

The Skeletal System

- overview of the skeleton
- the skull
- the vertebral column and thoracic cage
- the pectoral girdle and upper limb
- the pelvic girdle and lower limb

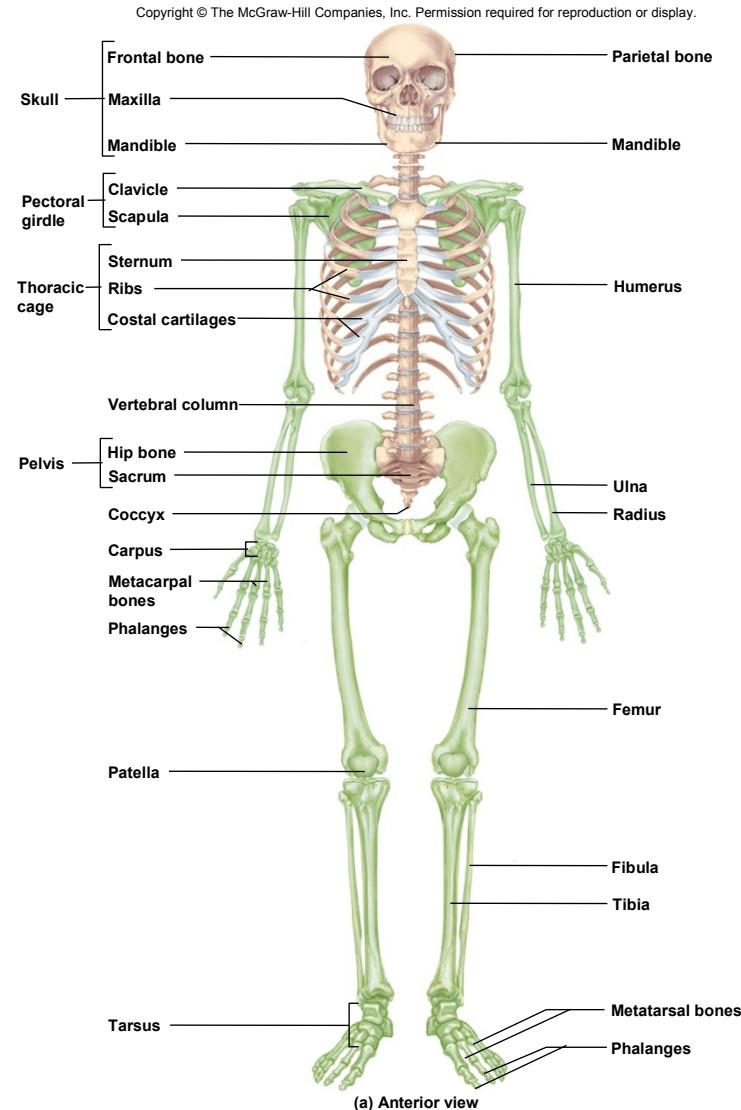
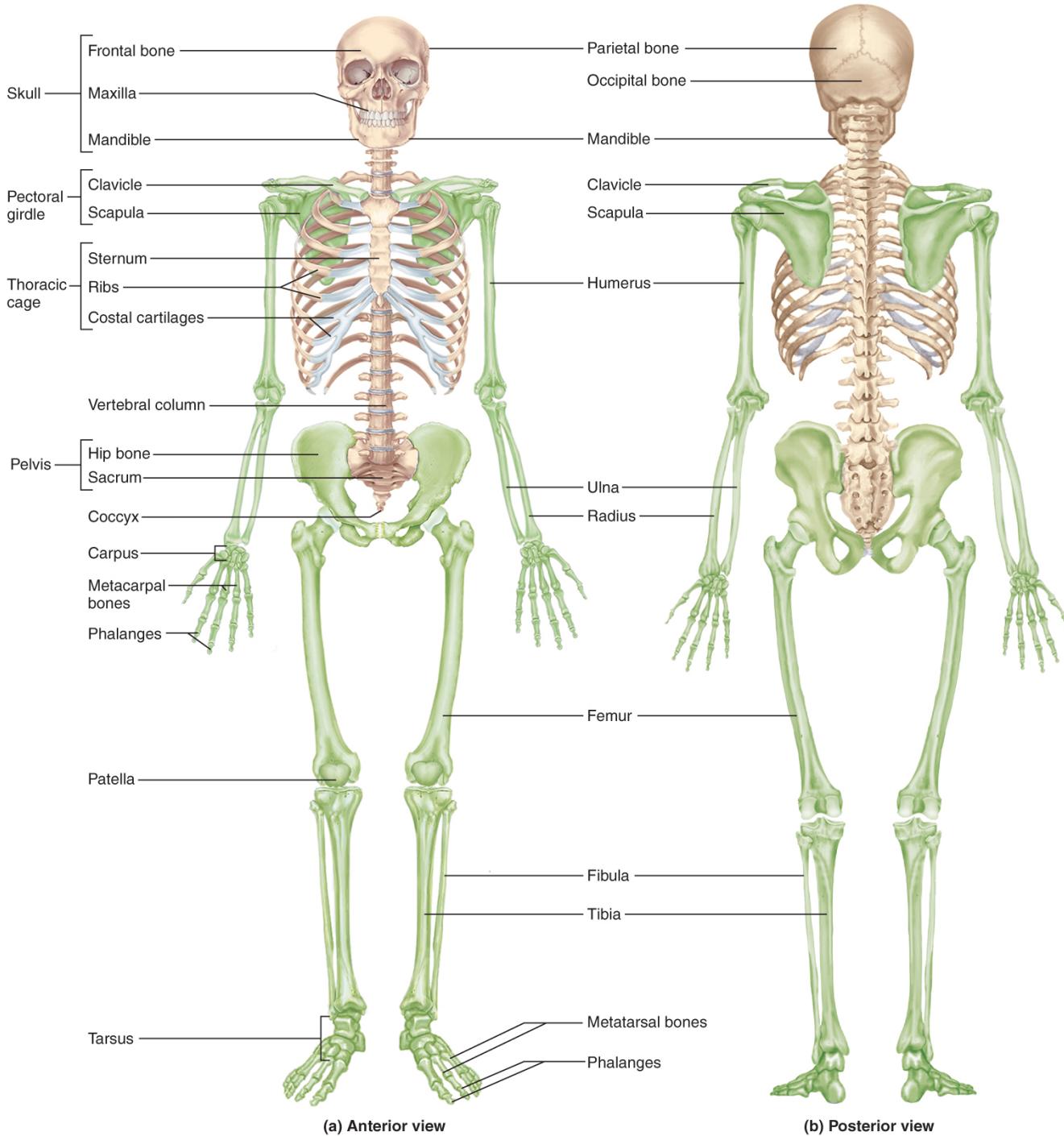


Figure 8.1a

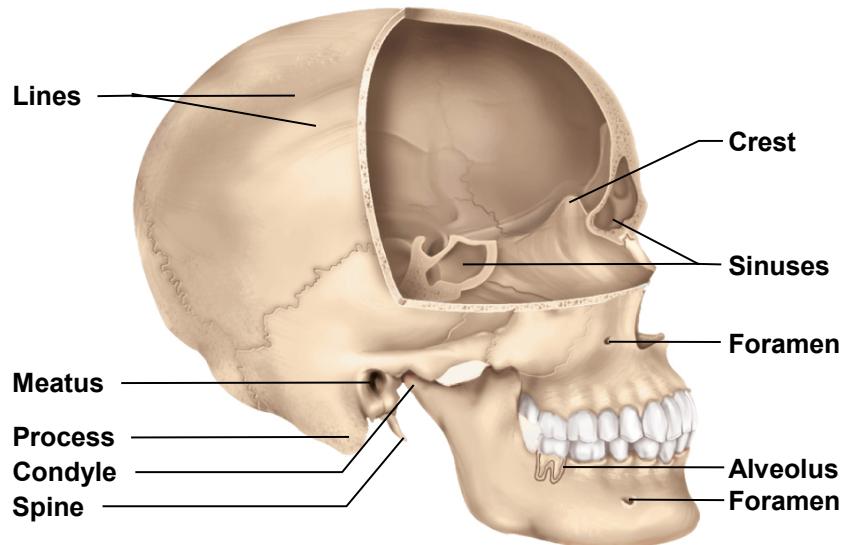
Overview of the Skeleton

- **two regions** of the skeleton
 - **axial skeleton** – forms the central supporting axis of the body
 - skull, auditory ossicles, hyoid bone, vertebral column, and thoracic cage (ribs and sternum)
 - **appendicular skeleton** – includes the bones of the upper limb and pectoral girdle, and the bones of the lower limb and pelvic girdle

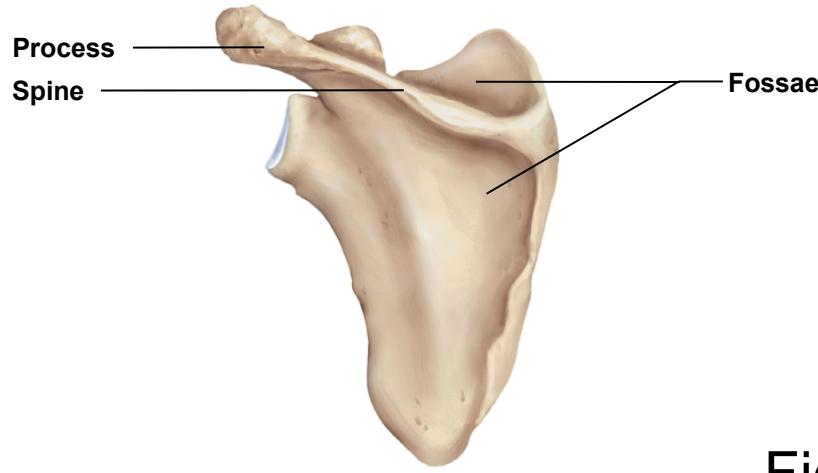


Anatomical Features of Bones

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(a) Skull (lateral view)



(b) Scapula (posterior view)

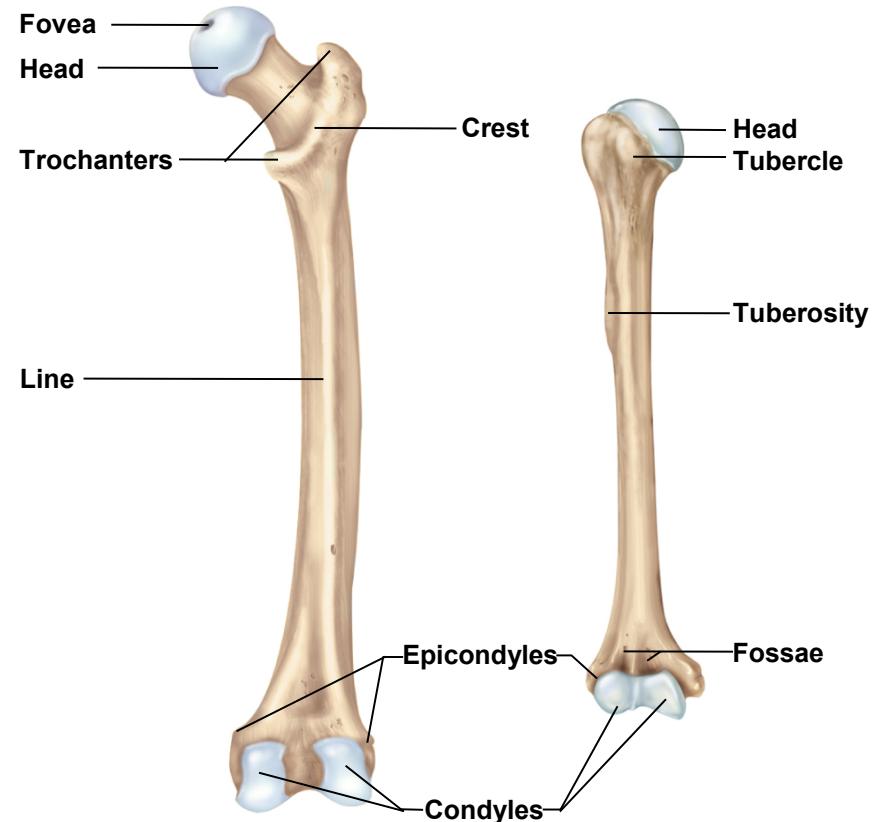


Figure 8.2

(c) Femur
(posterior view)

(d) Humerus
(anterior view)

The Skull

- **skull** – the most complex part of the skeleton
- **22 bones** joined together by **sutures** (immovable joints)
- **8 cranial bones** surround **cranial cavity** which encloses the **brain**
- **other cavities** – orbits, nasal cavity, oral (buccal) cavity, middle-, and inner ear cavities, and paranasal sinuses
- **paranasal sinuses** – frontal, sphenoid, ethmoid, and maxillary
 - lined by mucous membrane and air-filled
 - lighten the anterior portion of the skull
 - act as chambers that add resonance to the voice
- **foramina** – holes that allow passage for nerves and blood vessels
- **14 facial bones** support teeth, facial and jaw muscles

Major Skull Cavities

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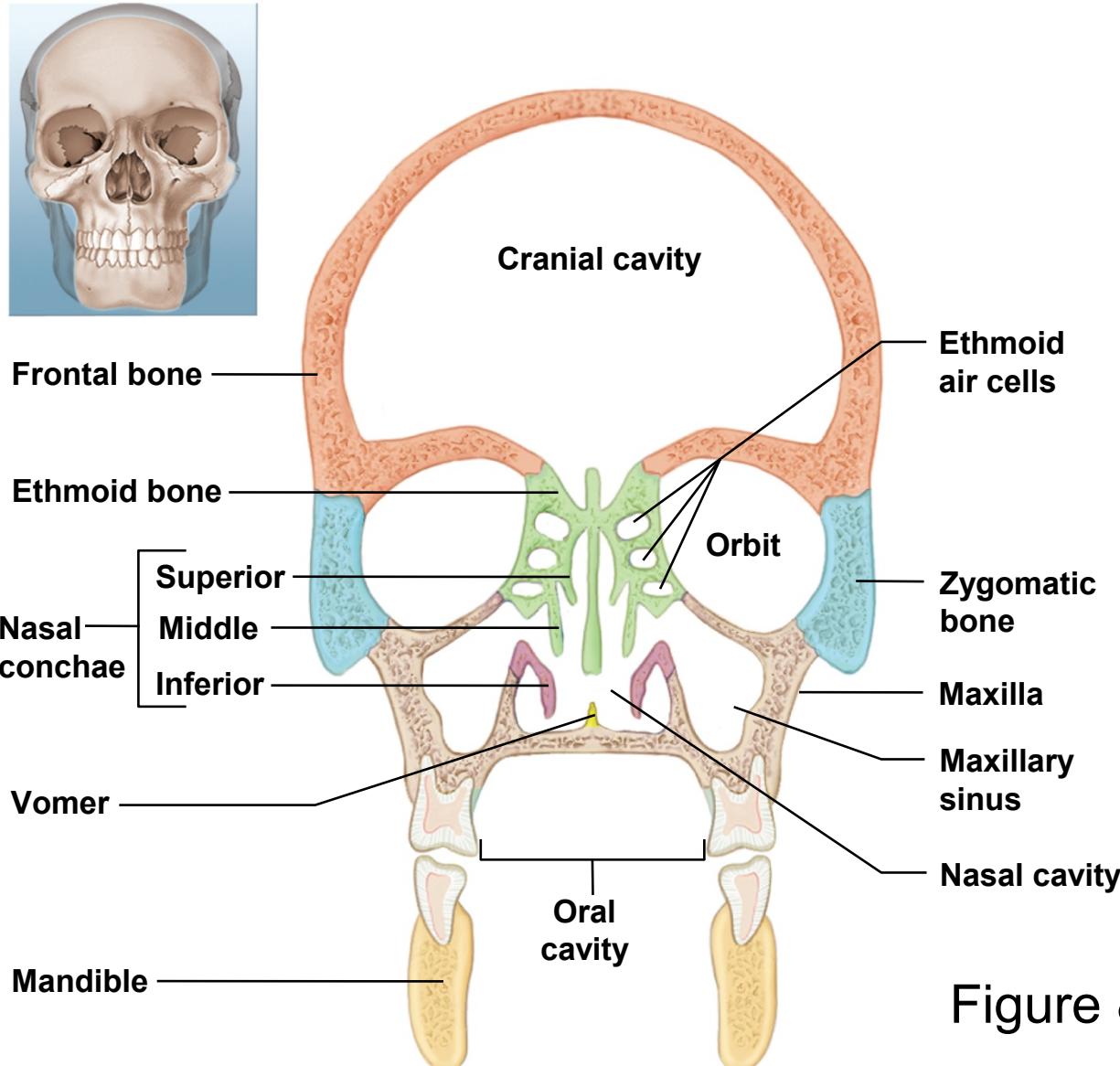
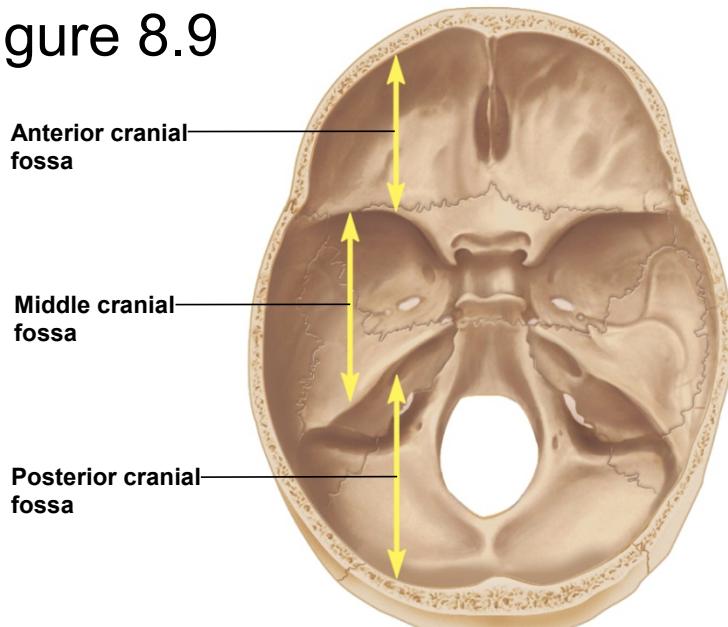


Figure 8.7

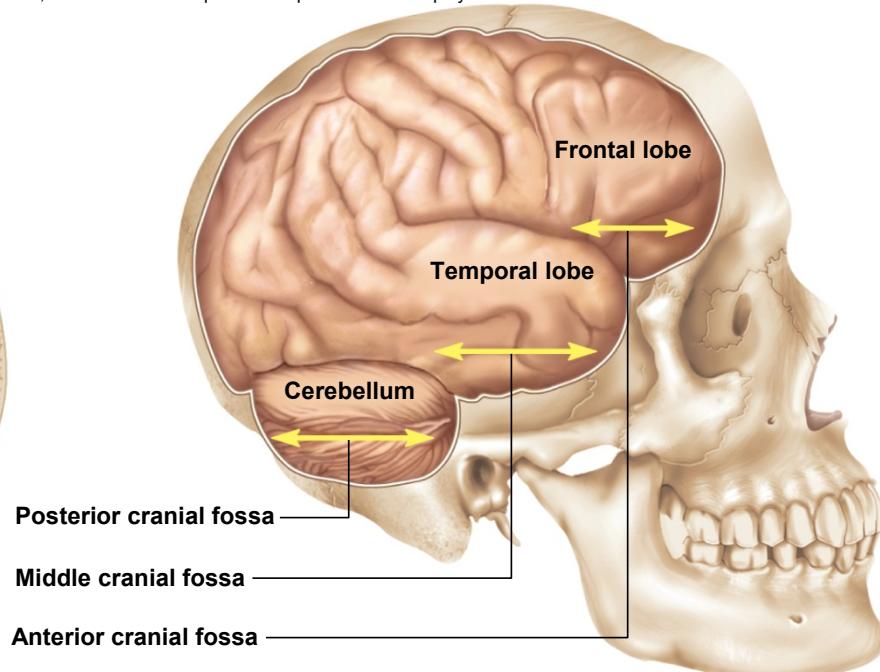
Cranial Fossa

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Figure 8.9



(a) Superior view



(b) Lateral view

- **cranium (braincase)** – protects the brain and associated sense organs
 - swelling of the brain inside the rigid cranium may force tissue through foramen magnum resulting in death
- **base** is divided into three basins that comprise the cranial floor
 - **anterior cranial fossa** holds the frontal lobe of the brain
 - **middle cranial fossa** holds the temporal lobes of the brain
 - **posterior cranial fossa** contains the cerebellum

Frontal Bone

- forms **forehead** and part of the roof of the cranium
- **coronal suture** – posterior boundary of frontal bone
- contains **frontal sinus**

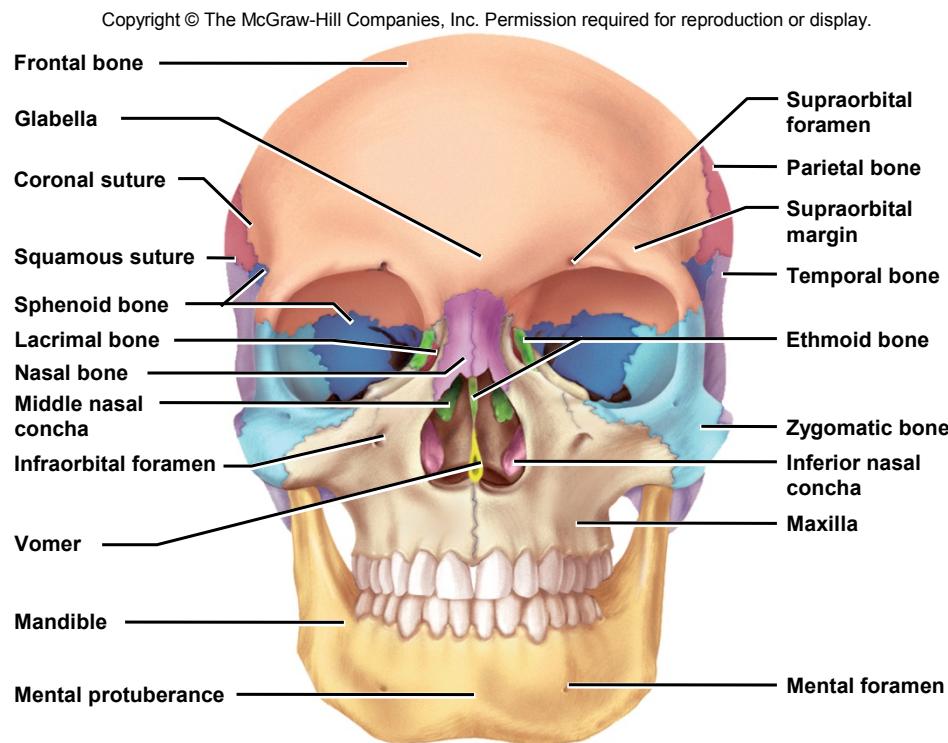


Figure 8.3

Parietal Bone

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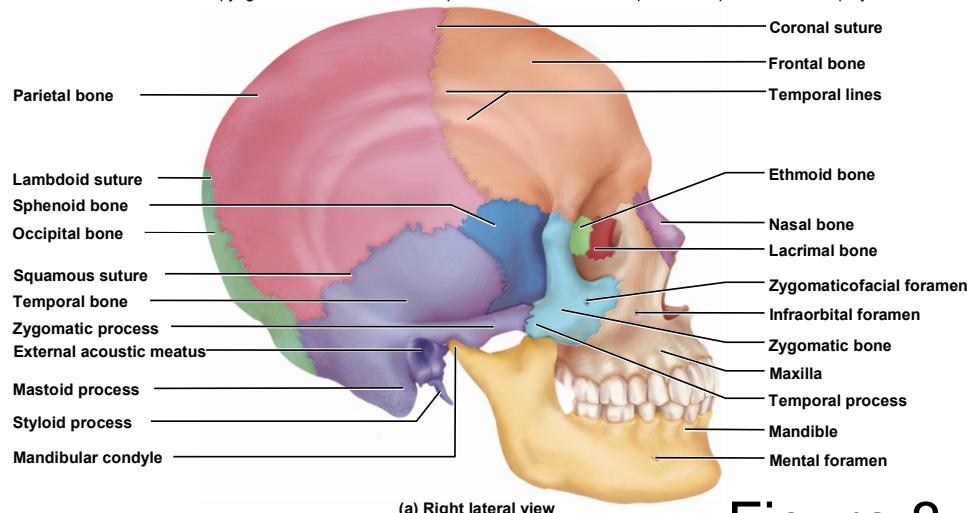


Figure 8.4a

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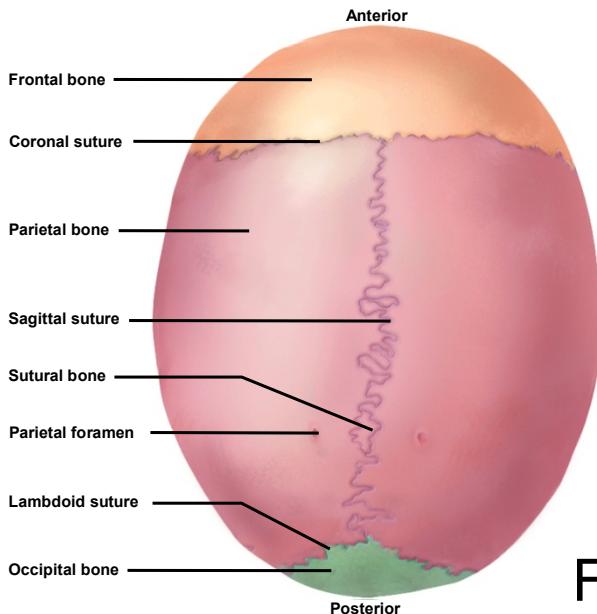


Figure 8.6

- form most of cranial roof and part of its lateral walls
- bordered by 4 sutures
 - **sagittal** – between parietal bones
 - **coronal** – at anterior margin
 - **lambdoid** – at posterior margin
 - **squamous** – at lateral border

Temporal Bone

- lateral wall and part of floor of cranial cavity
 - **squamous part**
 - encircled by squamous suture
 - **zygomatic process**
 - **mandibular fossa**
 - **tympanic part**
 - **external auditory meatus**
 - **styloid process**
 - **mastoid part**
 - **mastoid process**

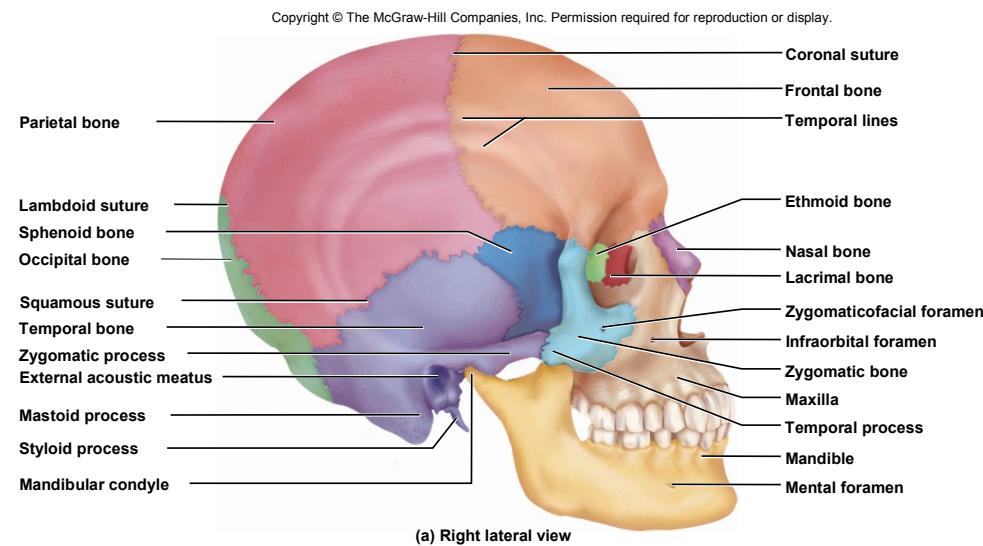


Figure 8.4a

Temporal Bone

- part of cranial floor

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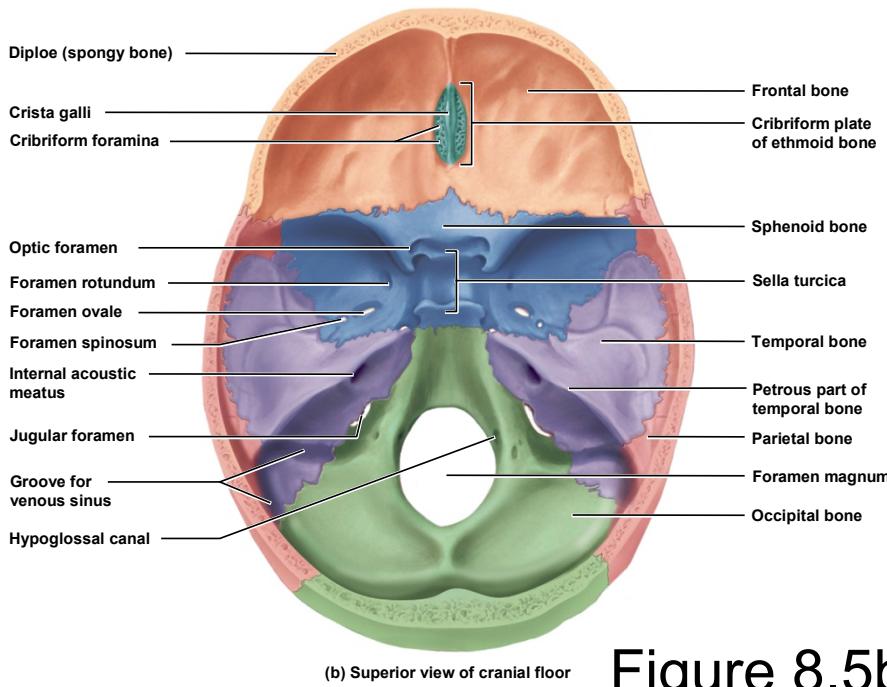


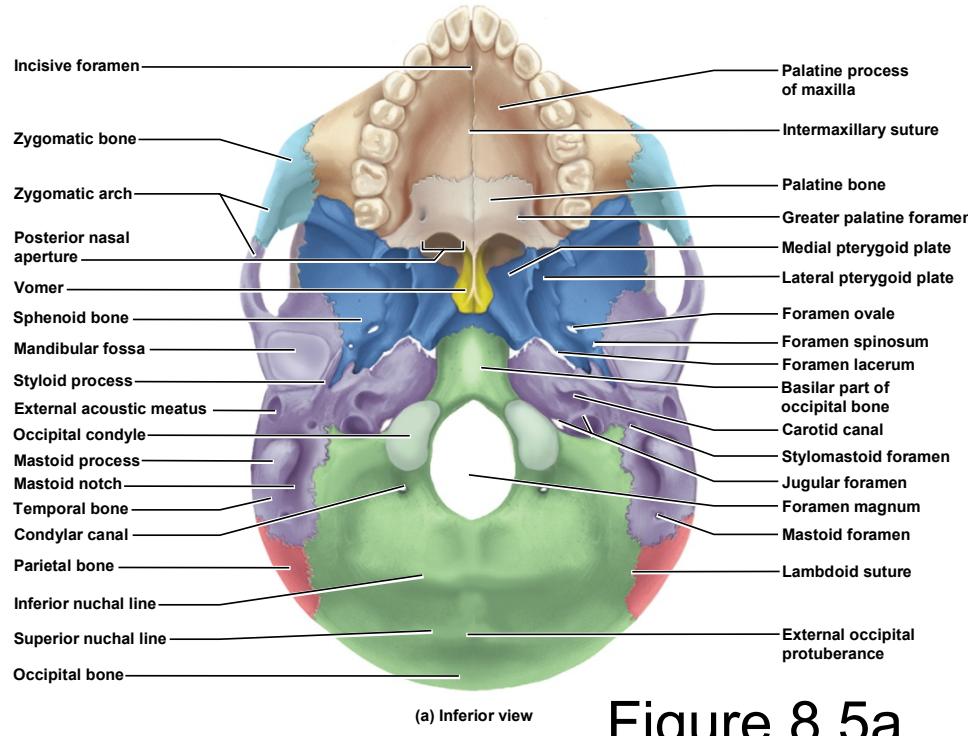
Figure 8.5b

- separates middle from posterior cranial fossa
- houses middle and inner ear cavities
- **internal auditory meatus**

Occipital Bone

- rear and base of skull
- **foramen magnum** holds spinal cord
- skull rests on atlas at **occipital condyles**

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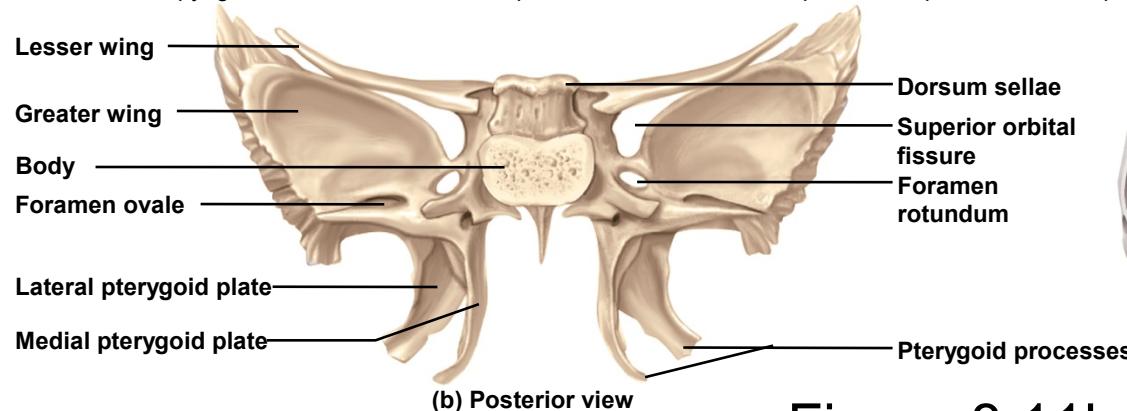


(a) Inferior view

Figure 8.5a

Sphenoid Bone

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- **optic foramen**

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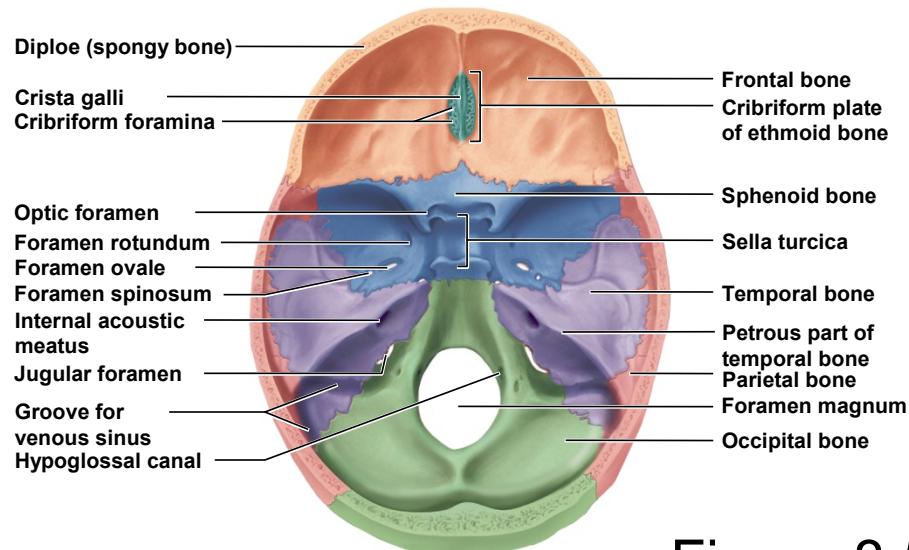


Figure 8.5b

Sphenoid Bone

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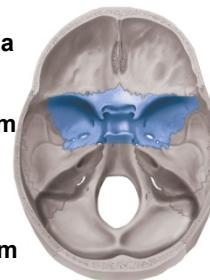
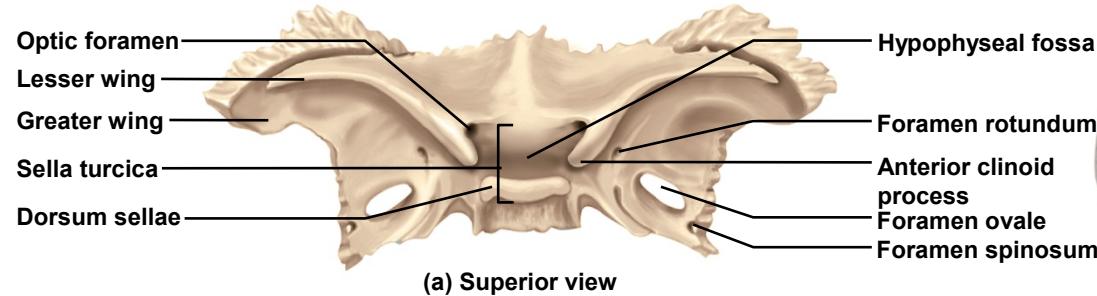


Figure 8.11a

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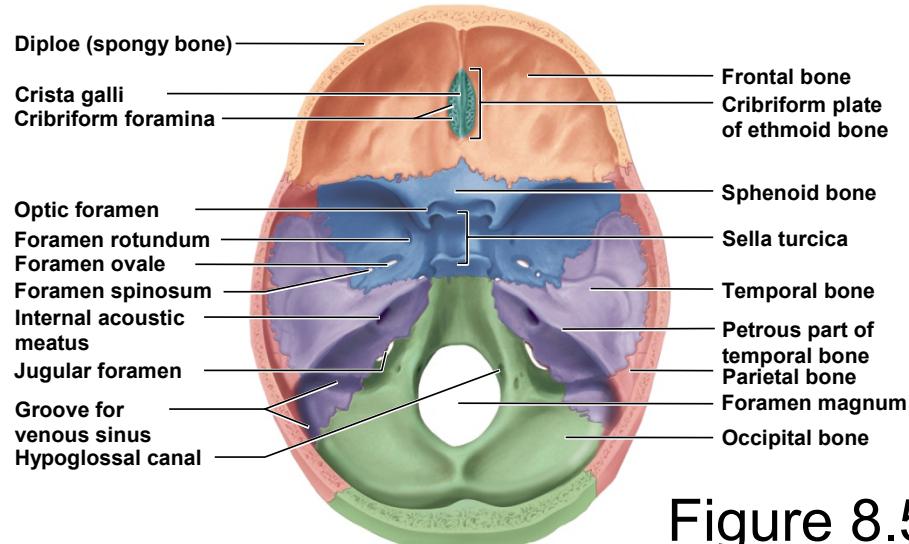


Figure 8.5b

(b) Superior view of cranial floor

Sphenoid Bone

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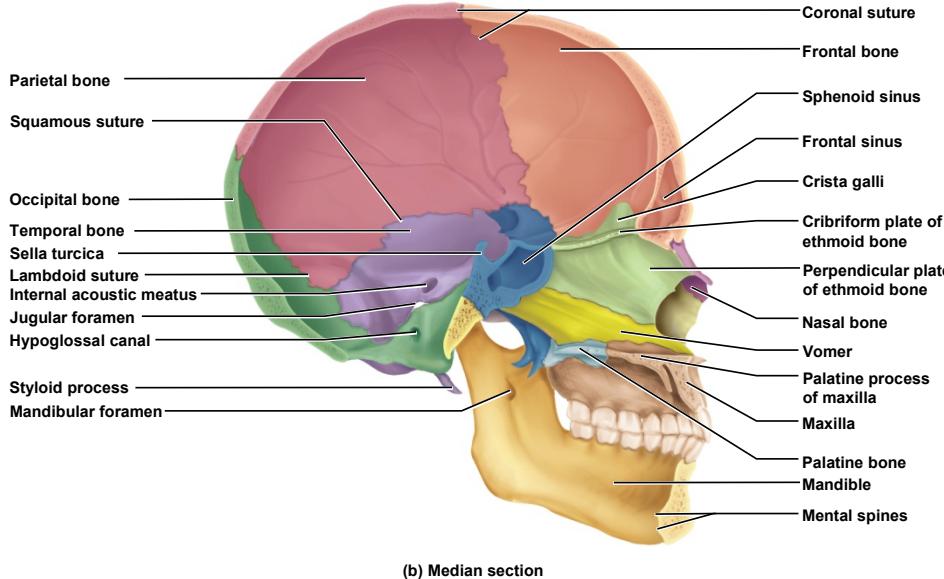


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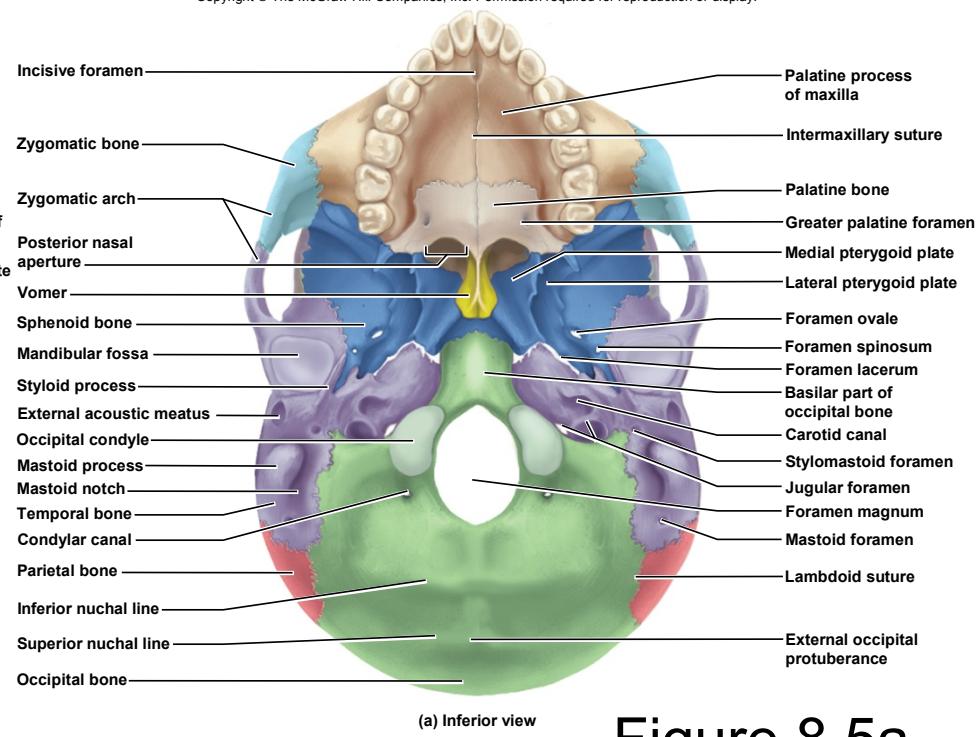


Figure 8.5a

sphenoid sinus

Ethmoid Bone

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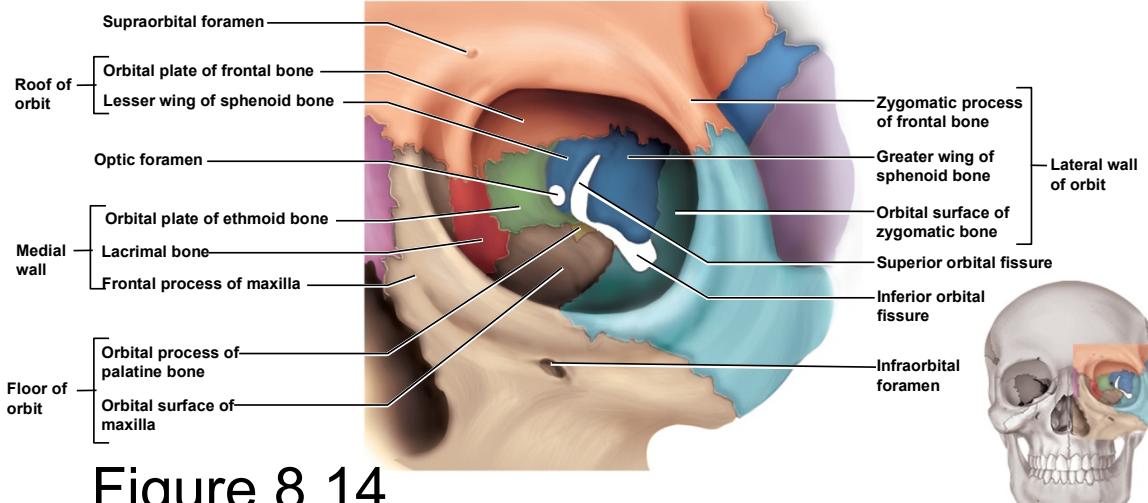


Figure 8.14

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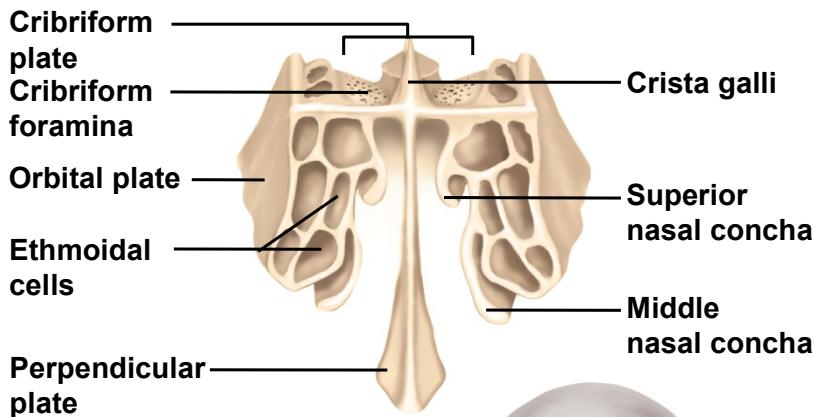
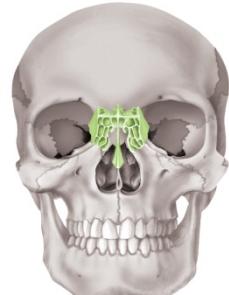


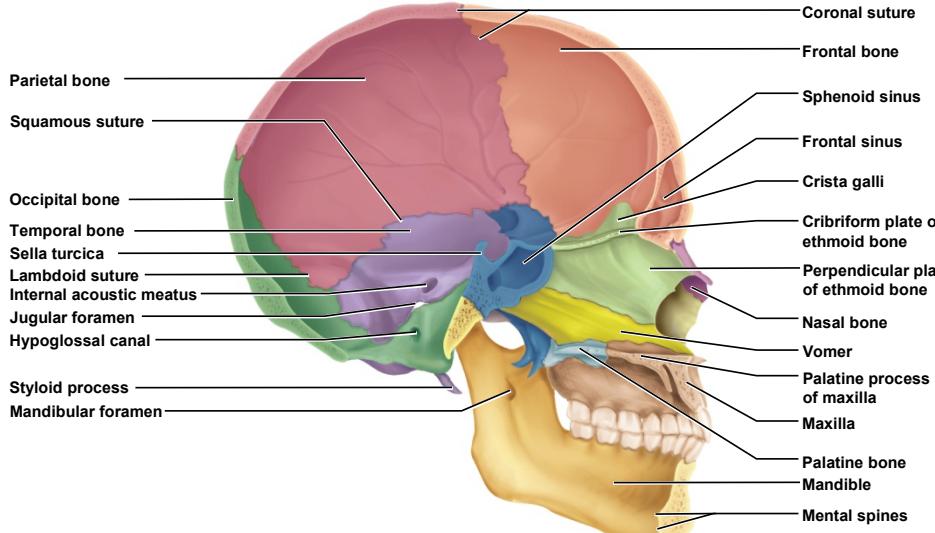
Figure 8.12



- between the eyes
- contributes to medial wall of orbit
- lateral walls and roof of nasal cavity, and nasal septum

Ethmoid Bone

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(b) Median section

Figure 8.4b

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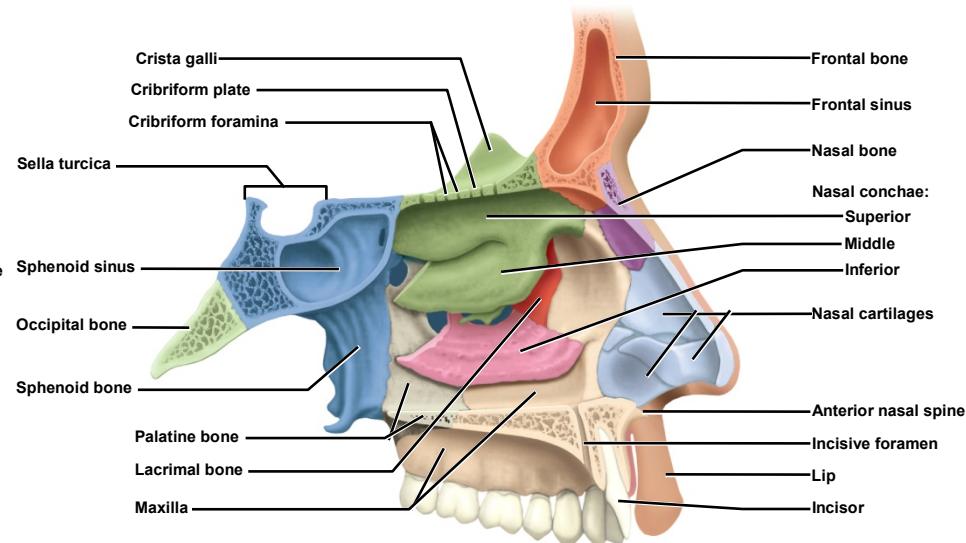


Figure 8.13

superior and middle concha
perpendicular plate of nasal septum

Facial Bones

- **facial bones** (14)— those that have no direct contact with the brain or meninges
 - support the teeth
 - give shape and individuality to the face
 - form part of the orbital and nasal cavities
 - provide attachments for muscles of facial expression and mastication

2 maxillae

2 nasal bones

2 palatine bones

2 inferior nasal conchae

2 zygomatic bones

1 vomer

2 lacrimal bones

1 mandible

Maxillary Bones

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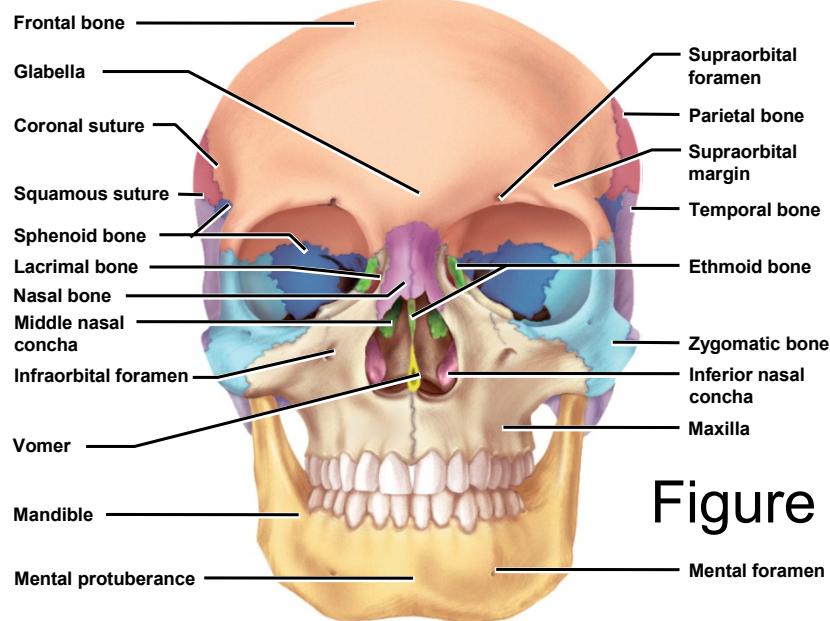


Figure 8.3

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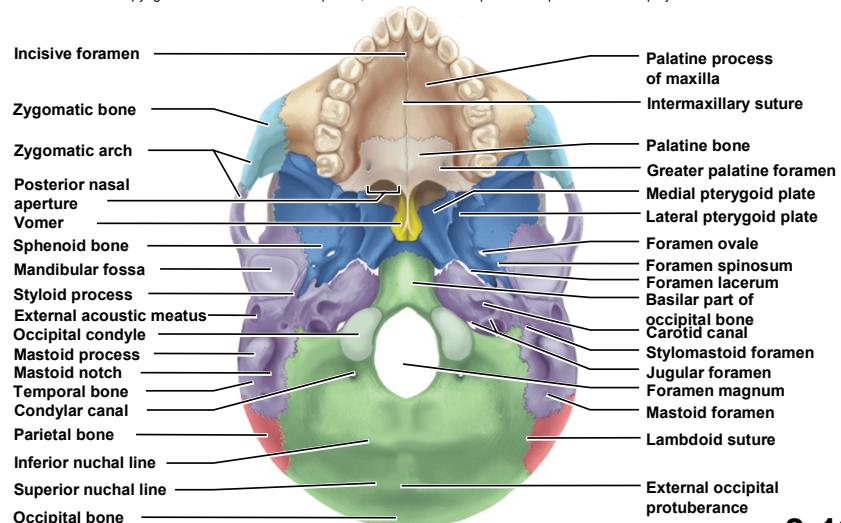


Figure 8.5a

Location of Maxillary Sinus

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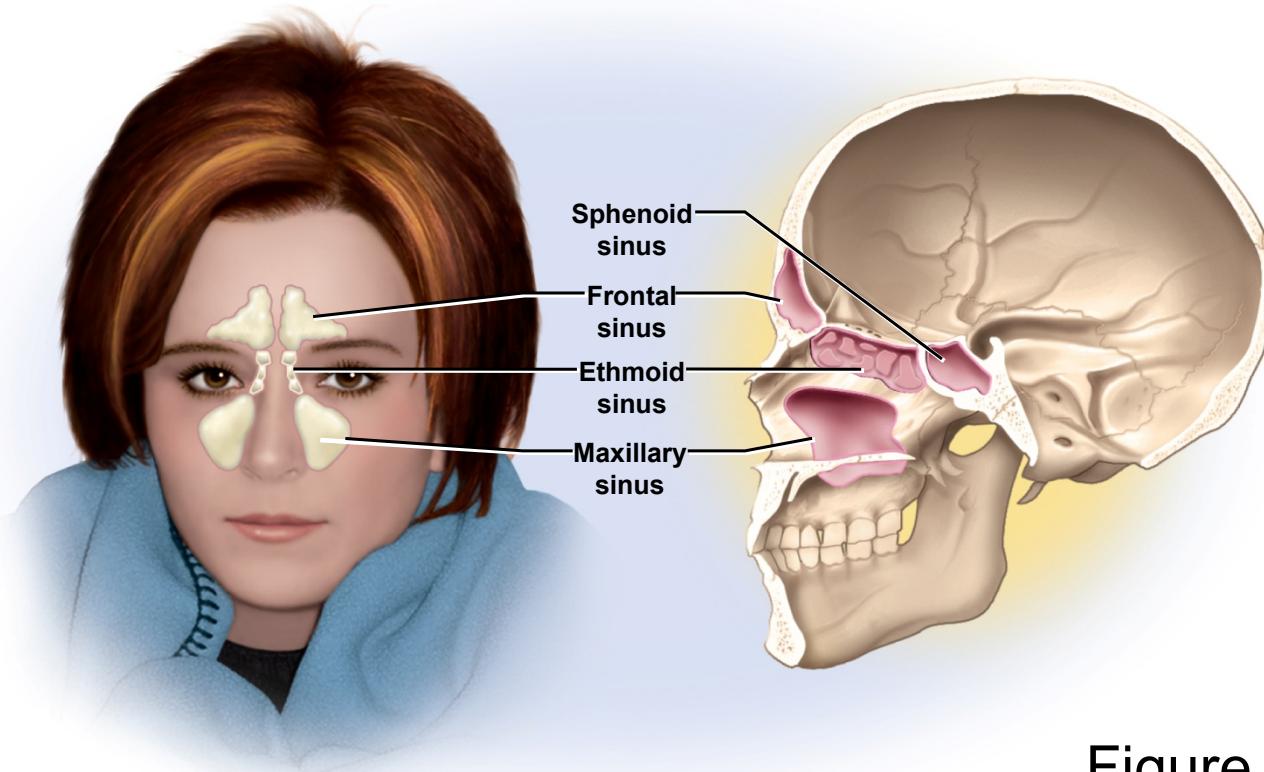


Figure 8.8

- **maxillary sinus** fills maxillae bone
- larger in volume than frontal, sphenoid and ethmoid sinuses

Palatine Bones

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- form the posterior portion of the hard palate

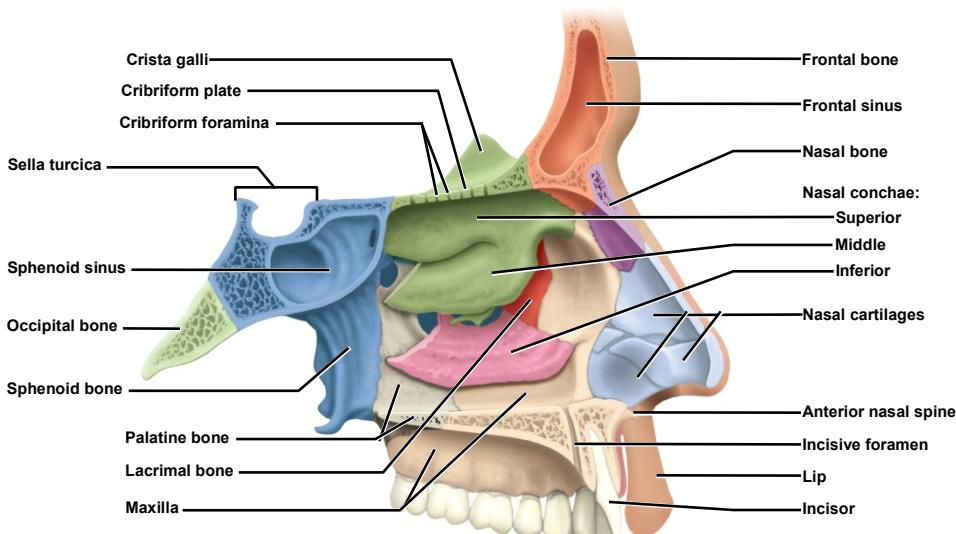


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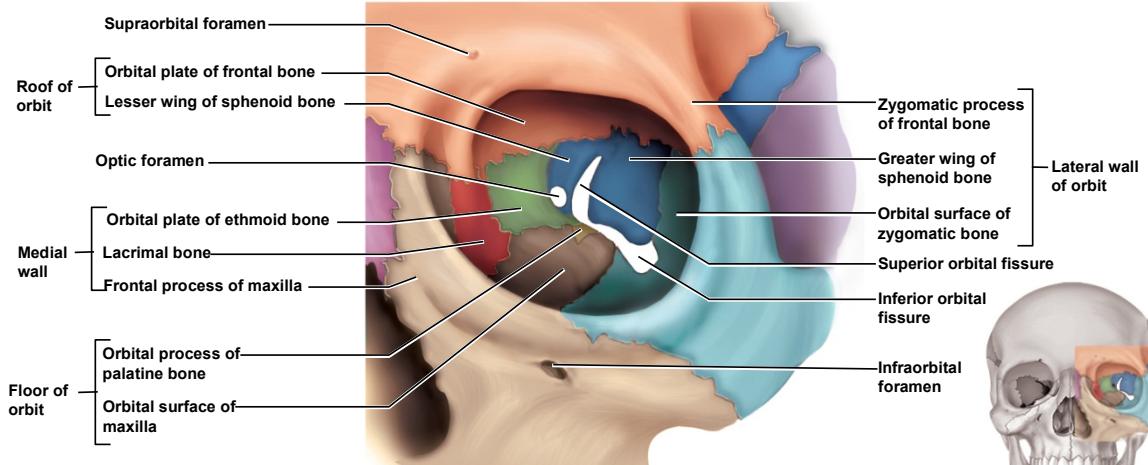


Figure 8.14

Zygomatic Bones

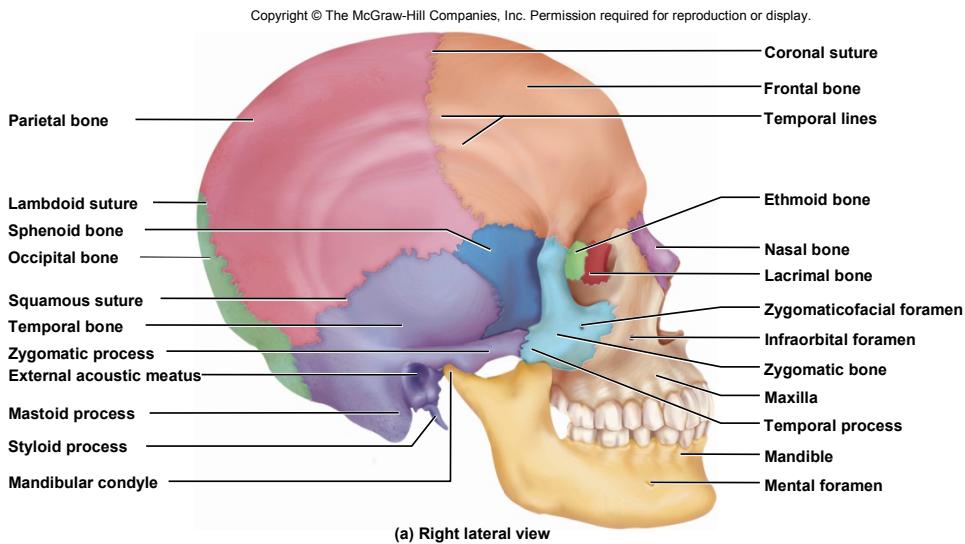


Figure 8.4a

- forms angles of the cheekbones and part of lateral orbital wall
- **zygomatic arch is formed from *temporal process of zygomatic bone* and *zygomatic process of temporal bone***

Lacrimal Bones

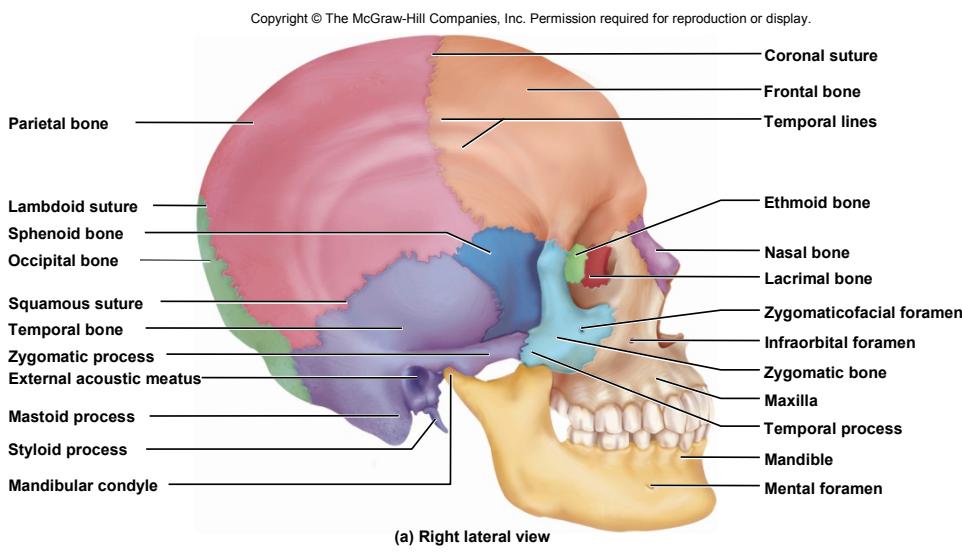


Figure 8.4a

- form part of medial wall of each orbit
- smallest bone of skull
- **lacrimal fossa** houses lacrimal sac in life
 - tears collect in lacrimal sac and drain into nasal cavity

Nasal Bones

- forms bridge of nose
- supports cartilages that shape lower portion of the nose

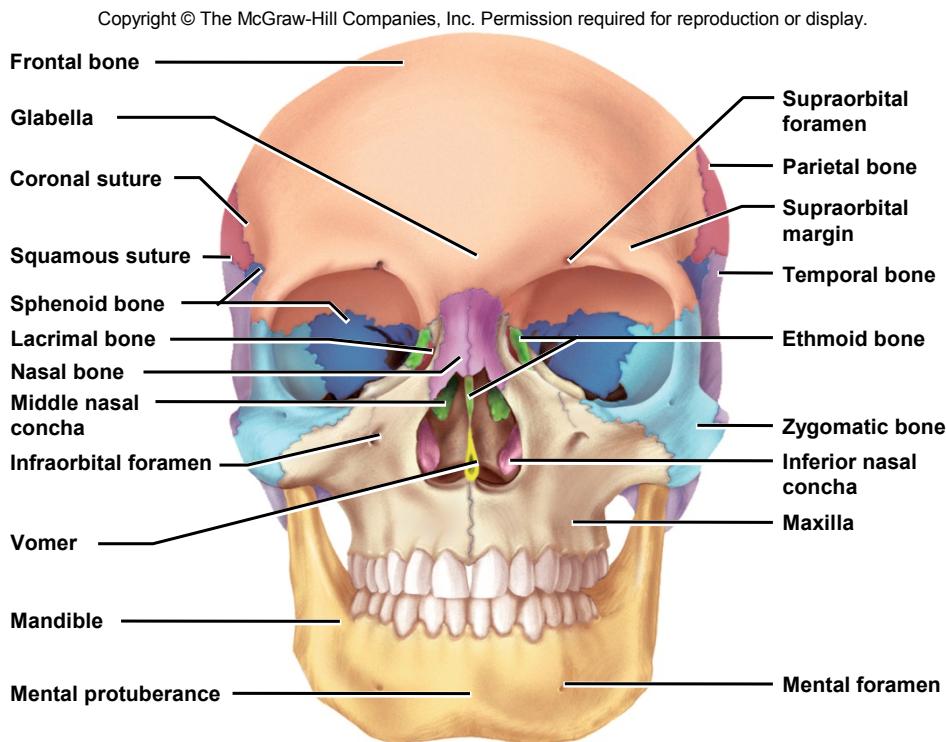


Figure 8.3

Vomer

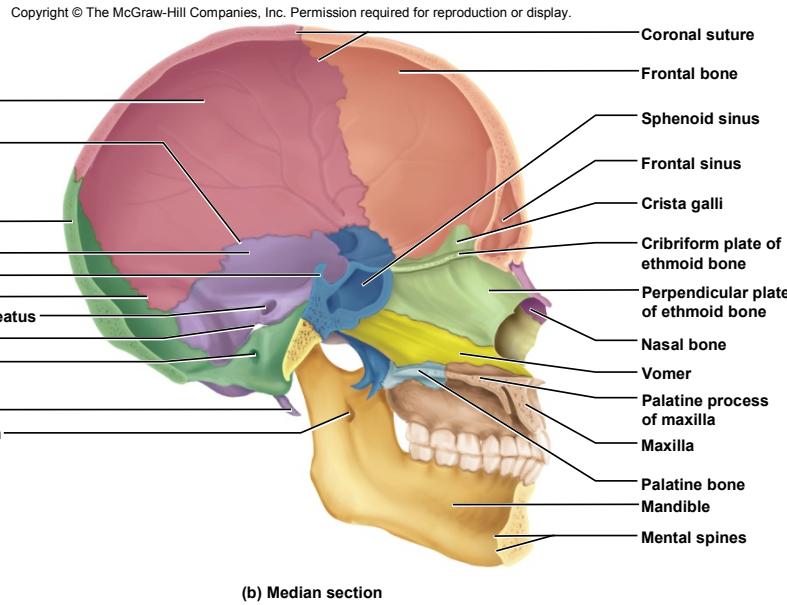


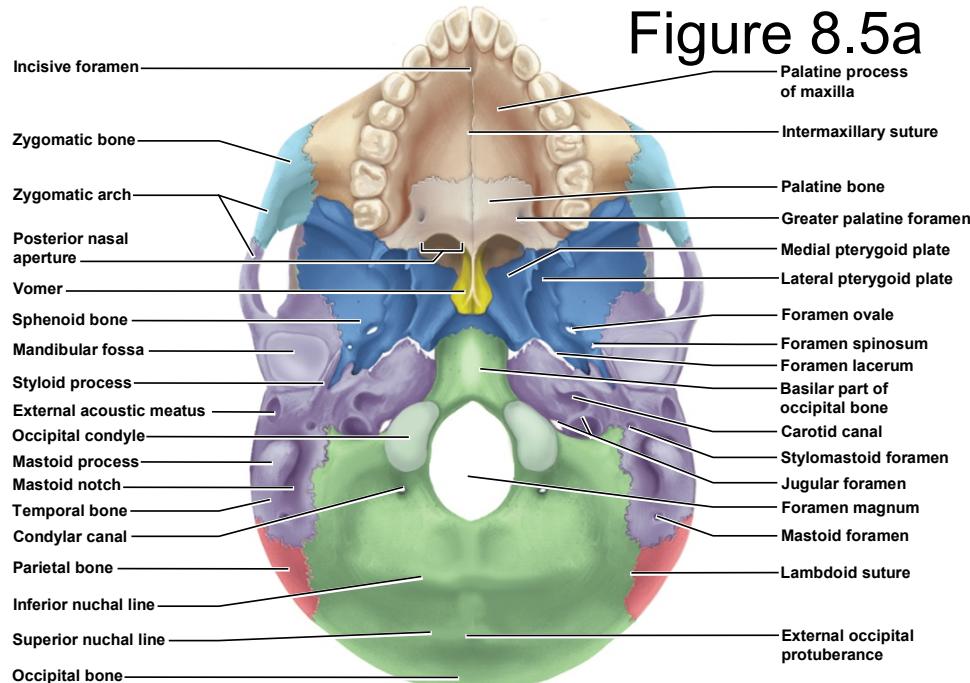
Figure 8.4b

- inferior half of the nasal septum
 - superior half formed by perpendicular plate of ethmoid
- supports cartilage that forms the anterior part of the nasal septum

Mandible

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- strongest bone of the skull
- only bone of skull that moves noticeably
- supports lower teeth
- provides attachments for muscles of facial expression and mastication



(a) Inferior view

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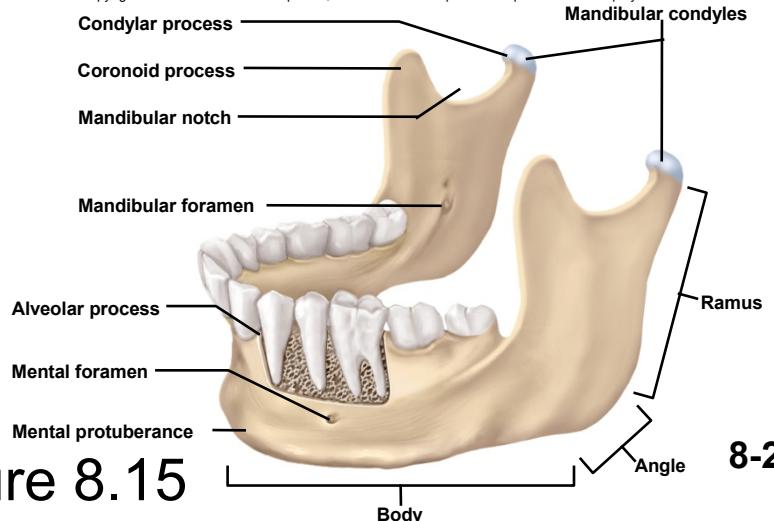


Figure 8.15

8-26

Ramus, Angle and Body of Mandible

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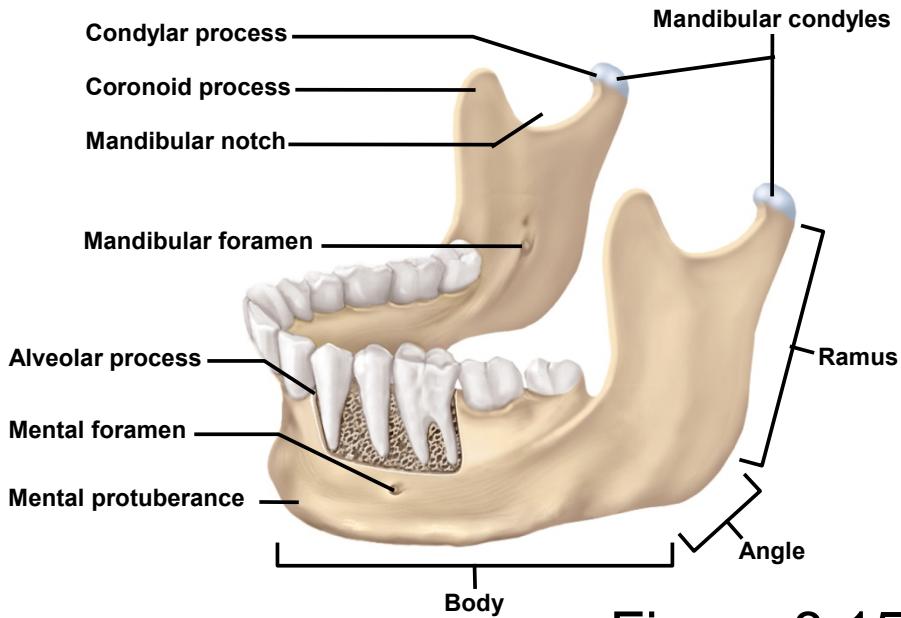


Figure 8.15

- **condylar process** bears the **mandibular condyle** – oval knob that articulates with the mandibular fossa of the temporal bone forming the hinge **temporomandibular joint (TMJ)**
- **coronoid process** – point of insertion of temporalis muscle

Bones Associated With Skull

- **auditory ossicles**

- **hyoid bone**

- slender u-shaped bone between the chin and larynx
- does not articulate with any other bone
- suspended from styloid process of skull by muscle and ligament

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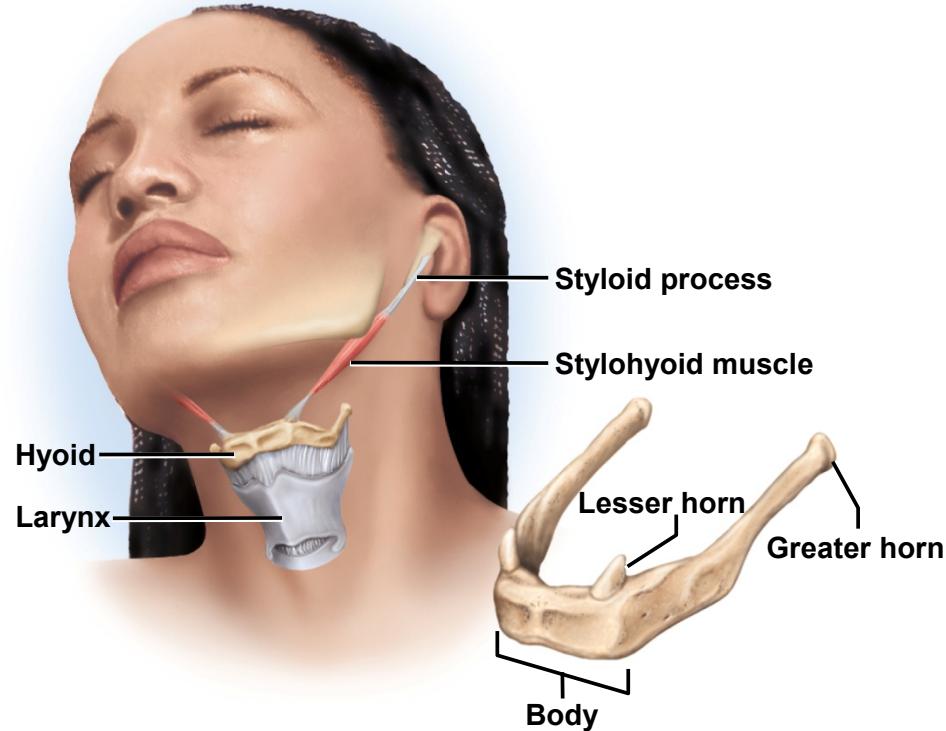
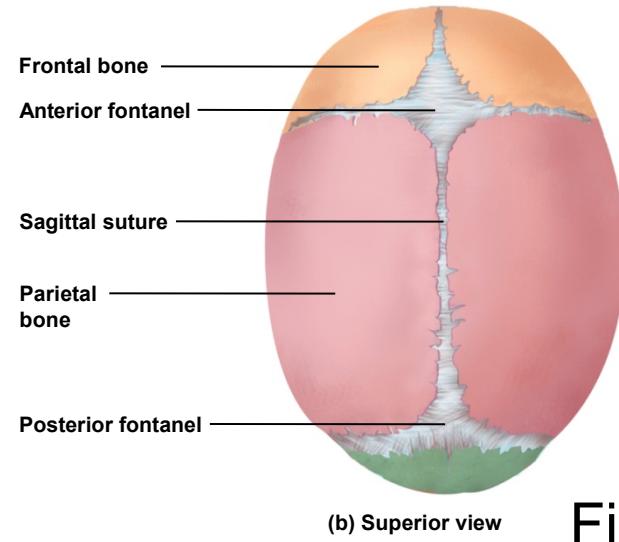
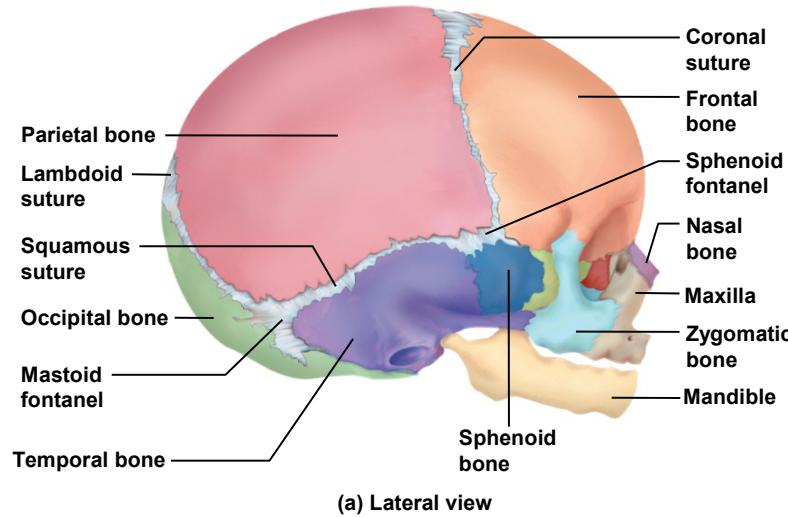


Figure 8.16

Skull in Infancy and Childhood

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- **fontanelles** - spaces between unfused bones
 - filled with fibrous membrane
 - allow shifting of bones during birth and growth of brain
- two frontal bones fuse by age 6
- skull reaches adult size by 8 or 9 years of age

Figure 8.17

The Vertebral Column (Spine)

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- **functions**
 - supports the skull and trunk
 - allows for their movement
 - protects the spinal cord
 - absorbs stress of walking, running, and lifting
 - provides attachments for limbs thoracic cage, and postural muscles
- **33 vertebrae with intervertebral discs of fibrocartilage between most of them**

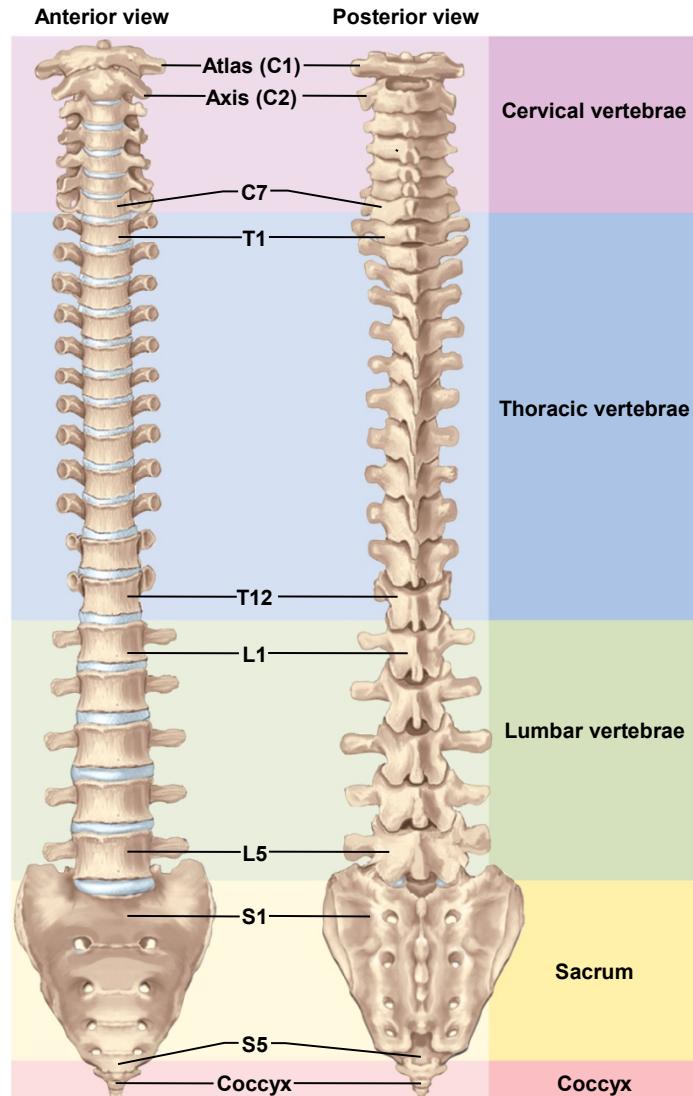


Figure 8.18

The Vertebral Column (Spine)

- five vertebral groups
 - **7 cervical** in the neck
 - **12 thoracic** in the chest
 - **5 lumbar** in lower back
 - **5 fused sacral** at base of spine
 - **4 fused coccygeal**

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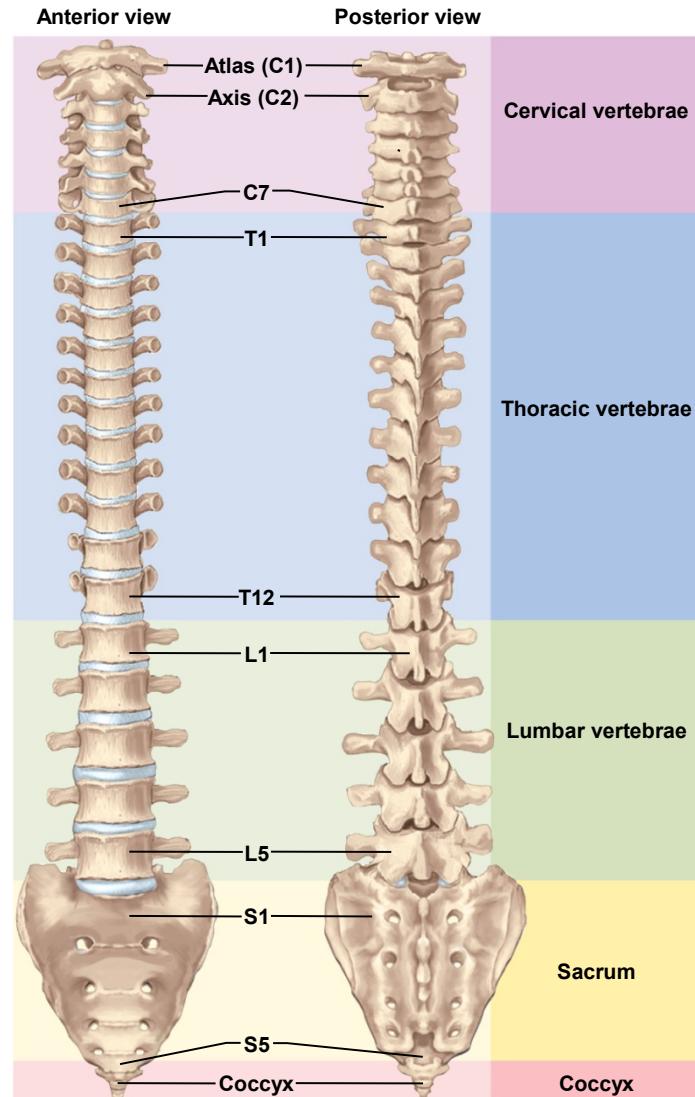
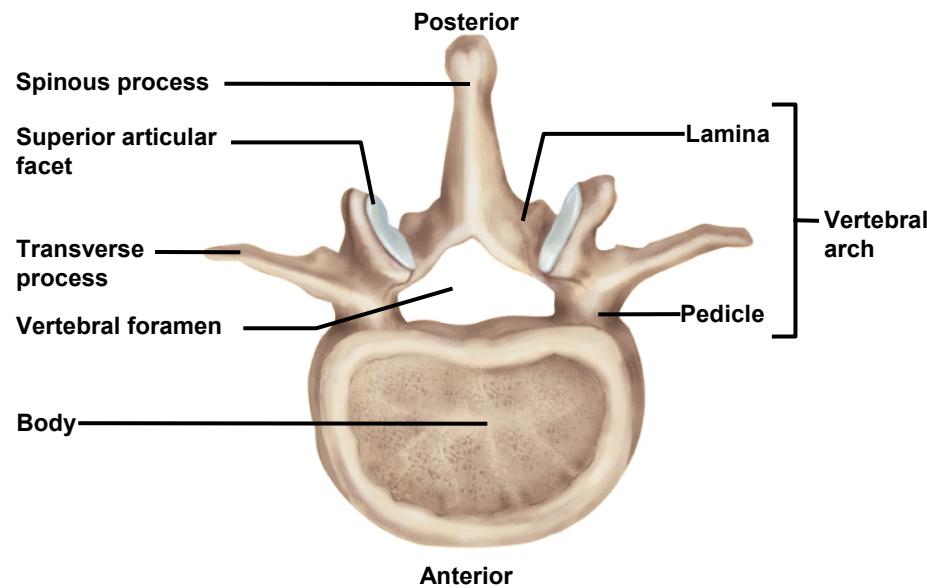


Figure 8.18

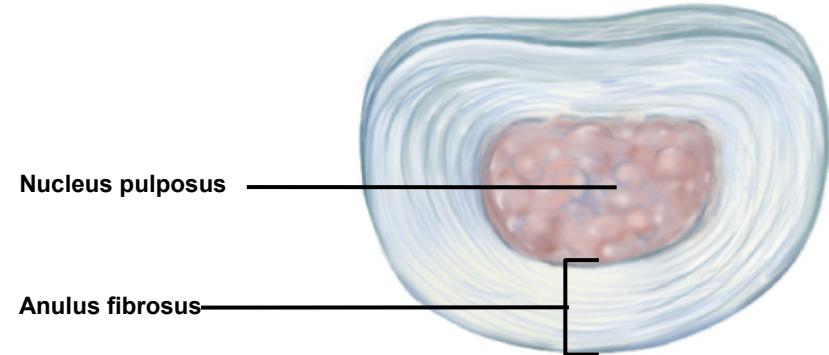
General Structure of Vertebra

- **body (centrum)**
 - weight bearing portion
 - rough superior and inferior surfaces provide firm attachment for intervertebral discs
- **vertebral foramina**
 - collectively form **vertebral canal** for spinal cord
- **spinous process**
 - projection extending from the apex of arch
 - extends posteriorly and downward
- **transverse process**
 - extends laterally
- **superior articular processes**
 - project upward from one vertebra and meets **inferior articular processes** from the vertebra above
- **facets**
 - flat articular surfaces covered with hyaline cartilage

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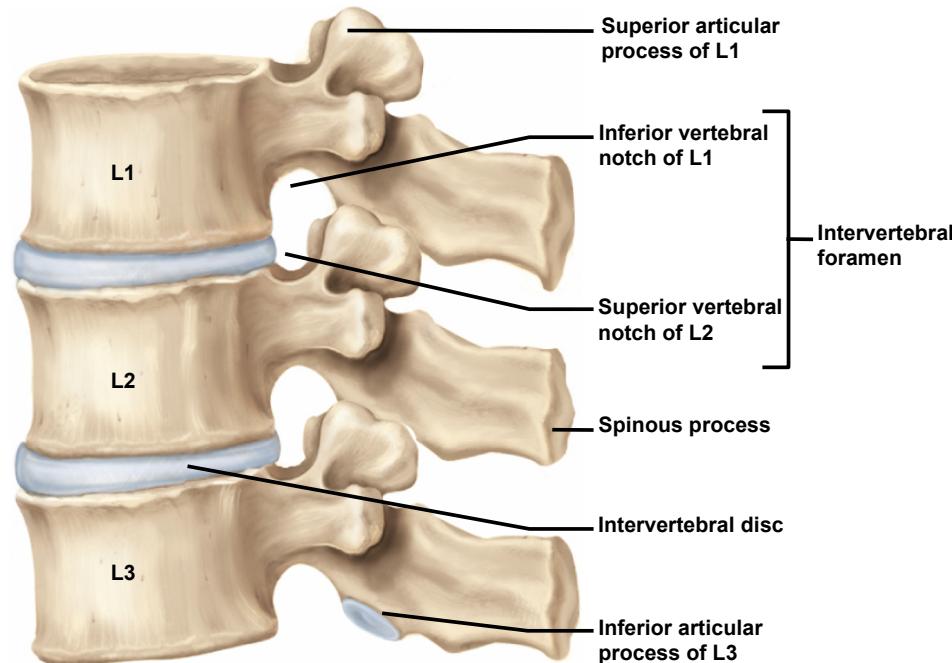
(a) 2nd lumbar vertebra (L2)



(b) Intervertebral disc

Intervertebral Foramen and Discs

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(b) Left lateral view

Figure 8.23b

- **intervertebral foramen**
 - passageway for spinal nerves
- **intervertebral discs (23)**
 - first one between C2 and C3
 - last one between L5 and sacrum
 - bind vertebrae together
 - support weight of the body
 - absorb shock
 - **herniated disc** ('ruptured' or 'slipped' disc) puts painful pressure on spinal nerve or spinal cord

Cervical Vertebra C1 + C2

[†]**atlas (C1)**

- [†] articulates with occipital condyles
- [†] allows nodding motion of skull gesturing 'yes'

[†]**axis (C2)**

- [†] allows rotation of the head gesturing 'no'

Cervical Vertebra C2 - Axis

- **axis (C2)**
 - allows rotation of the head gesturing ‘no’

Atlas and Axis Articulation

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Axis of rotation

Dens

Atlas

Transverse
ligament

Axis

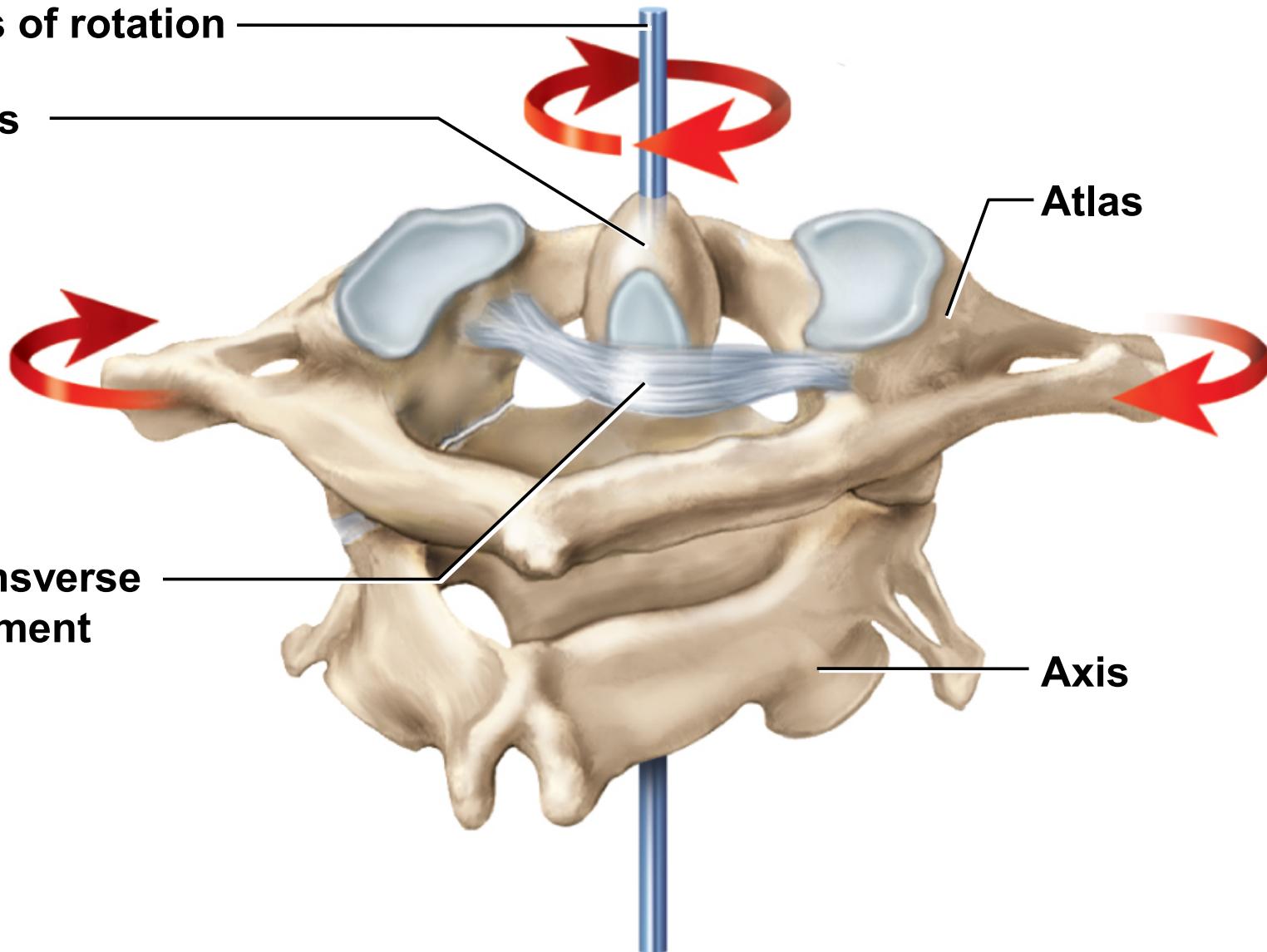


Figure 8.24c

(c) Atlantoaxial joint

Sacrum and Coccyx

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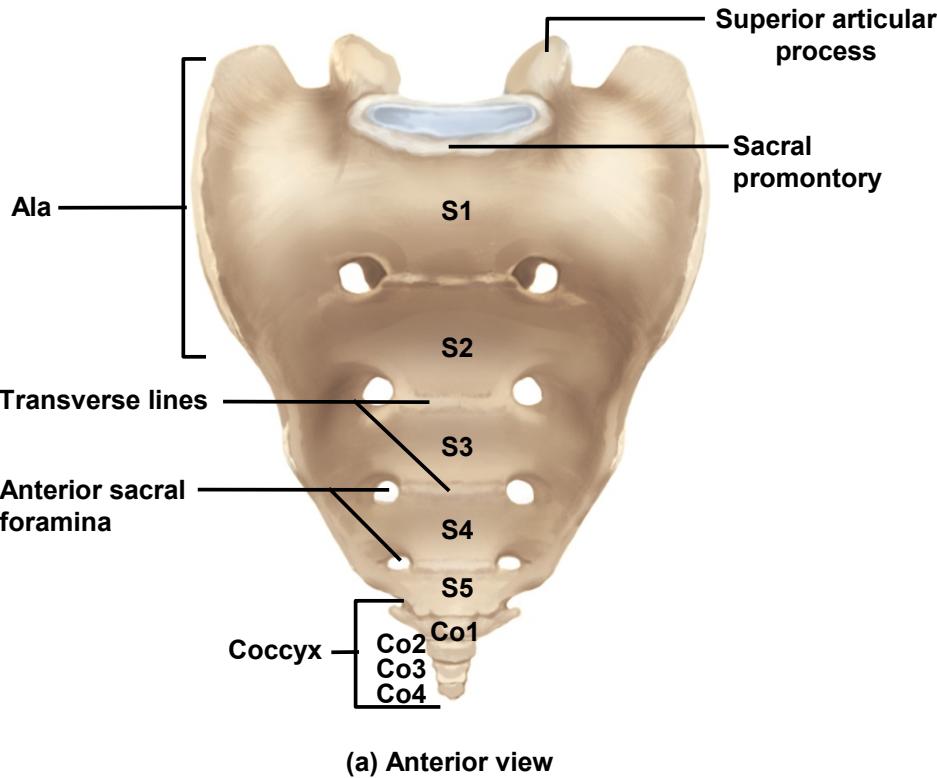


Figure 8.26a

sacrum – bony plate that forms the posterior wall of the pelvic cavity in children, five separate sacral vertebrae

coccyx – usually consists of four sometimes five, fuse into a single, triangular bone by age 20 – 30

Thoracic Cage

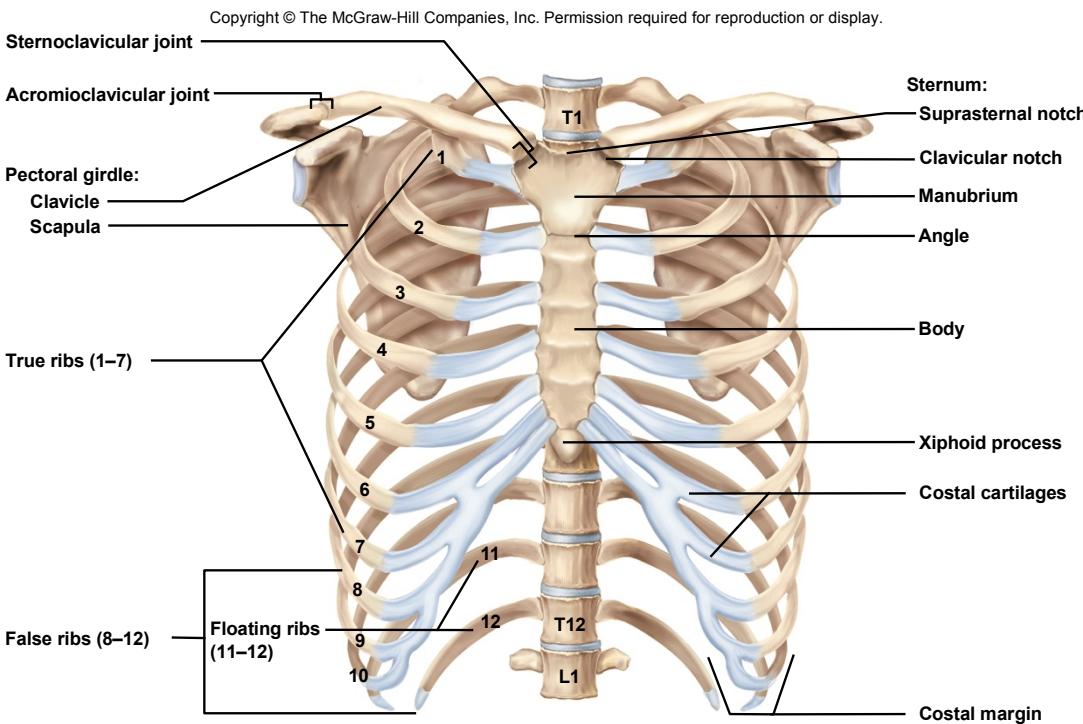


Figure 8.27

- consists of **thoracic vertebrae, sternum and ribs**
- provides attachment for pectoral girdle and upper limbs

Sternum

- **sternum** (breastbone) – bony plate anterior to the heart
- divided into **three regions**:
 - **Manubrium**
 - **body**
 - **xiphoid**

Articulation of Rib 6 with Vertebrae T5 and T6

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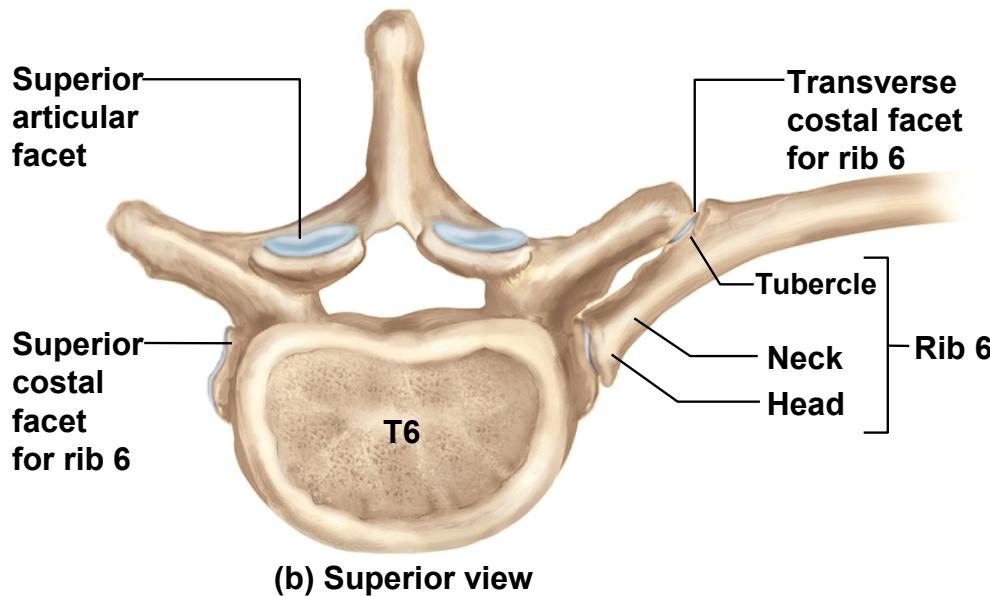
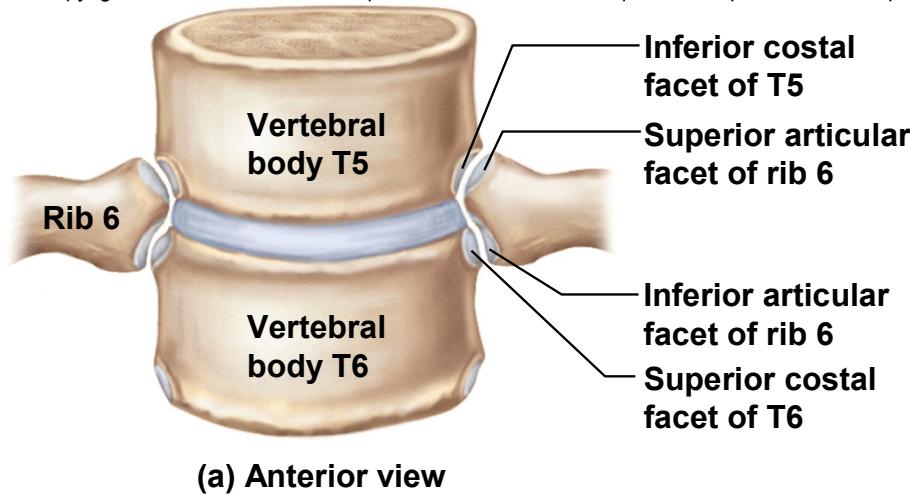


Figure 8.29

True and False Ribs

- **true ribs (ribs 1 to 7)**
 - each has its own costal cartilage connecting it to the sternum
- **false ribs (ribs 8-12)**
 - lack independent cartilaginous connection to the sternum
 - **floating ribs (ribs 11 – 12)**

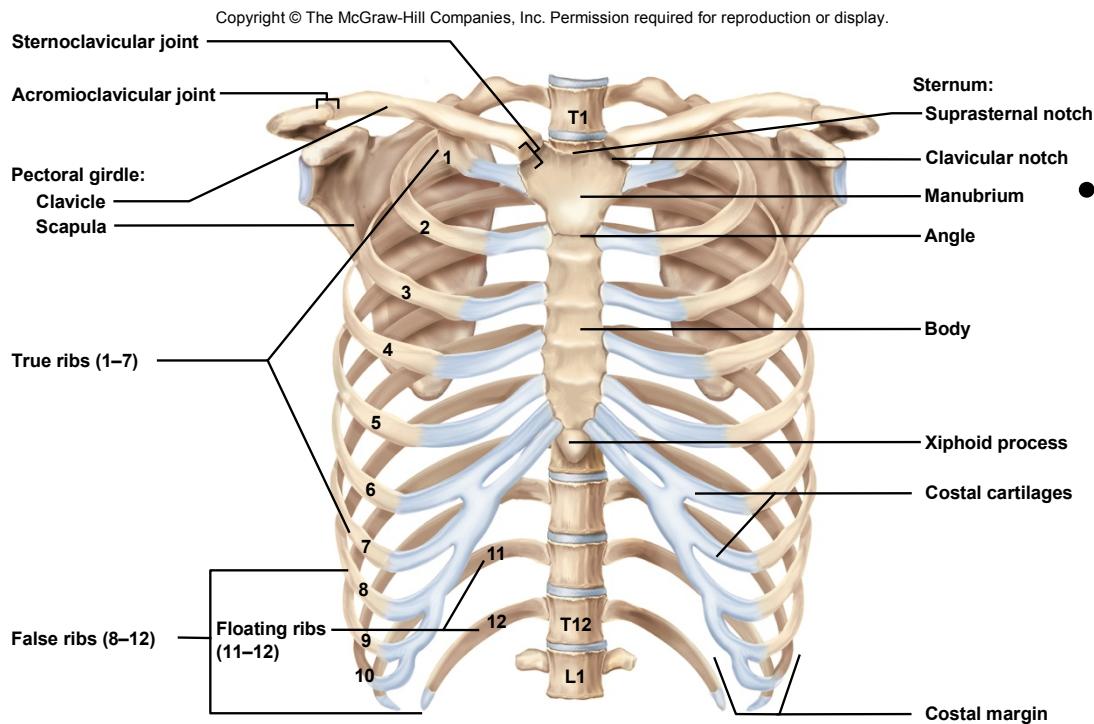


Figure 8.27

Pectoral Girdle

- **pectoral girdle** (shoulder girdle) – supports the arm
- consists of two bones on each side of the body
 - **clavicle** (collarbone) and **scapula** (shoulder blade)
- clavicle articulates medially to the sternum and laterally to the scapula
- scapula articulates with the humerus
 - **glenohumeral joint** - shoulder joint

Clavicle

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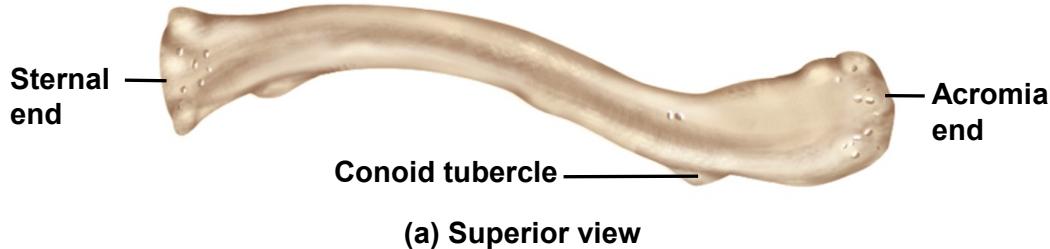
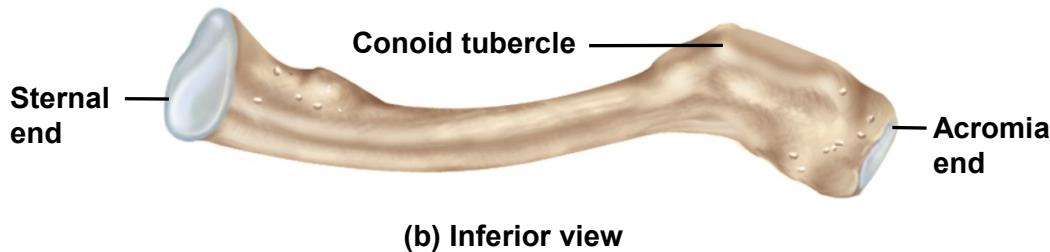


Figure 8.30



- **clavicle** - S-shaped, somewhat flattened bone
- **inferior** – grooves and ridges for muscle attachment
- **sternal end** - rounded head
- **acromial end** – flattened

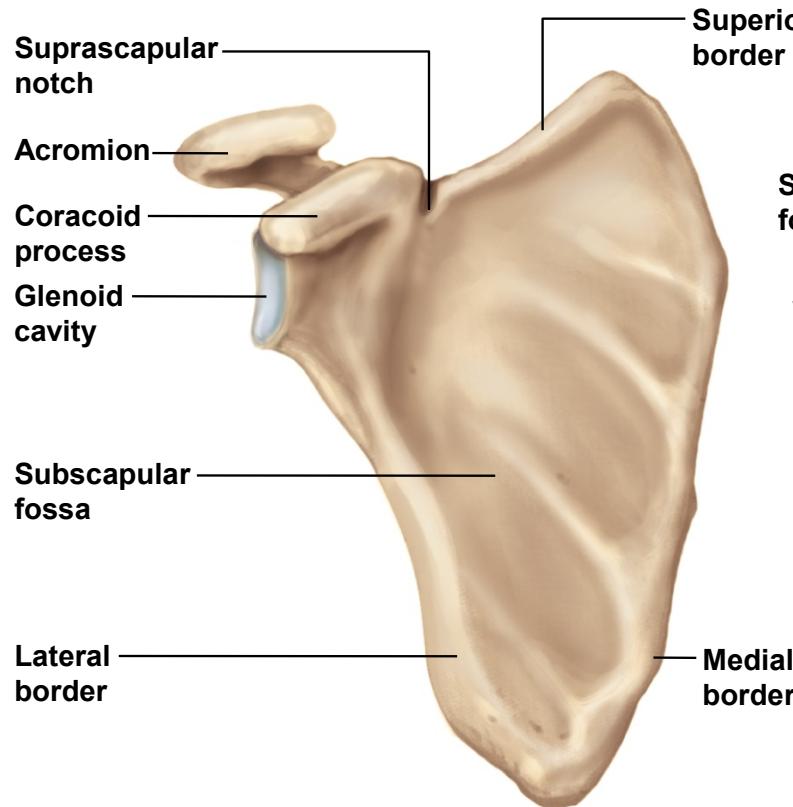
- braces the shoulder keeping upper limb away from the midline of the body

Scapula

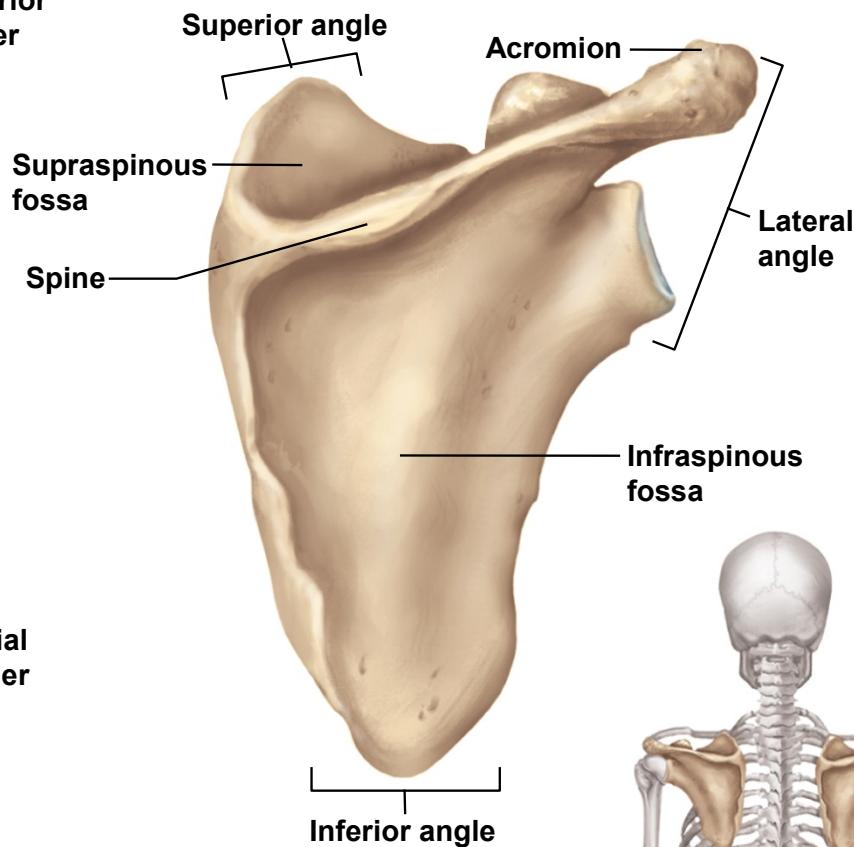
- **scapula**
- **lateral angle of scapula** has three main features:
 - **acromion**
 - forms apex of the shoulder
 - **articulates with the clavicle**
 - **coracoid process**
 - provides attachment for tendons of the biceps brachii and other arm muscles
 - **glenoid cavity** – shallow socket that articulates with the head of the humerus
 - forming **glenohumeral joint**

Scapula

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(a) Anterior view



(b) Posterior view



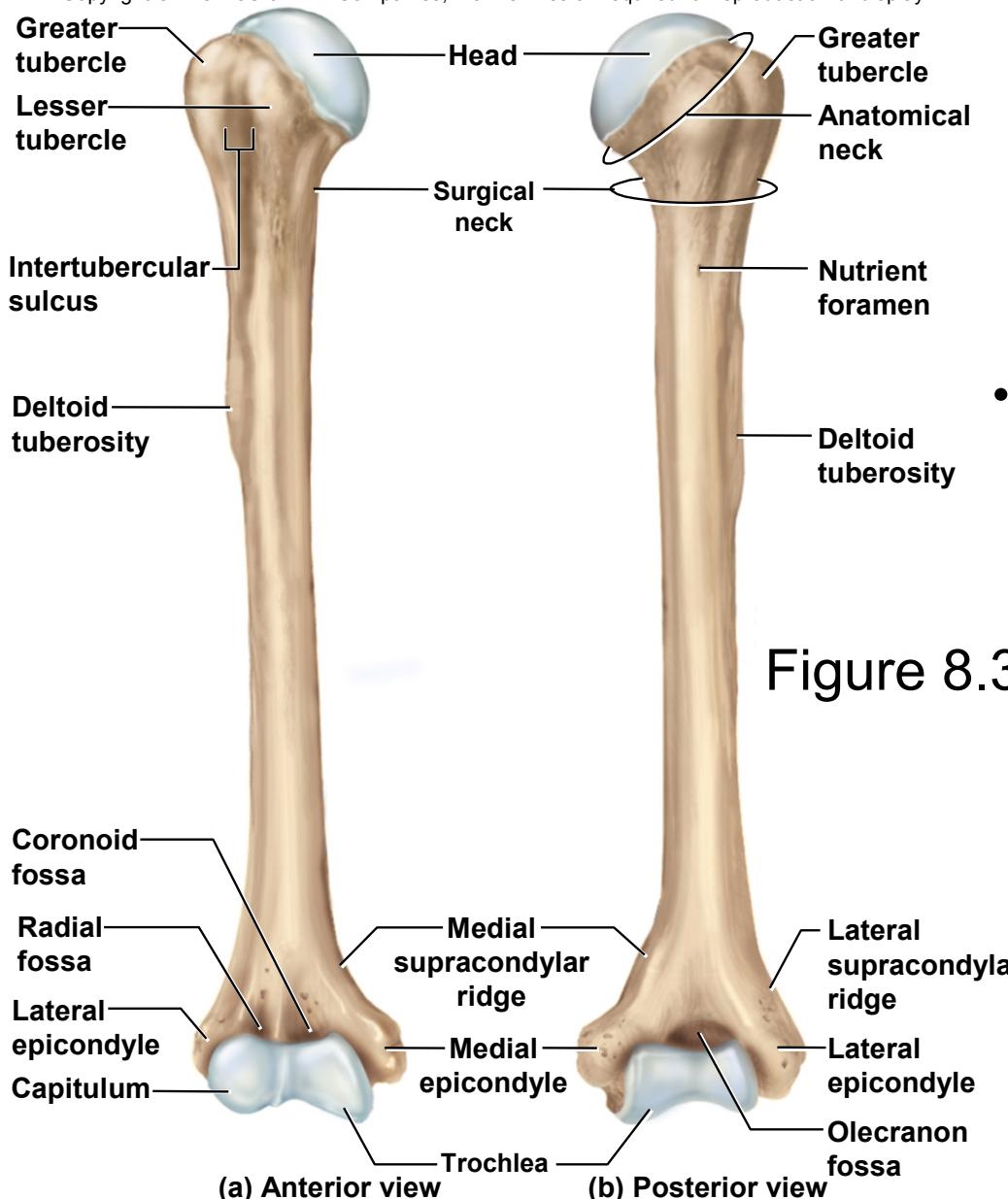
Figure 8.31

Upper Limb

- **Humerus**
- **Radius and ulna**
- **Carpal bones** (wrist)
- **5 metacarpals** in palm
- **14 phalanges** in fingers

Humerus

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- **proximal end**

- hemispherical **head** that articulates with the **glenoid cavity** of scapula
- **greater and lesser tubercles** and deltoid tuberosity
- **intertubercular sulcus** holds biceps tendon

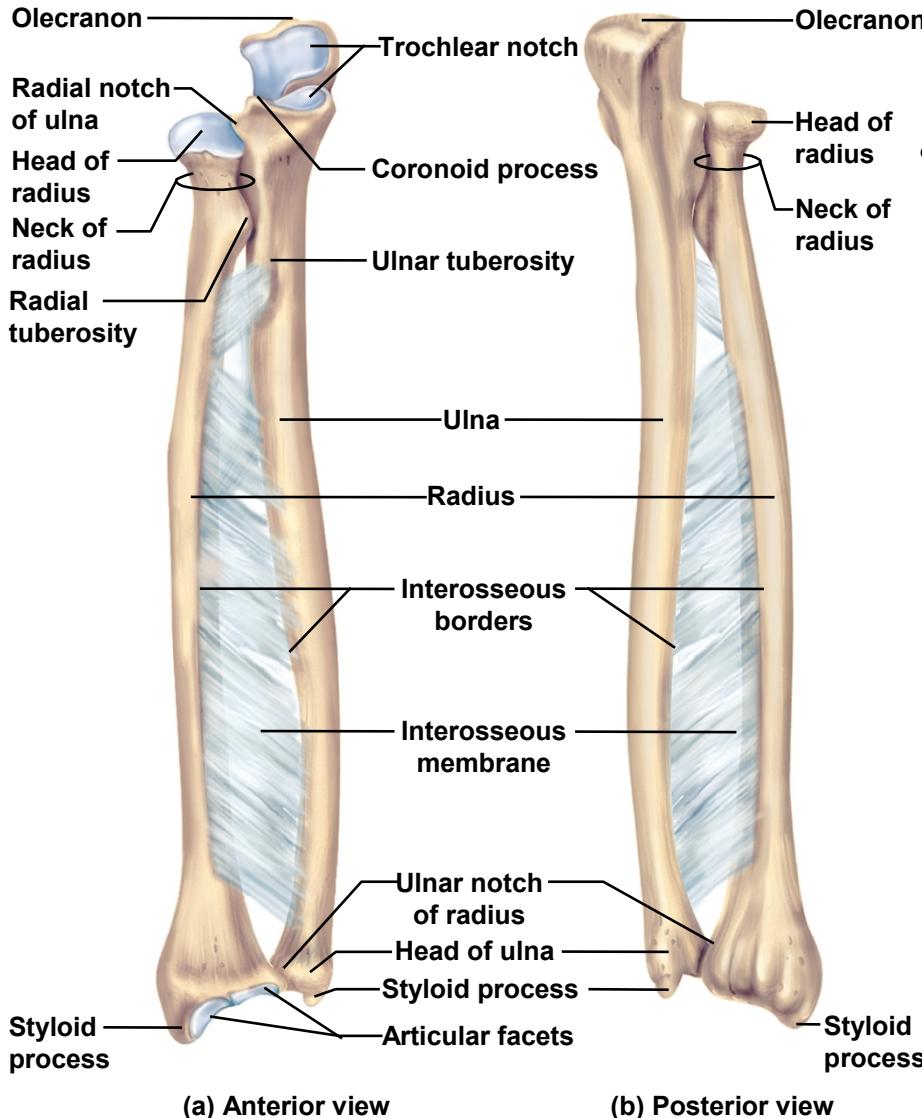
- **distal end**

- rounded **capitulum** articulates with head of radius
- **trochlea** articulates with ulna
- **lateral and medial epicondyles**
- **olecranon fossa** holds olecranon process of ulna

Figure 8.32

Radius

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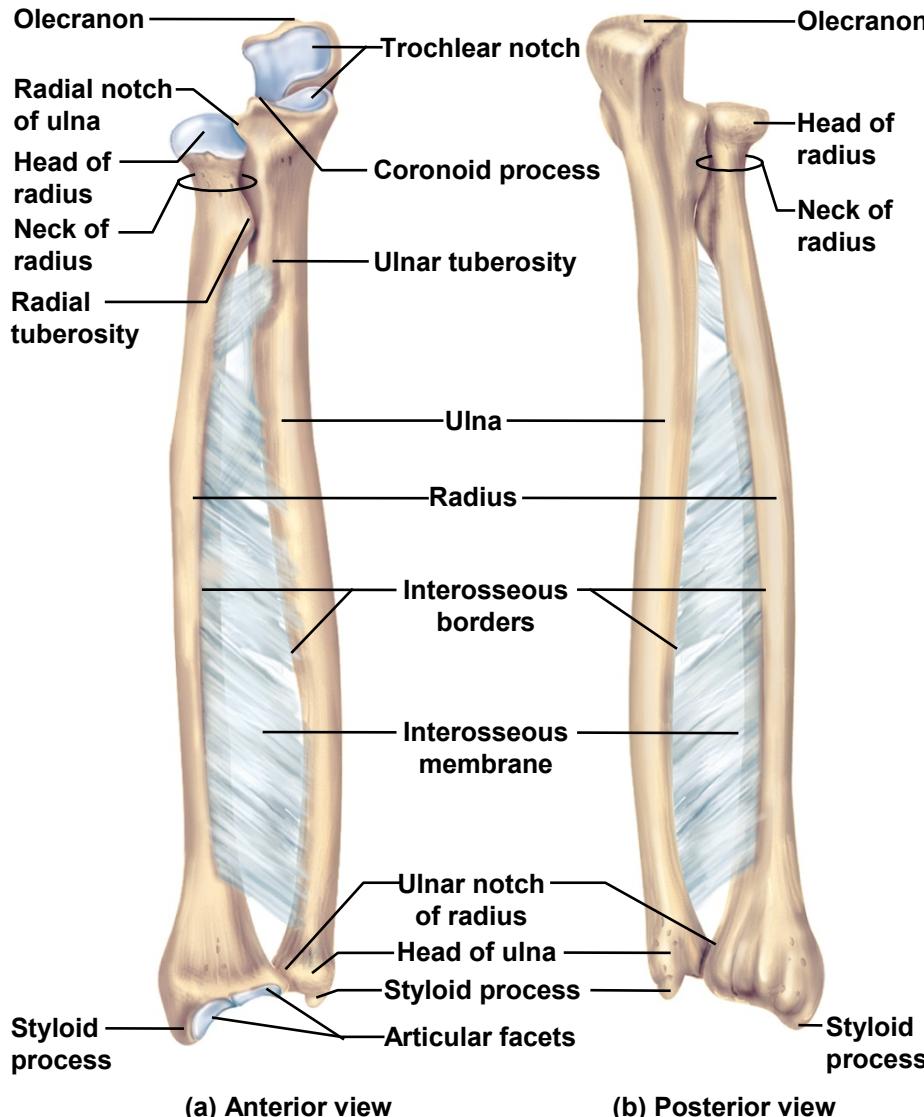
• radius

- **head** – disc-shape, allows for rotation around the longitudinal axis of the bone during pronation and supination of hand
 - superior surface articulates with **capitulum** on humerus
 - side of disc spins on **radial notch** on ulna
- **radial tuberosity** for biceps muscle
- **styloid process** can be palpated near thumb
- **ulnar notch**

Figure 8.33

Ulna and Interosseous Membrane

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(a) Anterior view

(b) Posterior view

Figure 8.33

- **ulna**

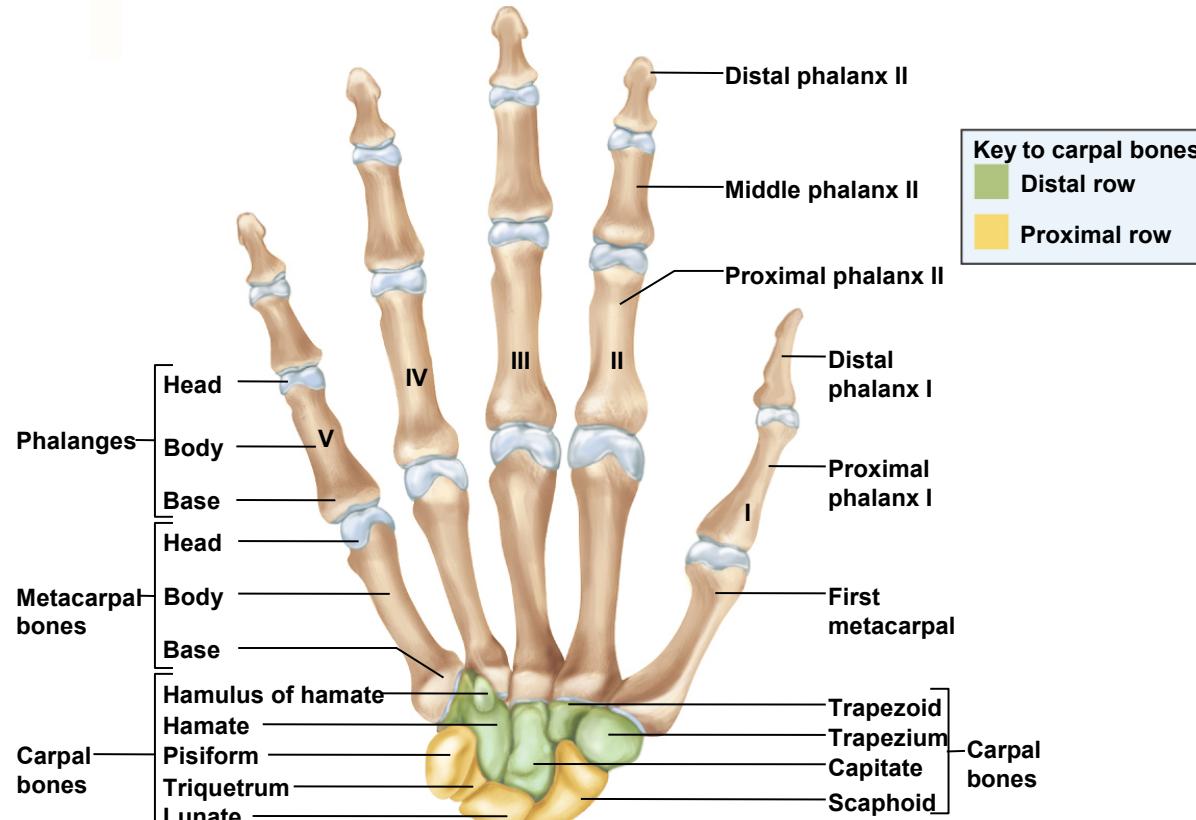
- **trochlear notch** articulates with trochlea of humerus
- **olecranon** – bony point at back of elbow
- **coronoid process**
- **radial notch** holds head of radius
- **styloid process**

- **interosseous membrane**

- ligament **attaches radius to ulna** along interosseous margin of each bone
- enables the two elbow joints to share the load

Carpal Bones

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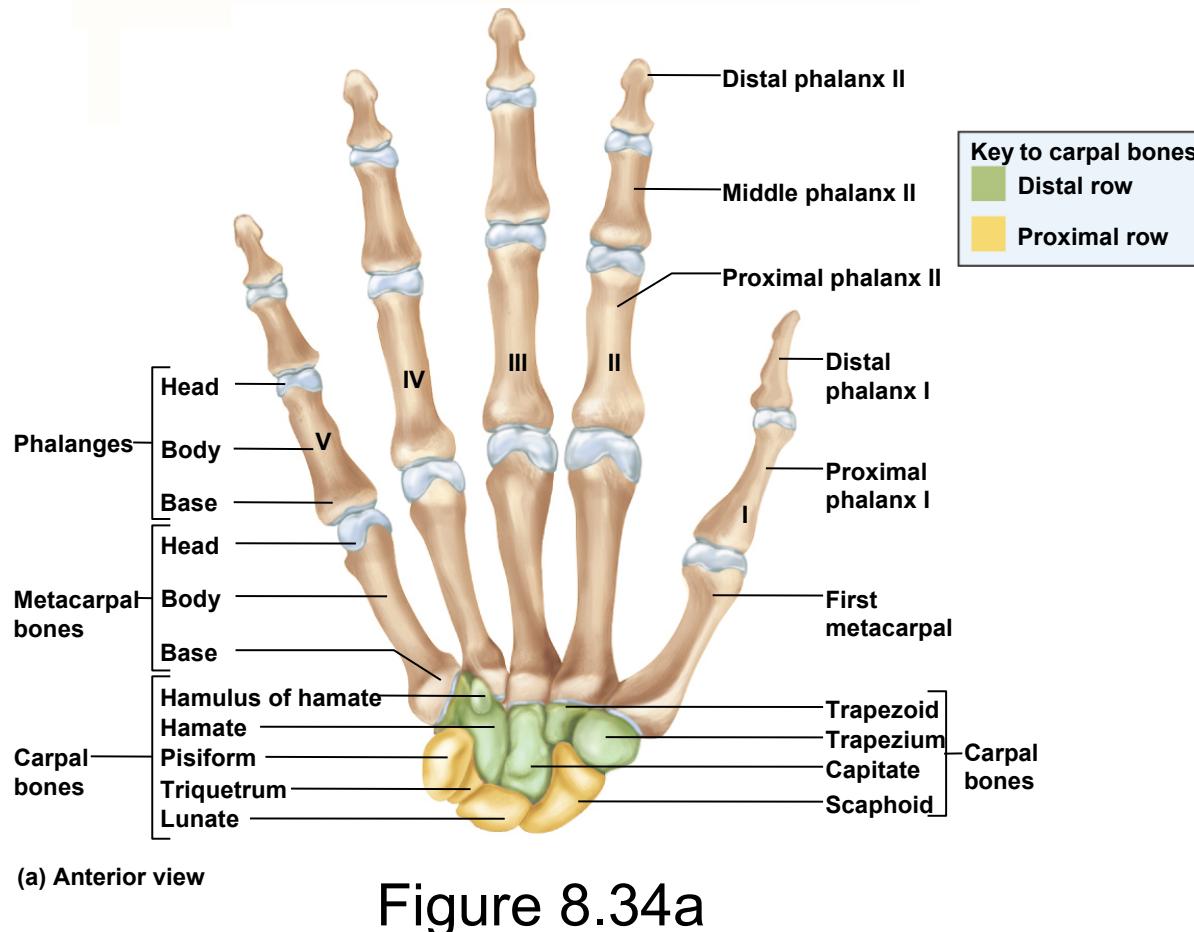


(a) Anterior view

Figure 8.34a

Metacarpals and Phalanges

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- **pelvic girdle** – consists of a complete ring composed of three bones
 - two **hip (coxal) bones**
 - also called **osса coxae** or **innominate bones**
 - **sacrum** that is also part of the vertebral column
- **pelvis** – bowl-shaped structure composed of the two coxal bones and sacrum as well as their ligaments and muscles that line the pelvic cavity and form its floor
 - supports trunk on the lower limbs and protects viscera, lower colon, urinary bladder, and internal reproductive organs
- **sacroiliac joint** - joins hipbone to the vertebral column
 - **auricular surface** of ileum to **auricular surface** of sacrum
- anteriorly, **interpubic disc** – pad of fibrocartilage joins pubic bones
- **pubic symphysis** – the interpubic disc and adjacent regions of the pubic bone on each side

Pelvic Girdle

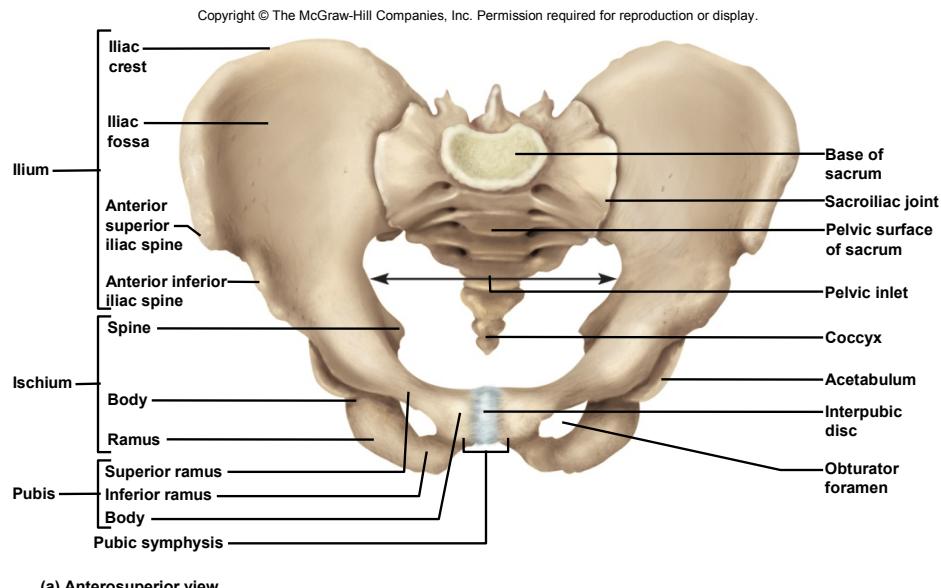
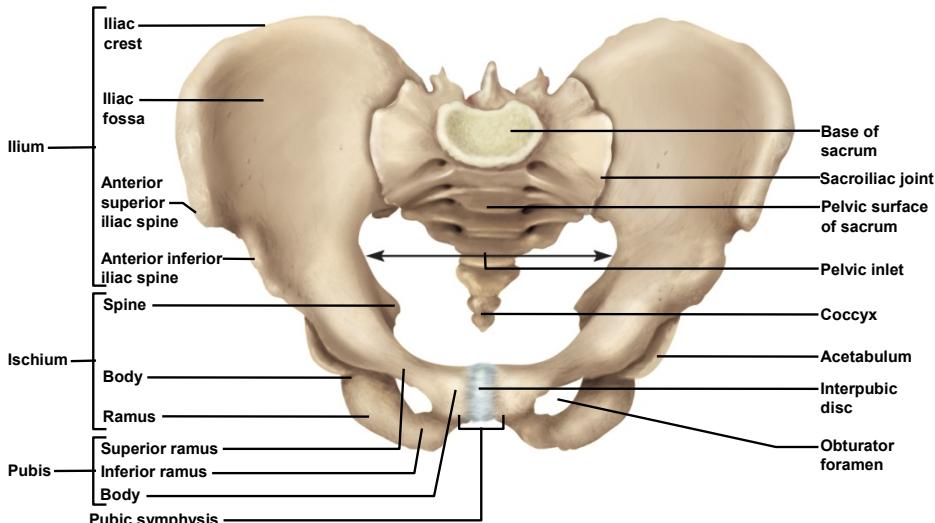


Figure 8.35a

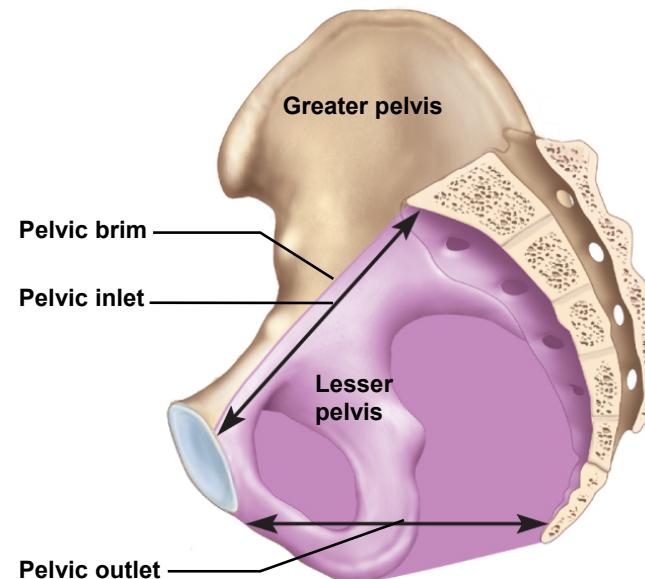
Pelvic Inlet and Outlet

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(a) Anterosuperior view

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(b) Median section Figure 8.35b

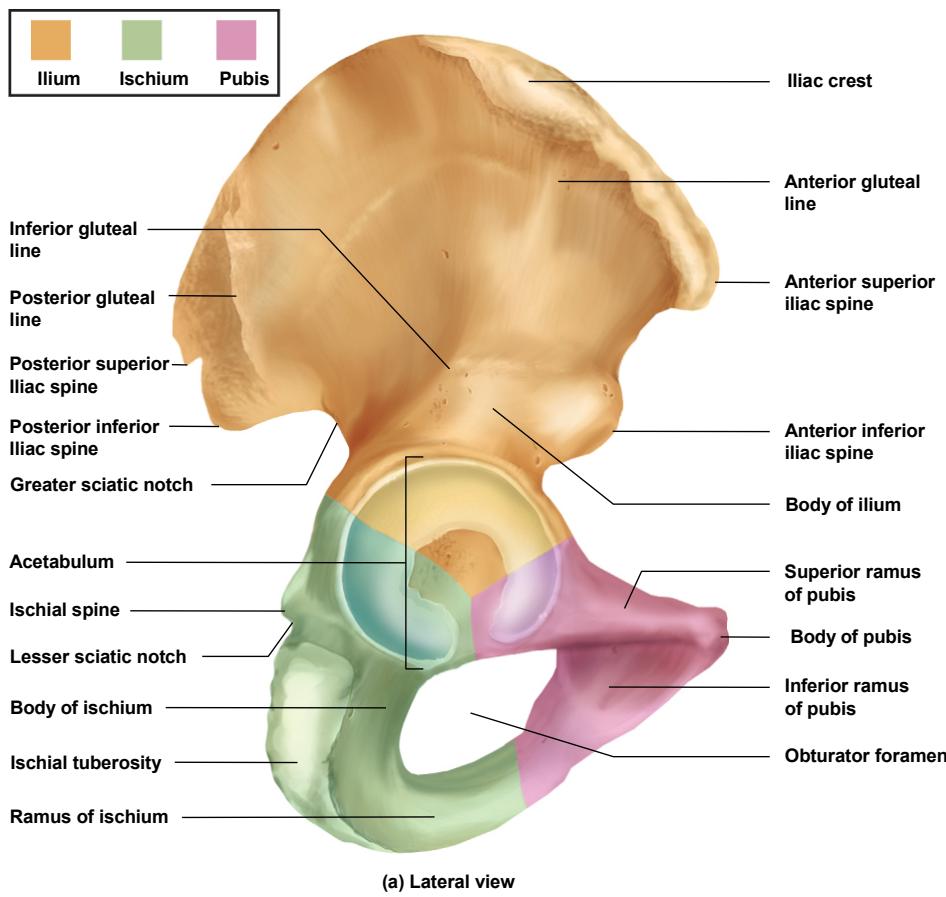
Figure 8.35a

- **greater (false) pelvis** – between flare of the hips
- **lesser (true) pelvis** – narrower and below
- **pelvic brim** – round margin that separates the two
- **pelvic inlet** – opening circumscribed by brim that infant's head must pass during birth
- **pelvic outlet** – lower margin of the lesser pelvis

Hip Bone

- three distinct features of hip bone
 - **iliac crest** – superior crest of hip
 - **acetabulum** – the hip socket
 - **obturator foramen** – large hole below acetabulum
- each adult hip bone is formed by the fusion of **three childhood bones**
 - **ileum**
 - **ischium**
 - **pubis (public bone)**

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(a) Lateral view

Figure 8.36a

Comparison of Male and Female

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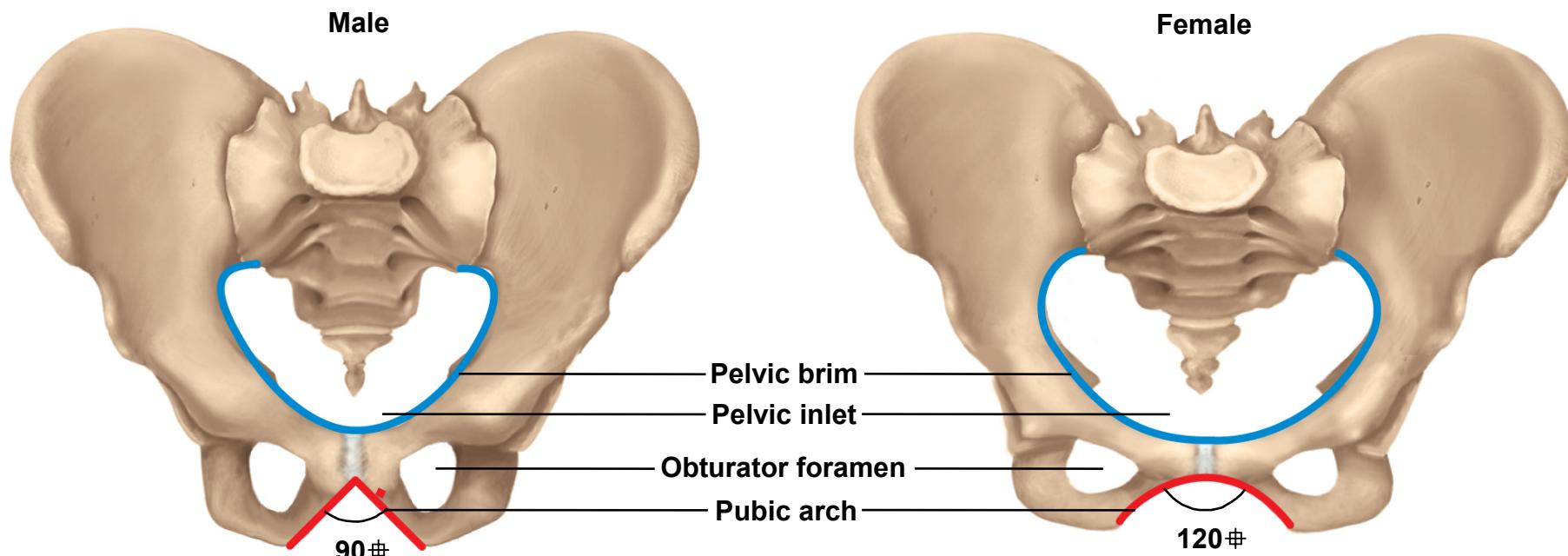


Figure 8.37

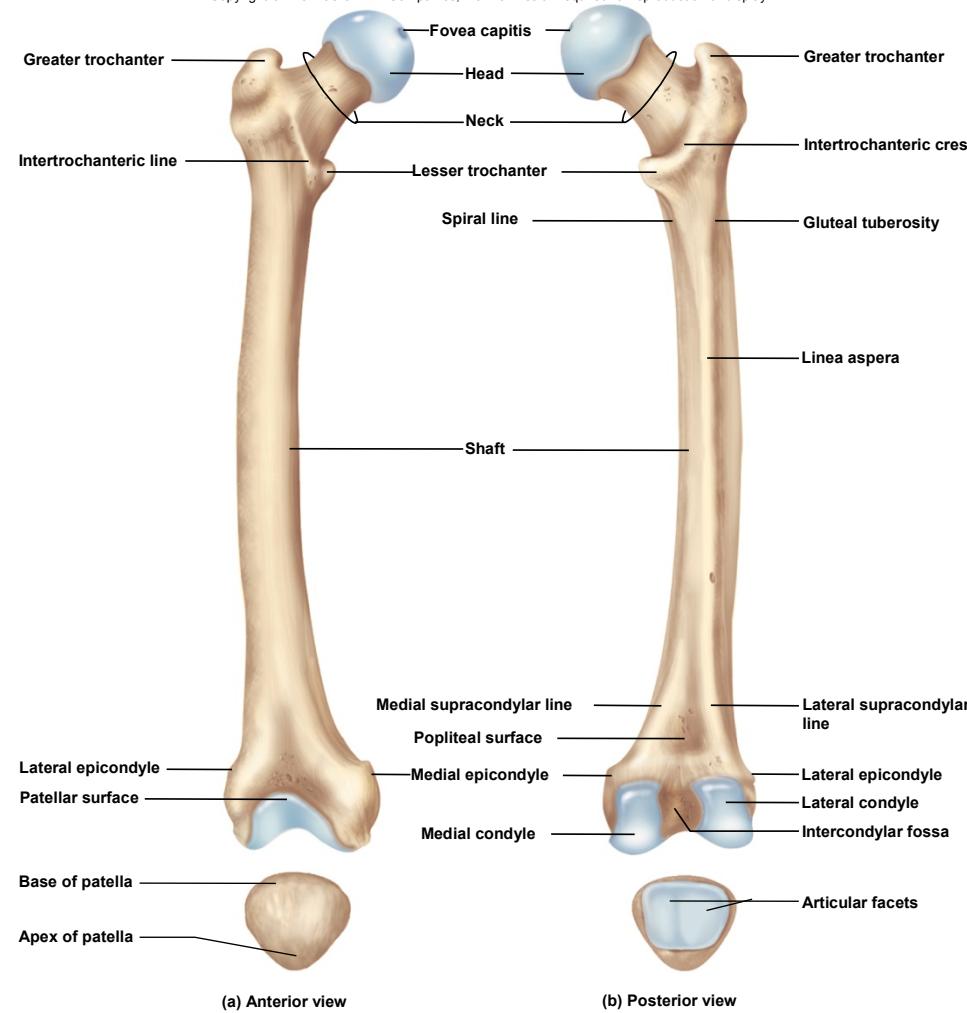
- male - heavier and thicker due to forces exerted by stronger muscles
- female - wider and shallower, and adapted to the needs of pregnancy and childbirth, larger pelvic inlet and outlet for passage of infant's head

Lower Limb

- **Femur (upper leg)**
- **Patella (knee cap)**
- medial **tibia** and lateral **fibula (lower leg)**
- 7 tarsal bones, 5 metatarsals, and 14 phalanges in the toes (foot)

Femur

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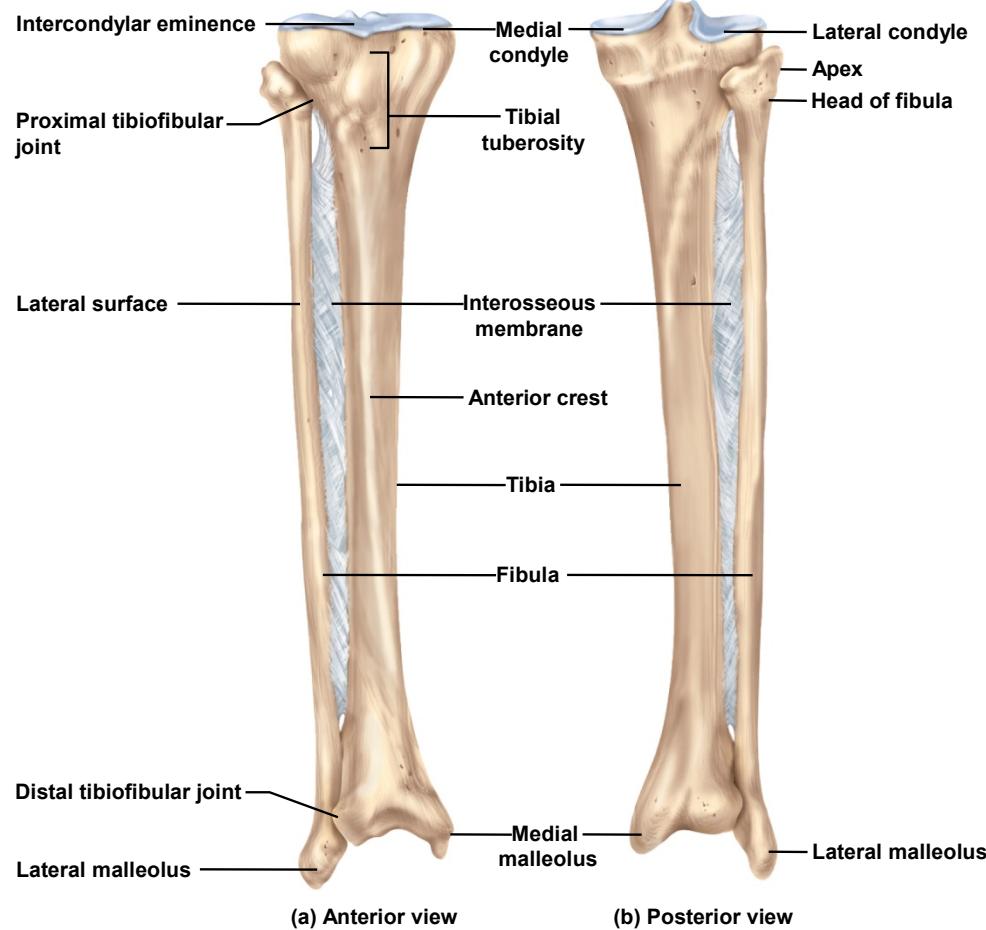


- **head** that articulates with the acetabulum of the pelvis
 - forms ball-and-socket joint
- **greater and lesser trochanters** for muscle attachment
- **medial and lateral condyles** and **epicondyles** found distally

Figure 8.38

Tibia

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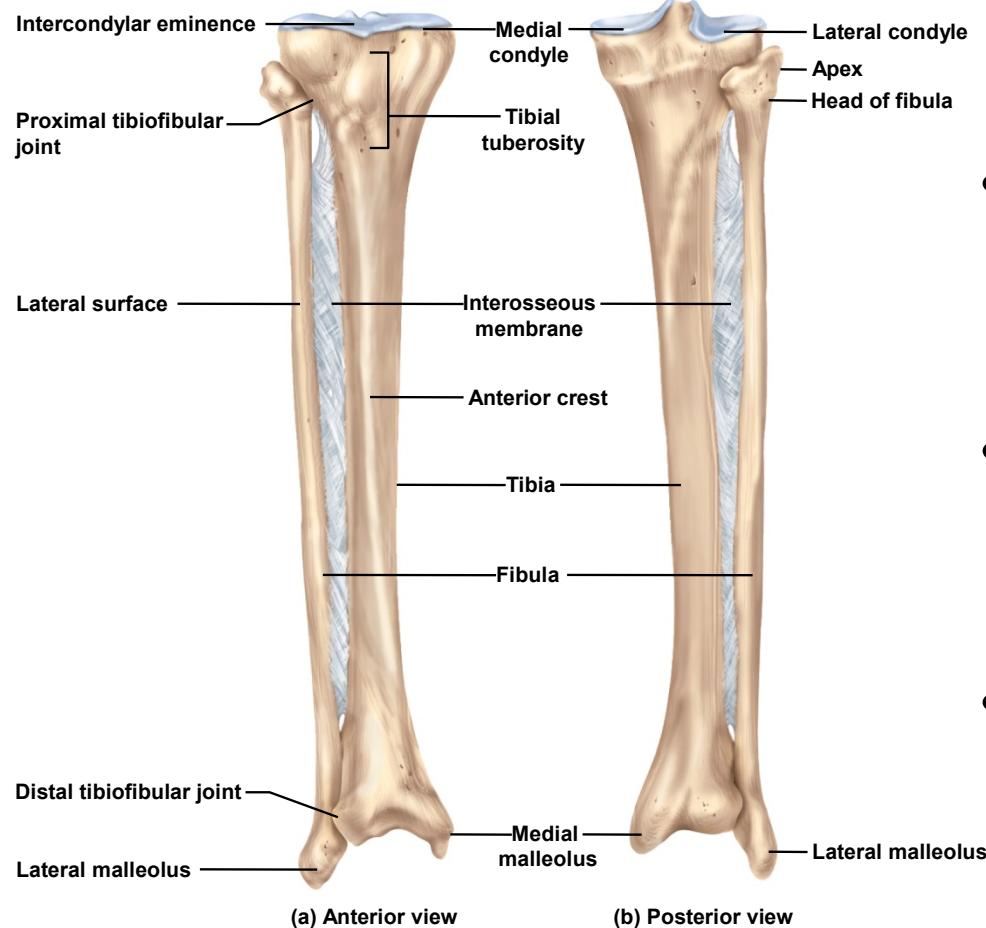


- **tibia** - thick, medial, weight-bearing bone
 - **medial and lateral condyles**
 - fairly flat articular surfaces
 - articulate with condyle of femur
 - **tibial tuberosity** – attachment of quadricep muscles
 - **medial malleolus** – bony knob on inside of ankle

Figure 8.39

Fibula

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- **fibula** – slender, lateral strut that helps stabilizes ankle
- does not bear any body weight
- **lateral malleolus** - distal expansion, bony knob on lateral side of ankle
- joined to tibia by **interosseous membrane**

Figure 8.39

The Ankle and Foot

- **tarsal bones** – arranged in proximal and distal groups
- **calcaneus** – largest tarsal bone
 - forms heel
 - distal portion is point of attachment for **calcaneal (Achilles) tendon**
- **talus** is most superior tarsal bone
 - forms ankle joint with tibia and fibula
 - sits upon calcaneus and articulates with navicular

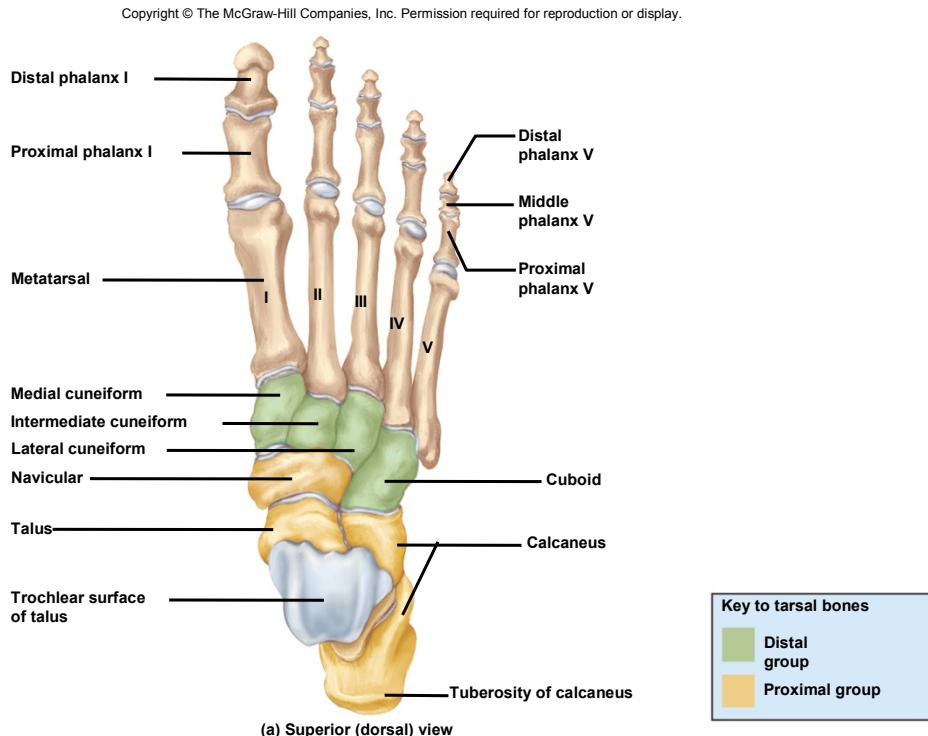
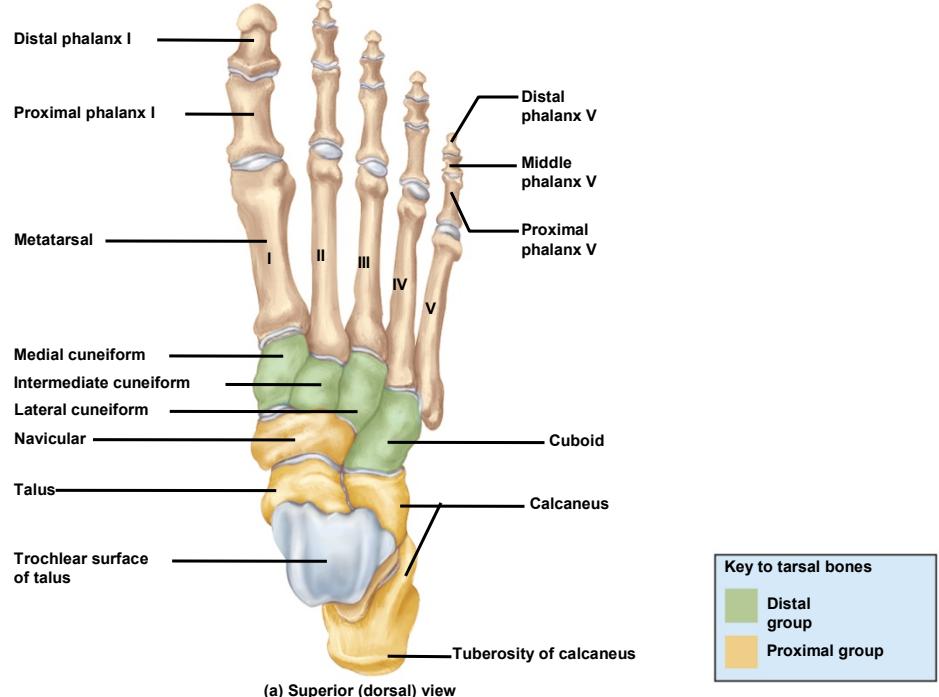


Figure 8.40a

The Foot

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- remaining bones of foot are similar in name and arrangement to the hand
 - **metatarsals**
 - **phalanges**

Figure 8.40a