Chapter 7

The Axial Skeleton

An Introduction to the Axial Skeleton

- Structures of Bones
  - Articulations
    - Contacts with other bones
  - Landmarks (bone markings; marks)
    - Areas of muscle and ligament attachment
  - Foramina
    - Openings for nerves and blood vessels

7-1 The Axial Skeleton

- The Axial Skeleton
  - Forms the longitudinal axis of the body
  - Has 80 bones
    - The *skull*
      - 8 cranial bones
      - 14 facial bones
    - Bones associated with the skull
      - 6 *auditory ossicles*
      - The *hyoid bone*

7-1 The Axial Skeleton

- The Axial Skeleton
  - The *vertebral column*
    - 24 vertebrae (singular = vertebra)
    - The sacrum
    - The coccyx
  - The *thoracic cage*
    - 24 ribs
    - The sternum

7-1 The Axial Skeleton

- Functions of the Axial Skeleton
  - Supports and protects organs in body cavities
    1. Attaches to muscles of head, neck, and trunk
    2. Performs respiratory movements
    3. Stabilizes parts of **appendicular skeleton**

7-2 The Skull

- The Skull
  - Protects:
    - The brain
    - Entrances to respiratory system
    - Entrance to digestive system
  - Contains:
    - 22 bones
      - 8 **cranial bones**
        - Form the *braincase*, or cranium
      - 14 **facial bones**
        - Protect and support entrances to digestive and respiratory tracts

7-2 The Skull

- **Cranial Bones**
  - Enclose the cranial cavity
  - Which contains the brain
    - And its fluids, blood vessels, nerves, and membranes

7-2 The Skull

- **Facial Bones**
  - Superficial facial bones
    - For muscle attachment
  - Deep facial bones
    - Separate the oral and nasal cavities
    - Form the **nasal septum**

7-2 The Skull

- Superficial Facial Bones
  - *Maxillae* = maxillary bones
  - *Lacrimal*
  - *Nasal*
  - *Zygomatic*
  - *Mandible*
- Deep Facial Bones
  - *Palatine*
  - *Inferior nasal conchae*
  - *Vomer*

7-2 The Skull

- **Sinuses**

- Cavities that decrease the weight of the skull
    1. Lined with mucous membranes
    2. Protect the entrances of the respiratory system

7-2 The Skull

- **Sutures**
    - The immovable joints of the skull
    - The four major sutures
        1. **Lambdoid suture**
        2. **Coronal suture**
        3. **Sagittal suture**
        4. **Squamous suture**

7-2 The Skull

- **Lambdoid Suture**
    - Separates occipital from parietal bones
    - May contain **sutural** (*Wormian*) **bones**

- **Coronal Suture**
    - Attaches frontal bone to parietal bones
    - The **calvaria** (skullcap)
        - Consists of occipital, parietal, and frontal bones

7-2 The Skull

- **Sagittal Suture**
    - Between the parietal bones
    - From lambdoid suture to coronal suture

- **Squamous Sutures**
    - Form boundaries between temporal bones and parietal bones

7-2 The Cranial Bones of the Skull

- The **Cranial Bones**
    - Occipital bone
    - Parietal bones
    - Frontal bone
    - Temporal bones
    - Sphenoid
    - Ethmoid

7-2 The Cranial Bones of the Skull

- The **Occipital Bone**

- Functions of the occipital bone
  - Forms the posterior and inferior surfaces of the cranium
- Articulations of the occipital bone
  - Parietal bones
  - Temporal bones
  - Sphenoid
  - First cervical vertebra (atlas)

7-2 The Cranial Bones of the Skull

- The Occipital Bone
  - Marks of the occipital bone
    - **External occipital protuberance**
    - **External occipital crest**
    - **Occipital condyles** articulate with neck
    - *Inferior* and *superior nuchal lines*: attachment sites of muscles and ligaments

7-2 The Cranial Bones of the Skull

- The Occipital Bone
  - Foramina of the occipital bone
    - **Foramen magnum** connects cranial and spinal cavities
    - **Jugular foramen** for jugular vein
    - **Hypoglossal canals** for hypoglossal nerves

7-2 The Cranial Bones of the Skull

- The **Parietal Bones**
  - Functions of the parietal bones
    - Form part of the superior and lateral surfaces of the cranium
  - Articulations of the parietal bones
    - Other parietal bone
    - Occipital bone
    - Temporal bone
    - Frontal bone
    - Sphenoid

7-2 The Cranial Bones of the Skull

- The Parietal Bones
  - Marks of the parietal bones
    - *Superior* and *inferior temporal lines*
      - To attach *temporalis muscle*
    - Grooves for cranial blood vessels

7-2 The Cranial Bones of the Skull

- The Frontal Bone
  - Functions of the frontal bone
    - Forms the anterior cranium and upper eye sockets
    - Contains *frontal sinuses*
  - Articulations of the frontal bone
    - Parietal bone
    - Maxillary
    - Metopic suture
    - Ethmoid
    - Lacrimal bone
    - Zygomatic bone
    - Spenoid
    - Nasal bone

7-2 The Cranial Bones of the Skull

- The Frontal Bone
  - Marks of the frontal bone
    - **Frontal squama** (forehead)
    - **Supraorbital margin** (protects eye)
    - **Lacrimal fossa** (for tear ducts)
    - **Frontal sinuses**

7-2 The Cranial Bones of the Skull

- The Frontal Bone
  - Foramina of the frontal bone
    - **Supraorbital foramen**
      - For blood vessels of eyebrows, eyelids, and frontal sinuses
    - **Supraorbital notch**
      - An incomplete supraorbital foramen

7-2 The Cranial Bones of the Skull

- The **Temporal Bones**
  - Functions of the temporal bones
    1. Part of lateral walls of cranium and *zygomatic arches*
    2. Articulate with mandible
    3. Surround and protect inner ear
    4. Attach muscles of jaws and head

7-2 The Cranial Bones of the Skull

- The Temporal Bones
  - Articulations of the temporal bones

        - Zygomatic bone
        - Sphenoid
        - Parietal bone
        - Occipital bone
        - Mandible

7-2 The Cranial Bones of the Skull

- The Temporal Bones
    - Marks of the temporal bones
        - **Squamous part**
        - **Zygomatic process**
        - **Mandibular fossa**
        - **Mastoid process**
        - **Styloid process**
        - **Petrous part**
        - **Auditory ossicles**

7-2 The Cranial Bones of the Skull

- **Squamous Part**
    - Borders the squamous suture
- **Zygomatic Process**
    - Inferior to the squamous portion
    - Articulates with *temporal process* of zygomatic bone
    - Forms **zygomatic arch** (cheekbone)
- **Mandibular Fossa**
    - Articulates with the mandible

7-2 The Cranial Bones of the Skull

- **Mastoid Process**
    - For muscle attachment
    - Contains mastoid air cells connected to middle ear
- **Styloid Process**
    - To attach tendons and ligaments of the hyoid, tongue, and pharynx
- **Petrous Part**
    - Encloses structures of the *inner ear*

7-2 The Cranial Bones of the Skull

- **Auditory Ossicles**
    - Three tiny bones in *tympanic cavity* (*middle ear*)
    - Transfer sound from *tympanic membrane* (eardrum) to inner ear

7-2 The Cranial Bones of the Skull

- The Temporal Bones
  - Foramina of the temporal bones
    - **Carotid canal** for internal carotid artery
    - **Foramen lacerum**
      - For carotid and small arteries
      - Hyaline cartilage
      - *Auditory tube*

7-2 The Cranial Bones of the Skull

- The Temporal Bones
  - Foramina of the temporal bones
    - **External acoustic meatus** (*canal*) ends at tympanic membrane
    - **Stylomastoid foramen** for *facial nerve*
    - **Internal acoustic meatus** (*canal*)
      - For blood vessels and nerves of the inner ear
      - Facial nerve

7-2 The Cranial Bones of the Skull

- The **Sphenoid**
  - Functions of the sphenoid
    - Part of the floor of the cranium
    - Unites cranial and facial bones
    - Strengthens sides of the skull
    - Contains *sphenoidal sinuses*

7-2 The Cranial Bones of the Skull

- The Sphenoid
  - Articulations of the sphenoid
    - Ethmoid
    - Frontal bone
    - Occipital bone
    - Parietal bone
    - Temporal bone
    - Palatine bones
    - Zygomatic bones
    - Maxillae
    - Vomer

7-2 The Cranial Bones of the Skull

- The Sphenoid
  - Marks of the sphenoid

        - **Sphenoid body**
        - **Sella turcica**
        - **Hypophyseal fossa**
        - **Sphenoidal sinuses**
        - **Lesser wings**
        - **Greater wings**
        - **Pterygoid processes**

7-2 The Cranial Bones of the Skull

- **Sphenoid Body**
    - At the central axis of the sphenoid
- **Sella Turcica**
    - Saddle-shaped enclosure
    - On the superior surface of the body
- **Hypophyseal Fossa**
    - A depression within the sella turcica
    - Holds the *pituitary gland*

7-2 The Cranial Bones of the Skull

- **Sphenoidal Sinuses**
    - On either side of the body
    - Inferior to the sella turcica

- **Lesser Wings**
    - Anterior to the sella turcica

7-2 The Cranial Bones of the Skull

- **Greater Wings**
    - Form part of the cranial floor
    - *Sphenoidal spine*
    - Posterior wall of the orbit

- **Pterygoid Processes**
    - Form *pterygoid plates*
    - To attach muscles of the lower jaw and soft palate

7-2 The Cranial Bones of the Skull

- The Sphenoid
    - Foramina of the sphenoid
        - **Optic canals** for optic nerves
        - **Superior orbital fissure** for blood vessels and nerves of the orbit
        - **Foramen rotundum** for blood vessels and nerves of the face

        - **Foramen ovale** for blood vessels and nerves of the face
        - **Foramen spinosum** for blood vessels and nerves of the jaws

7-2 The Cranial Bones of the Skull

- The **Ethmoid**
    - Functions of the ethmoid
        - Forms anteromedial floor of the cranium
        - Roof of the nasal cavity
        - Part of the nasal septum and medial orbital wall
        - Contains *ethmoidal air cells* (network of sinuses)

7-2 The Cranial Bones of the Skull

- The Ethmoid
    - Articulations of the ethmoid
        - Frontal bone
        - Sphenoid
        - Nasal bone
        - Lacrimal bone
        - Palatine bone
        - Maxillary bones
        - Inferior nasal conchae
        - Vomer

7-2 The Cranial Bones of the Skull

- The Ethmoid
    - Three parts of the ethmoid
        1. The **cribriform plate**
        2. The two **lateral masses**
        3. The **perpendicular plate**

7-2 The Cranial Bones of the Skull

- The **Cribriform Plate**
    - Floor of the cranium
    - Roof of the nasal cavity
    - Contains the **crista galli**
- The Two **Lateral Masses**
    - Ethmoidal labyrinth (ethmoidal air cells)
    - Superior nasal conchae
    - Middle nasal conchae
- The **Perpendicular Plate**
    - Part of the nasal septum

7-2 The Cranial Bones of the Skull

- The Ethmoid
  - Foramina of the ethmoid
    - **Olfactory foramina**
      - In the cribriform plate
      - For olfactory nerves

7-2 The Facial Bones of the Skull

- The **Facial Bones**
  - **Maxillae** (*maxillary bones*)
  - **Palatine bones**
  - **Nasal bones**
  - **Vomer**
  - **Inferior nasal conchae**
  - **Zygomatic bones**
  - **Lacrimal bones**
  - **Mandible**

7-2 The Facial Bones of the Skull

- The **Maxillae**
  - Functions of the maxillae
    - Support upper teeth
    - Form inferior orbital rim
    - Form lateral margins of external nares
    - Form upper jaw and hard palate
    - Contain *maxillary sinuses* (largest sinuses)

7-2 The Facial Bones of the Skull

- The Maxillae
  - Articulations of the maxillae
    - Frontal bones
    - Ethmoid
    - With one another
    - All other facial bones except the mandible

7-2 The Facial Bones of the Skull

- The Maxillae
  - Marks of the maxillae
    - **Orbital rim** protects eye and orbit
    - *Anterior nasal spine* attaches cartilaginous anterior nasal septum
    - **Alveolar processes** border the mouth and support upper teeth
    - **Palatine processes** form the **hard palate** (roof of mouth)

        - **Maxillary sinuses** lighten bone
        - **Nasolacrimal canal** protects *lacrimal sac* and *nasolacrimal duct*

7-2 The Facial Bones of the Skull

- The Maxillae
    - Foramina of the maxillae
        - **Infraorbital foramen**
            - For sensory nerve to brain (via foramen rotundum of sphenoid)
        - **Inferior orbital fissure**
            - For cranial nerves and blood vessels

7-2 The Facial Bones of the Skull

- The **Palatine Bones**
    - Functions of the palatine bones
        - Form the posterior portion of the hard palate
        - Contribute to the floors of the orbits

7-2 The Facial Bones of the Skull

- The Palatine Bones
    - Articulations of the palatine bones
        - With other palatine bone
        - Maxillae
        - Sphenoid
        - Ethmoid
        - Inferior nasal conchae
        - Vomer

7-2 The Facial Bones of the Skull

- The Palatine Bones
    - Divisions of the palatine bones
        - **Horizontal plate**: posterior part of hard palate
        - **Perpendicular plate** from horizontal plate to orbital process of orbit floor
    - Foramina of the palatine bones
        - Many in the lateral portion of the horizontal plate
        - For small blood vessels and nerves of the roof of the mouth

7-2 The Facial Bones of the Skull

- The **Nasal Bones**
    - Functions of the nasal bones
        - Support the bridge of the nose
        - Connect to cartilages of the distal part of the nose (**external nares**)

7-2 The Facial Bones of the Skull

- The Nasal Bones
  - Articulations of the nasal bones
    - With other nasal bones
    - Ethmoid
    - Frontal bones
    - Maxillae

7-2 The Facial Bones of the Skull

- The **Vomer**
  - Functions of the vomer
    - Forms the inferior portion of the bony nasal septum
  - Articulations of the vomer
    - Sphenoid
    - Ethmoid
    - Palatine bones
    - Maxillae
    - Cartilaginous part of the nasal septum

7-2 The Facial Bones of the Skull

- The **Inferior Nasal Conchae**
  - Functions of the inferior nasal conchae
    - To create air turbulence in the nasal cavity
    - To increase the epithelial surface area
    - To warm and humidify inhaled air

7-2 The Facial Bones of the Skull

- The Inferior Nasal Conchae
  - Articulations of the inferior nasal conchae
    - Ethmoid
    - Maxillae
    - Palatine bones
    - Lacrimal bones

7-2 The Facial Bones of the Skull

- The **Zygomatic Bones**
  - Functions of the zygomatic bones
    - Contribute to the rim and lateral wall of the orbit
    - Form part of the zygomatic arch
  - Articulations of the zygomatic bones
    - Sphenoid
    - Frontal bone

        - Temporal bones
        - Maxillae

7-2 The Facial Bones of the Skull

- The Zygomatic Bones
    - Marks of the zygomatic bones
        - Temporal process
            - Meets the zygomatic process of the temporal bone
    - Foramina of the zygomatic bones
        - Zygomaticofacial foramen
            - For sensory nerves of cheeks

7-2 The Facial Bones of the Skull

- The **Lacrimal Bones**
    - Functions of the lacrimal bones
        - The smallest facial bones
        - Form part of the medial wall of the orbit
    - Articulations of the lacrimal bones
        - Frontal bone
        - Maxillae
        - Ethmoid

7-2 The Facial Bones of the Skull

- The Lacrimal Bones
    - Marks of the lacrimal bones
        - **Lacrimal sulcus**
            - Location of the lacrimal sac
            - Leads to the nasolacrimal canal (between orbit and nasal cavity)

7-2 The Facial Bones of the Skull

- The **Mandible**
    - Functions of the mandible
        - Forms the lower jaw
    - Articulations of the mandible
        - Mandibular fossae of the temporal bones

7-2 The Facial Bones of the Skull

- The Mandible
    - Marks of the mandible
        - **Body** of the mandible is horizontal portion
        - **Alveolar processes** support the lower teeth
        - *Mental protuberance* attaches facial muscles

        - A depression on the medial surface for *submandibular salivary gland*
        - *Mylohyoid line* for insertion of the mylohyoid muscle (floor of mouth)

7-2 The Facial Bones of the Skull

- The Mandible
    - Marks of the mandible
        - **Ramus** ascending from the *mandibular angle* on either side
        - **Condylar process** articulates with temporal bone at *temporomandibular* joint
        - **Coronoid process**: insertion point for *temporalis muscle* (closes the jaws)
        - **Mandibular notch** separates condylar and coronoid processes

7-2 The Facial Bones of the Skull

- The Mandible
    - Foramina of the mandible
        - **Mental foramina**
            - For sensory nerves of lips and chin
        - **Mandibular foramen**
            - Entrance to the *mandibular canal*
            - For blood vessels and nerves of lower teeth

7-2 The Facial Bones of the Skull

- The **Hyoid Bone**
    - Functions of the hyoid bone
        - Supports the larynx
        - Attaches muscles of the larynx, pharynx, and tongue
    - Articulations of the hyoid bone
        - Connects *lesser horns* to styloid processes of temporal bones

7-2 The Facial Bones of the Skull

- The Hyoid Bone
    - Marks of the hyoid bone
        - **Body** of the hyoid
            - Attaches muscles of larynx, tongue, and pharynx

7-2 The Facial Bones of the Skull

- The Hyoid Bone
    - Marks of the hyoid bone
        - **Greater horns** (*greater cornua*)
            - Support larynx
            - Attach muscles of the tongue

        - **Lesser horns** (*lesser cornua*)
            - Attach stylohyoid ligaments
            - Support hyoid and larynx

7-3 The Orbital and Nasal Complexes

- The Eye Sockets (**Orbits**)
    - Frontal bone (roof)
    - Maxilla (floor)
    - Maxillary, lacrimal, and ethmoid bones (orbital rim and medial wall)
    - Sphenoid and palatine bones

7-3 The Orbital and Nasal Complexes

- Bones of the **Nasal Cavities** and **Paranasal Sinuses** Make Up the **Nasal Complex**
    - Frontal bone, sphenoid, and ethmoid
        - Superior wall of nasal cavities
    - Maxillae, lacrimal bones, ethmoid, and inferior nasal conchae
        - Lateral walls of nasal cavities
    - Maxillae and nasal bones
        - Bridge of nose

7-3 The Orbital and Nasal Complexes

- Paranasal Sinuses
    - Air-filled chambers connected to the nasal cavities
        - Lighten skull bones
        - Provide mucous epithelium (flushes nasal cavities)

7-4 Fontanelles

- The Infant Skull
    - Grows rapidly
    - Is large compared to the body
    - Has many ossification centers

7-4 Fontanelles

- The Infant Skull
    - Fusion is not complete at birth
        - Two frontal bones
        - Four occipital bones
        - Several sphenoidal and temporal elements

7-4 Fontanelles

- **Fontanelles**

- Are areas of fibrous connective tissue (soft spots)
- Cover unfused sutures in the infant skull
- Allow the skull to flex during birth

7-4 Fontanelles

- *Anterior Fontanelle*
  - Frontal, sagittal, and coronal sutures
- *Occipital Fontanelle*
  - Lambdoid and sagittal sutures
- *Sphenoidal Fontanelles*
  - Squamous and coronal sutures
- *Mastoid Fontanelles*
  - Squamous and lambdoid sutures

7-5 The Vertebral Column

- The **Vertebral Column** (*Spine*)
  - Protects the spinal cord
  - Supports the head and body
  - 26 bones
    - 24 **vertebrae**, the **sacrum**, and the **coccyx**

7-5 The Vertebral Column

- Vertebrae
  - The neck
    - Seven **cervical vertebrae**
  - The upper back
    - 12 **thoracic vertebrae**
    - Each articulates with one or more pair of ribs
  - The lower back
    - Five **lumbar vertebrae**

7-5 The Vertebral Column

- The Sacrum and Coccyx
  - The fifth lumbar vertebra articulates with the **sacrum**
  - The sacrum articulates with the **coccyx**

7-5 The Vertebral Column

- Four **Spinal Curves**
  1. **Cervical curve**
  2. **Thoracic curve**
  3. **Lumbar curve**

4. **Sacral curve**

7-5 The Vertebral Column

- **Thoracic** and **Sacral Curves**
  - Are called **primary curves** (present during fetal development)
  - Or **accommodation curves** (accommodate internal organs)
- **Lumbar** and **Cervical Curves**
  - Are called **secondary curves** (appear after birth)
  - Or **compensation curves** (shift body weight for upright posture)

7-5 The Vertebral Column

- Vertebral Anatomy
  - The **vertebral body** (*centrum*)
    - Transfers weight along the spine
  - The **vertebral arch**
    - Posterior margin of **vertebral foramen**
  - The **articular processes**
    - Lateral projections between laminae and pedicles

7-5 The Vertebral Column

- Vertebral Anatomy
  - The **vertebral arch**
    - **Pedicles**
      - Walls of the vertebral arch
    - **Laminae**
      - Roof of the vertebral arch

7-5 The Vertebral Column

- Vertebral Anatomy
  - The vertebral arch
    - **Spinous process**
      - Projection where vertebral laminae fuse
    - **Transverse process**
      - Projection where laminae join pedicles

7-5 The Vertebral Column

- Vertebral Anatomy
  - The **articular processes**
    - **Superior articular process**
    - **Inferior articular process**
      - Have **articular facets** on articular faces

7-5 The Vertebral Column

- Vertebral Foramina
  - **Intervertebral foramina**
    - Gaps between pedicles of adjacent vertebrae
    - For nerve connections to spinal cord
  - **Vertebral canal**
    - Formed by vertebral foramina
    - Encloses the spinal cord

7-5 The Vertebral Column

- **Intervertebral Discs**
  - Are pads of fibrocartilage
  - Separate the vertebral bodies
  - Absorb shocks

7-6 Vertebral Regions

- Vertebral Regions
  - Vertebrae are numbered
    - By region, from top (superior) to bottom (inferior)
    - C_1 articulates with skull, L_5 with sacrum
  - Vertebrae of each region
    - Have characteristics determined by functions

7-6 Vertebral Regions

- Regions of the Vertebral Column
  - **Cervical** (C)
  - **Thoracic** (T)
  - **Lumbar** (L)
  - **Sacral** (S)
  - **Coccygeal** (Co)

7-6 Vertebral Regions

- The **Cervical Vertebrae**
  - Small body (support only head)
  - Large vertebral foramen (largest part of spinal cord)
  - Concave superior surface
  - Slope posterior to anterior
  - C_1 (**atlas**) has no spinous process
    - All others have short spinous processes
      - Tip of each spinous process is notched (**bifid**)

7-6 Vertebral Regions

- The Cervical Vertebrae
  - Transverse processes
    - Are fused to **costal processes**
    - Which encircle **transverse foramina** (protect arteries and veins)
  - **Atlas** (C_1)
    - Articulates with occipital condyles of skull
    - Has no body or spinous process
    - Has a large, round foramen within **anterior** and **posterior arches**

7-6 Vertebral Regions

- The Cervical Vertebrae
  - **Axis** (C_2)
    - Supports the atlas
    - Has heavy spinous process
    - To attach muscles of head and neck
  - Axis and atlas bodies fuse during development to form the **dens**

7-6 Vertebral Regions

- The Cervical Vertebrae
  - **Vertebra prominens** (C_7)
    - Transitions to thoracic vertebrae
    - Has a long spinous process with a broad tubercle
    - Has large transverse processes
  - **Ligamentum nuchae** (elastic ligament) extends from C_7 to skull

7-6 Vertebral Regions

- **Thoracic Vertebrae** (T_1–T_{12})
  - Have heart-shaped bodies
  - Larger bodies than in C_1–C_7
  - Smaller vertebral foramen than in C_1–C_7
  - Long, slender spinous processes
  - Dorsolateral surfaces of body have **costal facets**
    - Which articulate with heads of ribs

7-6 Vertebral Regions

- Thoracic Vertebrae (T_1–T_{12})
  - T_1–T_{10}
    - Have **transverse costal facets**
    - On thick transverse processes for rib articulation
  - Ribs at T_1–T_{10}
    - Contact **costal** and **transverse costal facets**

- T_1–T_8 articulate with two pairs of ribs
  - At *superior* and *inferior* costal facets
- T_9–T_{11} articulate with one pair of ribs
- T_{10}–T_{12} transition to lumbar vertebrae

7-6 Vertebral Regions

- **Lumbar Vertebrae** (L_1–L_5)
  - Largest vertebrae
  - Oval-shaped bodies
  - Thicker bodies than T_1–T_{12}
  - No costal or transverse costal facets
  - Triangular vertebral foramen
  - Superior articular processes
    - Face up and in
  - Inferior articular processes
    - Face down and out

7-6 Vertebral Regions

- Lumbar Vertebrae (L_1–L_5)
  - Transverse processes
    - Slender
    - Project dorsolaterally
  - Spinous processes
    - Short, heavy
    - For attachment of lower back muscles

7-6 Vertebral Regions

- The **Sacrum**
  - Is curved, more in males than in females
  - Protects reproductive, urinary, and digestive organs
  - Attaches:
    - The axial skeleton to pelvic girdle of appendicular skeleton
    - Broad muscles that move the thigh

7-6 Vertebral Regions

- The Sacrum
  - The adult sacrum
    - Consists of five fused sacral vertebrae
    - Fuses between puberty and ages 25–30
    - Leaving *transverse lines*
  - **Sacral canal**
    - Replaces the vertebral canal

7-6 Vertebral Regions

- The Sacrum
  - **Sacral cornua**
    - Horn shaped
    - Formed by laminae of the fifth sacral vertebra
    - Which do not meet at midline
  - **Sacral hiatus**
    - Opening at the inferior end of the sacral canal
    - Formed by ridges of sacral cornua
    - Covered by connective tissues

7-6 Vertebral Regions

- The Sacrum
  - **Median sacral crest**
    - Fused spinous processes
    - Four pairs of **sacral foramina** open to either side
  - **Lateral sacral crest**
    - Fused transverse processes
    - Attach to muscles of lower back and hip

7-6 Vertebral Regions

- The Sacrum
  - **Auricular surface**
    - Thick, flattened area
    - Articulates with pelvic girdle (forming *sacroiliac joint*)
  - **Sacral tuberosity**
    - Rough area
    - Attaches ligaments of the sacroiliac joint

7-6 Vertebral Regions

- The Sacrum
  - **Base**
    - The broad superior surface
  - **Ala**
    - Wings at either side of the base
    - To attach muscles
  - **Sacral promontory**
    - At the center of the base
  - **Apex**
    - The narrow inferior portion
    - Articulates with the coccyx

7-6 Vertebral Regions

- The **Coccyx**
  - Attaches ligaments and a constricting muscle of the anus
  - Mature coccyx
    - Consists of three to five fused coccygeal vertebrae
  - First two coccygeal vertebrae
- Have transverse processes
    - Have unfused vertebral arches
  - **Coccygeal cornua**
    - Formed by laminae of first coccygeal vertebra

7-7 The Thoracic Cage

- The **Thoracic Cage**
  - The skeleton of the chest
  - Supports the thoracic cavity
    - Consists of:
      - Thoracic vertebrae
      - Ribs
      - Sternum (breastbone)
- The Rib Cage
  - Formed of ribs and sternum

7-7 The Thoracic Cage

- Functions of the Thoracic Cage
  1. Protects organs of the thoracic cavity
     - Heart, lungs, and thymus
  2. Attaches muscles
     1. For respiration
     2. Of the vertebral column
     3. Of the pectoral girdle and the upper limbs

7-7 The Thoracic Cage

- **Ribs** (*Costae*)
  - Are 12 pairs of long, curved, flat bones
  - Extending from the thoracic vertebrae
  - Ribs are divided into two types
    1. **True ribs**
    2. **False ribs**

7-7 The Thoracic Cage

- Ribs 1–7 (**True Ribs**)
  - *Vertebrosternal ribs*

- Connected to the sternum by **costal cartilages**

7-7 The Thoracic Cage

- Ribs 8–12 (**False Ribs**)
- Do not attach directly to the sternum
  - *Vertebrochondral* ribs (ribs 8–10)
    - Fuse together
    - Merge with cartilage before reaching the sternum
  - *Floating or vertebral ribs* (ribs 11–12)
    - Connect only to the vertebrae and back muscles
    - Have no connection with the sternum

7-7 The Thoracic Cage

- Structures of the Ribs
  - The **head** (capitulum)
    - At the vertebral end of the rib
    - Has superior and inferior articular facets
  - The **neck**
    - The short area between the head and the tubercle

7-7 The Thoracic Cage

- Structures of the Ribs
  - The **tubercle** (tuberculum)
    - A small dorsal elevation
    - Has an auricular facet that contacts the facet of its thoracic vertebra (at T_1–T_{10} only)
  - The tubular **body** (*shaft*)
    - Attaches muscles of the pectoral girdle and trunk
    - Attaches to the intercostal muscles that move the ribs

7-7 The Thoracic Cage

- The **Sternum**
  - A flat bone
  - In the midline of the thoracic wall
  - Three parts of the sternum
    1. The **manubrium**
    2. The sternal **body**
    3. The **xiphoid process**

7-7 The Thoracic Cage

- Manubrium
  - The superior portion of sternum

- Broad, triangular shape
- Articulates with *clavicles* (collarbones)
- Articulates with cartilages of first rib pair
- Has a **jugular notch**, a shallow indentation between clavicular articulations

7-7 The Thoracic Cage

- The Sternal **Body**
  - Is tongue-shaped
  - Attaches to the manubrium
  - Attaches to costal cartilages of ribs 2–7
  -
- The **Xiphoid Process**
  - Is the smallest part of the sternum
  - Attaches to the sternal body
  - Attaches to *diaphragm* and *rectus abdominis muscles*

7-7 The Thoracic Cage

- Development of the Sternum
  - The developing sternal body
    - Consists of four unfused bones
    - Completes fusion about age 25
    - Leaving transverse lines
  - The xiphoid process
    - Is the last part of sternum to fuse
    - Can easily be broken away