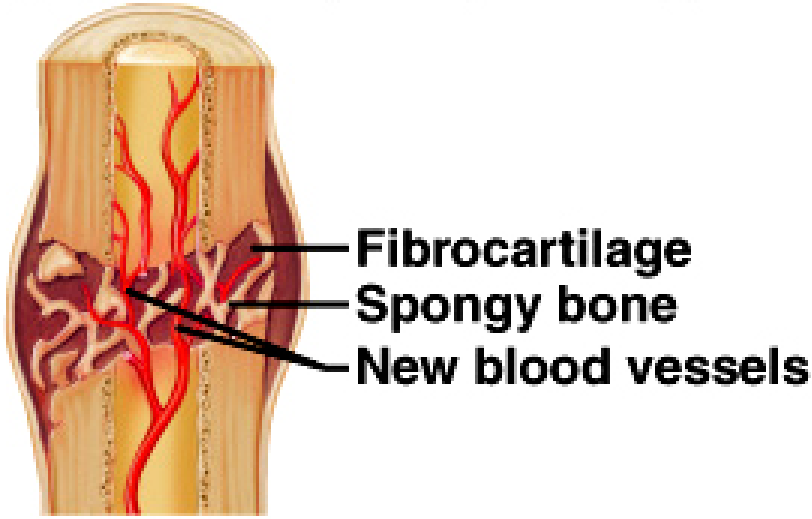
**X-radiograph of a broken humerus**

**Shoulder Spica -** A cast of fiber glass or plaster that includes the entire torso and an entire arm. Used to treat fractures of the humerus or extreme fractures of the shoulder bones.

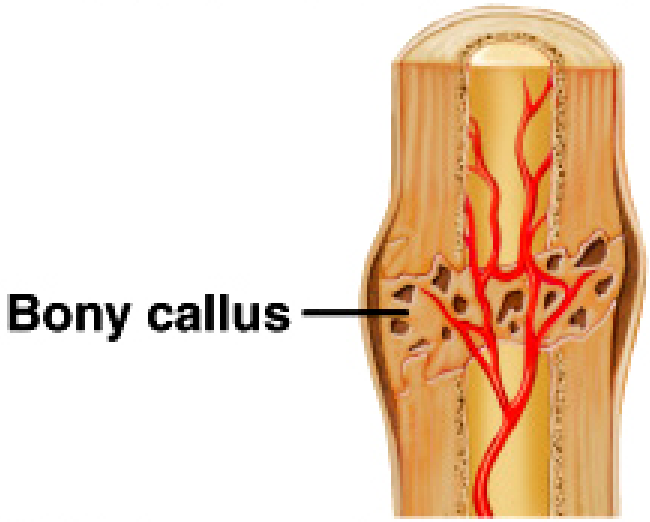
*Spica – Origin L, an ear, as of corn. A kind of bandage passing, by successive turns and crosses, from an extremity to the trunk; so called from its resemblance to a spike of a barley.*



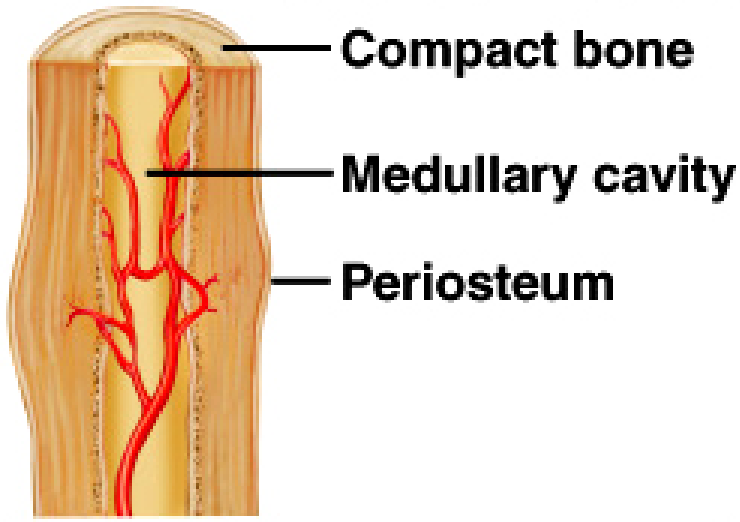

(a) Blood escapes from ruptured blood vessels and forms a hematoma.




(b) Spongy bone forms in regions close to developing blood vessels, and fibrocartilage forms in more distant regions.




(c) A bony callus replaces fibrocartilage.




(d) Osteoclasts remove excess bony tissue, restoring new bone structure much like the original.

# TABLE 7.13 Reasons for Falls Among the Elderly

- Overall frailty
- Decreased muscle strength
- Decreased coordination
- Side effects of medication
- Slowed reaction time due to stiffening joints
- Poor vision and/or hearing
- Disease (cancer, infection, arthritis)

# Clinical Terms Related to the Skeletal System

- Review terms in left column on page 232 in the textbook.