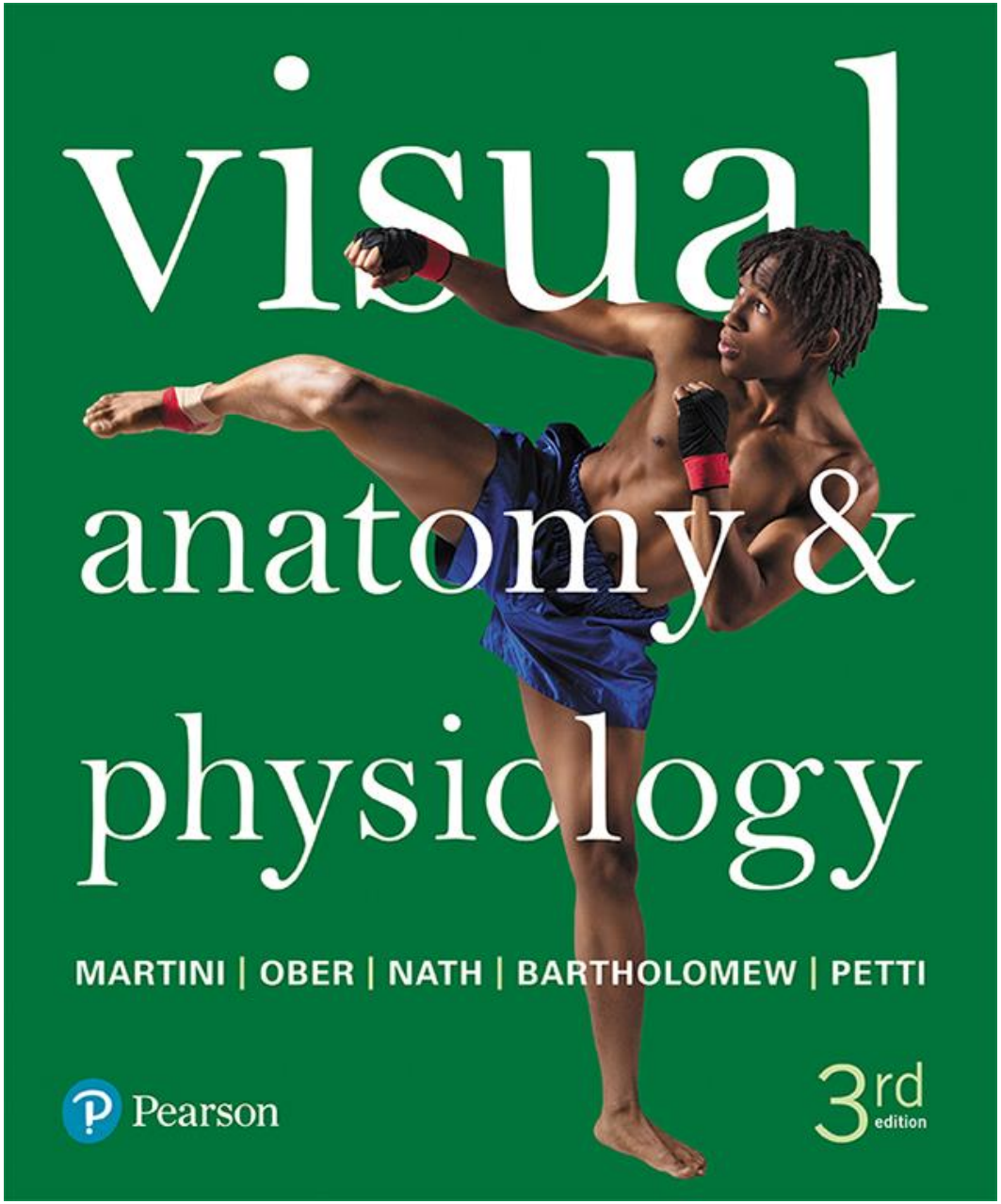


7

The Skeleton

Lecture Presentation by
Lori Garrett

Section 1: Axial Skeleton

Learning Outcomes

7.1 List the four major components of the axial skeleton, and describe its major functions.

7.2 Identify the bones of the cranium and face, and locate and identify the cranial sutures.

7.3 Explain the significance of the markings and locations of the anterior and posterior aspects of the facial and cranial bones.

7.4 Explain the significance of the markings and locations of the lateral and medial aspects of the facial and cranial bones.

Section 1: Axial Skeleton

Learning Outcomes (continued)

7.5 Explain the significance of the markings and locations of the inferior and interior aspects of the facial and cranial bones.

7.6 Describe and locate the bone markings of the sphenoid, ethmoid, and palatine bones.

7.7 Describe the structure of the orbital complex and nasal complex and the functions of their individual bones.

7.8 Describe the mandible and the associated bones of the skull.

Section 1: Axial Skeleton

Learning Outcomes (continued)

7.9 Describe key structural differences among the skulls of infants, children, and adults.

7.10 Identify and describe the curves of the spinal column and their functions, and identify the vertebral regions.

7.11 Describe the distinctive structural and functional characteristics of the cervical and thoracic vertebrae.

7.12 Describe the distinctive structural and functional characteristics of the lumbar vertebrae.

Section 1: Axial Skeleton

Learning Outcomes (continued)

7.13 Describe the distinctive structural and functional characteristics of the sacrum and coccyx.

7.14 Explain the significance of the articulations between the thoracic vertebrae and the ribs, and between the ribs and the sternum.

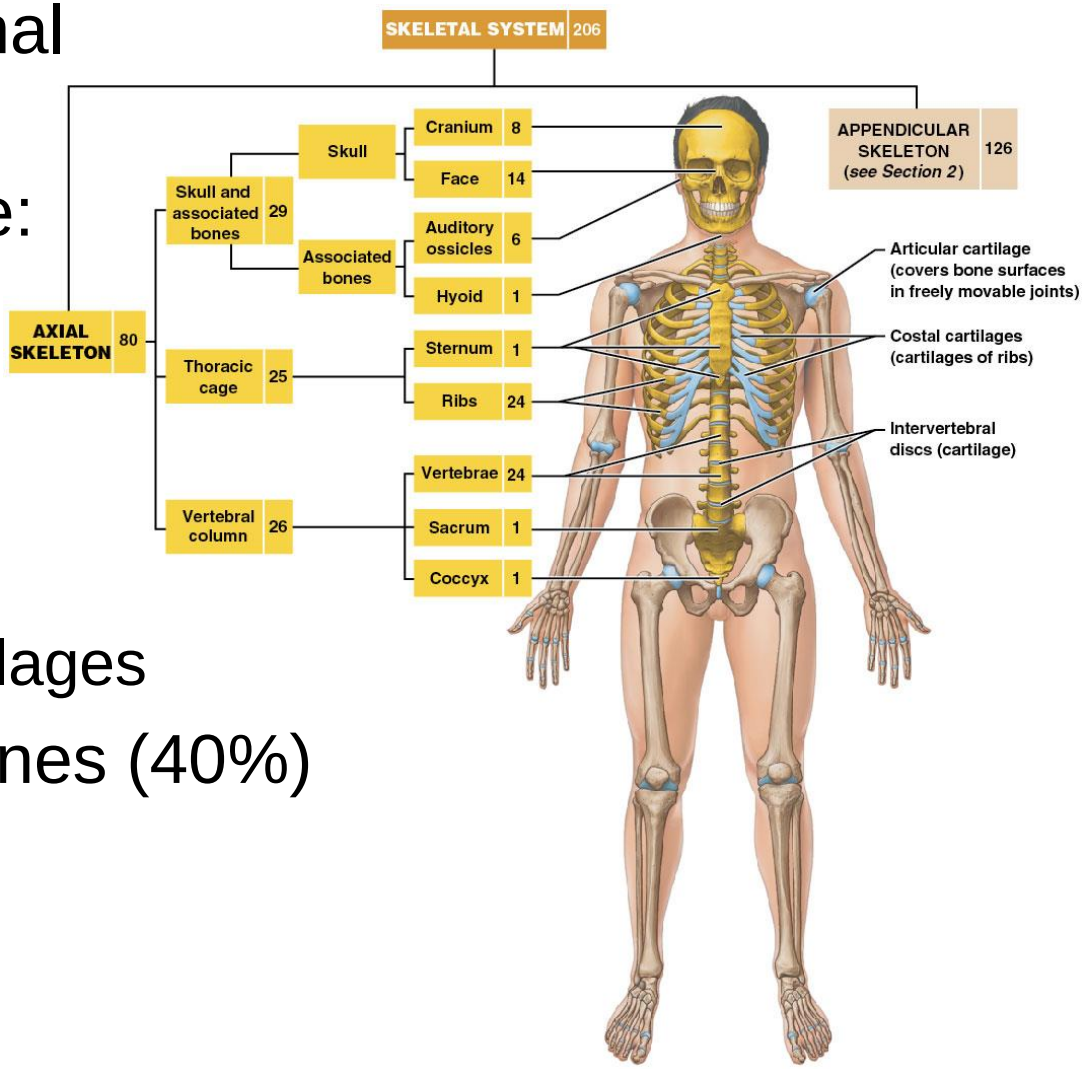
Module 7.1: The axial skeleton includes bones of the head, vertebral column, and trunk

Axial skeleton

- Forms the longitudinal axis of the body
- Components include:
  - Skull and associated bones
  - Thoracic cage
  - Vertebral column
  - Supplemental cartilages
- In total, about 80 bones
  - About 40 percent of the bones in the human body

Module 7.1: The axial skeleton

- Forms the longitudinal axis of the body
- Components include:
  - Skull and associated bones
  - Thoracic cage
  - Vertebral column
  - Supplemental cartilages
- In total, about 80 bones (40%)



Module 7.1: The axial skeleton

Axial skeleton functions

- Supports and protects brain, spinal cord, and organs in trunk body cavities
- Provides attachment sites for certain muscles that:
  - Adjust the position of the head, neck, and trunk
  - Perform respiratory movements
  - Stabilize or position parts of the appendicular skeleton that support the limbs
- Joints of the axial skeleton
  - Limited in movement but very strong

Module 7.1: Review

A. How many bones comprise the skull and its associated bones?
B. What are the primary functions of the axial skeleton?
C. Describe the general role of the muscles that attach to the axial skeleton.

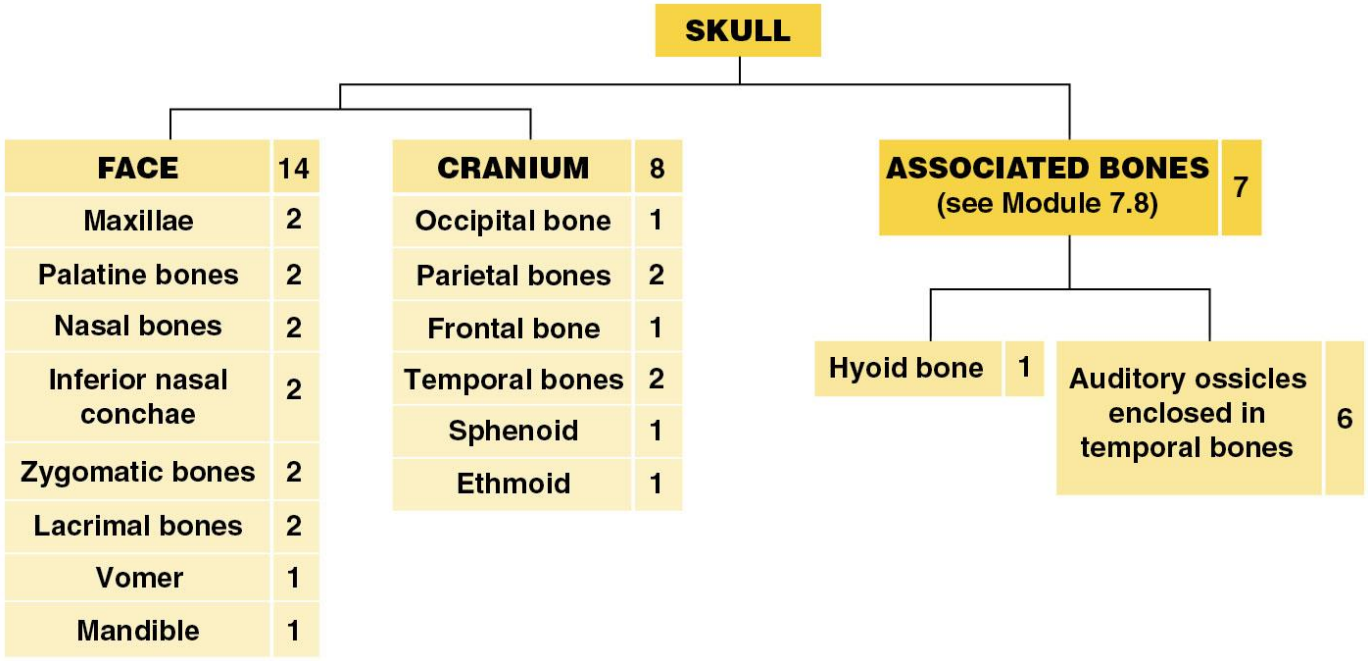
Learning Outcome: List the four major components of the axial skeleton, and describe its major functions.

Module 7.2: The skull has cranial and facial components that are usually bound together by sutures

Skull bones

- 22 bones in total
  - 14 **facial bones**
  - 8 **cranial bones** form the **cranium**, or braincase
- 7 associated bones
  - 6 auditory ossicles
    - Located within the temporal bones (3 on each side)
  - 1 hyoid
    - Connected by ligaments to the inferior surface of the temporal bones

Module 7.2: Skull components



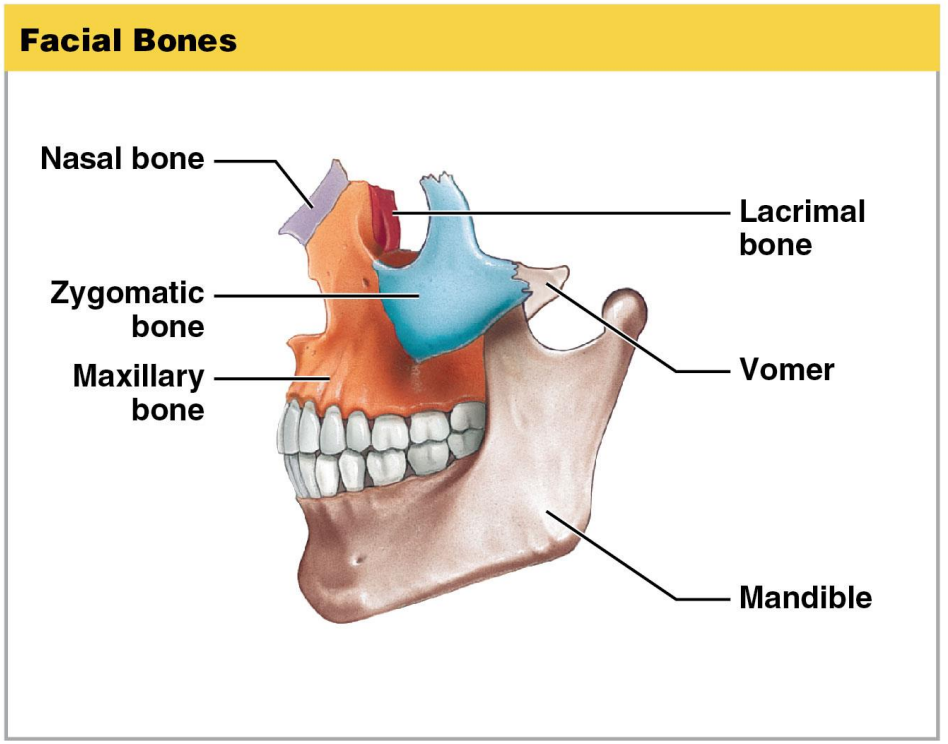
Skull bones

- 22 bones in total
  - 14 **facial bones**
  - 8 **cranial bones** form the **cranium**, or braincase
- **7 associated bones**

Module 7.2: Skull components

Facial bones (14)

- Protect and support entrances to the digestive and respiratory tracts
- Provide attachment points for muscles that:
  - Control facial expression
  - Assist in manipulation of food

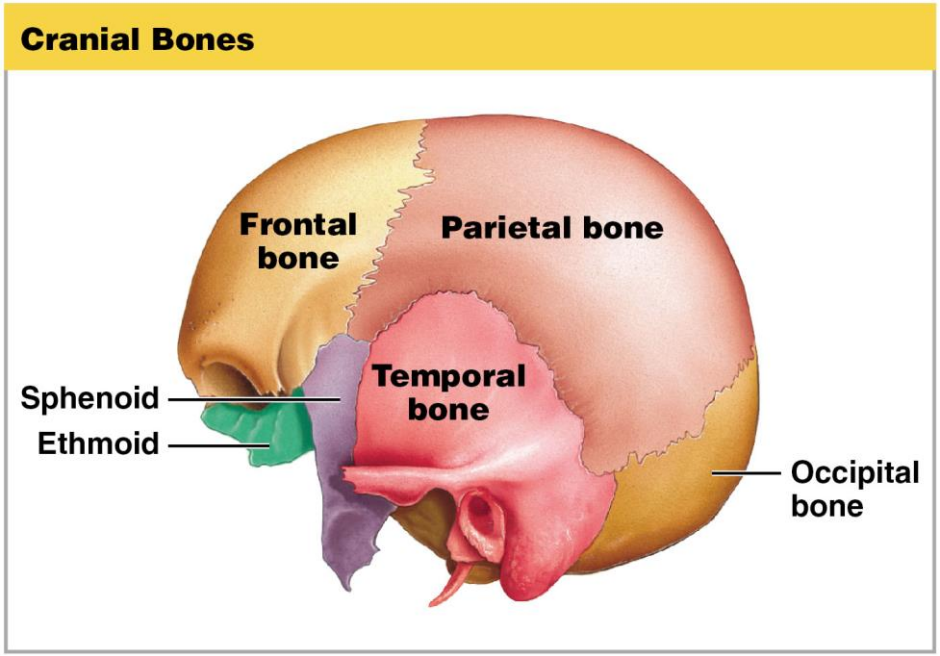


Video: Facial Bones

Module 7.2: Skull components

Cranial bones (8)

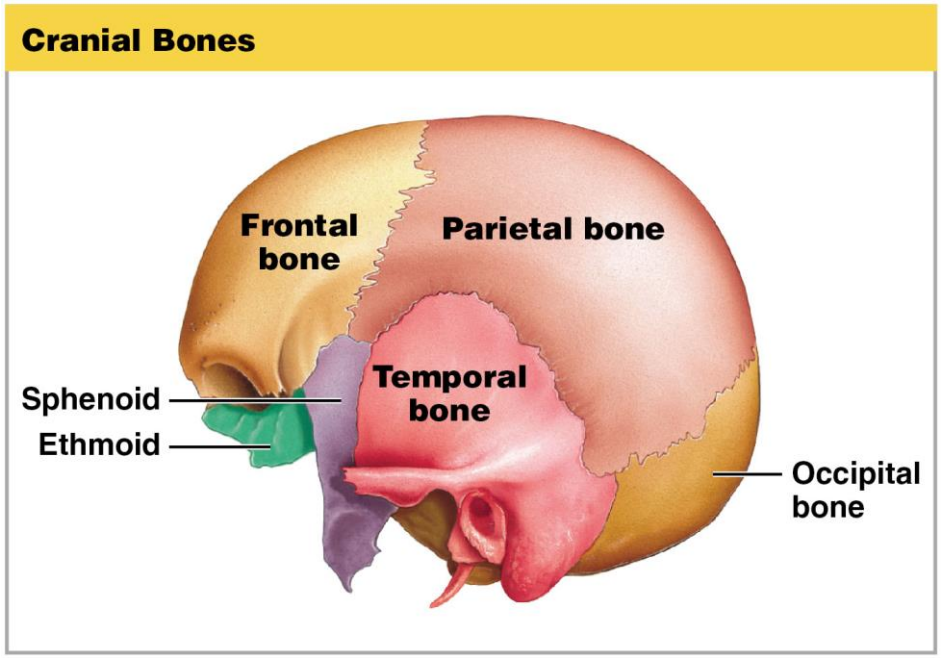
- Form the **cranium**
- Enclose the **cranial cavity**
  - Fluid-filled chamber that cushions and supports the brain
- Inner surface
  - Attachment point for blood vessels, nerves, and membranes stabilizing the position of the brain



Module 7.2: Skull components

Cranial bones (continued)

- Outer surface
  - Attachment point for muscles that move the eyes, jaws, and head
- **Calvaria** (skullcap)
  - Roof of the skull formed by the occipital, parietal, and frontal bones

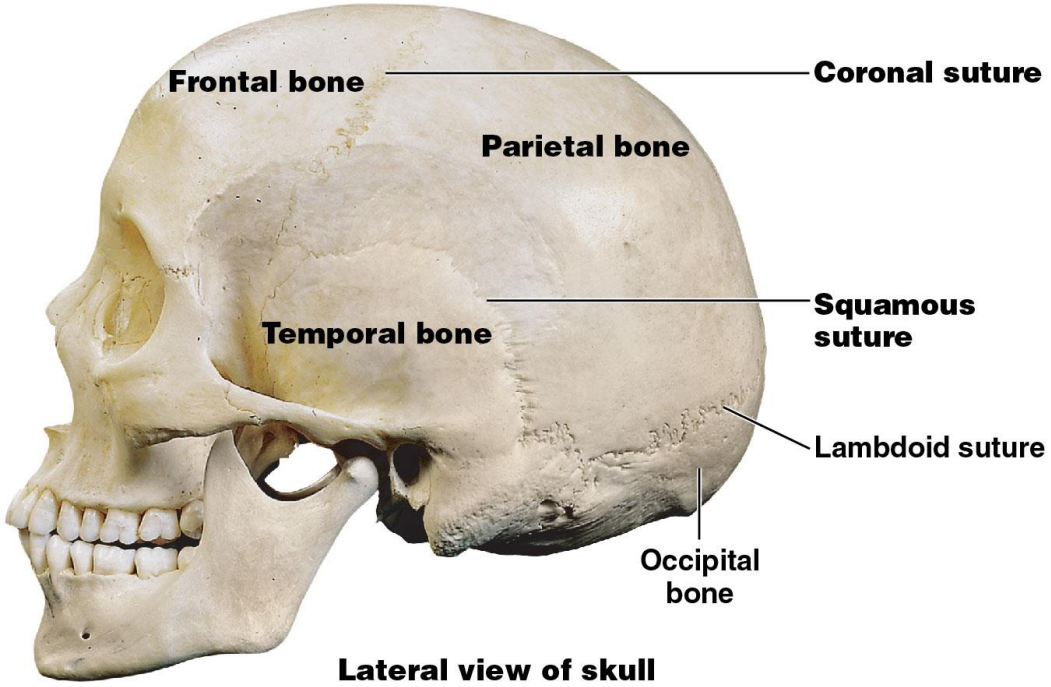


Video: Cranial Bones

Module 7.2: Skull components

Sutures: Joints (articulations) between the skull bones of adults

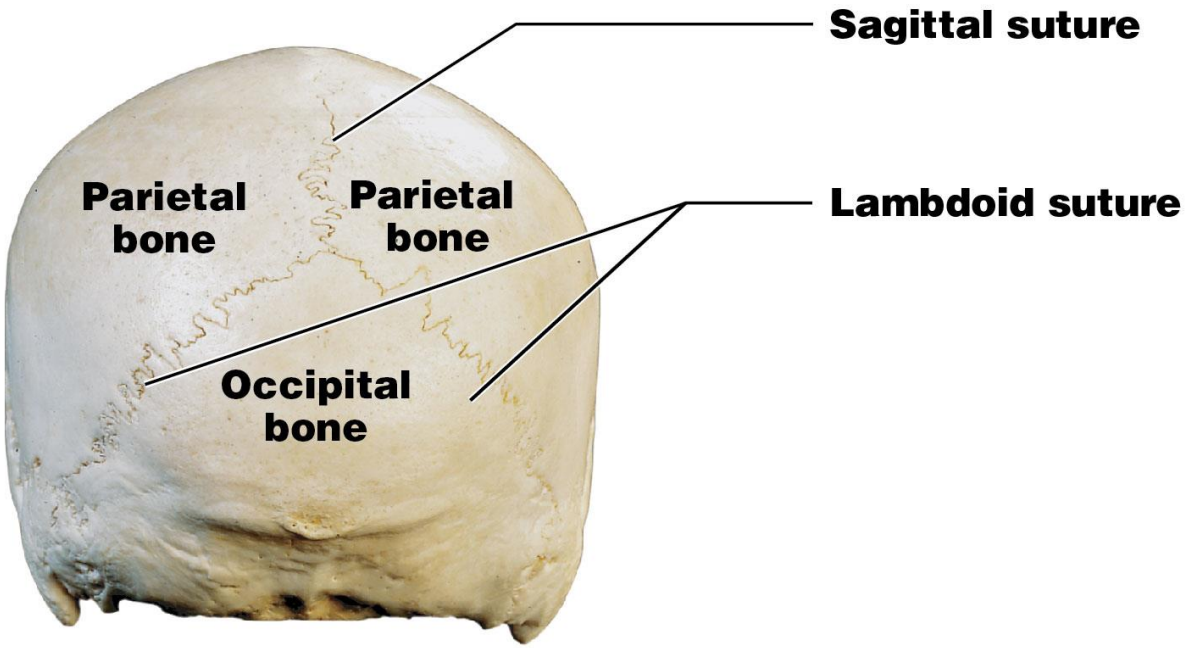
- Four major sutures:
  1. **Coronal** (attaches frontal to parietal bones)
  2. **Squamous** (attaches temporal and parietal bones)



Lateral view of skull

Module 7.2: Skull components

- Four major sutures (continued):
  3. **Sagittal** (attaches parietal bones)
  4. **Lambdoid** (attaches occipital to parietal bones)
     - Sutural bones may be present along this suture



Posterior view of skull

Module 7.2: Review

A. Identify the bones of the cranium.
B. Describe the functions of the facial bones.
C. Define *suture*.
D. Name the sutures that mark the boundaries of each parietal bone.

Learning Outcome: Identify the bones of the cranium and face, and locate and identify the cranial sutures.

Module 7.3: Facial bones dominate the anterior aspect of the skull, and cranial bones dominate the posterior surface

Paired facial bones

- **Nasal bones**
  - Support superior portion of the bridge of the nose
  - Connected to cartilage supporting distal portions of the nose
- **Lacrimal bones**
  - Form part of medial wall of the orbit (eye socket)
- **Palatine bones**
  - Form the posterior portion of the hard palate
  - Contribute to the floor of each orbit

Module 7.3: Facial and cranial bones

Paired facial bones (continued)

- **Zygomatic bones**
  - Form part of the cheekbone
  - Contribute to the rim and lateral wall of the orbit
- **Maxillae**
  - Support the upper teeth
  - Form inferior orbital rim, the upper jaw, lateral margins of the external nares, and most of hard palate

Module 7.3: Facial and cranial bones

Paired facial bones (continued)

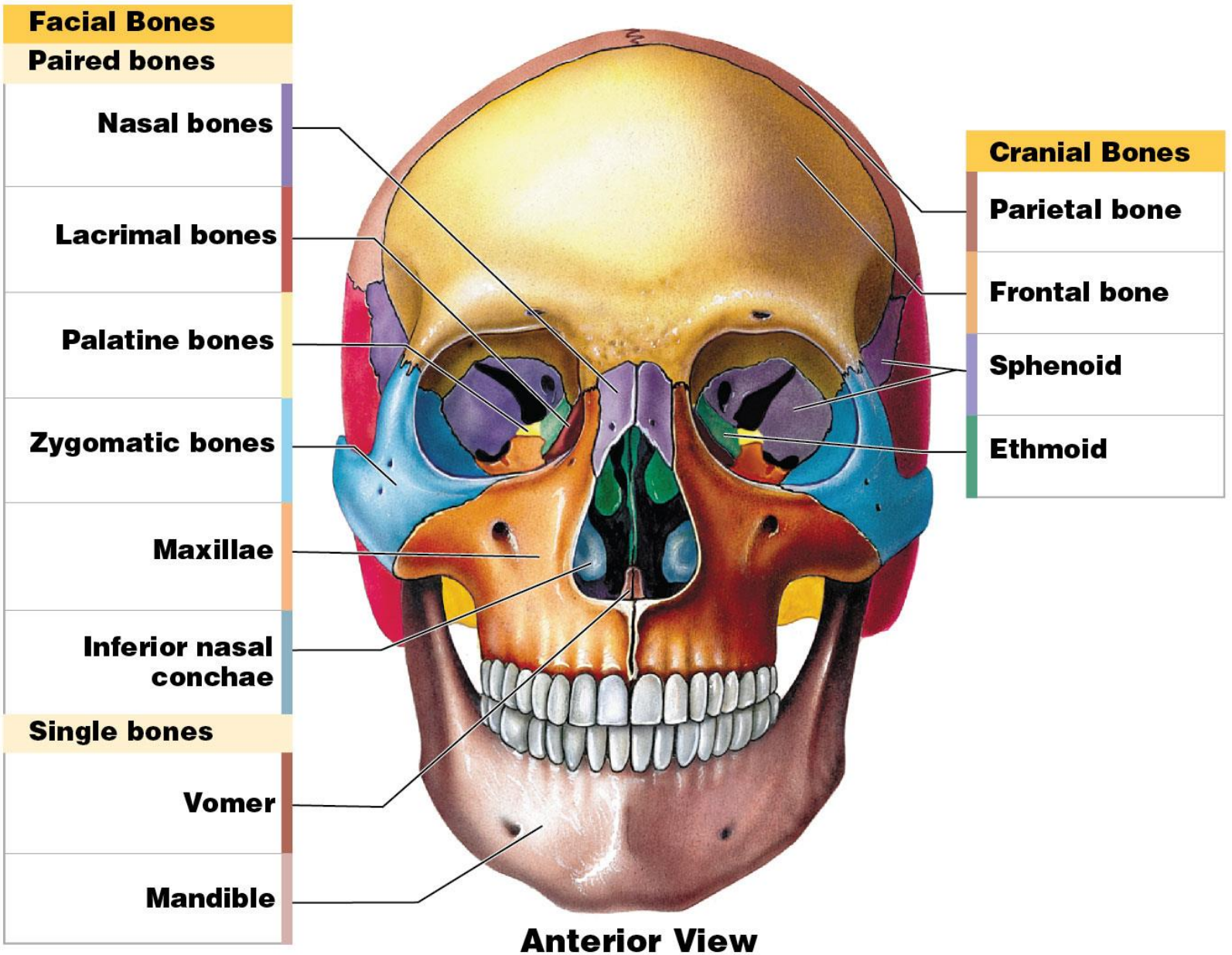
- **Inferior nasal conchae**
  - Create turbulence in air entering the nasal cavity
  - Increase epithelial surface area to warm and humidify inhaled air

Module 7.3: Facial and cranial bones

Single facial bones

- **Vomer**
  - Forms the inferior portion of the bony nasal septum
- **Mandible**
  - Forms the lower jaw
- Facial bones dominate the anterior aspect of the skull

Facial and cranial bones, anterior view



Module 7.3: Facial and cranial bones

Cranial bones seen from an anterior view

- **Frontal bone**
  - Forms the anterior portion of the cranium and roof of the orbits
  - Fontal sinuses secrete mucus that helps flush the nasal cavities
- **Sphenoid bone**
  - Forms part of the floor of the cranium
  - Unites facial and cranial bones
  - Acts as a cross-brace to strengthen sides of the skull

Module 7.3: Facial and cranial bones

Cranial bones seen from an anterior view (continued)

- **Ethmoid bone**
  - Forms the anteromedial floor of the cranium, the roof of the nasal cavity, and part of nasal septum and medial orbital wall

Module 7.3: Facial and cranial bones

Cranial bones seen from a posterior view

- **Parietal bones**
  - Form part of the superior and lateral surfaces of the cranium
- **Occipital bone**
  - Contributes to the posterior, lateral, and inferior cranial surfaces
    - **External occipital crest**
      - Extends from the **external occipital protuberance**
      - Attachment point for ligament that helps stabilize the vertebrae of the neck

Module 7.3: Facial and cranial bones

Cranial bones seen from a posterior view (continued)

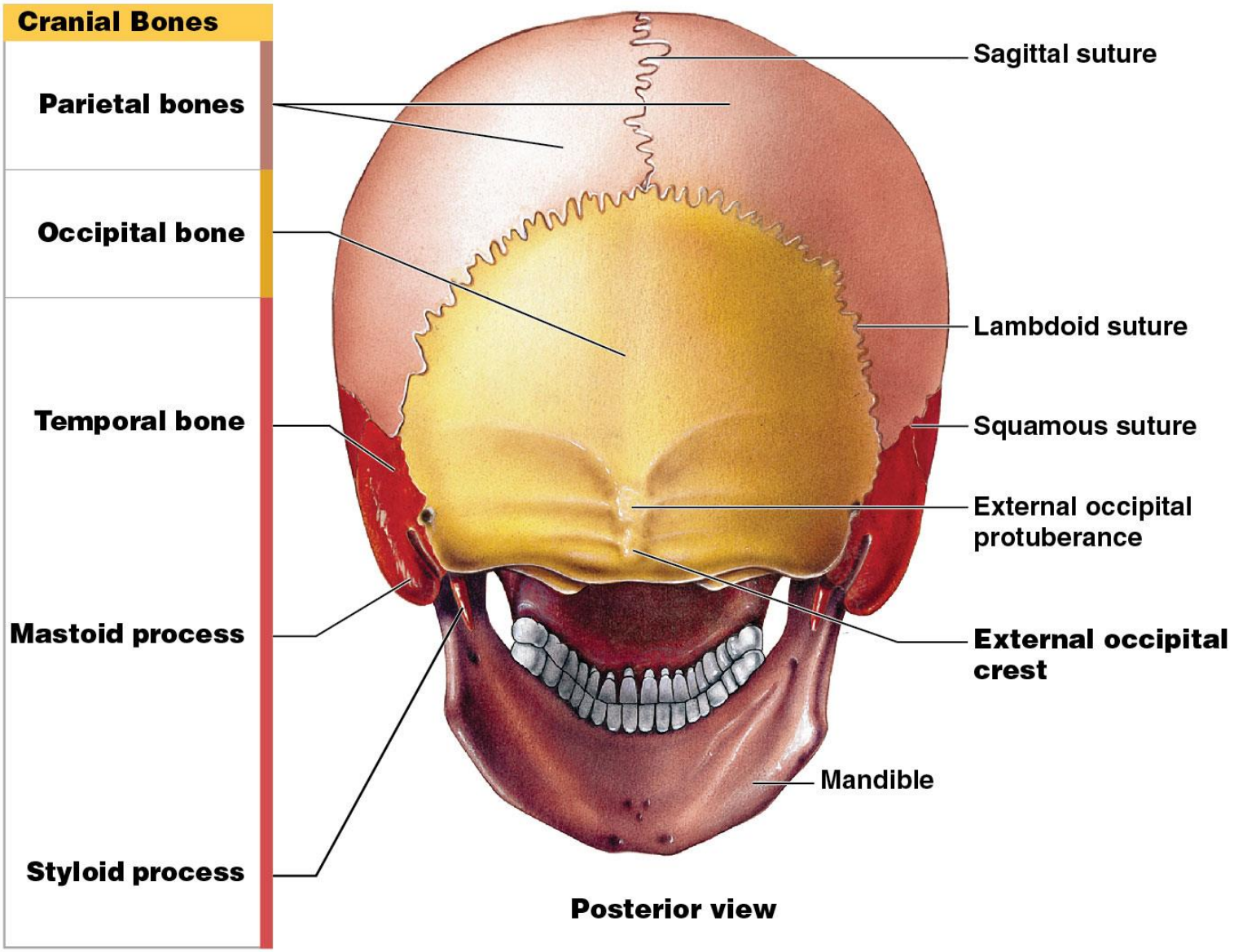
- **Temporal bones**
  - Form part of the lateral wall of the cranium
  - Articulate with the mandible and facial bones
  - Surround the sense organs of the inner ear

Module 7.3: Facial and cranial bones

Cranial bones seen from a posterior view (continued)

- **Temporal bones** (continued)
  - Attachment site for muscles closing the jaw and moving the head
    - **Mastoid process**
      - Attachment for muscles that rotate or extend head
    - **Styloid process**
    - Attached to ligaments supporting the hyoid bone and tendons of several muscles

Facial and cranial bones, posterior view



Module 7.3: Review

A. Identify the facial bones.
B. Identify the following bones as either a facial bone or a cranial bone: vomer, ethmoid, sphenoid, temporal, and inferior nasal conchae.
C. The mandible articulates with which other cranial bones?
D. Quincy suffers a hit to the skull that fractures the right superior lateral surface of his cranium. Which bone is fractured?

Learning Outcome: Explain the significance of the markings and locations of the anterior and posterior aspects of the facial and cranial bones.

Module 7.4: The lateral and medial aspects of the skull share many bone markings

Bone markings on the lateral aspect

- **Forehead**
  - Forms anterior, superior portion of the cranium
  - Provides attachment site for facial muscles
- **Superior and inferior temporal lines**
  - Ridges marking attachment sites of the temporalis muscle
- **Squamous part** of the temporal bone (temporal squama)
  - Convex, irregular surface bordering the squamous suture

Module 7.4: Bone markings on lateral and medial aspects of skull

Bone markings on the lateral aspect (continued)

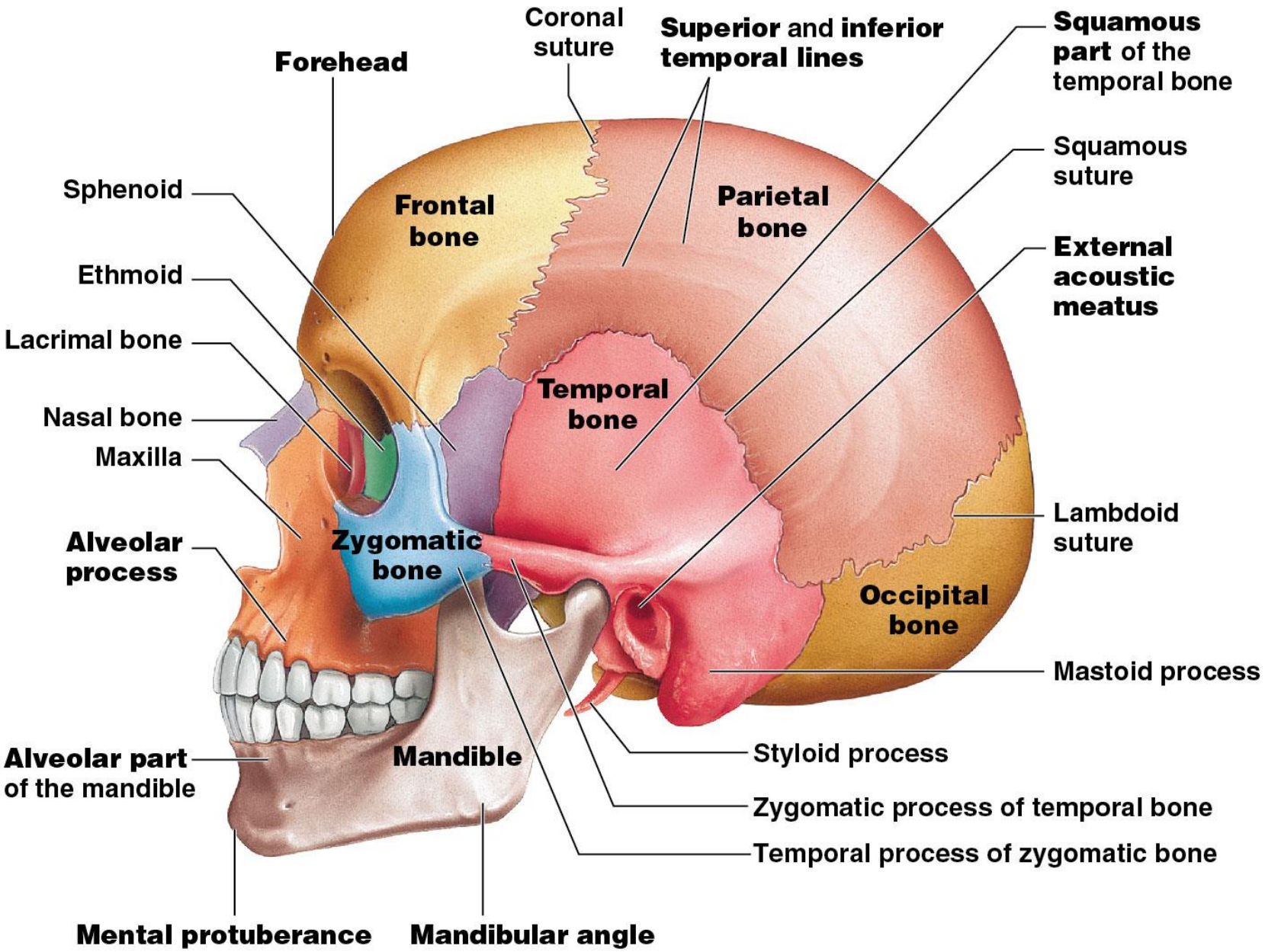
- **External acoustic meatus**
  - Canal beginning on lateral surface of the temporal bone
  - Ends at the tympanic membrane
- **Zygomatic process of the temporal bone**
  - Articulates with the **temporal process of the zygomatic bone** to form the **zygomatic arch**

Module 7.4: Bone markings on lateral and medial aspects of skull

Bone markings on the lateral aspect (continued)

- **Mandibular angle**
  - Posterior, inferior corner of lower jaw
- **Mental protuberance** (*mentalis,* chin)
  - Attachment site for several facial muscles
- **Alveolar part** of mandible
  - Surrounds and supports lower teeth
- **Alveolar processes**
  - Projecting ridges of maxillae and mandible
  - Support the upper and lower teeth

Skull bone markings, lateral view

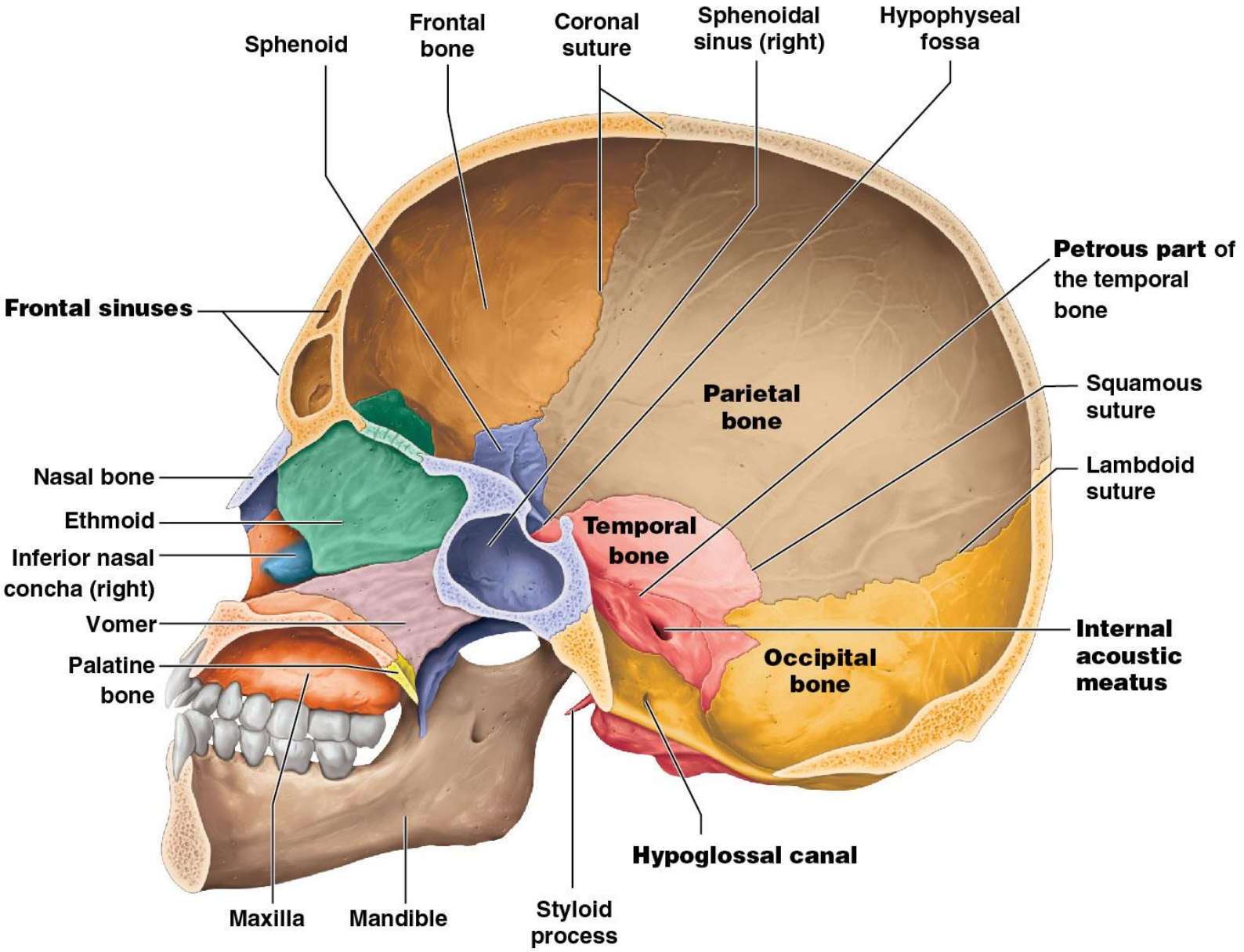


Module 7.4: Bone markings on lateral and medial aspects of skull

Bone markings on the medial aspect

- **Frontal sinuses**
  - Hollow spaces in the bone
- **Petrous part** of the temporal bone
  - Encloses structures of the inner ear and auditory ossicles in the middle ear
- **Internal acoustic meatus**
  - Passageway for blood vessels and facial and vestibulocochlear nerves
- **Hypoglossal canal**
  - Passageway for hypoglossal nerves

Skull bone markings: sagittal section



Module 7.4: Review

A. Describe the alveolar process.
B. What bone processes form the zygomatic arch?
C. Name each meatus found in the temporal bone.
D. What is the function of the internal acoustic meatus?

Learning Outcome: Explain the significance of the markings and locations of the lateral and medial aspects of the facial and cranial bones.

Module 7.5: The foramina on the inferior surface of the skull mark the passageways for nerves and blood vessels

Foramina on the inferior aspect

- **Foramen lacerum** (*lacerare,* to tear)
  - Jagged slit between sphenoid and petrous portion of temporal bone
  - Contains hyaline cartilage and small arteries
- **Foramen ovale**
  - Passage for nerves innervating the jaws
- **Carotid canal**
  - Passage for the internal carotid artery

Module 7.5: Bone markings on inferior and interior aspects of skull

Foramina on the inferior aspect (continued)

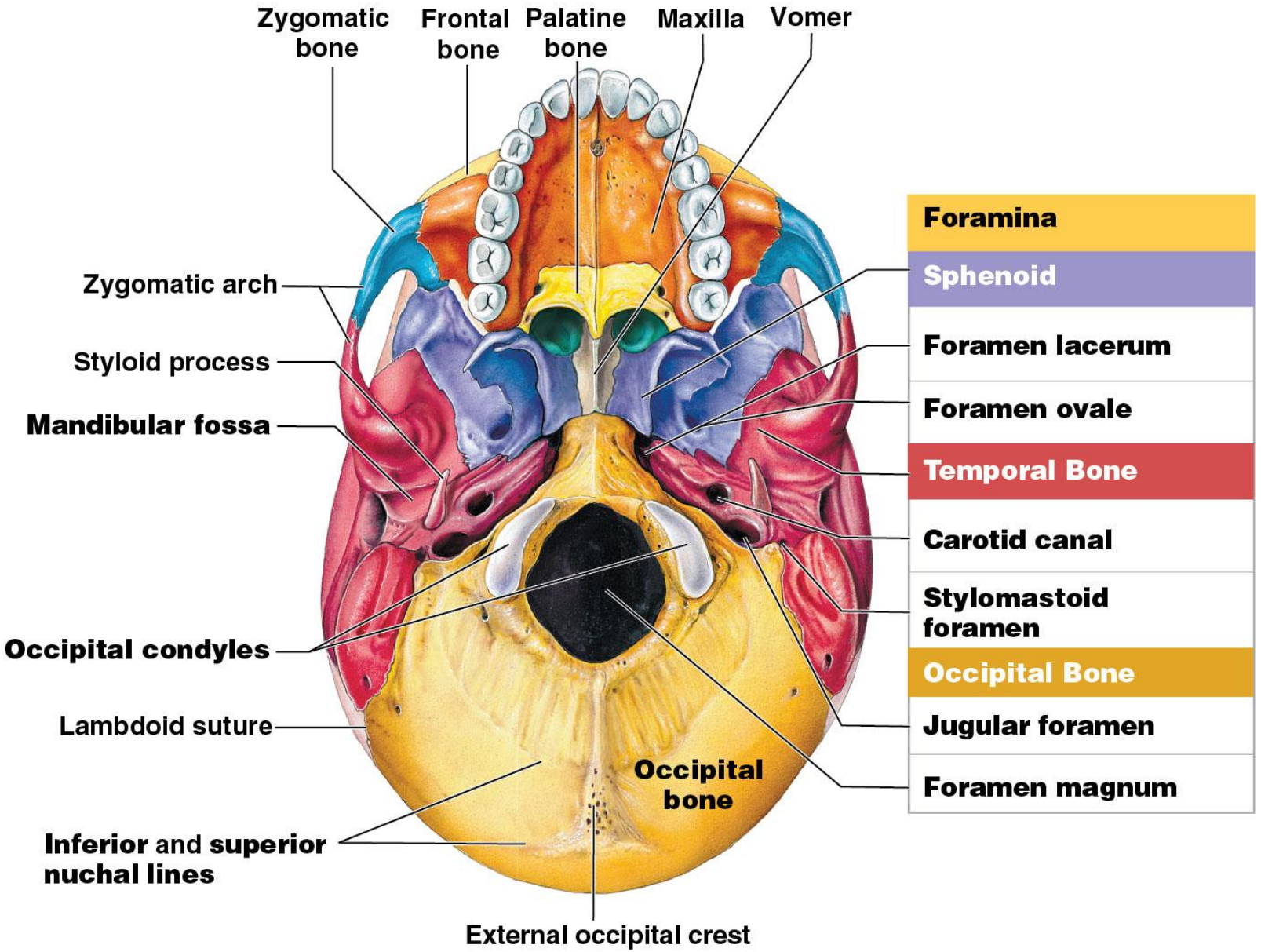
- **Stylomastoid foramen**
  - Posterior to the base of the styloid process
  - Passage for facial nerve
- **Jugular foramen**
  - Located between the occipital and temporal bone
  - Passage for internal jugular vein
- **Foramen magnum**
  - Connects cranial cavity with the vertebral canal
  - Surrounds the connection between the brain and spinal cord

Module 7.5: Bone markings on inferior and interior aspects of skull

Bone markings on the inferior aspect

- **Mandibular fossa**
  - On the inferior surface of the temporal bone
  - Articulation site for temporal bone and mandible
- **Occipital condyles**
  - Articulation site between skull and first cervical vertebra
- **Inferior** and **superior nuchal lines**
  - Intersect at the occipital crest
  - Attachment sites for muscles and ligaments that stabilize the head over the cervical vertebrae

Inferior view of foramina



Module 7.5: Bone markings on inferior and interior aspects of skull

Bone markings on the interior aspect

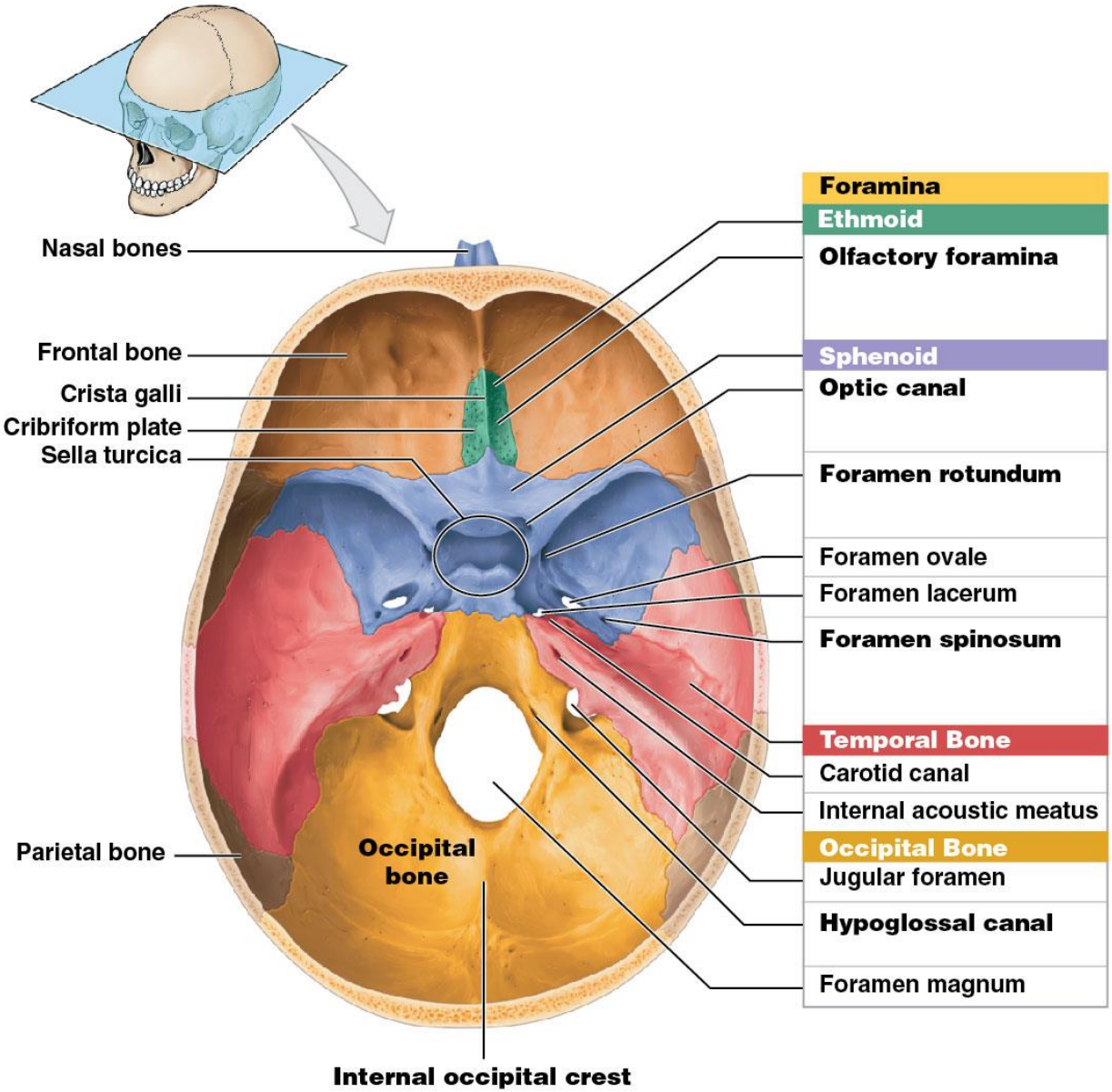
- **Olfactory foramina**
  - Permit passage of olfactory nerves
- **Optic canals**
  - Permit passage of optic nerves
- **Foramen rotundum**
  - Permit passage of a branch of trigeminal nerve
- **Foramen spinosum**
  - Passage of blood vessels to CNS membranes

Module 7.5: Bone markings on inferior and interior aspects of skull

Bone markings on the interior aspect (continued)

- **Hypoglossal canal**
  - Passage of hypoglossal nerve
- **Internal occipital crest**
  - Anchors blood vessels and membranes that stabilize the position of the brain

Superior view of foramina



Module 7.5: Review

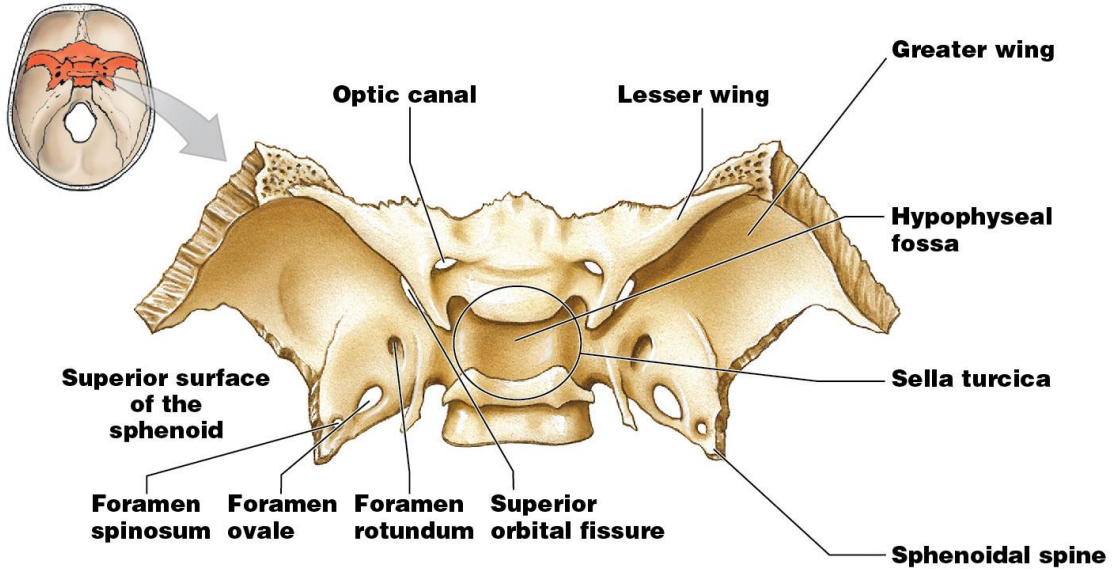
A. Identify the bone containing the carotid canal, and name the structure that runs through this passageway.
B. Which foramen provides a passageway for nerves innervating the jaw?
C. In which bone is the foramen magnum located, and what is significant about this opening?

Learning Outcome: Explain the significance of the markings and locations of the inferior and interior aspects of the facial and cranial bones.

Module 7.6: The shapes and markings of the sphenoid, ethmoid, and palatine bones are best seen in the isolated bones

Sphenoid bone features

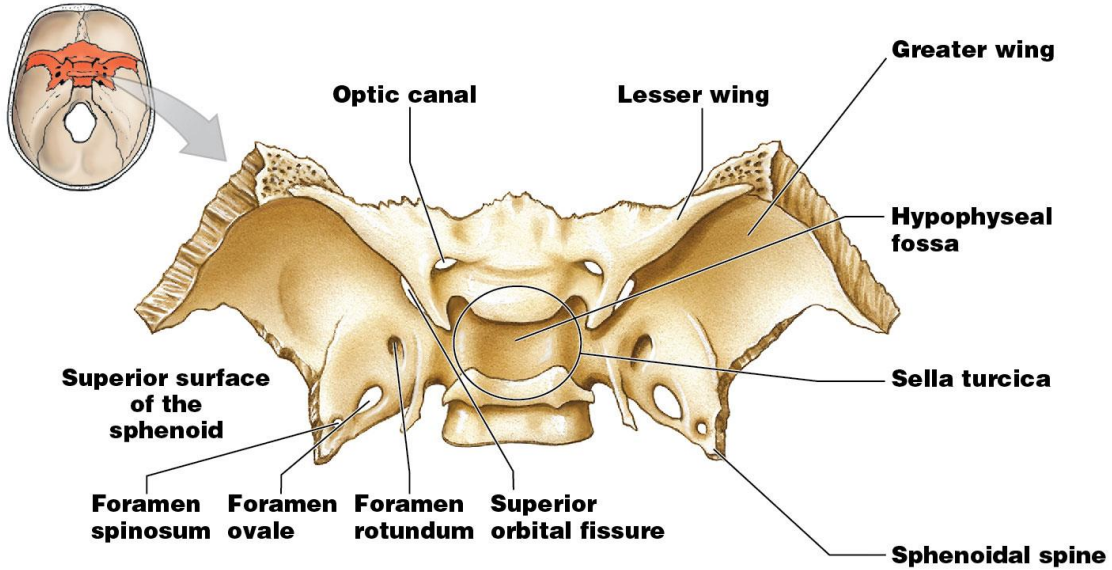
- **Optic canals**
  - Passage for optic nerves from eyes to the brain
- **Lesser wings**
  - Extend horizontally anterior to the sella turcica
- **Greater wings**
  - Extend laterally from the body



Module 7.6: The sphenoid, ethmoid, and palatine bones

Sphenoid bone features (continued)

- **Hypophyseal fossa** (pituitary fossa)
  - Depression in the sella turcica
  - Supports and protects the pituitary gland
- **Sella turcica**
  - Saddle-shaped enclosure

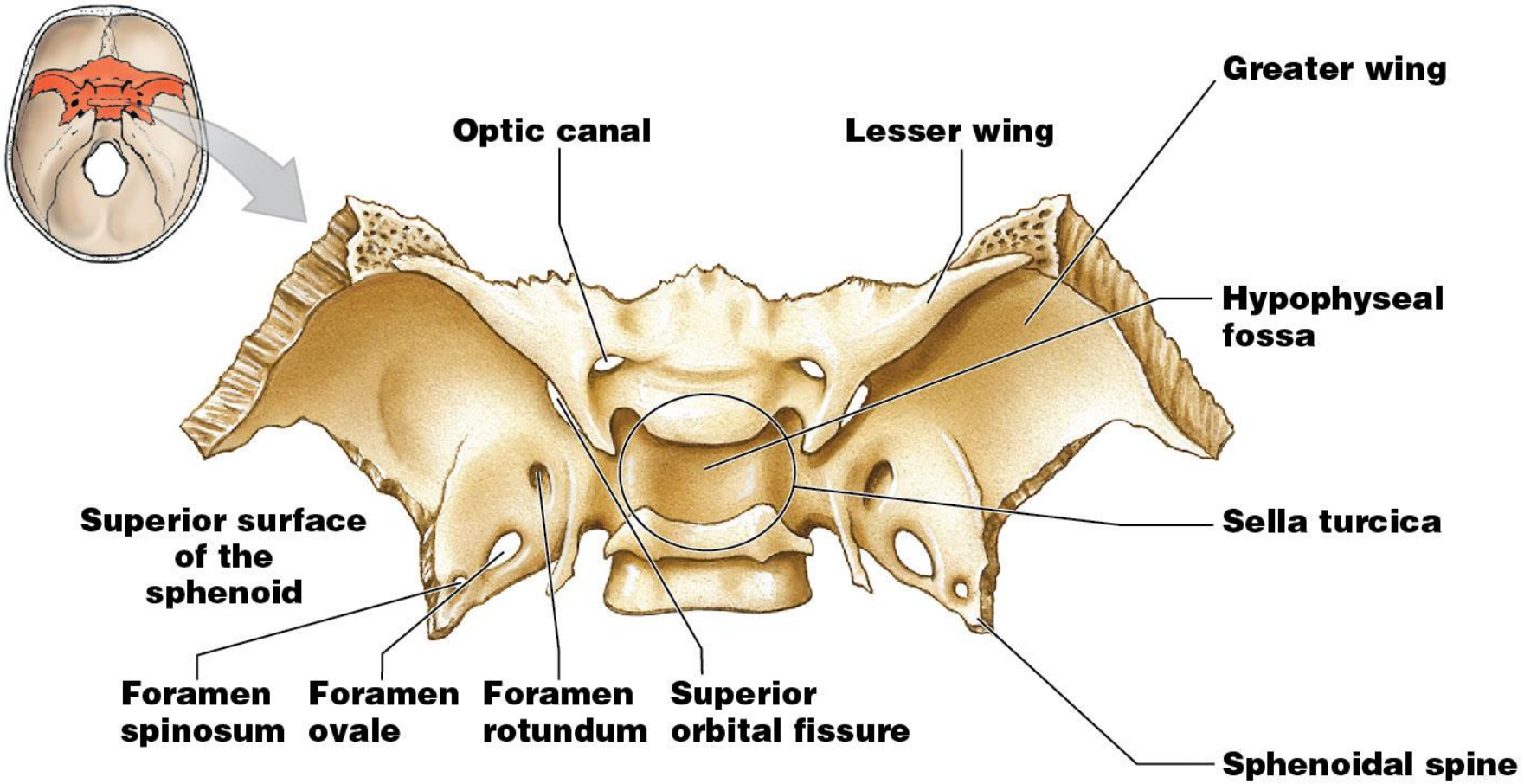


Module 7.6: The sphenoid, ethmoid, and palatine bones

Sphenoid bone features (continued)

- **Sphenoidal spine**
  - Projection at the posterior, lateral corner of each greater wing
- Foramina penetrate each greater wing
  - **Foramen spinosum** (to orbit)
  - **Foramen ovale** (to face)
  - **Foramen rotundum** (to jaws)
  - **Superior orbital fissure** (to cranial cavity membranes)

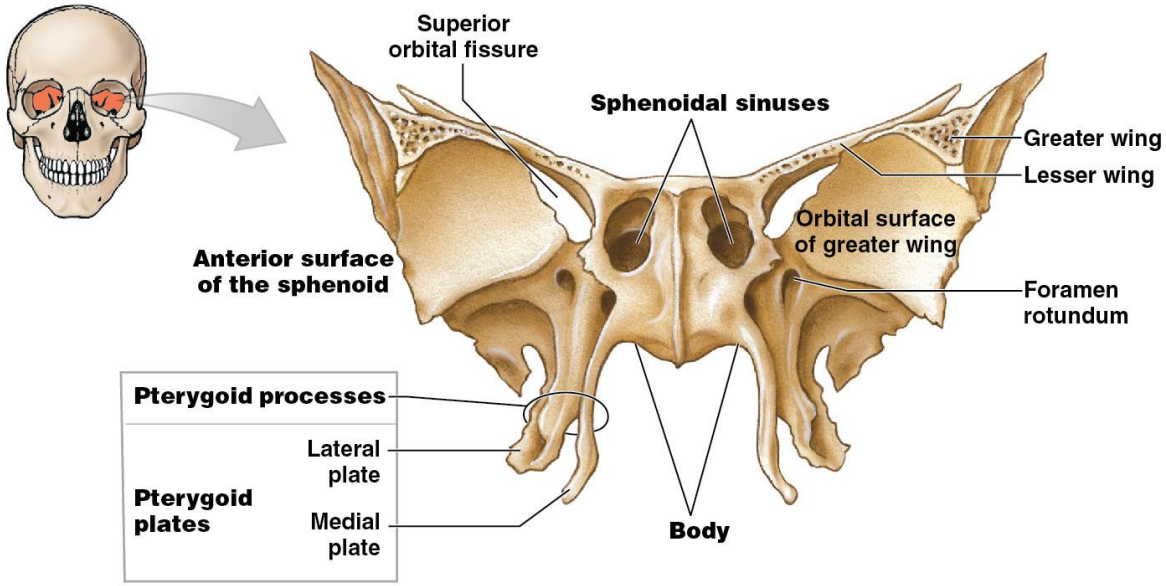
The sphenoid bone



Module 7.6: The sphenoid, ethmoid, and palatine bones

Sphenoid bone features (continued)

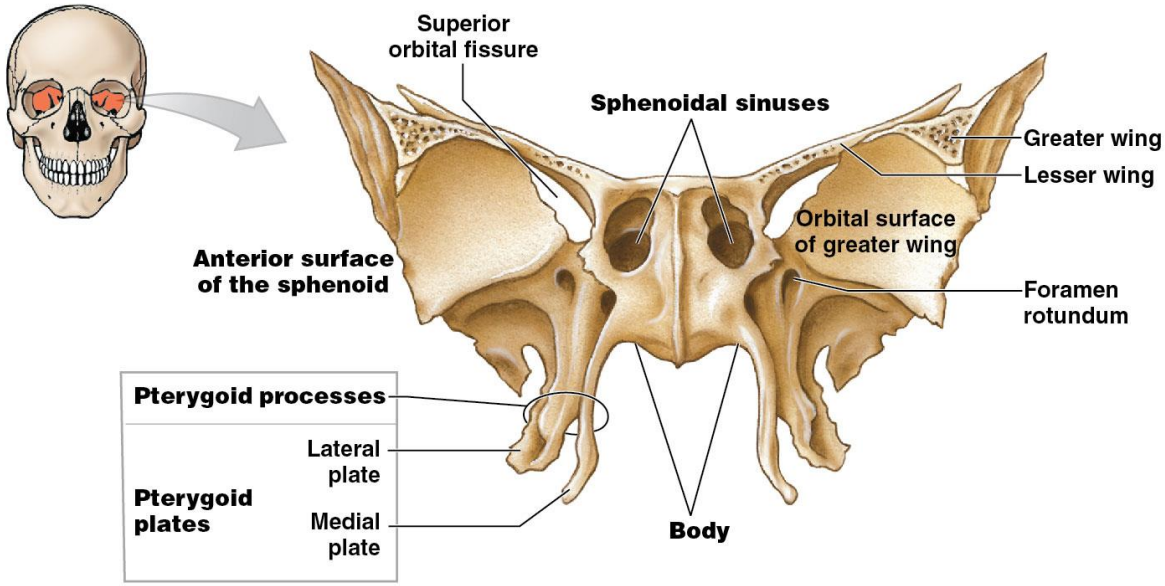
- **Body**
  - Forms the central axis of the sphenoid
- **Sphenoidal sinuses**
  - Inferior to the sella turcica
  - Hollow spaces on either side of the body



Module 7.6: The sphenoid, ethmoid, and palatine bones

Sphenoid bone features (continued)

- **Pterygoid processes**
  - Vertical projections on either side of the body
  - Each forms pair of **pterygoid plates**
    - Attachment sites for muscles moving the mandible and soft palate



Module 7.6: The sphenoid, ethmoid, and palatine bones

Ethmoid bone

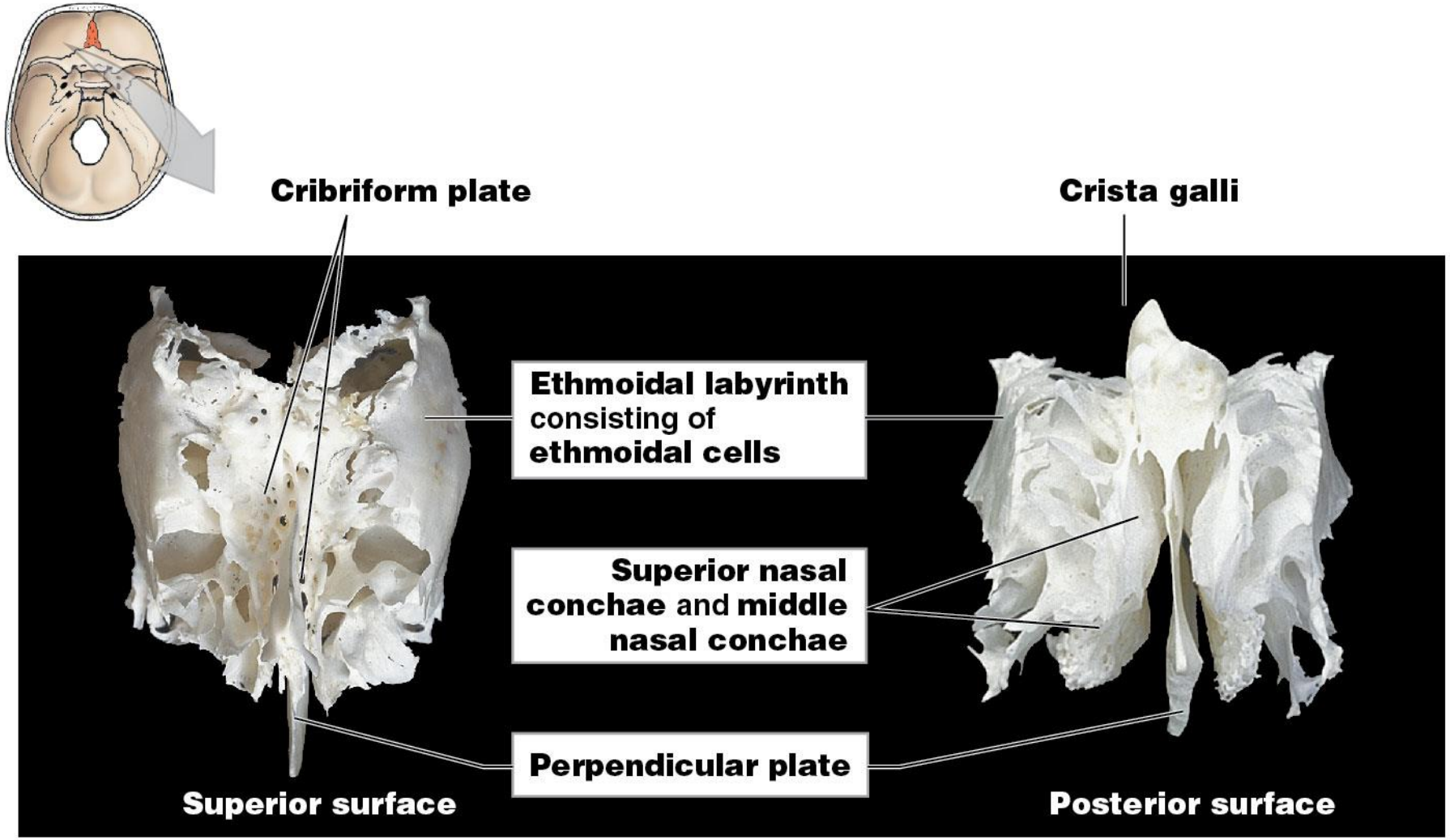
- Three parts
  1. **Cribriform plate** (*cribrum,* sieve)
     - Forms anteromedial cranial floor and nasal cavity roof
     - Olfactory foramina permit passage of olfactory nerves for sense of smell
     - **Crista galli** (*crista,* crest + *gallus,* rooster; cock's comb)
       - Bony ridge that projects superior to cribriform plate
       - Attachment point for falx cerebri (membrane that stabilizes the brain)

Module 7.6: The sphenoid, ethmoid, and palatine bones

Ethmoid bone (continued)

- Three parts (continued)
  2. Paired **ethmoidal labyrinth**
     - Interconnected air-filled cavities that open into the nasal cavity
     - Two sets of delicate projections
       - **Superior nasal conchae**
       - **Middle nasal conchae**
  3. **Perpendicular plate**
     - Forms part of the nasal septum

The ethmoid bone

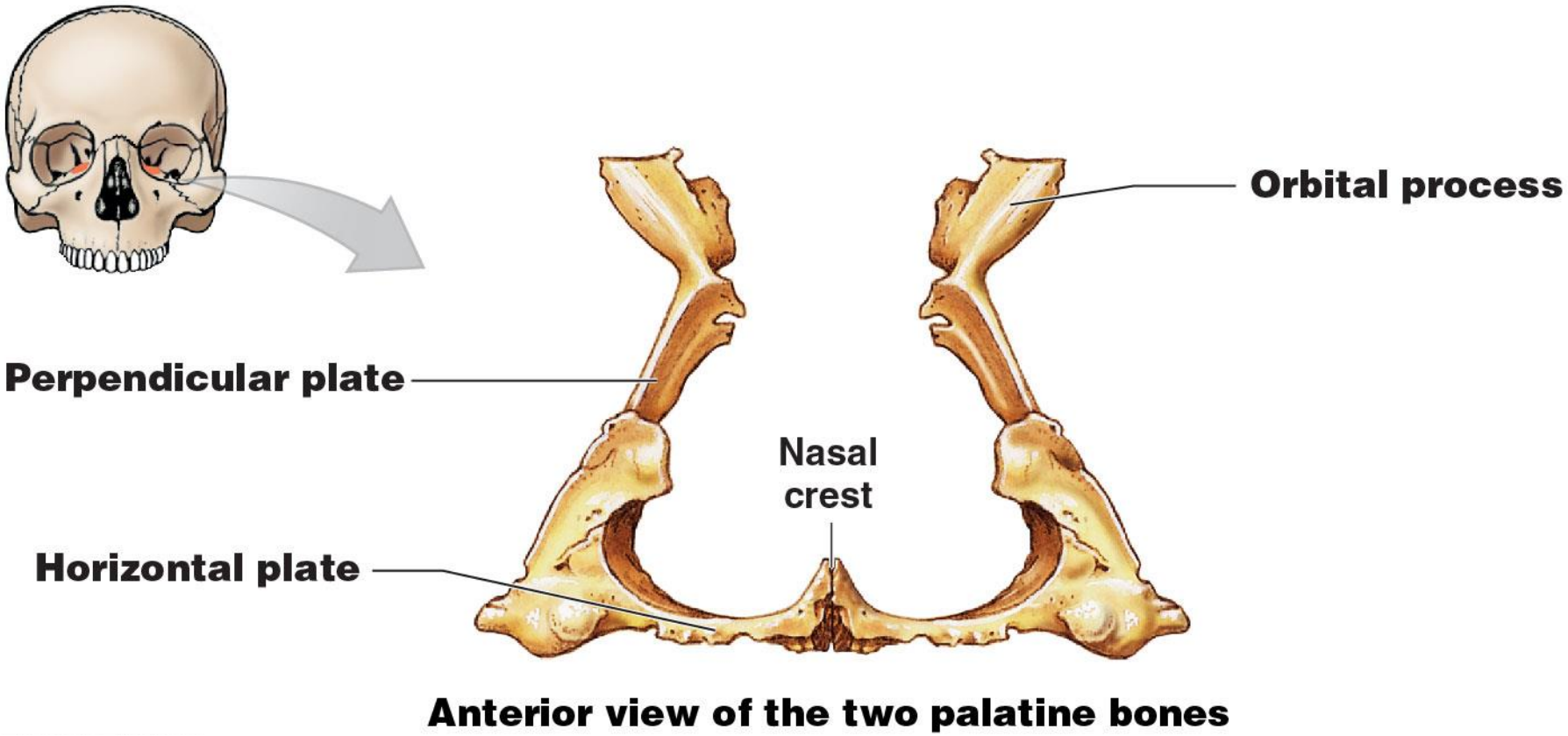


Module 7.6: The sphenoid, ethmoid, and palatine bones

Palatine bone

- Forms posterior portion of the hard palate and contributes to the floor of each orbit
  - **Orbital process**
    - Forms part of the floor of the orbit
    - Contains a small sinus that usually opens into the sphenoidal sinus
  - **Horizontal plate**
    - Forms the posterior part of the hard palate
  - **Perpendicular plate**
    - Extends from the horizontal plate to the orbital process

Palatine bone



Anterior view of the two palatine bones

Module 7.6: Review

A. Identify the bone containing the optic canals, and cite the structures using this passageway.
B. Which bone contains the sella turcica? What structure is found within the sella turcica depression?
C. Identify the bone containing the cribriform plate. What is significant about this structure?
D. Which bone acts as a uniting bridge between cranial and facial portions of the skull?

Learning Outcome: Describe and locate the bone markings of the sphenoid, ethmoid, and palatine bones.

Module 7.7: Each orbital complex contains one eye, and the nasal complex encloses the nasal cavities

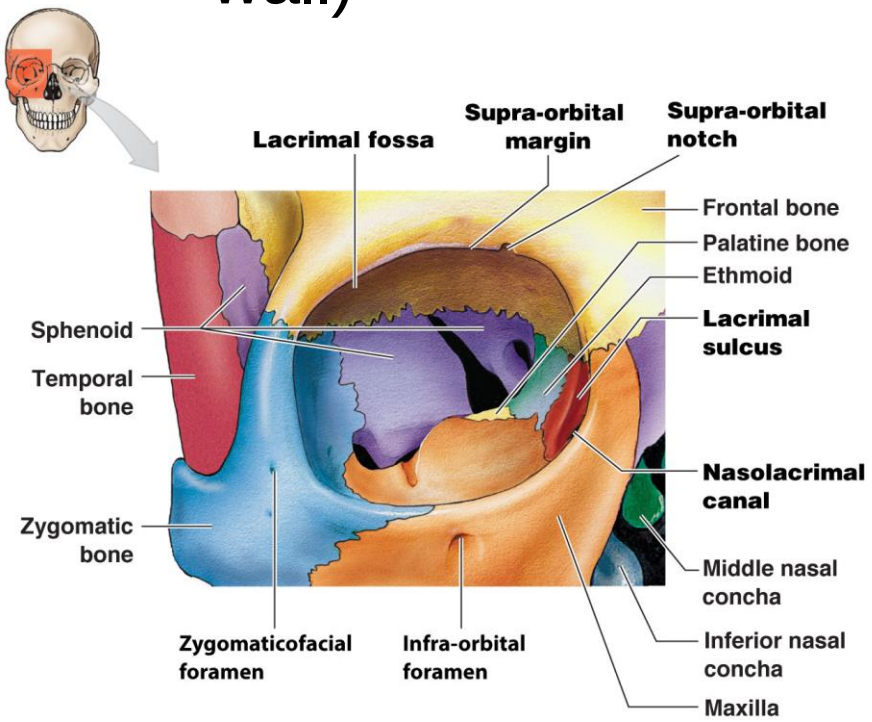
Complexes

- Collections of facial bones protecting sense organs
- Two **orbital complexes**
  - Form the **orbits**
  - Each contain an eye
- **Nasal complex**
  - Surrounds the nasal conchae

Module 7.7: Complexes: Orbital and nasal

Orbital complex

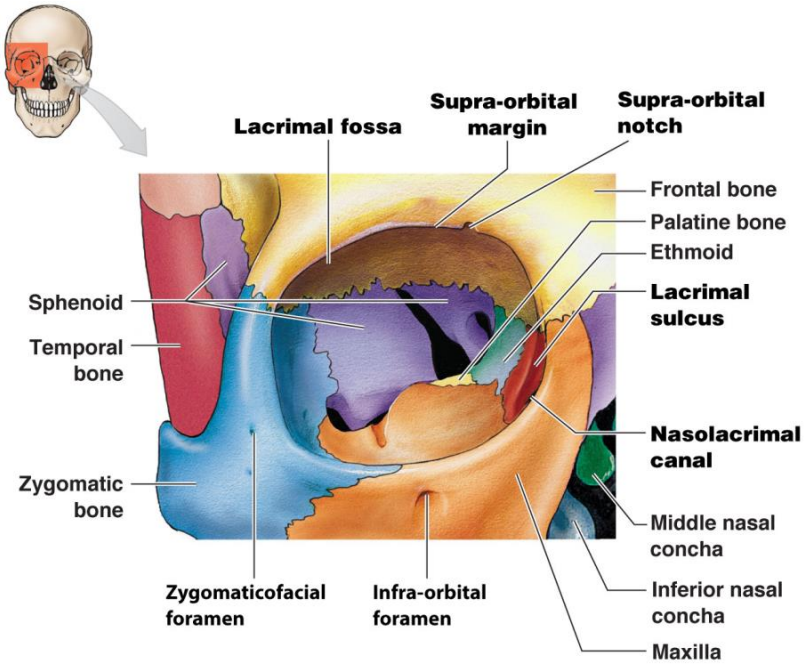
1. Frontal (roof)
2. Zygomatic (lateral wall)
3. Maxilla (most of the floor)
4. Lacrimal (medial wall)
4. Ethmoid (medial wall)
5. Sphenoid (posterior wall)
6. Palatine (posterior wall)



Module 7.7: Complexes: Orbital and nasal

Orbital complex (continued)

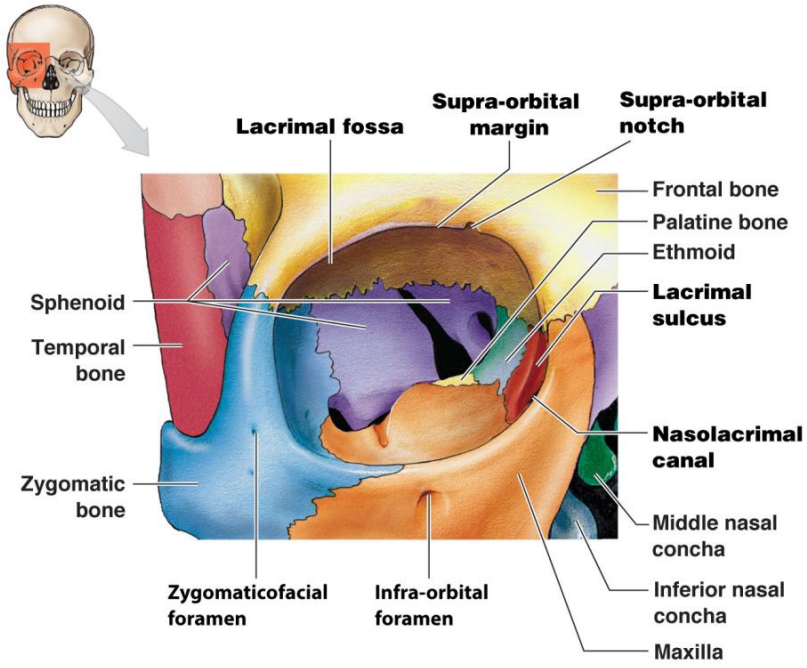
- Bony features
  - **Lacrimal fossa**
    - Marks location of the lacrimal (tear) gland
  - **Supra-orbital margin**
    - Thickened part of frontal bone that helps protect the eye
  - **Supra-orbital notch**
    - Passageway for blood vessels to eyebrow, eyelids, and frontal sinuses



Module 7.7: Complexes: Orbital and nasal

Orbital complex (continued)

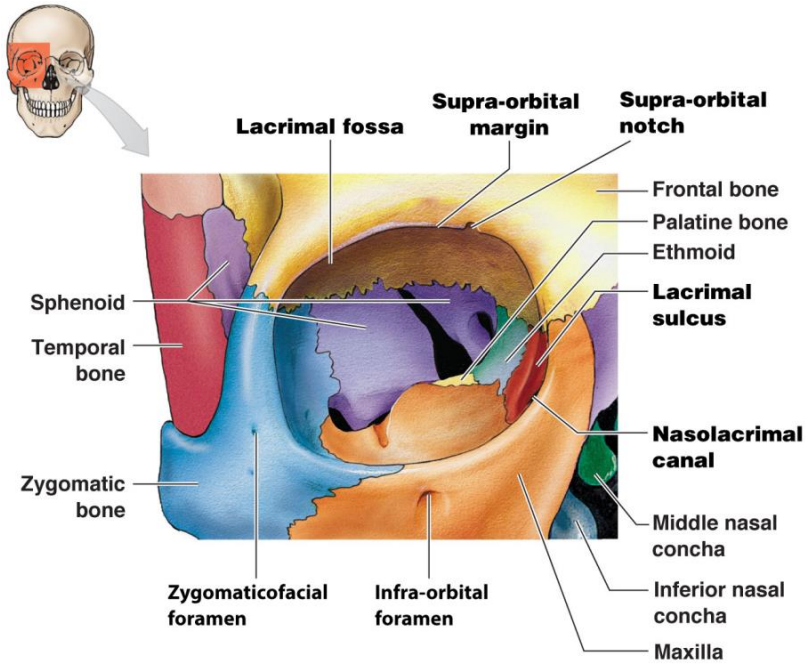
- Bony features (continued)
  - **Lacrimal sulcus**
    - Marks location of lacrimal sac
  - **Nasolacrimal canal**
    - Protects lacrimal sac and nasolacrimal duct
      - Nasolacrimal duct carries tears to nasal cavity



Module 7.7: Complexes: Orbital and nasal

Orbital complex (continued)

- Bony features (continued)
  - **Infra-orbital foramen**
    - Sensory nerve path
  - **Zygomaticofacial foramen**
    - Carries sensory nerve that innervates the cheek



Module 7.7: Complexes: Orbital and nasal

Nasal complex

- **Paranasal sinuses**
  - Lighten skull weight
  - Allow the voice to resonate
  - Provide extensive area of mucous epithelium
  - Found in the sphenoid, ethmoid, frontal bone, palatine bone, and maxillae
  - Inflammation of the sinuses is **sinusitis**

Module 7.7: Complexes: Orbital and nasal

Nasal complex (continued)

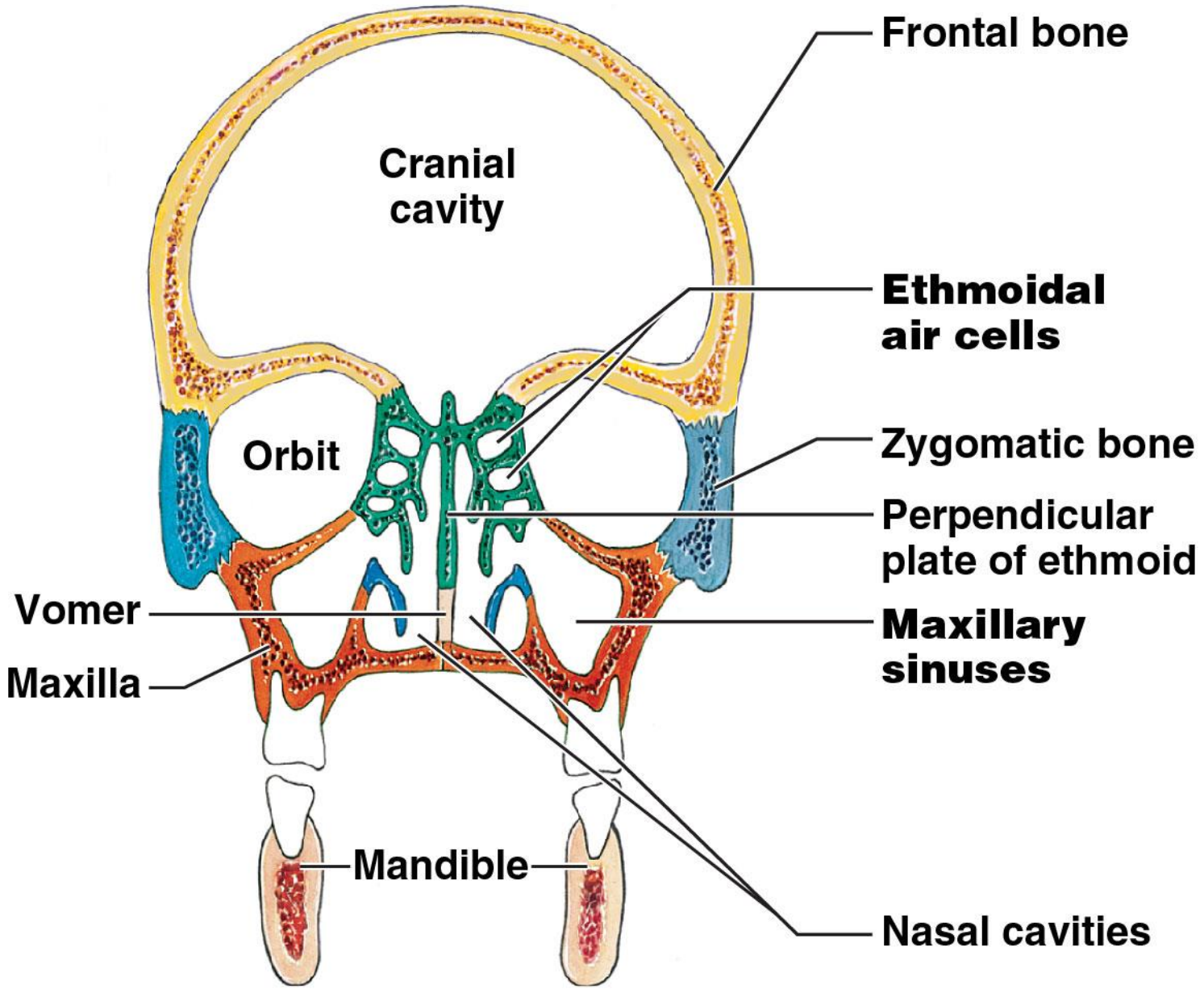
- Includes bones that enclose the nasal cavities and **paranasal sinuses** (Air-filled chambers connected to the nasal cavities)
  - **Sphenoidal sinuses**
    - Found on either side of body of sphenoid
  - **Ethmoid air cells**
    - Secrete mucus to flush the nasal cavity surfaces

Module 7.7: Complexes: Orbital and nasal

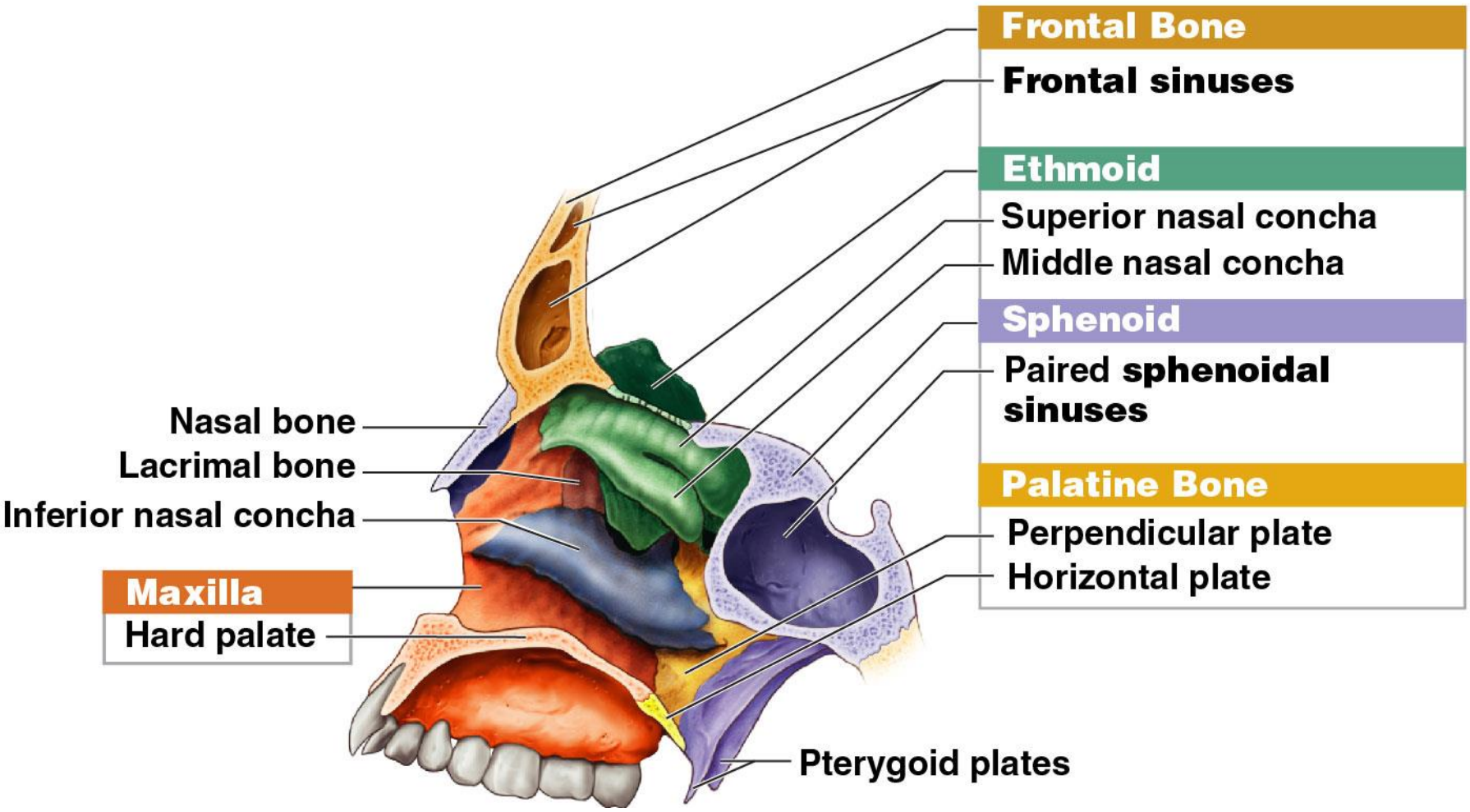
Nasal complex (continued)

- **Paranasal sinuses** (continued)
  - **Frontal sinuses**
    - Generally appear after age 6; may not develop
  - Palatine sinuses
    - Open into the sphenoidal sinuses
  - **Maxillary sinuses**
    - Secrete mucus to flush inferior nasal cavity surfaces
    - Largest sinuses

Paranasal sinuses



Sagittal section of paranasal sinuses



Module 7.7: Review

A. Identify the bones of the orbital complex.
B. What are the functions of the paranasal sinuses?
C. Name the complex—nasal, orbital, or both—where you find each of the following bones: frontal, maxilla, palatine, and nasal bones.

Learning Outcome: Describe the structure of the orbital complex and nasal complex and the functions of their individual bones.

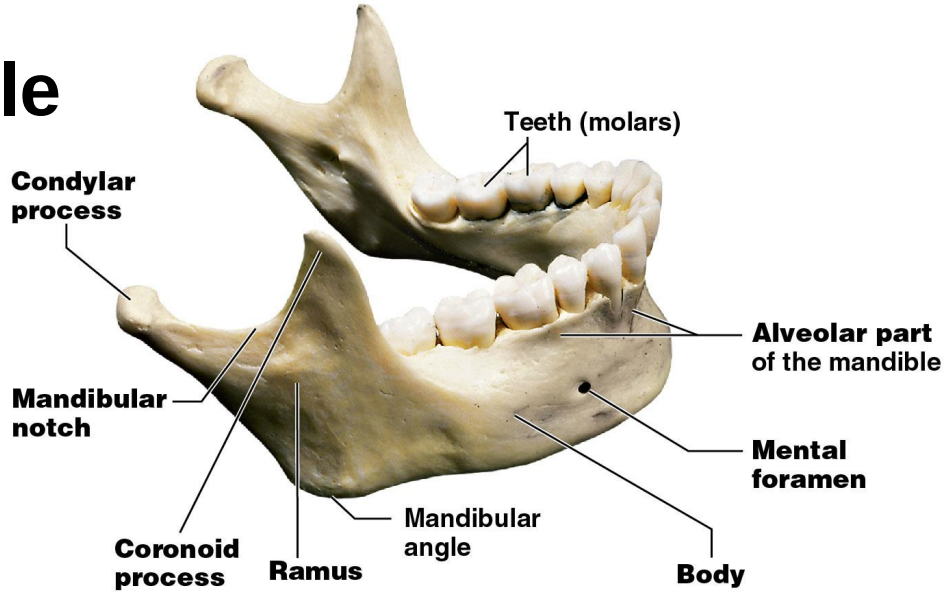
Module 7.8: The mandible forms the lower jaw…

The mandible

- Forms the entire lower jaw
- Articulates with the mandibular fossae of the temporal bones
- Subdivided into:
  - Horizontal body
  - Ascending rami (singular, *ramus*)

Module 7.8: The mandible

Features of the mandible

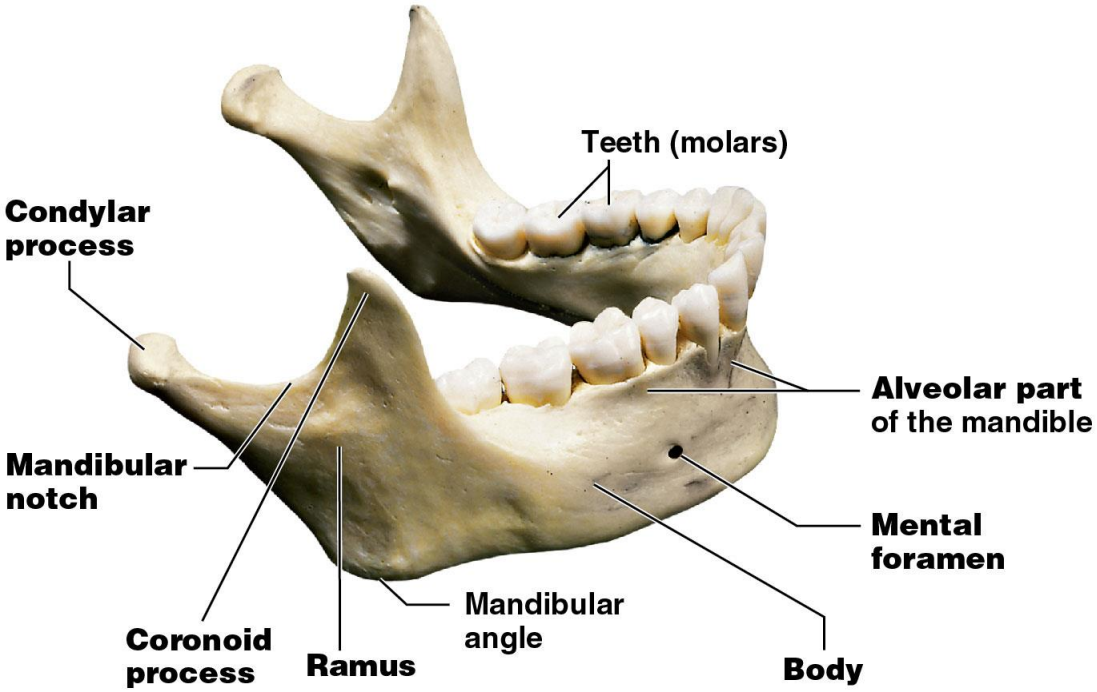


- **Ramus**
  - Begins at the mandibular angle
  - Attachment site for the masseter muscle
    - **Condylar process**
      - Articulates with the temporal bone at the temporomandibular joint
    - **Mandibular notch**
      - Depression that separates the condylar and coronoid processes
    - **Coronoid process**
      - Insertion point for the temporalis muscle

Module 7.8: The mandible

Features of the mandible (continued)

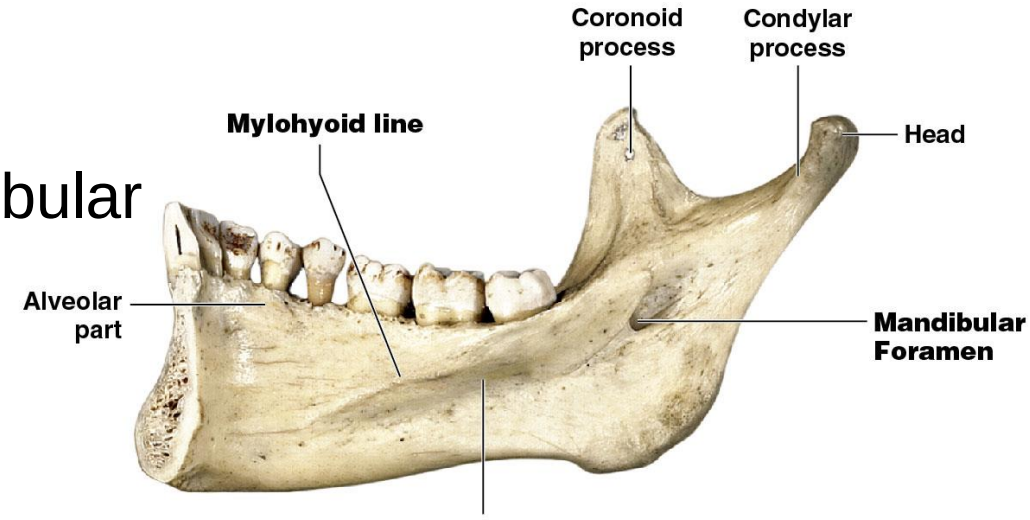
- **Body**
  - Horizontal portion of the mandible
    - **Alveolar process**
      - Supports the lower teeth



Module 7.8: The mandible

Features of the mandible (continued)

- Medial surface features
  - **Mylohyoid line**
    - Marks the insertion of the mylohyoid muscle (which supports the floor of the mouth)
  - **Mandibular foramen**
    - Passageway for blood vessels and nerves supplying the lower teeth
  - Depression marking position of submandibular salivary gland

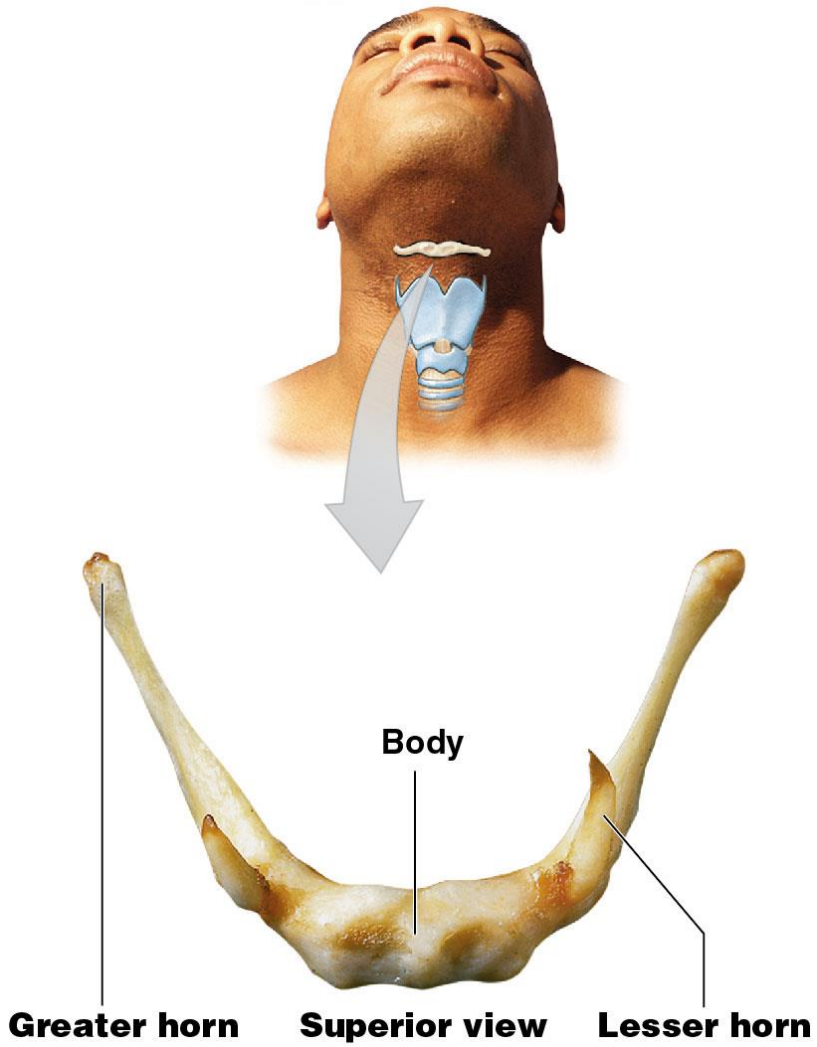


A prominent depression on the medial surface marks the position of the submandibular salivary gland.

Module 7.8: …and the associated bones of the skull perform specialized functions

Associated bones of the skull

- **Hyoid bone**
  - Supports the larynx
  - **Greater horn** (greater cornu)
    - Attachment for muscles that move the tongue
  - **Lesser horn** (lesser cornu)
    - Attachment for hyoid and laryngeal ligaments



Module 7.8: Associated bones of the skull

Associated bones of the skull (continued)

- **Auditory ossicles**
  - Located within each middle ear cavity
  - Enclosed in petrous part of the temporal bone
  - Play key role in hearing
    - Conduct vibrations from the tympanic membrane to internal ear
  - Three bones
    - Malleus
    - Incus
    - Stapes

Module 7.8: Review

A. Name the foramina of the mandible.
B. Explain why your lab partner is correct when she claims that the hyoid bone does not join directly with any other bone.
C. Describe the location and function of the auditory ossicles.

Learning Outcome: Describe the mandible and the associated bones of the skull.

Module 7.9: Fontanelles permit cranial growth in infants and small children

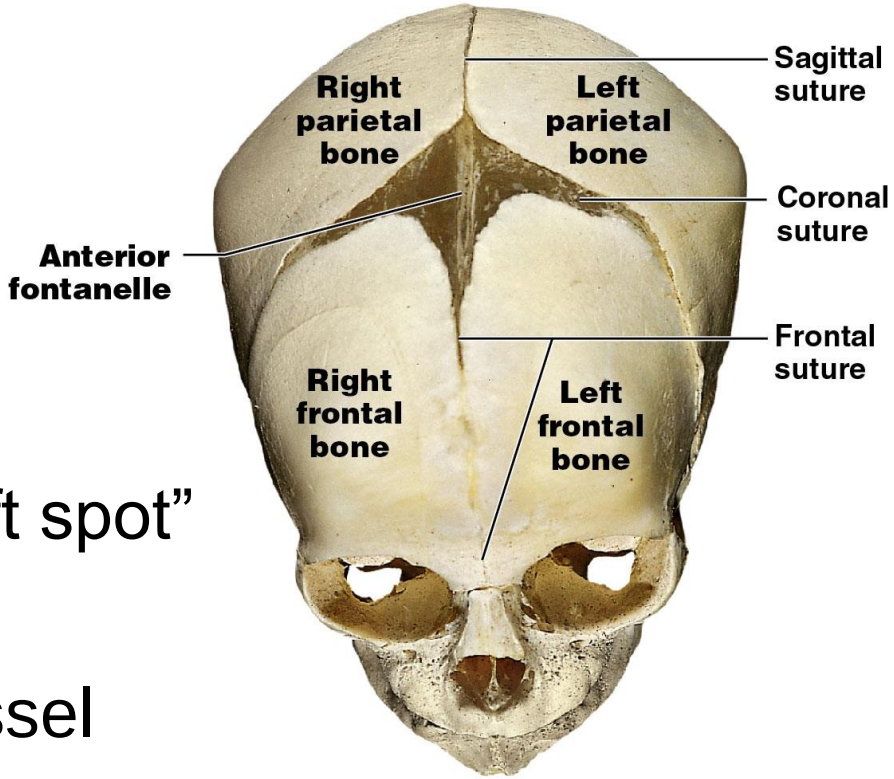
Fontanelles

- Allow for cranial growth to keep pace with brain growth in later fetal stages
- Ease passage of head through birth canal
- Over time, fontanelles are replaced with sutures
  - Occipital, sphenoidal, and mastoid fontanelles disappear a month or two after birth
  - All fontanelles replaced before age 5, when brain stops growing

Module 7.9: Fontanelles

Anterior fontanelle

- Intersection of frontal, sagittal, and coronal sutures
- Largest fontanelle
- Commonly called the “soft spot”
- Persists until about age 2
- Covers a major blood vessel
  - Pulses as heart beats



Anterior/superior view

Module 7.9: Fontanelles

Sphenoidal fontanelle

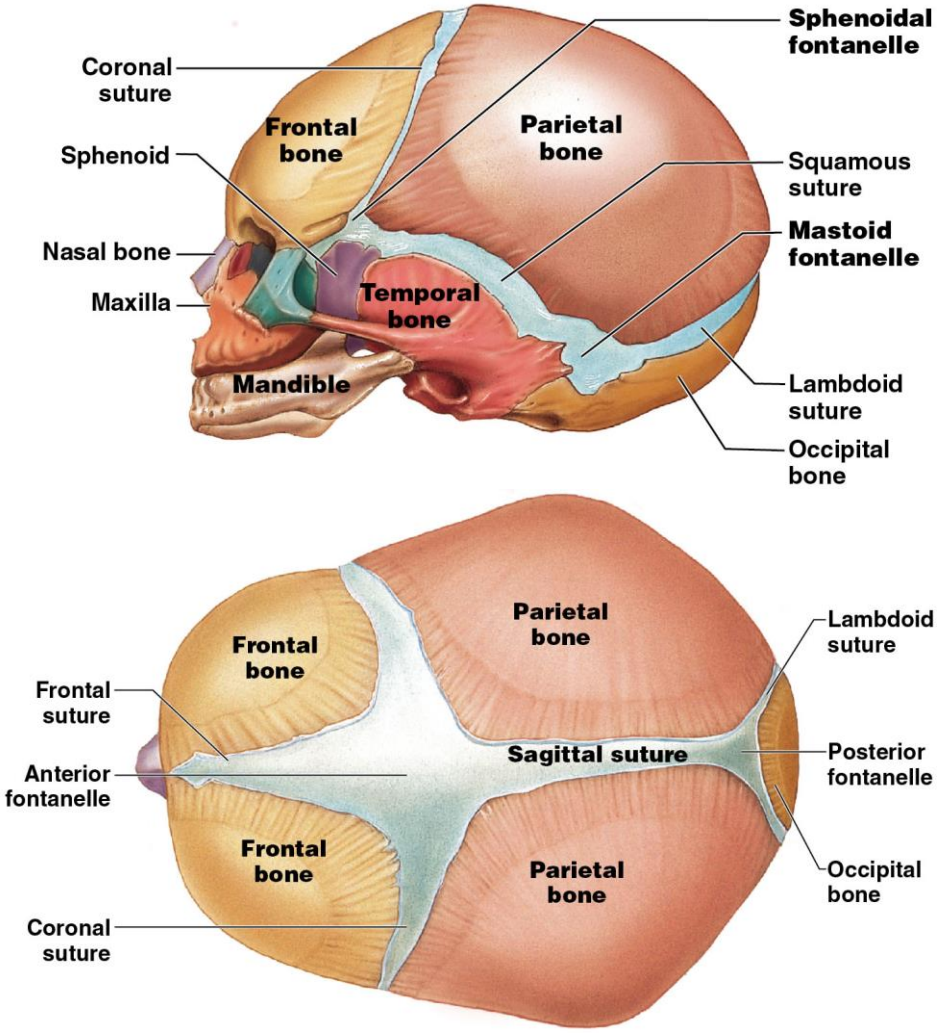
- Junction of squamous and coronal sutures

Mastoid fontanelle

- Junction of squamous and lambdoid sutures

Posterior fontanelle

- Junction of lambdoid and sagittal sutures



Module 7.9: Review

A. Identify the major fontanelles.
B. What purposes do fontanelles serve?
C. Why are an infant's facial bones so small compared with its cranium?

Learning Outcome: Describe key structural differences among the skulls of infants, children, and adults.

Module 7.10: The vertebral column has four spinal curves, and vertebrae share a basic structure that differs regionally

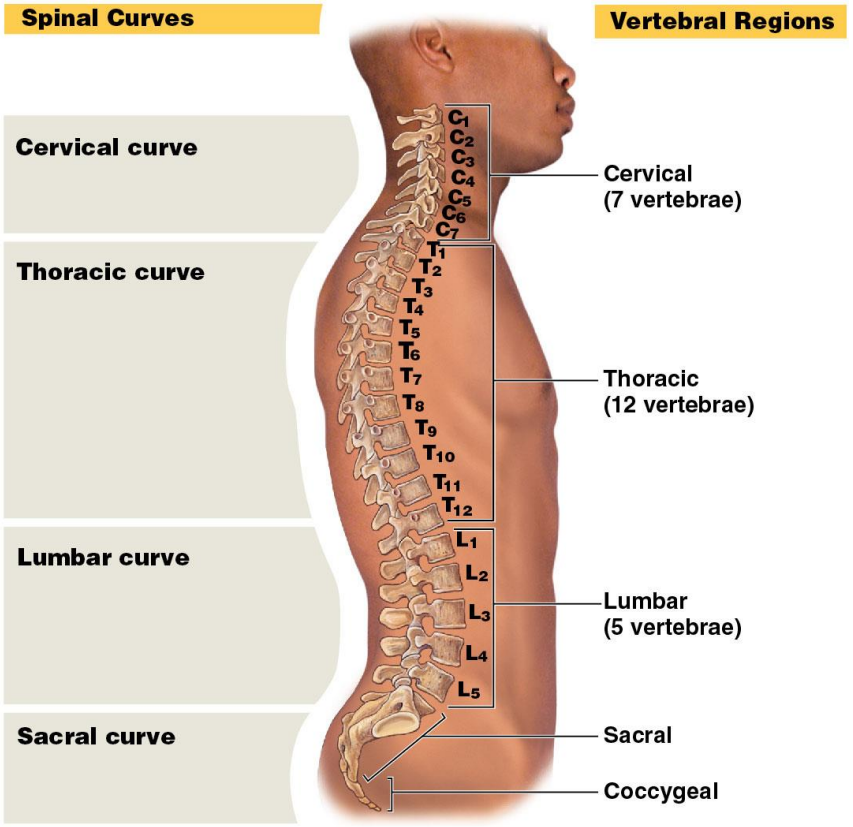
Vertebral column (spine) anatomy

- Composed of 26 bones
  - Separated into **vertebral regions** defined by anatomical characteristics of individual vertebrae
  - Cervical region (7 vertebrae)
  - Thoracic region (12 vertebrae)
  - Lumbar region (5 vertebrae)
  - Sacral region (sacrum)
  - Coccygeal region (coccyx, or tailbone)
- Average length in an adult is 71 cm (28 in.)

Module 7.10: The vertebral column and vertebrae

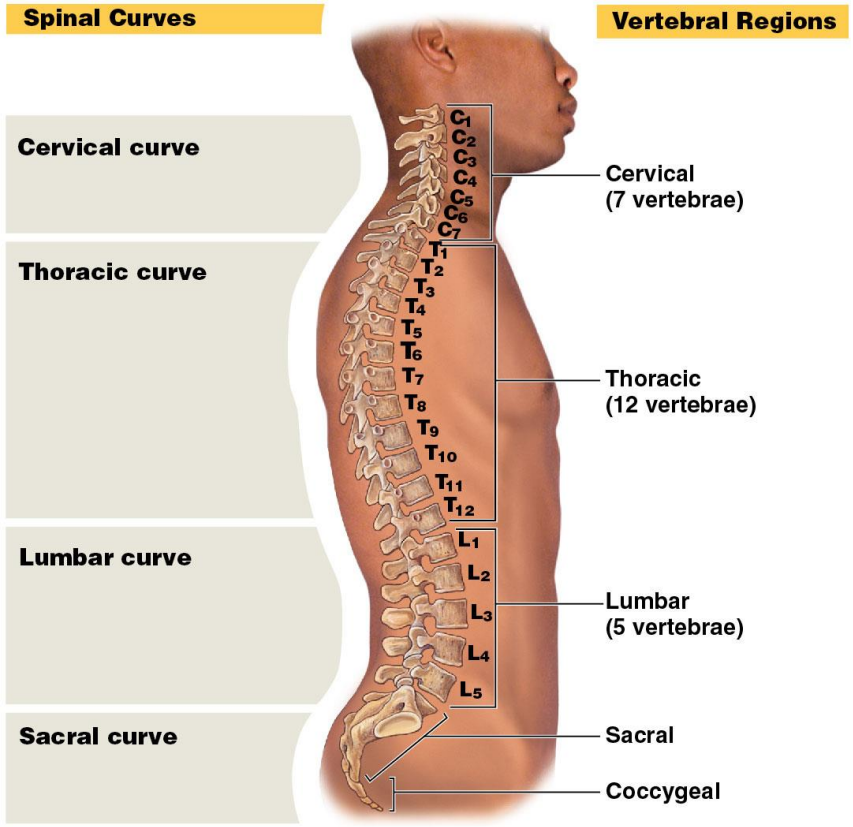
Vertebral column curvatures

- Primary curves (develop before birth)
  - **Thoracic curve**
    - Accommodates the thoracic organs
  - **Sacral curve**
    - Accommodates the abdominopelvic organs



Module 7.10: The vertebral column and vertebrae

- Secondary curves (develop after birth)
  - **Cervical curve**
    - Develops as an infant learns to lift the head
    - Balances the head on the neck
  - **Lumbar curve**
    - Balances the weight of the trunk over lower limbs
    - Develops with the ability to stand

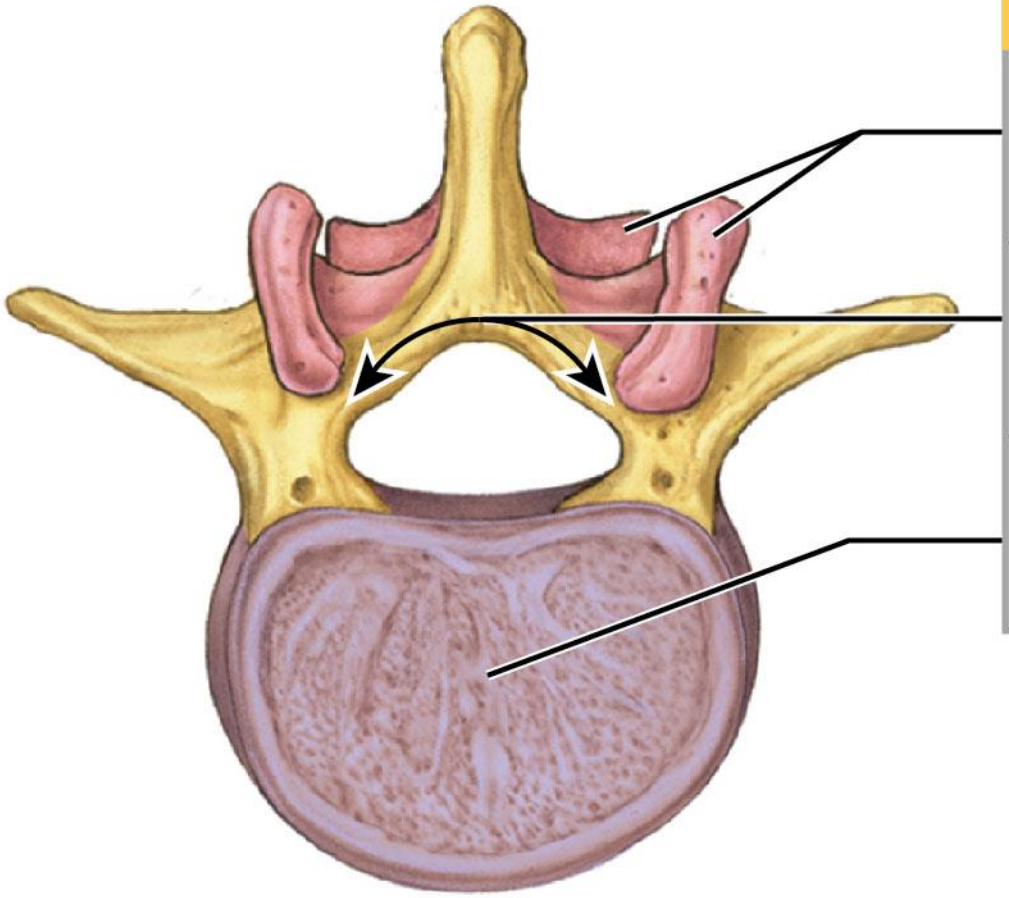


Module 7.10: The vertebral column and vertebrae

Vertebrae

- Each consists of three basic parts
  1. **Articular processes**
     - Extend superiorly and inferiorly to articulate with adjacent vertebrae
  2. **Vertebral arch**
     - Forms posterior and lateral margins of the vertebral foramen
  3. **Vertebral body**
     - Transfers weight along the axis of the vertebral column
  4. **Vertebral foramen**
     - The opening framed by the vertebral body and the vertebral arch

The vertebral column and vertebrae



Superior view

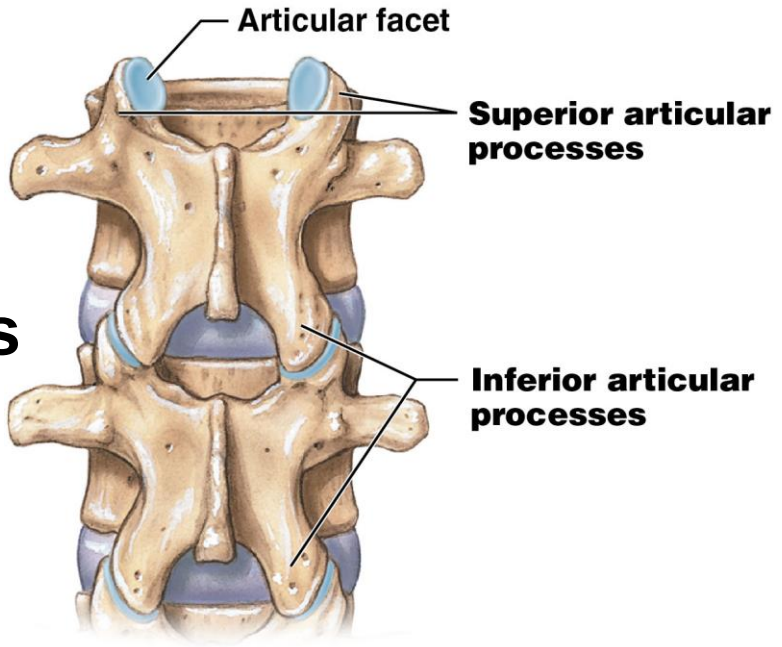
Parts of a Vertebra
Articular processes
Vertebral arch
Vertebral body

Video: Typical Vertebra

Module 7.10: The vertebral column and vertebrae

Articulations between vertebrae

- **Articular facet**
  - Forms the joint with the adjacent vertebra
- **Superior articular processes**
  - Articulate with the inferior articular processes of a superior vertebra
- **Inferior articular processes**
  - Articulate with the superior articular processes of an inferior vertebra

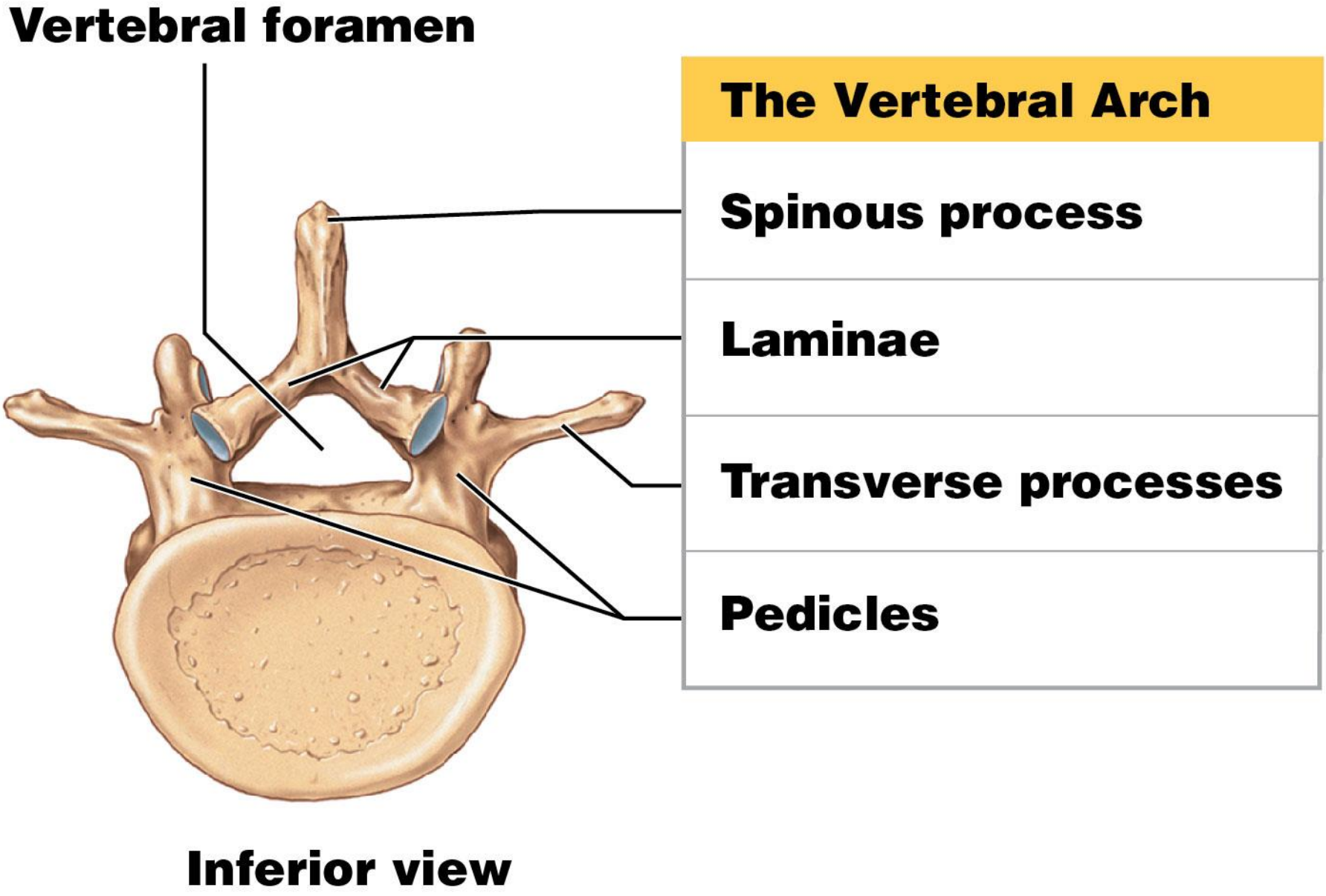


Module 7.10: The vertebral column and vertebrae

Vertebral arch components

- **Laminae**
  - Form the “roof” of the vertebral foramen
- **Pedicles**
  - Form the sides of the vertebral arch
- **Spinous process**
  - Projects posteriorly from point of fusion of the laminae
- **Transverse processes**
  - Project laterally from where pedicles join the laminae
  - Sites of muscle attachment
  - May articulate with the ribs

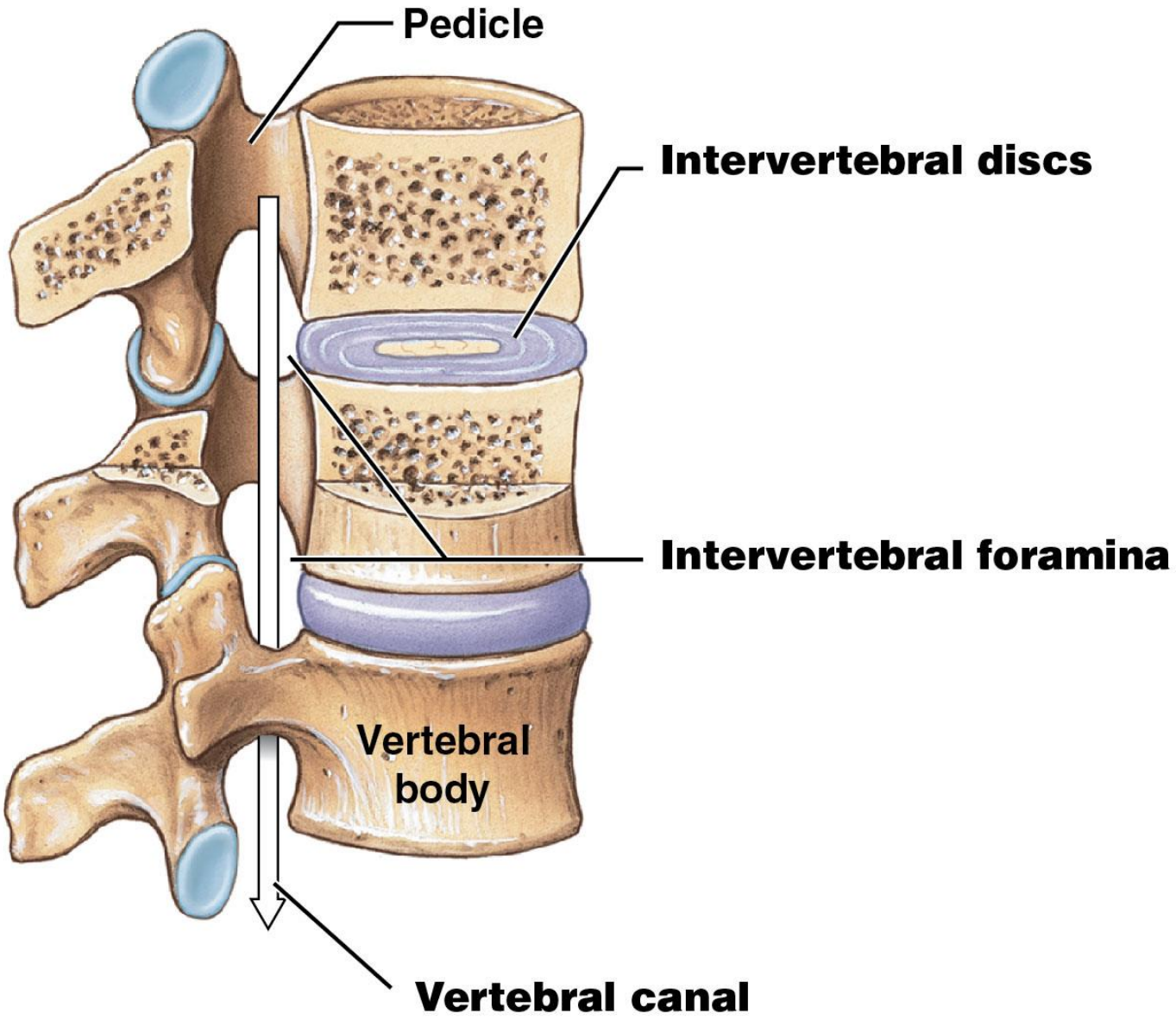
Parts of a vertebra



Module 7.10: The vertebral column and vertebrae

- The **vertebral canal**
  - Formed by the vertebral foramina of successive vertebrae
  - Encloses the spinal cord
- **Intervertebral discs**
  - Pads of fibrocartilage separating the bodies of adjacent vertebrae
- **Intervertebral foramina**
  - Spaces formed between successive pedicles
  - Allow passage of nerves and blood vessels

Vertebral column



Module 7.10: The vertebral column and vertebrae

- Vertebrae naming conventions
  - In reference to a specific vertebra, capital letters designate the region (cervical, thoracic, lumbar, sacral, coccygeal)
    - *Examples:* C, T, L, S, Co
  - The relative position of the vertebra within the region is indicated by a subscript number
    - 1 designates the vertebra closest to the skull
    - *Example:* C_3 = third cervical vertebra

Regional comparison of vertebral structure and function

Regional Comparison of Vertebral Structure and Function

	Cervical Vertebrae (7)	Thoracic Vertebrae (12)	Lumbar Vertebrae (5)
Location	Neck	Chest	Inferior portion of back
Vertebral Body	Small, oval, curved faces	Medium, heart-shaped, flat faces; facets for rib articulations	Massive, oval, flat faces
Vertebral Foramen	Large	Smaller	Smallest
Spinous Process	Long; split tip; points inferiorly	Long, slender; not split; points inferiorly	Blunt, broad; points posteriorly
Transverse Processes	Have transverse foramina	All but two have facets for rib articulations	Short; no articular facets or transverse foramina
Functions	Support skull, stabilize relative positions of brain and spinal cord, and allow controlled head movements	Support weight of head, neck, upper limbs, and chest; articulate with ribs to allow changes in volume of thoracic cage	Support weight of head, neck, upper limbs, and trunk

Module 7.10: Review

A. What is the importance of the secondary curves of the spine?
B. Name the major components of a typical vertebra.
C. To which part of the vertebra do the intervertebral discs attach?

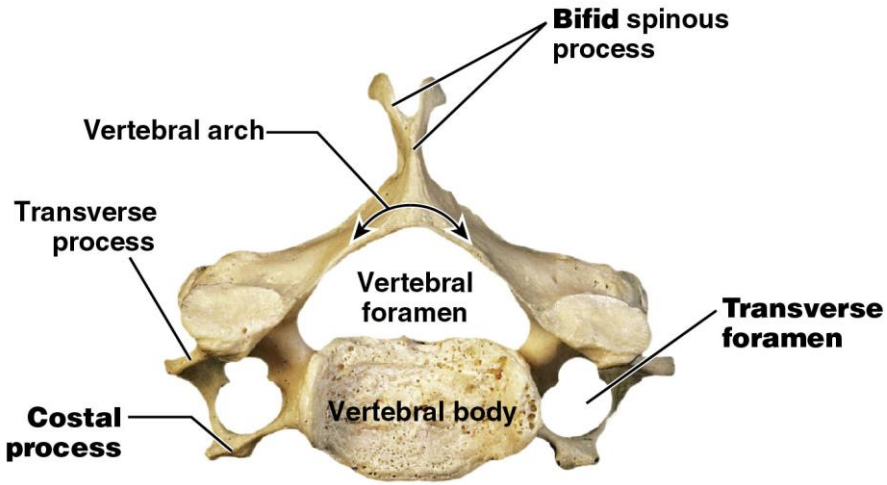
Learning Outcome: Identify and describe the curves of the spinal column and their functions, and identify the vertebral regions.

Module 7.11: There are seven cervical vertebrae …

- Seven smallest vertebrae in the vertebral column
- Extend from occipital bone to thorax
- Large vertebral foramen
  - Spinal cord here has many axons connecting to brain
- Vertebral body is small and light
  - Supports only weight of head

Module 7.11: Cervical vertebrae

- **Bifid** spinous process (notch in the tip)
- Transverse processes are short and stumpy
- **Transverse foramen**
  - Protects vertebral arteries and veins serving the brain
- **Costal processes**
  - Extend anterolaterally from either side of the body

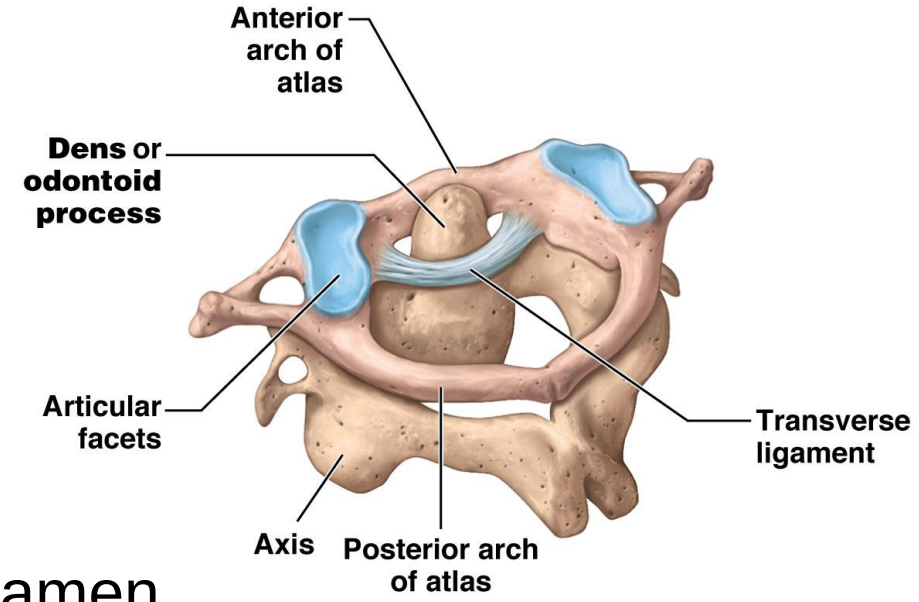


Cervical vertebra (superior view)

Module 7.11: Cervical vertebrae

First two cervical vertebrae are specialized to support and stabilize the cranium and allow head movement

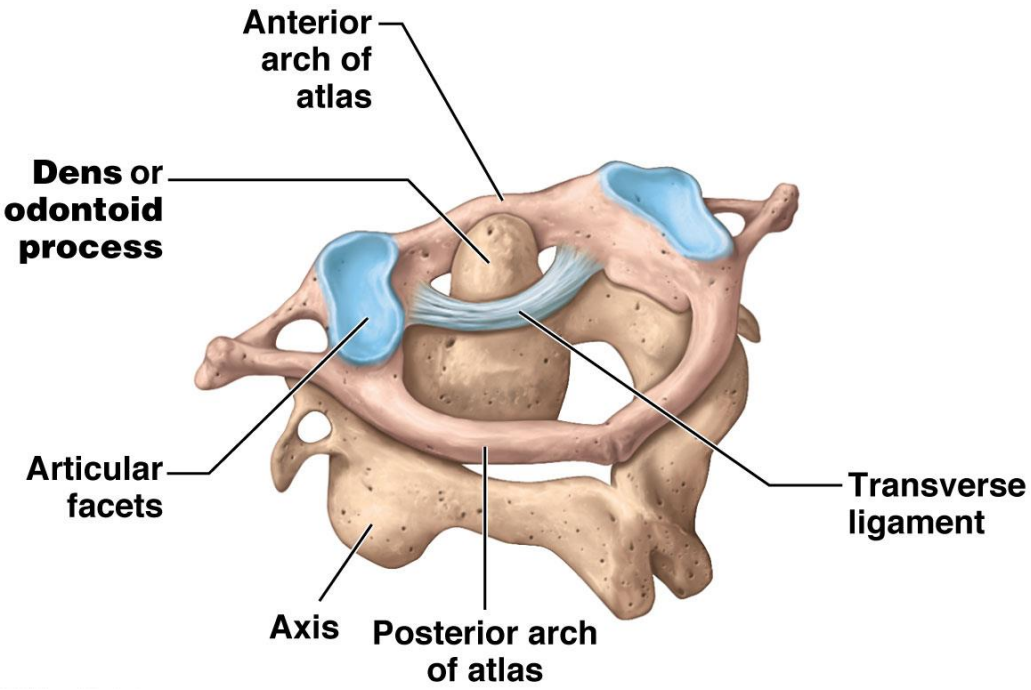
1. **Atlas (C_1)** (named after Greek mythical figure holding the world on his shoulders)
   - No spinous process or vertebral body
   - Large round vertebral foramen
   - Articulates with the occipital condyles
   - Permits nodding “yes”



Module 7.11: Cervical vertebrae

2. Axis (C_2)

- Prominent **dens,** or **odontoid** (*odontos,* tooth) **process**, on superior surface
- Dens bound to atlas by transverse ligament
- Permits rotation, as in shaking head “no”

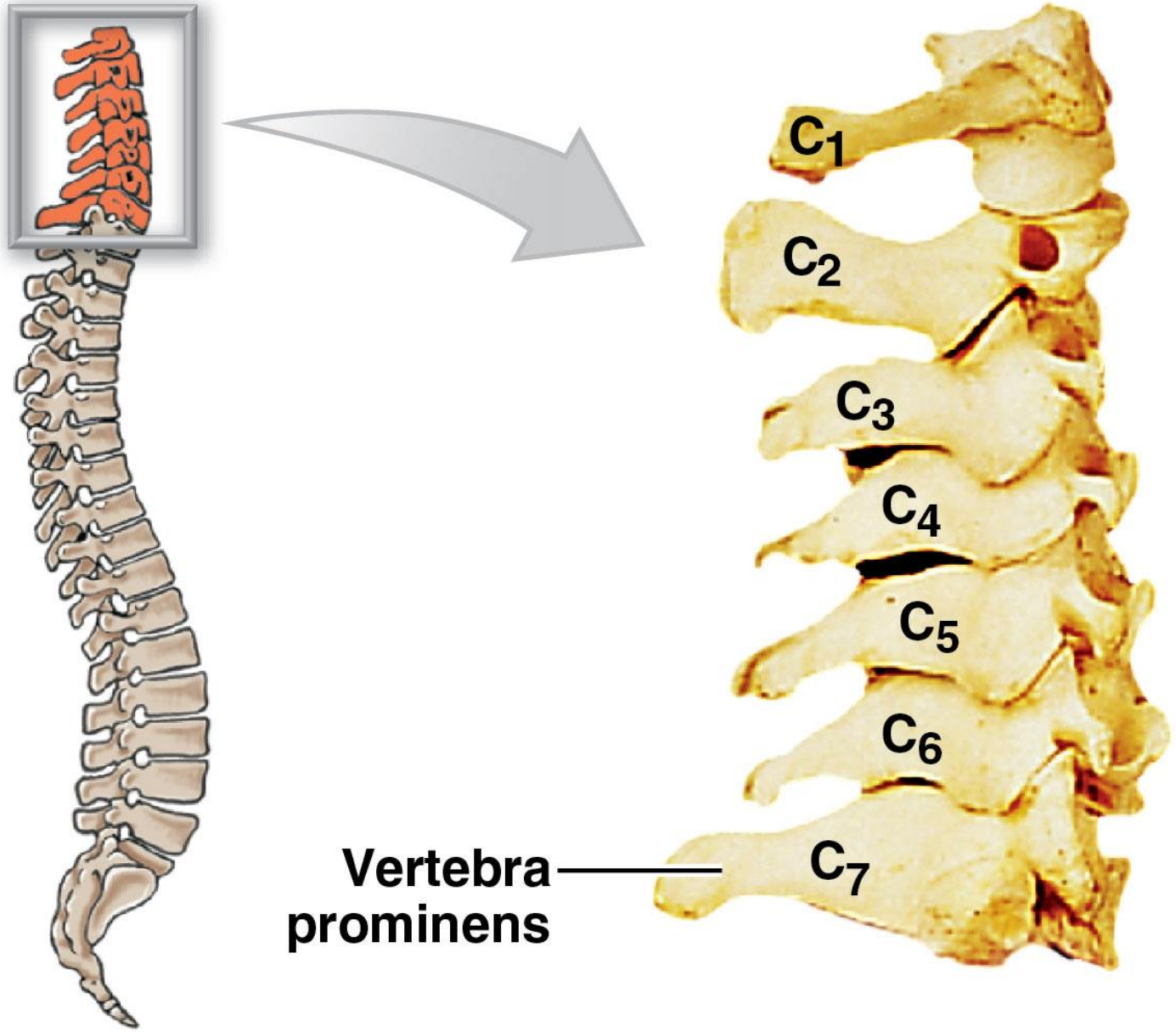


Video: Atlas and Axis

Module 7.11: Cervical vertebrae

- **Last cervical vertebra (C_7)**
  - Also known as the **vertebra prominens,** or prominent vertebra
    - Has large spinous process ending in a tubercle
    - Can be felt through the skin
  - **Ligamentum nuchae** (*nucha,* nape)
    - Elastic ligament that connects the vertebra prominens to the external occipital crest
    - Acts like a bow string to maintain the cervical curvature without muscular effort

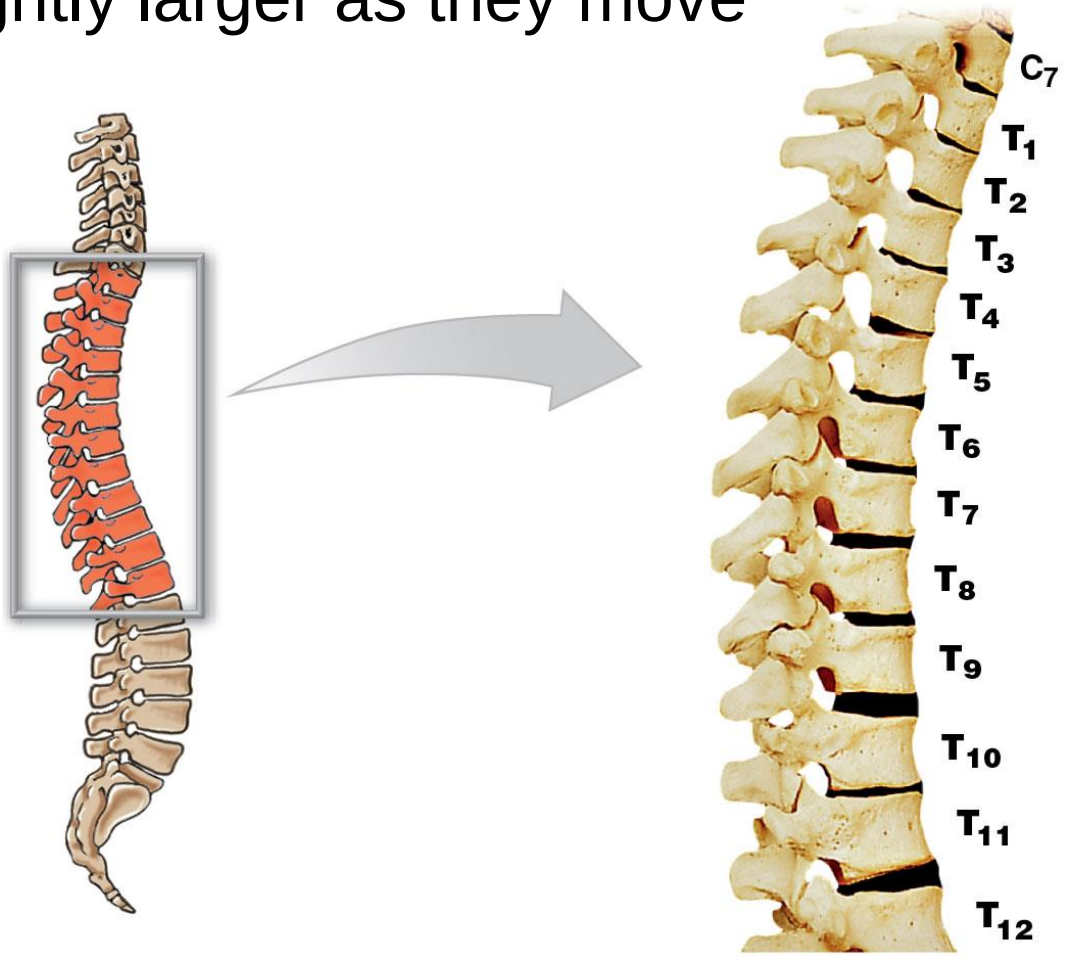
Cervical vertebrae



Module 7.11: … and twelve thoracic vertebrae

Thoracic vertebrae

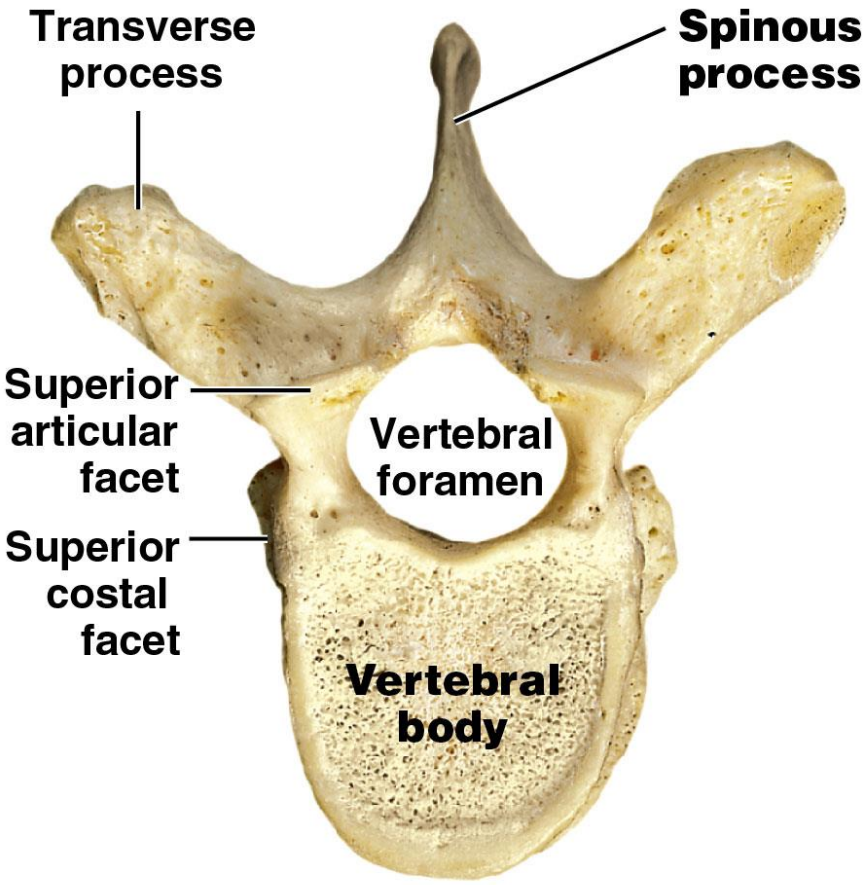
- 12 thoracic vertebrae
- Body of each one slightly larger as they move inferiorly
  - Able to bear increasing weight



Module 7.11: Thoracic vertebrae

Thoracic vertebrae (continued)

- Long, slender **spinous process** that projects posteriorly and inferiorly
- Smaller vertebral foramen than cervical vertebrae

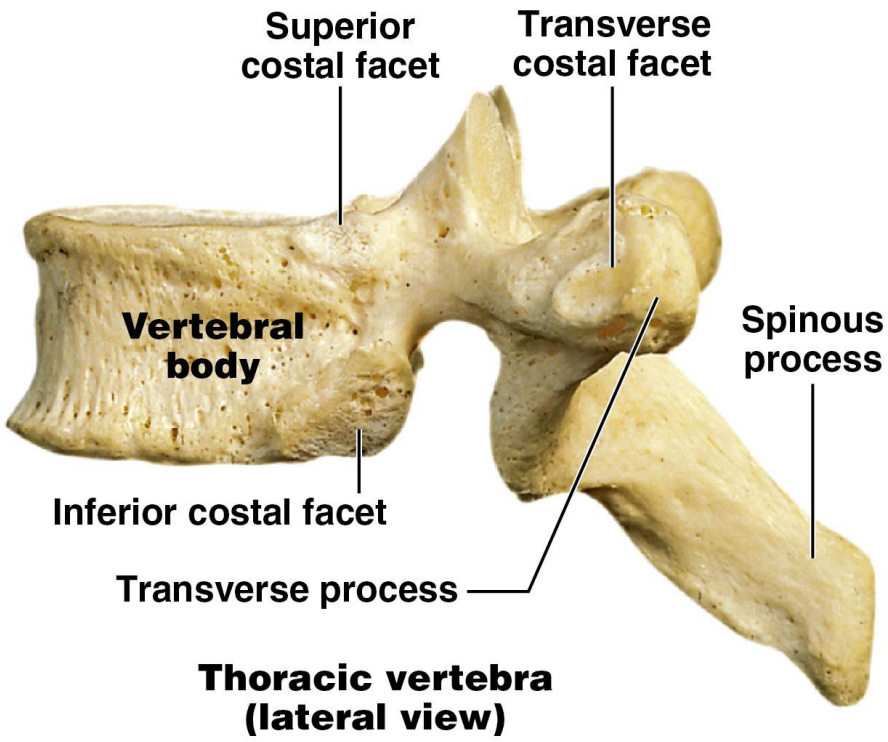


Thoracic vertebra (superior view)

Module 7.11: Thoracic vertebrae

Thoracic vertebrae (continued)

- **Costal facets** on dorsolateral surface of vertebral body for rib articulation
  - T_1–T_{10} also have costal facets on the transverse processes



Video: Thoracic Vertebra

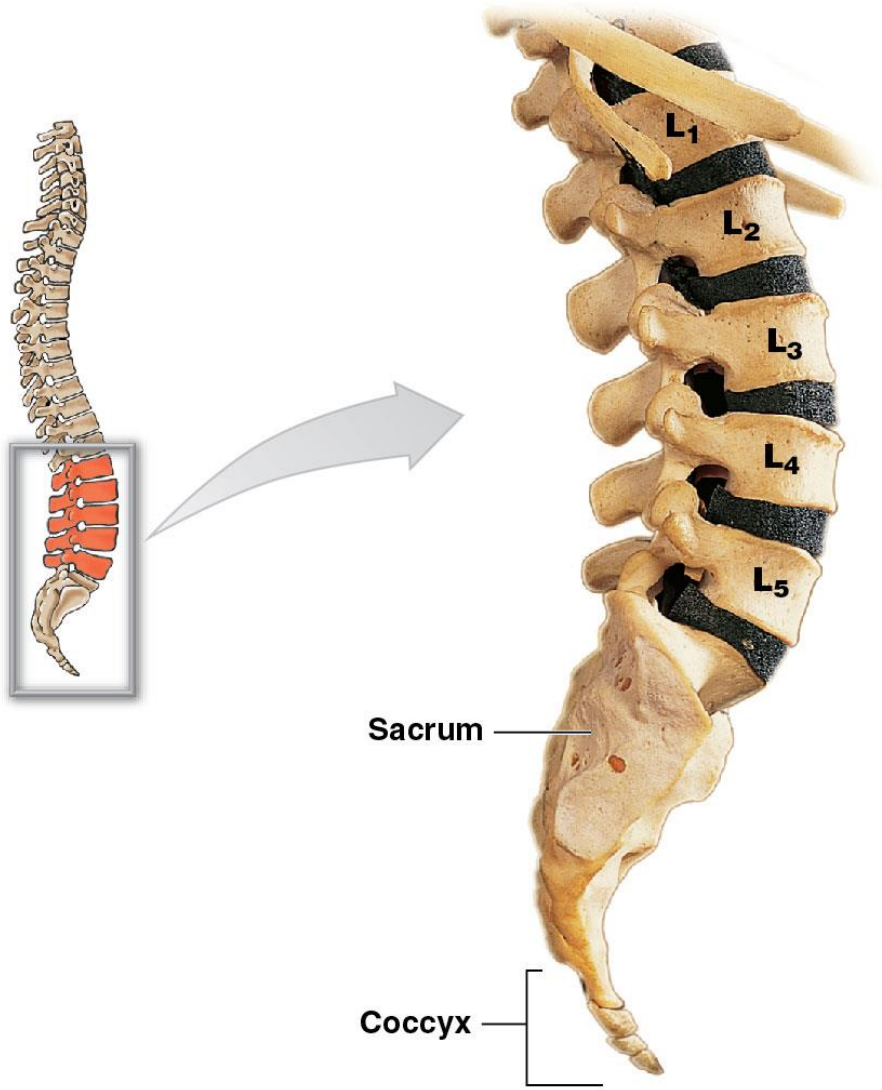
Module 7.11: Review

A. Joe suffered a hairline fracture at the base of the dens. Identify the bone and fracture site.
B. In which region of the vertebral column would you find a vertebra with a large foramen and two smaller foramina within the transverse process?
C. When you run your finger down the middle of a person's spine, what part of each vertebra are you feeling just beneath the skin?

Learning Outcome: Describe the distinctive structural and functional characteristics of the cervical and thoracic vertebrae.

Module 7.12: There are five lumbar vertebrae

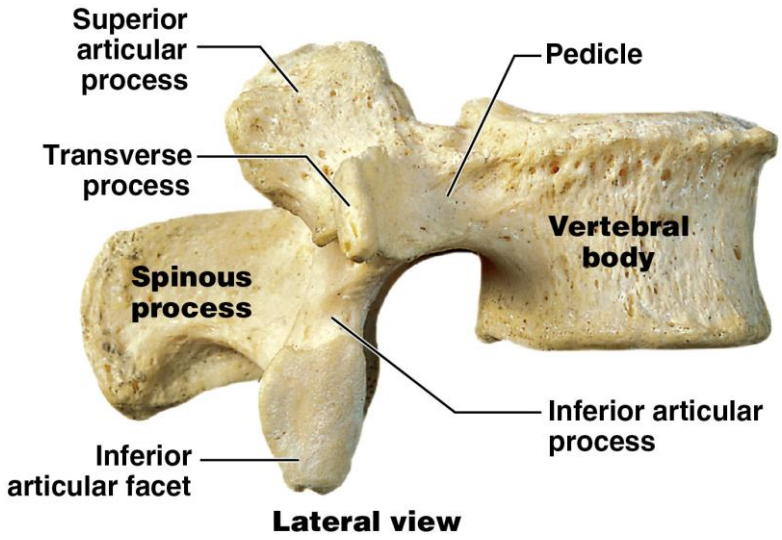
- Five lumbar vertebrae
- Largest vertebrae (transmit the most weight)
  - Thicker body than that of a thoracic vertebra
  - Superior and inferior surfaces are oval (not heart shaped)



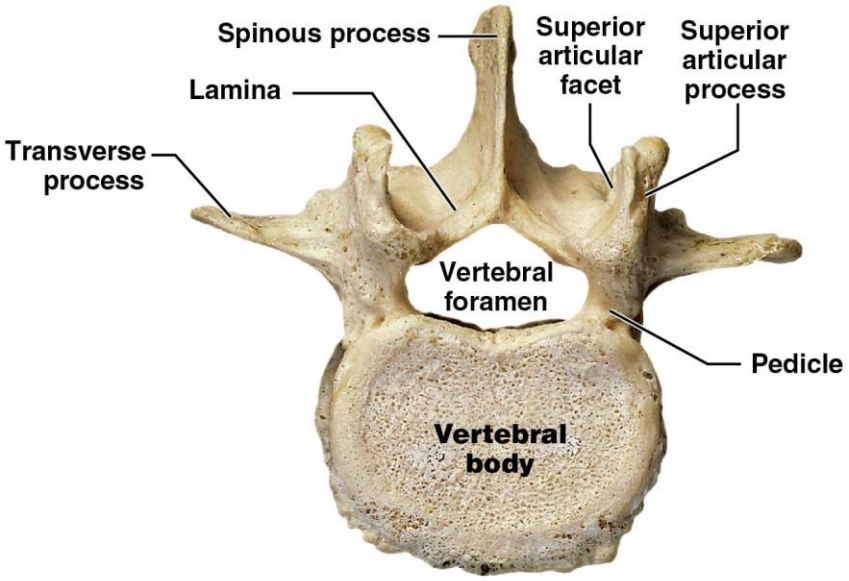
Module 7.12: Lumbar vertebrae

Lumbar vertebrae features

- No costal facets
- Slender transverse processes
- Triangular vertebral foramen
- Stumpy spinous process
- Superior articular processes face medially
- Inferior articular processes face laterally



Lateral view



Superior view

Video: Lumbar Vertebra

Module 7.12: Review

A. How many vertebrae are in the lumbar region of the vertebral column?
B. Why are the bodies of lumbar vertebrae so large?

Learning Outcome: Describe the distinctive structural and functional characteristics of the lumbar vertebrae.

Module 7.13: The sacrum and coccyx consist of fused vertebrae

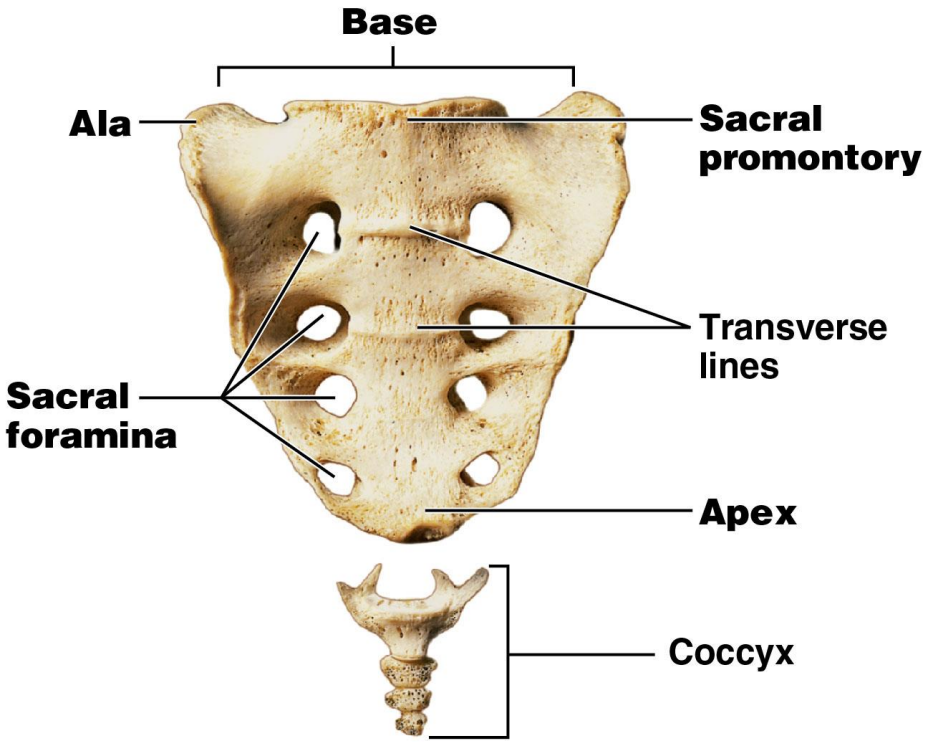
Sacrum

- Five fused vertebrae
  - Begin fusing after puberty
  - Completely fused by age 25–30
  - Transverse lines mark former boundaries of individual vertebrae
- Protects reproductive, digestive, and urinary organs
- Attaches the axial skeleton to the appendicular skeleton
- Anterior surface concave; posterior surface convex
  - Curvature more pronounced in males than females

Module 7.13: The sacrum and the coccyx

Sacrum features

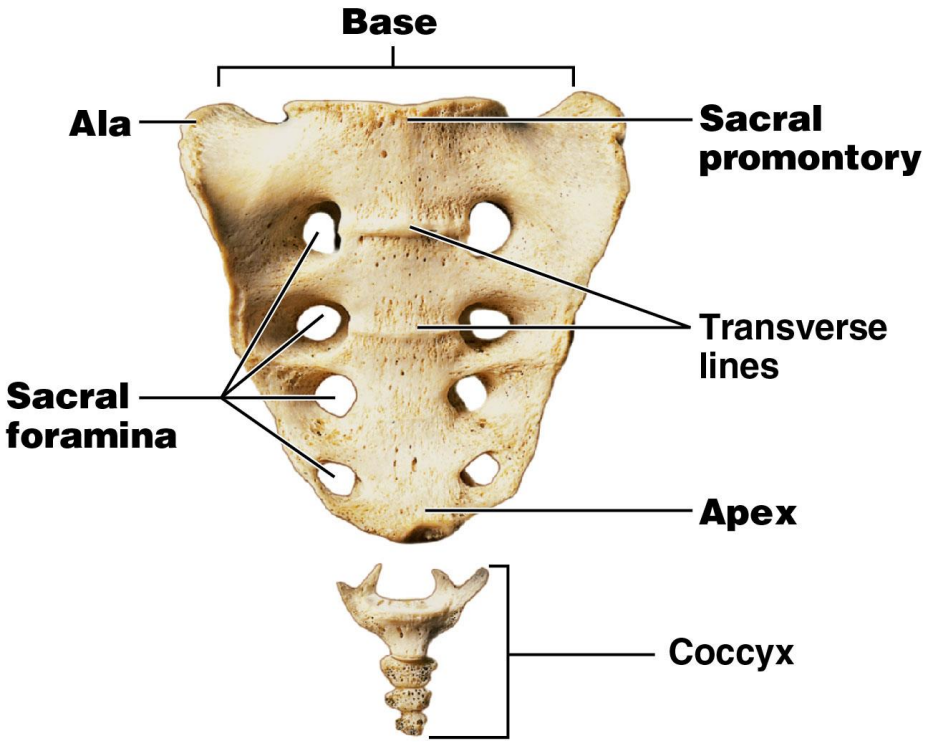
- **Base**
  - Broad, superior surface
- **Ala, or wing**
  - Extends to each side from the base
- **Sacral promontory**
  - Important landmark in female pelvic exams and in labor and delivery



Module 7.13: The sacrum and the coccyx

Sacrum features (continued)

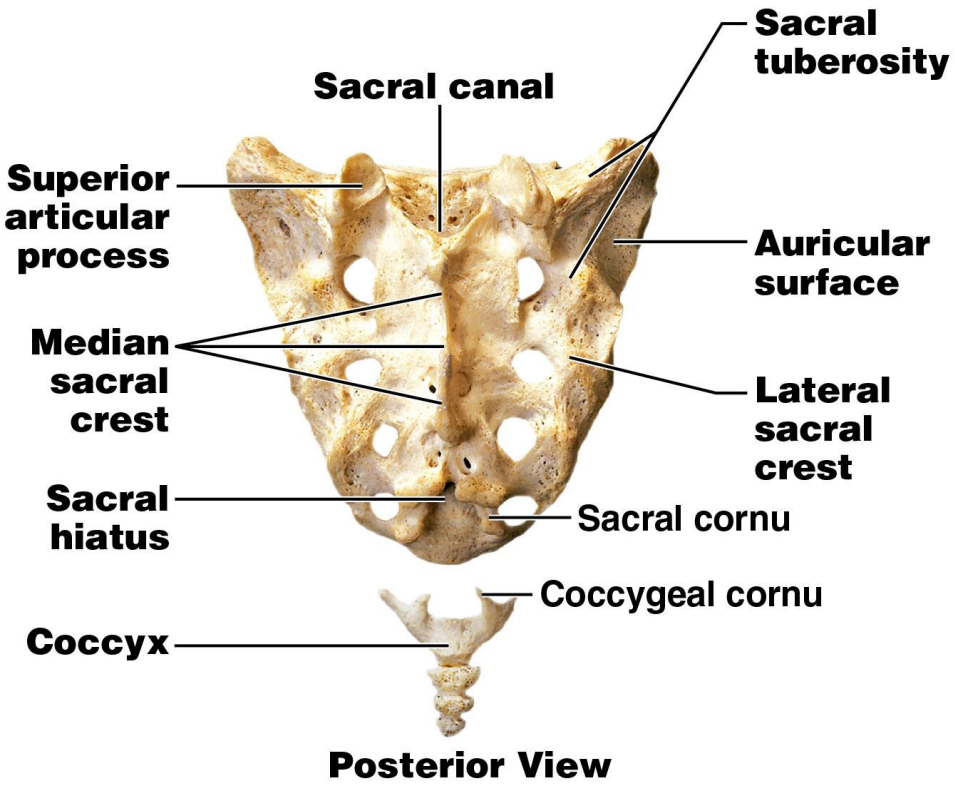
- **Sacral foramina**
  - Intervertebral foramina of fused vertebrae
- **Apex**
  - Narrow, inferior portion



Module 7.13: The sacrum and the coccyx

Sacrum features (continued)

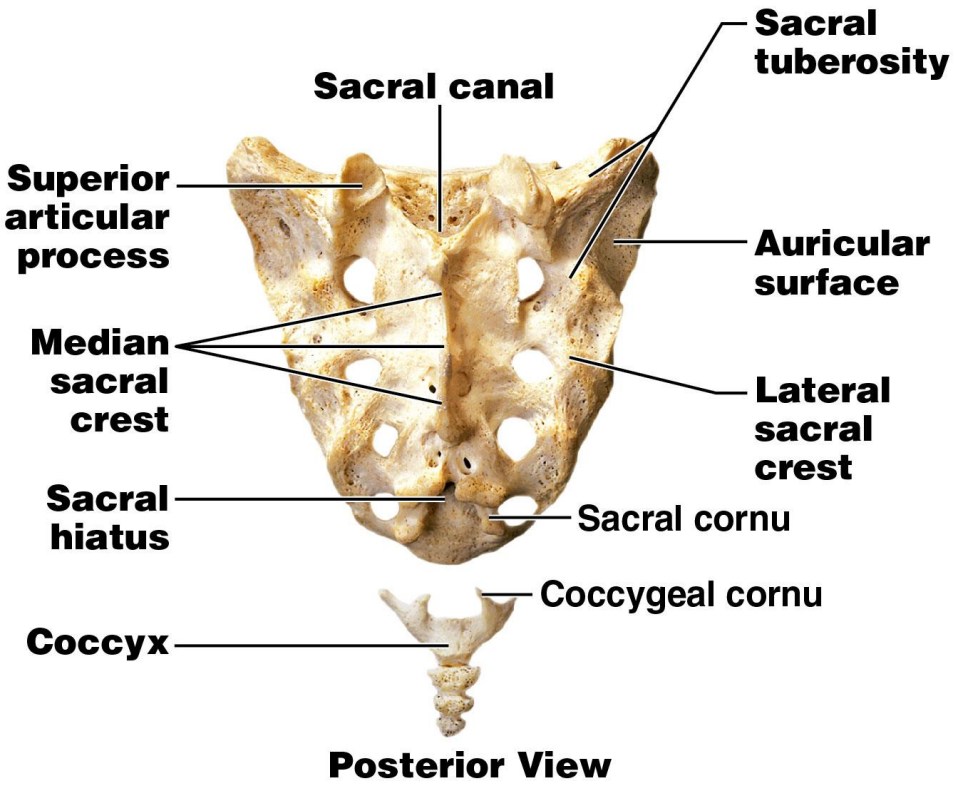
- **Sacral canal**
  - Passageway extending the length of the sacrum
  - Contains nerves and membranes of the spinal cord
- **Auricular surface**
  - Thickened, flattened lateral surfaces
  - Site of articulation with pelvic bones (sacro-iliac joint)



Module 7.13: The sacrum and the coccyx

Sacrum features (continued)

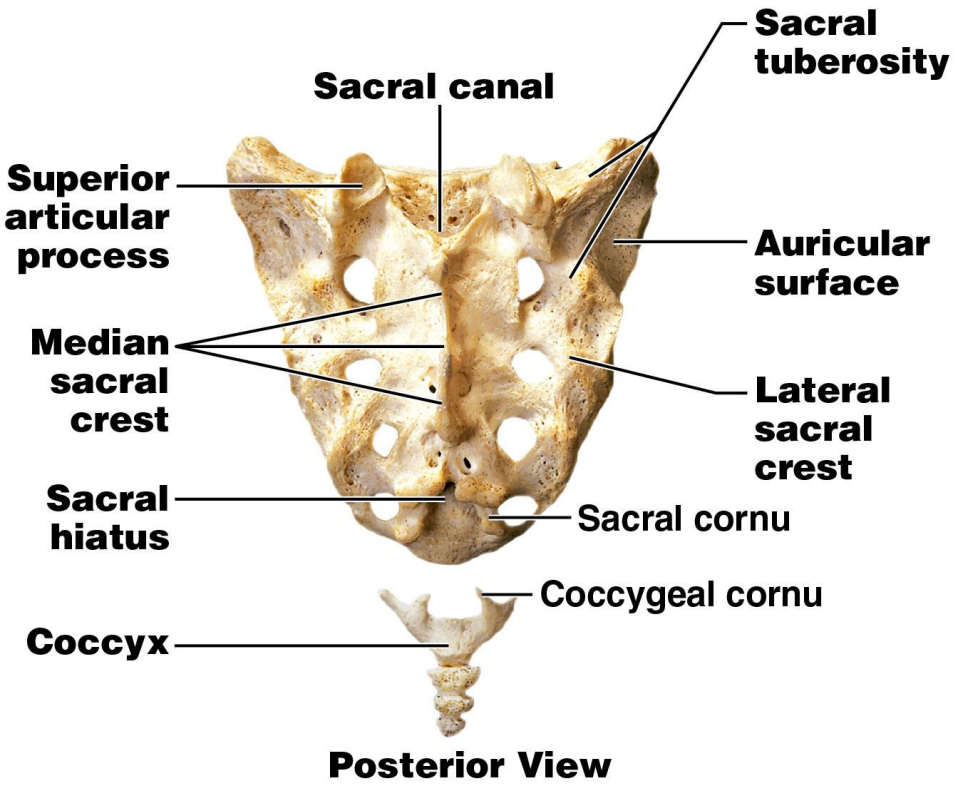
- **Sacral tuberosity**
  - Roughened area posterior to auricular surface
  - Attachment site of sacro-iliac joint ligaments
- **Superior articular process**
  - Articulates with last lumbar vertebra



Module 7.13: The sacrum and the coccyx

Sacrum features (continued)

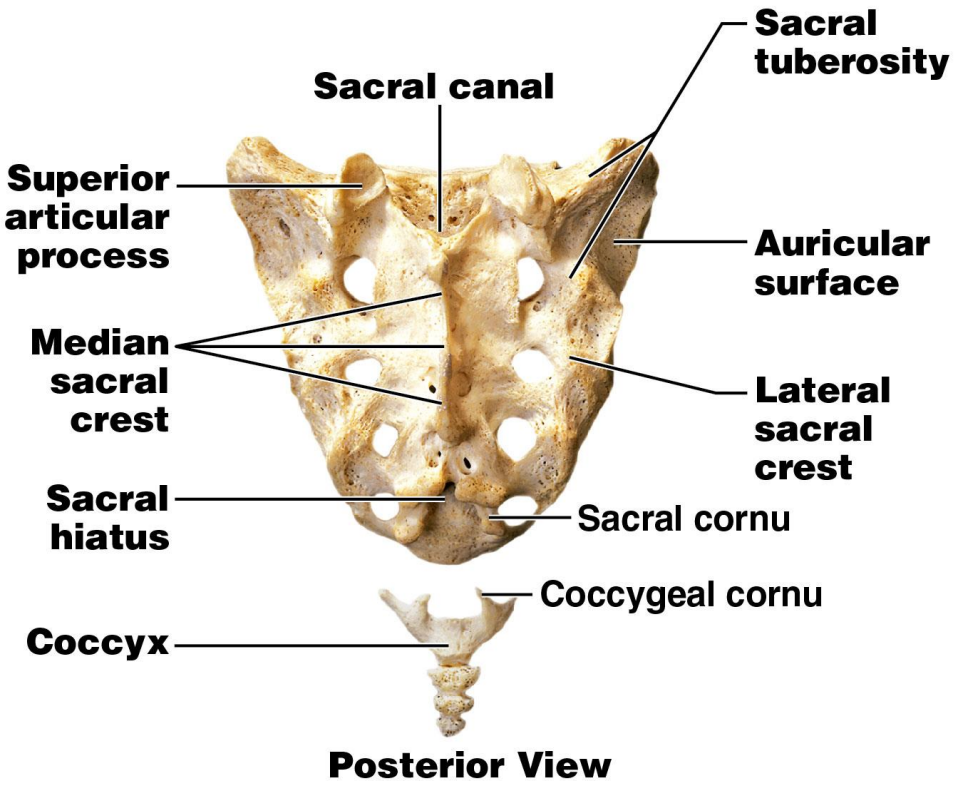
- **Median sacral crest**
  - Ridge formed by fused spinous processes of sacral vertebrae
- **Lateral sacral crest**
  - Ridge from fused transverse processes of sacral vertebrae
- **Sacral hiatus**
  - Opening at inferior end of sacral canal



Module 7.13: The sacrum and the coccyx

Coccyx

- Three to five fused vertebrae
- Begin fusing about age 26
- **Coccygeal cornu**
  - Curves to met sacral cornu superior to it



Video: Sacrum and Coccyx

Module 7.13: Review

A. Which bone of the axial skeleton joins with the hip bones of the appendicular skeleton?
B. Which regions of the vertebral column do not consist of individual vertebrae?

Learning Outcome: Describe the distinctive structural and functional characteristics of the sacrum and coccyx.

Module 7.14: The thoracic cage protects organs in the chest and provides sites for muscle attachment

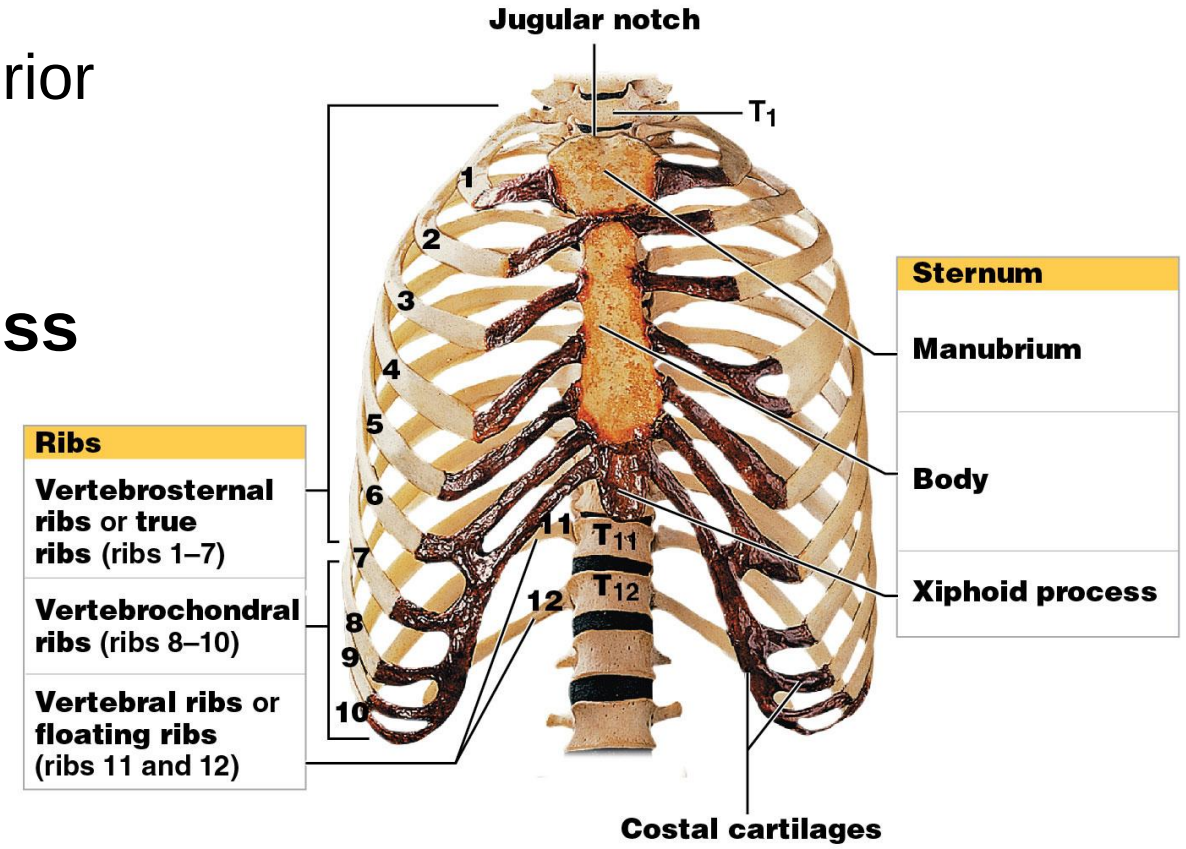
Thoracic cage overview

- Provides bony support to thoracic cavity walls
- Protects heart, lungs, thymus, and other thoracic cavity organs
- Composed of thoracic vertebrae, ribs, and sternum
  - Ribs and sternum form the rib cage
- Attachment for muscles involved in:
  1. Breathing
  2. Maintaining position of the vertebral column
  3. Moving the pectoral girdles and upper limbs

Module 7.14: The thoracic cage

Sternum

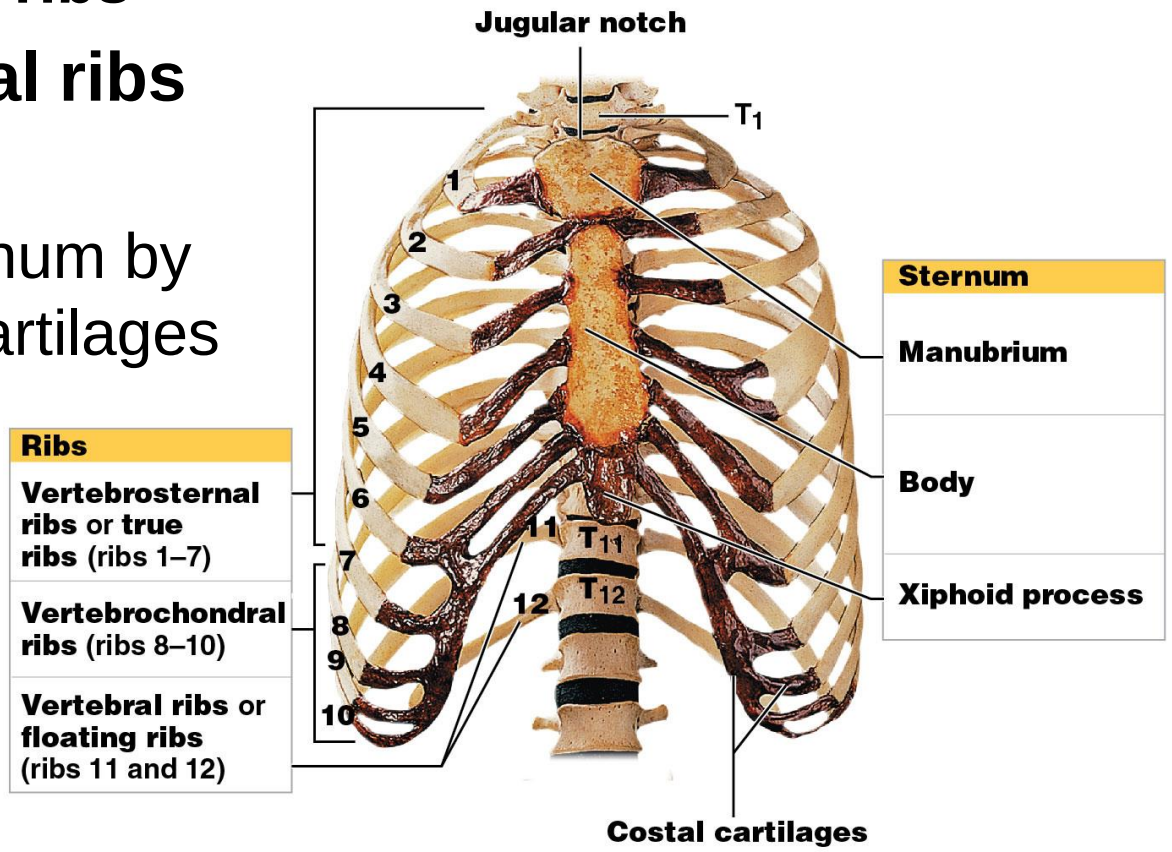
1. **Manubrium**
   - Trapezoid-shaped superior portion
2. **Body**
   - Attaches to inferior surface of the manubrium
3. **Xiphoid process**
   - Attached to inferior portion of body



Module 7.14: The thoracic cage

Ribs

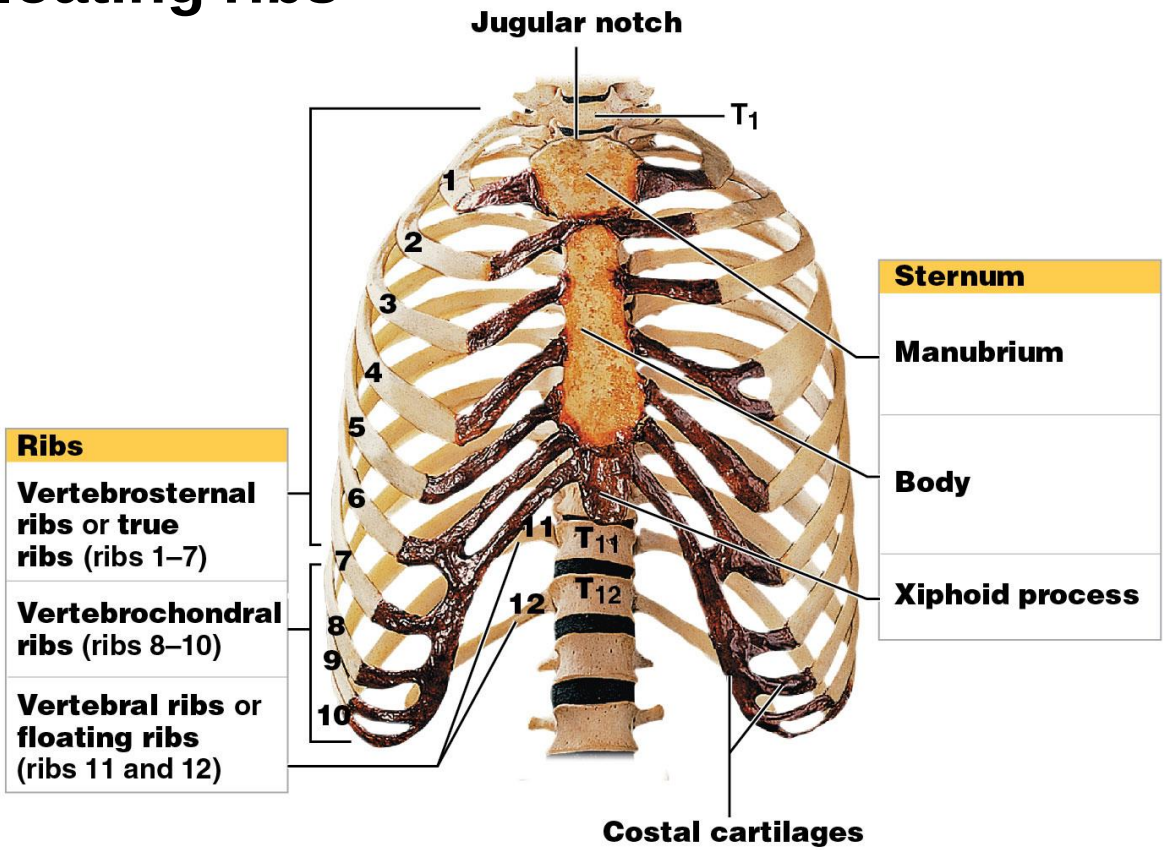
- **Vertebrosternal ribs** (ribs 1–7)
  - Connect to sternum by individual costal cartilages
  - Also called **true ribs**
- **Vertebrochondral ribs** (ribs 8–10)
  - Connect to sternum by shared costal cartilages



Module 7.14: The thoracic cage

Ribs (continued)

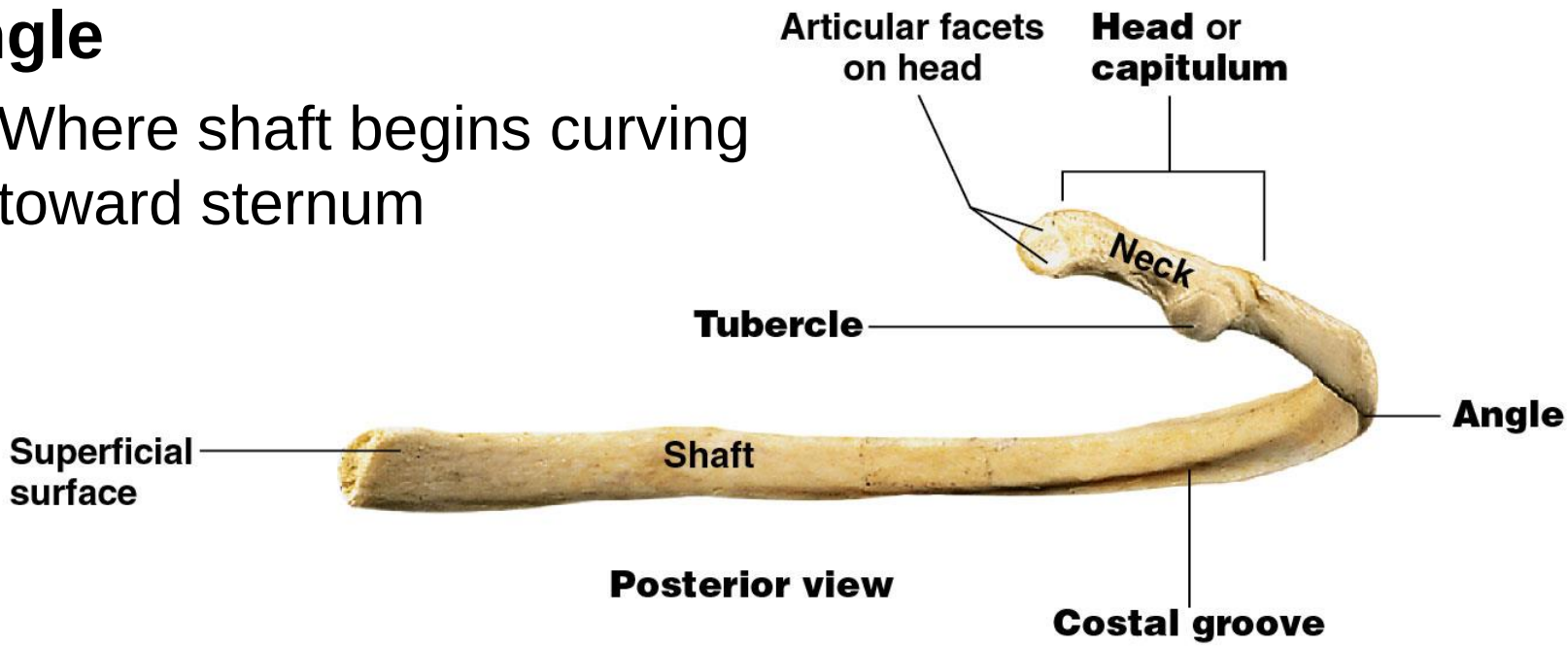
- **Vertebral ribs** (ribs 11 and 12)
  - No connection to sternum
  - Also known as **floating ribs**
- Ribs 8–12 also called **false ribs**



Module 7.14: The thoracic cage

Ribs (continued)

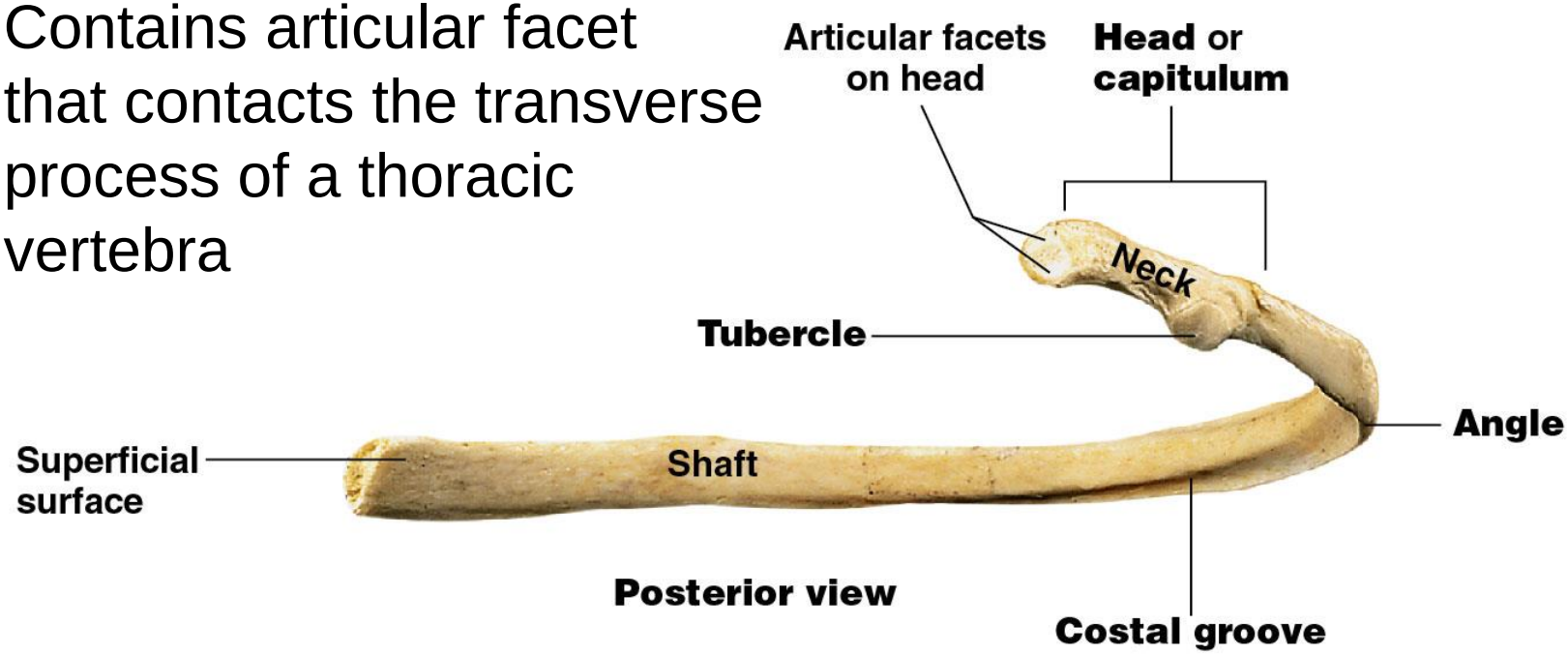
- **Costal groove** on the inferior border
  - Marks path of nerves and blood vessels
- **Shaft**
  - Tubular body of the rib
- **Angle**
  - Where shaft begins curving toward sternum



Module 7.14: The thoracic cage

Ribs (continued)

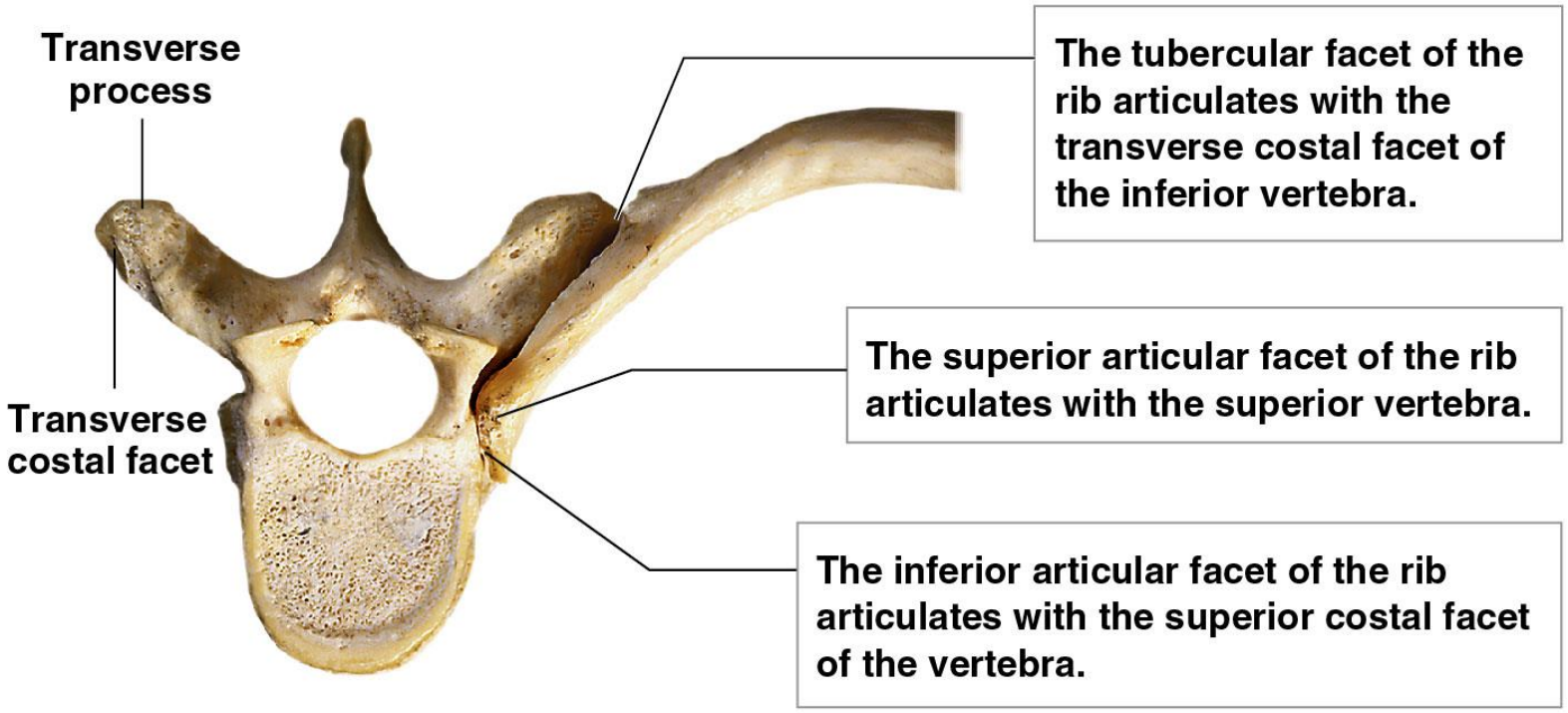
- **Head** or **capitulum**
  - Vertebral end of the rib where rib articulates with vertebral column at specific points (**articular facets**)
- **Tubercle**
  - Contains articular facet that contacts the transverse process of a thoracic vertebra



Module 7.14: The thoracic cage

Rib articulations with a thoracic vertebra

- Ribs 2–9
  - Heads articulate with costal facets of two adjacent vertebrae



Module 7.14: The thoracic cage

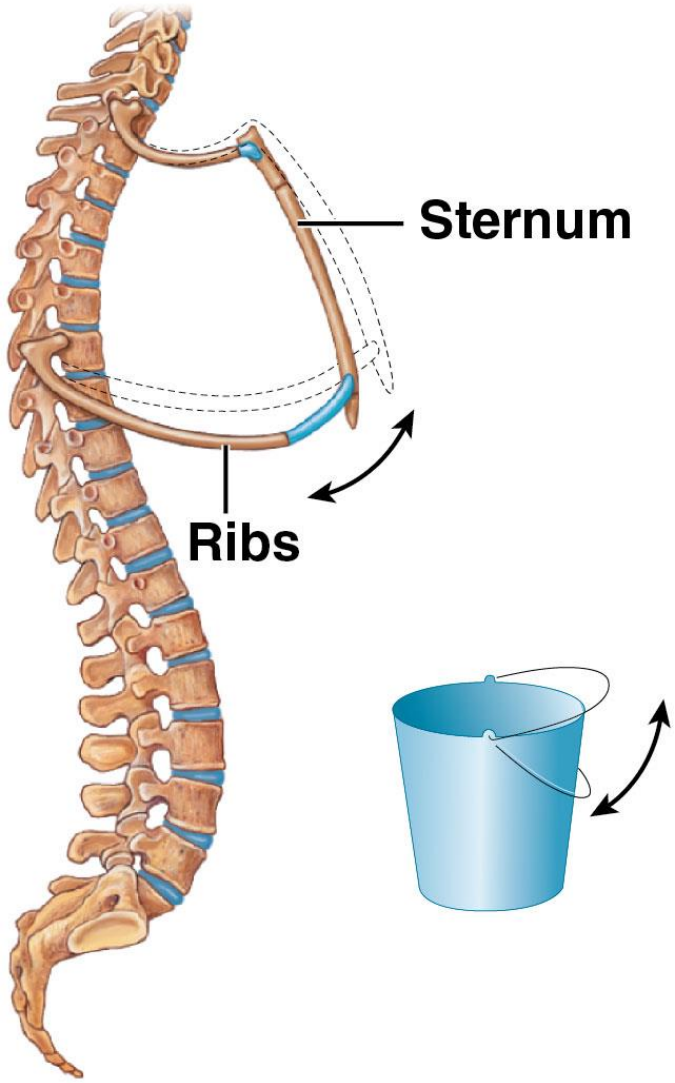
Rib articulations with a thoracic vertebra (continued)

- Ribs 1, 10, 11, and 12
  - Heads articulate with single costal facet of individual vertebrae
  - Tubercular facets of ribs 1 and 10 attach to transverse costal facets
  - No tubercular facets on ribs 11 and 12

Module 7.14: The thoracic cage

Movement of ribs

- Typical rib acts like a bucket handle held out to the side horizontally
- Pushing down moves rib inward
- Pulling up moves rib outward
- Movements affect width and depth of thoracic cage
  - Increases or decreases volume



Module 7.14: Review

A. How are vertebrosternal ribs distinguished from vertebrochondral ribs?
B. Why are ribs 11 and 12 called *floating ribs*?
C. Along with the ribs and sternum, what other bones make up the thoracic cage?

Learning Outcome: Explain the significance of the articulations between the thoracic vertebrae and the ribs, and between the ribs and sternum.

Section 2: Appendicular Skeleton

Learning Outcomes

7.15 List the four major components of the appendicular skeleton.

7.16 Identify the bones that form the pectoral girdles, their functions, and their superficial features.

7.17 Identify the bones of the arm and forearm, their functions, and their bone markings.

7.18 Identify the bones of the wrist and hand, and describe their locations using anatomical terminology.

Section 2: Appendicular Skeleton

Learning Outcomes (continued)

7.19 Describe the hip bones that form the pelvic girdle, their functions, and their bone markings.

7.20 Identify the bones of the pelvis.

7.21 Discuss the differences between the male and female skeletons.

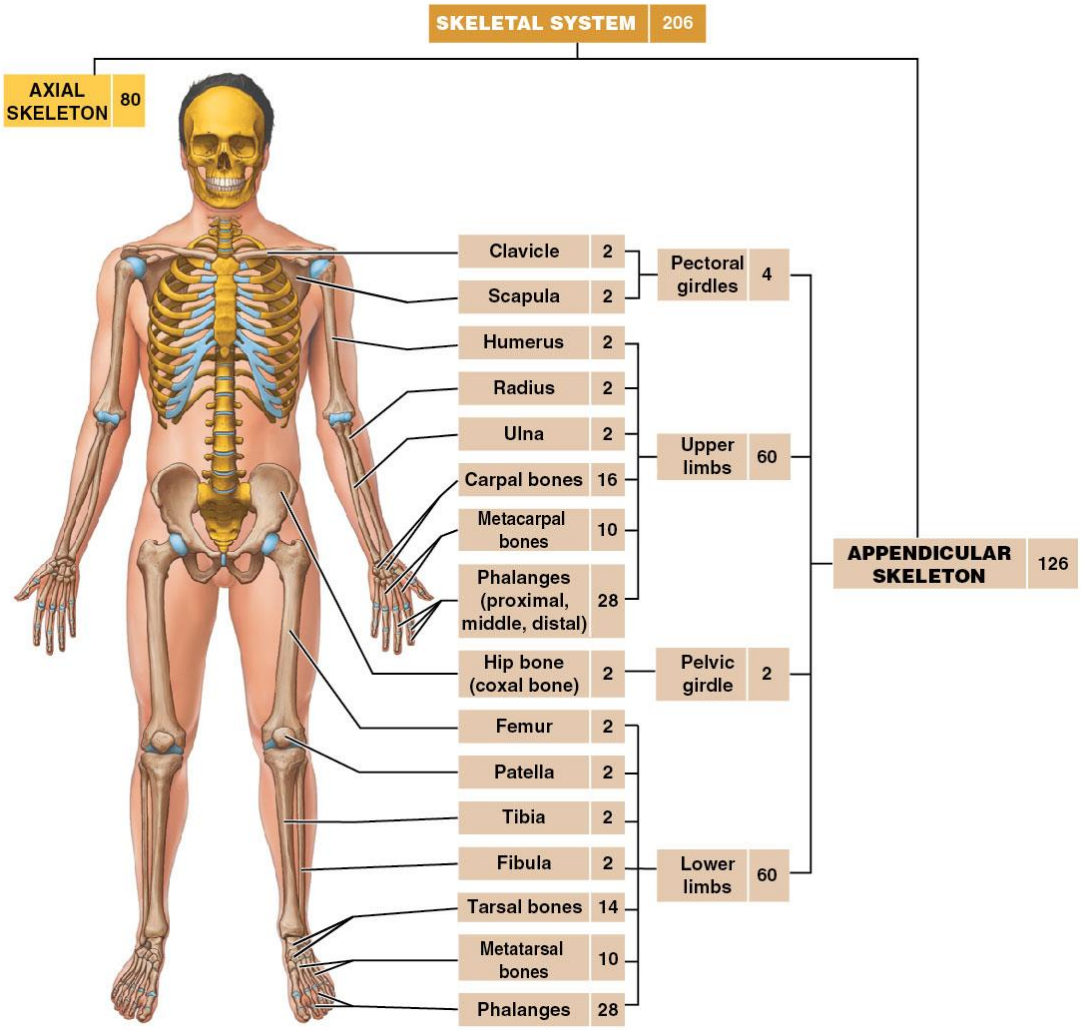
7.22 Identify the bones of the thigh and leg, their functions, and their bone markings.

7.23 Identify the bones of the ankle and foot, and describe their locations using anatomical terminology.

Module 7.15: The appendicular skeleton includes the limb bones and the pectoral and pelvic girdles

Appendicular skeleton

- Includes bones of the limbs and supporting bone girdles that connect the limbs to the trunk



Module 7.15: Review

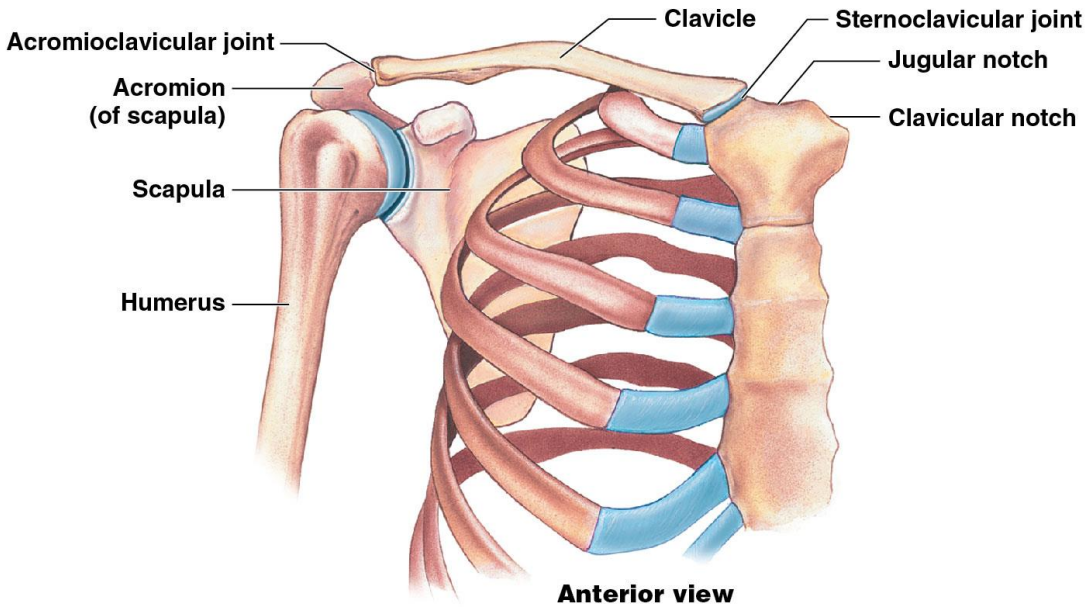
A. How many bones are in the appendicular skeleton?
B. What is the function of the pectoral and pelvic girdles?

Learning Outcome: List the four major components of the appendicular skeleton.

Module 7.16: The pectoral girdles—the clavicles and scapulae—connect the upper limbs to the axial skeleton

Pectoral girdle, or shoulder girdle

- Joins the arms to the trunk
- Each consists of:
  - An S-shaped **clavicle**
  - A broad, flat **scapula**



Module 7.16: The pectoral girdles

Clavicle

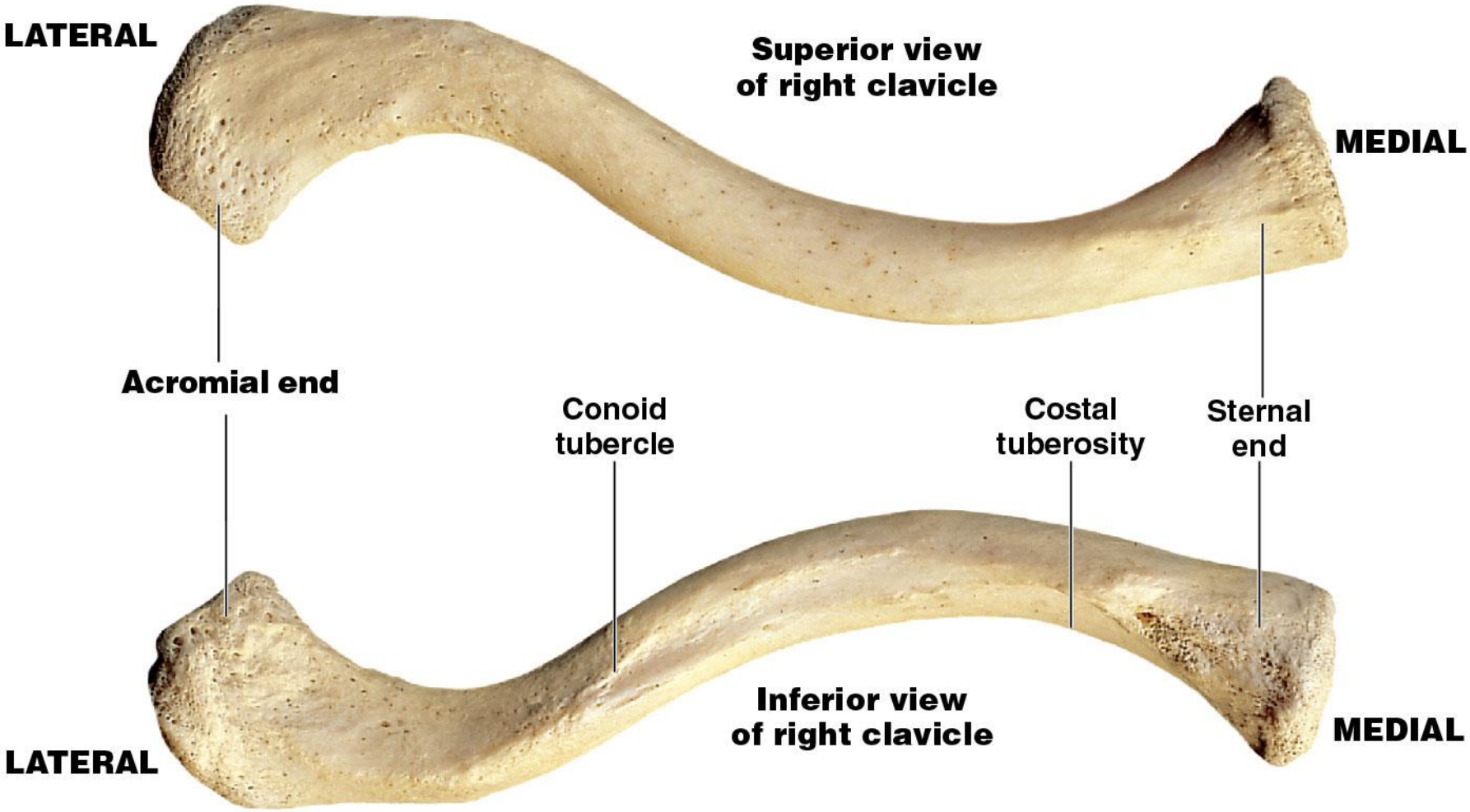
- Originates at articulation with the superior, lateral border of the manubrium of the sternum (lateral to jugular notch)
  - Forms the **sternoclavicular joint**
    - Only articulation between pectoral girdle and the axial skeleton
  - **Sternal end** of the clavicle
    - Pyramid shaped
- Curves laterally and posteriorly then forms a posterior curve to the scapula

Module 7.16: The pectoral girdles

Clavicle (continued)

- Articulates with **acromion** of scapula at the clavicular notch
  - Forms the **acromioclavicular joint**
  - Stabilizing ligaments attach to conoid tubercle and costal tuberosity
  - **Acromial end** of the clavicle
    - Flatter, broader than sternal end
    - Rough inferior surface bearing lines and tubercles

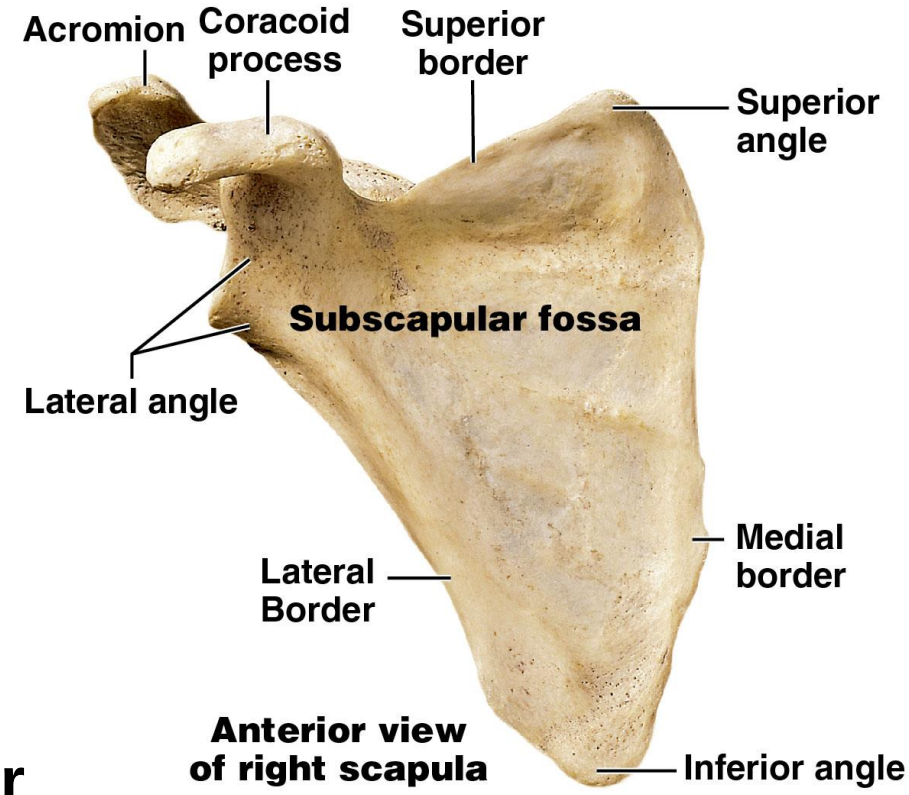
The clavicle



Module 7.16: The pectoral girdles

Scapula

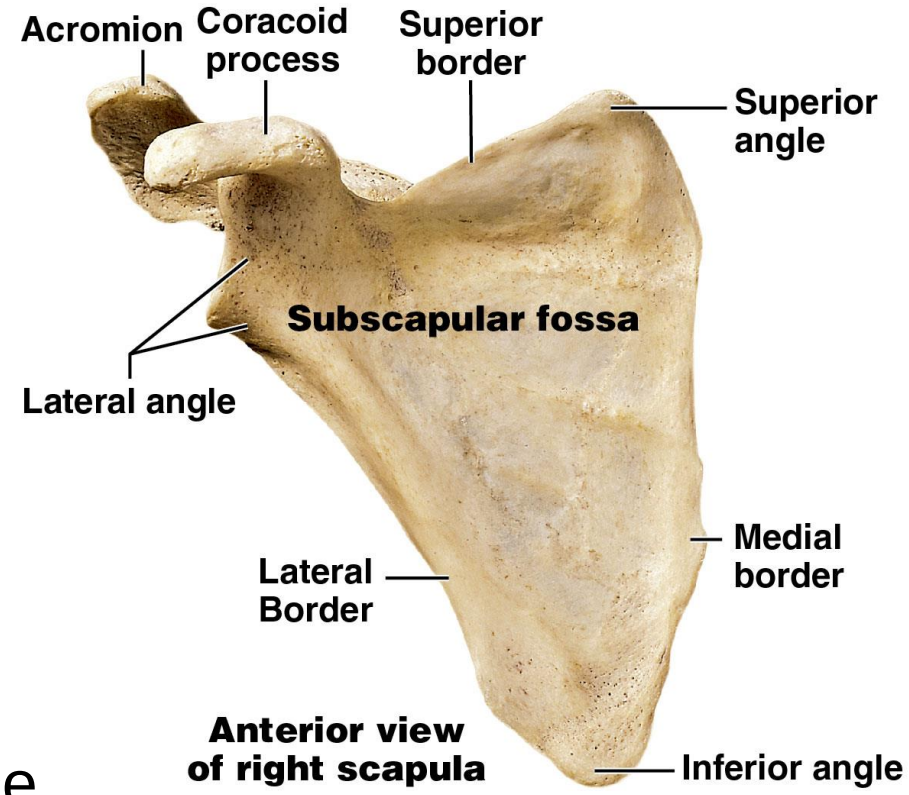
- Anterior surface forms smooth, broad triangle
- Three sides (muscle attachment sites)
  - **Superior border**
  - **Medial** (vertebral) **border**
  - **Lateral** (axillary) **border**



Module 7.16: The pectoral girdles

Scapula (continued)

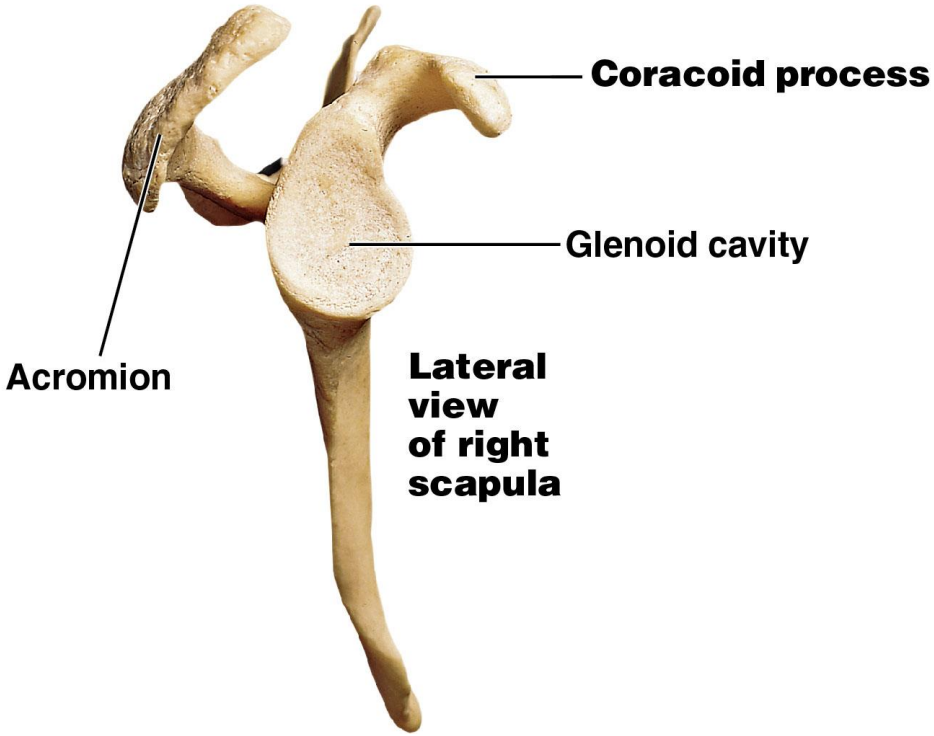
- Corners of the triangle
  - **Superior angle**
  - **Inferior angle**
  - **Lateral angle** (location of the **glenoid cavity**)
- **Subscapular fossa**
  - Depression on the anterior scapular surface



Module 7.16: The pectoral girdles

Scapula (continued)

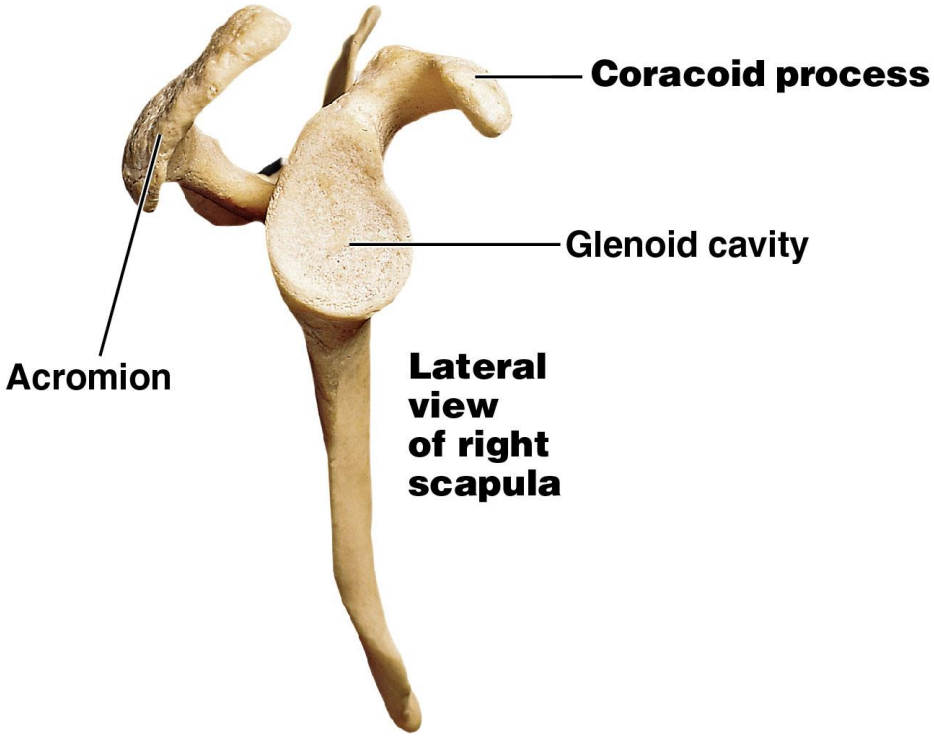
- **Glenoid cavity**
  - Cup-shaped depression
  - Where scapula articulates with the humerus, forming the glenohumoral joint



Module 7.16: The pectoral girdles

Scapula (continued)

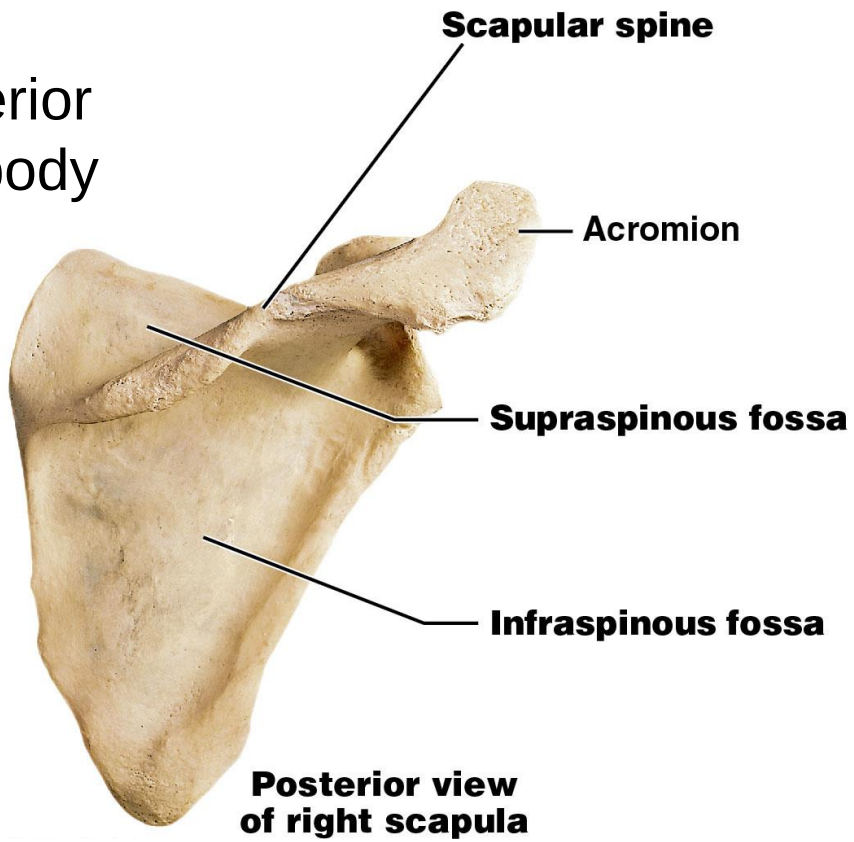
- **Acromion**
  - Large process that extends laterally
  - Projects posterior and superior to the glenoid cavity
  - Continuous with the scapular spine
- **Coracoid process**
  - Projects anterior and superior to glenoid cavity



Module 7.16: The pectoral girdles

Scapula (continued)

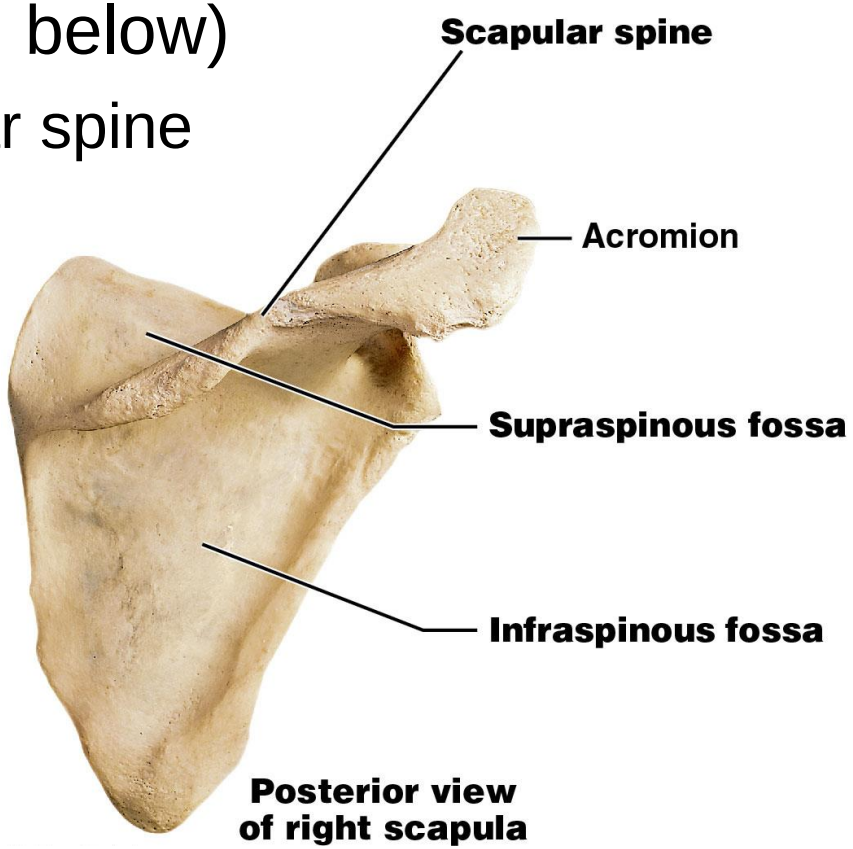
- Posterior surface is convex with prominent ridges and processes for muscle attachment
  - **Scapular spine**
    - Ridge crossing the posterior surface of the scapular body
    - Continuous with the acromion
    - Ends at the medial border of the body



Module 7.16: The pectoral girdles

Scapula (continued)

- **Supraspinous fossa** (*supra,* above)
  - Depression superior to the scapular spine
- **Infraspinous fossa** (*infra,* below)
  - Region inferior to scapular spine



Module 7.16: Review

A. Name the bones of the pectoral girdles.
B. How would a broken clavicle affect the mobility and stability of the scapula?
C. Which bone articulates with the scapula at the glenoid cavity?
D. How are the pectoral girdles of the appendicular skeleton attached to the axial skeleton?

Learning Outcome: Identify the bones that form the pectoral girdles, their functions, and their superficial features.

Module 7.17: The humerus of the arm articulates with the radius and ulna of the forearm

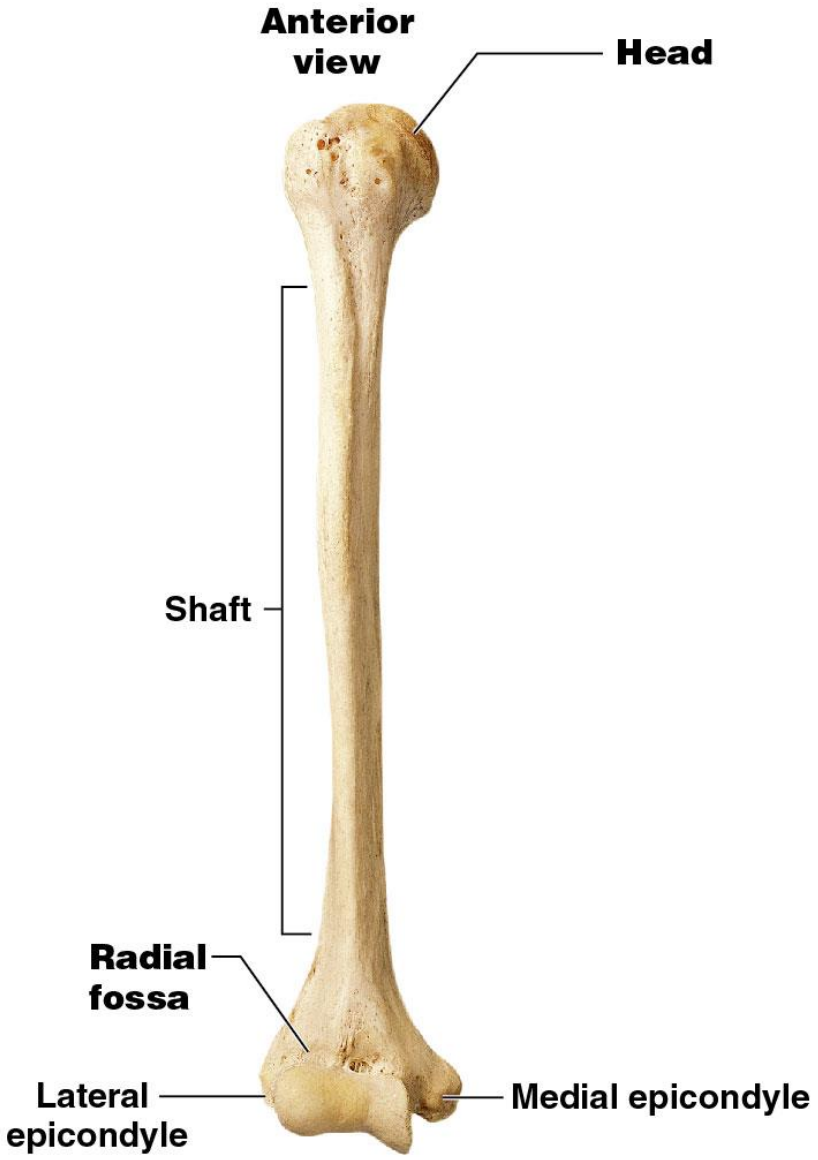
Upper limb

- Consists of bones of the:
  - Arm (shoulder to elbow)
    - **Humerus**
  - Forearm (elbow to wrist)
    - **Ulna**
    - **Radius**
  - Wrist
    - **Carpals**
  - Hands
    - **Metacarpals** and **phalanges**

Module 7.17: Bones of the arm and forearm

Humerus

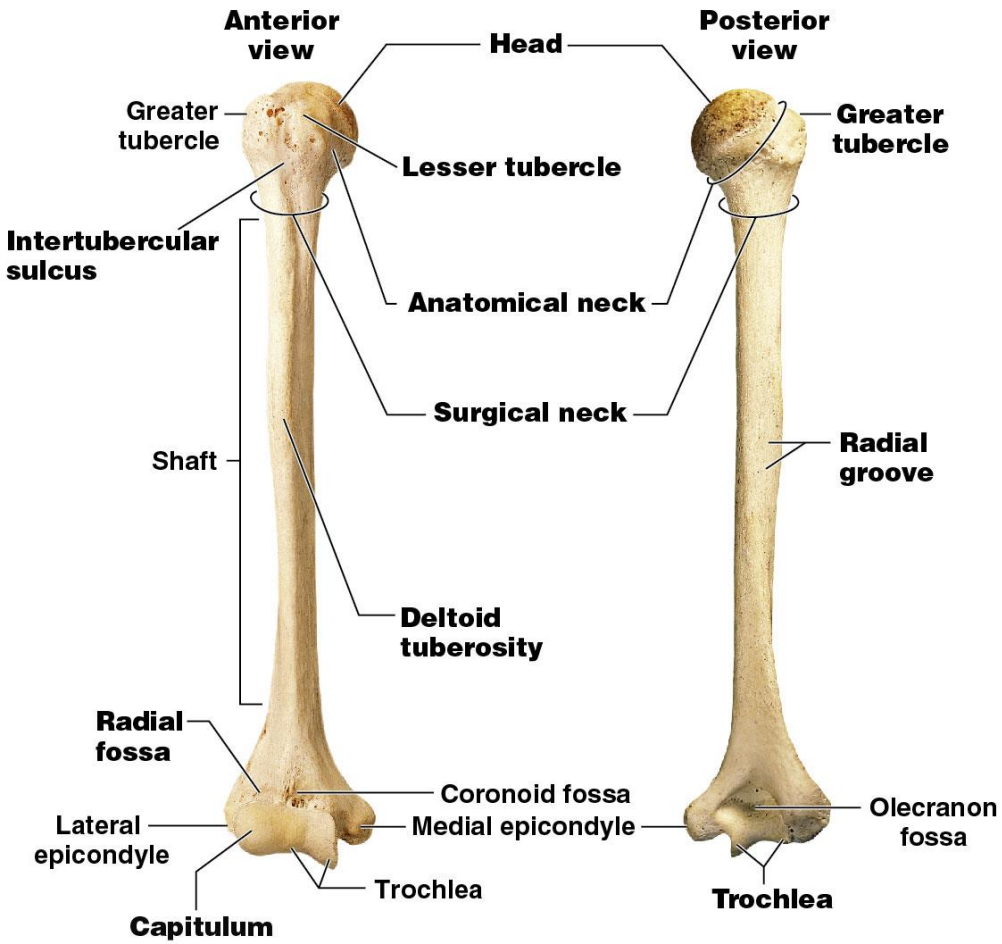
- Only bone in the arm (**brachium**)
- Shaft expands at distal end to form epicondyles
  - Provide additional surface area for muscle attachment
    - **Medial epicondyle**
    - **Lateral epicondyle**



Module 7.17: Bones of the arm and forearm

Humerus (continued)

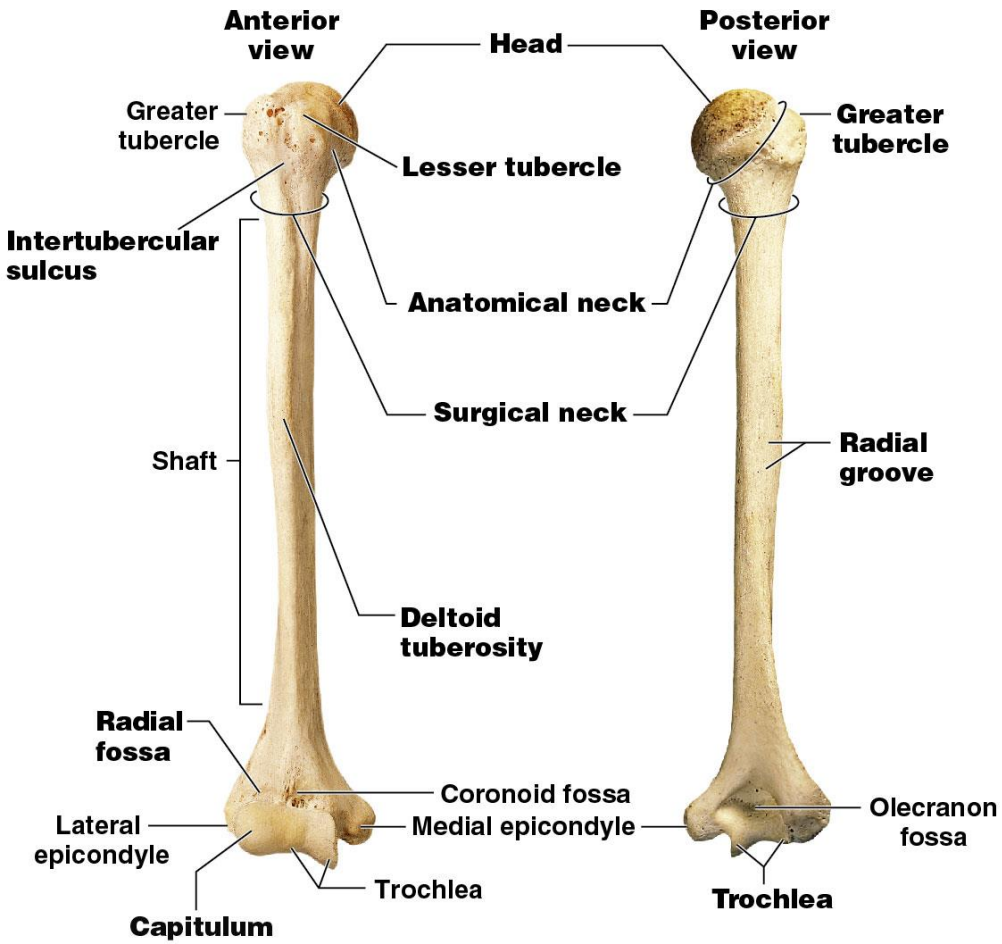
- **Head**
  - Proximal end that articulates with the glenoid cavity
- **Anatomical neck**
  - Marks the extent of the joint capsule
- **Surgical neck**
  - Corresponds to the metaphysis of growing bone
  - Typical site for fractures



Module 7.17: Bones of the arm and forearm

Humerus (continued)

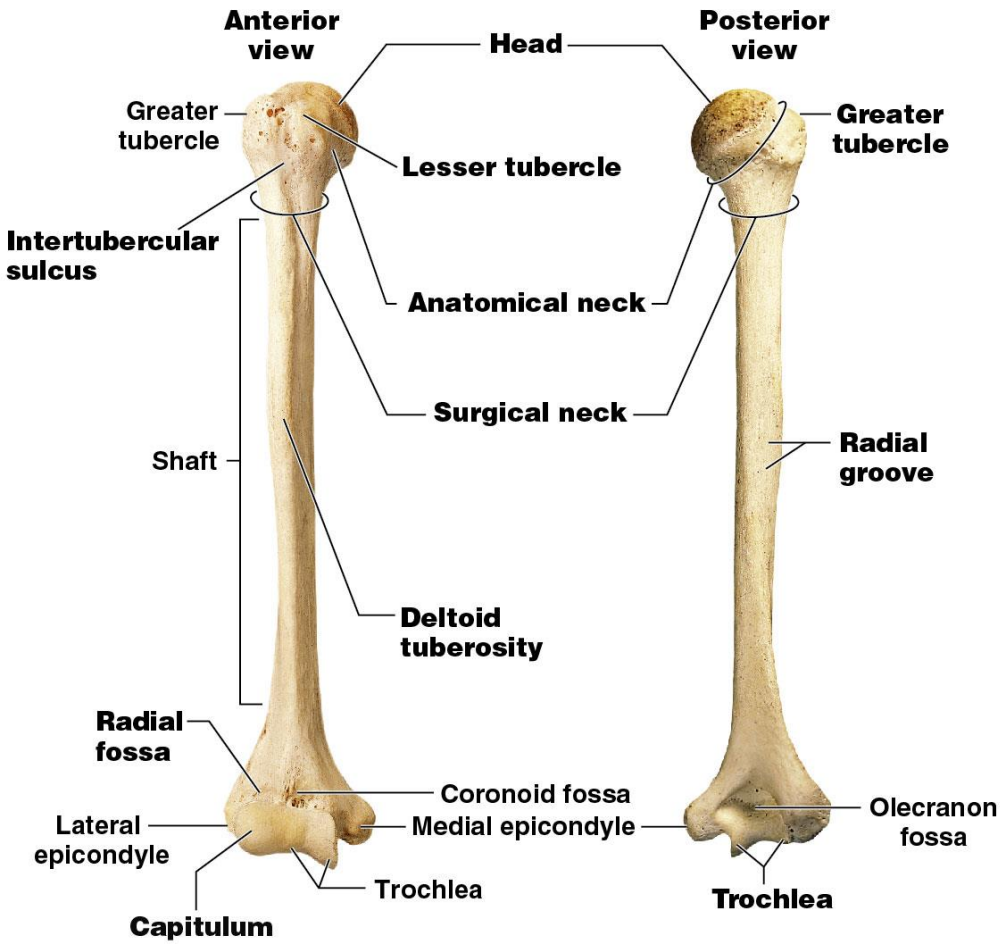
- **Greater tubercle**
  - Rounded projection on lateral epiphyseal surface
  - Establishes lateral contour of the shoulder
- **Lesser tubercle**
  - Smaller projection on anterior medial surface of the epiphysis



Module 7.17: Bones of the arm and forearm

Humerus (continued)

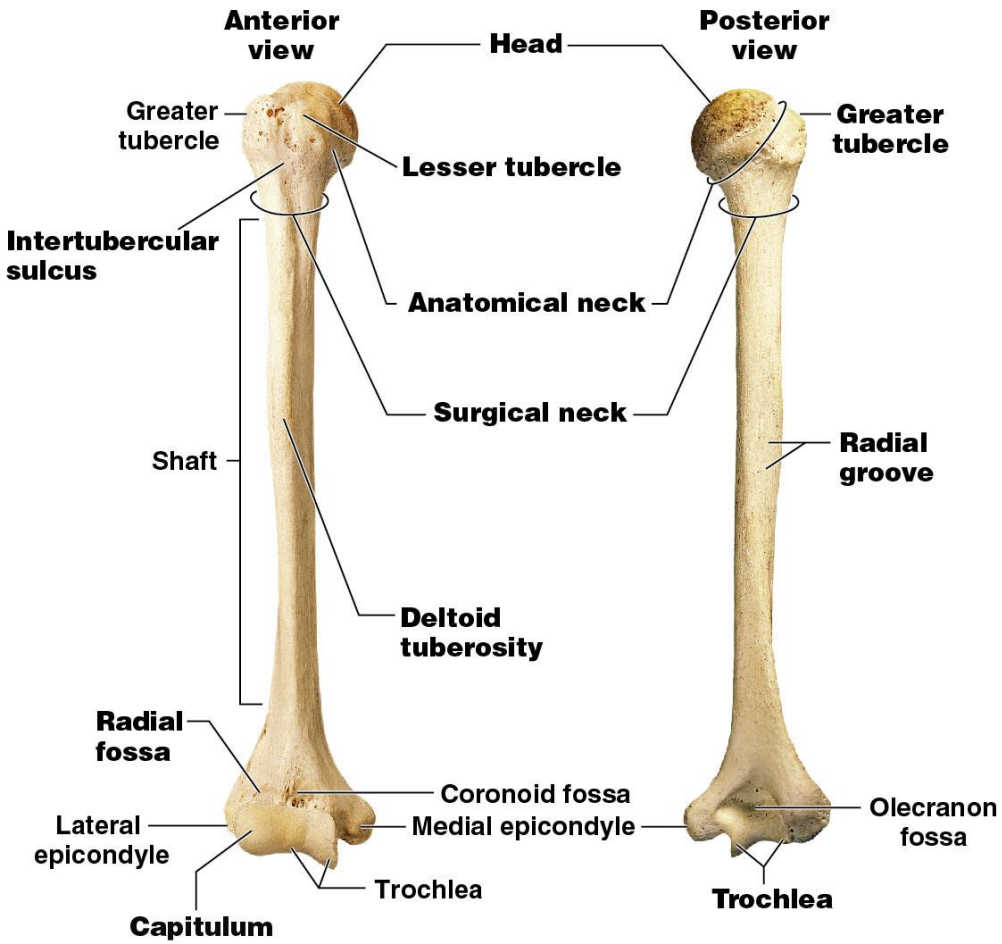
- **Intertubercular sulcus** (intertubercular groove, or bicipital groove)
  - Between the greater and lesser tubercles (both important muscle attachment sites)
  - Large tendon runs through the groove



Module 7.17: Bones of the arm and forearm

Humerus (continued)

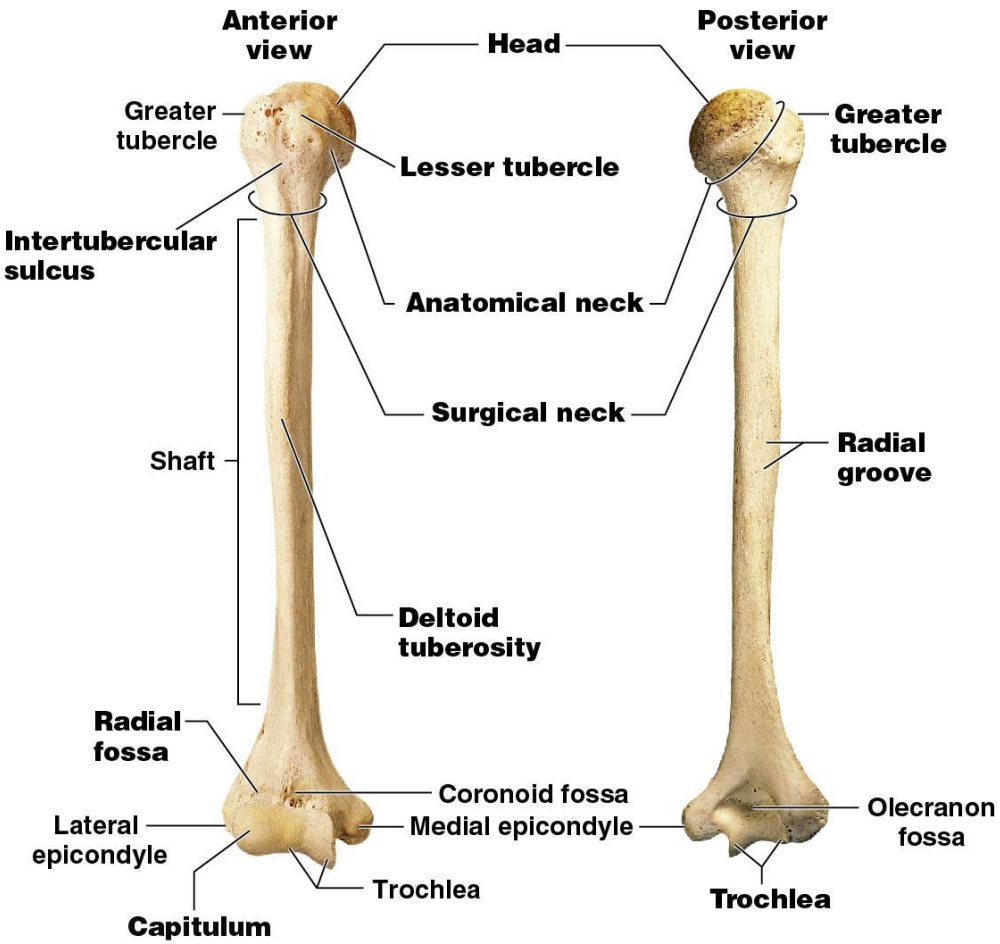
- **Deltoid tuberosity**
  - Large, rough elevation on the lateral humeral shaft
  - Attachment site for deltoid muscle



Module 7.17: Bones of the arm and forearm

Humerus (continued)

- **Radial groove**
  - Crosses inferior end of deltoid tuberosity
  - Marks path of radial nerve
- **Radial fossa**
  - Shallow depression on anterior humeral surface

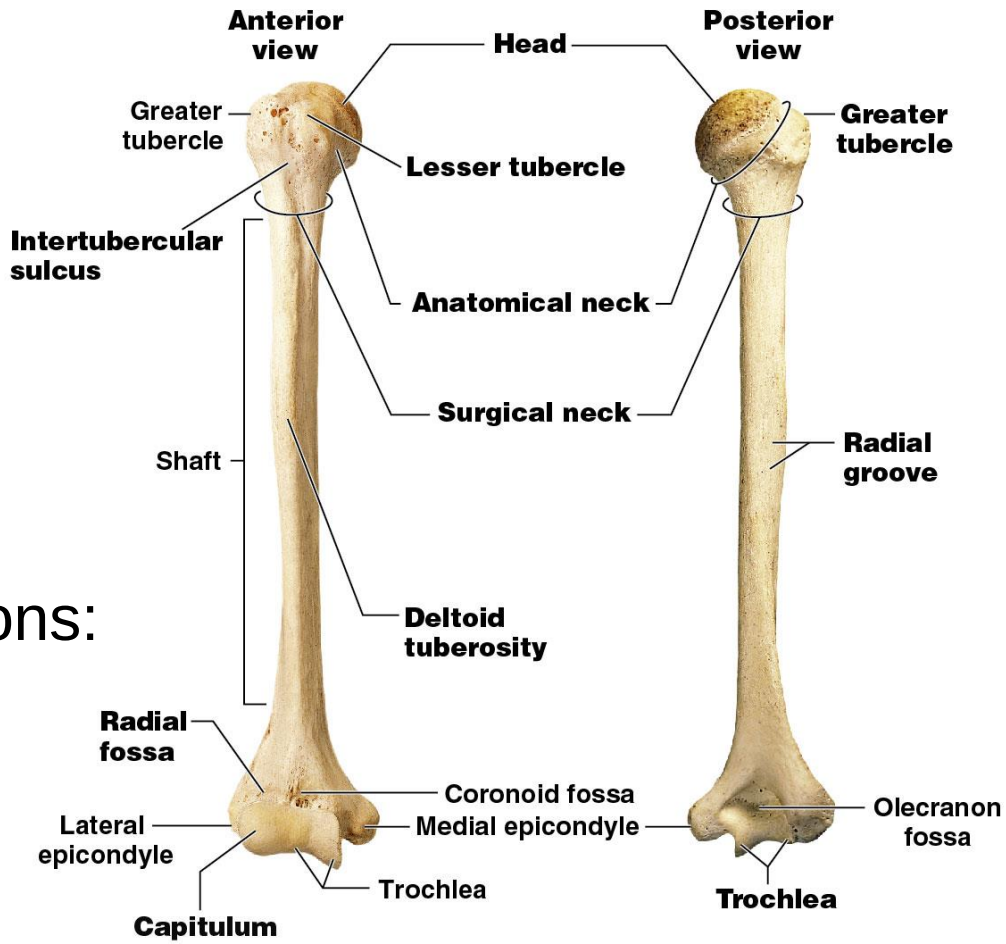


Module 7.17: Bones of the arm and forearm

Humerus (continued)

- **Condyle**
  - Site where humerus articulates with both radius (radiohumeral joint) and ulna (humero-ulnar joint)
  - Divided into two regions:

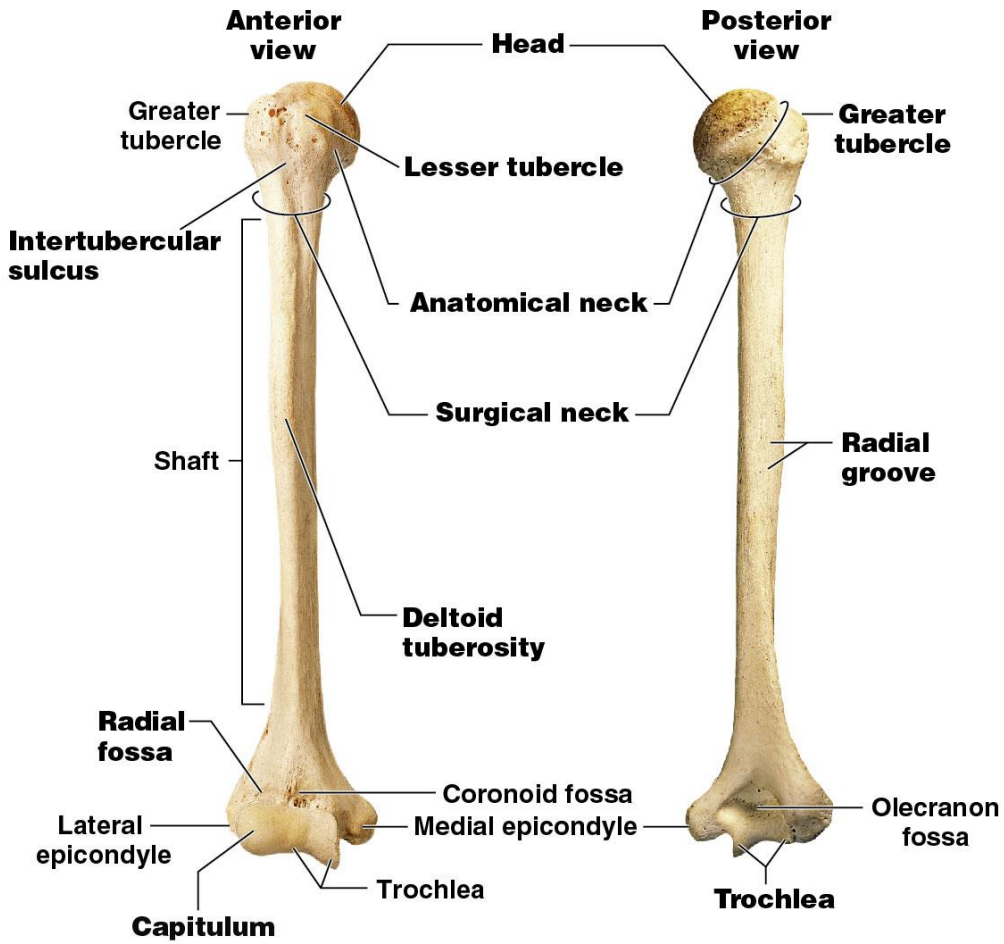
1. **Capitulum**
   - Rounded portion forming lateral surface
   - Articulates with the radius



Module 7.17: Bones of the arm and forearm

Humerus (continued)

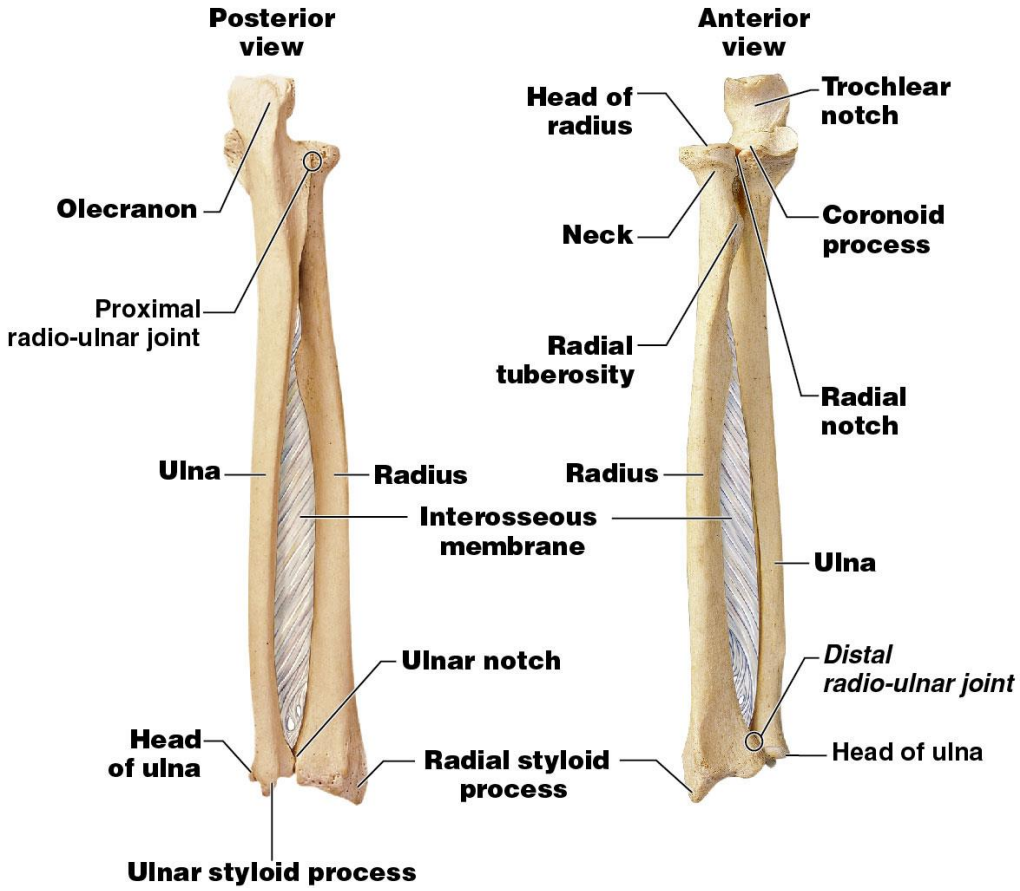
- **Condyle** (continued)
  2. **Trochlea** (*trochlea*, a pulley)
     - Forms medial surface
     - Extends from **olecranon fossa** (posterior) to **coronoid fossa** (anterior)
     - These depressions accept projections of ulna



Module 7.17: Bones of the arm and forearm

Ulna and radius

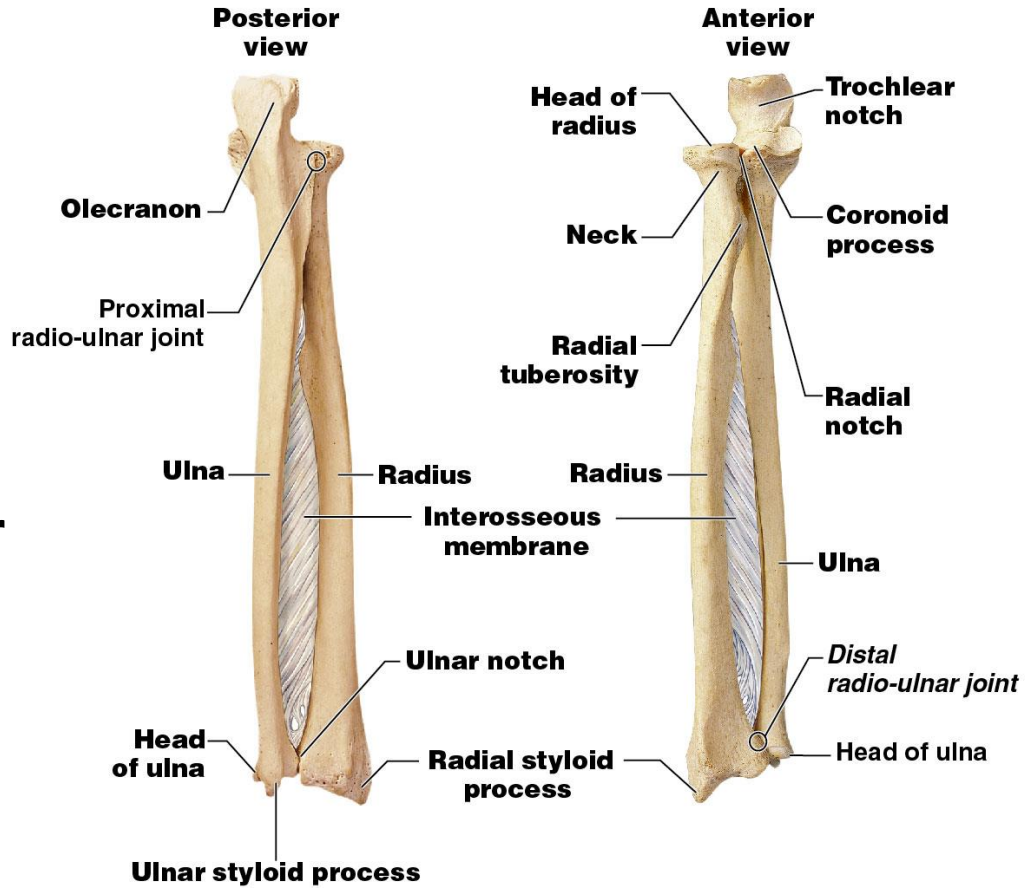
- Parallel bones that support the forearm (**antebrachium**)
- Shafts are connected by the **interosseous membrane** of the forearm



Module 7.17: Bones of the arm and forearm

Ulna and radius (continued)

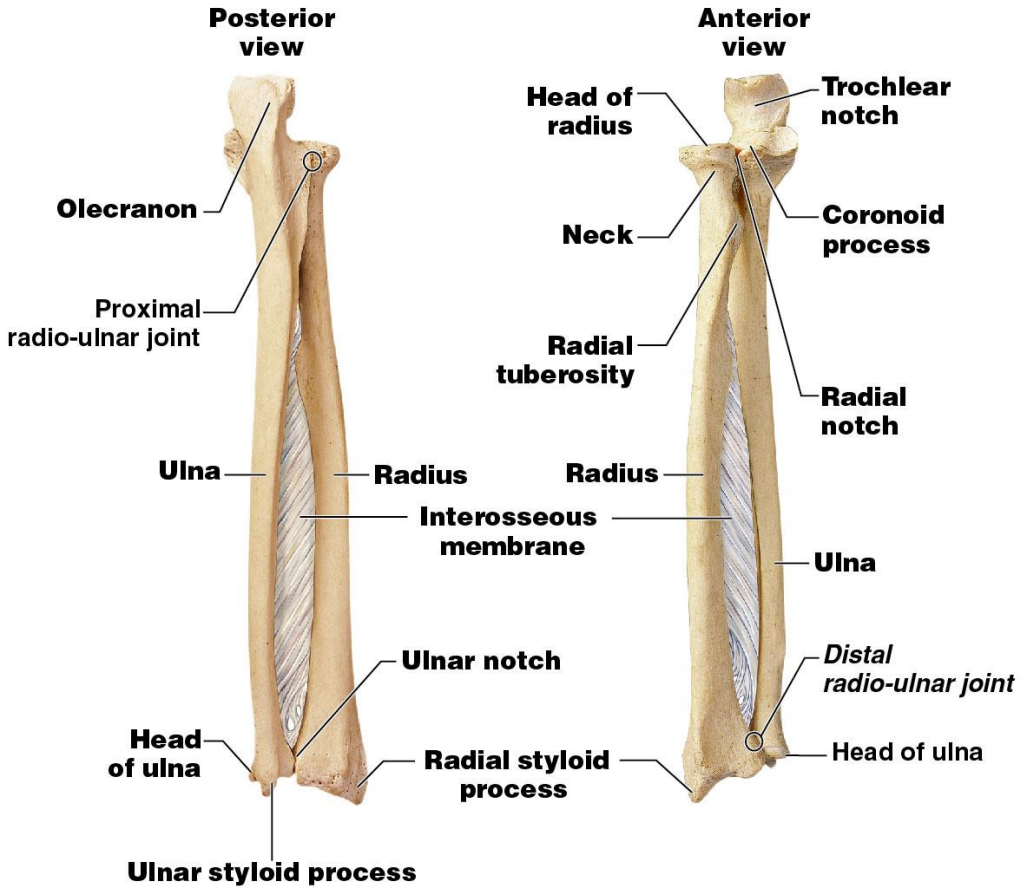
- **Proximal radio-ulnar joint**
  - **Radial notch** on ulna articulates with **radial head**
- **Distal radio-ulnar joint**
  - Lateral surface of **head of ulna** articulates with **ulnar notch** on distal end of radius



Module 7.17: Bones of the arm and forearm

Features of the ulna

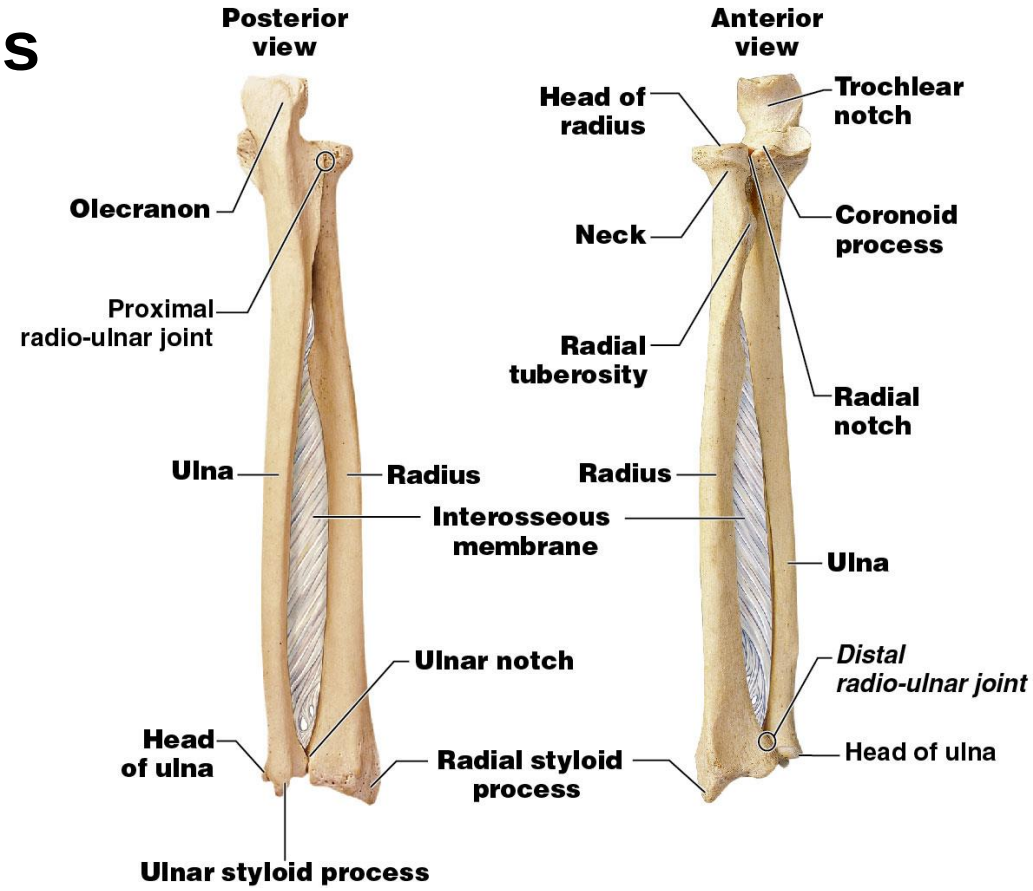
- **Olecranon**
  - Proximal end of ulna forming the point of the elbow
- **Trochlear notch**
  - Articulates with the trochlea of the humerus
- **Coronoid process**
  - Forms inferior lip of trochlear notch
  - Fits into coronoid fossa of humerus during flexion



Module 7.17: Bones of the arm and forearm

Features of the ulna (continued)

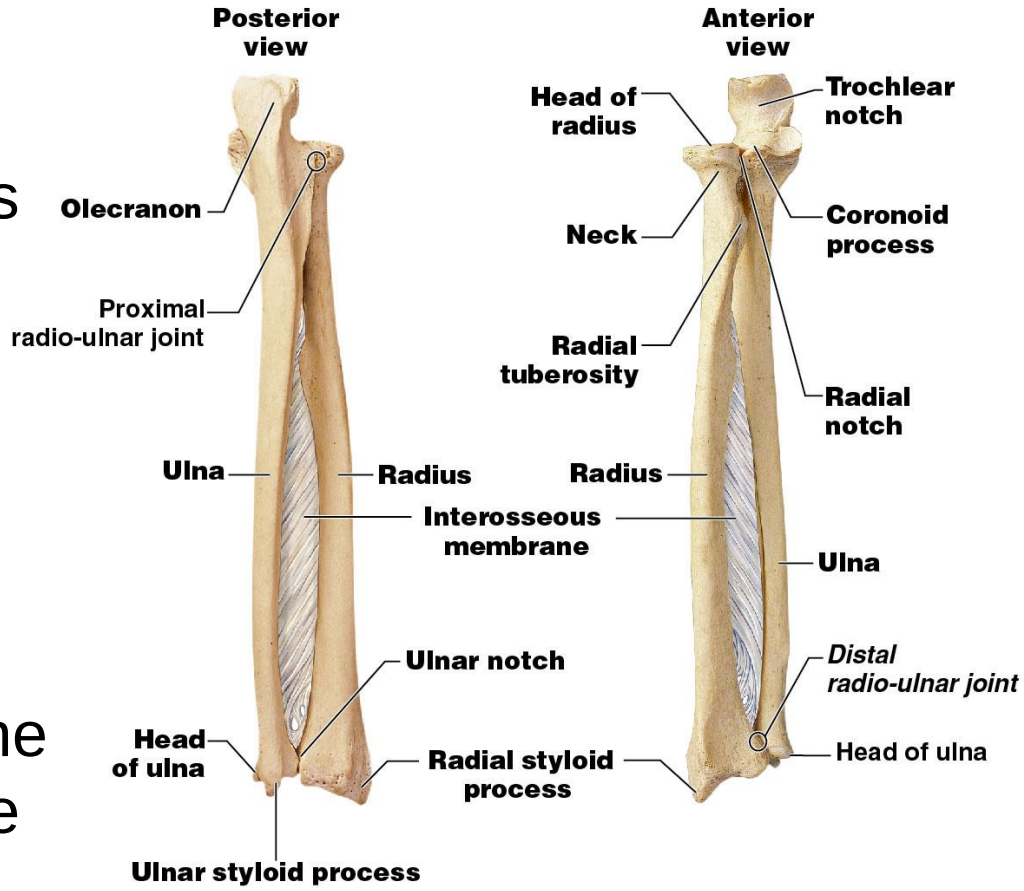
- **Head of ulna** (ulnar head)
  - Slender, rounded distal end of the ulna
- **Ulnar styloid process**
  - Pointed projection on lateral surface of ulnar head



Module 7.17: Bones of the arm and forearm

Features of the radius

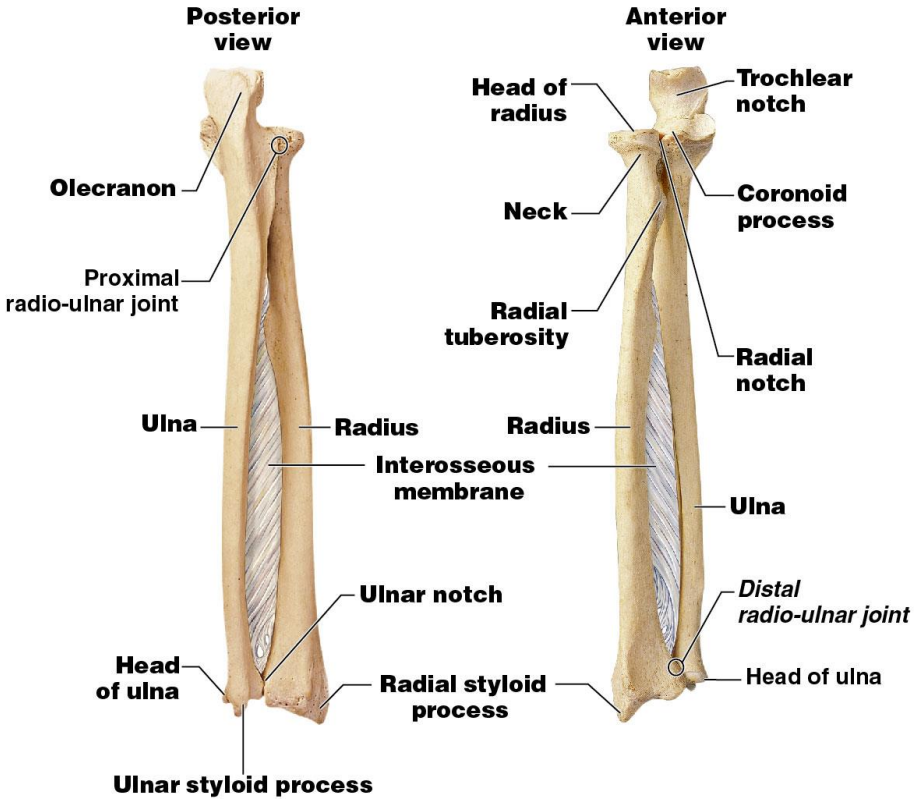
- **Radial head**
  - Disc-shaped proximal end of the radius
  - Articulates with the capitulum of humerus
- **Neck** of the radius
  - Extends from the radial head to radial tuberosity
- **Radial tuberosity**
  - Attachment site for the biceps brachii muscle



Module 7.17: Bones of the arm and forearm

Features of the radius (continued)

- **Ulnar notch** of the radius
  - Site of articulation with the head of the ulna
- **Radial styloid process**
  - Pointed projection on the distal end of the radius
  - Helps stabilize the wrist joint



Module 7.17: Review

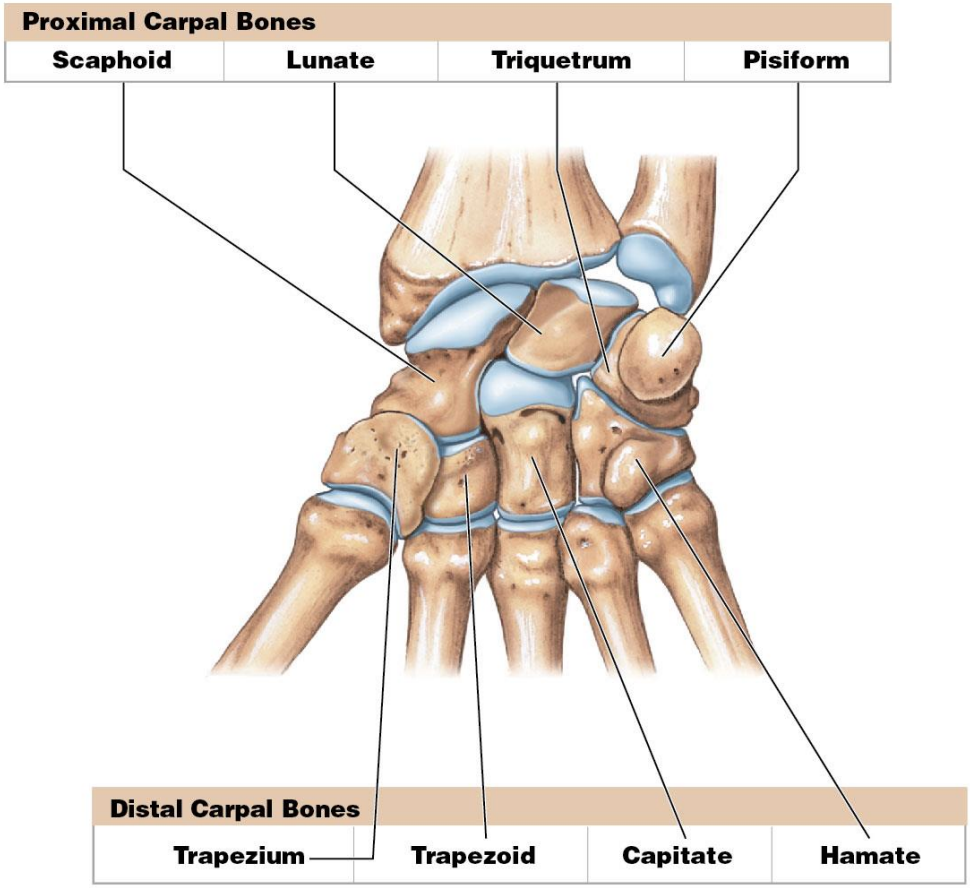
A. Identify the two rounded projections on either side of the elbow, and state to which bone they belong.
B. Which bone of the forearm is positioned laterally while in anatomical position?
C. Name four different bone markings associated with the proximal portion of the ulna.

Learning Outcome: Identify the bones of the arm and forearm, their functions, and their bone markings.

Module 7.18: The wrist consists of carpal bones …

Carpus, or wrist

- Eight **carpal bones** arranged in two rows
  - Proximal carpal bones
  1. **Scaphoid** (*skaphe,* boat)
     - Closest to styloid process of radius
  2. **Lunate** (*luna,* moon
     - Articulates with the radius

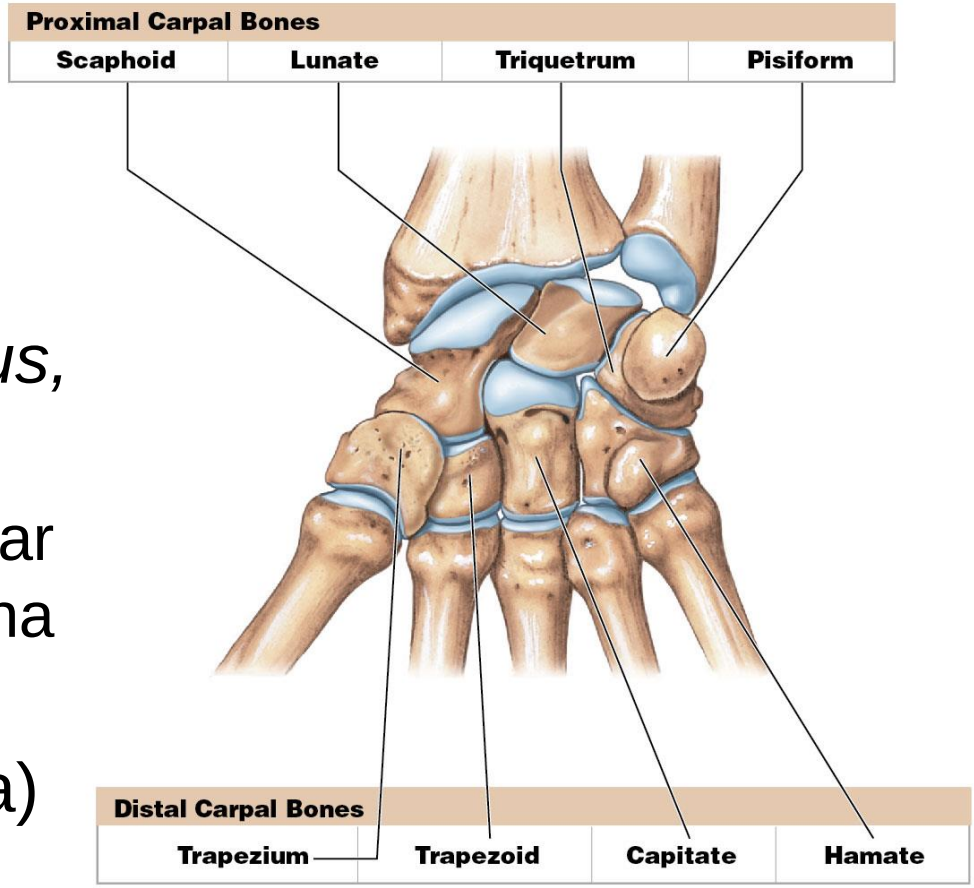


Module 7.18: Bones of the wrist

Carpus, or wrist (continued)

Proximal carpal bones (continued)

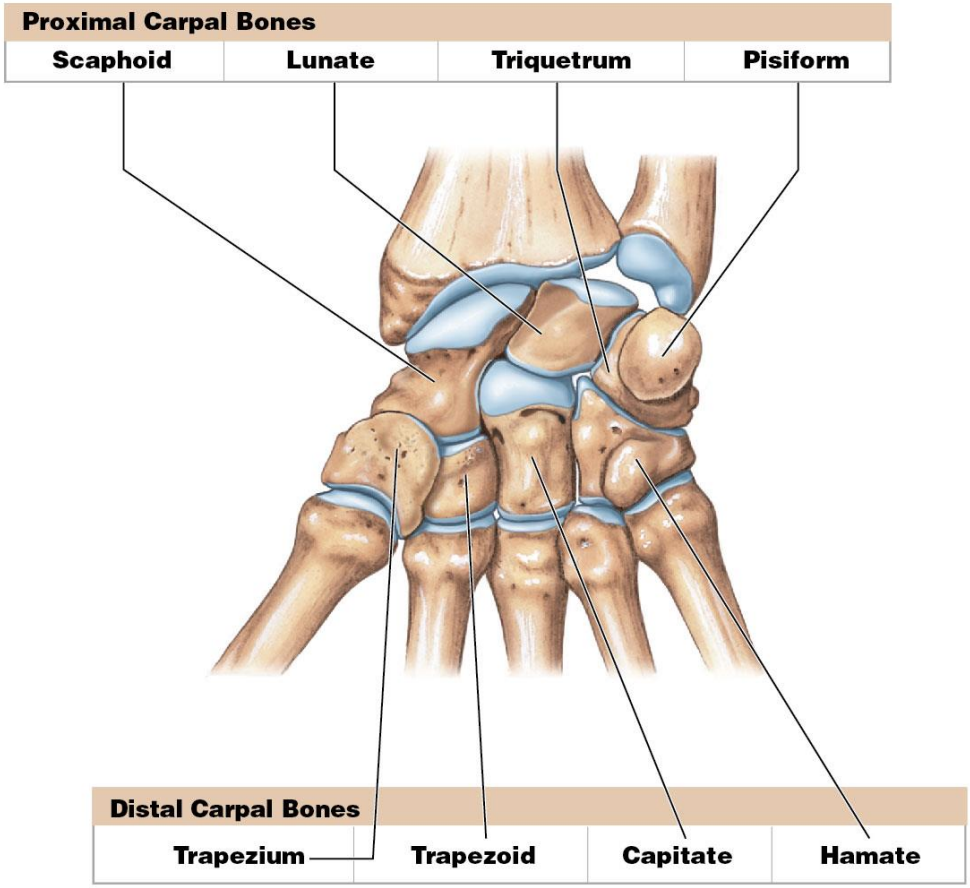
3. **Triquetrum** (*triquetrus,* three-cornered)
   - Articulates with articular disc separating the ulna from the wrist
4. **Pisiform** (*pisum,* pea)
   - Pea-shaped
   - Anterior to the triquetrum



Module 7.18: Bones of the wrist

Distal carpal bones

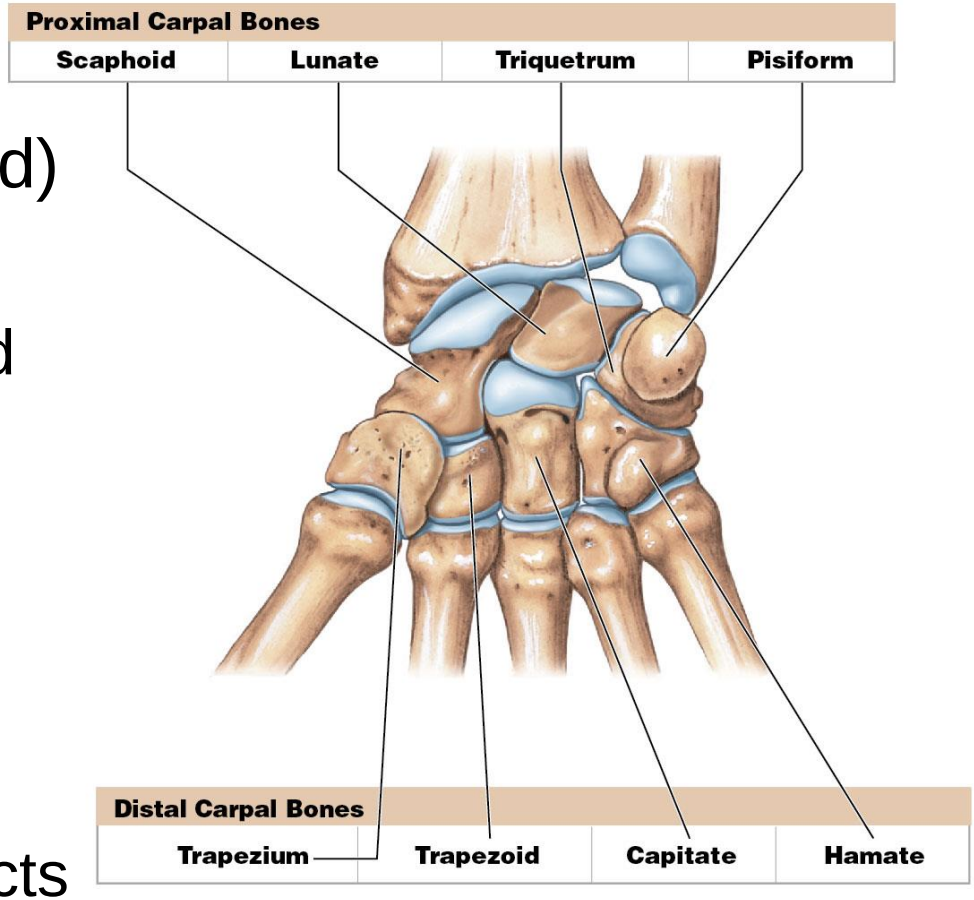
1. **Trapezium** (*trapezion*, table)
   - Proximal surface articulates with scaphoid
2. **Trapezoid**
   - Wedge-shaped bone medial to trapezium
   - Also articulates with the scaphoid



Module 7.18: Bones of the wrist

Distal carpal bones (continued)

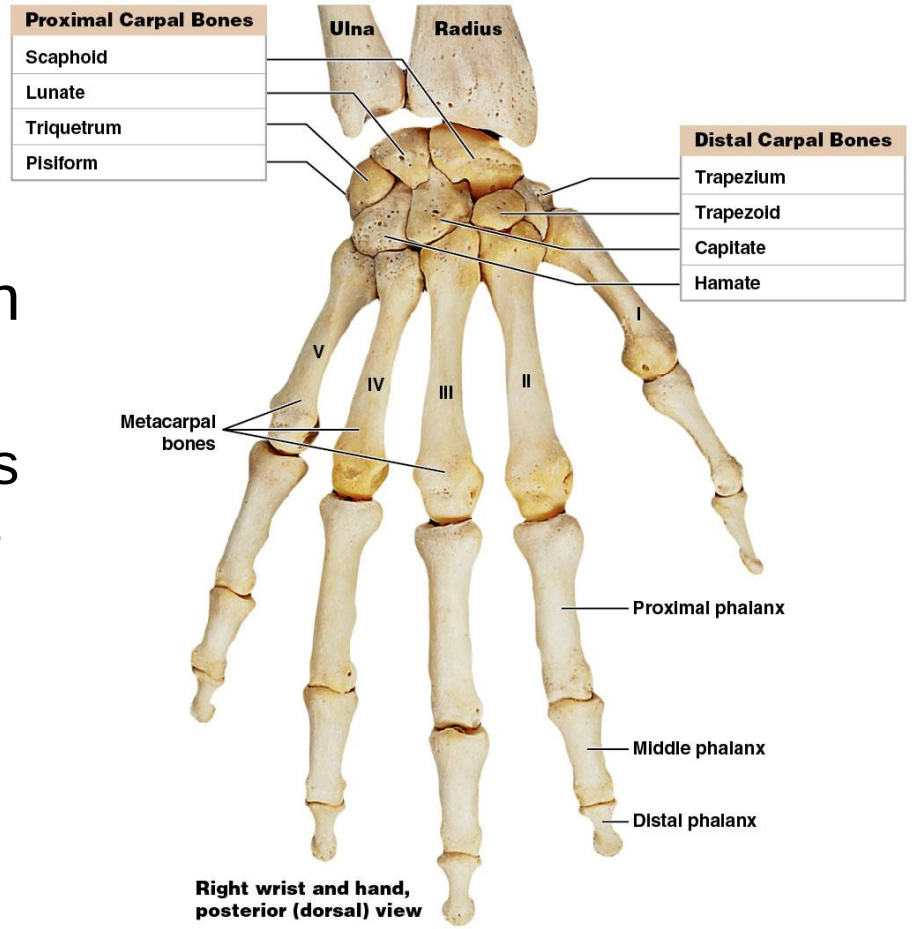
3. **Capitate** (*caput*, head)
   - Largest carpal bone
   - Between the trapezoid and hamate
4. **Hamate** (*hamatum*, hooked)
   - Medial distal carpal bone
   - Prominent hook projects anteriorly



Module 7.18: … and the hand consists of metacarpal bones and phalanges

Bones of the hand

- **Metacarpal bones**
  - Identified by Roman numerals I–V starting on the lateral side
    - Metacarpal I articulates with trapezium and the thumb

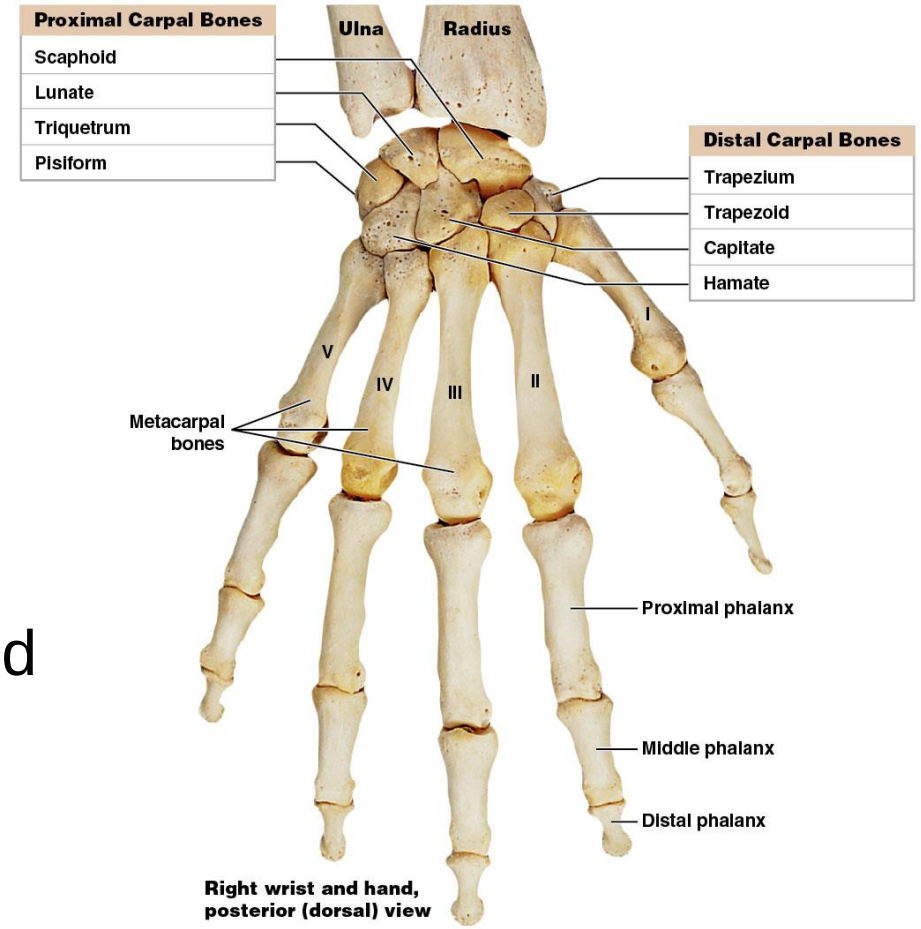


Right wrist and hand, posterior (dorsal) view

Module 7.18: Bones of the hand

Bones of the hand (continued)

- **Phalanges,** or finger bones
  - Articulate with the metacarpals
  - 14 phalanges per hand
  - **Pollex** (thumb) has two phalanges (proximal and distal)
  - All other fingers have three phalanges (proximal, middle, and distal)



Video: The Hand

Module 7.18: Review

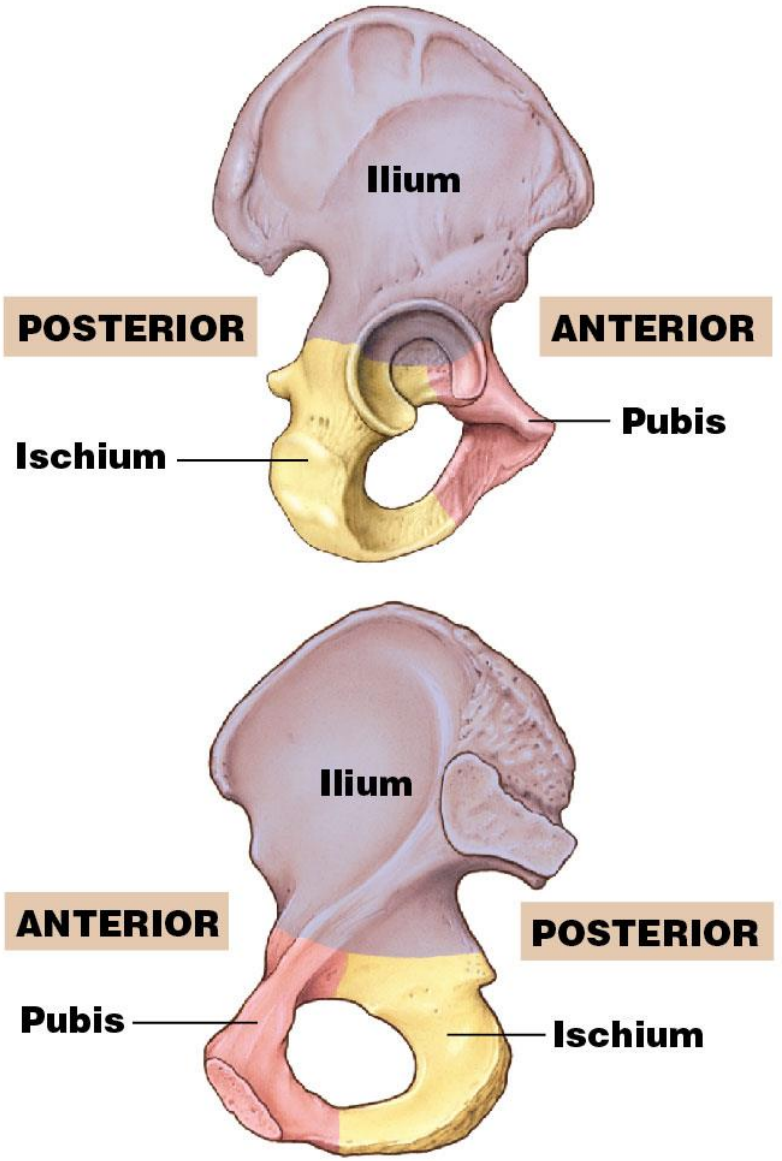
A. Name the carpal bones.
B. Define *phalanges*.
C. Bill accidentally fractures his first distal phalanx with a hammer. Which finger is broken?

Learning Outcome: Identify the bones of the wrist and hand, and describe their locations using anatomical terminology.

Module 7.19: The hip bone forms by the fusion of the ilium, ischium, and pubis

Pelvic girdle

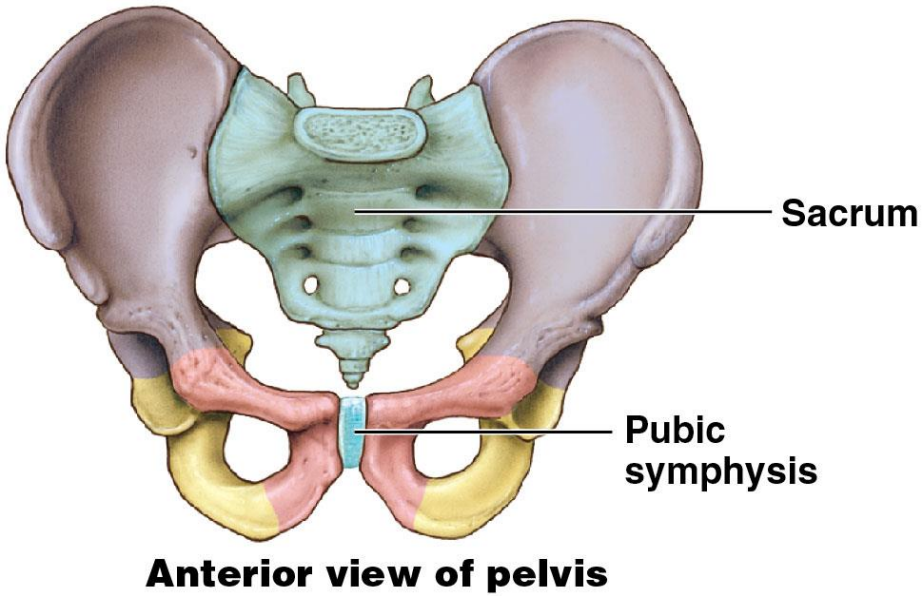
- Composed of two **hip bones,** also called **coxal bones** or innominate (“no-name”) bones
  - Each hip bone is formed by the fusion of three bones
    1. **Ilium**
    2. **Ischium**
    3. **Pubis**



Module 7.19: The hip bone

Pelvic girdle (continued)

- **Pubic symphysis**
  - Fibrocartilage pad connecting the right and left pubic bones

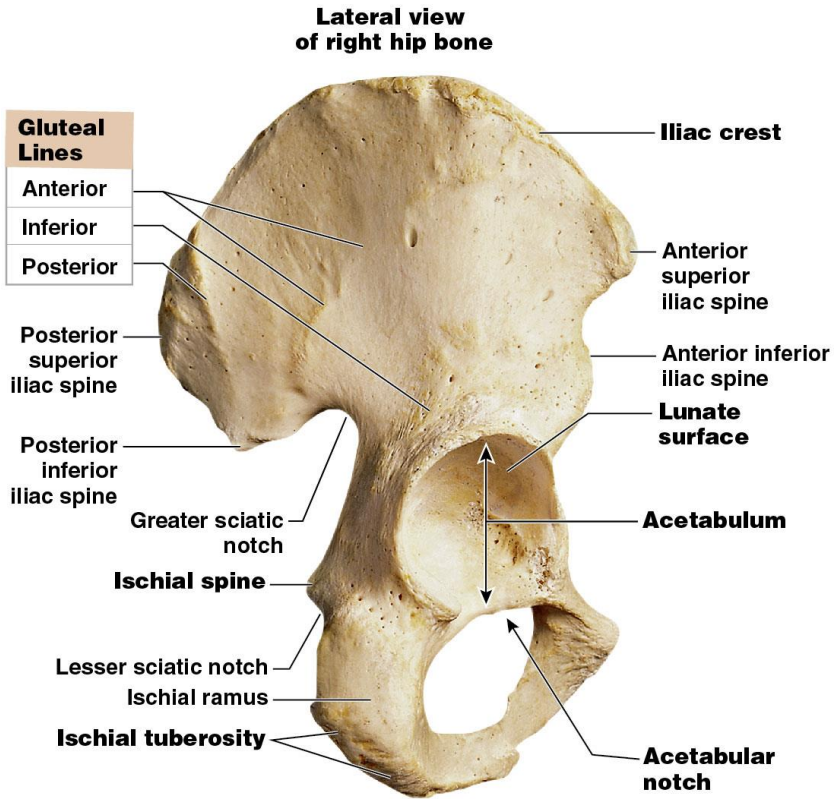


Anterior view of pelvis

Module 7.19: The hip bone

Features seen in a lateral view

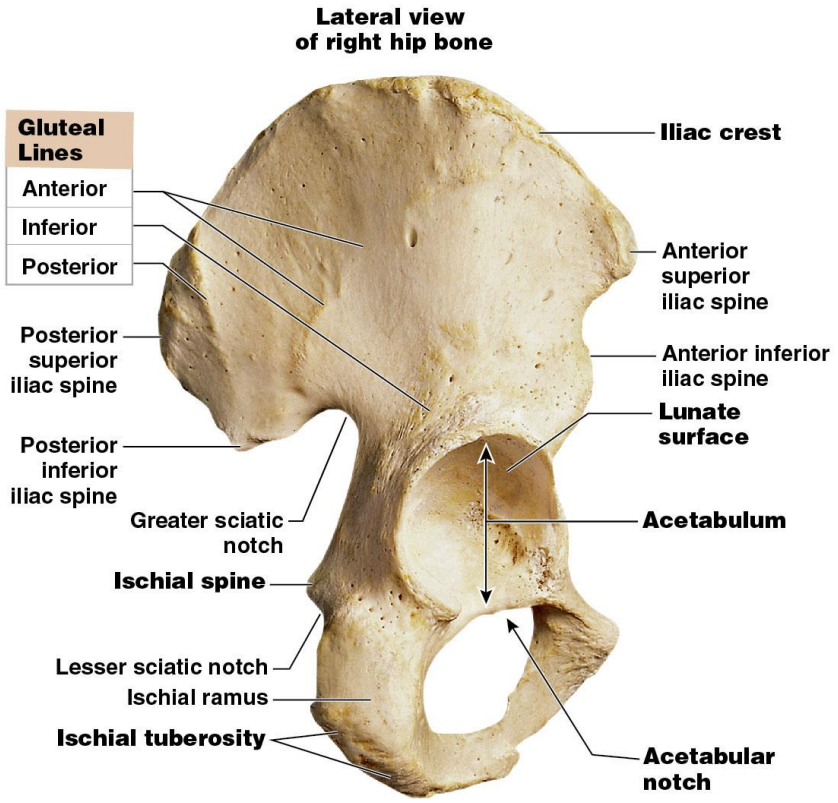
- **Iliac spines** (posterior superior, posterior inferior, anterior superior, and anterior inferior)
  - Attachment sites for important muscles and ligaments
- **Gluteal lines** (anterior and posterior)
  - Attachment site for large hip muscles



Module 7.19: The hip bone

Features seen in a lateral view (continued)

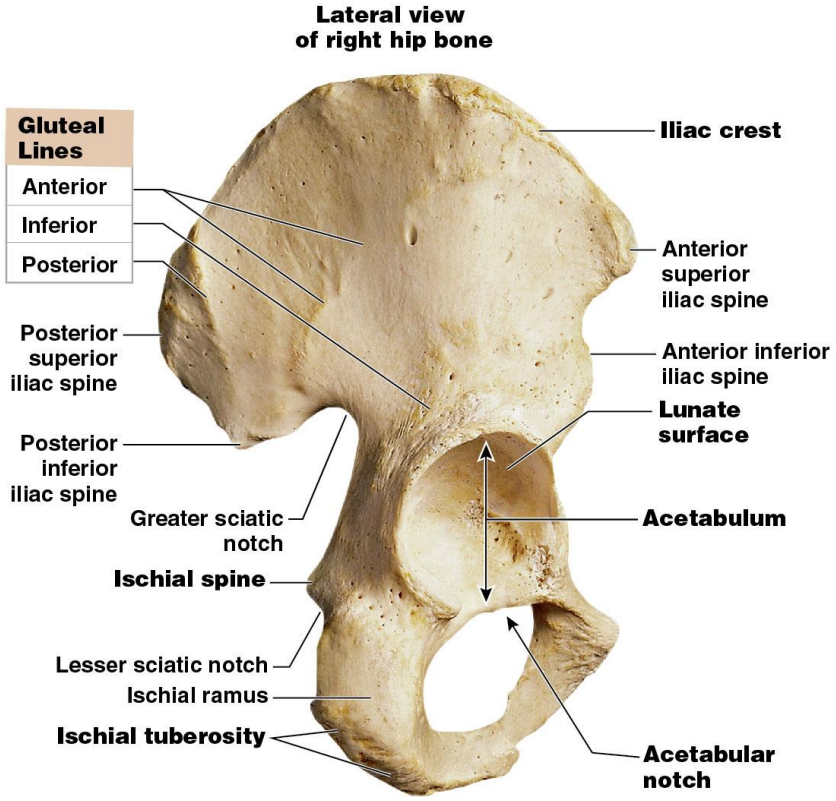
- **Greater sciatic notch**
  - Passage of sciatic nerve to lower limb
- **Iliac crest**
  - Important ridge for muscle attachment



Module 7.19: The hip bone

Features seen in a lateral view (continued)

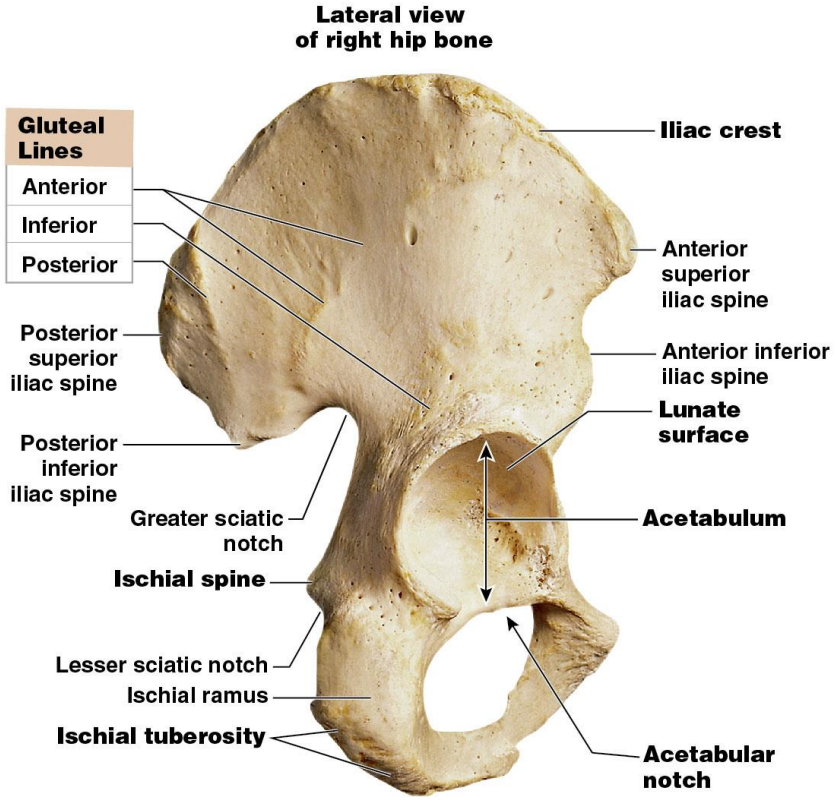
- **Ischial spine**
  - Projects superior to lesser sciatic notch
  - Marks passage of blood vessels, nerves, and small muscle
- **Ischial tuberosity**
  - Roughened projection
  - Bears body weight when seated



Module 7.19: The hip bone

Features seen in a lateral view (continued)

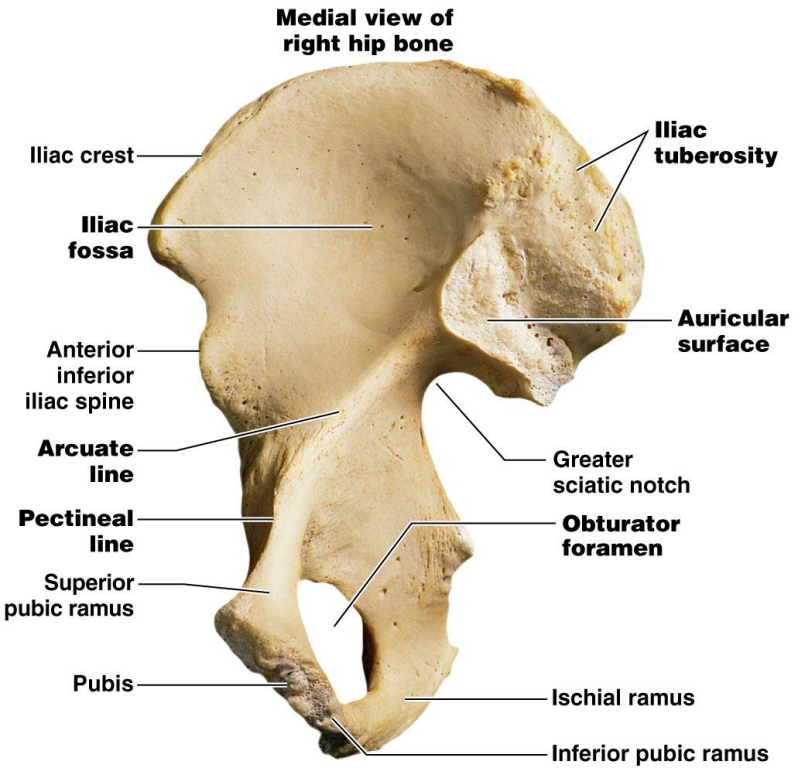
- **Acetabulum** (*acetabulum*, vinegar cup)
  - Concave socket formed by all three fused bones
  - Articulates with head of femur
  - Smooth, cup-shaped surface (**lunate surface**)
  - Gap in inferior portion of bony rim (**acetabular notch**)



Module 7.19: The hip bone

Features seen in a medial view

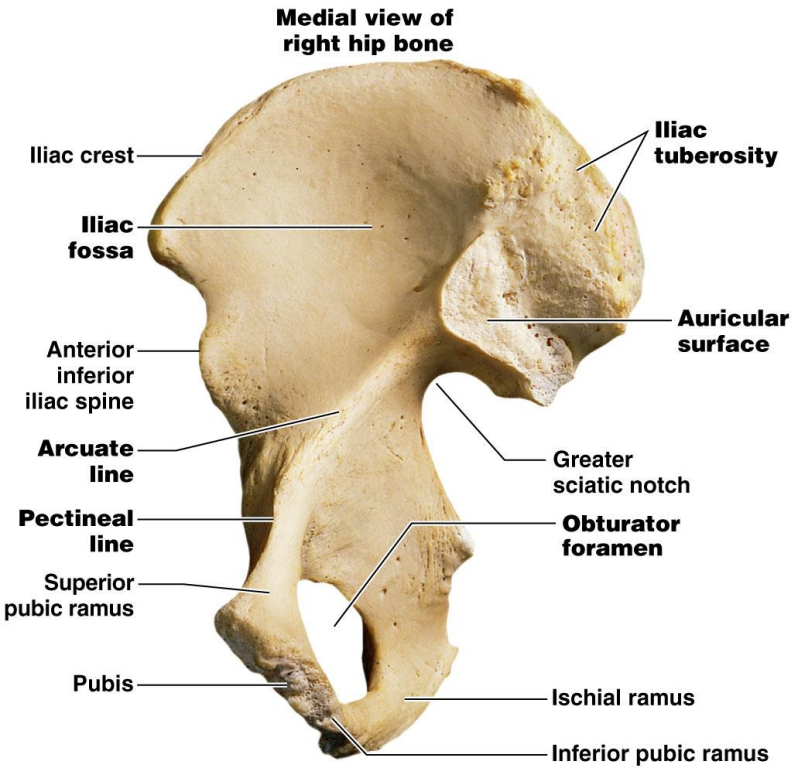
- **Iliac fossa**
  - Shallow depression
  - Helps support abdominal organs
  - Provides area for muscle attachment
- **Pectineal line**
  - Ridge that ends in **pubic tubercle** (small, elevated area anterior and lateral to the pubic symphysis)



Module 7.19: The hip bone

Features seen in a medial view (continued)

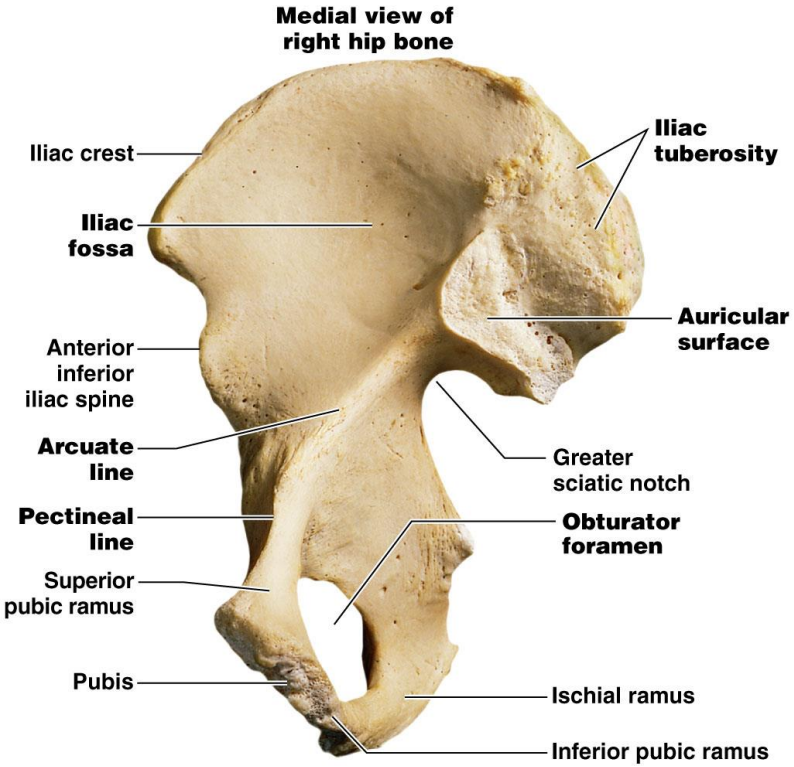
- **Arcuate line of the ilium**
  - Continuous with the pectineal line of the pubis
  - **Auricular surface** of the ilium
    - Articulates with auricular surface of the sacrum at the sacro-iliac joint



Module 7.19: The hip bone

Features seen in a medial view (continued)

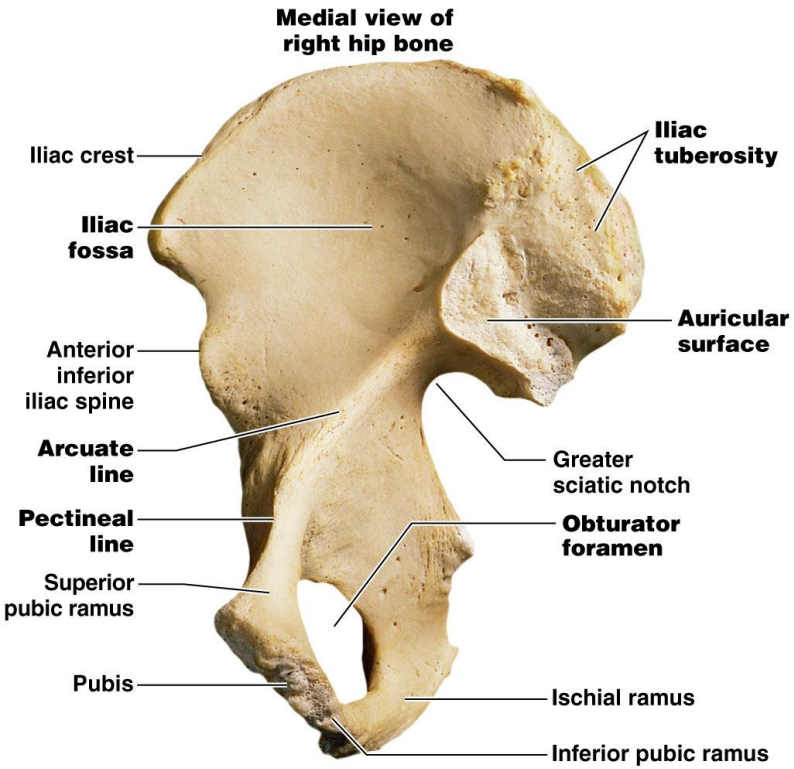
- **Iliac tuberosity**
  - Roughened area superior to the auricular surface
  - Ligaments from here stabilize sacro-iliac joint



Module 7.19: The hip bone

Features seen in a medial view (continued)

- **Obturator foramen**
  - Space that is closed by sheet of collagen fibers
  - Inner and outer surfaces provide base for muscle attachment
  - Bounded by the **ischial ramus**, **inferior pubic ramus**, and **superior pubic ramus**



Video: Hip Bone

Module 7.19: Review

A. Which three bones fuse to make up a hip bone?
B. Describe the acetabulum.
C. When you are seated, which part of the hip bone bears your body's weight?
D. Which bones articulate at the sacro-iliac joint?

Learning Outcome: Describe the hip bones that form the pelvic girdle, their functions, and their bone markings.

Module 7.20: The pelvis consists of the two hip bones, the sacrum, and the coccyx

Pelvis

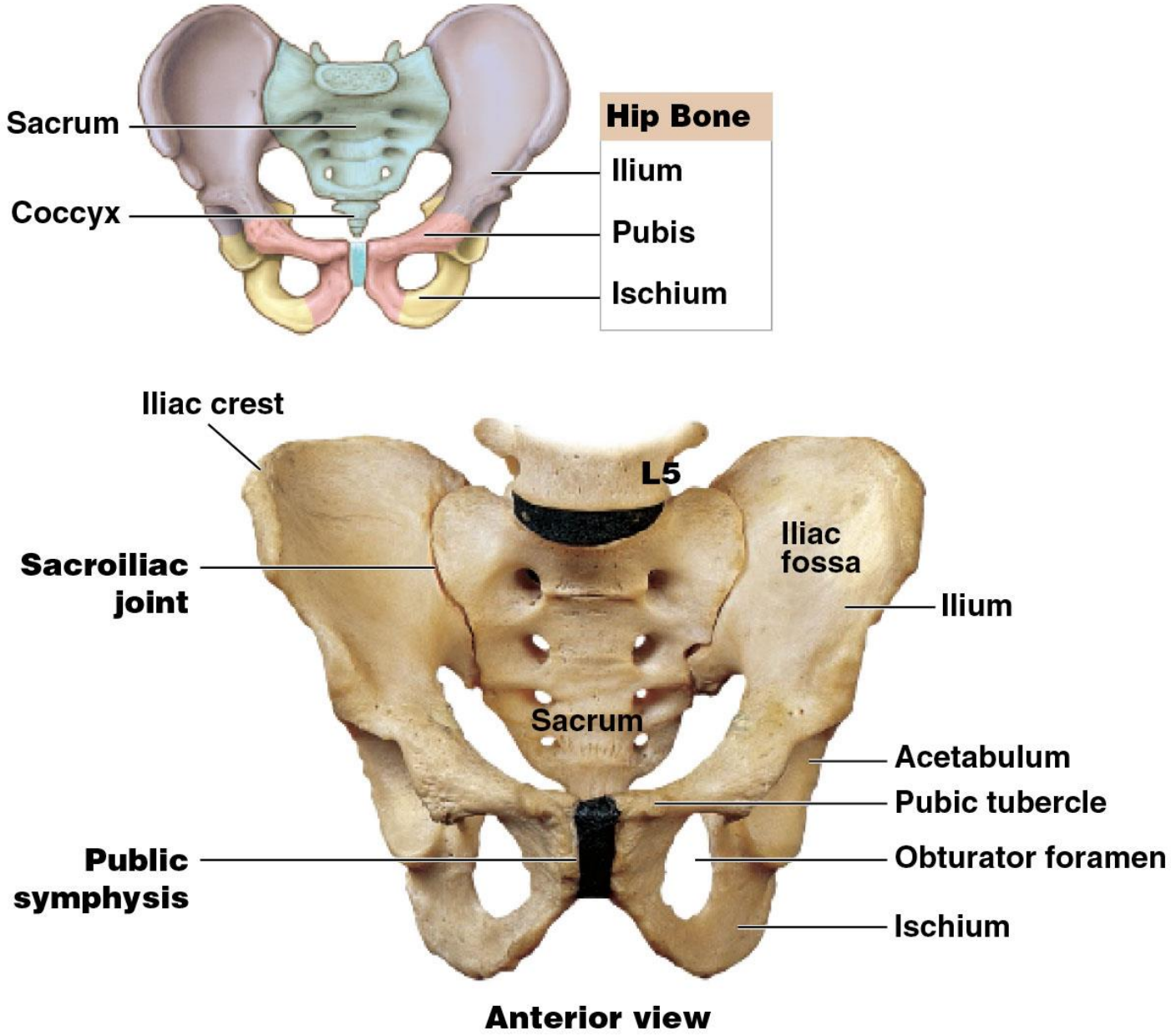
- Contains bones of the:
  - Axial skeleton (sacrum and coccyx)
  - Appendicular skeleton (hip bones)
- Extensive network of ligaments connect sacrum with:
  - Iliac crest
  - Ischial tuberosity
  - Ischial spine
  - Arcuate line

Module 7.20: The pelvis consists of the two hip bones, the sacrum, and the coccyx

Pelvis (continued)

- Other ligaments connect the ilia to the lumbar vertebrae
- **Sacro-iliac joint**
  - Articulation between sacrum and adjacent ilium

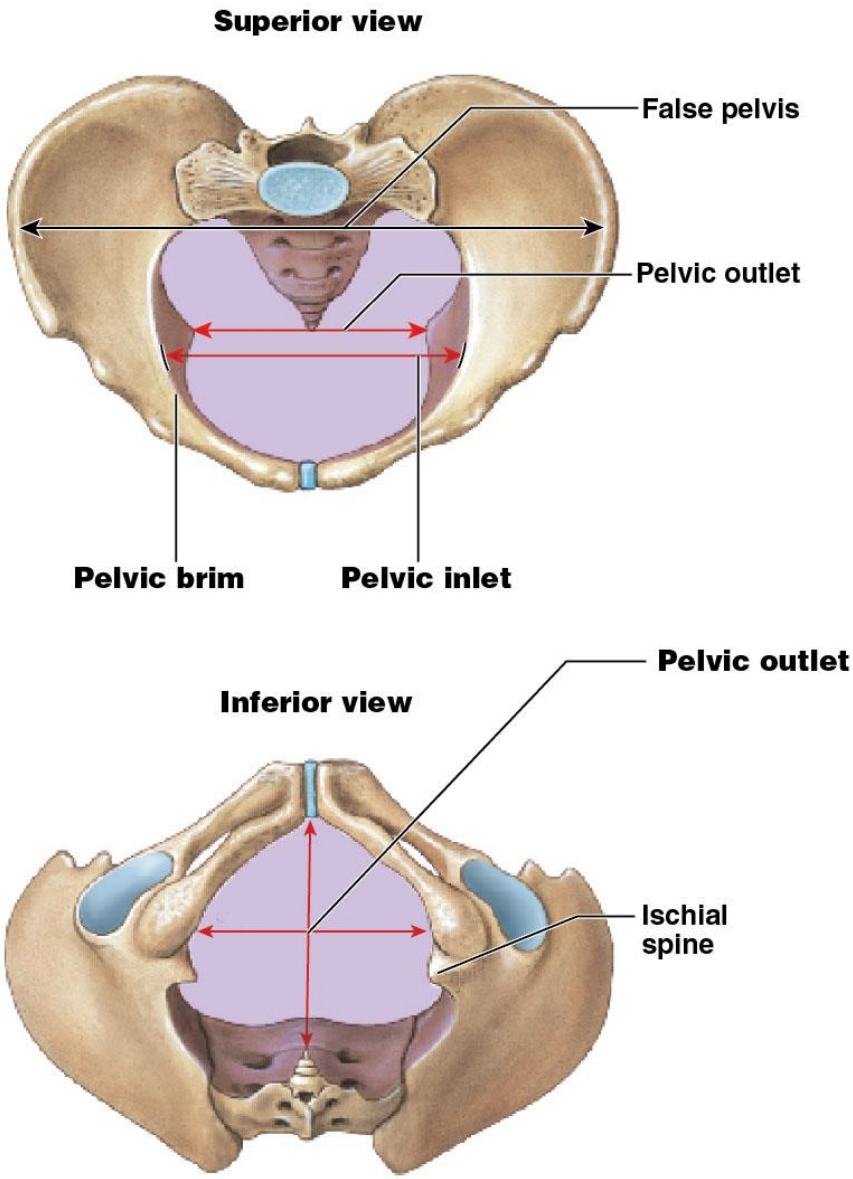
The pelvis



Module 7.20: The pelvis

Divisions of the pelvis

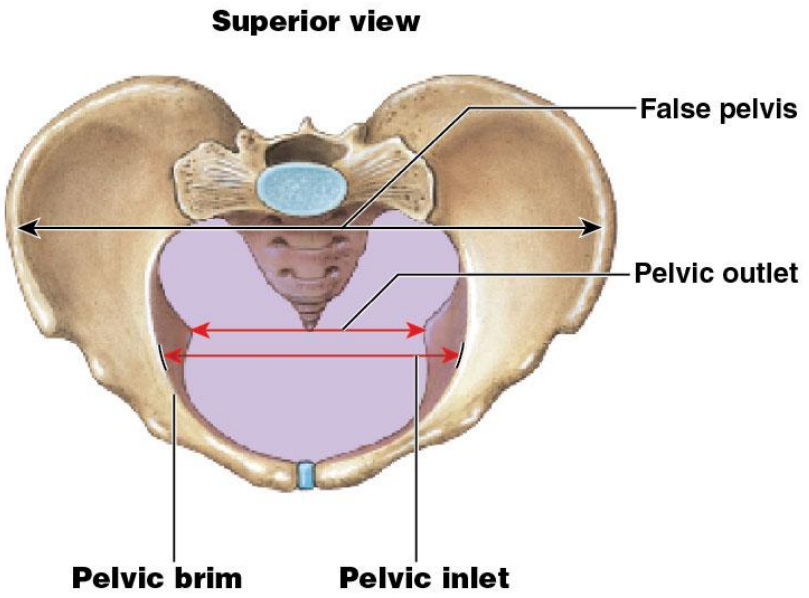
1. **True** (lesser) **pelvis**
   - Encloses the pelvic cavity
   - Superior limit is called **pelvic brim**
     - Encloses an opening called the **pelvic inlet**
   - **Pelvic outlet**
     - Opening bounded by coccyx, ischial tuberosities, ischial spines, and inferior pubic symphysis

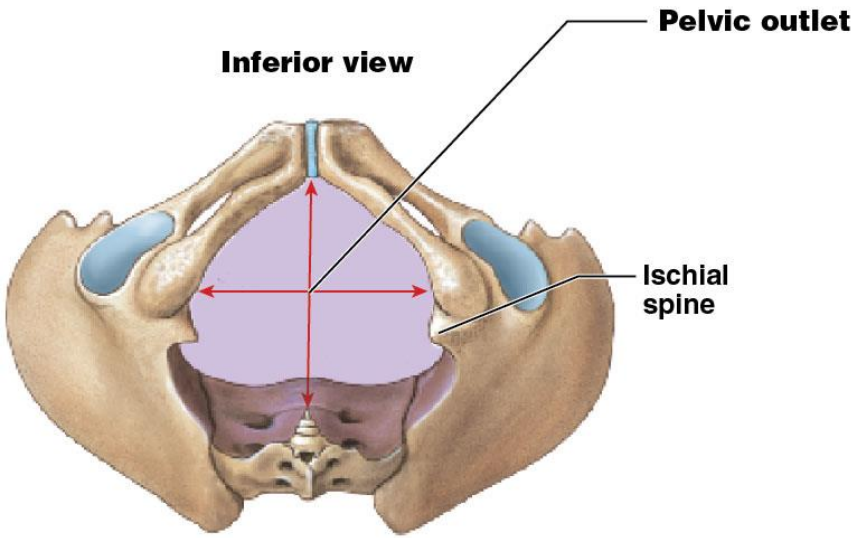


Module 7.20: The pelvis

Divisions of the pelvis (continued)

2. **False** (greater) **pelvis**
   - Consists of area enclosed by bladelike portions of ilia superior to pelvic brim





Module 7.20: Review

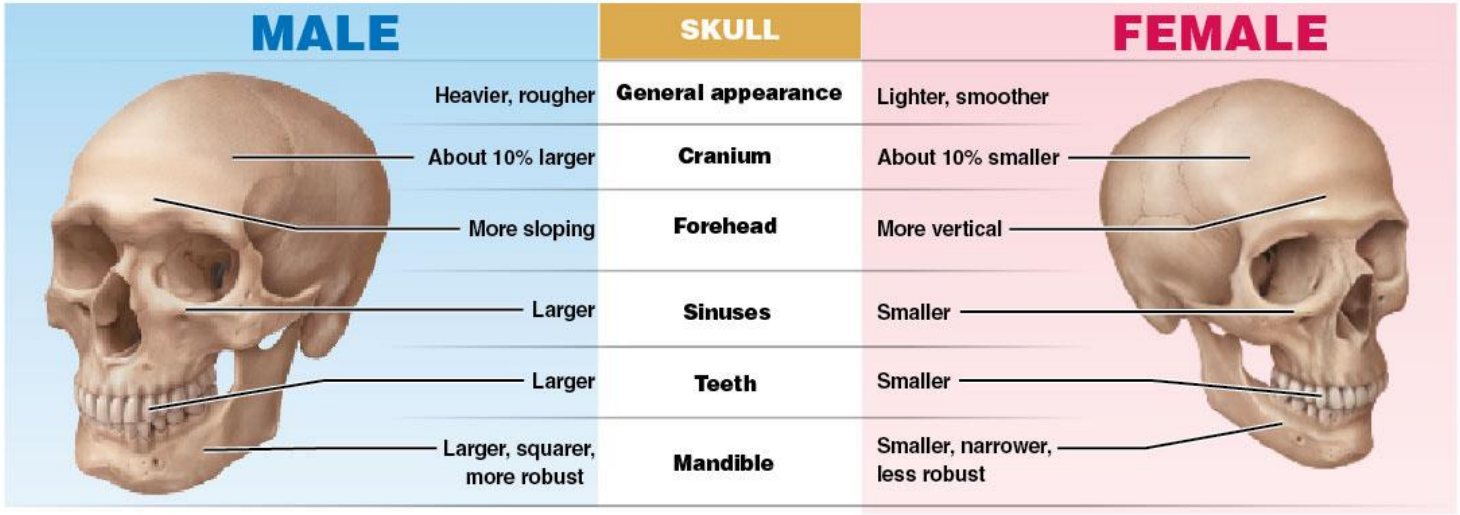
A. Name the bones of the pelvis.
B. The pubic bones are joined anteriorly by what structure?

Learning Outcome: Identify the bones of the pelvis.

Module 7.21: The adult male and female skeletons have significant differences

Female skull compared to male skull

- Female skull 10% smaller; lighter and smoother
- Female forehead more vertical
- Female sinuses, teeth, and mandible smaller

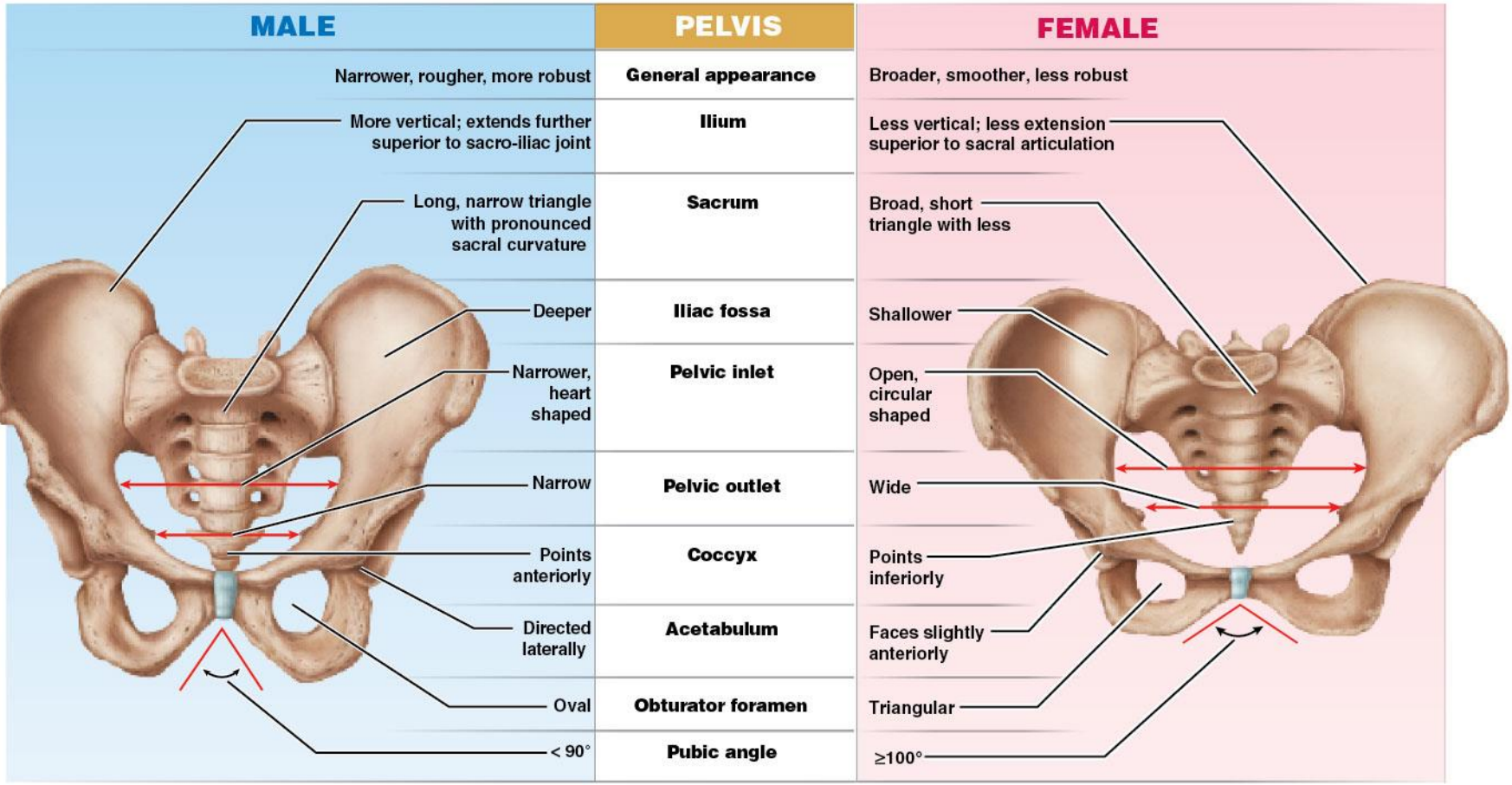


Module 7.21: The male and female skeletons

Female pelvis compared to male pelvis

- Differences due to variations in body size and muscle mass
- Female pelvis is smaller, lighter, and with less prominent markings
- Adaptations for childbearing
  - Enlarged pelvic outlet
  - Broader pubic angle (greater than 100º)
  - Less curvature on sacrum and coccyx
  - Wider, more circular pelvic inlet
  - Broad, shallow pelvis
    - Ilia project farther laterally but not as far superiorly

Module 7.21: The male and female skeletons



Module 7.21: Review

A. How does the female skull differ from the male skull?

Learning Outcome: Discuss the differences between the male and female skeletons.

Module 7.22: The femur, tibia, and patella meet at the knee

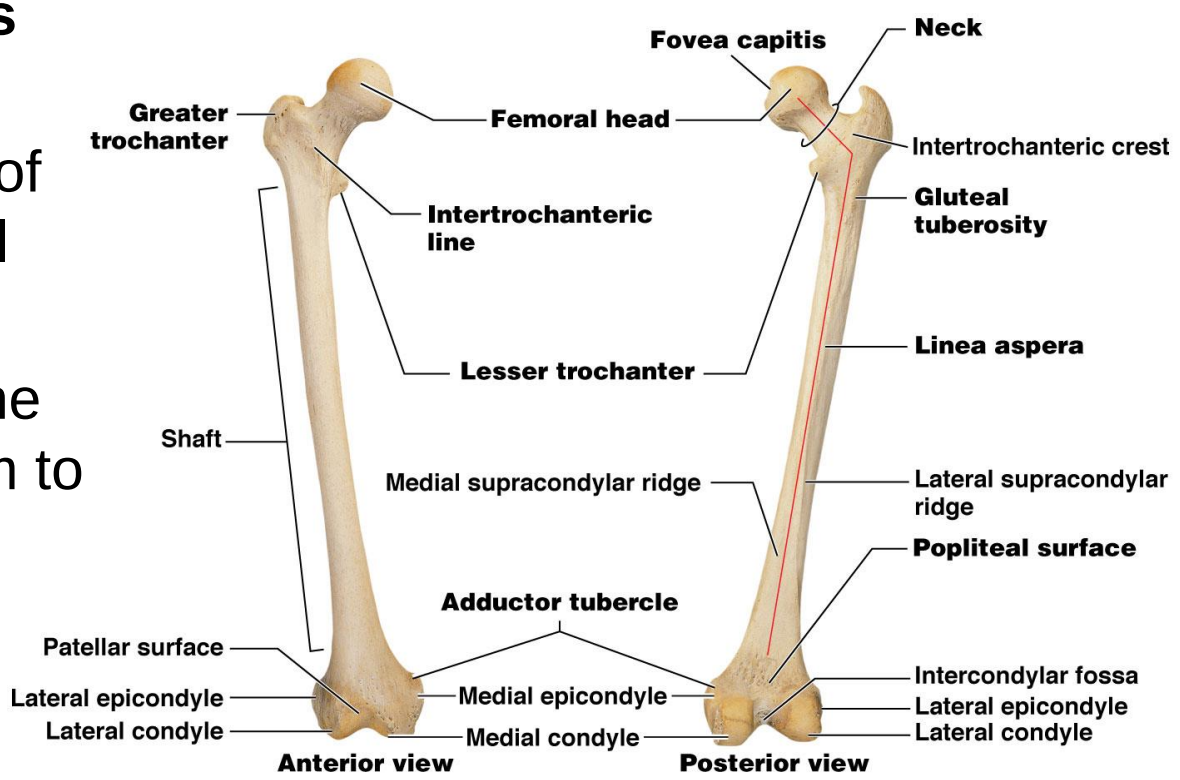
Lower limb

- Transfers the body weight to the ground
- Consists of bones of the:
  - Thigh (proximal portion of the limb)
    - **Femur**
  - Leg (distal portion of the limb)
    - **Tibia** and **fibula**
    - Connected by the **interosseous membrane**
      - Kneecap–**patella**
      - Ankle–**tarsals**
      - Foot–**metatarsals** and **phalanges**

Module 7.22: Bones of the lower limb

Femur

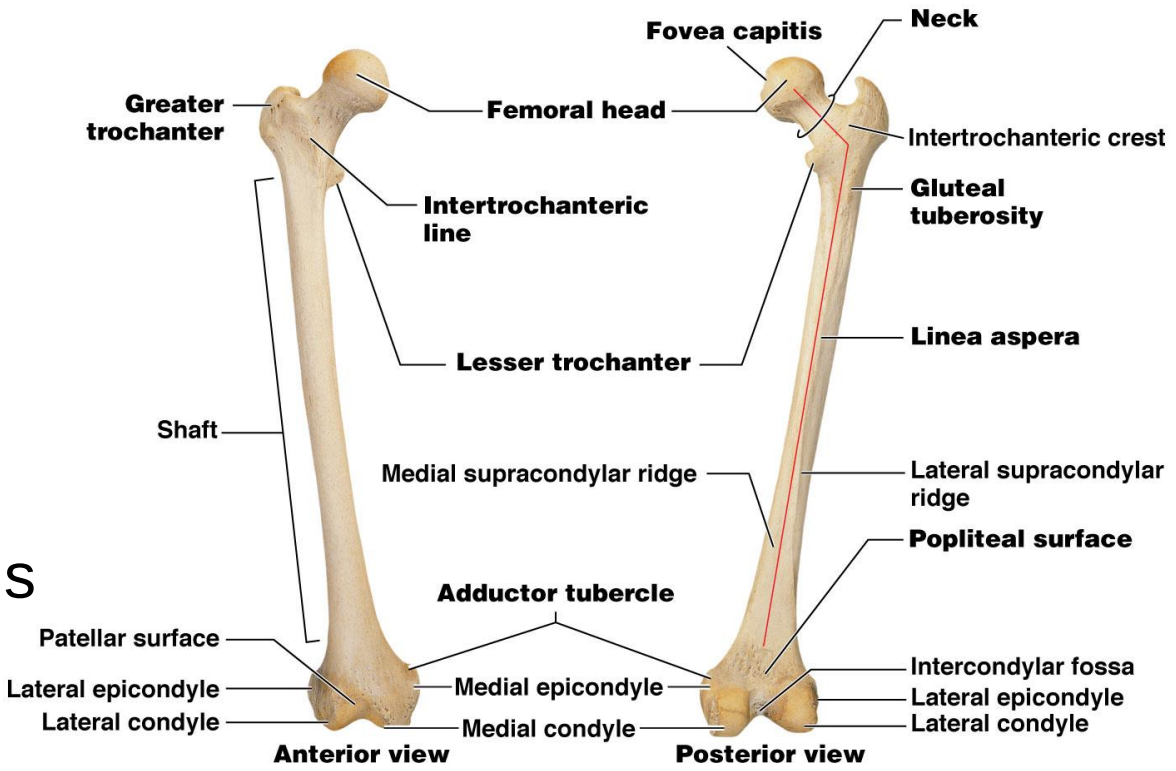
- Longest and heaviest bone in the body
  - **Femoral head**
    - Articulates with the pelvis at the acetabulum
    - **Fovea capitis**
      - Small pit in the center of the femoral head
      - Attaches the acetabulum to the femur



Module 7.22: Bones of the lower limb

Femur (continued)

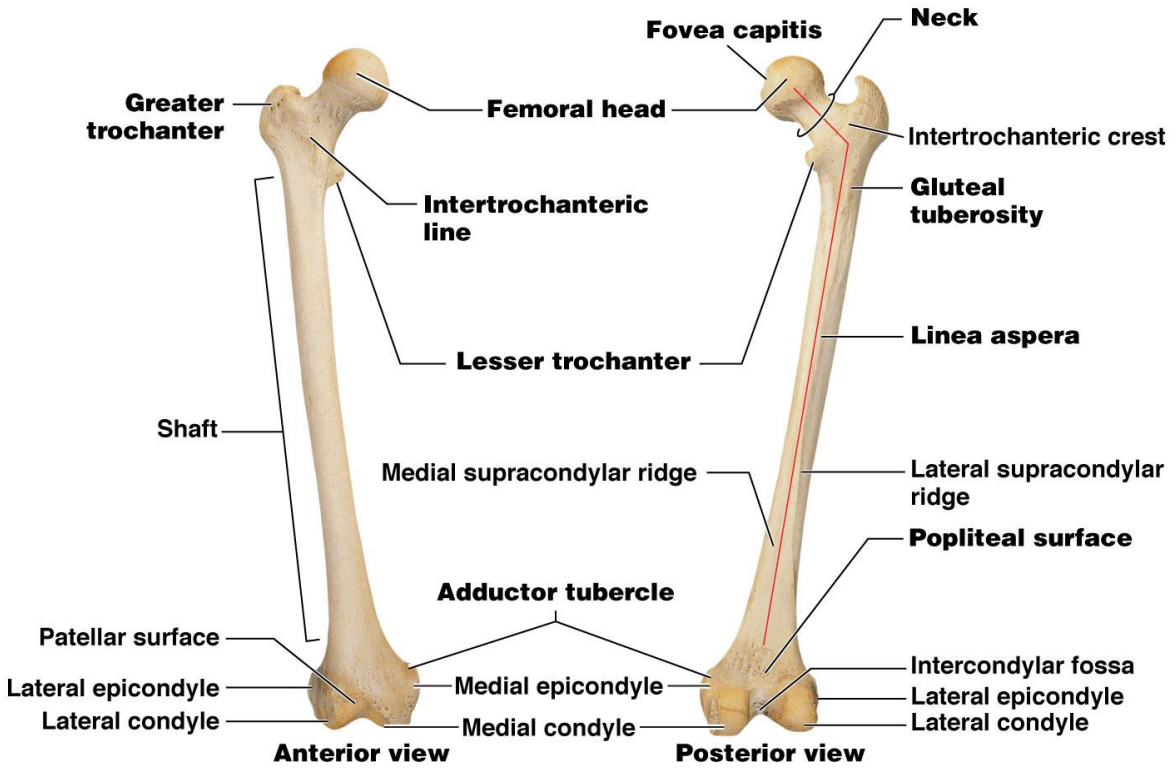
- **Neck** of the femur
  - Joins head to the **shaft** at about 125º
- **Greater trochanter**
  - Large, rough projection extending laterally from head and shaft junction
  - Attachment site for large tendons



Module 7.22: Bones of the lower limb

Femur (continued)

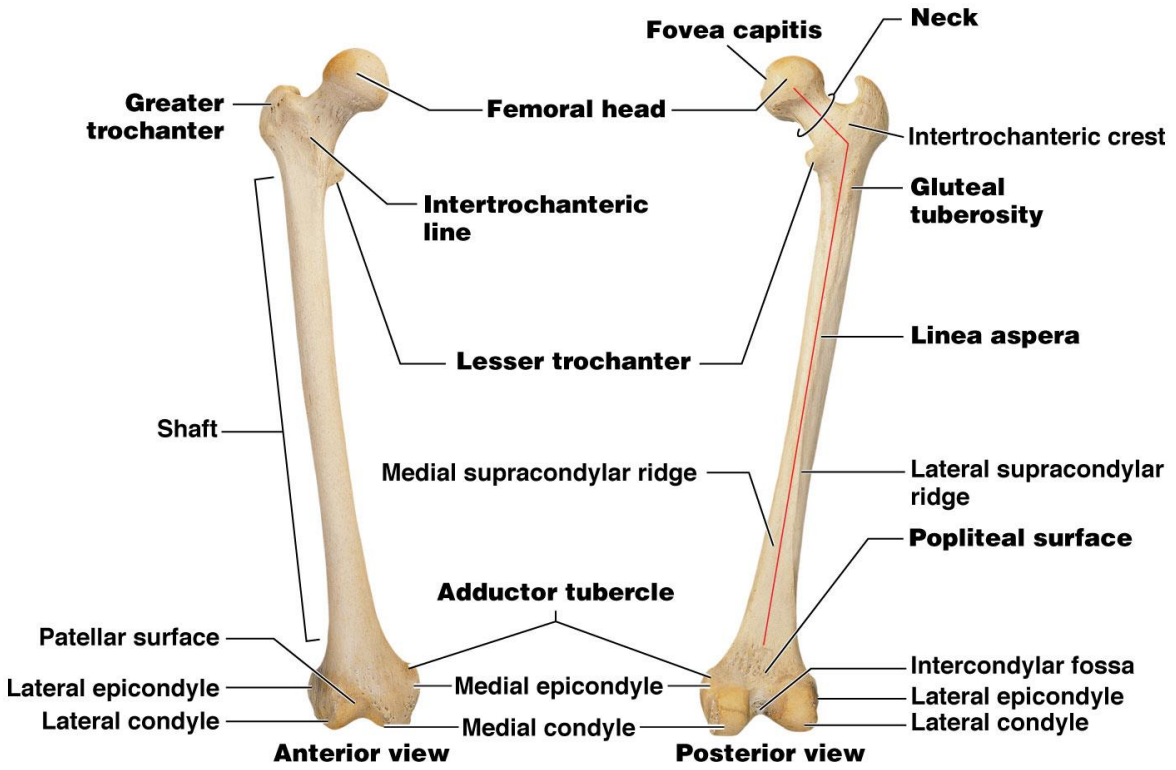
- **Lesser trochanter**
  - Smaller projection extending posteriorly and medially
- **Intertrochanteric line**
  - Marks the edge of the articular capsule on the anterior surface



Module 7.22: Bones of the lower limb

Femur (continued)

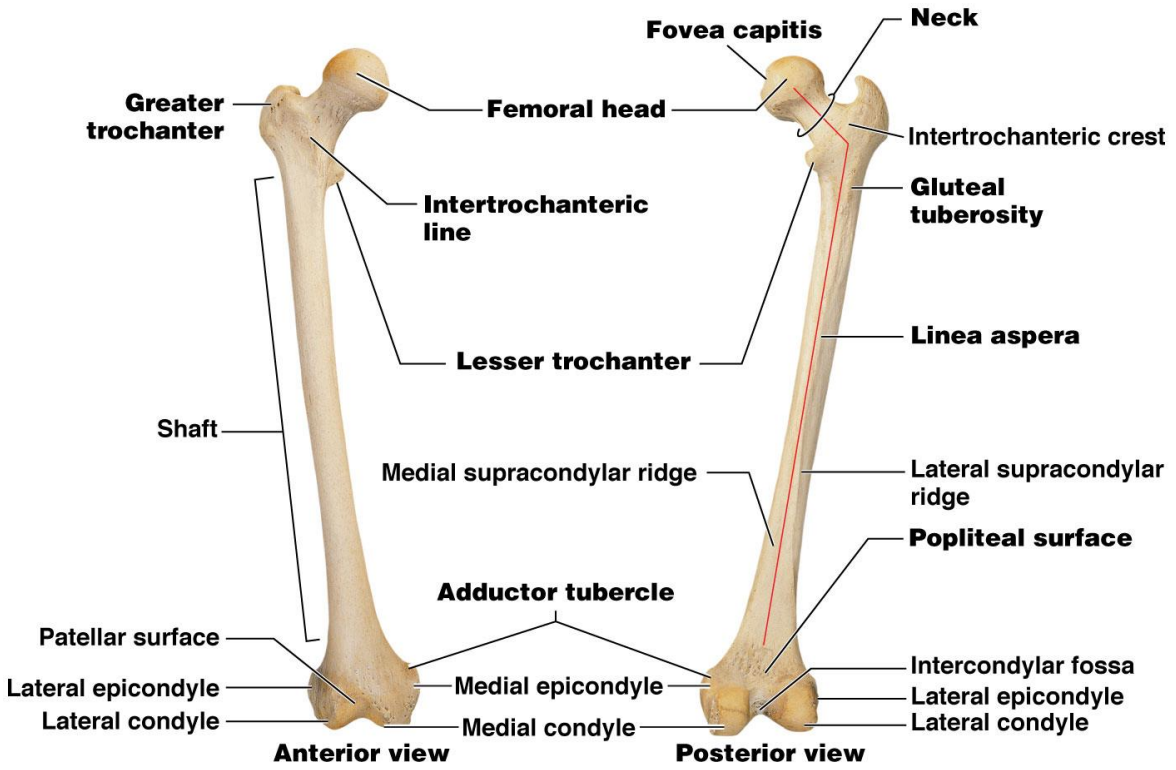
- **Gluteal tuberosity**
  - Attachment site for gluteus maximus muscle
- **Linea aspera**
  - Attachment site for powerful hip muscles



Module 7.22: Bones of the lower limb

Femur (continued)

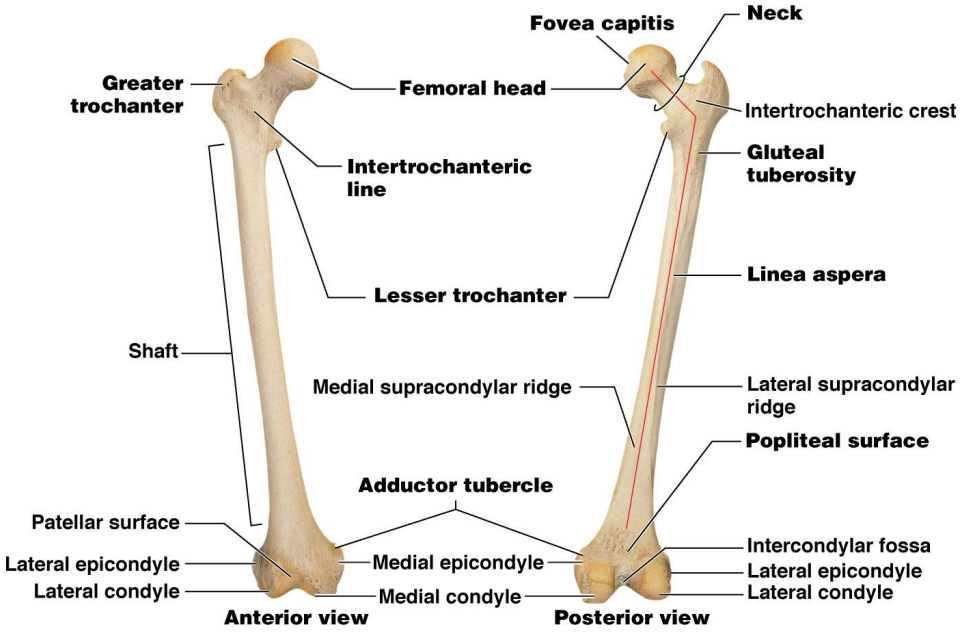
- **Popliteal surface** (*poples*, hollow of knee)
  - Flattened triangular area on posterior surface



Module 7.22: Bones of the lower limb

Femur (continued)

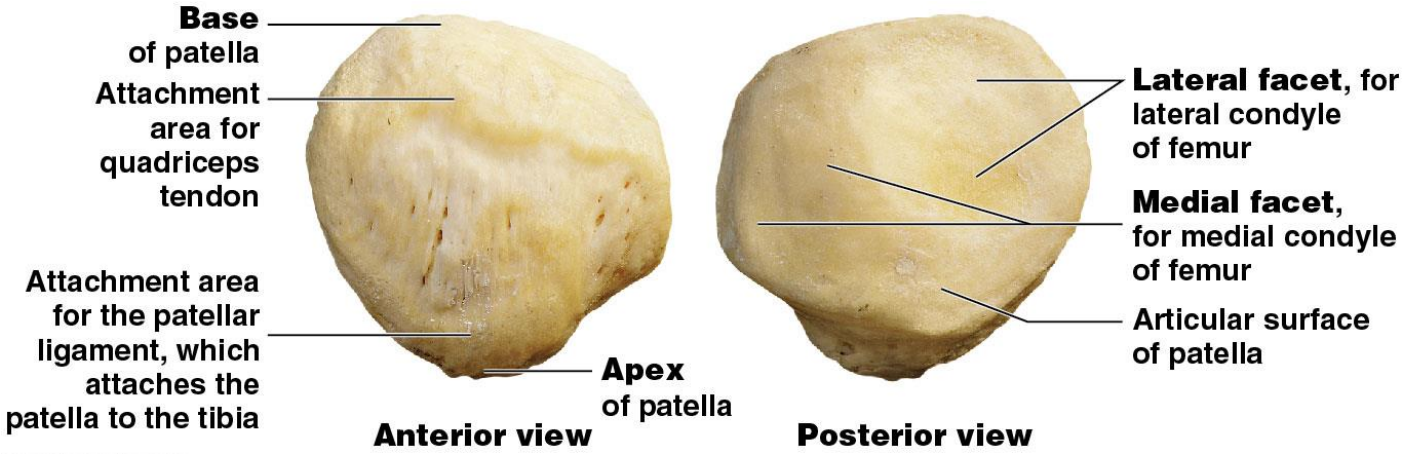
- **Medial and lateral condyles**
  - Part of the knee joint at distal end of femur
  - Separated by:
    - **Patellar surface** (anterior)
      - Smooth surface on which patella glides
    - **Intercondylar fossa** (posterior)



Module 7.22: Bones of the lower limb

Patella

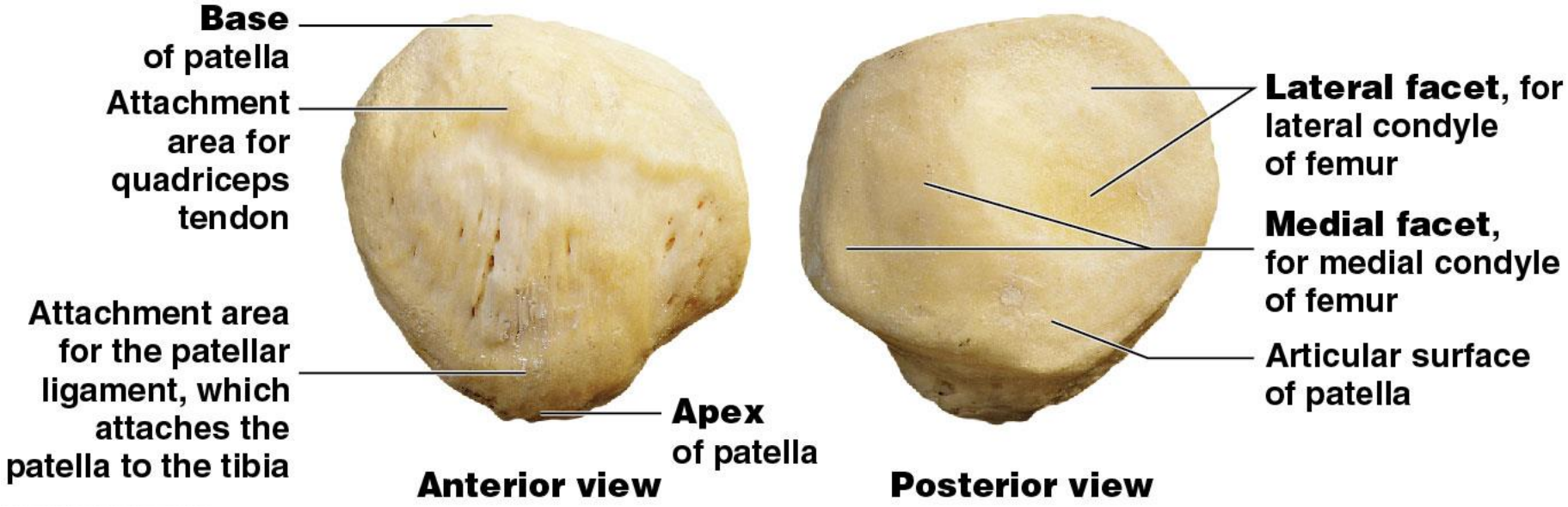
- Large sesamoid bone that forms in the quadriceps tendon
  - **Base**
    - Attachment area for quadriceps tendon
  - **Apex**
    - Attachment area for patellar ligament (connects patella to tibia)



Module 7.22: Bones of the lower limb

Patella (continued)

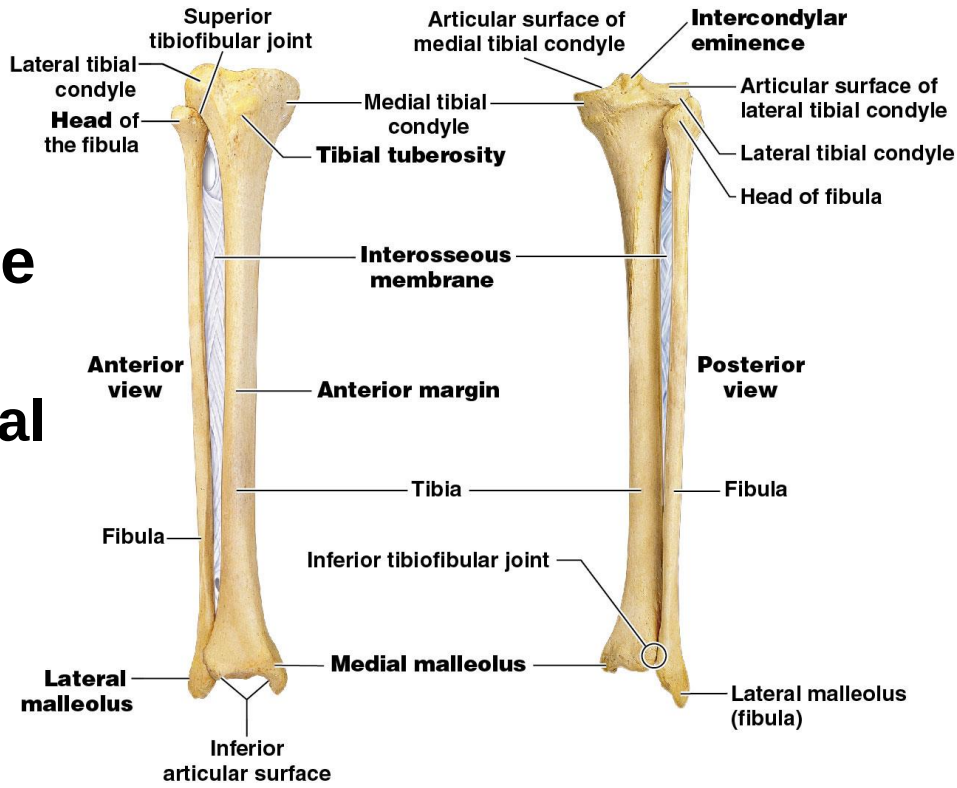
- **Lateral facet**
  - For lateral condyle of femur
- **Medial facet**
  - For medial condyle of femur



Module 7.22: Bones of the lower limb

Tibia (shinbone)

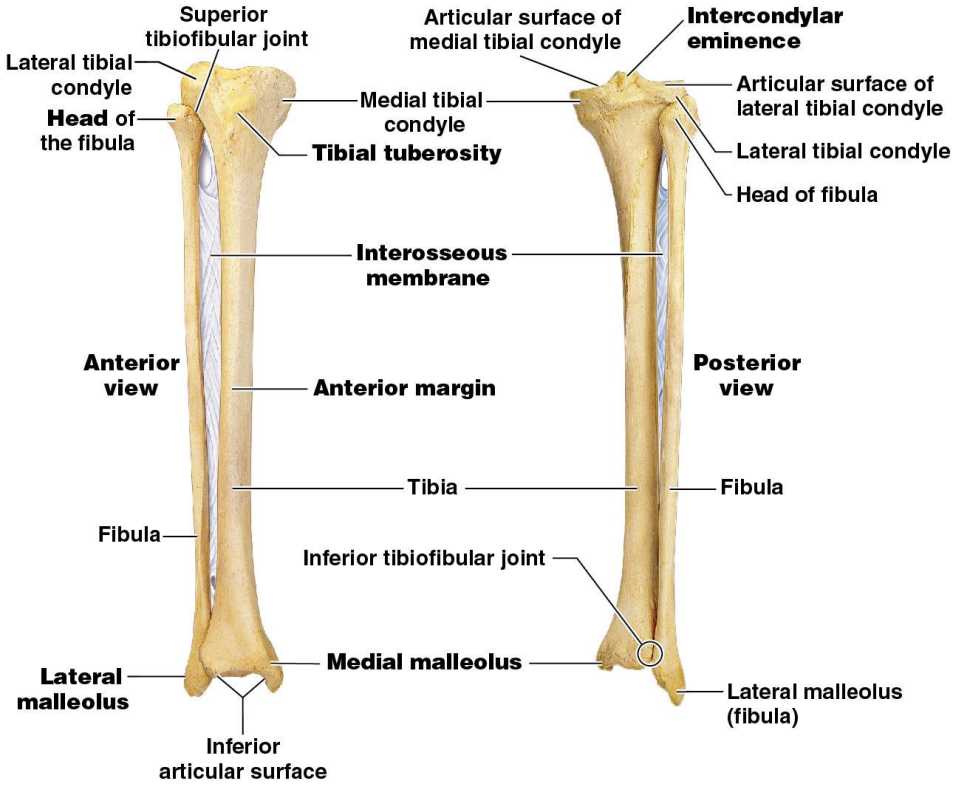
- Large medial bone of leg
  - **Intercondylar eminence**
    - Ridge separating the **medial** and **lateral tibial condyles**
  - **Tibial tuberosity**
    - Attachment site of the patellar ligament
  - **Anterior margin**
    - Ridge beginning at tibial tuberosity, extending along anterior surface



Module 7.22: Bones of the lower limb

Tibia (shinbone) (continued)

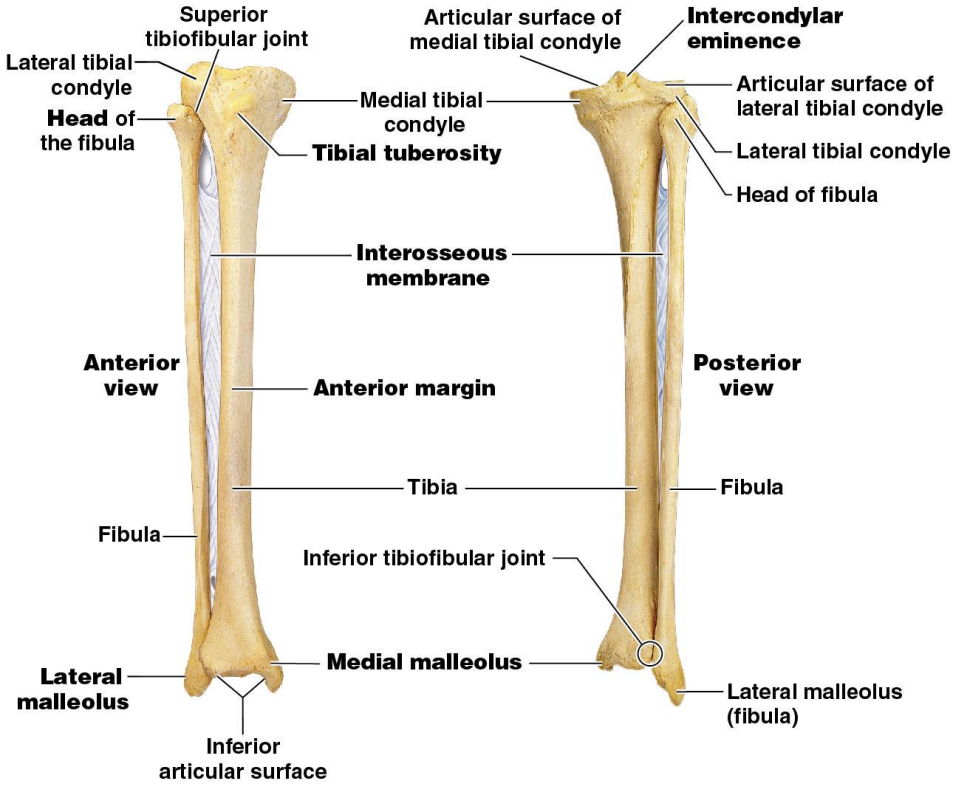
- **Medial malleolus** (*malleolus,* hammer)
  - Medial projection of ankle that provides medial support for the ankle joint



Module 7.22: Bones of the lower limb

Fibula

- Small, slender bone
- Does not participate in knee joint; does not bear weight
- Site of attachment for muscles of foot and toes
- **Head** of the fibula
  - Articulates with the tibia
- **Lateral malleolus**
  - Distal tip that extends lateral to the ankle
  - Provides lateral stability to the ankle



Module 7.22: Review

A. Identify the bones of the lower limb.
B. Which structure articulates with the acetabulum?
C. Identify the sesamoid bone of the lower limb.
D. The fibula neither participates in the knee joint nor bears weight. Yet when it is fractured, walking becomes difficult. Why?

Learning Outcome: Identify the bones of the thigh and leg, their functions, and their bone markings.

Module 7.23: The ankle and foot consist of tarsal bones, metatarsal bones, and phalanges

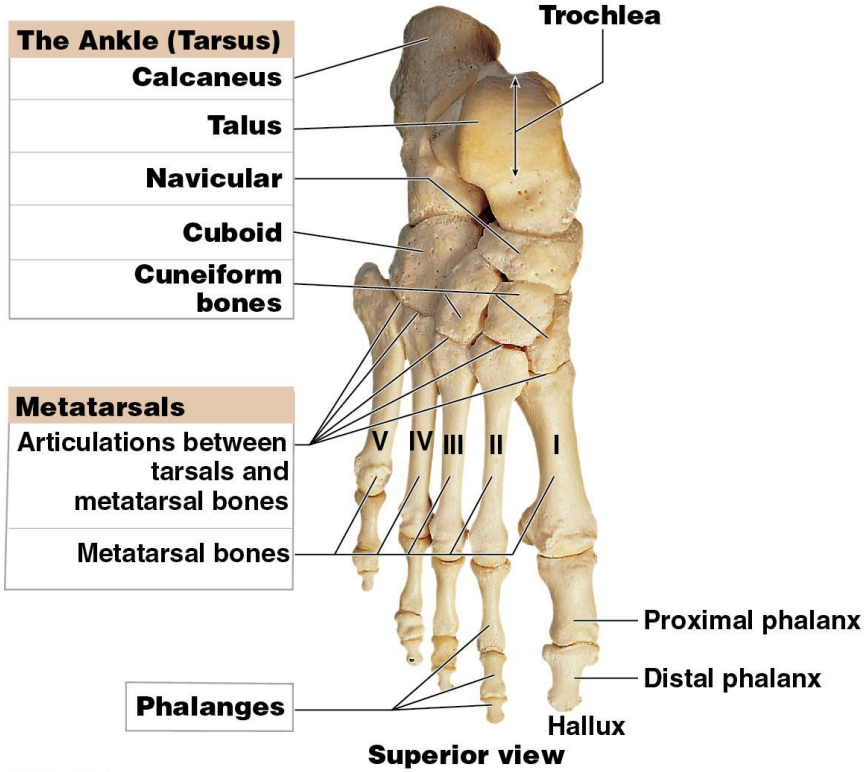
Functions of the ankle and foot bones

- Ankle bones accept the body weight from the leg
- Transfer that weight to the ground
- Distribute the weight through the foot bones
- Ankle and foot bones together:
  - Must be both strong and flexible to carry weight and deal with changes in distribution of that weight with various motions (walking, running, jumping)

Module 7.23: Bones of the ankle and foot

The ankle (tarsus)

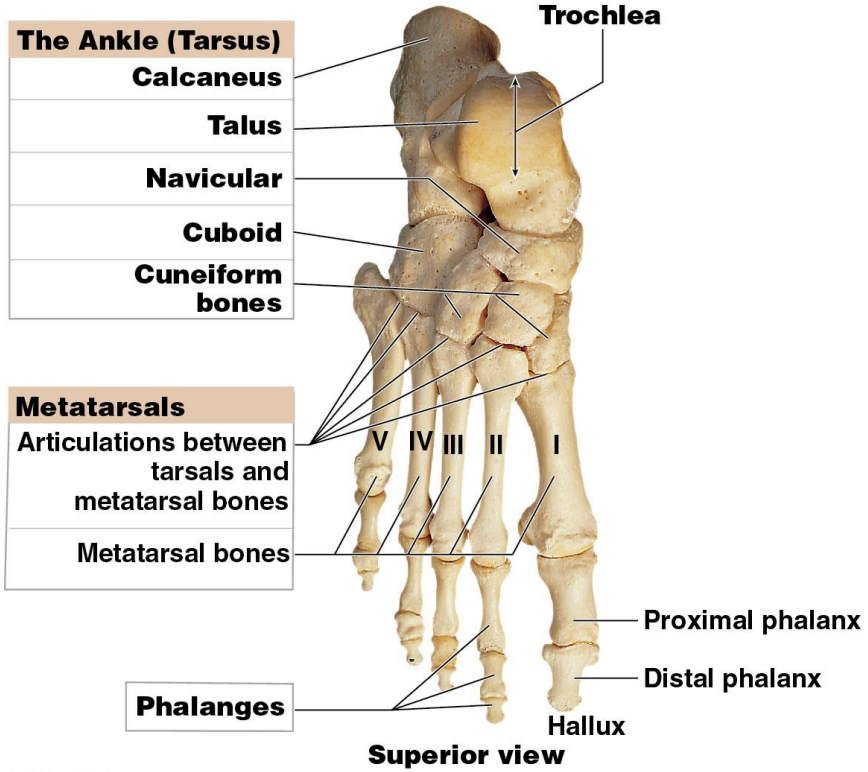
- Consists of seven **tarsal bones**
  1. **Calcaneus** (heel bone)
     - Body weight is transmitted from the talus to the calcaneus to the ground
     - Rough, knob-shaped projection on posterior portion for attachment of the **calcaneal tendon** (Achilles tendon)



Module 7.23: Bones of the ankle and foot

The ankle (tarsus) (continued)

2. **Talus**
   - Transmits body weight from tibia toward the toes
   - **Trochlea**
     - Spool- or pulley-shaped articular process between tibia and talus



Module 7.23: Bones of the ankle and foot

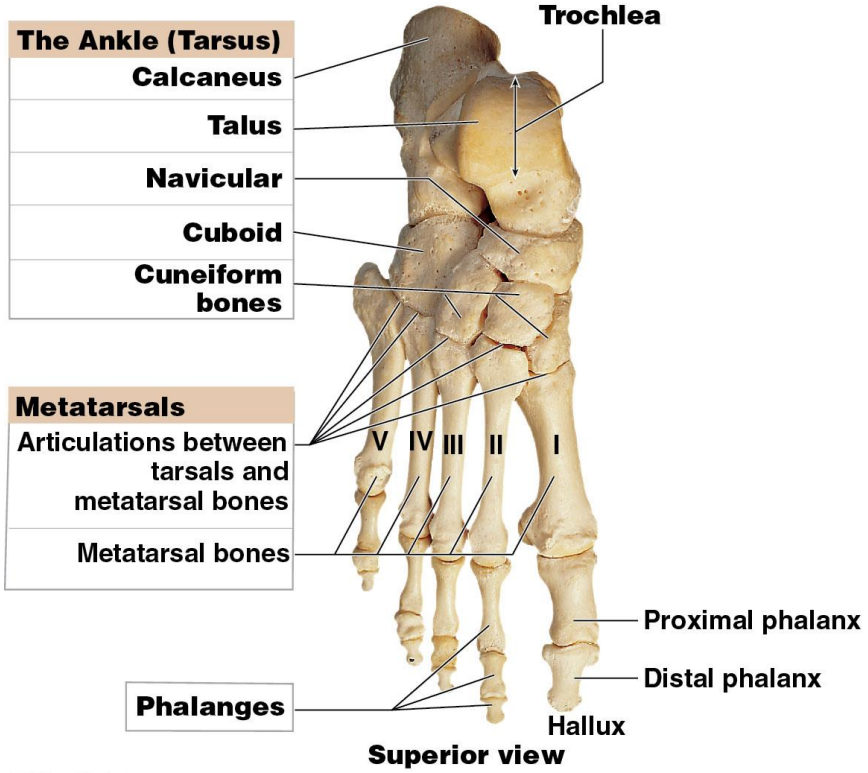
The ankle (continued)

3. Navicular

- Articulates with the talus and cuneiform bones
- On medial side of the ankle

4. Cuboid

- Articulates with the anterior surface of the calcaneus

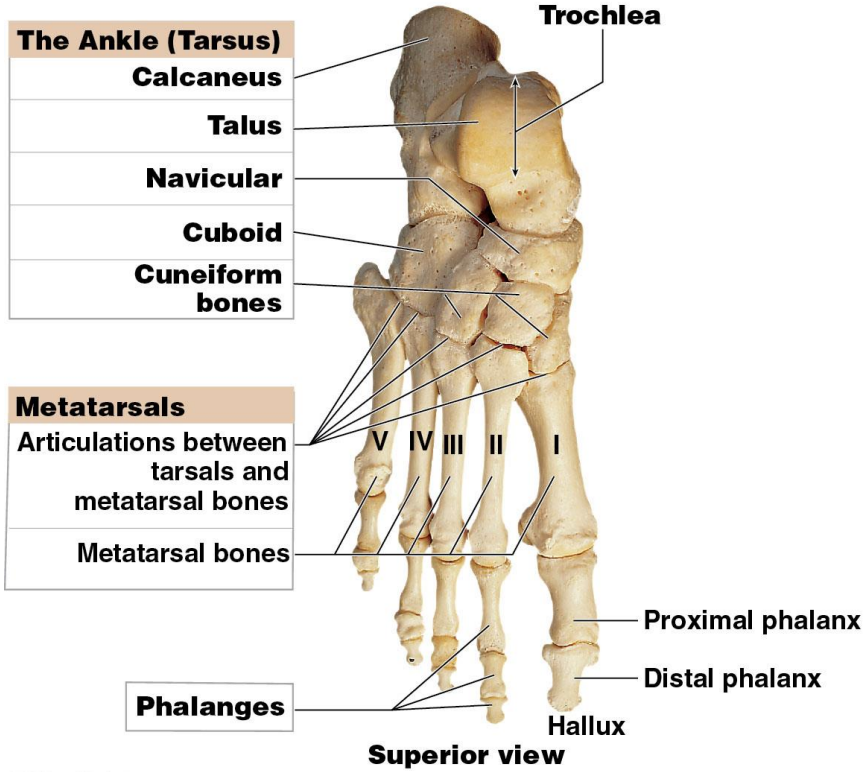


Module 7.23: Bones of the ankle and foot

The ankle (continued)

5–7. **Cuneiform bones**

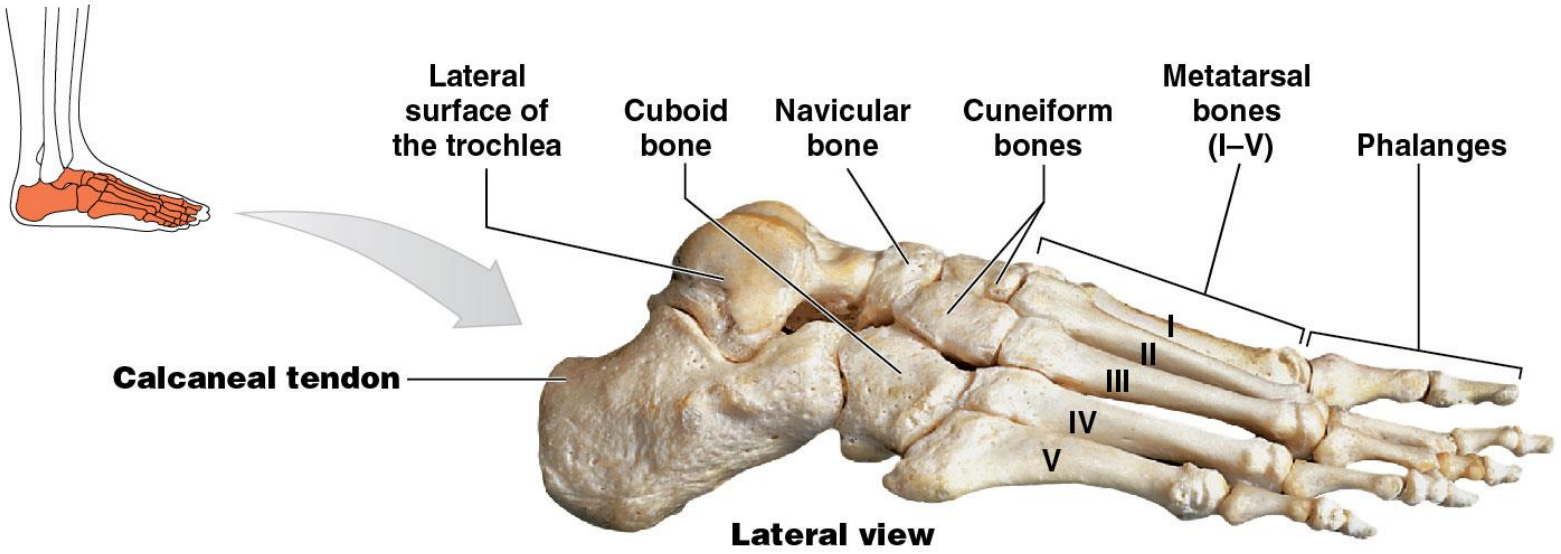
- Arranged in a row
- Named according to their relative position (medial, intermediate, and lateral)



Module 7.23: Bones of the ankle and foot

Metatarsals

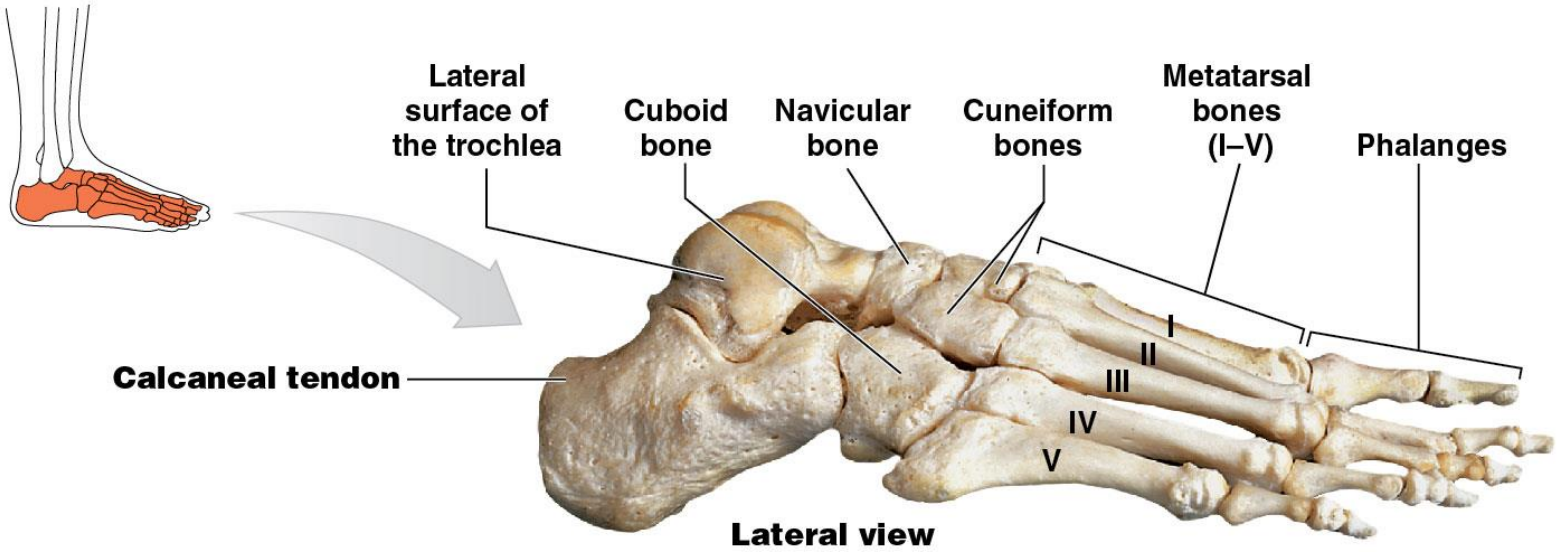
- Identified by Roman numerals I–V from medial to lateral (metatarsal I articulates with **hallux**, or great toe)
  - I–III articulate with the cuneiform bones
  - IV and V articulate with the cuboid



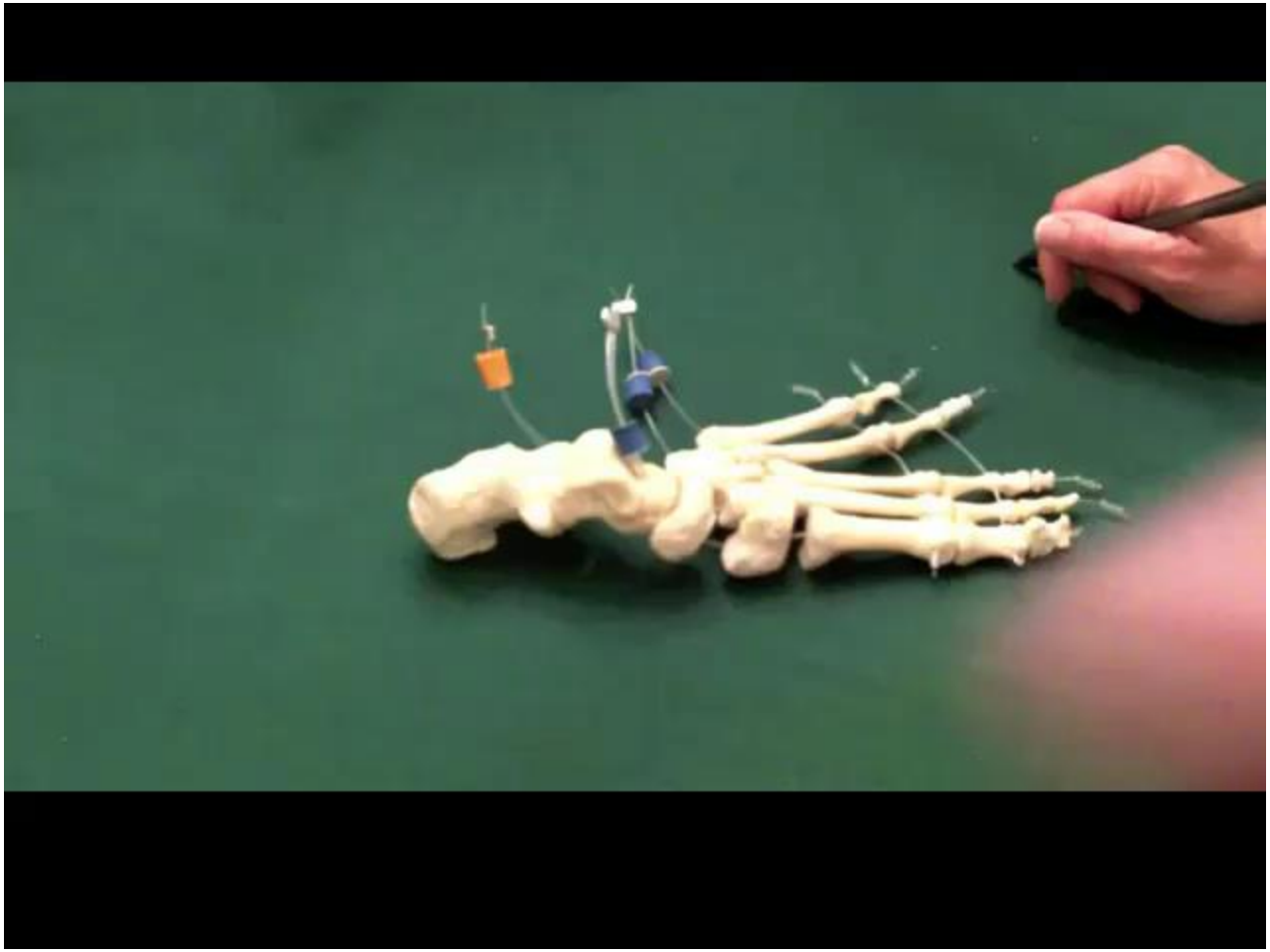
Module 7.23: Bones of the ankle and foot

Phalanges (toe bones)

- Same anatomical organization as fingers (14 bones)
  - **Hallux** (great toe) has two bones (proximal and distal)
  - All other toes have three bones (proximal, middle, distal)



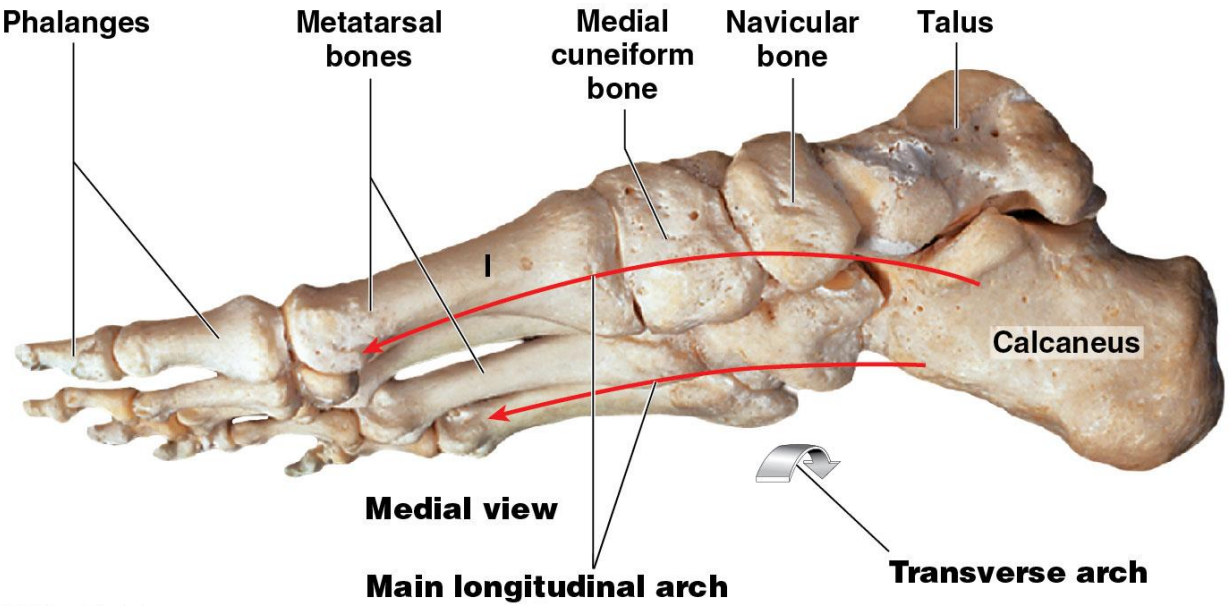
Video: Foot



Module 7.23: Bones of the ankle and foot

Arches of the foot

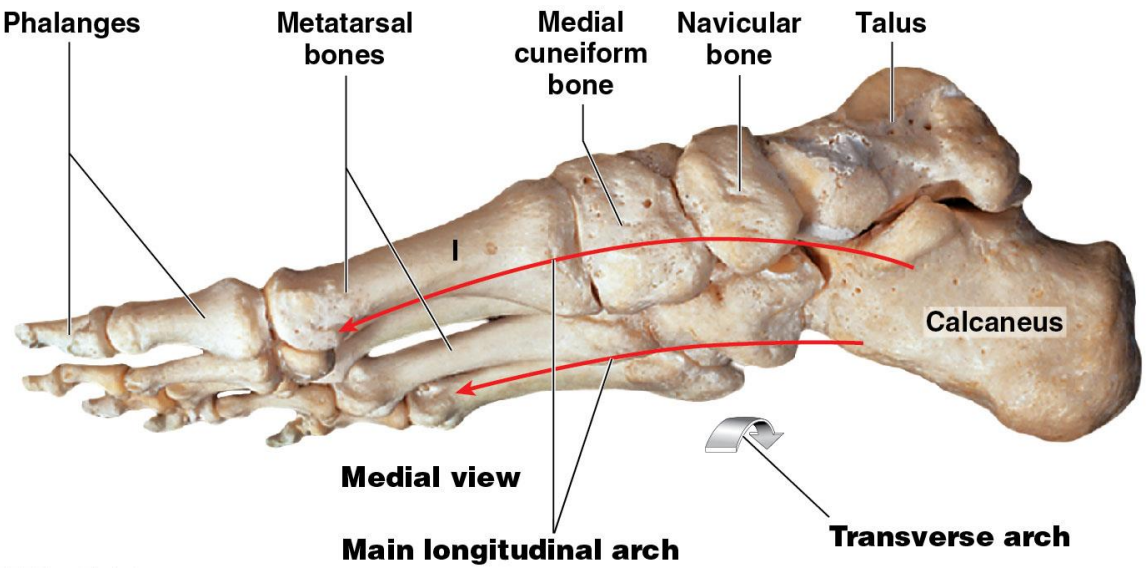
- **Longitudinal arch**
  - Formed from the ligaments and tendons connecting calcaneus to distal part of metatarsal bones
  - Allows for weight transfer (amount depends on position of foot and placement of weight)



Module 7.23: Bones of the ankle and foot

Arches of the foot (continued)

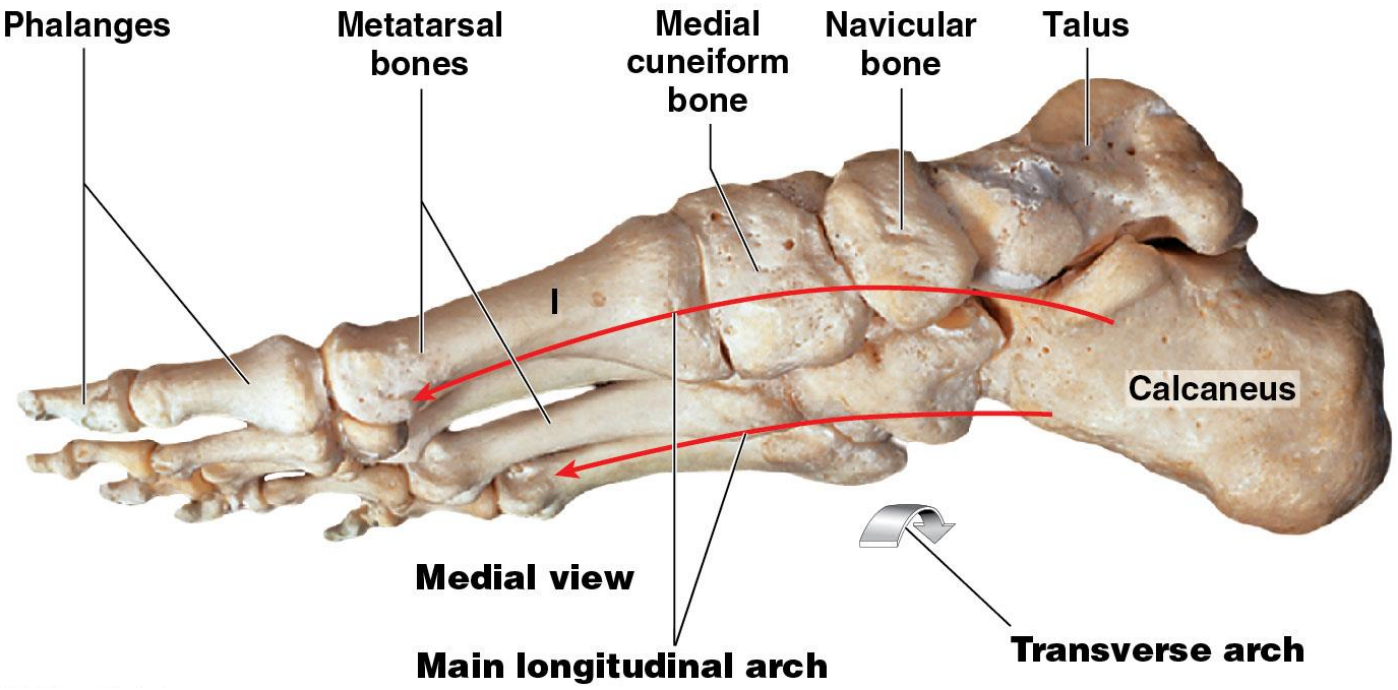
- **Longitudinal arch** (continued)
  - Lateral (calcaneal) portion less elastic, so has much less curvature than medial (talar) portion
    - Result of difference is an elevated medial plantar surface
    - Allows room for inferior surface muscles, blood vessels, and nerves



Module 7.23: Bones of the ankle and foot

Arches of the foot (continued)

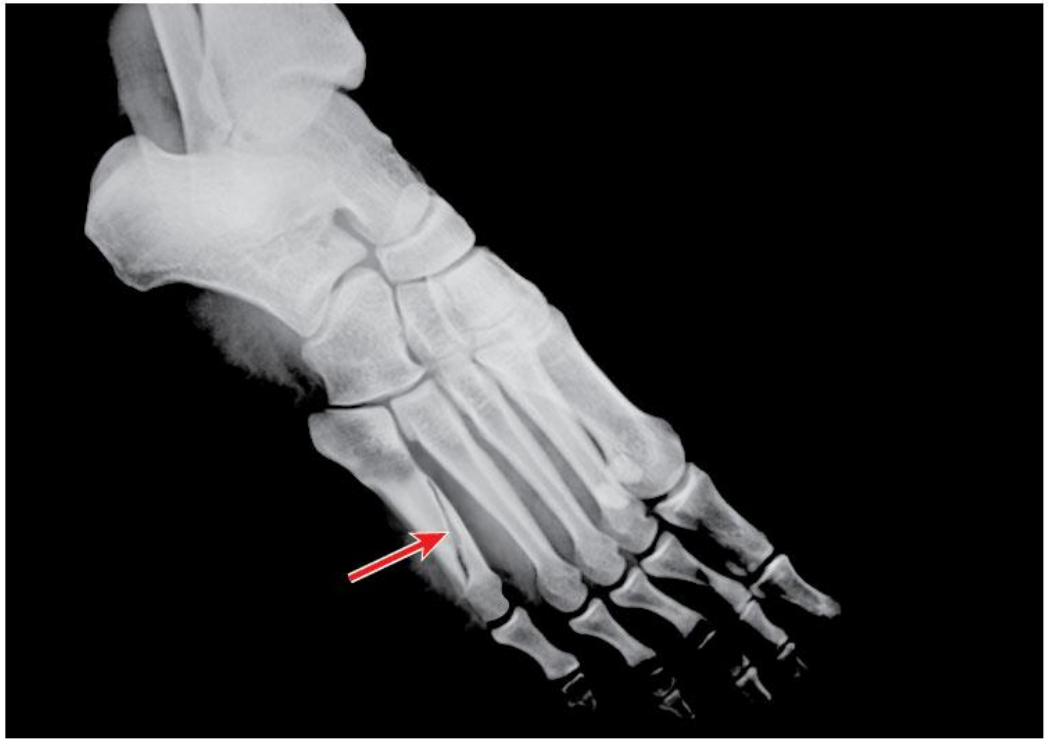
- **Transverse arch**
  - Formed from the change in the degree of longitudinal curvature from medial to lateral border



Module 7.23: Bones of the ankle and foot

Dancer's fracture

- Fracture of the fifth metatarsal
- Usually occurs while body weight is supported by the longitudinal arch (as in ballet dancing)



Module 7.23: Review

A. Identify the tarsal bones.
B. Which foot bone transmits the weight of the body from the tibia toward the toes?
C. Ten-year-old Joey jumps off the back porch, lands on his right heel, and breaks his foot. Which foot bone is likely broken?

Learning Outcome: Identify the bones of the ankle and foot, and describe their locations using anatomical terminology.