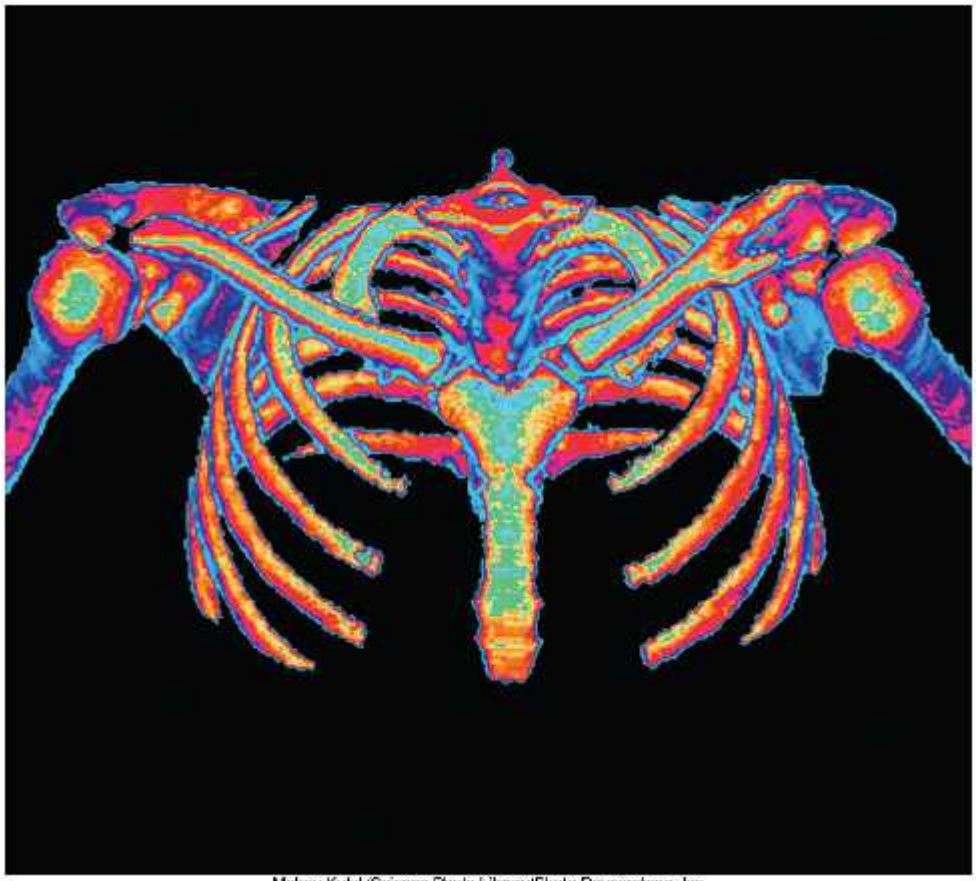


Mehau Kulyk/Science Photo Library/Photo Researchers, Inc

Chapter 8

*Lecture PowerPoint

The Skeletal System

*See separate *FlexArt PowerPoint* slides for all figures and tables preinserted into PowerPoint without notes.

Introduction

- Many organs are named for their relationships to nearby bones
- Understanding muscle movements also depends on knowledge of skeletal anatomy
- Positions, shapes, and processes of bones can serve as landmarks for clinicians

Overview of the Skeleton

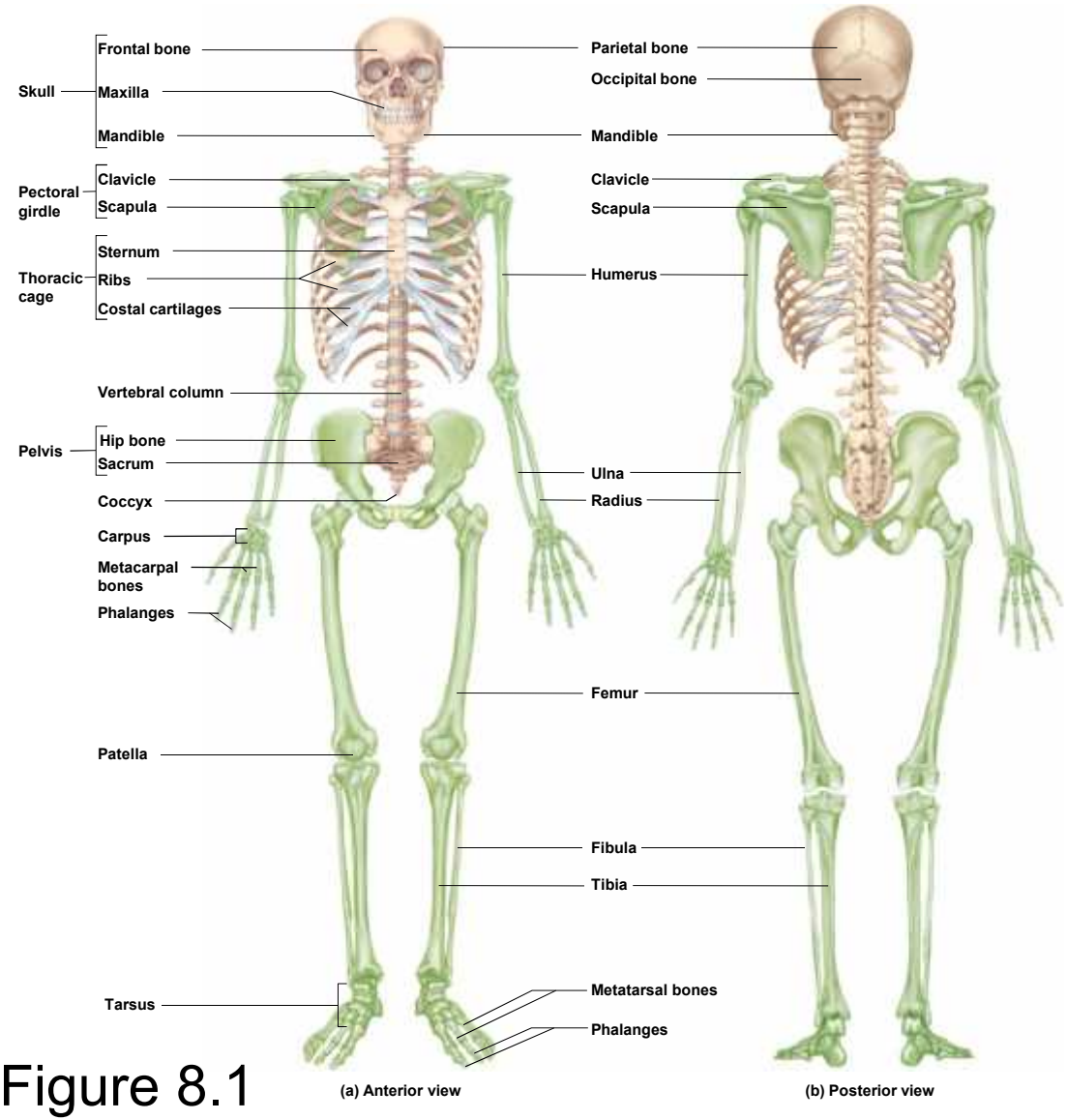


Figure 8.1

- **Axial skeleton** is colored **tan**
  - Forms central supporting axis of the body
  - Skull, vertebrae, sternum, ribs, sacrum, and hyoid
- **Appendicular skeleton** is colored **green**
  - Pectoral girdle
  - Upper extremity
  - Pelvic girdle
  - Lower extremity

Bones of the Skeletal System

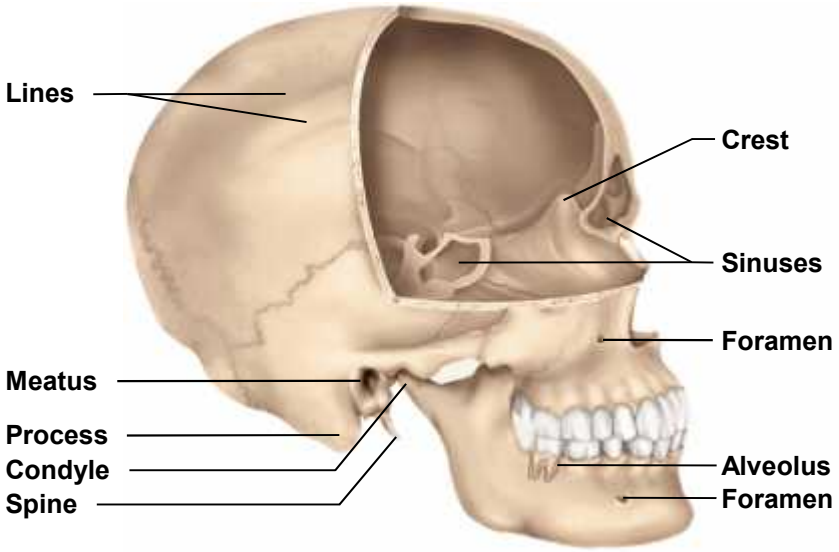
- **Number of bones**
  - **206** in typical adult skeleton
    - Varies with development of **sesamoid bones (patella)**
      - Bones that form within some tendons in response to stress
    - Varies with presence of **sutural (wormian) bones** in skull
      - Extra bones that develop in skull suture lines
  - **270** bones at birth, decreases with fusion
- **Surface markings**
  - Ridges, spines, bumps, depressions, canals, pores, slits, cavities, and articular surfaces

Anatomical Features of Bones

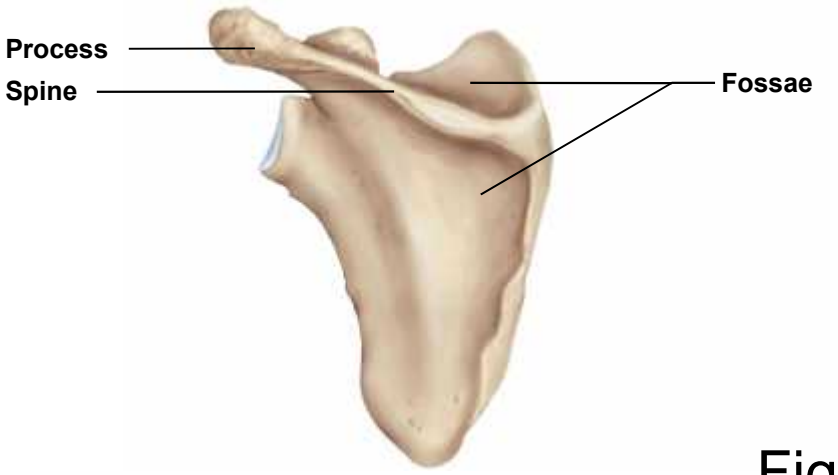
- **Bone markings**—ridges, spines, bumps, depressions, canals, pores, slits, cavities, and articular surfaces

- Ways to study bones
  - Articulated skeleton: held together by wire and rods, show spatial relationship to each other
  - Disarticulated bones: bones taken apart so their surface features can be studied in more detail

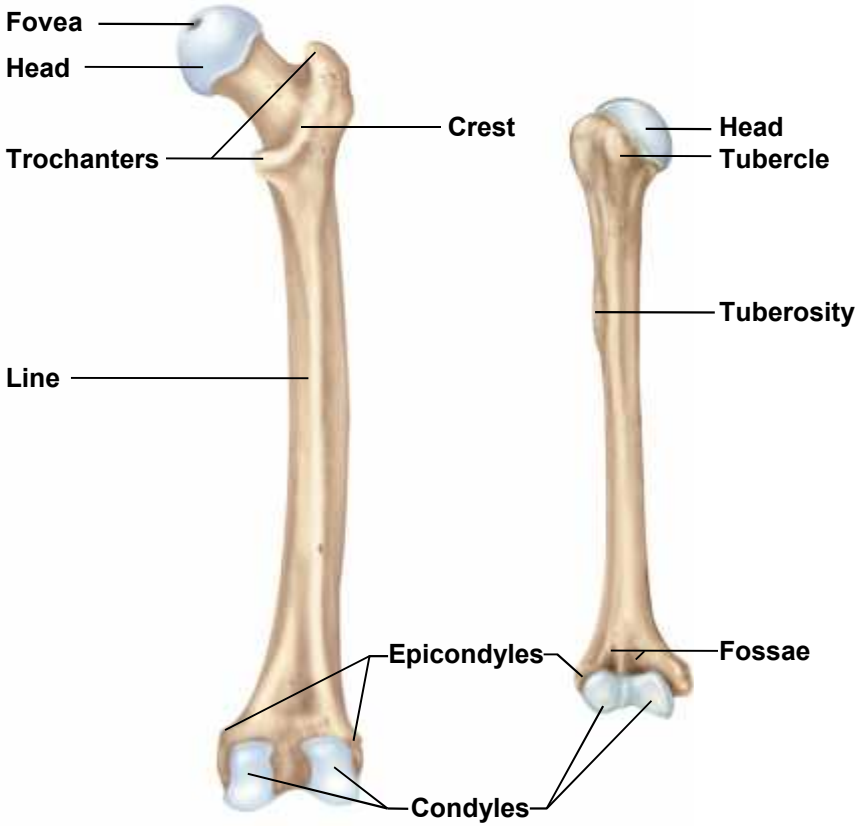
Anatomical Features of Bones



(a) Skull (lateral view)



(b) Scapula (posterior view)



(c) Femur (posterior view)

(d) Humerus (anterior view)

Figure 8.2

The Skull

- **Expected Learning Outcomes**
  - Distinguish between cranial and facial bones.
  - Name the bones of the skull and the anatomical features.
  - Identify the cavities in the skull and in some of its individual bones.
  - Name the principal sutures that join the bones of the skull.
  - Describe some bones that are closely associated with the skull.
  - Describe the development of the skull from infancy through childhood.

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

The Skull

- **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

The Skull

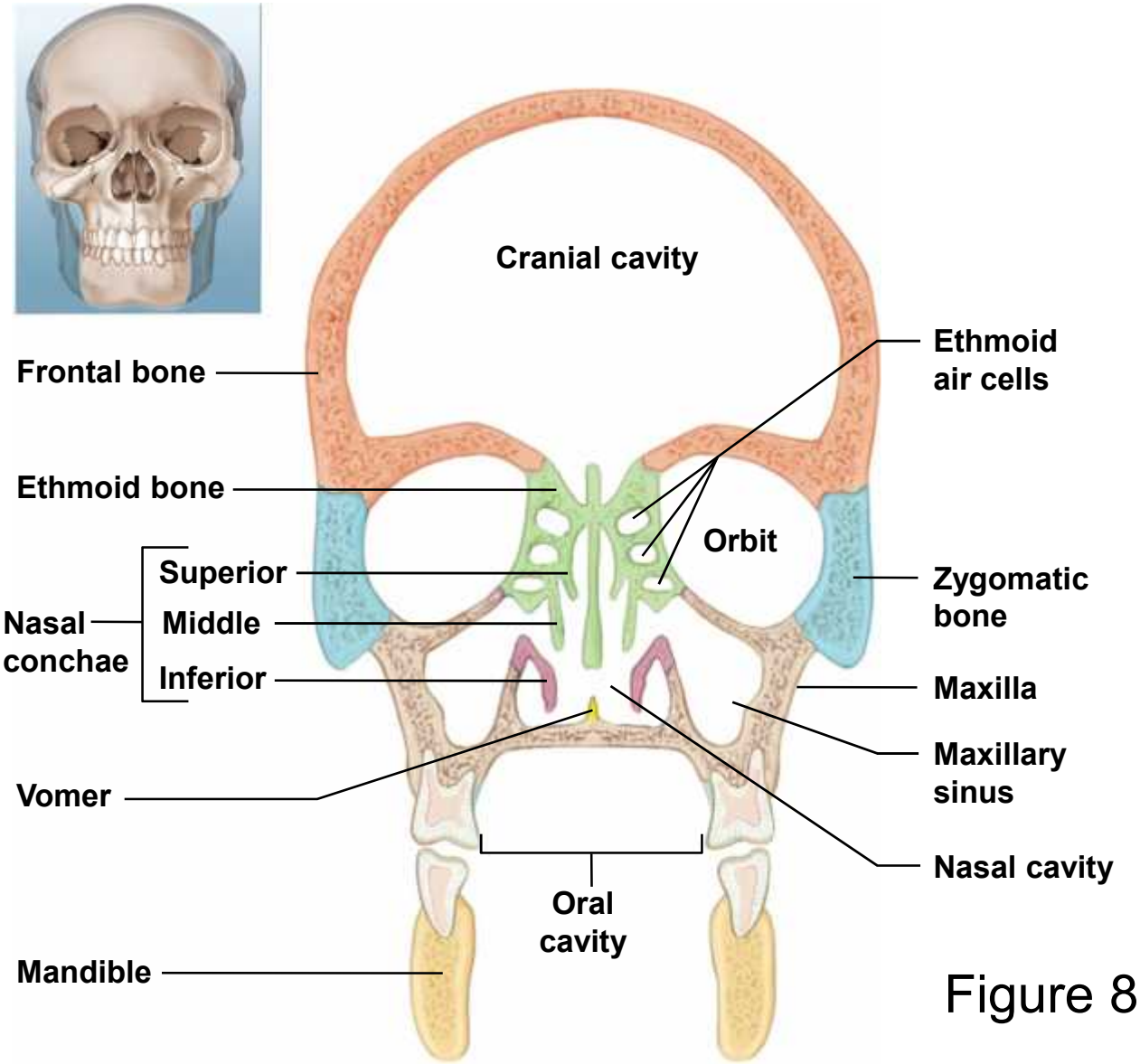


Figure 8.7

Cranial Bones

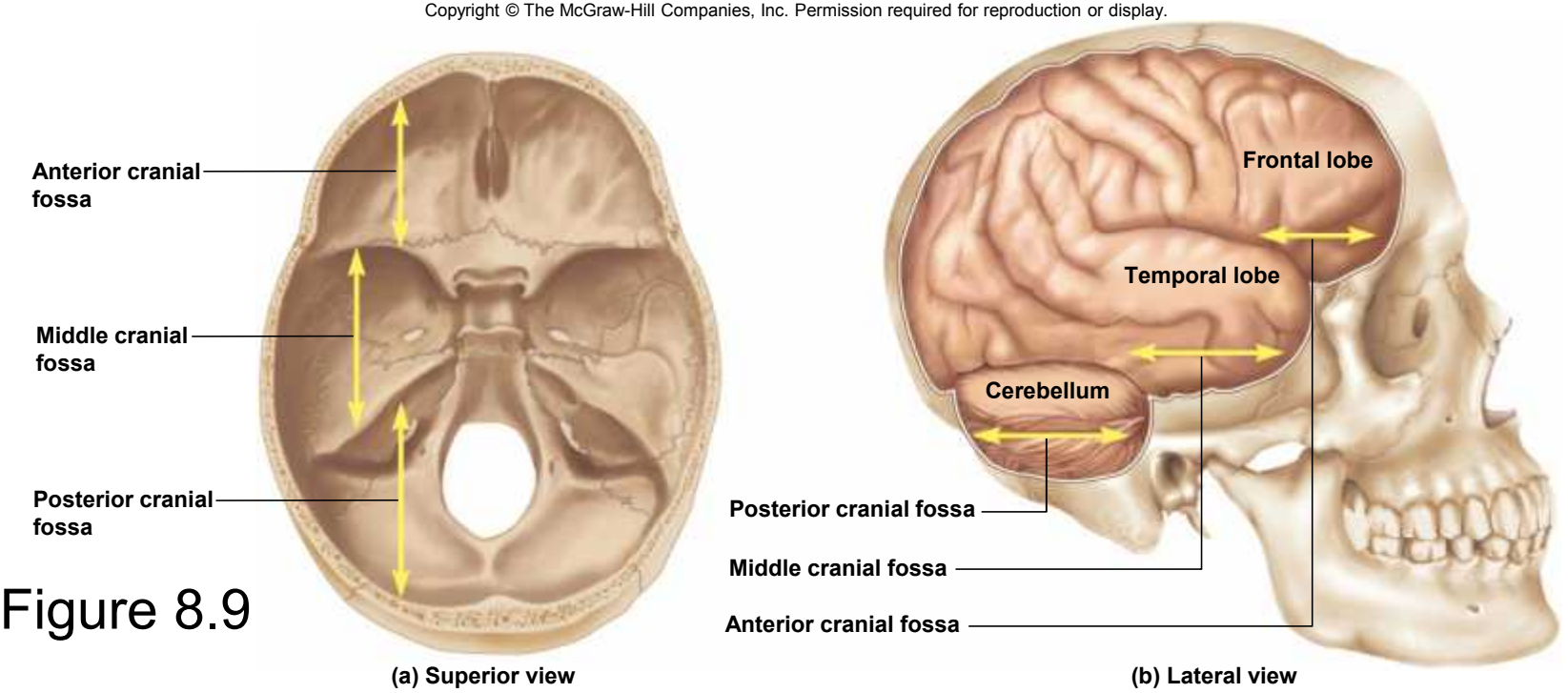
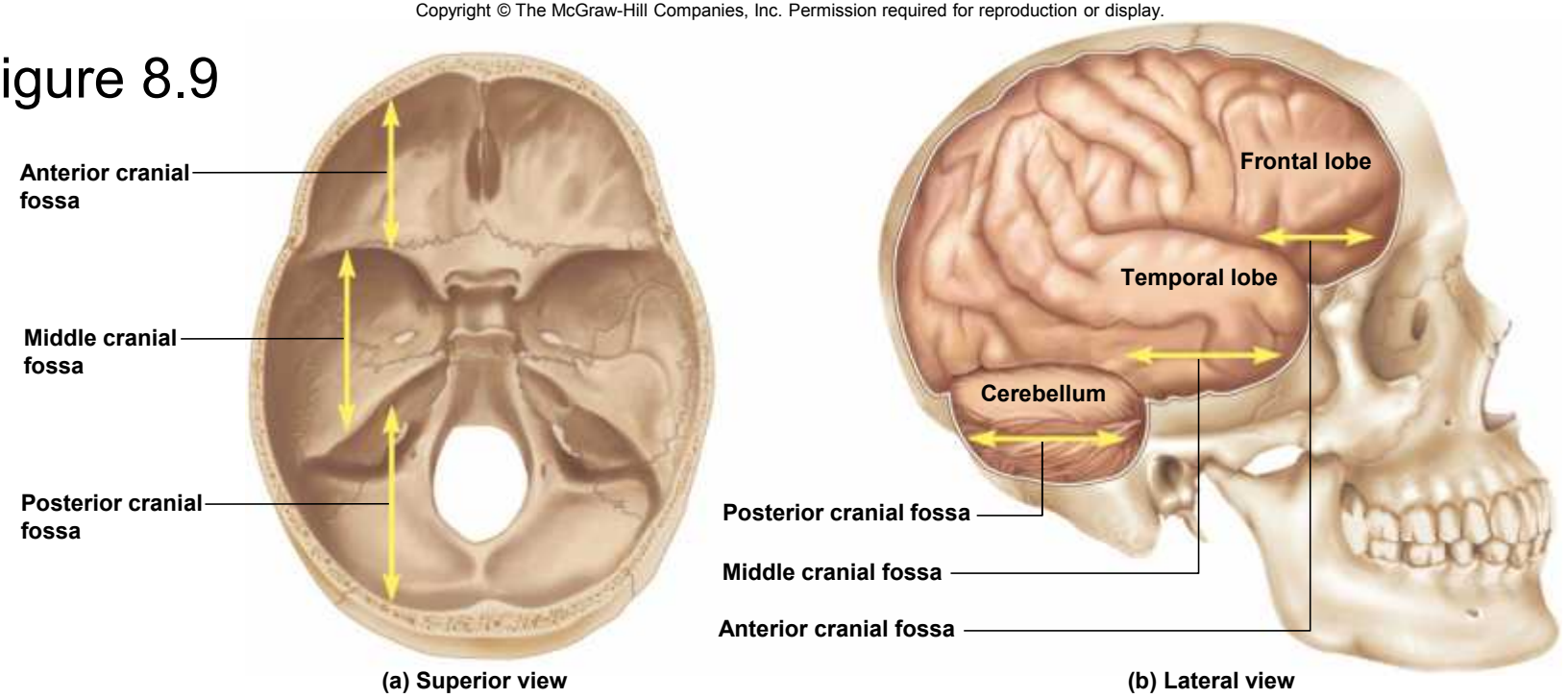


Figure 8.9

- **Cranium (braincase)**—protects the brain and associated sense organs
  - Meninges separates brain from direct contact with bones—that is, dura mater
  - Swelling of the brain inside the rigid cranium may force tissue through foramen magnum (large hole, exit for spinal cord) resulting in death
  - Consists of two parts: **calvaria** (skullcap) and cranial **base**

Cranial Bones

Figure 8.9



- **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
- **8 cranial bones: 1 frontal, 2 parietal, 2 temporal, 1 occipital, 1 sphenoid, 1 ethmoid**

The Frontal Bone

- Forms **forehead** and part of the roof of the cranium
- **Coronal suture**—posterior boundary of frontal bone
- **Supraorbital margin** forms roof of the orbit
- **Supraorbital foramen** provides passage for nerve, artery, and vein
- **Glabella**—smooth area above root of the nose
- Contains **frontal sinus**

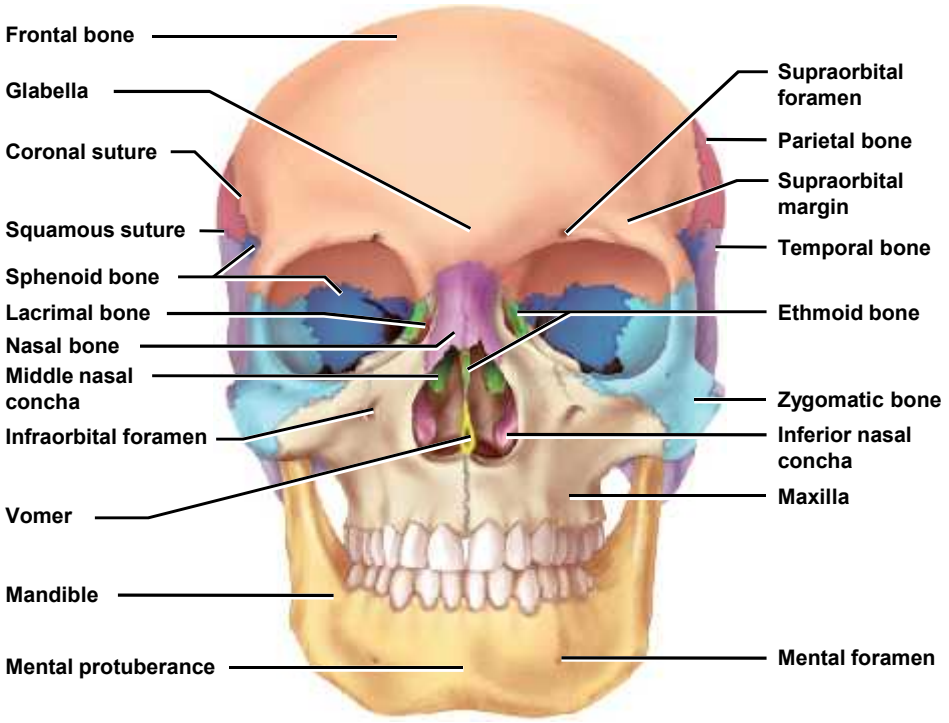


Figure 8.3

The Parietal Bones

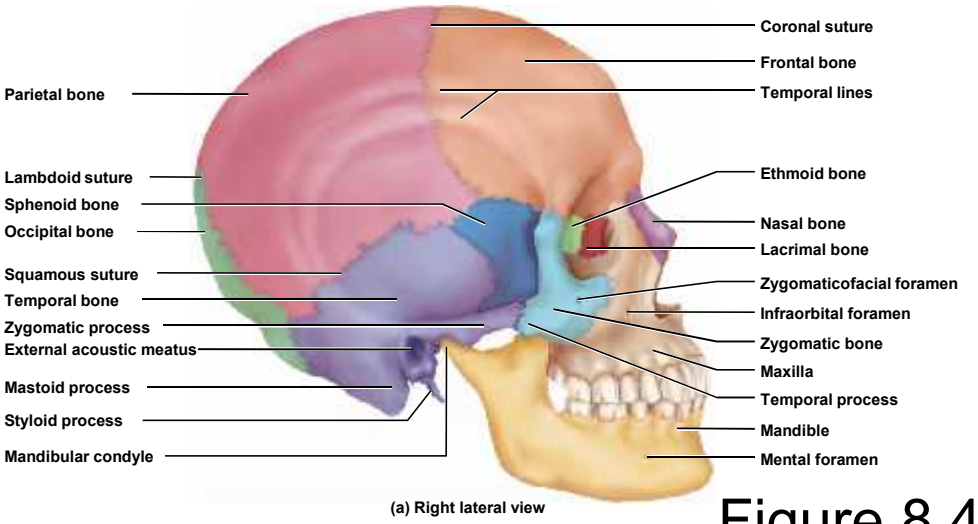


Figure 8.4a

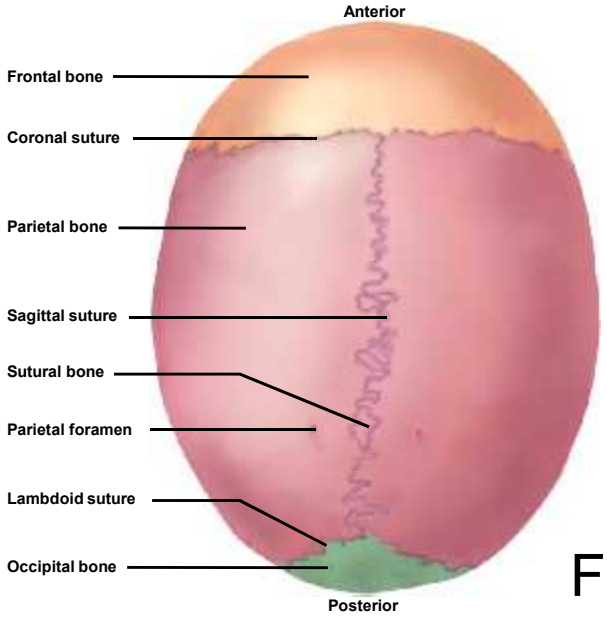
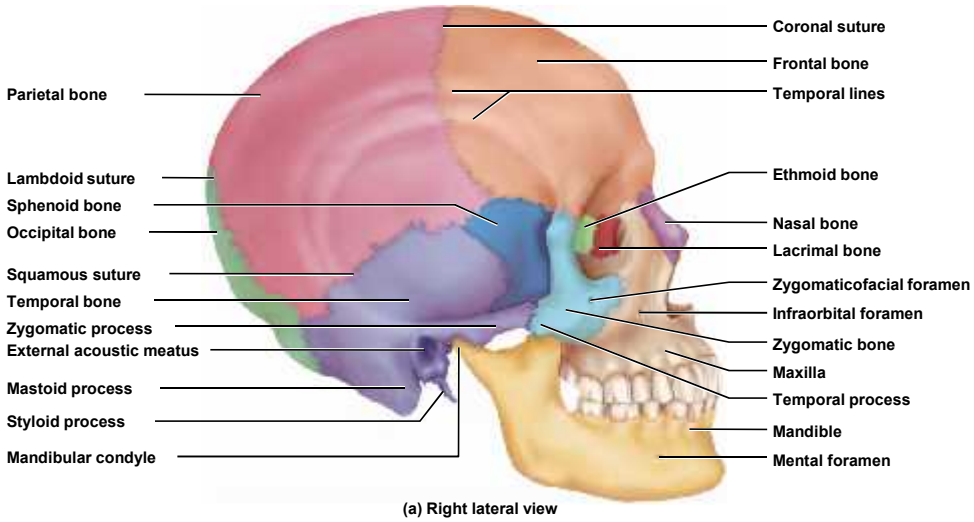


Figure 8.6

- Form most of cranial roof and part of its lateral walls
- Bordered by **four sutures**
  - **Sagittal:** between parietal bones
  - **Coronal:** at anterior margin
  - **Lambdoid:** at posterior margin
  - **Squamous:** at lateral border
- Two **temporal lines** serve as attachment of the temporalis muscle

The Temporal Bones



(a) Right lateral view

Figure 8.4a

- 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

The Temporal Bones

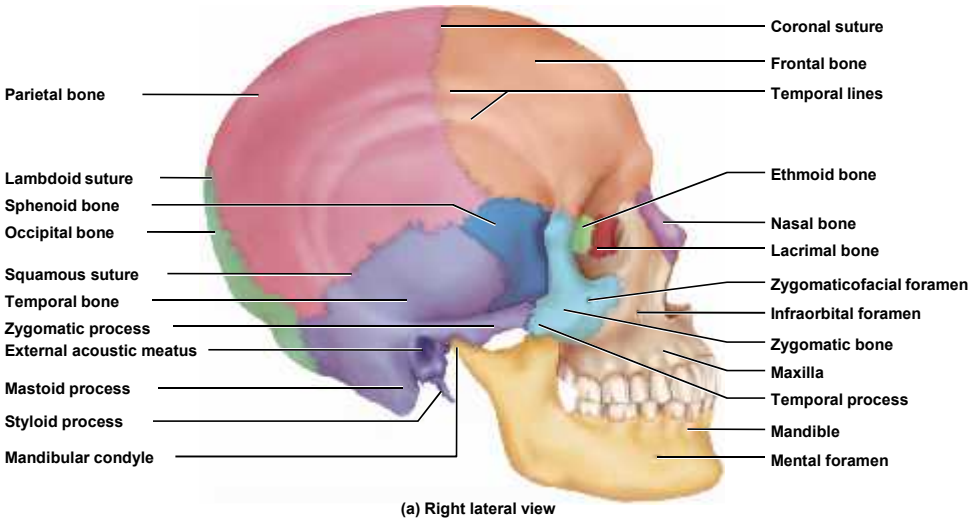
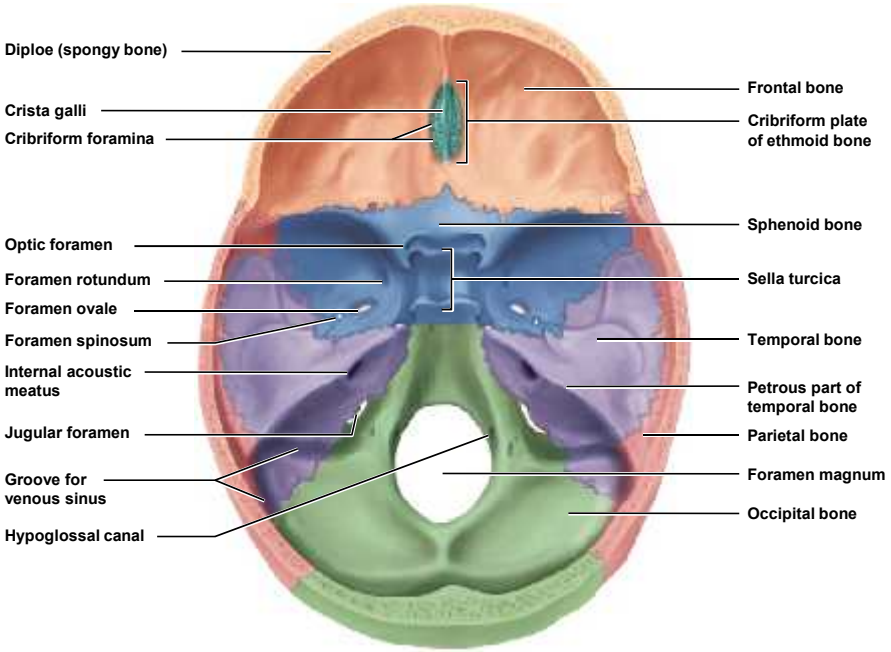


Figure 8.4a

- **Mastoid part**
  - **Mastoid process**
    - Mastoiditis from ear infection
  - Mastoid notch
  - Stylomastoid foramen
  - Mastoid foramen

The Temporal Bones

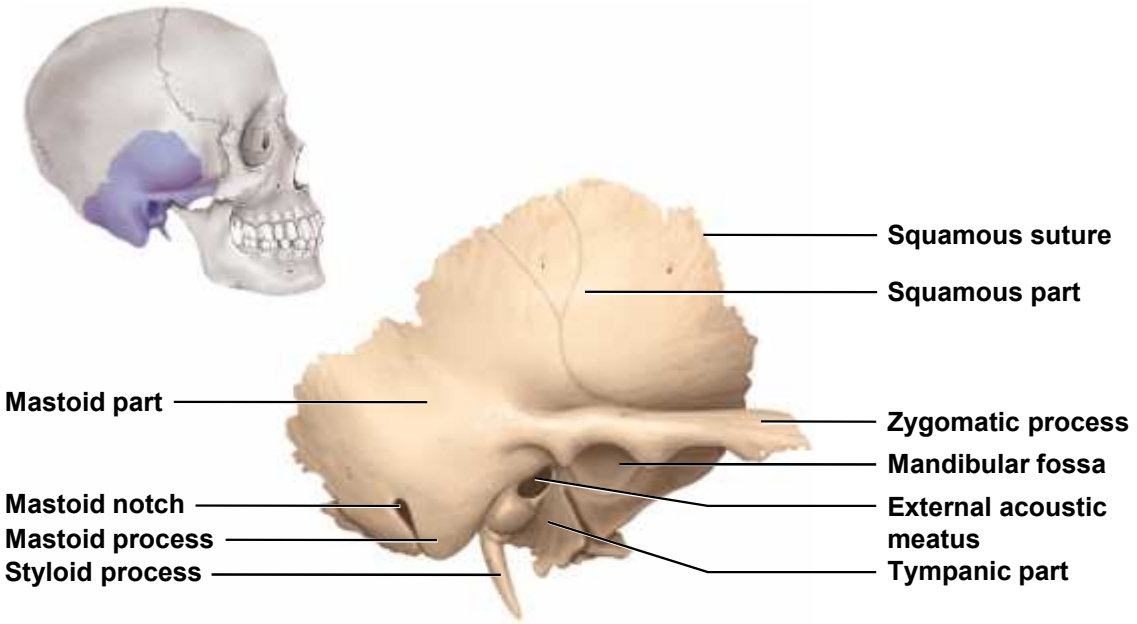


(b) Superior view of cranial floor

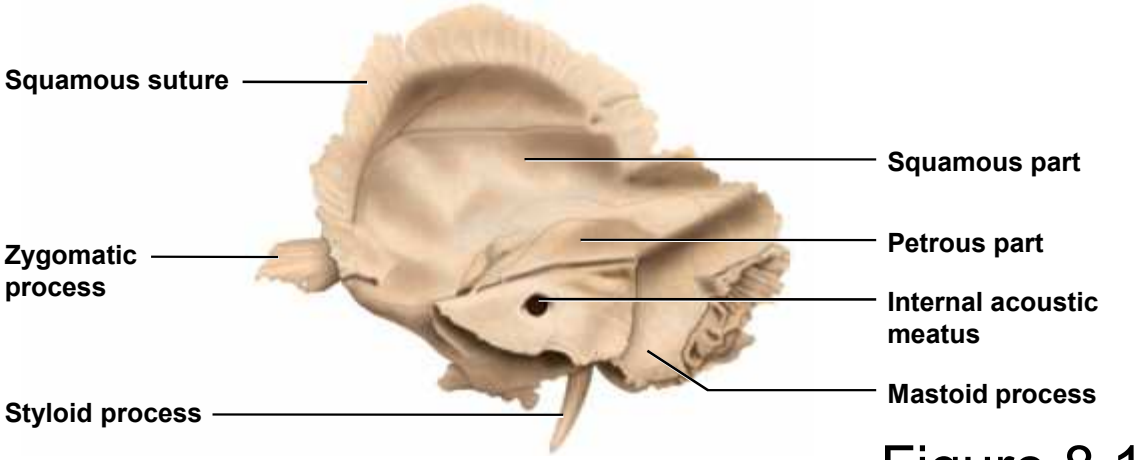
Figure 8.5b

– **Petrous part**
  - Part of cranial floor
  - Separates middle from posterior cranial fossa
  - Houses middle- and inner-ear cavities
  - Receptors for hearing and sense of balance
  - **Internal auditory meatus—o**pening for CN VII (vestibulocochlear nerve)
  - **Carotid canal**
  - **Jugular foramen**

The Temporal Bones



(a) Lateral surface



(b) Medial surface

Figure 8.10

The Occipital Bone

- Rear and base of skull
- **Foramen magnum** holds spinal cord
- **Basilar part,** thick median plate
- Skull rests on atlas at **occipital condyles**
  - **Condylar canal,** posterior to each occipital condyle
- **Hypoglossal canal** transmits hypoglossal nerve (CN XII) supplying tongue muscles
- **External occipital protuberance** for **nuchal ligament**
- **Superior and inferior nuchal lines** mark neck muscles

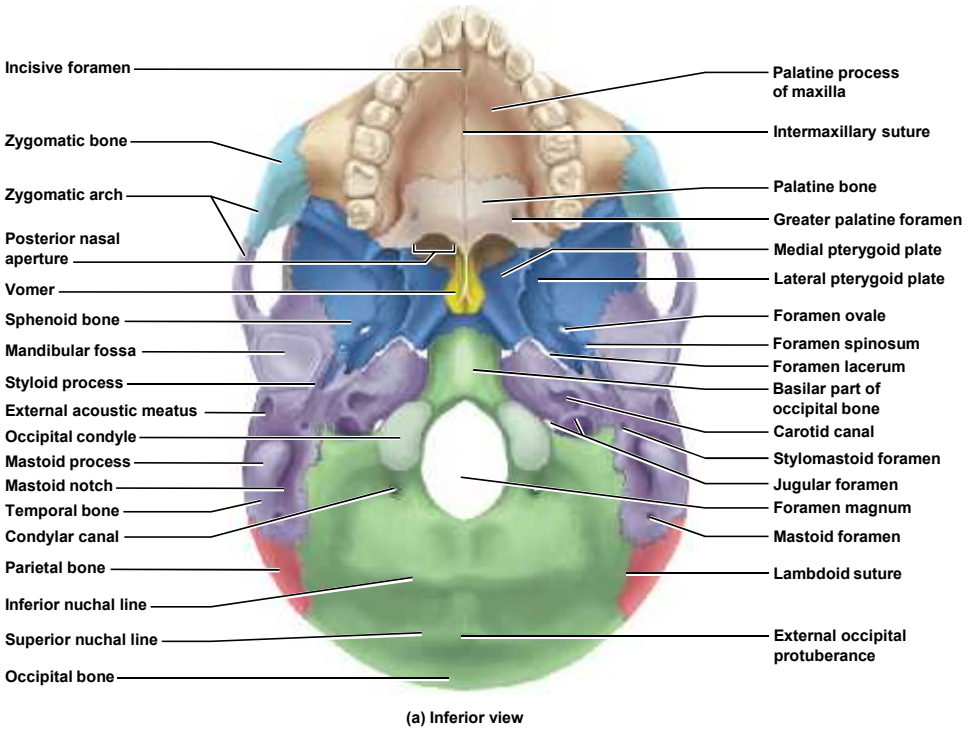
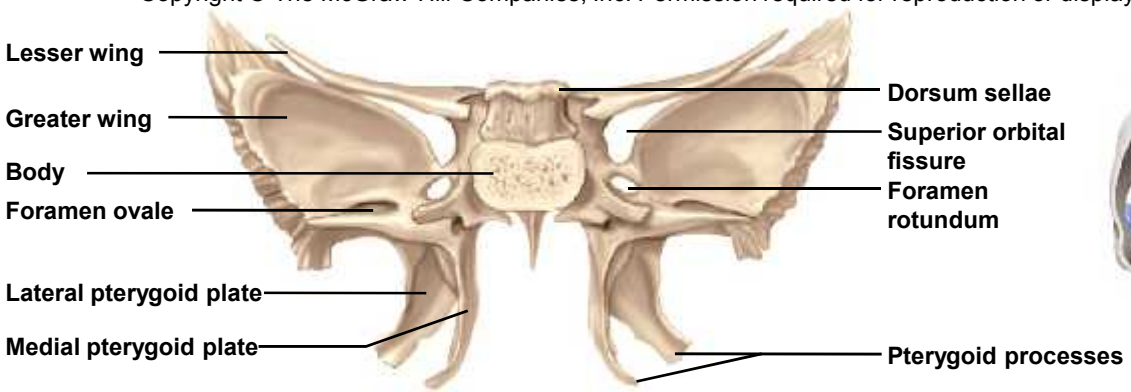


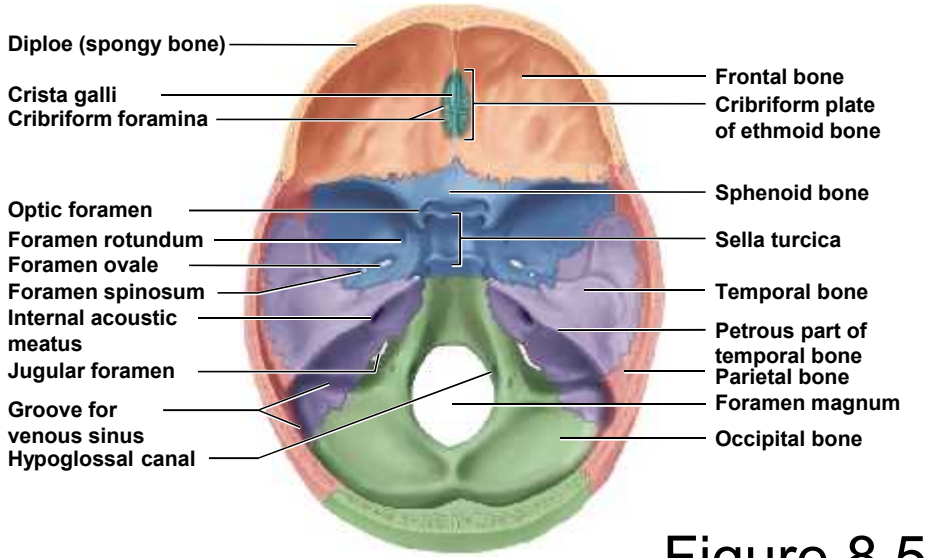
Figure 8.5a

The Sphenoid Bone



(b) Posterior view

Figure 8.11b

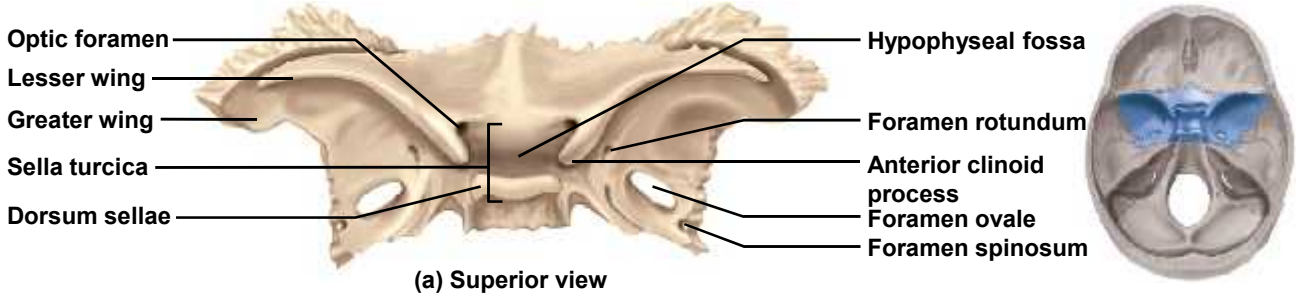


(b) Superior view of cranial floor

Figure 8.5b

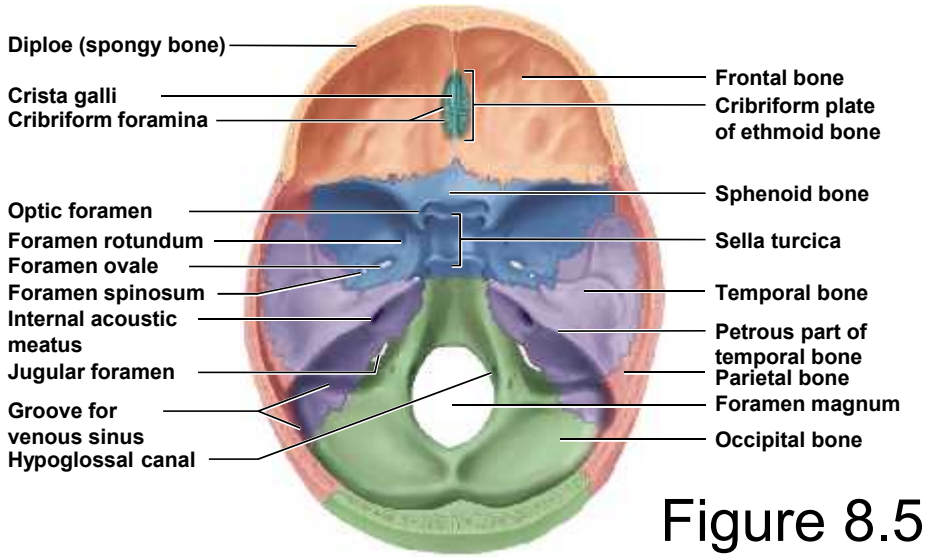
- Body
- Greater wing
- Lesser wing
- Optic foramen
- Anterior clinoid processes
- Superior orbital fissure

The Sphenoid Bone



(a) Superior view

Figure 8.11a

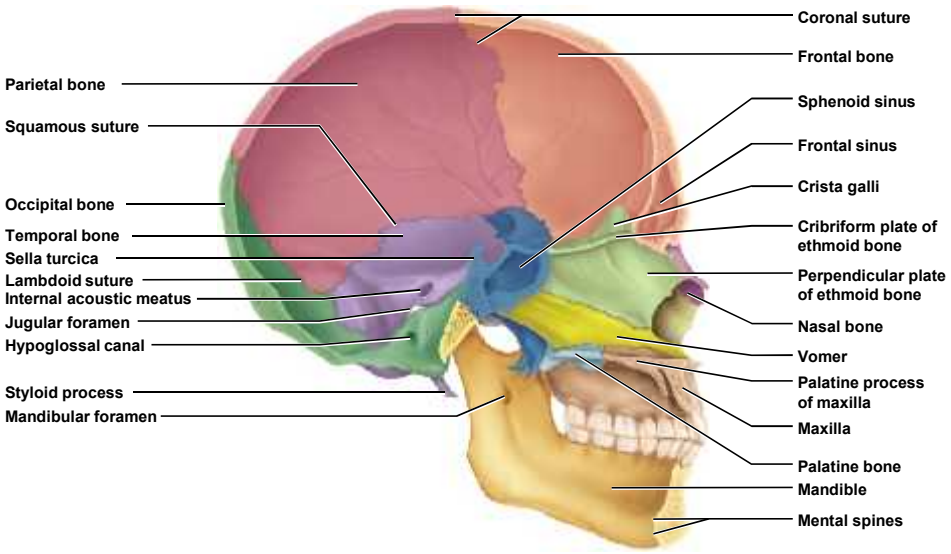


(b) Superior view of cranial floor

Figure 8.5b

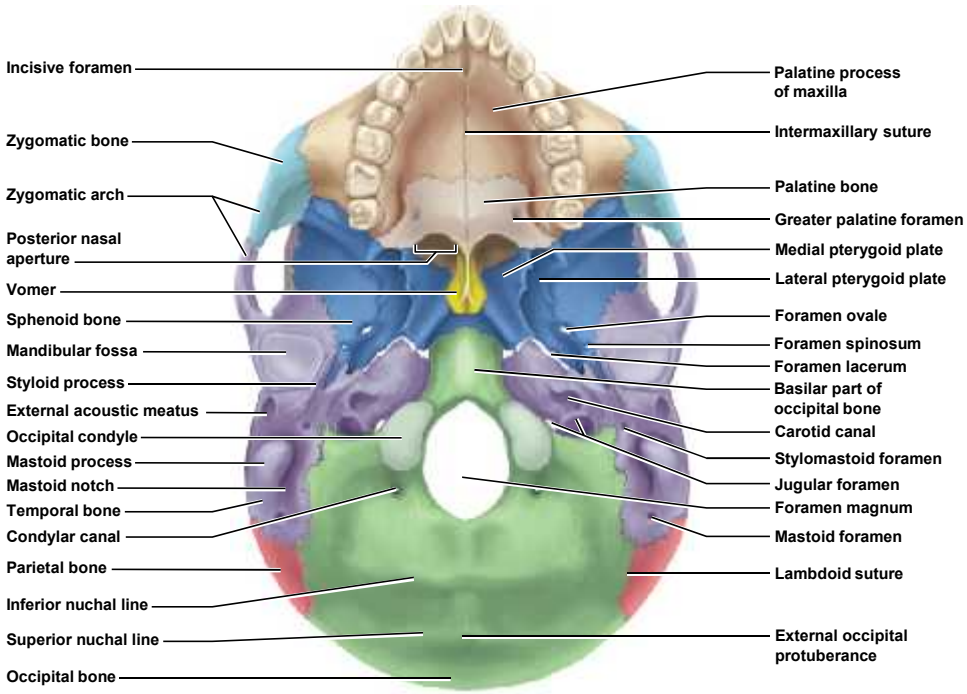
- Foramen rotundum
- Foramen ovale
- Foramen lacerum
- Posterior nasal apertures or choanae
- Medial pterygoid plate
- Lateral pterygoid plate
- Sphenoid sinus

The Sphenoid Bone



(b) Median section

Figure 8.4b



(a) Inferior view

Figure 8.5a

Sphenoid sinus

The Ethmoid Bone

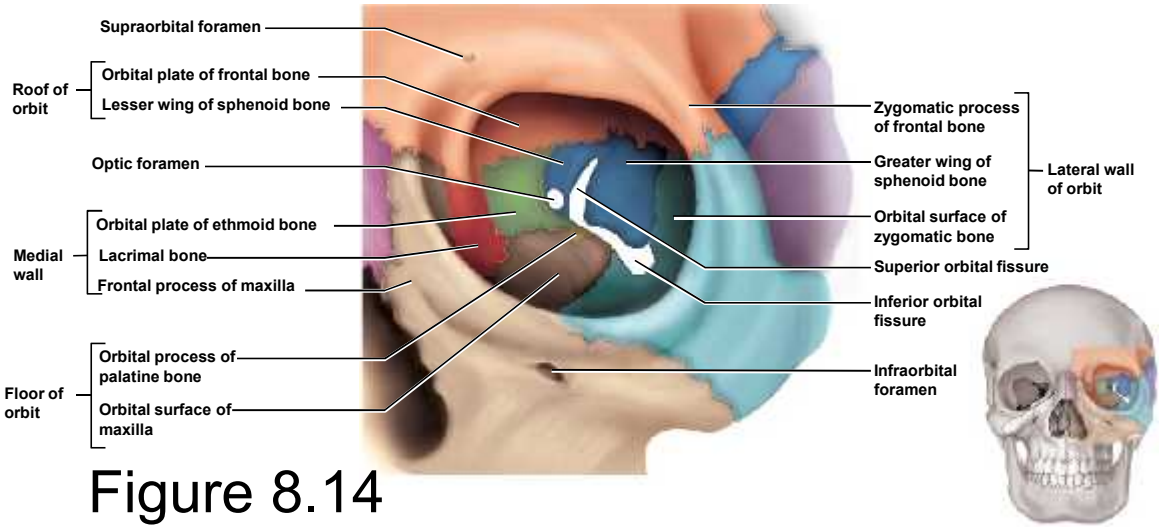


Figure 8.14

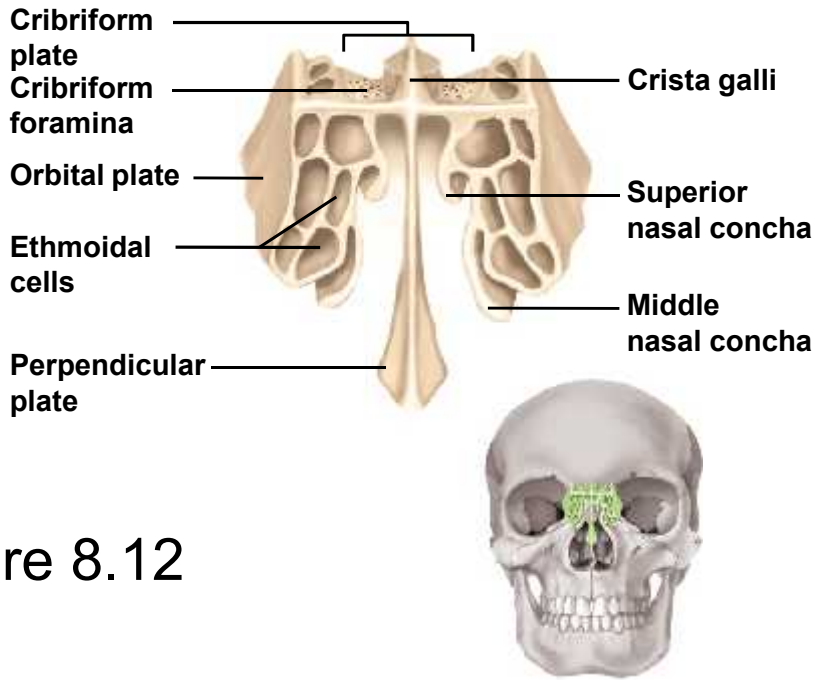


Figure 8.12

- Anterior cranial bones located between the eyes
- Contributes to medial wall of orbit
- Lateral walls and roof of nasal cavity, and nasal septum
- **Three major portions** of this porous, delicate bone
- **Perpendicular plate** forms superior two-thirds of nasal septum

The Ethmoid Bone

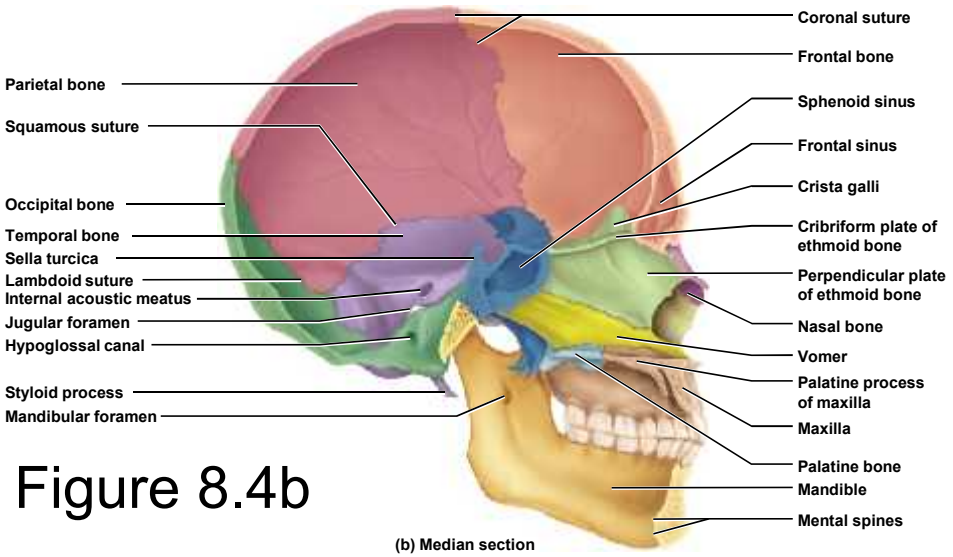


Figure 8.4b

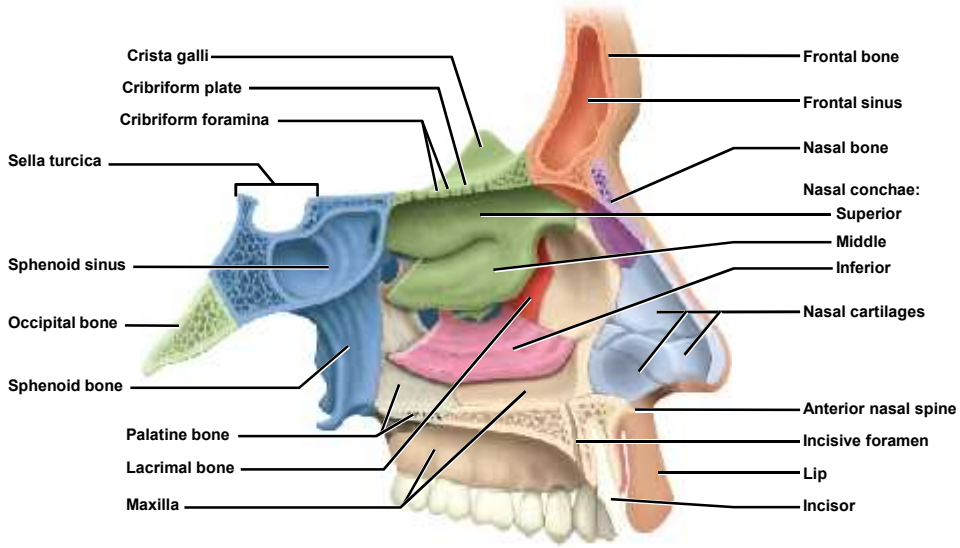
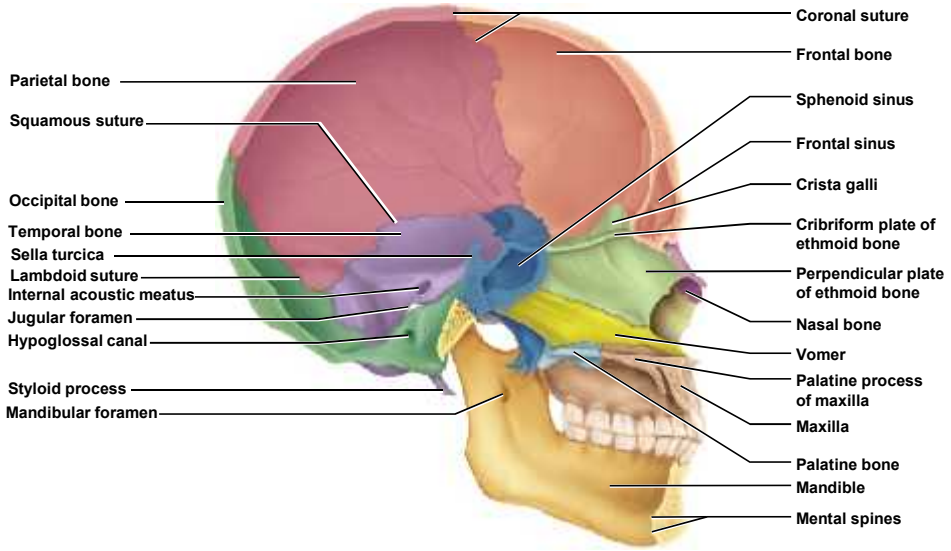


Figure 8.13

- **Cribriform plate**—forms roof of nasal cavity
  - Crista galli: attachment point for meninges
  - Cribriform (olfactory) foramina
- **Labyrinth**—large mass on each side of perpendicular plate
  - Ethmoidal cells make up the ethmoid sinus
  - Orbital plate

The Ethmoid Bone



(b) Median section

Figure 8.4b

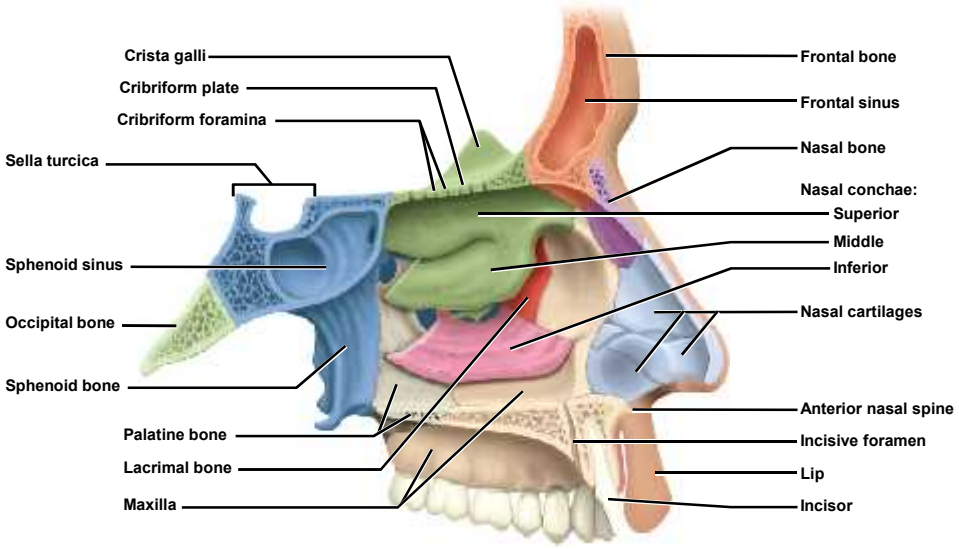


Figure 8.13

- **Superior and middle nasal conchae**—scroll-like plates project into the nasal fossa
- **Inferior nasal concha**—separate bone
- Three chonchae occupy most of the nasal cavity, create turbulence of airflow, humidify air before it reaches the lungs

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 palatine bones
2 zygomatic bones
2 lacrimal bones
2 nasal bones
2 inferior nasal conchae
1 vomer
1 mandible

The Maxillae

- Largest facial bones
- Forms upper jaw and meets at median **intermaxillary suture**
  - **Alveolar processes:** bony points between teeth
  - **Alveolus:** sockets that hold teeth

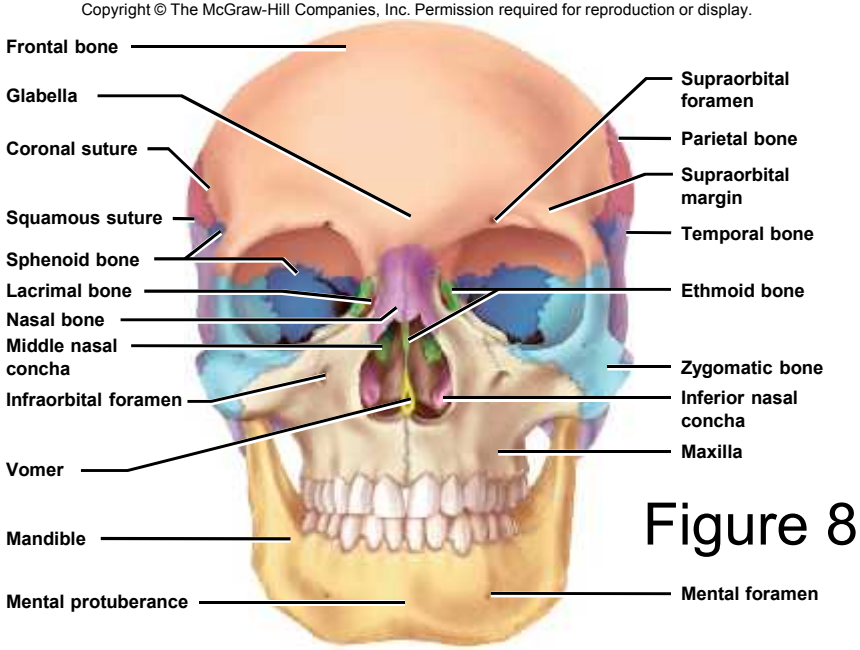


Figure 8.3

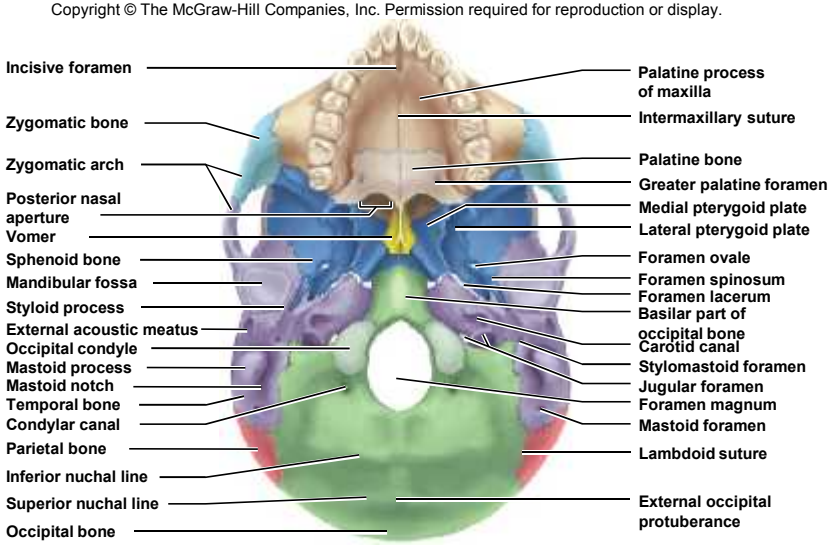


Figure 8.5a

The Maxillae

Cont.

- Forms inferomedial wall of orbit
  - **Infraorbital foramen**
  - **Inferior orbital fissure**

- Forms most of the hard palate
  - **Palatine process**
  - **Palate:** forms roof of mouth and floor of nasal cavity
  - **Incisive foramen**
  - Palate allows us to chew while breathing
  - **Cleft palate** and **cleft lip**

The Maxillae

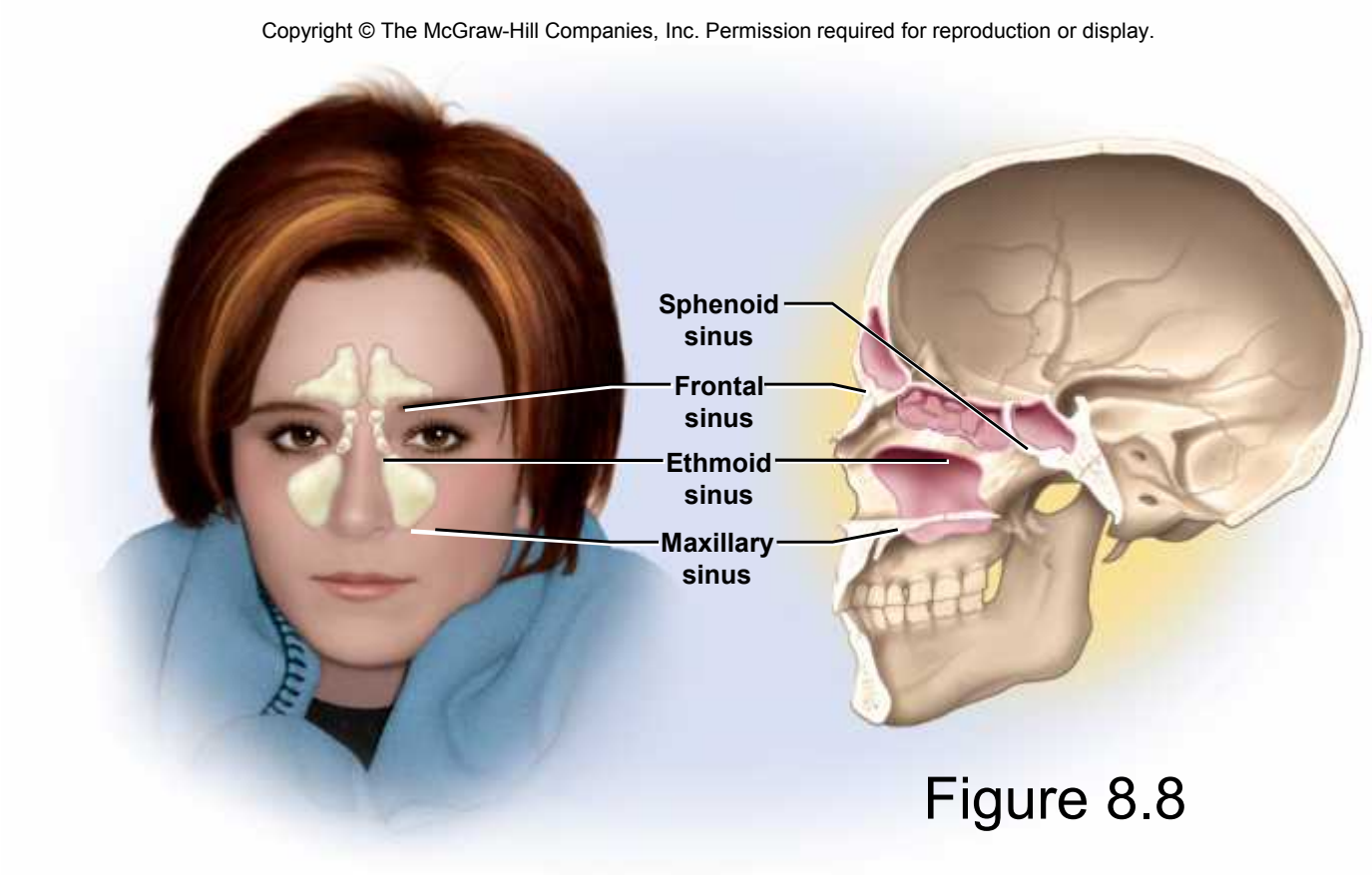


Figure 8.8

- **Maxillary sinus** fills maxillae bone
- Larger in volume than frontal, sphenoid, and ethmoid sinuses

The Palatine Bones

- L-shaped bone
- Form the posterior portion of the hard palate
- Part of lateral nasal cavity wall
- Part of the orbital floor
- **Greater palatine foramina**

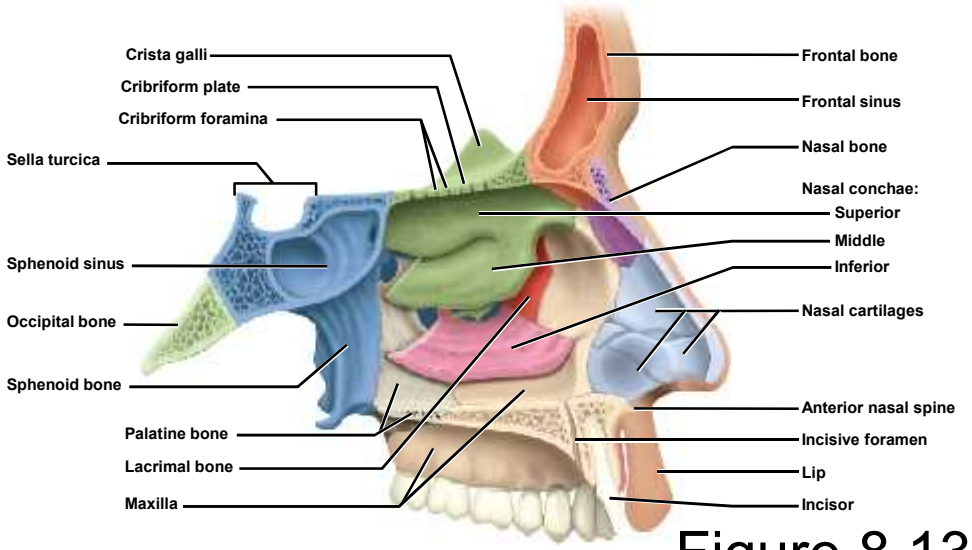


Figure 8.13

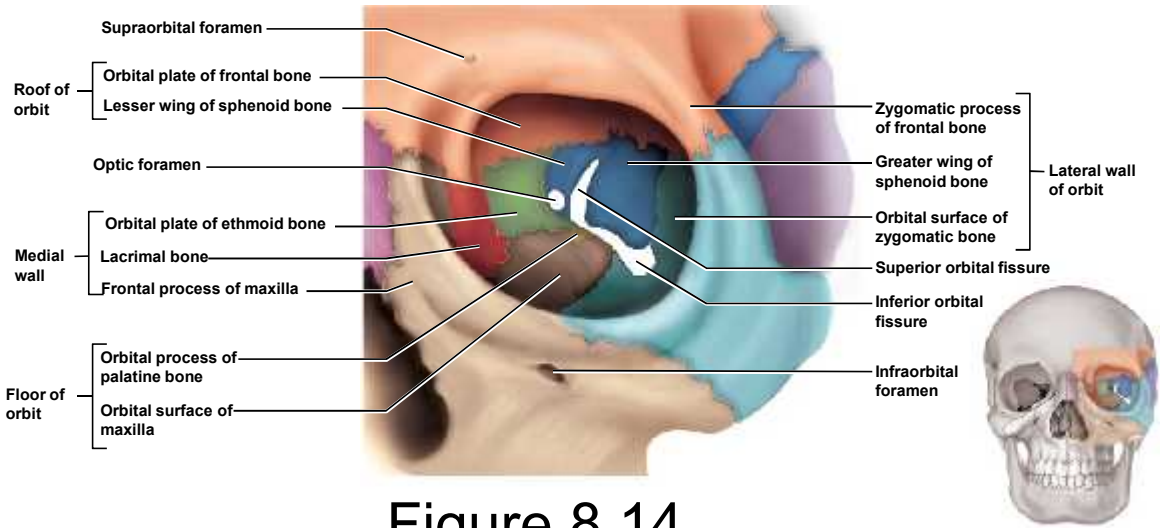


Figure 8.14

The Zygomatic Bones

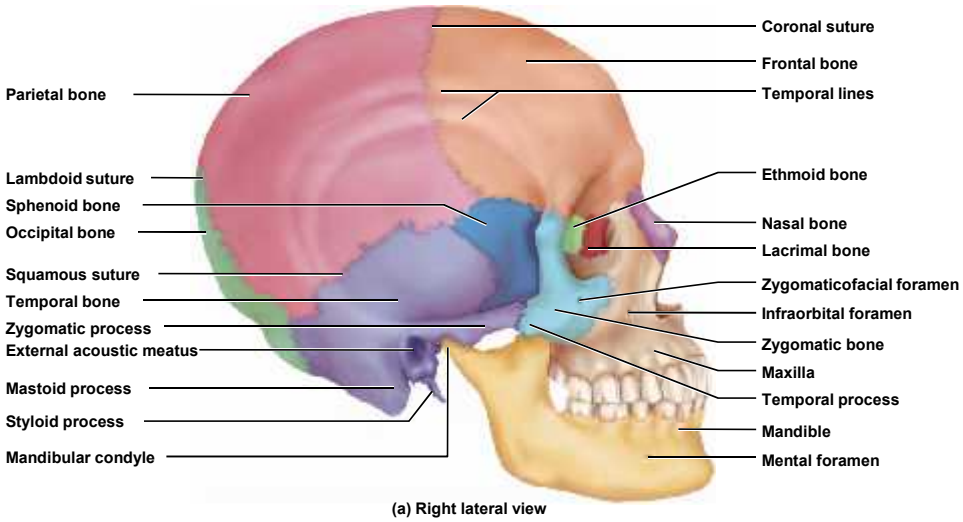


Figure 8.4a

- Forms angles of the cheekbones and part of lateral orbital wall
- **Zygomaticofacial foramen**
- **Zygomatic arch** is formed **from temporal process of zygomatic bone** and **zygomatic process of temporal bone**

The Lacrimal Bones

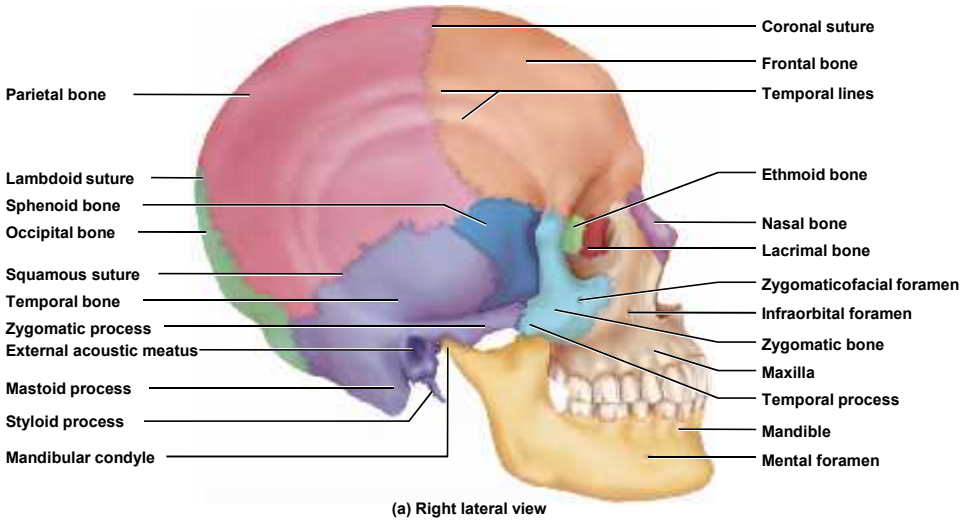


Figure 8.4a

- 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

The Nasal Bones

- Forms bridge of nose
- Supports cartilages that shape lower portion of the nose
- Often fractured by blow to the nose

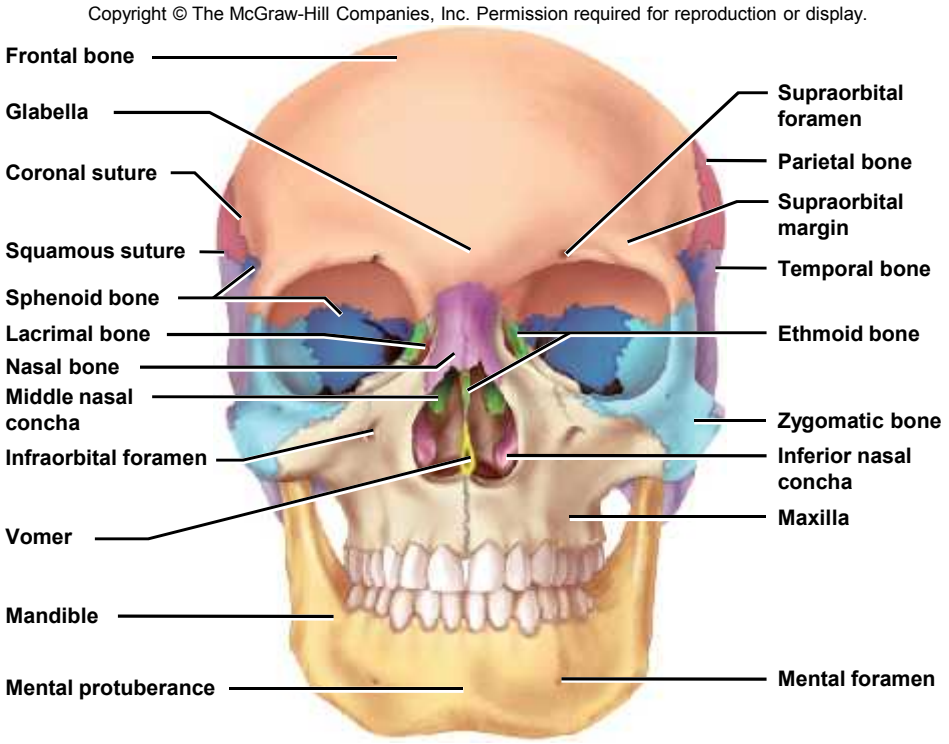


Figure 8.3

The Inferior Nasal Conchae

- Three conchae in the nasal cavity
  - Superior and middle are part of the ethmoid bone
- **Inferior nasal concha** is a separate bone
  - Largest of the three

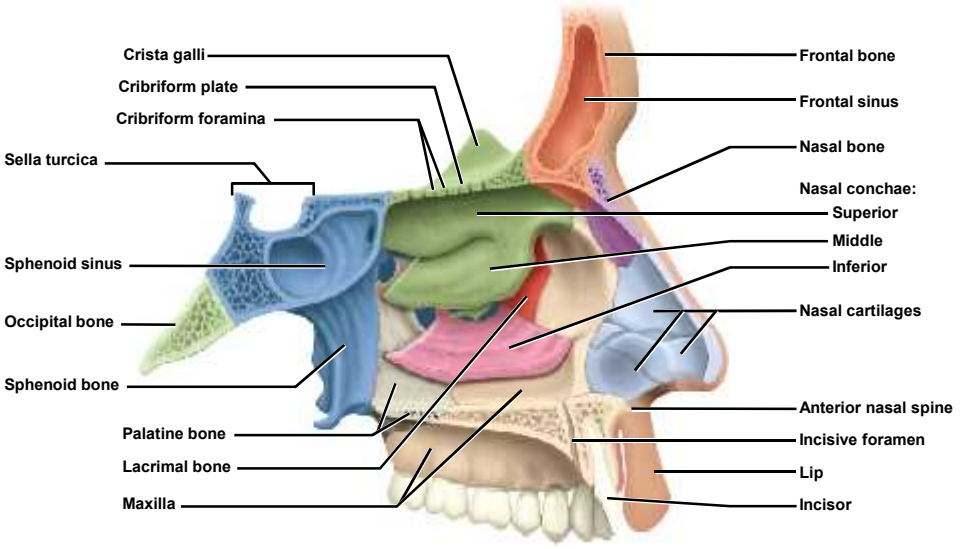
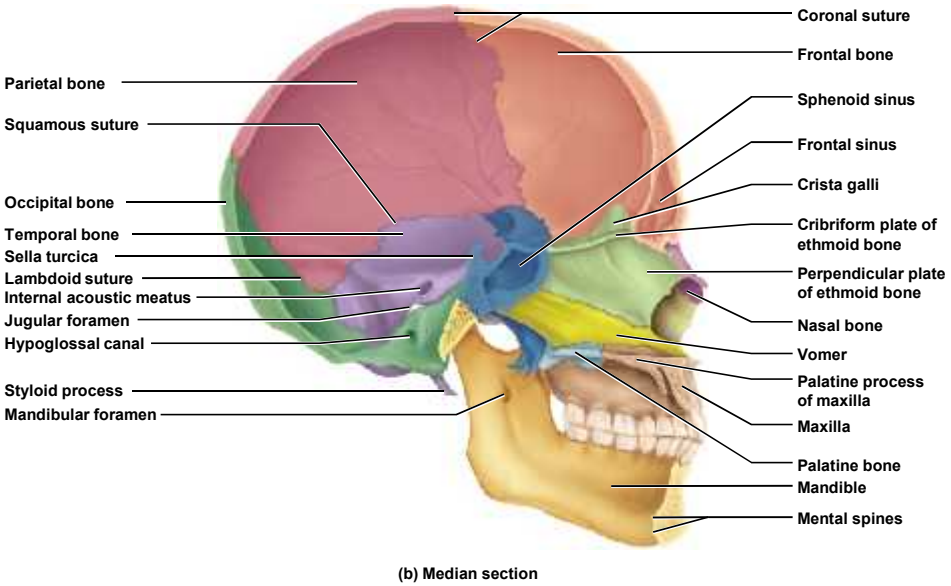


Figure 8.13

The Vomer



(b) Median section

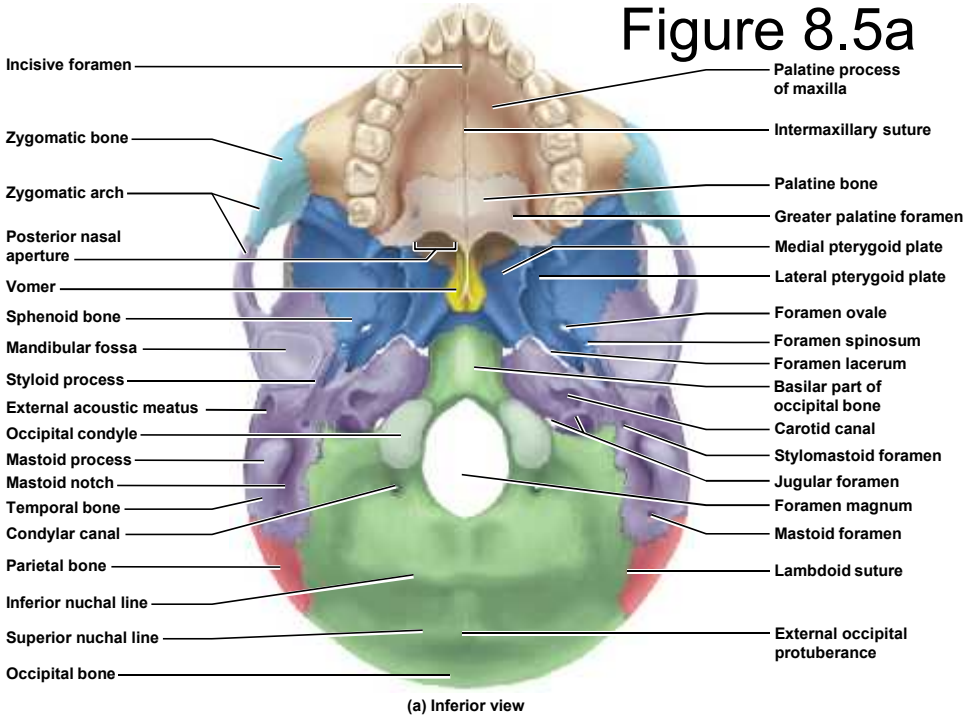
Figure 8.4b

- 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

The Mandible

- Strongest bone of the skull
  - Only bone of skull that moves noticeably
  - Supports lower teeth
- Provides attachments for muscles of facial expression and mastication
- **Mental symphysis**—median cartilaginous joint in fetus
  - Develops as two separate bones in fetus
  - Ossifies in early childhood

Figure 8.5a



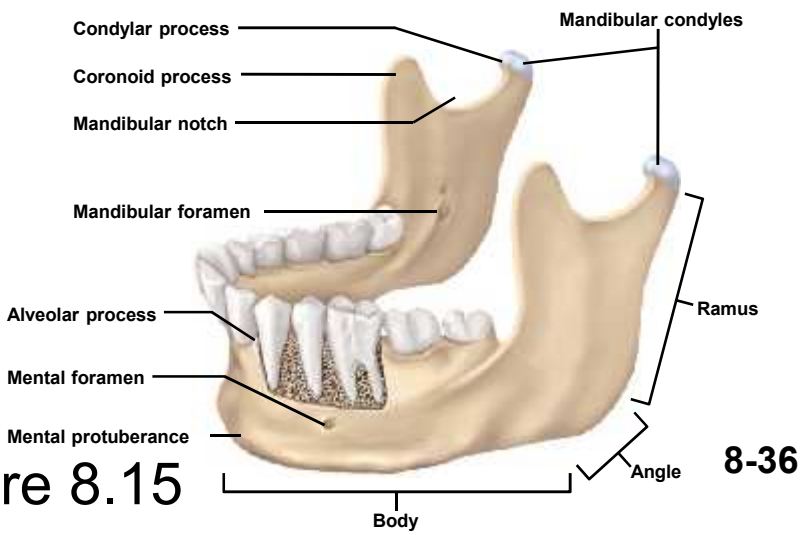
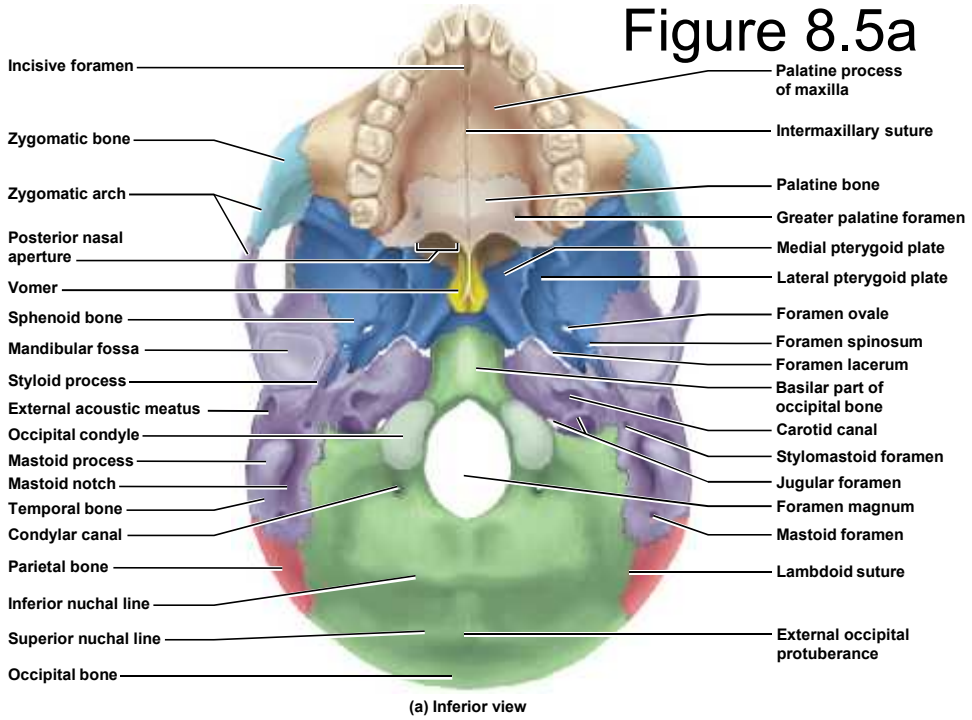


Figure 8.15

The Mandible

- **Mental protuberance**—point of chin
- Two major parts on each side
  - **Body:** supports teeth
  - **Ramus:** articulates with cranium
    - **Angle**—where body and ramus meet
- **Alveolar processes** between teeth
- **Mental foramen**—permits passage of nerves and BVs
- **Mental spines**

Figure 8.5a



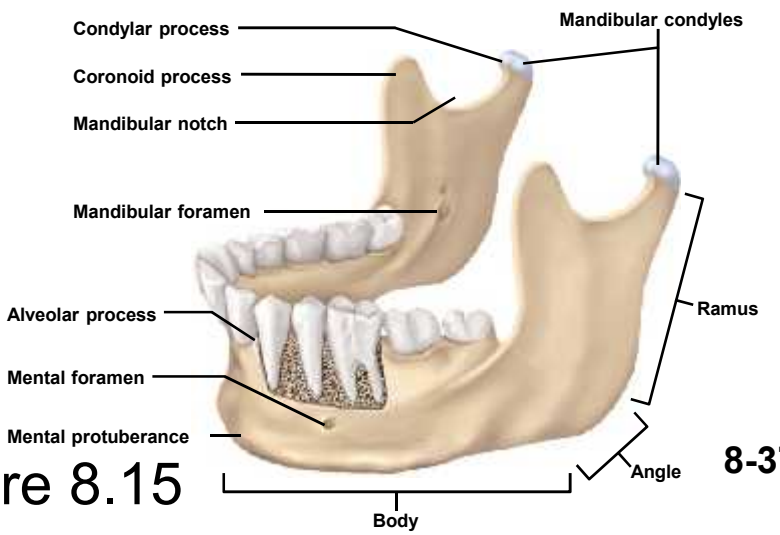


Figure 8.15

The Mandible

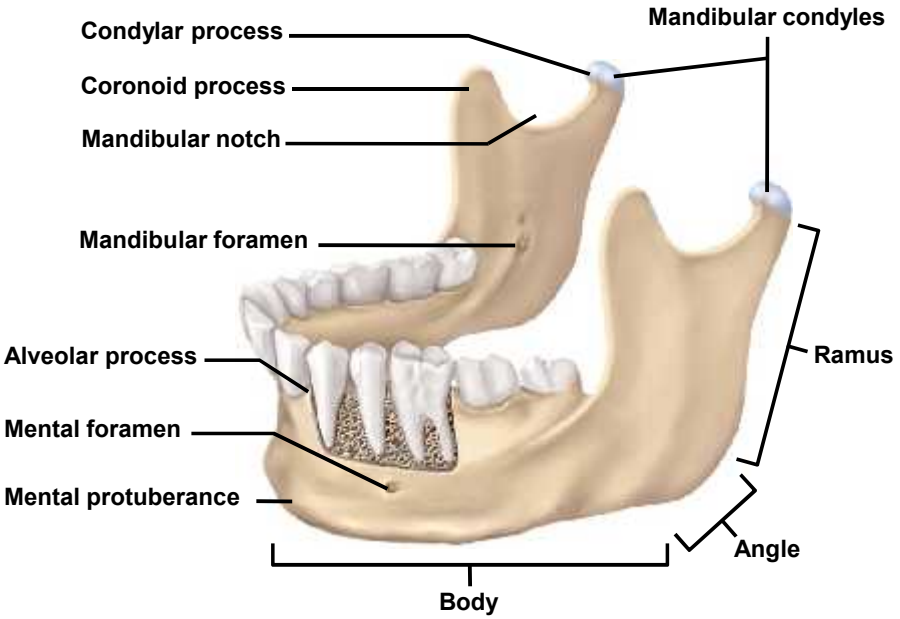


Figure 8.15

- **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
- **Mandibular notch**
- **Mandibular foramen**—BVs, nerves supply lower teeth

Bones Associated with the Skull

- **Auditory ossicles**
  - Three in each middle-ear cavity
  - **Malleus**, **incus**, and **stapes**

- **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
  - **Body** and **greater and lesser horns (cornua)**
  - Fractured hyoid bone is evidence of strangulation

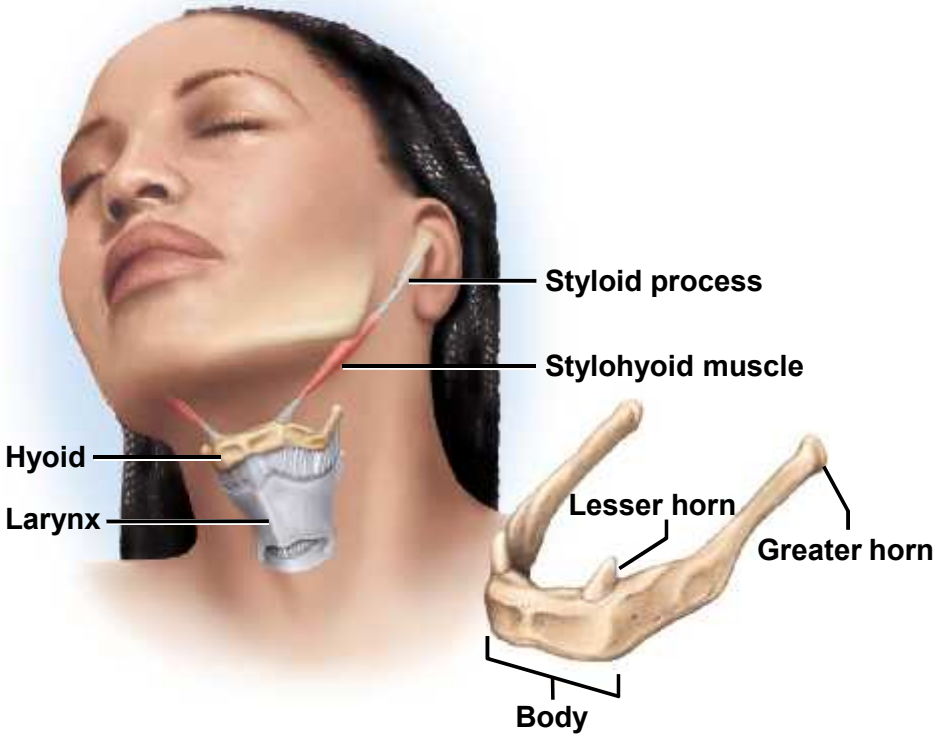
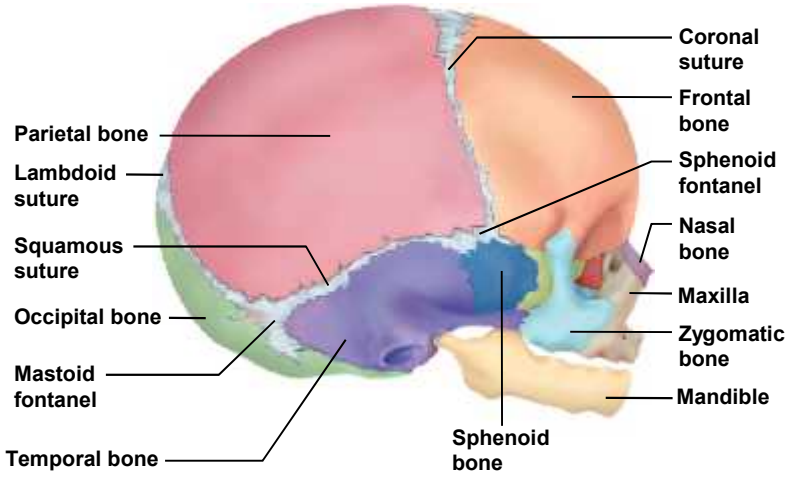
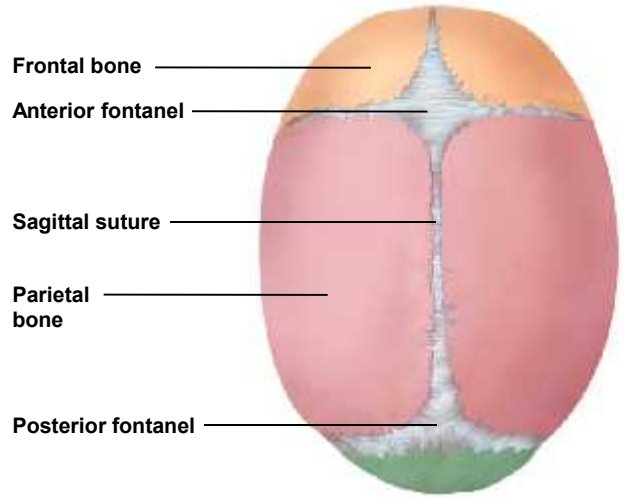


Figure 8.16

The Skull in Infancy and Childhood



(a) Lateral view



(b) Superior view

Figure 8.17

- **Fontanels**—spaces between unfused bones
  - Filled with fibrous membrane
  - Allow shifting of bones during birth and growth of brain
  - **Anterior, posterior, sphenoid** (anterolateral), and **mastoid** (posterolateral) **fontanels**
- Two frontal bones fuse by age 6 (**metopic suture**)
- Skull reaches adult size by 8 or 9 years of age

The Vertebral Column and Thoracic Cage

- **Expected Learning Outcomes**
  - Describe the general features of the vertebral column and those of a typical vertebra.
  - Describe the structure of the intervertebral discs and their relationship to the vertebrae.
  - Describe the special features of vertebrae in different regions of the vertebral column, and discuss the functional significance of the regional differences.
  - Describe the anatomy of the sternum and ribs and how the ribs articulate with the thoracic vertebrae.

General Features of the Vertebral Column

- **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

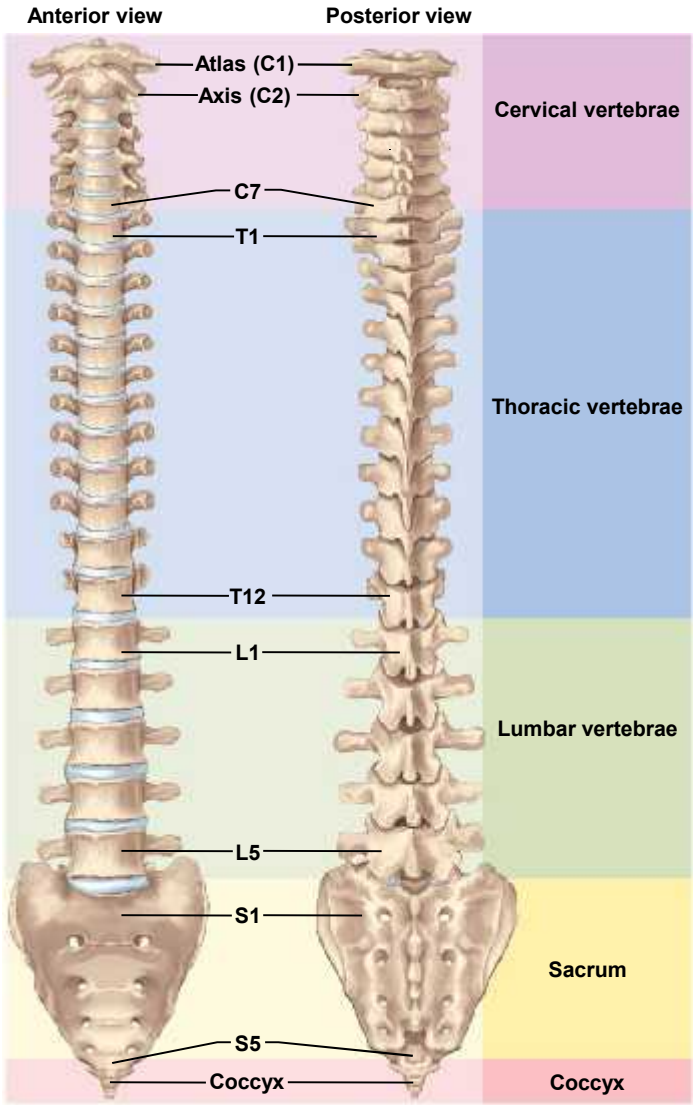


Figure 8.18

General Features of the Vertebral Column

- Adult vertebral column averages 71 cm (28 in.) long
  - Intervertebral discs account for about one-quarter of its length
  - Person is 1% shorter when in bed
  - Compression squeezes water out during the day and absorbs water when compression is removed during sleep

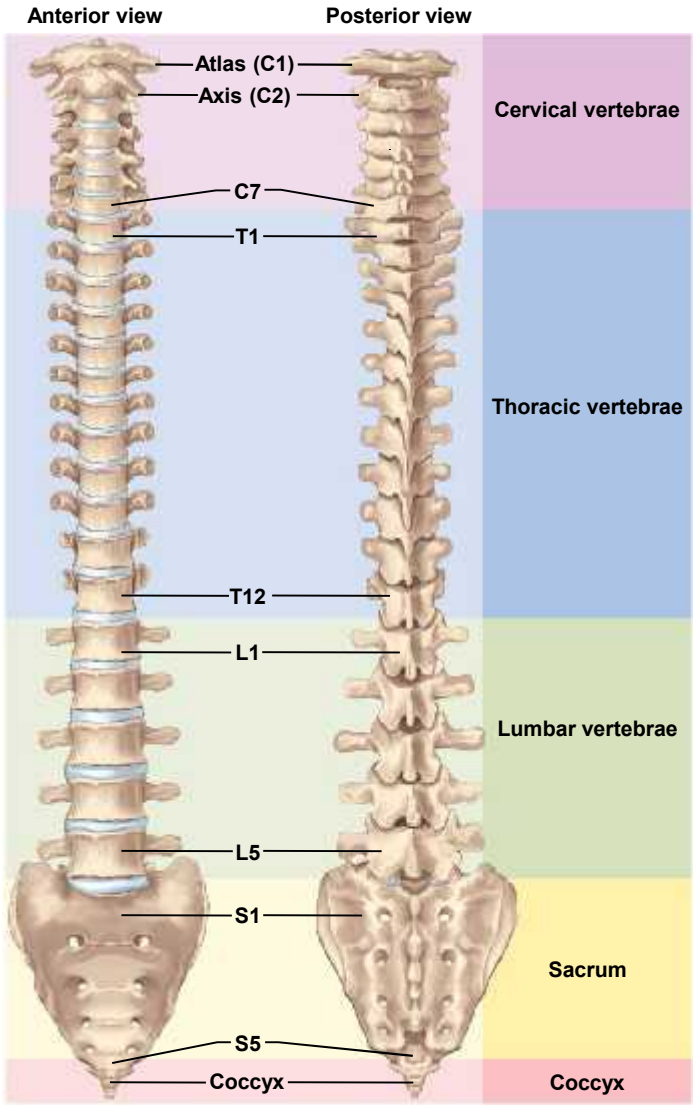


Figure 8.18

General Features of the Vertebral Column

- 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
- Variations in number of lumbar and sacral vertebrae occur in 1 in 20 people

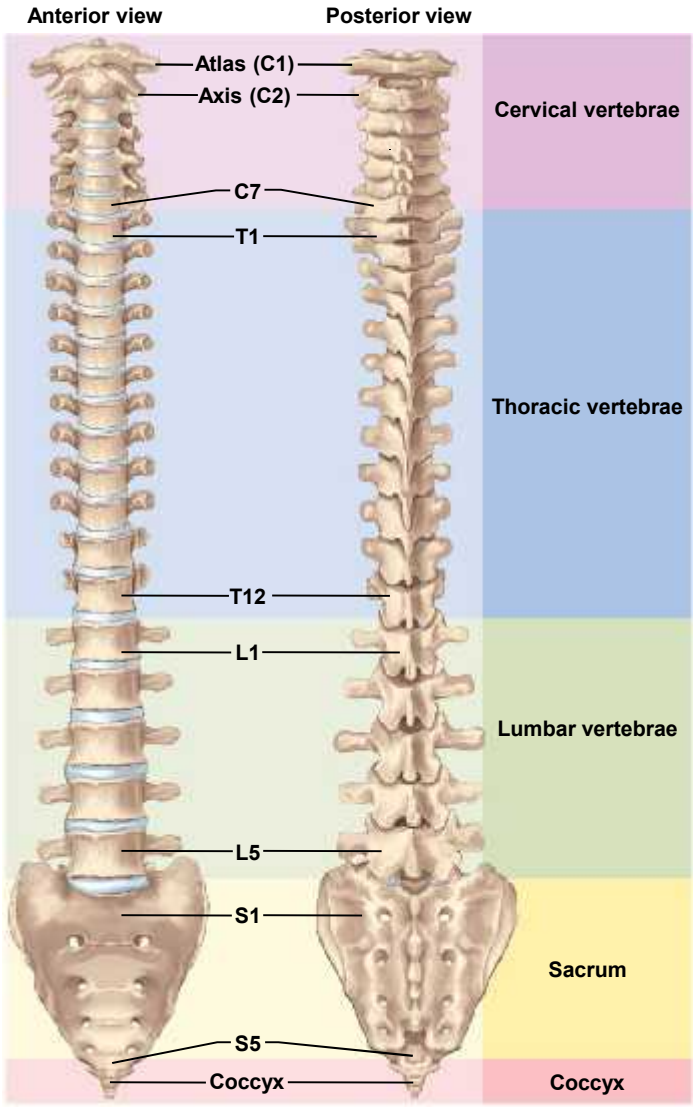


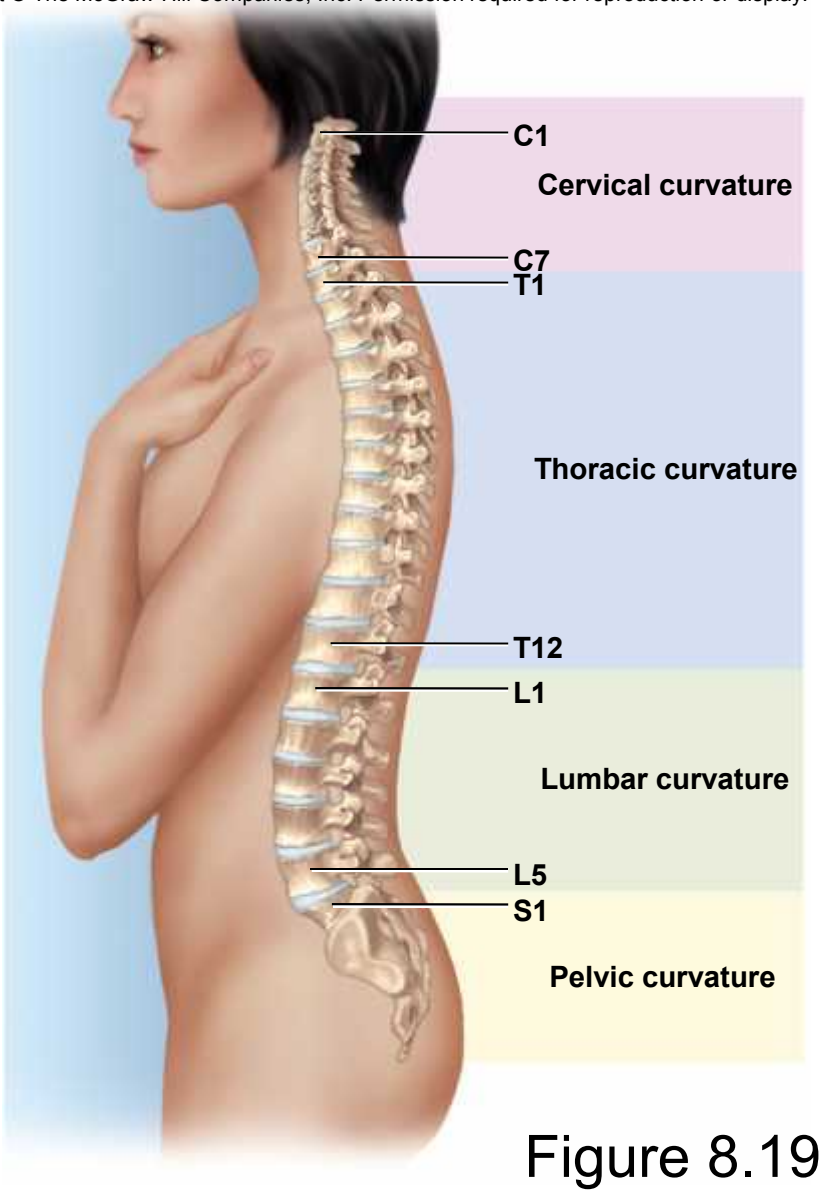
Figure 8.18

General Features of the Vertebral Column

- Spine exhibits one continuous C-shaped curve at birth
- Known as primary curvature

Figure 8.20

General Features of the Vertebral Column



- S-shaped vertebral column with **four normal curvatures**
  - **Cervical**
  - **Thoracic**
  - **Lumbar**
  - **Pelvic**

Figure 8.19

General Features of the Vertebral Column

- **Primary curvatures**—present at birth
  - **Thoracic and pelvic**

- **Secondary curvatures**—develop later
  - **Cervical and lumbar**
  - Lifting head as it begins to crawl develops cervical curvature
  - Walking upright develops lumbar curvature

Abnormal Spinal Curvatures

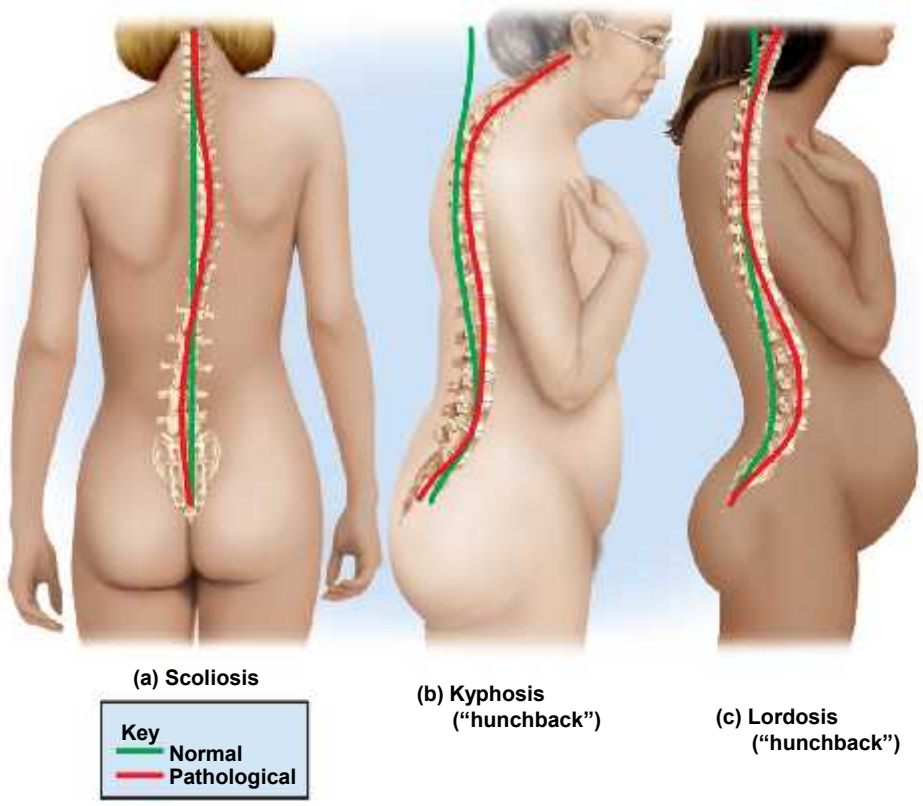


Figure 8.21

- From disease, paralysis of trunk muscles, poor posture, pregnancy, or congenital defect
- **Scoliosis**—abnormal lateral curvature
  - Most common
  - Usually in thoracic region
  - Particularly of adolescent girls
  - Developmental abnormality in which the body and arch fail to develop on one side of the vertebrae

Abnormal Spinal Curvatures

- **Kyphosis** (hunchback)—exaggerated thoracic curvature
  - Usually from osteoporosis, also osteomalacia or spinal tuberculosis, or wrestling or weight lifting in young boys

- **Lordosis** (swayback)—exaggerated lumbar curvature
  - From pregnancy or obesity

General Structure of Vertebra

- **Body (centrum)**
  - Mass of spongy bone that contains red bone marrow
  - Covered with thin shell of compact bone
  - Weight-bearing portion
  - Rough superior and inferior surfaces provide firm attachment for intervertebral discs
- **Vertebral foramina**
  - Collectively form **vertebral canal** for spinal cord

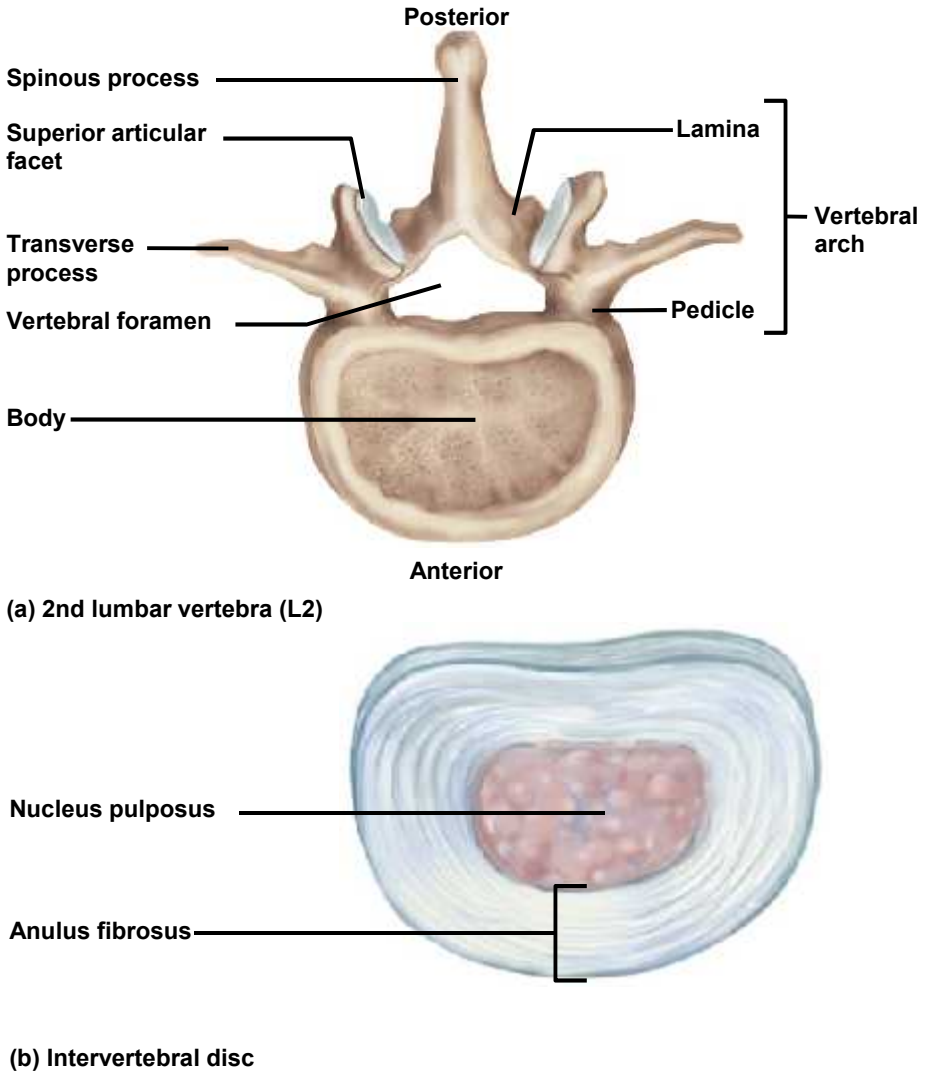
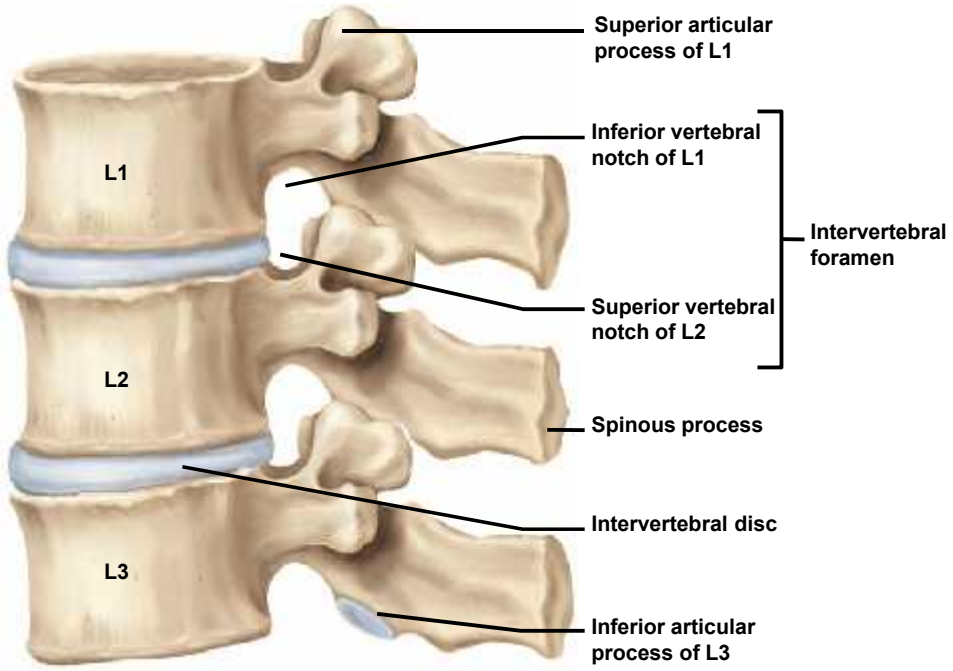


Figure 8.22a,b

General Structure of Vertebra

- **Vertebral arch**
  - Composed of two parts on each side
  - **Pedicle:** pillarlike and **lamina:** platelike
- **Spinous process**
  - Projection extending from the apex of arch
  - Extends posteriorly and downward
- **Transverse process**
  - Extends laterally from point where pedicel and lamina meet
- **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

General Structure of Vertebra



(b) Left lateral view

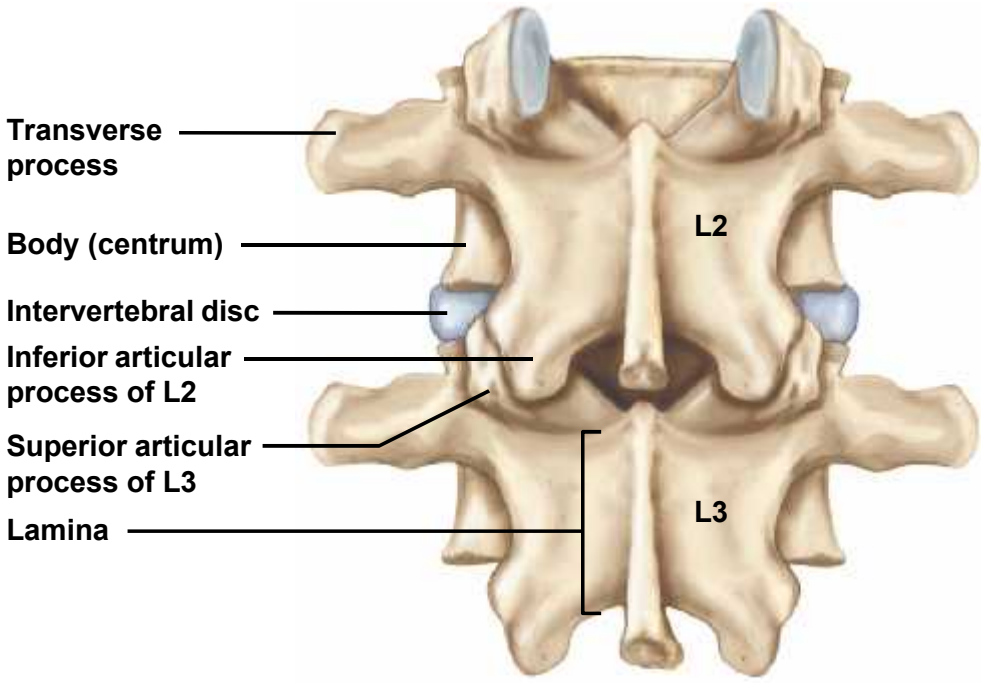
Figure 8.23b

- **Intervertebral foramen**
  - When two vertebrae are joined they exhibit an opening between their pedicles
  - Passageway for spinal nerves
  - **Inferior vertebral notch** in the pedicle of the upper vertebra
  - **Superior vertebral notch** in the pedicle of the lower vertebra

General Structure of Vertebra

- **Intervertebral discs (23)**
  - First one between C2 and C3
  - Last one between L5 and sacrum
  - Pad consisting of:
    - **Nucleus pulposus**—inner gelatinous mass
    - **Anulus fibrosus**—outer ring of fibrocartilage
  - 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

The Cervical Vertebrae

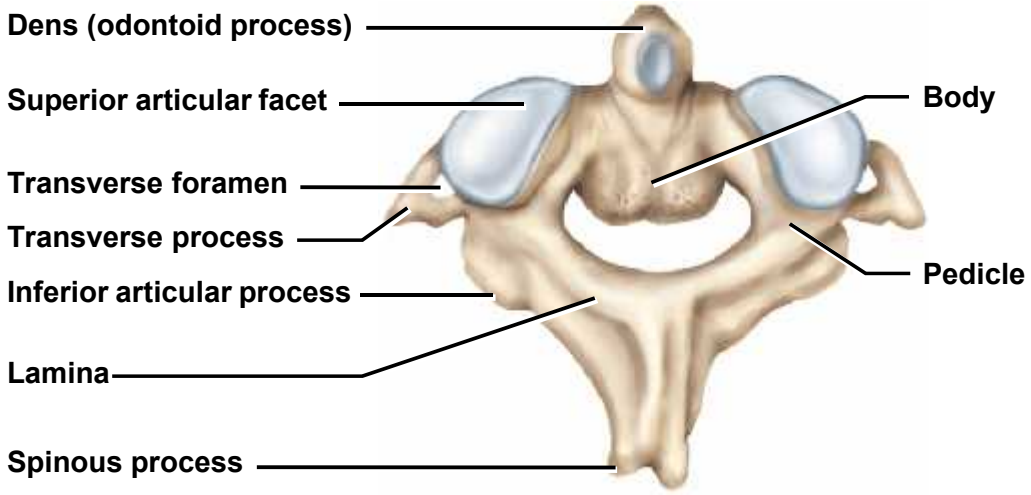


(a) Posterior (dorsal) view

Figure 8.23a

- **Cervical vertebrae—atlas (C1)**
  - Supports the head
  - Has **no body**
  - Delicate ring surrounding a large vertebral foramen
  - **Lateral masses** with **superior articular facets**
    - Articulates with occipital condyles
    - Allows nodding motion of skull gesturing “yes”
  - **Inferior articular facets** articulate with C2
  - **Anterior and posterior arches**
  - **Anterior and posterior tubercles**

The Cervical Vertebrae



(b) Axis

Figure 8.24b

- **Cervical vertebrae—axis (C2)**
  - Allows rotation of the head gesturing "no"
  - **Dens** or **odontoid process**—prominent knob on its anterosuperior side
    - Forms as an independent ossification center during first year of life
    - Fuses with axis by age 3 to 6 years
    - Projects into **vertebral foramen** of the atlas
    - Held in place by a **transverse ligament**
  - **Atlanto–occipital joint:** between atlas and cranium
  - **Atlantoaxial joint:** between atlas and axis

Atlas and Axis Articulation

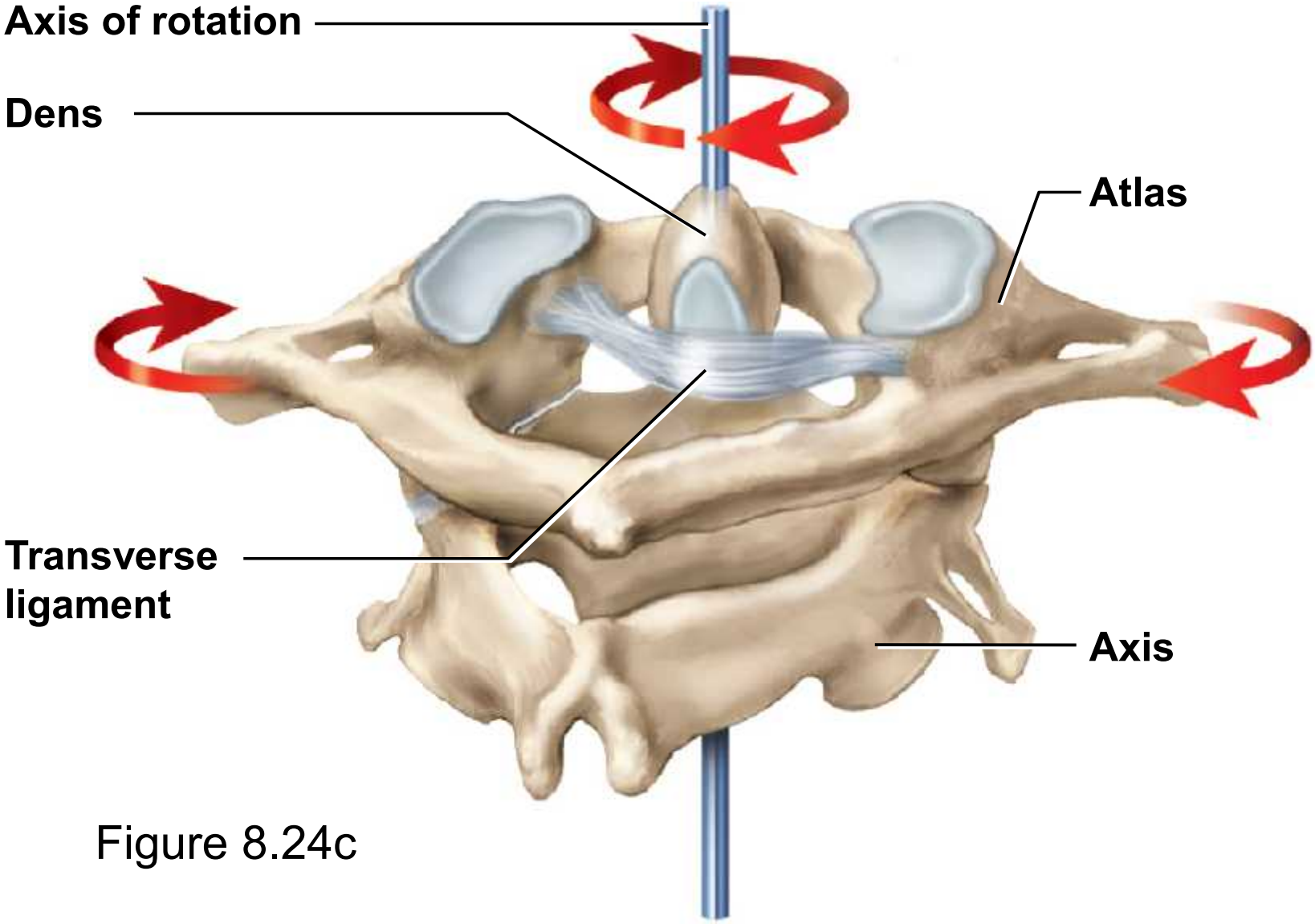


Figure 8.24c

(c) Atlantoaxial joint

The Cervical Vertebrae

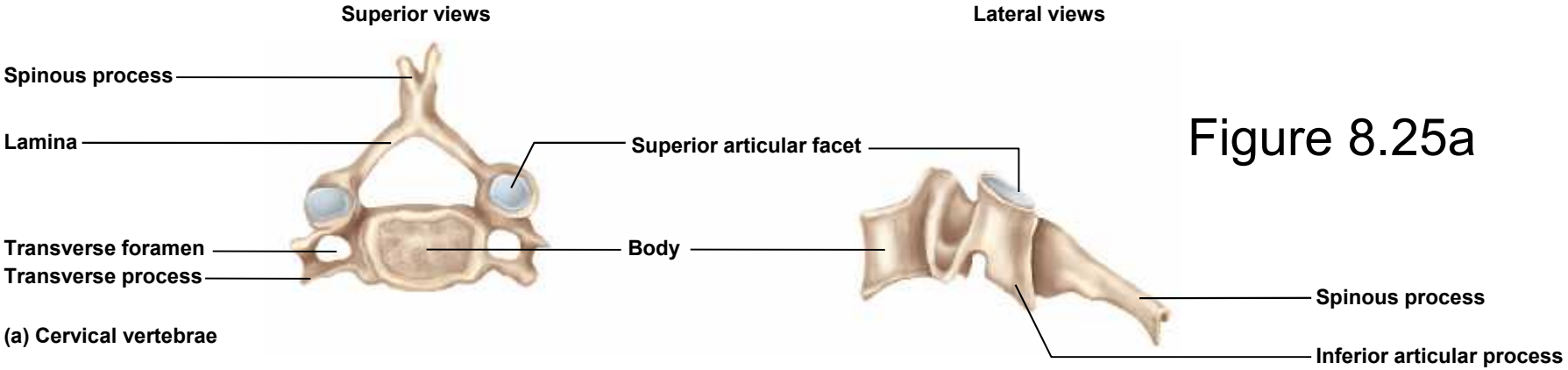


Figure 8.25a

- C1 to C7 are smallest and lightest vertebrae, other than the coccygeals
- **Bifid** or forked spinous processes in C2 to C6
- Small body and larger vertebral foramen
- **Transverse foramen** in each short **transverse process**
  - Provides passage and protection for vertebral arteries (supply blood to brain) and vertebral veins (drain blood from various neck structures)
  - Transverse foramen only found in cervical vertebrae
- **C7 vertebra prominens**—spinous process not bifid and especially long
  - Prominent bump on lower back of neck; convenient landmark for counting vertebrae

The Thoracic Vertebrae

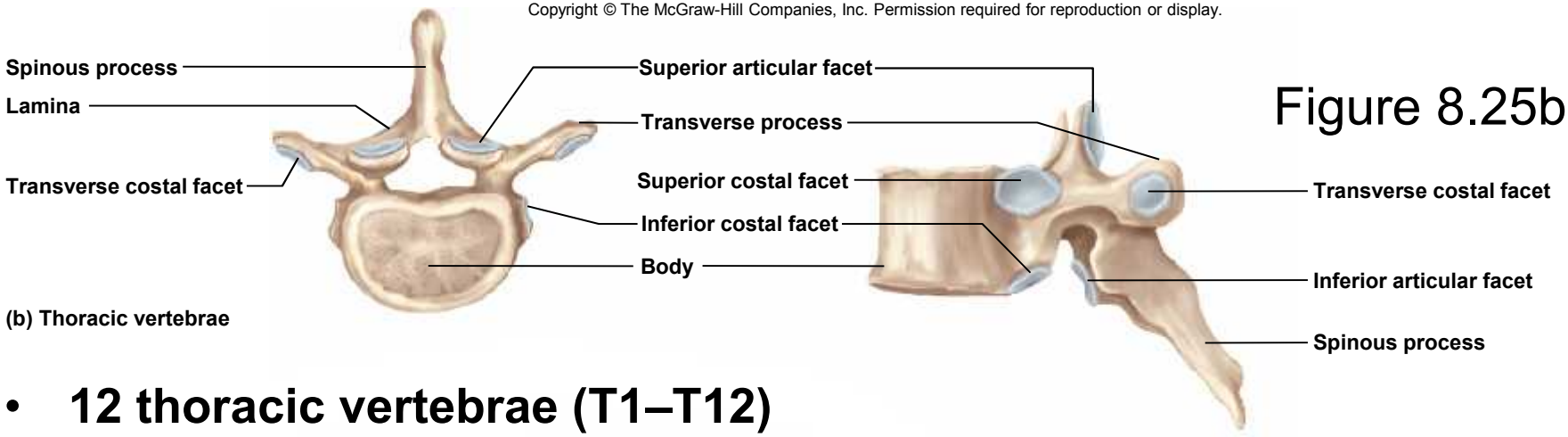


Figure 8.25b

- **12 thoracic vertebrae (T1–T12)**
  - Corresponds to the 12 pairs of ribs attached to them
- **Spinous processes** pointed and angled sharply downward
- **Larger body** than cervical, but smaller than lumbar
- **Costal facets** for attachment of ribs
  - On body as small, smooth, slightly concave spots
- **Transverse costal facets** at end of each transverse process T1–T10
  - Provide second point of articulation for ribs 1–10
- **Inferior and superior costal** facets on vertebral body
  - In most cases, ribs insert between the two vertebra

The Lumbar Vertebrae

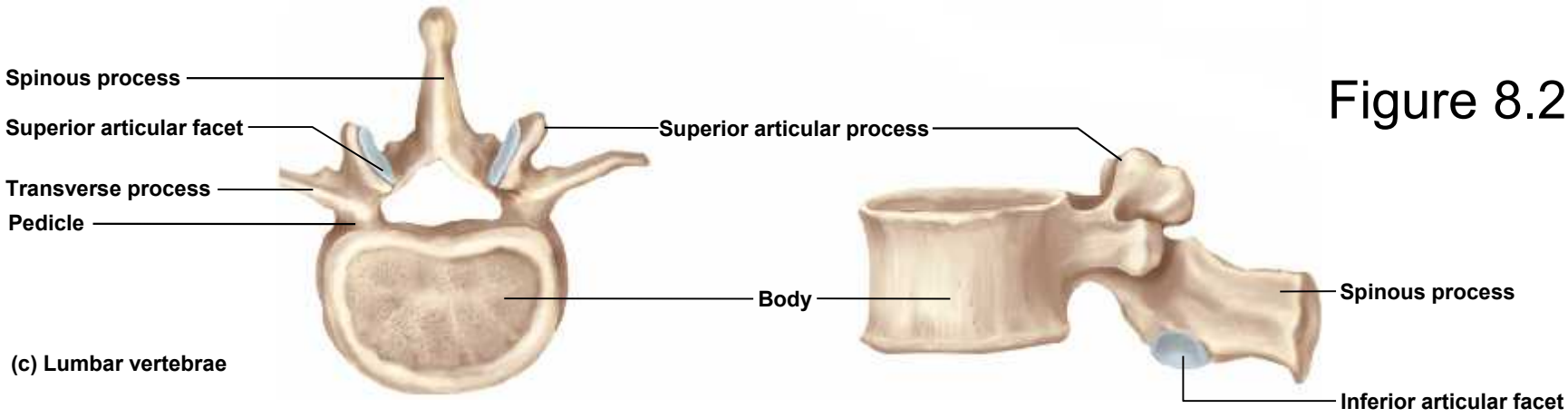
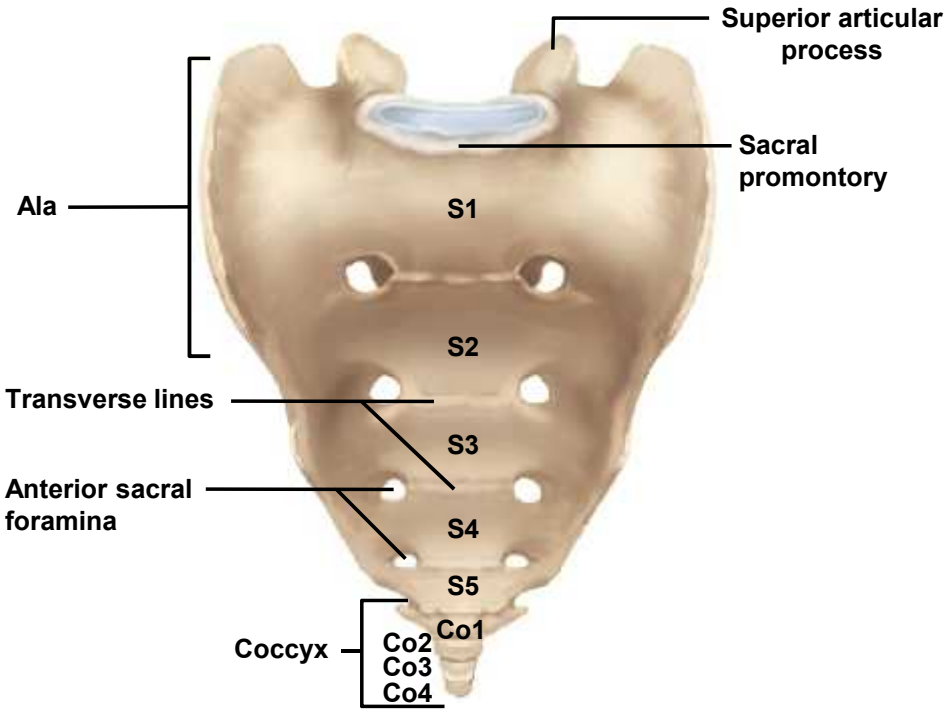


Figure 8.25c

- Five lumbar vertebrae (L1–L5)
- Thick, stout body
- Blunt, squarish spinous process
- **Superior articular processes** face medially
  - Lumbar region resistant to twisting movements

The Sacrum

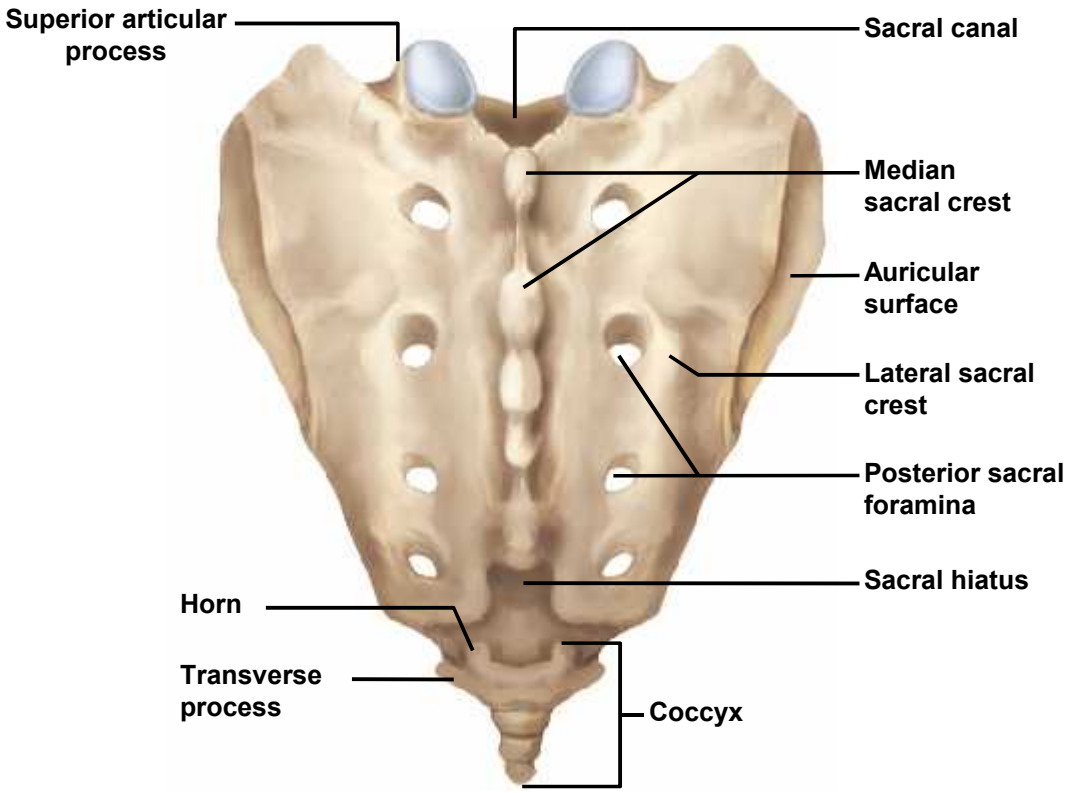


(a) Anterior view

Figure 8.26a

- **Sacrum**—bony plate that forms posterior wall of pelvic cavity
- Once considered **seat of the soul**
- In children, five separate sacral vertebrae (S1–S5)
- Begin fusion around age 16 and complete fusion by age 26
- Anterior surface
  - Smooth and concave
  - Four transverse lines indicate line of fusion of vertebrae
  - Four pairs of large **anterior sacral (pelvic) foramina**
    - Allow for passage of nerves and arteries into pelvic organs
- **Sacral promontory** on S1 supports L5

The Sacrum

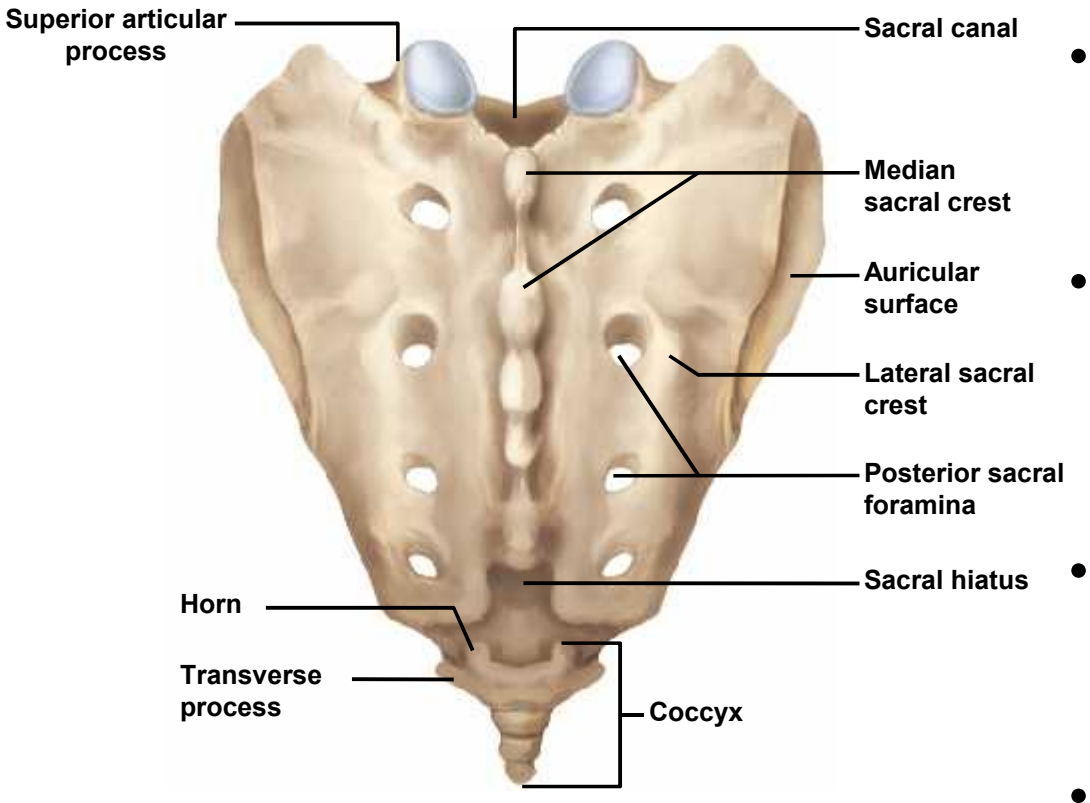


(b) Posterior view

Figure 8.26b

- Posterior surface very rough
- **Median sacral crest**
  - Formed from fusion of spinous processes
- **Lateral sacral crest**
  - Less prominent, and on either side of median sacral crest
  - Formed from the fusion of the transverse processes
- **Posterior sacral foramina**
  - Four pairs of openings for spinal nerves that supply gluteal region and lower limbs
- **Sacral canal** runs through sacrum and ends as **sacral hiatus**
  - Contains spinal nerve roots
- **Auricular surface** is part of **sacroiliac (SI) joint** formed with hip bone
- **Superior articular processes** on S1; articulates with L5
- **Alae**—pair of large, rough, winglike extensions lateral to the superior articular processes

The Coccyx



(b) Posterior view

Figure 8.26b

- **Coccyx**—usually consists of four small vertebrae (Co1–Co4); sometimes five
- Fuse into a single, triangular bone by age 20 to 30
- **Horns (cornua)** on Co1
  - Serve as attachment points for ligaments that bind the coccyx to the sacrum
- Fractured during difficult childbirth or by hard fall on buttocks
- Provide attachment for muscles of the pelvic floor

The Thoracic Cage

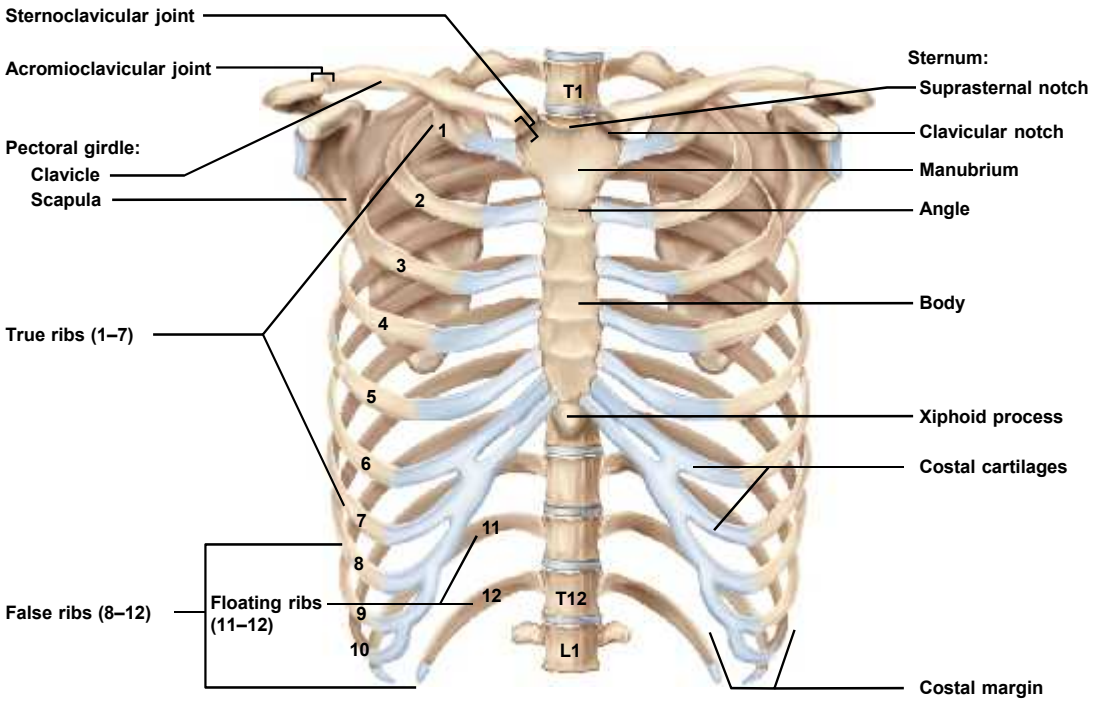


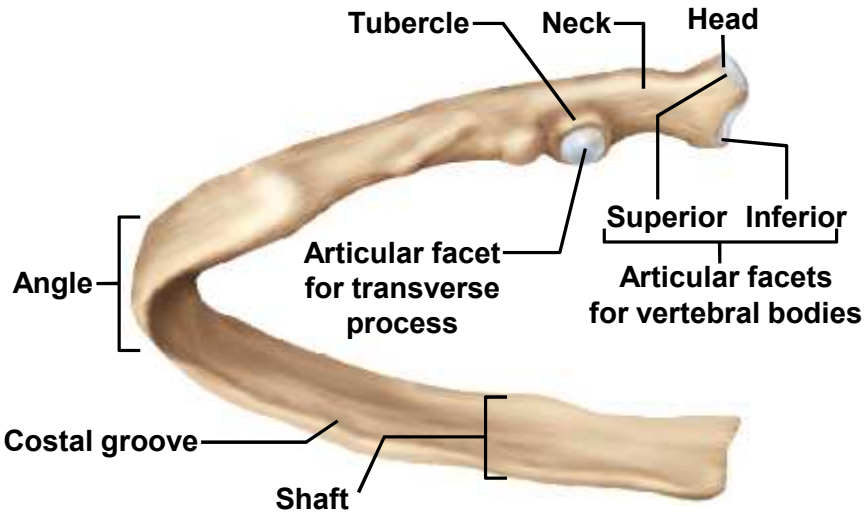
Figure 8.27

- Consists of **thoracic vertebrae, sternum, ribs**
- Forms conical enclosure for lungs and heart
- Provides attachment for pectoral girdle and upper limbs
- Broad **base** and narrower **apex**
- Rhythmically expanded by respiratory muscles to draw air into lungs
- **Costal margin**—inferior border of thoracic cage formed by downward arc of ribs
- Protect **thoracic organs,** but also **spleen,** most of **liver,** and to some extent the **kidneys**

The Sternum

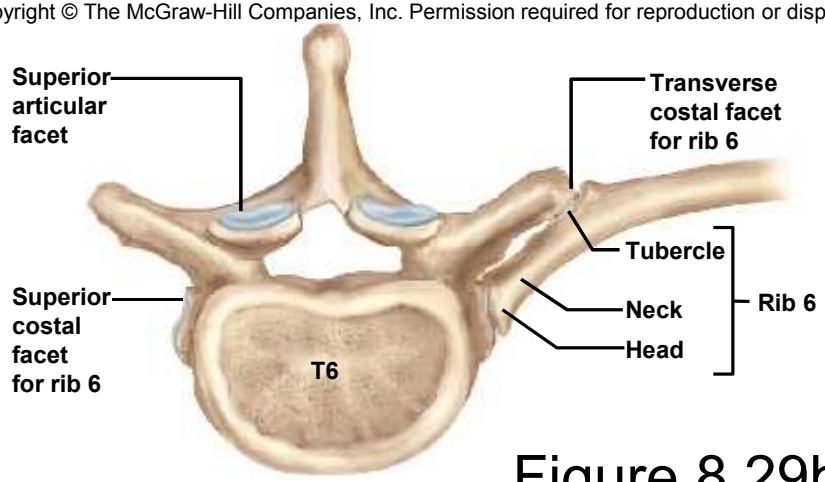
- **Sternum** (breastbone)—bony plate anterior to the heart
- Divided into **three regions**
  - **Manubrium**
    - Broad superior portion
    - **Suprasternal (jugular) notch** medially
    - **Clavicular notches**—articulate with clavicle
    - Ribs attach along scalloped lateral margins
  - **Body (gladiolus)**
    - Longest part of sternum
    - **Sternal angle**—point where body joins manubrium
    - Ribs attach along scalloped lateral margins
  - **Xiphoid**
    - Inferior end of sternum
    - Attachment for some abdominal muscles
    - In cardiopulmonary resuscitation, improperly performed chest compressions can drive xiphoid process into the liver and cause a fatal hemorrhage

The Ribs



(b) Ribs 2–10

Figure 8.28b

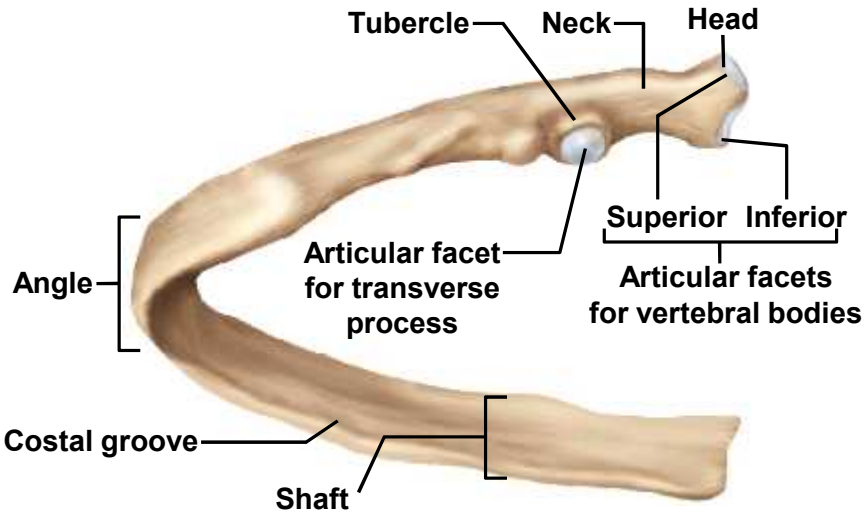


(b) Superior view

Figure 8.29b

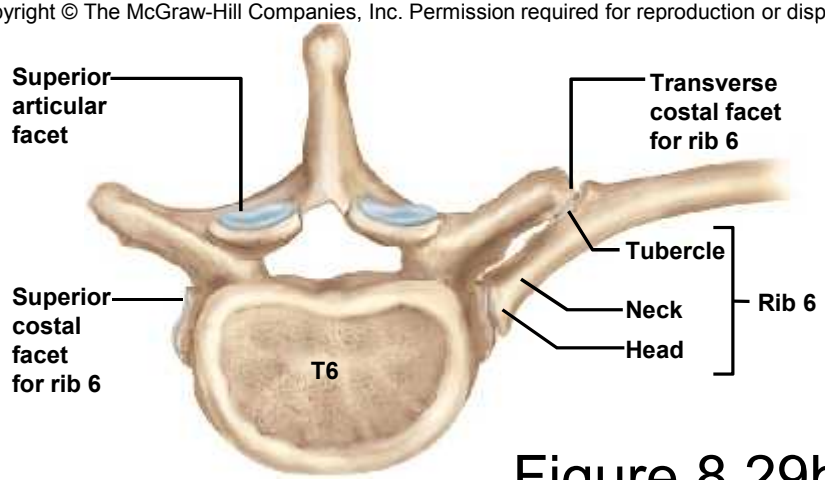
- **12 pairs of ribs**
  - No difference between sexes
  - **Posterior (proximal) end** attached to vertebral column
  - **Anterior (distal) ends** mostly attached to the sternum
  - **Costal cartilages** composed of **hyaline cartilage** attach anterior ends to sternum
- **Head**—portion of rib that articulates with thoracic vertebrae
  - Superior articular facet
  - Inferior articular facet

The Ribs



(b) Ribs 2–10

Figure 8.28b



(b) Superior view

Figure 8.29b

- **Neck**—narrow portion distal to the head
- **Tubercle**—wider rough area distal to the neck
  - Articulates with **transverse costal facet** of vertebra
- **Angle**—lateral curve of rib
- **Shaft**—long, gentle sloping, bladelike portion of rib
  - **Costal groove** on inferior margin of shaft

The Ribs

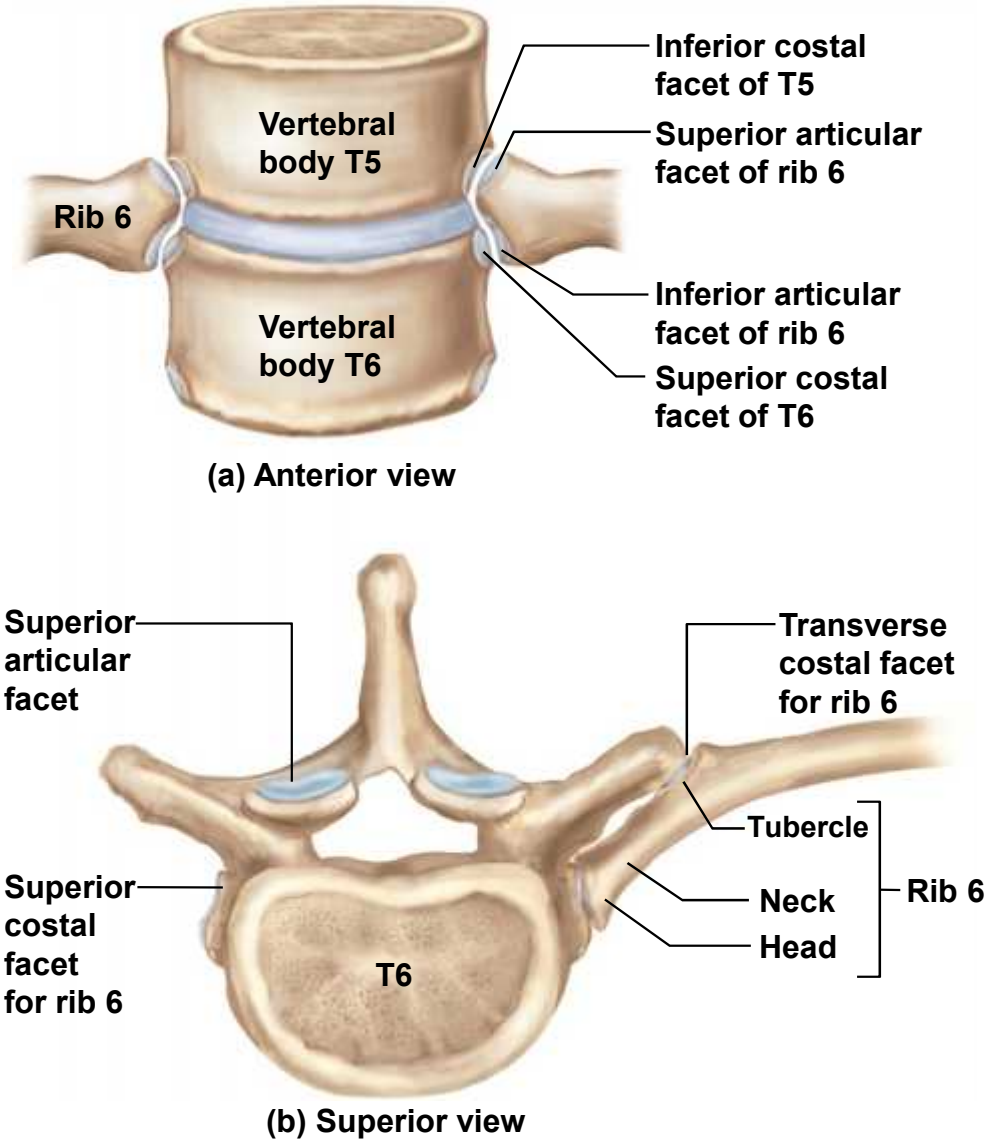


Figure 8.29

The Ribs

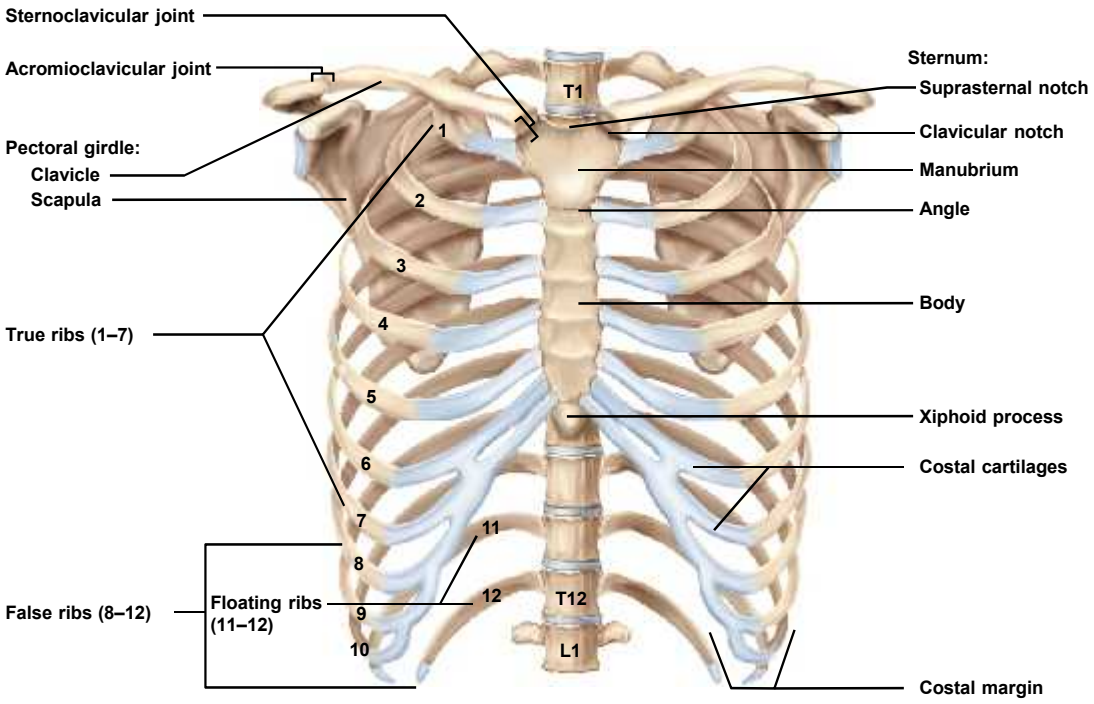


Figure 8.27

The Ribs

- **True ribs (ribs 1–7)**
  - Each has own costal cartilage connecting to sternum
- **False ribs (ribs 8–12)**
  - Lack independent cartilaginous connection to sternum
  - **Floating ribs (ribs 11–12)**
    - Articulate with bodies of vertebrae T11 and T12
    - Do not have tubercles
    - Do not attach to transverse processes of the vertebra
    - No cartilaginous connection to the sternum or any of the higher costal cartilages

The Pectoral Girdle and Upper Limb

- **Expected Learning Outcome**
  - Identify and describe the features of the clavicle, scapula, humerus, radius, ulna, and bones of the wrist and hand.

The 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
  - **Sternoclavicular joint**
  - **Acromioclavicular joint**
- Scapula articulates with the humerus
  - **Glenohumeral joint:** shoulder joint
  - Easily dislocated due to loose attachment

The Clavicle

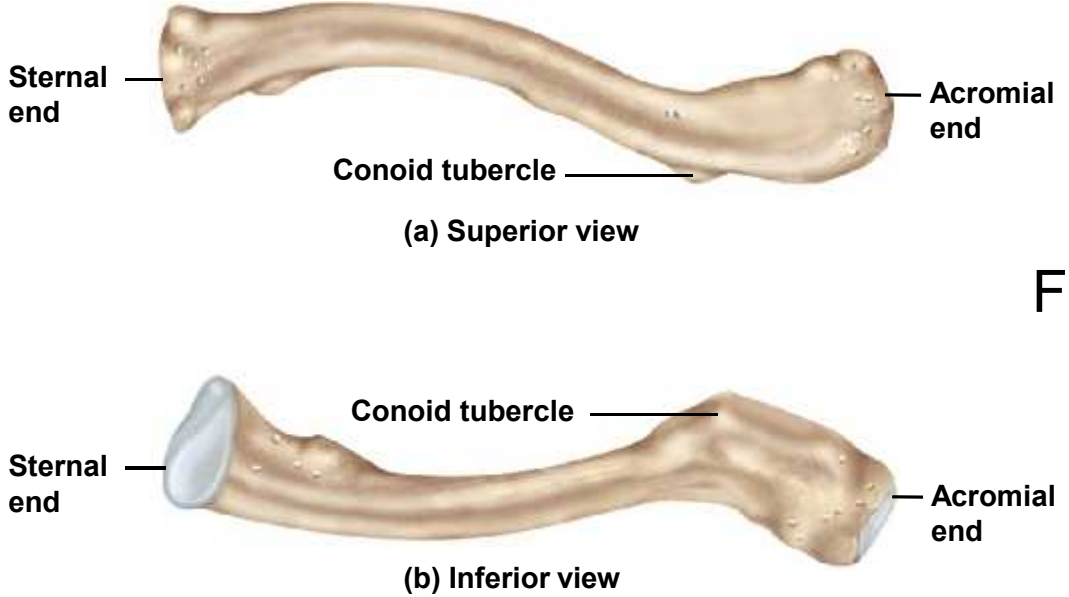


Figure 8.30

- **Clavicle**—S-shaped, somewhat flattened bone
- **Inferior**—grooves and ridges for muscle attachment
- **Sternal end**—rounded head

The Clavicle

- **Acromial end**—flattened
  - **Conoid tubercle:** roughened tuberosity near acromial end; ligament attachment
- Braces shoulder, keeping upper limb away from midline of body
- Most frequently fractured bone in the body

The Scapula

- **Scapula**—named for its resemblance to a spade or shovel
- Triangular plate that posteriorly overlies ribs 2 to 7
  - **Three sides:** superior, medial (vertebral), and lateral (axillary) borders
  - **Three angles:** superior, inferior, and lateral angles

The Scapula

- **Suprascapular notch**—conspicuous notch on superior border
  - Provides passage for a nerve

- **Spine**—transverse ridge on posterior surface
  - **Supraspinous fossa:** indentation superior to the spine
  - **Infraspinous fossa:** broad surface inferior to the spine

The Scapula

- **Subscapular fossa**—concave, anterior surface of scapula
- Complex **lateral angle of scapula** has three main features
  - **Acromion:** platelike extension of the spine
    - Forms apex of the shoulder
    - **Articulates with the clavicle**—the sole point of attachment of the scapula and the upper limb to the rest of the skeleton

The Scapula

Cont.

- **Coracoid process:** shaped like a bent finger
  - 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**

The Scapula

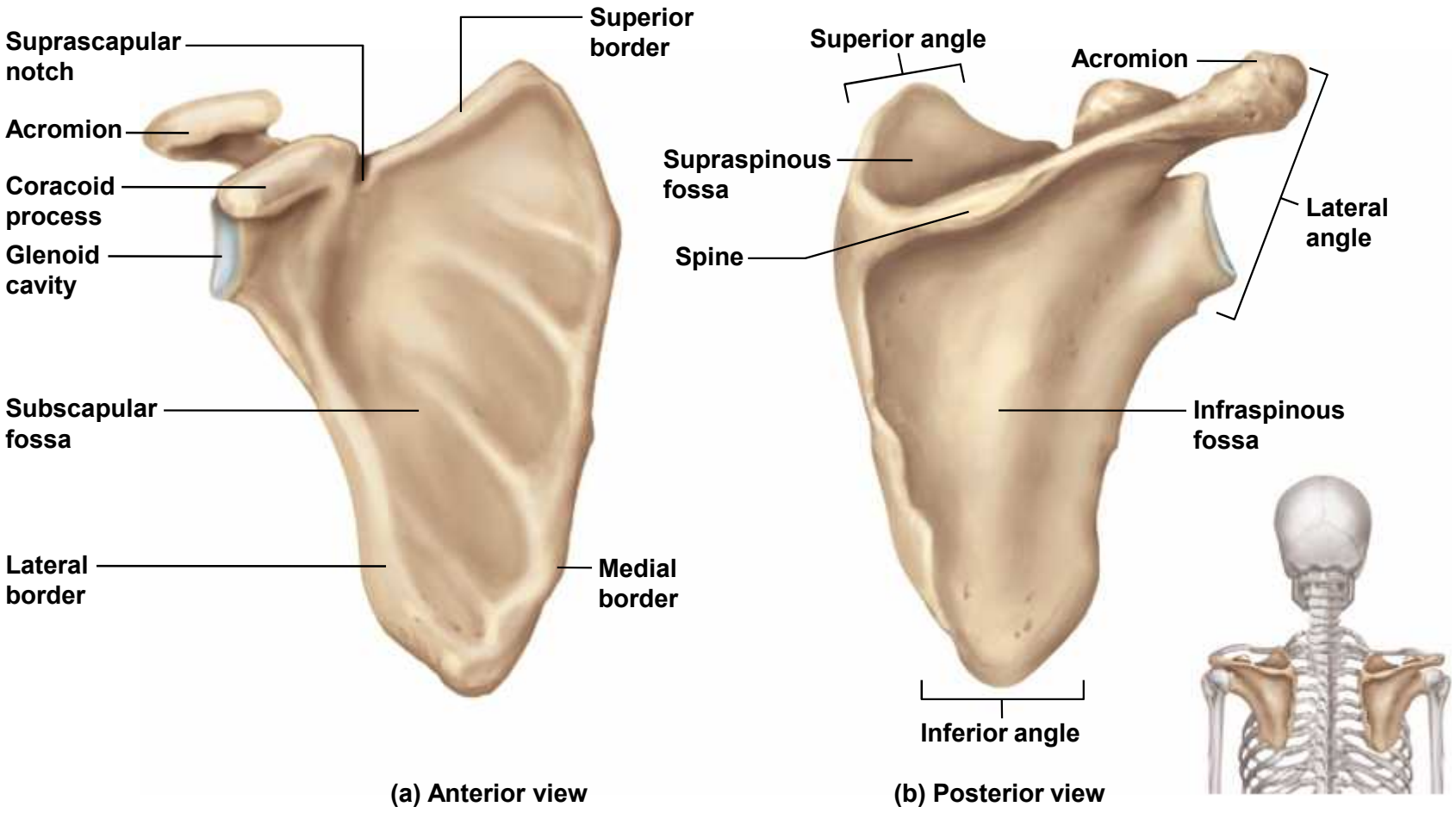
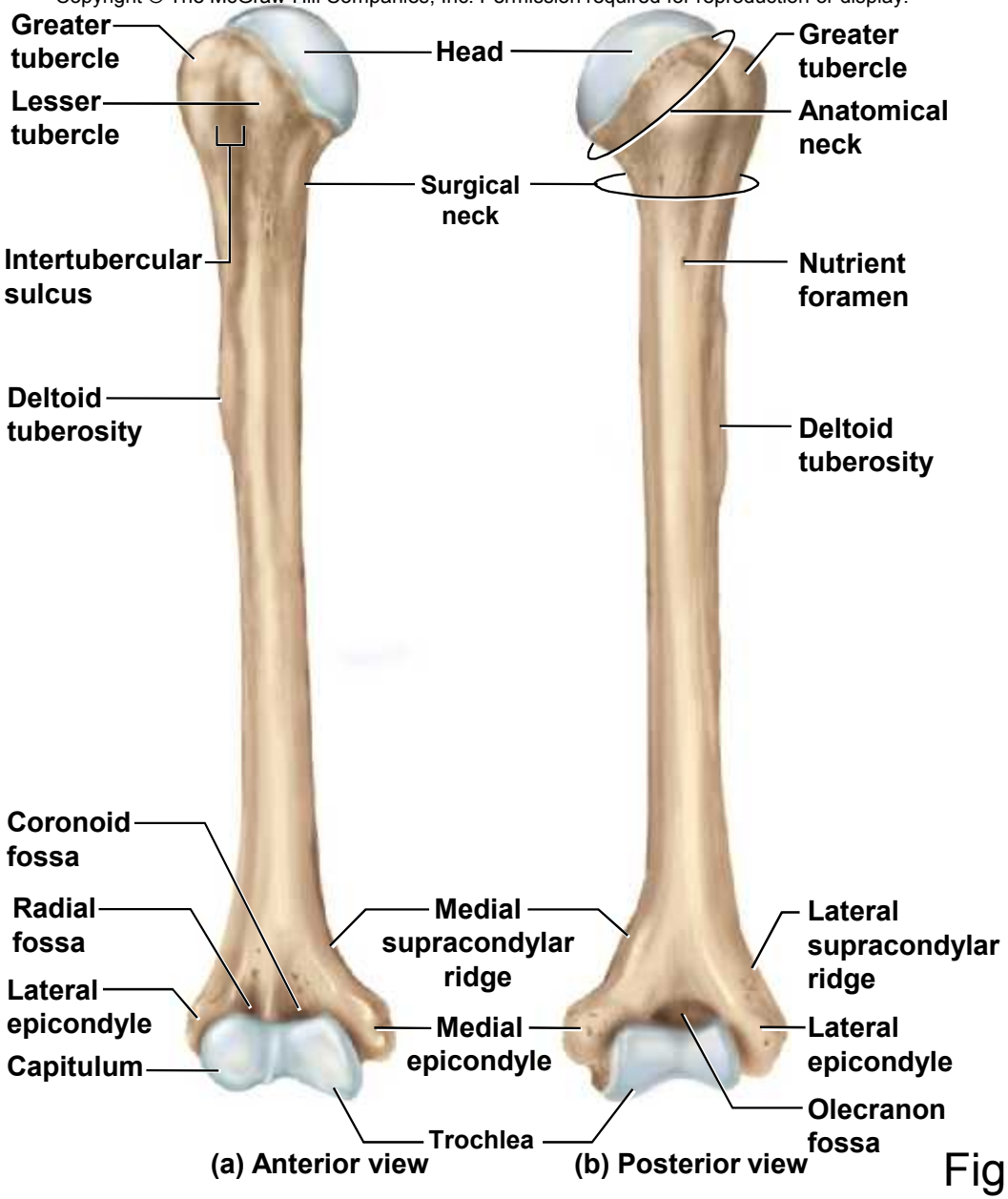


Figure 8.31

The Upper Limb

- Upper limb is divided into **four regions** containing a total of **30 bones per limb**
  - **Brachium** (arm proper): extends from shoulder to elbow
    - Contains only 1 bone—**humerus**
  - **Antebrachium** (forearm): extends from elbow to wrist
    - Contains 2 bones—**radius** and **ulna**
  - **Carpus** (wrist)
    - Contains 8 small bones arranged in two rows
  - **Manus** (hand)
    - 19 bones in two groups
      - **5 metacarpals** in palm
      - **14 phalanges** in fingers

The Humerus



- **Proximal end**
  - Hemispherical **head** that articulates with the **glenoid cavity** of scapula
  - **Anatomical neck**
  - **Greater** and **lesser tubercles** and deltoid tuberosity
  - **Intertubercular sulcus** holds biceps tendon
  - **Surgical neck**

Figure 8.32

The Humerus

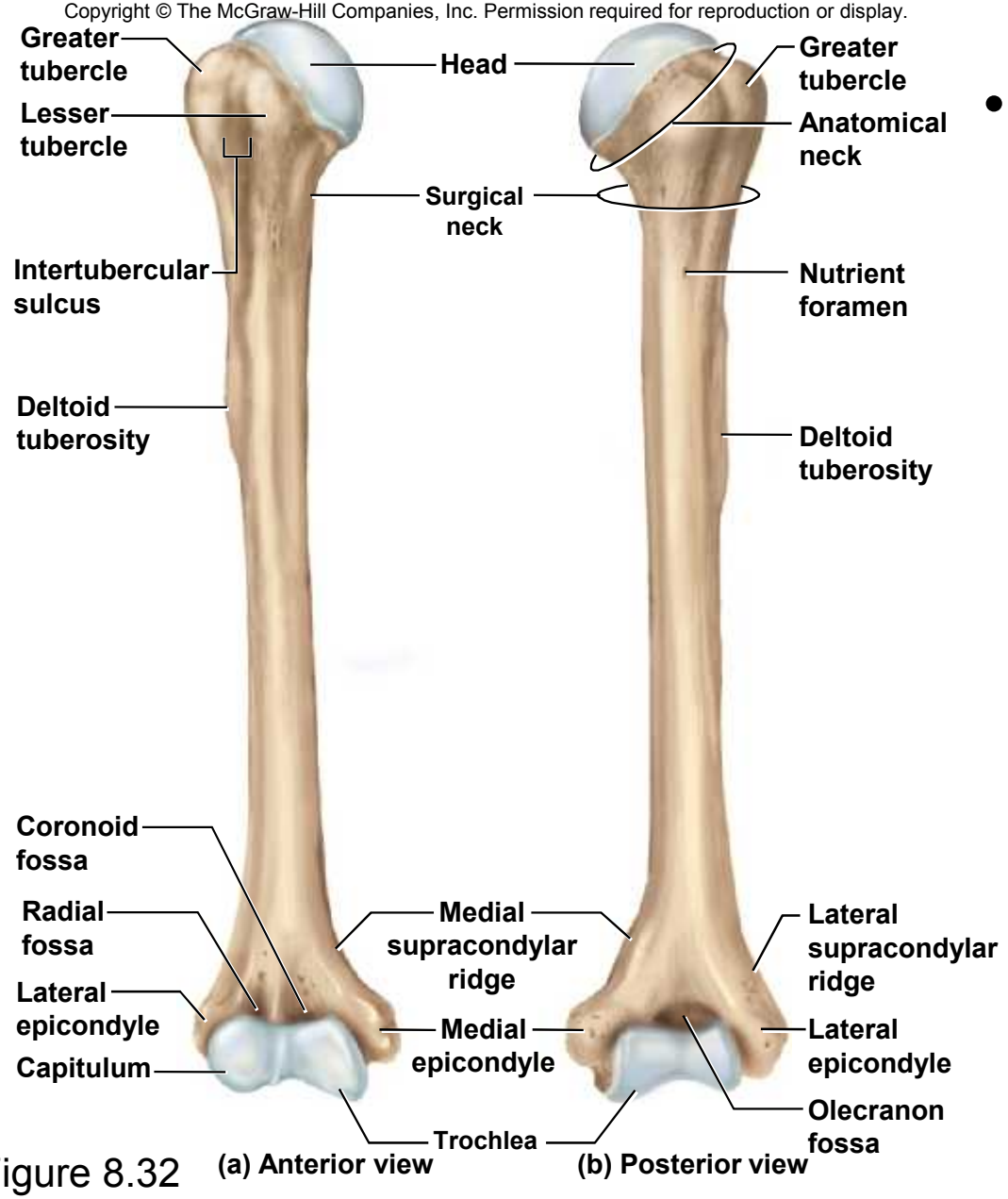


Figure 8.32

- **Distal end**
  - Rounded **capitulum** articulates with head of radius
  - **Trochlea** articulates with ulna
  - **Lateral** and **medial epicondyles**
  - **Lateral** and **medial supracondylar ridges**
  - **Olecranon fossa** holds olecranon process of ulna
  - **Coronoid fossa**
  - **Radial fossa**

The Radius

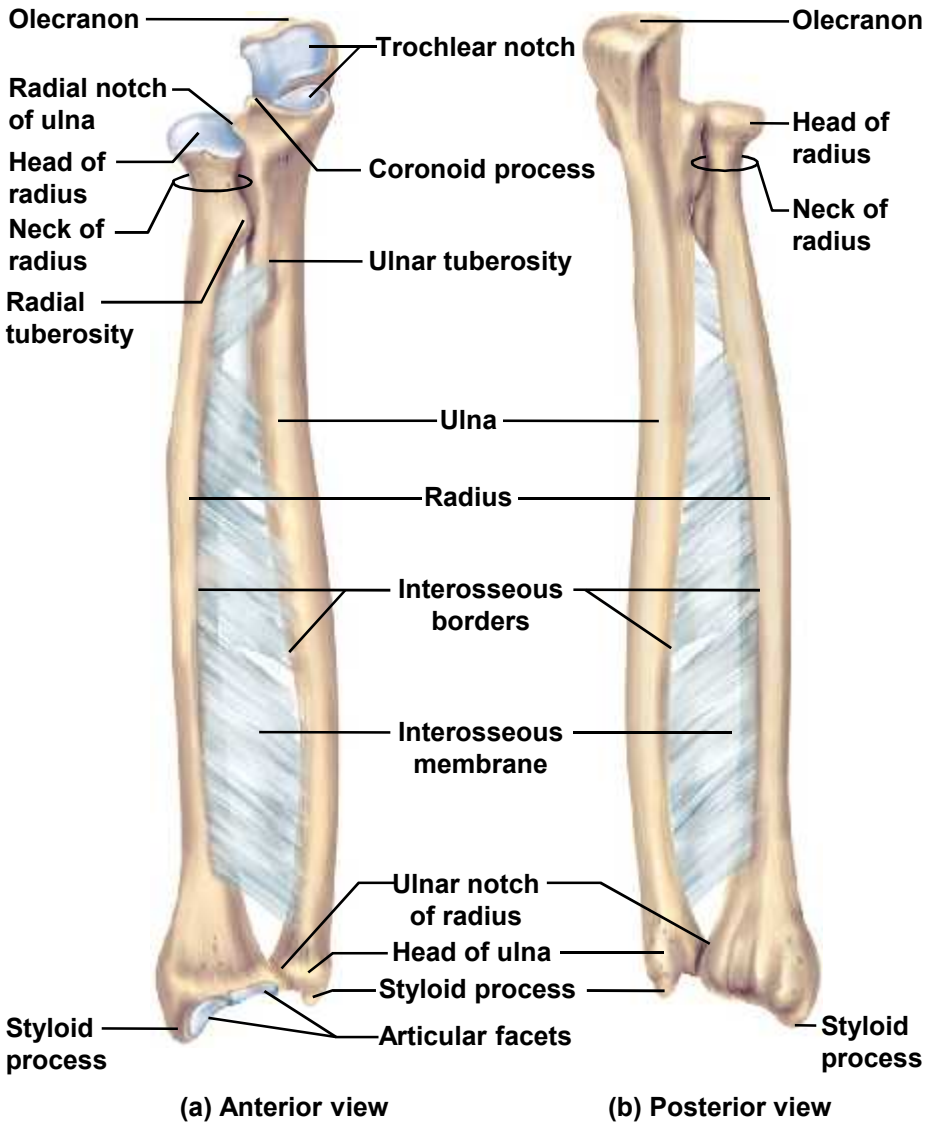


Figure 8.33

- **Radius**
  - **Head:** disc-shaped, 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
  - **Neck**
  - **Radial tuberosity** for biceps muscle
  - **Styloid process** can be palpated near thumb
  - **Ulnar notch**

The Ulna

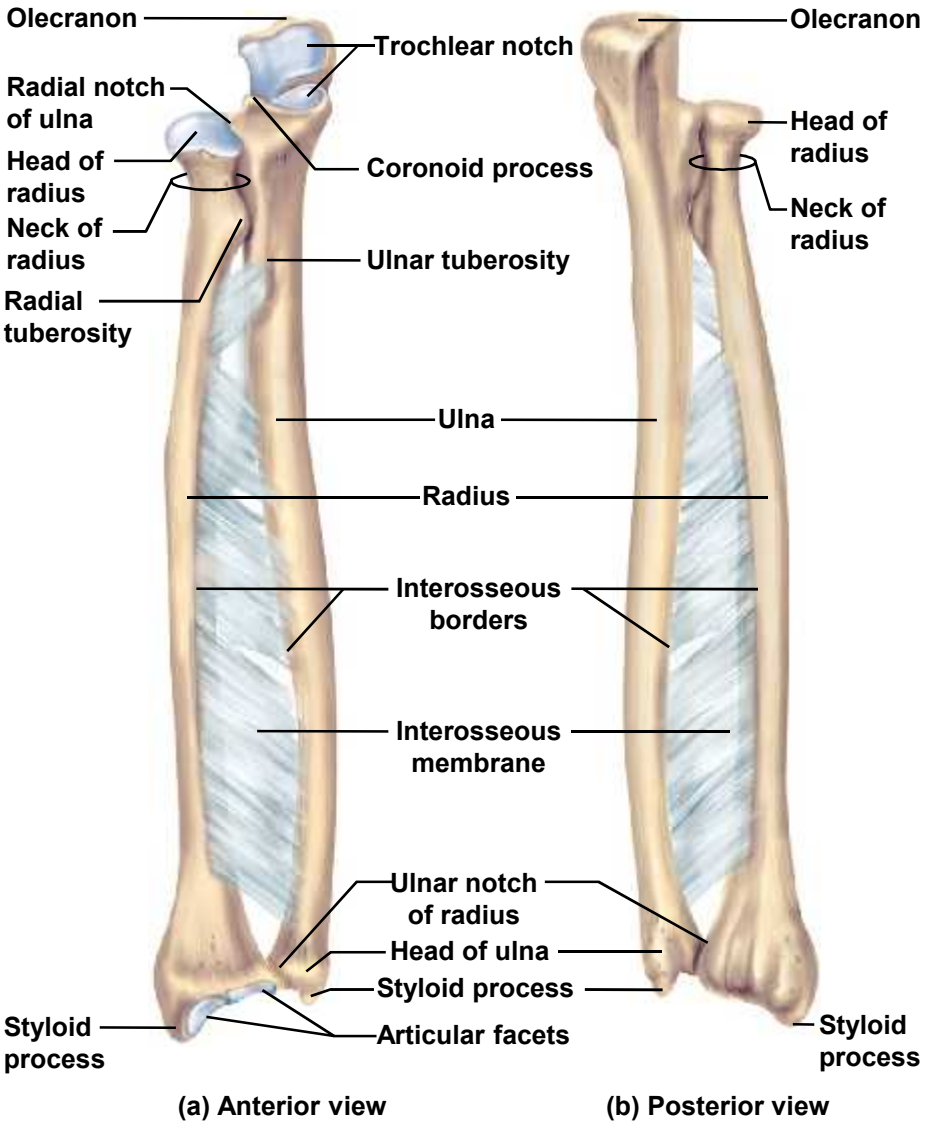


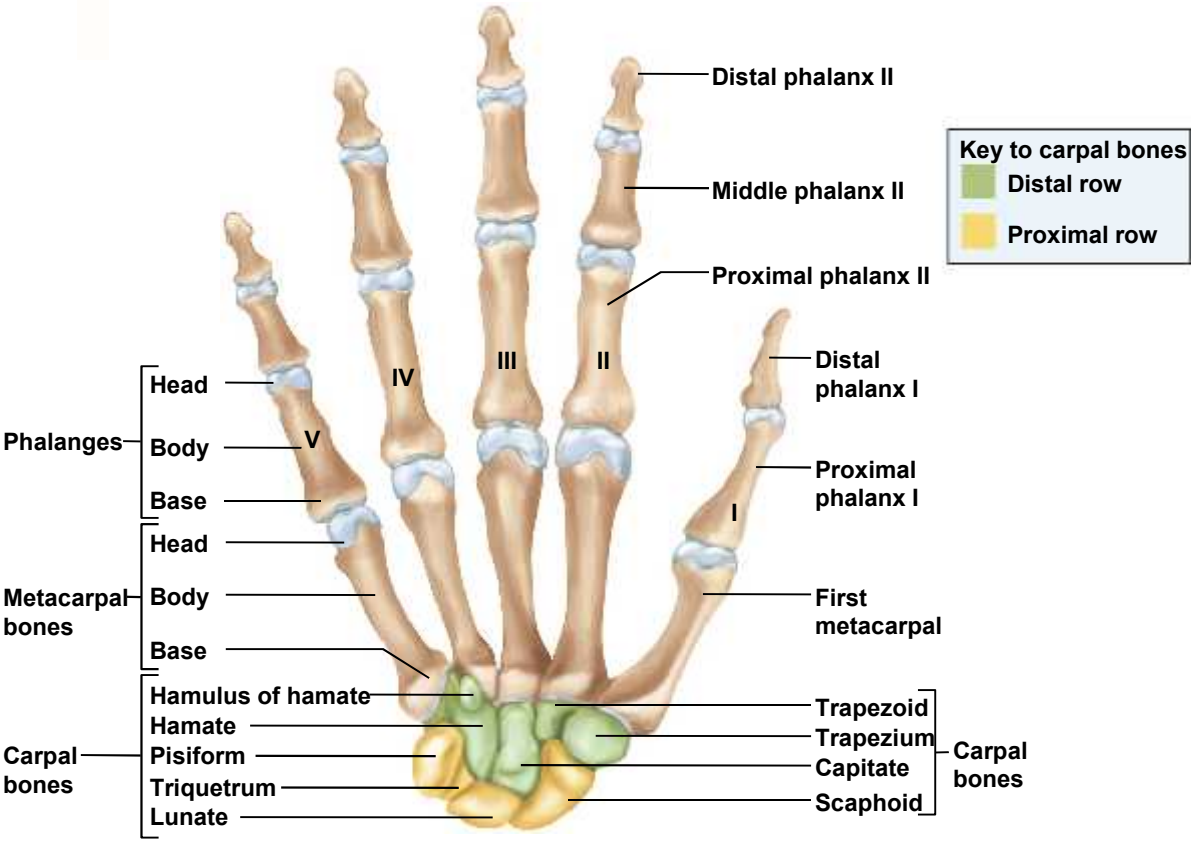
Figure 8.33

- **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

The Carpal Bones

- Eight bones form wrist
  - Allow movements of flexion, extension, abduction, and adduction
- Two rows (four bones each)
  - **Proximal row: scaphoid, lunate, triquetrum,** and **pisiform**
    - Pisiform is a sesamoid developed by age 9 to12 in tendon of flexor carpi ulnaris muscle
  - **Distal row: trapezium, trapezoid, capitate,** and **hamate**

The Right Wrist and Hand



(a) Anterior view

Figure 8.34a

The Metacarpal Bones and the Phalanges

- **Metacarpals—bones of the palm**
  - Metacarpal I proximal to base of thumb
  - Metacarpal V proximal to base of little finger
  - Proximal base, body, and distal head
- **Phalanges—bones of the fingers**
  - **Thumb or pollex has two phalanges**
    - **Proximal, distal phalanx**
  - **Fingers have three phalanges**
    - **Proximal, middle, distal phalanx**

The Pelvic Girdle and Lower Limb

- **Expected Learning Outcomes**
  - Identify and describe the features of the pelvic girdle, femur, patella, tibia, fibula, and bones of the foot.
  - Compare the anatomy of the male and female pelvic girdles and explain the functional significance of the differences.

The Pelvic Girdle

- **Pelvic girdle—** consists of a complete ring composed of three bones
  - Two **hip (coxal) bones,** also called **ossa coxae** or **innominate bones**
  - **Sacrum** is also part of the vertebral column

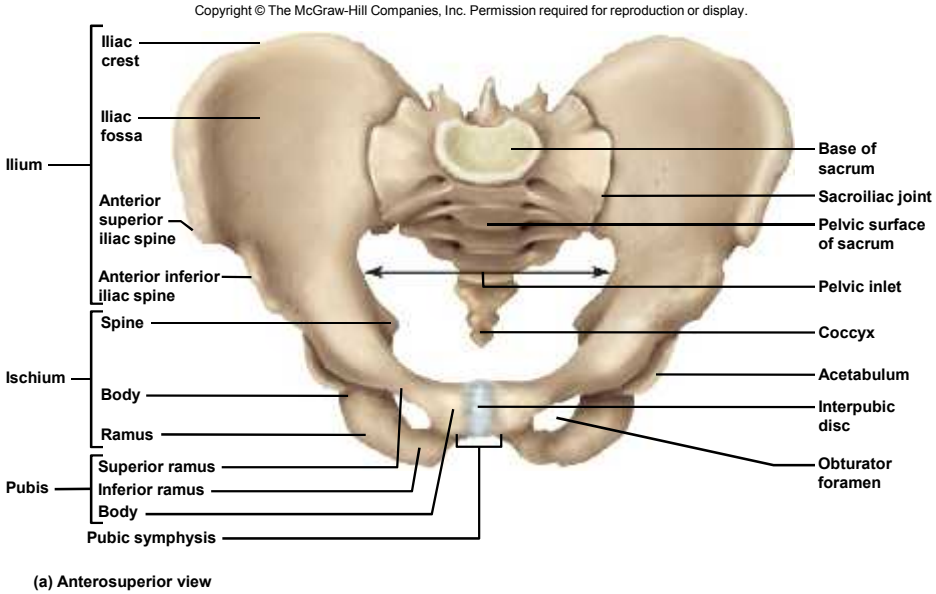


Figure 8.35a

The Pelvic Girdle

- **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

The Pelvic Girdle

- Anteriorly, **interpubic disc**—pad of fibrocartilage joins pubic bones
- **Pubic symphysis**—the interpubic disc and adjacent regions of the pubic bone on each side

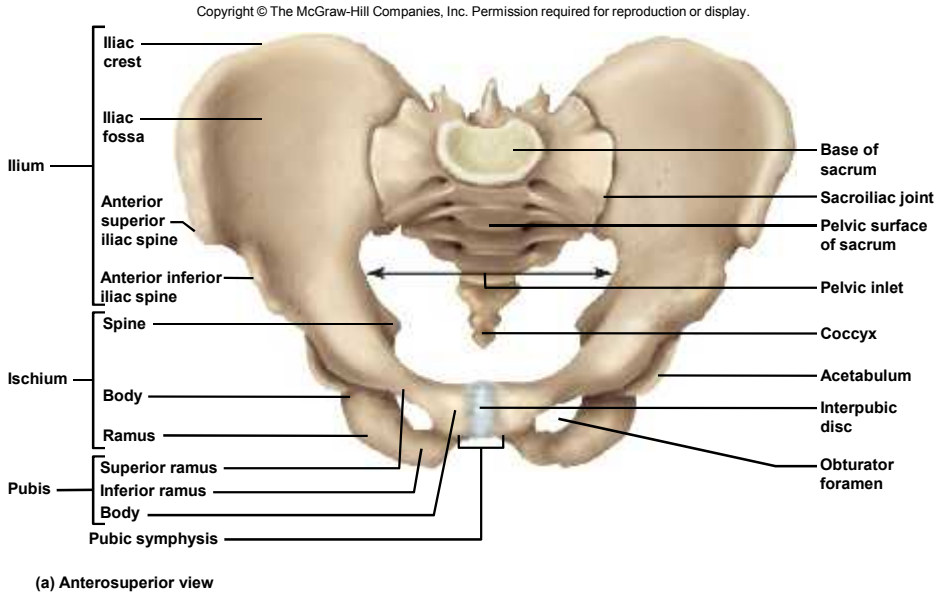
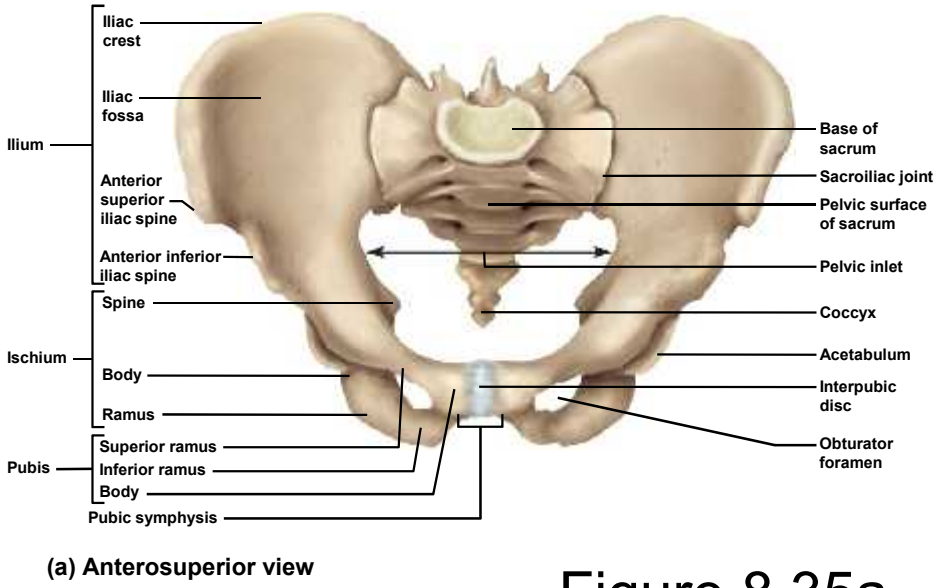


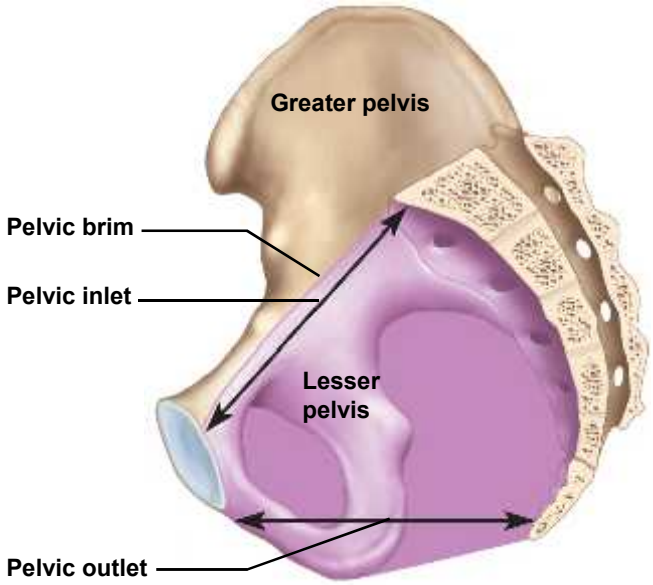
Figure 8.35a

The Pelvic Girdle



(a) Anterosuperior view

Figure 8.35a



(b) Median section

Figure 8.35b

- **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

The Pelvic Girdle

- Three distinct features of hip bone
  - **Iliac crest:** superior crest of hip
  - **Acetabulum:** hip socket
  - **Obturator foramen:** large hole below acetabulum

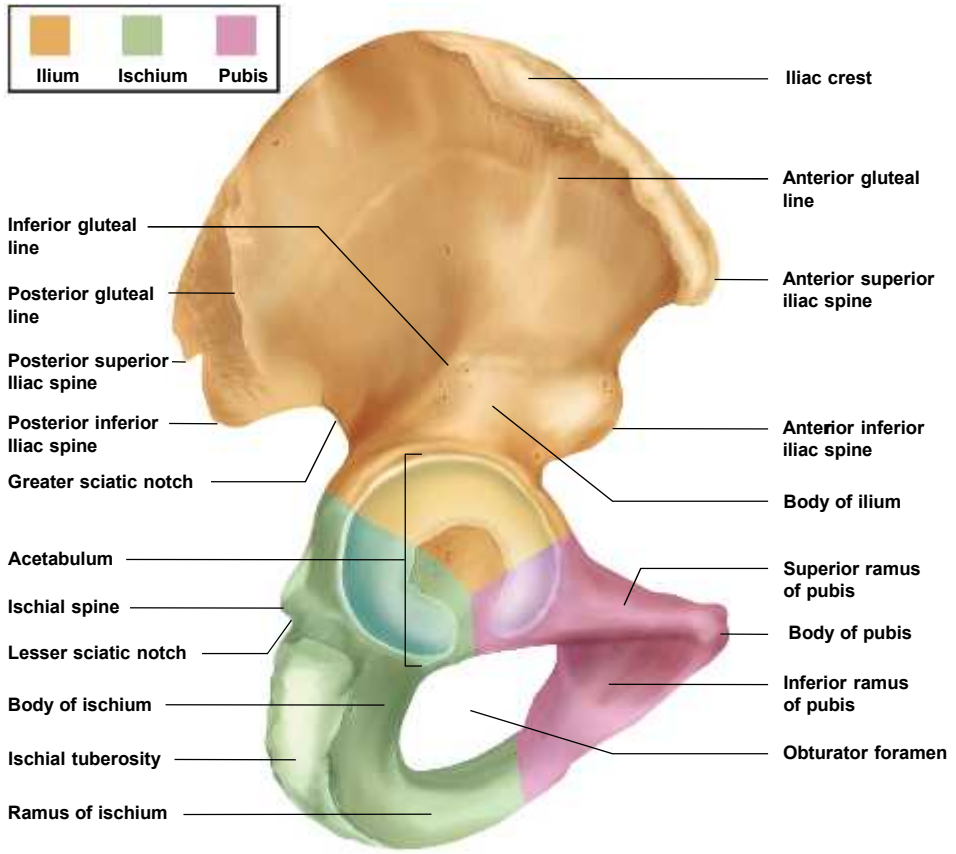


Figure 8.36a

The Pelvic Girdle

- Each adult hip bone is formed by the fusion of **three childhood bones: illeum, ishchium, pubis**

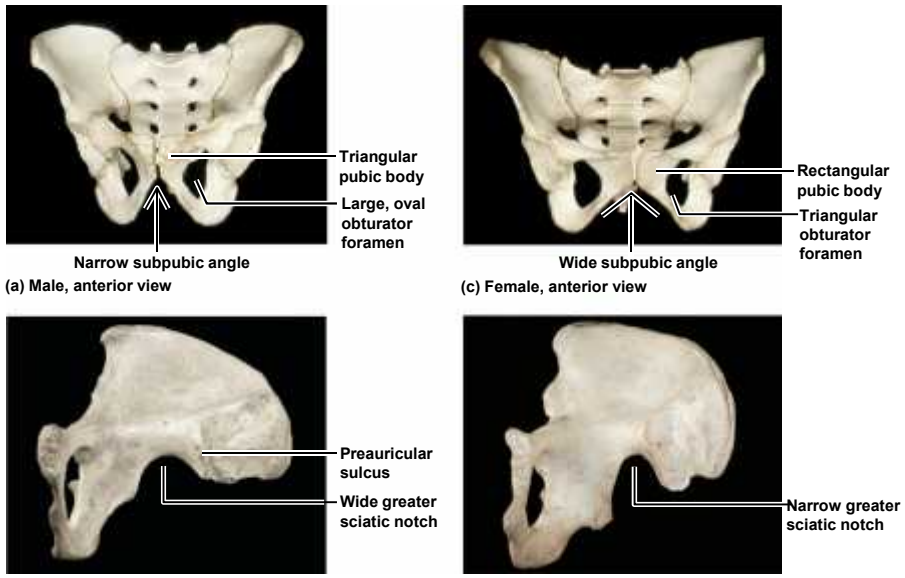
- **Ileum**
  - Largest
  - Extends from the **iliac crest** to the center of the acetabulum
  - **Anterior and posterior superior spine**
  - **Anterior and posterior inferior spines**
  - **Greater sciatic notch** and **iliac fossa**

The Pelvic Girdle

- **Ischium**
  - Inferioposterior portion of hip
  - Heavy **body** with prominent **spine**
  - **Lesser sciatic notch**
  - **Ischial tuberosity**
  - **Ramus**

- **Pubis (pubic bone)**
  - Most anterior portion of the hip bone
  - **Body, superior,** and **inferior ramus**

The Pelvic Girdle



(a): © David Hunt/specimens from the National Museum of Natural History, Smithsonian Institution; (b-c): © L. Bassett/Visuals Unlimited; (d): © David Hunt/specimens from the National Museum of Natural History, Smithsonian Institution

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

The Lower Limb

- Lower limb divided into **four regions** containing **30 bones** per limb
  - **Femoral region** (thigh): extends from hip to knee region
    - Contains the **femur** and **patella**
  - **Crural region** (leg proper): extends from knee to ankle
    - Contains medial **tibia** and lateral **fibula**
  - **Tarsal region** (tarsus): ankle—the union of the crural region with the foot
    - Tarsal bones are considered part of the foot
  - **Pedal region** (pes): foot
    - Composed of 7 tarsal bones, 5 metatarsals, and 14 phalanges in the toes

The Femur

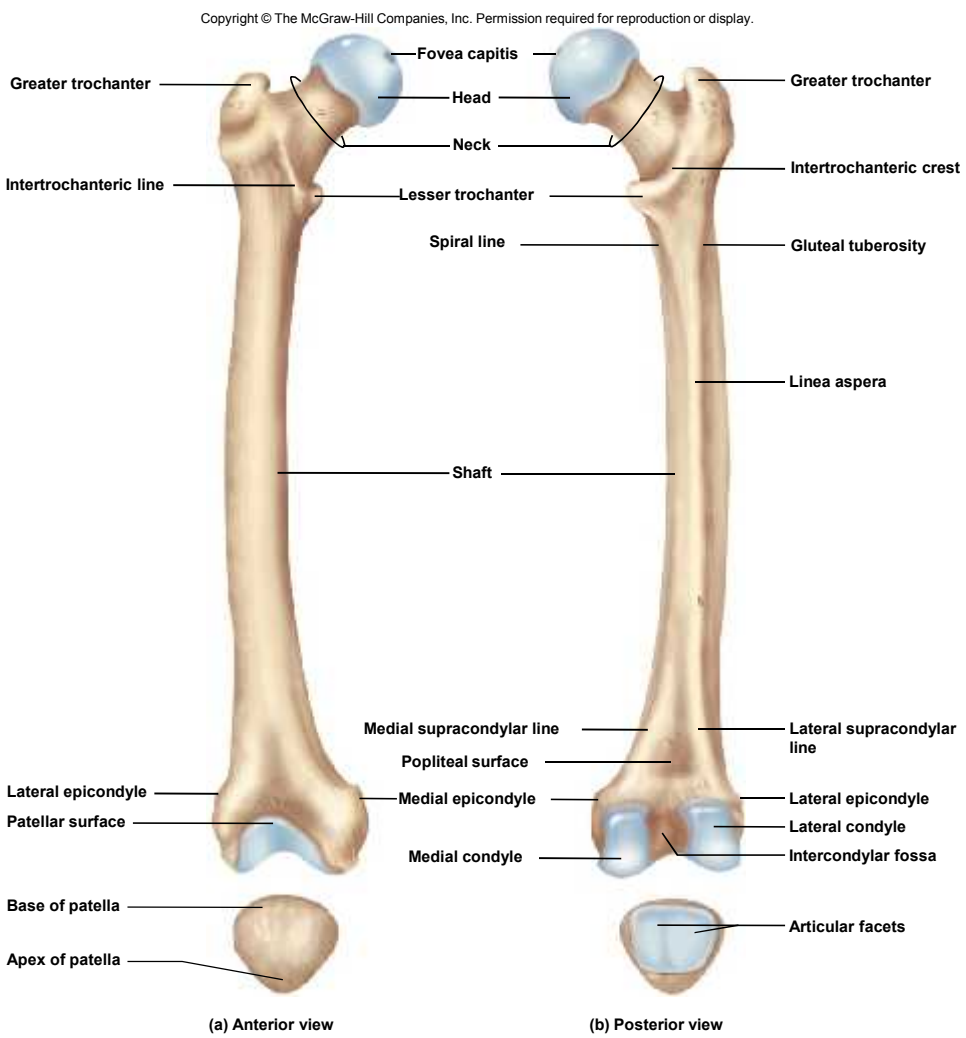


Figure 8.38

- Longest and strongest bone of the body
- Hemispherical **head** that articulates with the acetabulum of the pelvis
  - Forms ball-and-socket joint
  - **Fovea capitis:** pit in head of femur for attachment of a ligament
- **Greater** and **lesser trochanters** for muscle attachment
- **Intertrochanteric crest—** thick oblique ridge on the posterior surface that connects the trochanters

The Femur

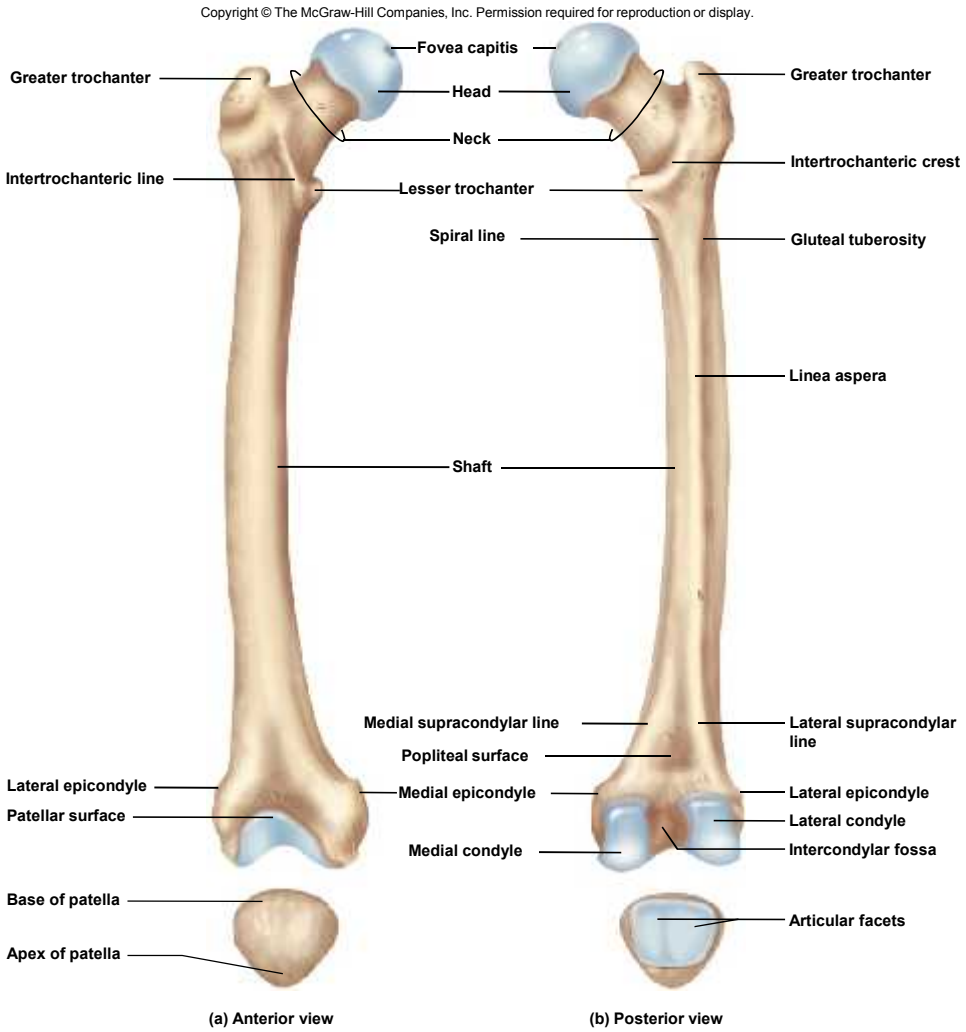


Figure 8.38

- **Intertrochanteric line—**more delicate ridge on the anterior surface that connects trochanters
- **Linea aspera—**ridge on posterior of the shaft
- **Spiral (pectineal) line** and **gluteal tuberosity**
- **Medial** and **lateral condyles** and **epicondyles** found distally
- **Intercondylar fossa**
- **Patellar** and **popliteal surface**

The Patella

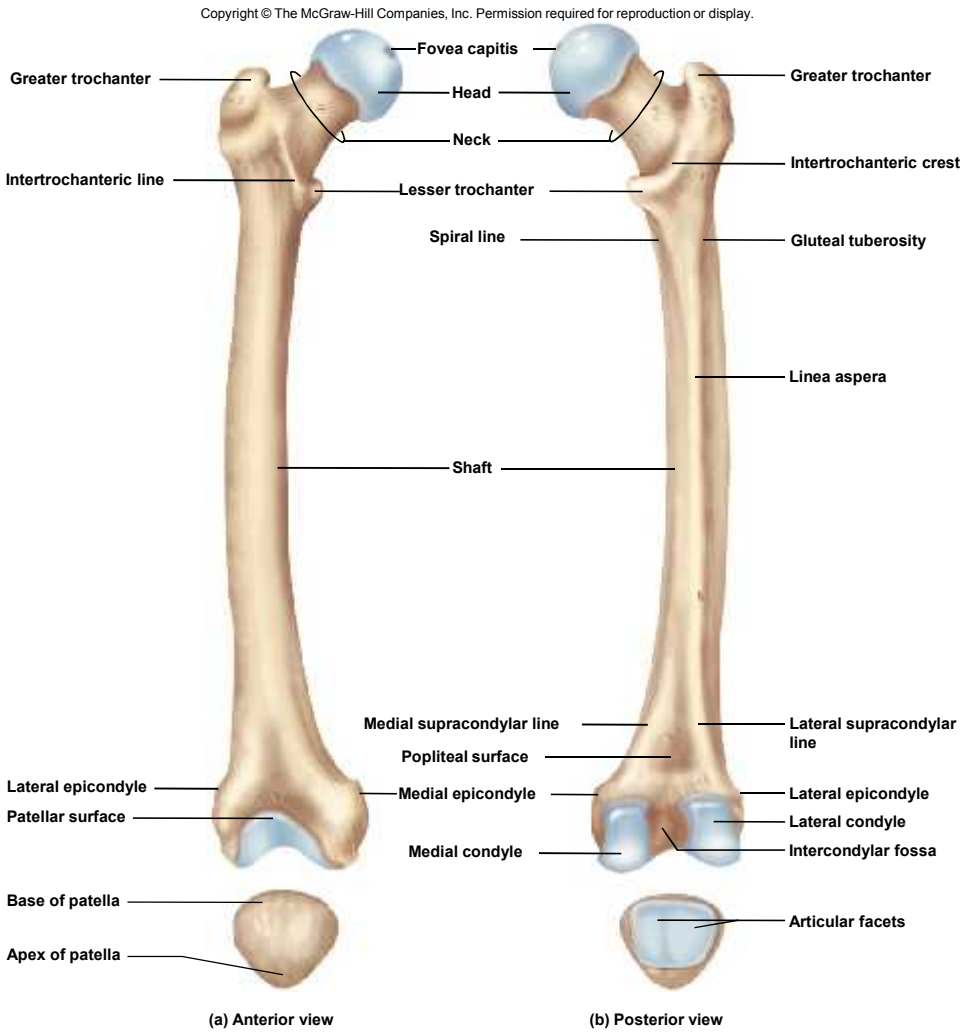


Figure 8.38

- **Patella**—triangular sesamoid bone embedded in tendon of knee
- Cartilaginous at birth
  - Ossifies at age 3 to 6 years
- **Base**—broad, superior portion
- **Apex**—pointed, inferior portion
- **Articular facets**—shallow, posterior portion
- Quadriceps femoris tendon extends from anterior muscle of thigh to patella
  - Continues as the **patellar ligament** from patella to tibia

Tibia

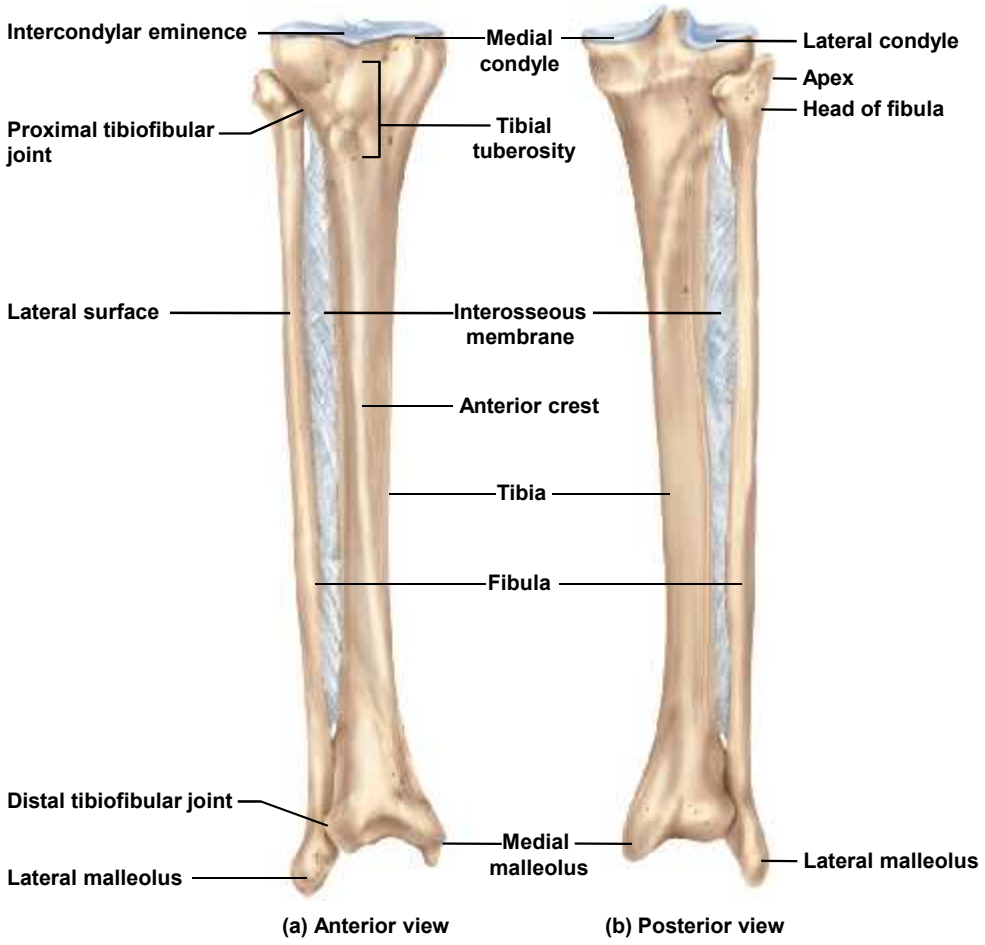


Figure 8.39

- **Tibia**—thick, medial, weight-bearing bone
  - Only weight-bearing bone of the crural region
  - Broad superior **head**
  - **Medial** and **lateral condyles**
    - Fairly flat articular surfaces
    - Articulate with condyle of femur
  - **Intercondylar eminence**—ridge separating condyles
  - **Tibial tuberosity**—attachment of quadricep muscles
  - **Anterior crest**—sharp, angular
  - **Medial malleolus**—bony knob on inside of ankle

The Fibula

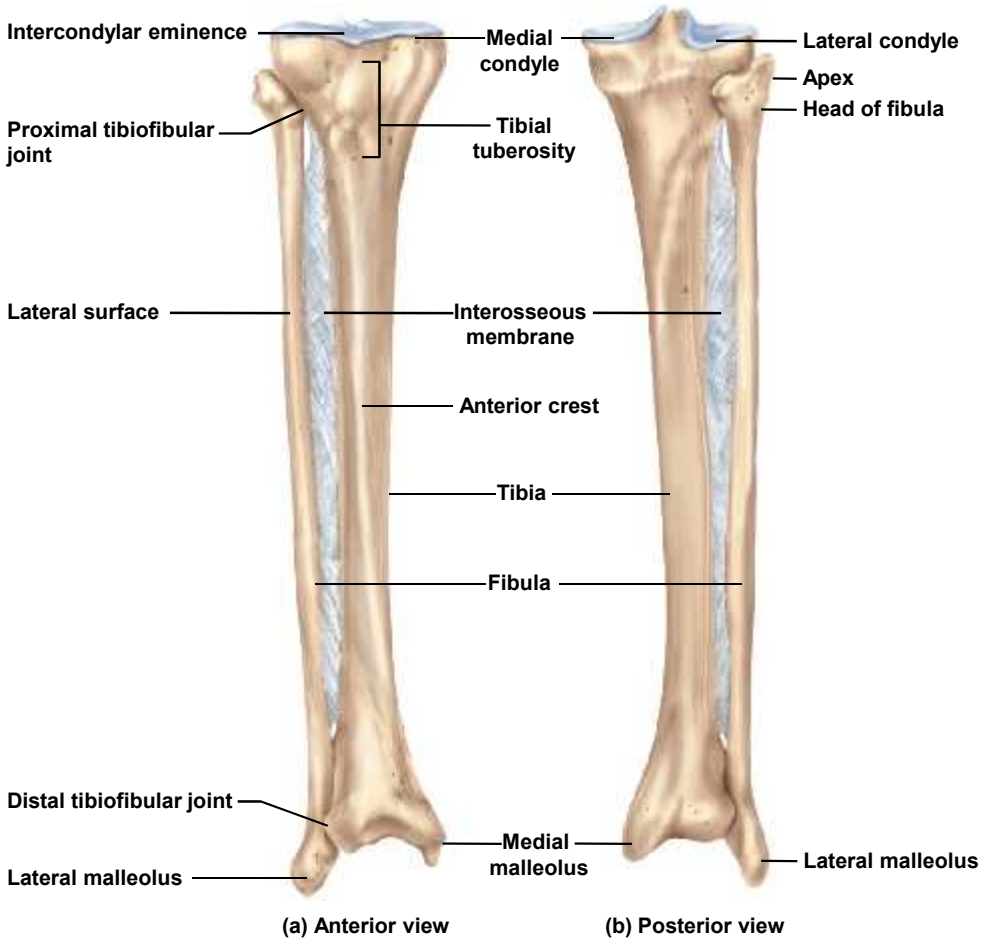


Figure 8.39

- **Fibula**—slender, lateral strut that helps stabilizes ankle
- Does not bear any body weight
  - Spare bone tissue for grafts
- **Head**—proximal end
- **Apex**—point of the head
- **Lateral malleolus**—distal expansion, bony knob on lateral side of ankle
- Joined to tibia by **interosseous membrane**

The Ankle and Foot

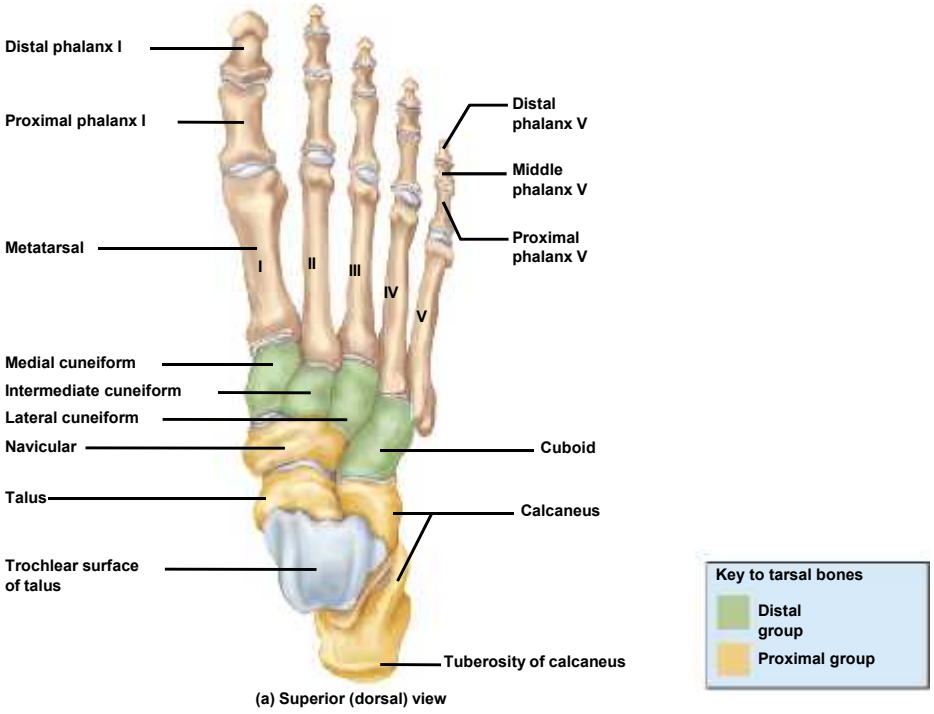


Figure 8.40a

- **Tarsal bones**—arranged in proximal and distal groups
  - Tarsal bones are shaped and arranged differently from carpal bones due to load-bearing role of the ankle
- **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
- **Proximal row** of tarsal bones
  - Talus, calcaneus, navicular
- **Distal row** of tarsal bones
  - Medial, intermediate, lateral cuneiforms and cuboid

The Ankle and Foot

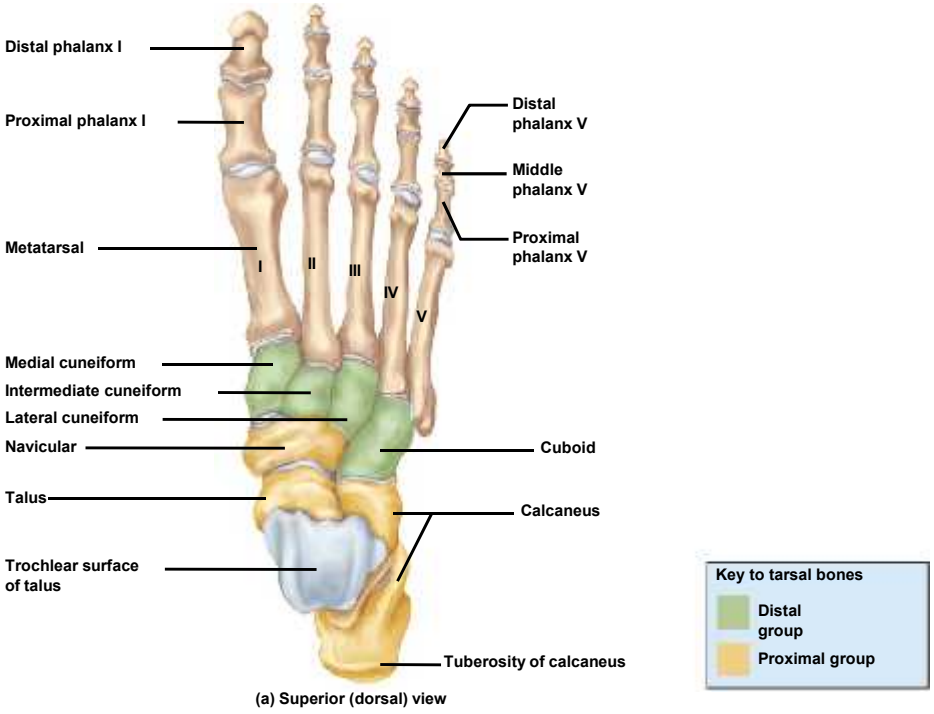


Figure 8.40a

- Remaining bones of foot are similar in name and arrangement to the hand
- **Metatarsals**
  - Metatarsal I is proximal to the great toe (hallux)
  - Metatarsal V is proximal to the little toe
  - Proximal base, intermediate shaft, and distal head
- **Phalanges**
  - Two in great toe
    - Proximal and distal phalanx
  - Three in all other toes
    - Proximal, middle, distal phalanx

The Ankle and Foot

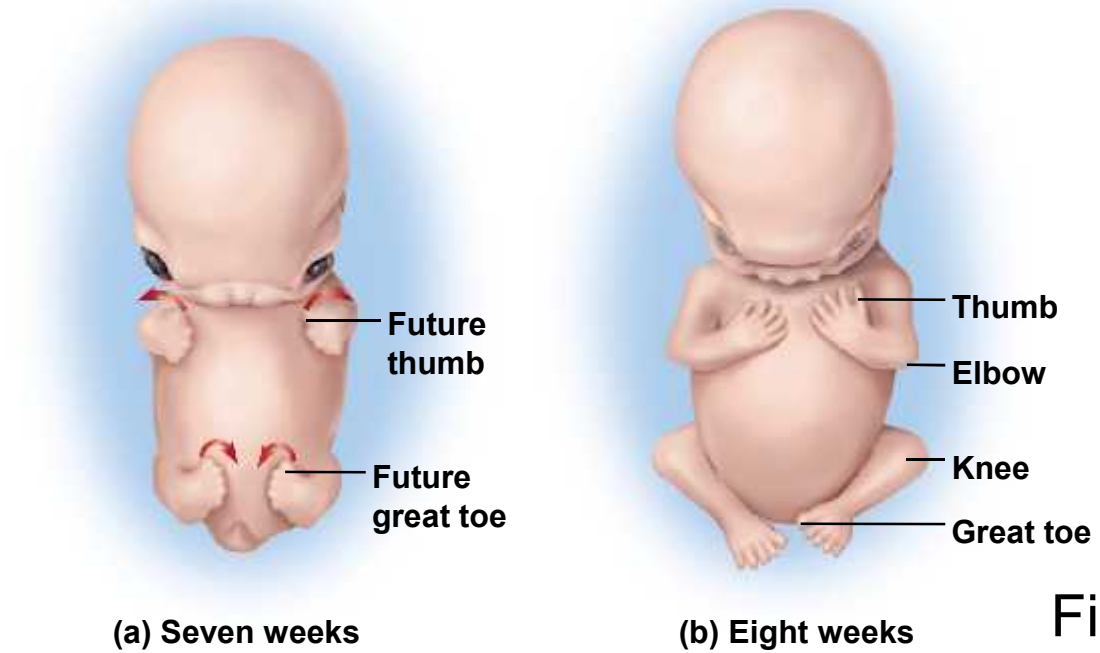


Figure 8.41

- Rotation of upper and lower limbs in opposite directions
  - Starts seventh week of embryonic development
  - Largest digit medial in foot and lateral in hand
  - Each limb rotates about 90° in opposite directions
  - Rotation also explains why elbow flexes posteriorly and knee flexes anteriorly

The Ankle and Foot

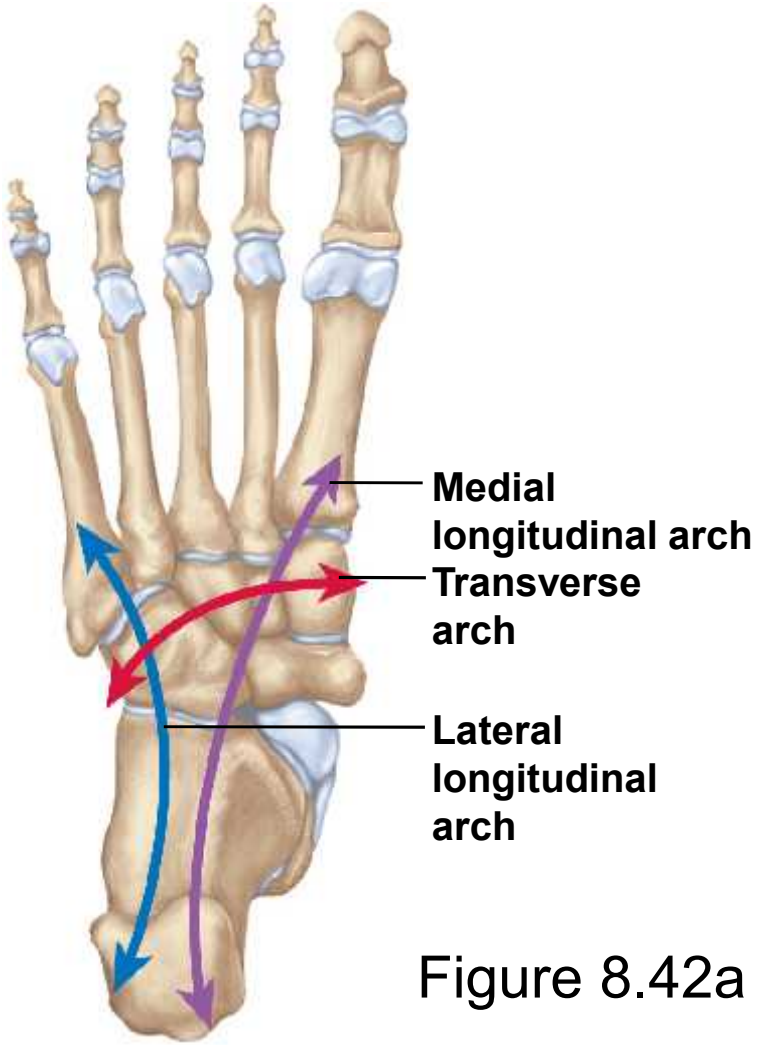


Figure 8.42a

(a) Inferior (plantar) view

- Sole of foot is not flat on ground
- **Three springy arches** absorb stress
  - **Medial longitudinal arch**
    - From heel to hallux
    - Formed from the calcaneus, talus, navicular, cuneiforms, and metatarsals I and III
- **Lateral longitudinal arch**
  - From heel to little toe
  - Includes calcaneus, cuboid, and metatarsals IV and V

The Ankle and Foot

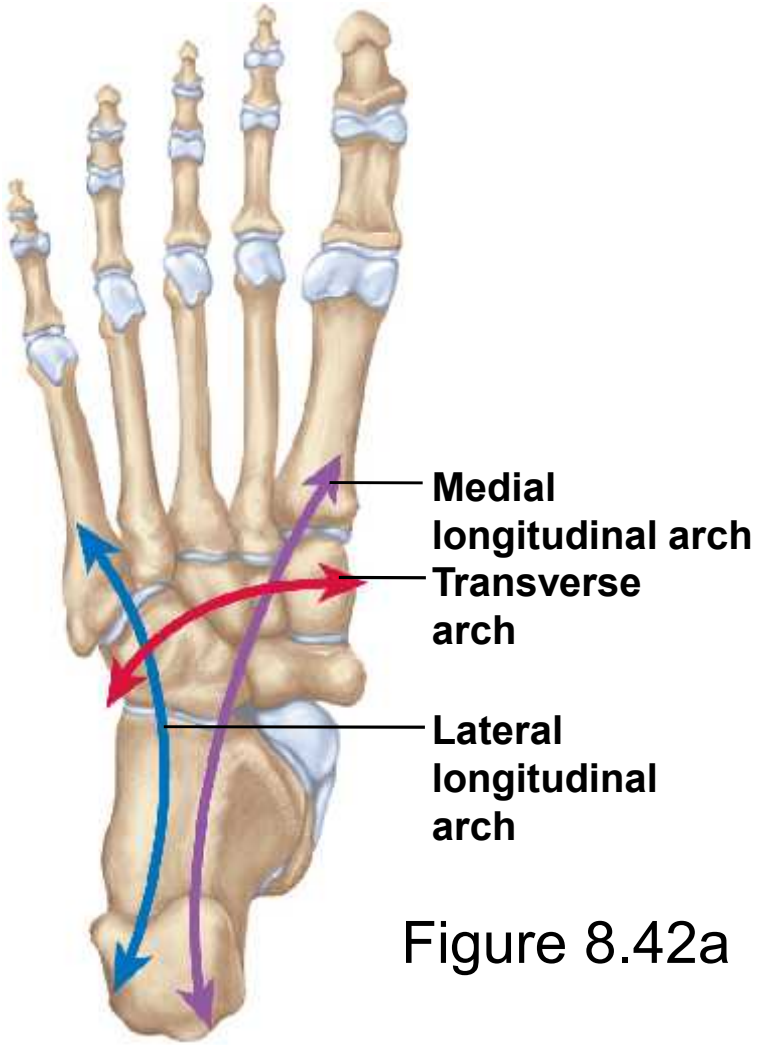


Figure 8.42a

(a) Inferior (plantar) view

- **Transverse arch**
  - Across middle of foot
  - Includes the cuboid, cuneiforms, and proximal heads of metatarsals
  - Arches held together by short, strong ligaments
- **Pes planus** (flat feet)—excessive weight, repetitious stress, or congenital weakness

Skeletal Adaptations for Bipedalism

- Humans are only animals habitually **bipedal**
  - 3.6-million-year-old human footprints indicate upright walking
- **Adaptations**
  - Strong, springy foot arches
  - Great toe not opposable
  - Femurs angle inward so knees are closer together—erect posture requires less muscular effort
  - Viscera supported in bowl-shaped pelvis
  - Insertions of gluteal muscles differ from other primates

Skeletal Adaptations for Bipedalism

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

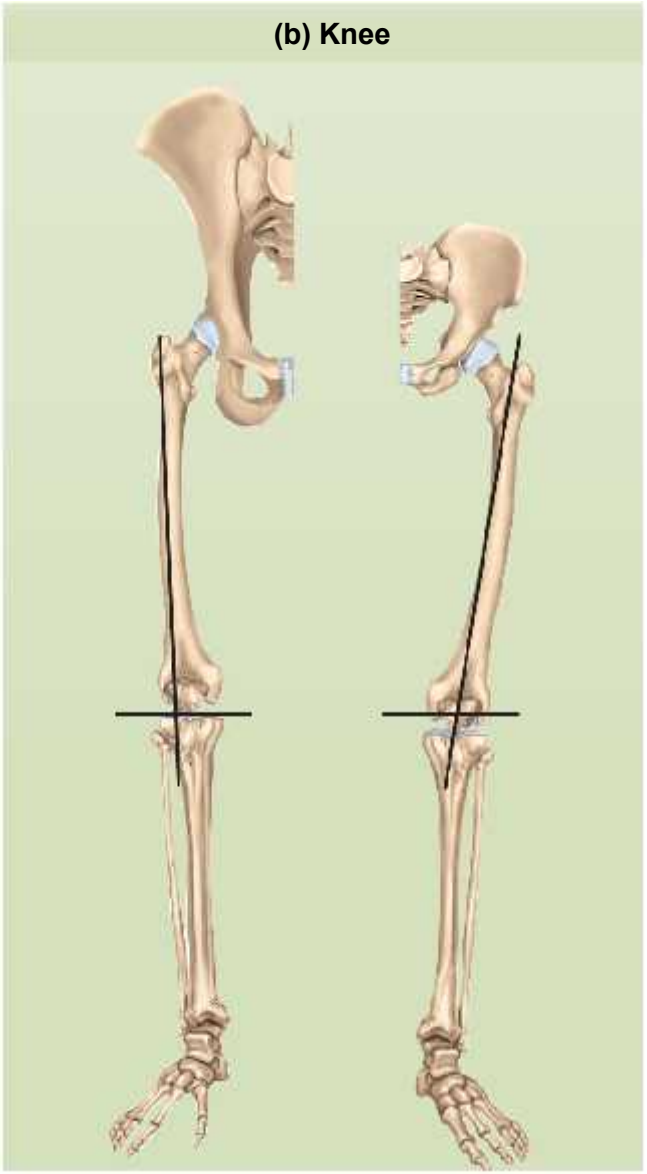


Figure 8.43a,b

Skeletal Adaptations for Bipedalism

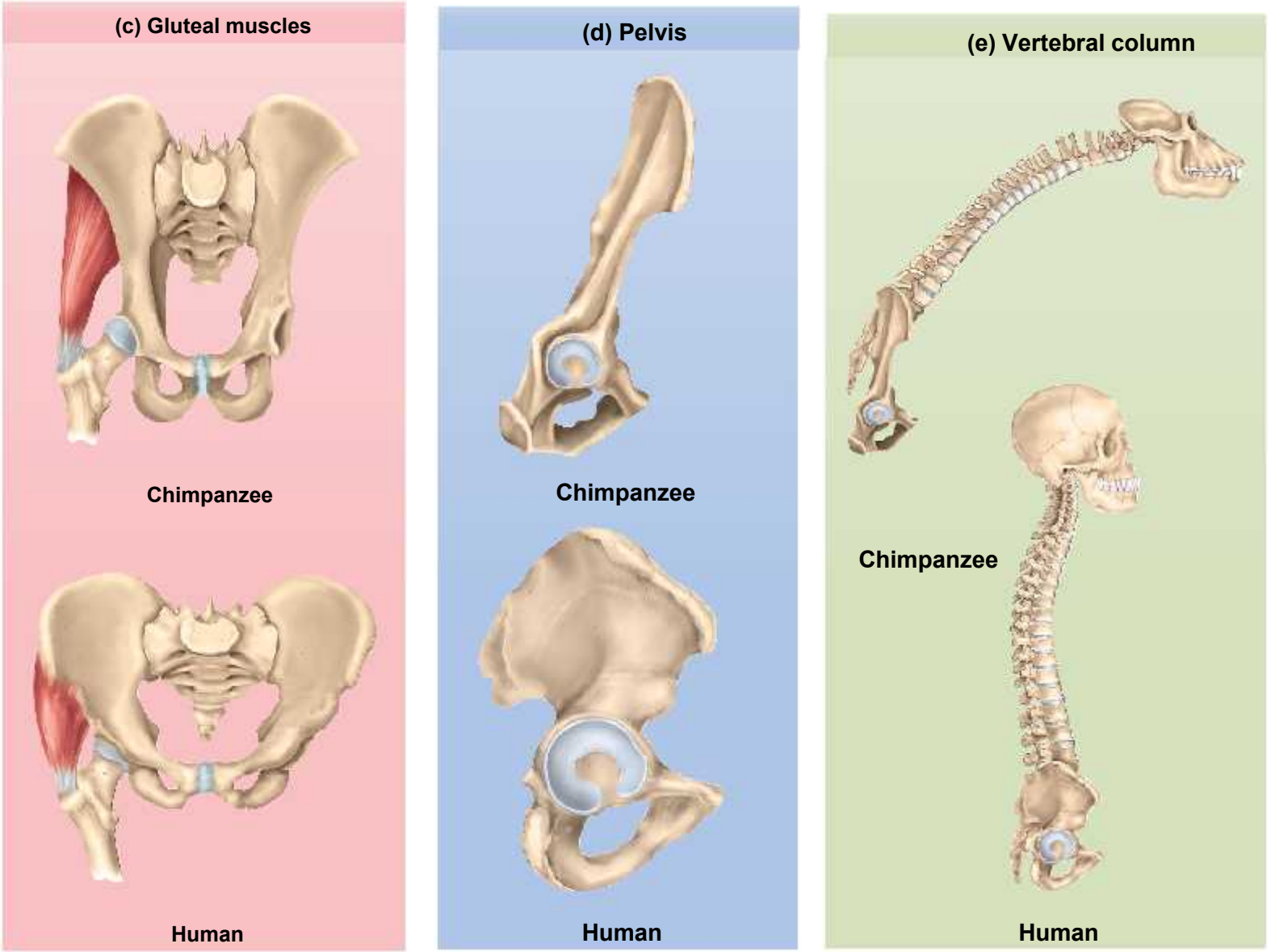


Figure 8.43c,d,e

Skeletal Adaptations for Bipedalism

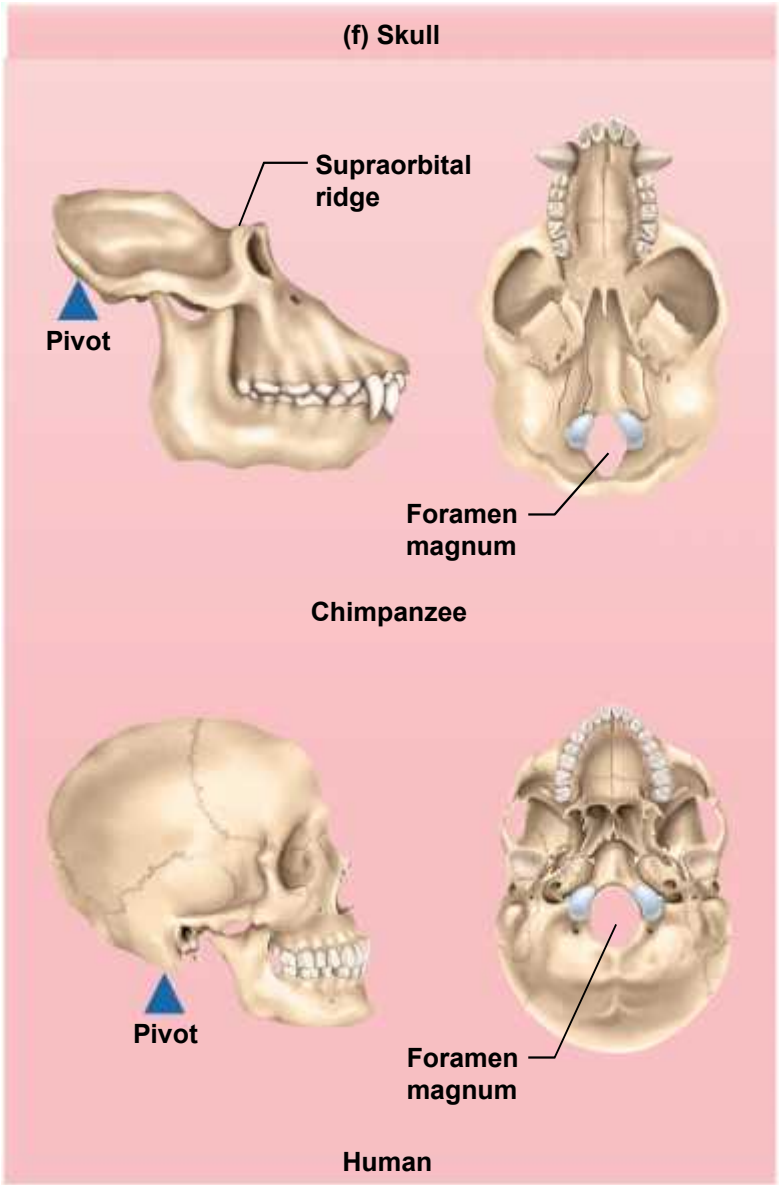


Figure 8.43f