

The Axial Skeleton

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The Skeleton

- Consists of:
 - Bones, cartilage, joints, and ligaments
 - Joints—also called articulations
- Is composed of 206 named bones grouped into two divisions
 - Axial skeleton (80 bones)
 - Skull, vertebral column, and thoracic cage
 - Appendicular skeleton (126 bones)
 - Upper and lower limbs



The Skull

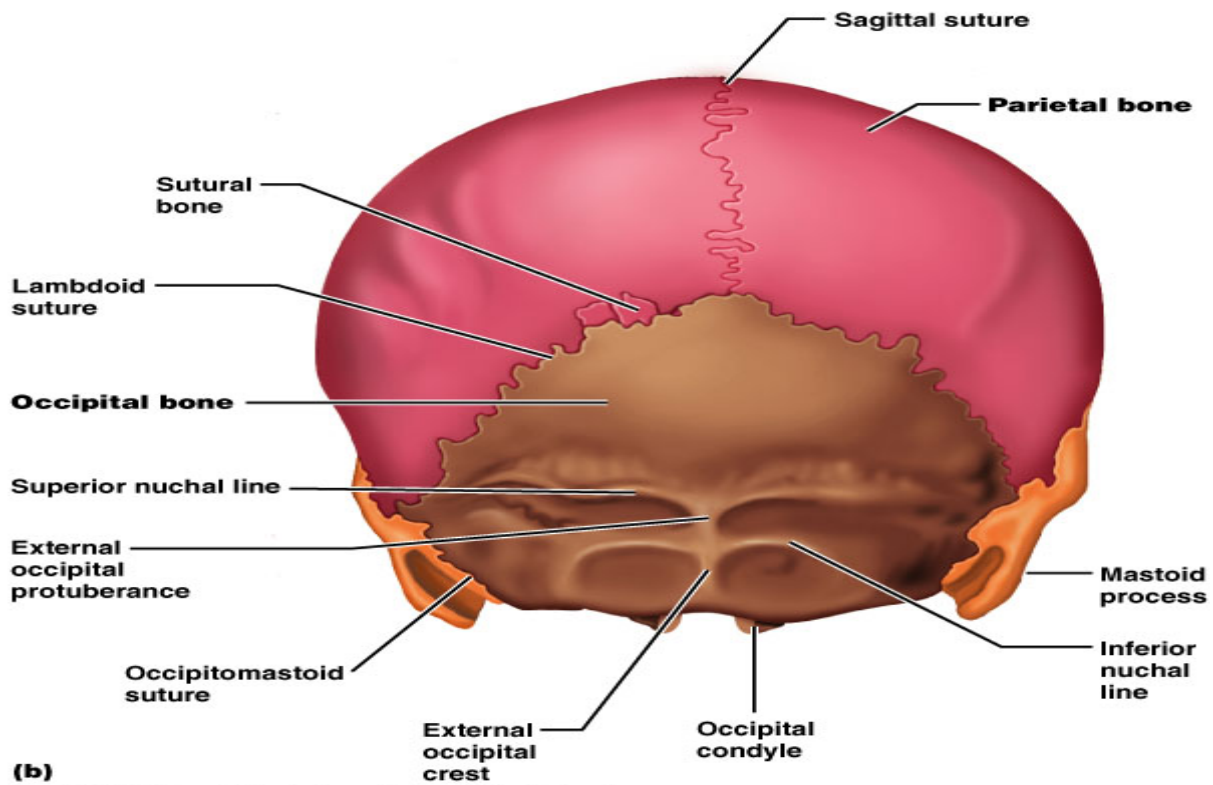
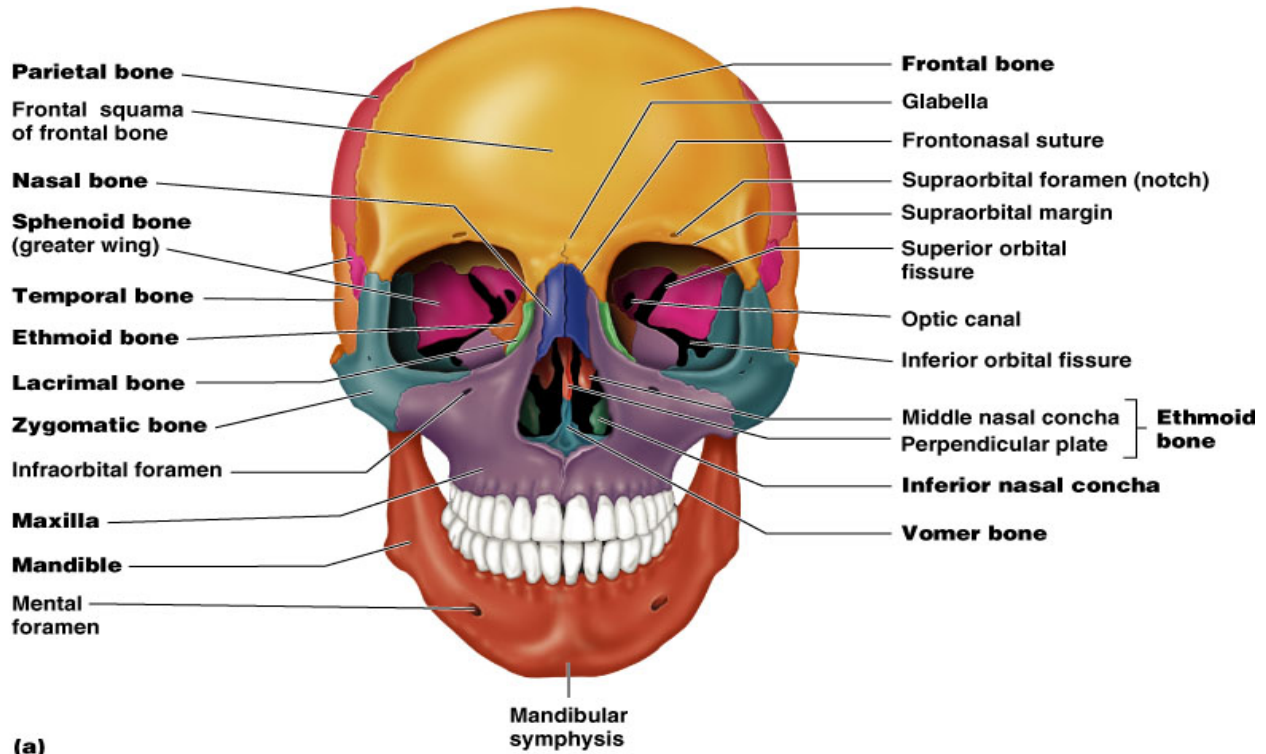
- Is the body's most complex bony structure
- Is formed by cranial and facial bones
 - Bones of the cranium
 - Enclose and protect the brain
 - Provide attachment sites for some muscles of the head and neck

The Skull

- **Facial bones** - form anterior aspect
 - Form framework of the face
 - Form cavities for sense organs of sight, taste, and smell
 - Provide openings for passage of air and food
 - Hold the teeth in place
 - Anchor muscles of the face
- **Cranium** is divided into cranial vault and the base

Overview of Skull Geography

- Internally, prominent bony ridges divide skull into distinct fossae
 - Anterior
 - Middle
 - Posterior
- Brain sits within the cranial fossa and occupies cranial cavity
- The skull contains smaller cavities
 - Middle and inner ear cavities—in lateral aspect of cranial base
 - Nasal cavity—lies in and posterior to the nose
 - Orbits—house the eyeballs
 - Air-filled sinuses—occur in several bones around the nasal cavity
- The skull contains approximately 85 named openings
 - Foramina, canals, and fissures
 - Provide openings for important structures
 - Spinal cord, Blood vessels serving the brain, 12 pairs of cranial nerves



Cranial Bones

- Formed from eight large bones
 - Paired bones include
 - Temporal bones
 - Parietal bones
 - Unpaired bones include
 - Frontal bone
 - Occipital bone
 - Sphenoid bone
 - Ethmoid bone

Parietal Bones and Sutures

- Parietal bones form superior and lateral parts of skull
- Four sutures of the cranium
 - **Coronal suture**—runs in the coronal plane
 - Located where parietal bones meet the frontal bone
 - **Squamous suture**—occurs where each parietal bone meets a temporal bone inferiorly
 - **Sagittal suture**—occurs where right and left parietal bones meet superiorly
 - **Lambdoid suture**—occurs where the parietal bones meet the occipital bone posteriorly

Sutural Bones

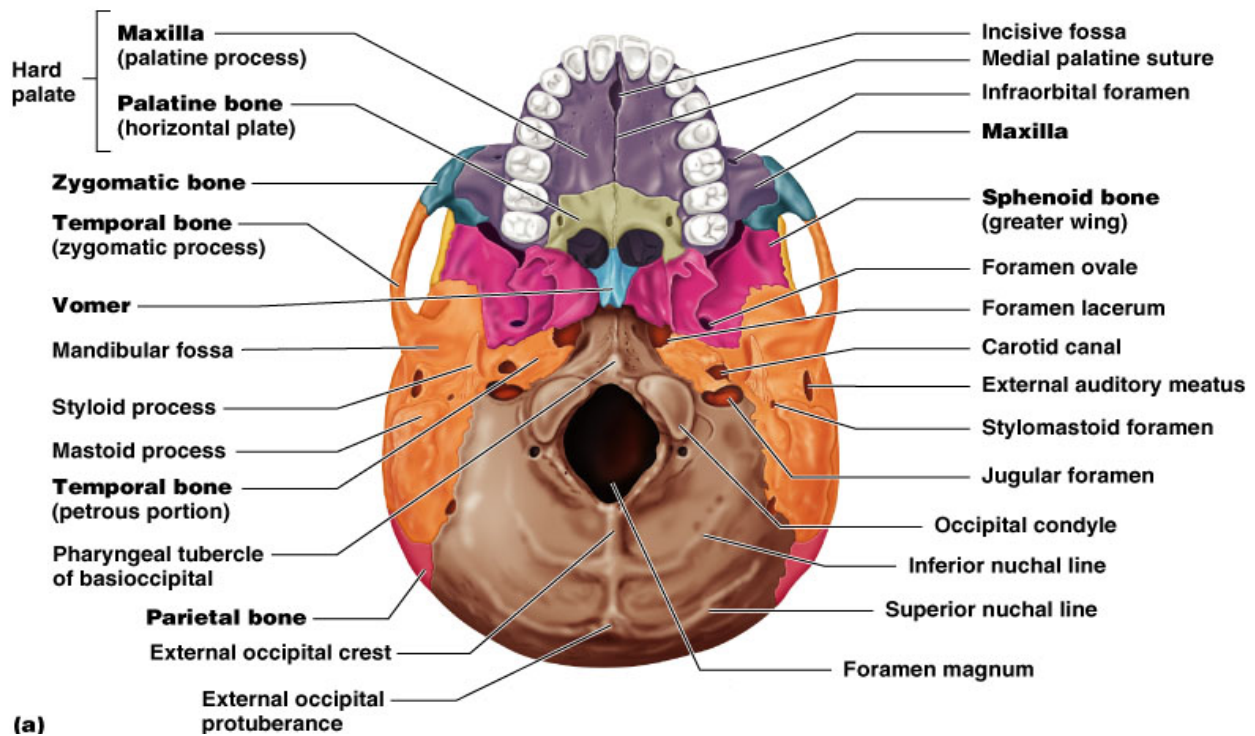
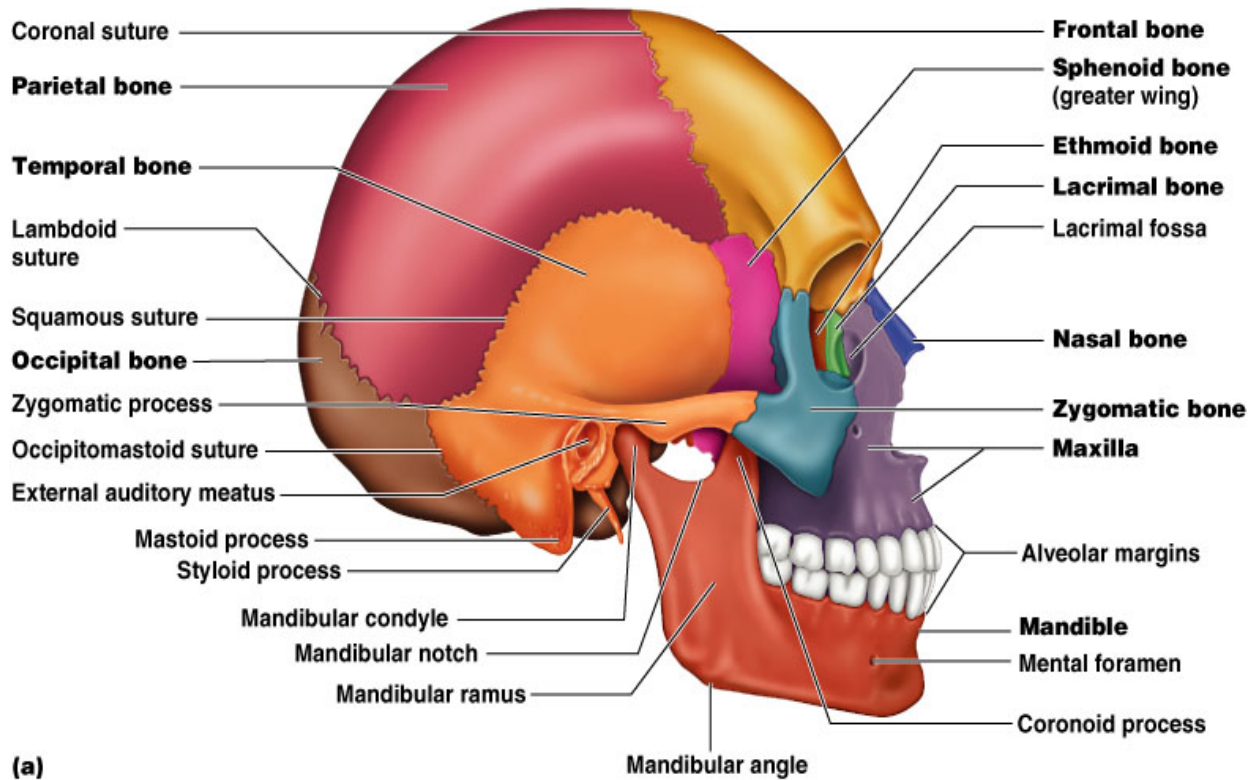
- Small bones that occur within sutures
- Irregular in shape, size, and location
- Not all people have sutural bones

Frontal Bone

- Forms the forehead and roofs of orbits
- **Supraorbital margin**—superior margin of orbits
- **Supraorbital foramen**—passage for supraorbital nerve and artery
- **Glabella**—smooth part of frontal bone between superciliary arches
- **Frontal sinuses** contributes to anterior cranial fossa

Occipital Bone

- Forms the posterior portion of the cranium and cranial base
- Articulates with the temporal bones and parietal bones
- Forms the posterior cranial fossa
- **Foramen magnum** located at its base
- Features and structures
 - Occipital condyles
 - Hypoglossal foramen
 - External occipital protuberance
 - Superior nuchal lines
 - Inferior nuchal lines

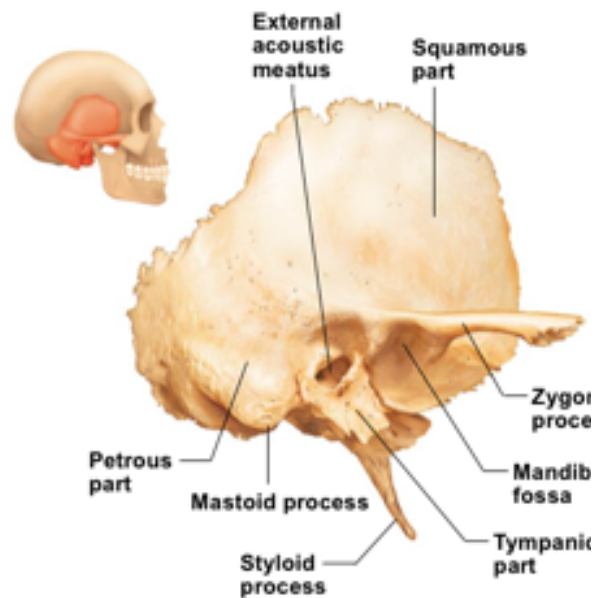


Temporal Bones

- Lie inferior to parietal bones
- Form the inferolateral portion of the skull
- Term temporal comes from Latin word for time
- Specific parts of temporal bone
 - Squamous
 - Temporal
 - Petrous

The Temporal Bone

- The **mastoid process**
 - Site for neck muscle attachment
- Contains air sinuses
- **Petrous part**
 - Projects medially, contributes to cranial base
 - Houses cavities of middle and internal ear
 - Contributes to the middle and posterior cranial fossae

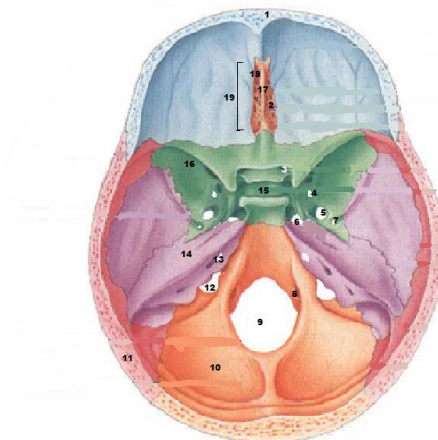


The Temporal Bone

- Foramina of the temporal bone
 - Jugular foramen
 - At boundary with occipital bone
 - Passage for internal jugular vein and cranial nerves IX, X, and XI
 - Carotid canal
 - Internal carotid artery passes through
 - Foramen lacerum
 - Internal acoustic meatus
 - Transmits cranial nerves VII and VIII

The Sphenoid Bone

- Spans the width of the cranial floor
- Resembles a bat with its wings spread
- Consists of a body and three pairs of processes
- Contains five important openings
- Is the “**keystone**” of the cranium
- Important landmarks of the sphenoid bone
 - Body, **Sella turcica**, Sphenoidal sinuses, Greater wings, Lesser wings, Pterygoid processes
- Important openings of the sphenoid bone
 - Optic canal, Superior orbital fissures,



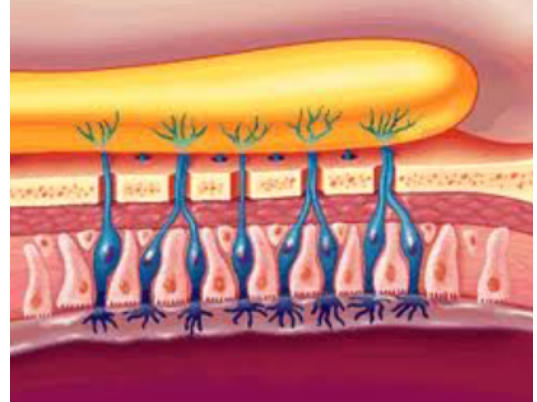
Foramen rotundum, Foramen ovale, Foramen spinosum

The Ethmoid Bone

- Lies between nasal and sphenoid bones
- Forms most of the medial bony region between the nasal cavity and orbits

The Ethmoid Bone Landmarks

- **Cribriform plate**
 - Superior surface of the ethmoid bone
 - Contains cribriform foramina
- Crista galli
 - Attachment for falx cerebri
- Perpendicular plate
 - Forms superior part of nasal septum
- Ethmoidal labyrinth—contains air cells
- Superior and middle nasal conchae
- Extend medially from lateral masses



Facial Bones

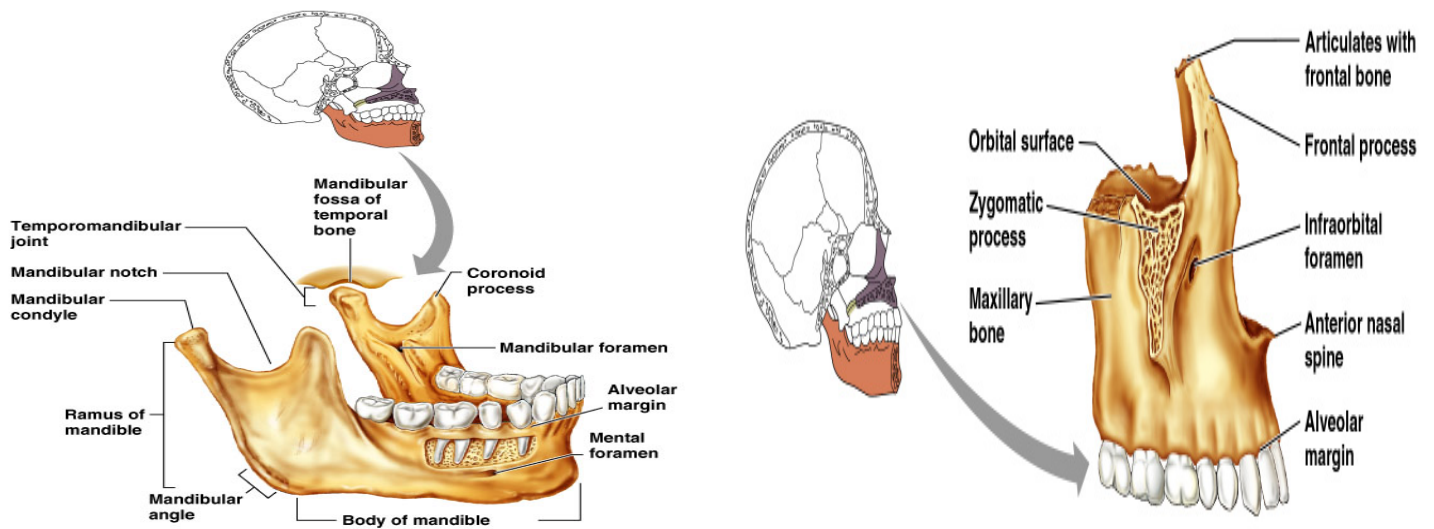
- Unpaired bones
 - Mandible and vomer
- Paired bones
 - Maxillae
 - Zygomatic bones
 - Nasal bones
 - Lacrimal bones
 - Palatine bones
 - Inferior nasal conchae

Mandible

- The lower jawbone is the largest and strongest facial bone
- Is the only movable bone of the skull
- Composed of two main parts
 - Horizontal body
 - Two upright rami
- Major landmarks
 - Mandibular fossa, mandibular foramen, alveolar process, mental foramen, condylar process, ramus

Maxillary Bones

- Articulate with all other facial bones except the mandible
- Contain maxillary sinuses
- Maxillary sinuses are the largest paranasal sinuses
- Forms part of the inferior orbital fissure
- Are the “**keystone**” bones of the face



Other Bones of the Face

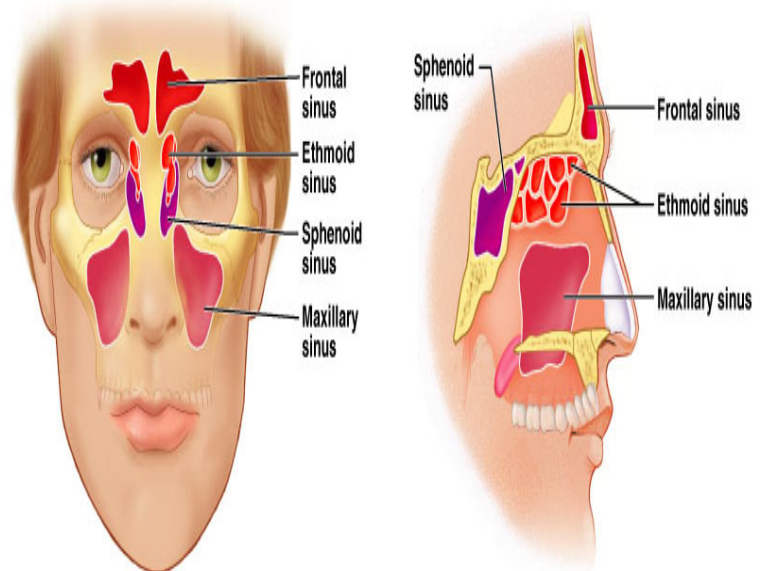
- **Zygomatic bones** - Form lateral wall of orbits
- **Nasal bones** - Form bridge of nose
- **Lacrimal bones** - Located in the medial orbital walls
- **Palatine bones** - Complete the posterior part of the hard palate
- **Vomer** - Forms the inferior part of the nasal septum
- **Inferior nasal conchae** - Thin, curved bones that project medially from the lateral walls of the nasal cavity

Special Parts of the Skull

- Nasal cavity
- Paranasal sinuses
- Orbits
- Hyoid bone

Paranasal Sinuses

- Air-filled sinuses are located within:
 - Frontal bone
 - Ethmoid bone
 - Sphenoid bone
 - Maxillary bones
- Lined with mucous membrane
- Lighten the skull



The Hyoid Bone

- Lies inferior to the mandible
- The only bone with no direct articulation with any other bone
- Acts as a movable base for the tongue

The Vertebral Column

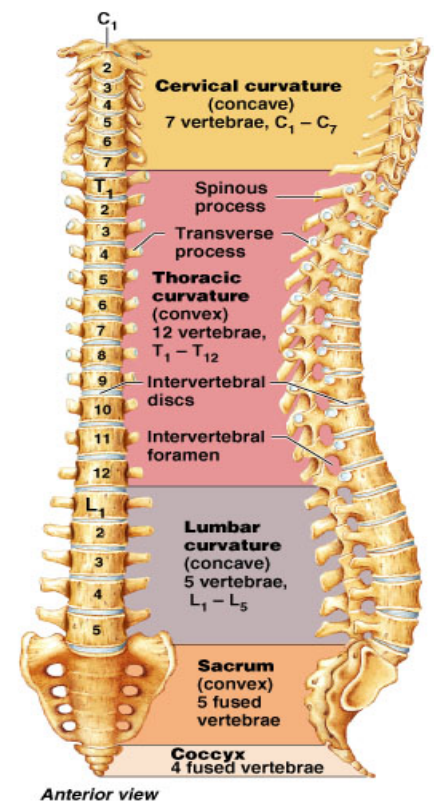
- In the adult, is formed from 26 bones
- Transmits weight of trunk to the lower limbs
- Surrounds and protects the spinal cord
- Serves as attachment sites for muscles of the neck and back
 - Held in place by ligaments
 - Anterior and posterior longitudinal ligaments
 - Ligamentum flavum

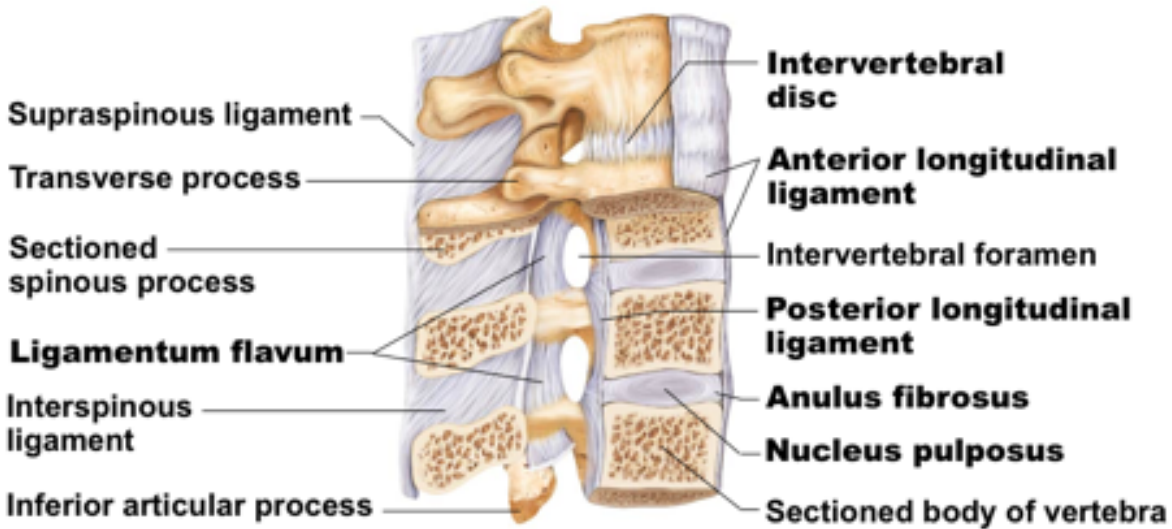
Spinal Regions

- The vertebral column has five major regions
 - **7 cervical** vertebrae of the neck region
 - **12 thoracic** vertebrae
 - **5 lumbar** vertebrae
 - **Sacrum**—five fused bones inferior to lumbar vertebrae
 - **Coccyx**—inferior to sacrum

Spinal Normal Curvatures

- Curvatures of the spine
 - Cervical and lumbar curvatures - concave posteriorly
 - Thoracic and sacral curvatures - convex posteriority
- Curvatures increase resilience of spine
- Primary curvatures are
 - Thoracic and sacral curvatures
 - Present at birth
- Secondary curvatures are
 - Cervical and lumbar curvatures
 - Develop when baby begins to walk



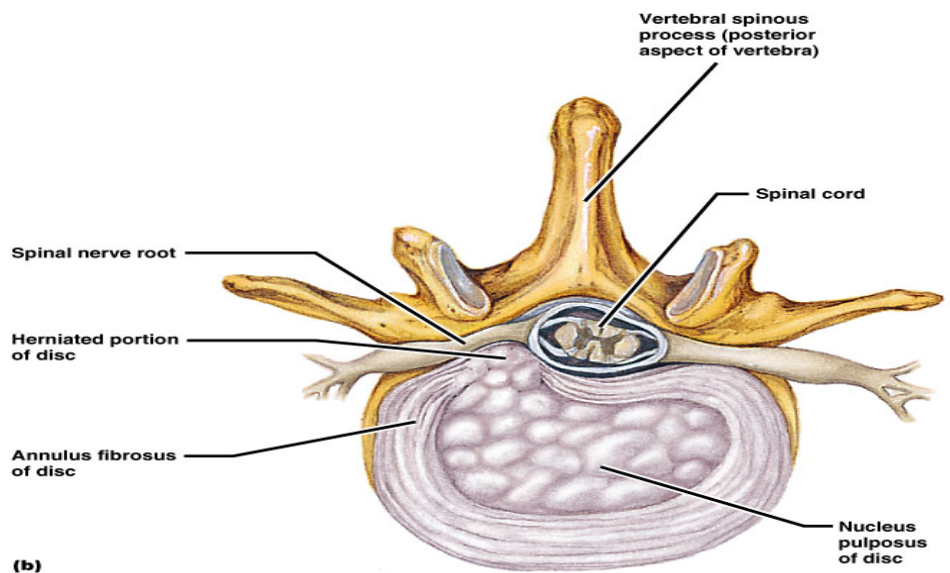


Ligaments of the Spine

- Major supporting ligaments
 - **Anterior longitudinal ligament**
 - Attaches to bony vertebrae and intervertebral discs
 - Prevents hyperextension
 - **Posterior longitudinal ligament**
 - Narrow and relatively weak
 - Attaches to intervertebral discs

Intervertebral Discs

- Are cushion-like pads between vertebrae
- Composed of
 - **Nucleus pulposus**
 - Gelatinous inner sphere
 - Absorbs compressive stresses
 - **Anulus fibrosus**
 - Outer rings formed of ligament
 - Inner rings formed of fibrocartilage

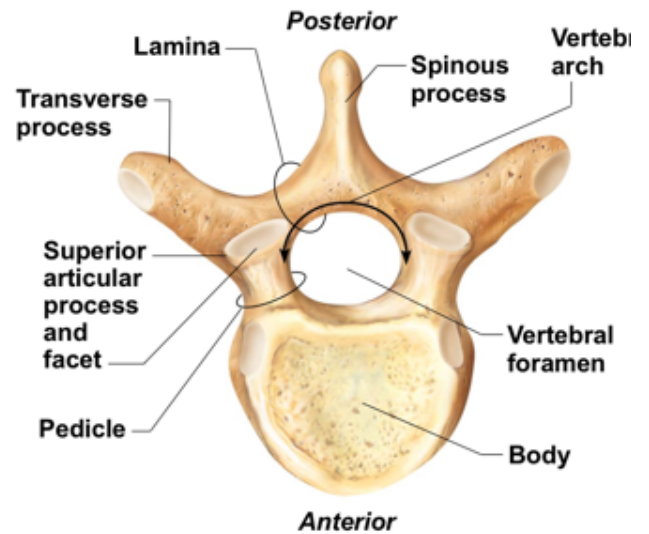


General Structure of Vertebrae

- Common structures to all regions
- Body
- Vertebral arch
- Vertebral foramen
- Spinous process
- Transverse process
- Superior and inferior articular processes
- Intervertebral foramina

Vertebral Characteristics

- Specific regions of the spine perform specific functions
- Types of movement that occur between vertebrae
 - Flexion and extension
 - Lateral flexion
 - Rotation in the long axis

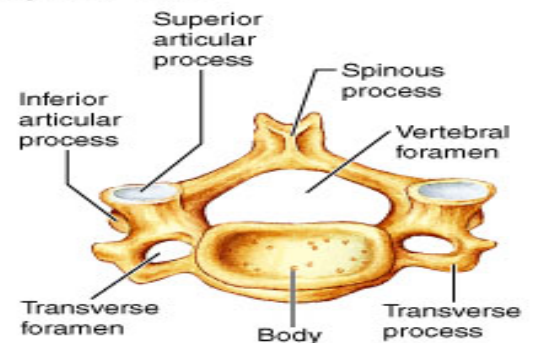


Cervical (3–7)

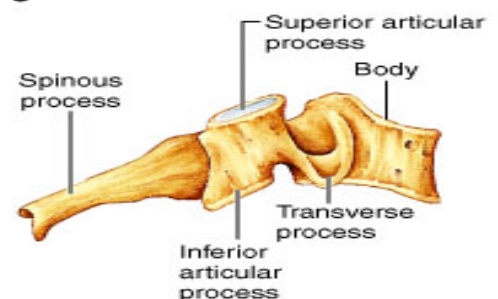
Cervical Vertebrae

- Seven **cervical vertebrae** (C₁–C₇)
- Are the smallest and lightest vertebrae
- C₃–C₇ are typical cervical vertebrae
 - Body is wider laterally
 - Spinous processes are short and bifid
- Vertebral foramen are large and triangular
- **Transverse processes** contain transverse foramina
- Superior articular facets face superoposteriorly

Superior View



Right Lateral View

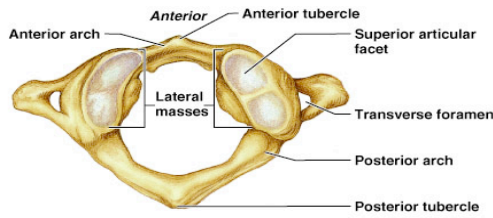


The Atlas – C1

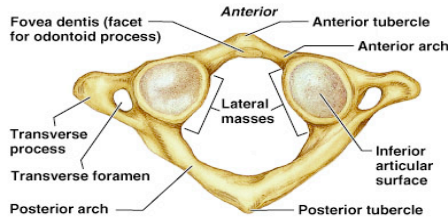
- C₁ lacks a body and spinous process
- Supports the skull
- Superior articular facets receive the occipital condyles
- Allows flexion and extension of neck
 - Nodding the head “yes”

The Axis – C2

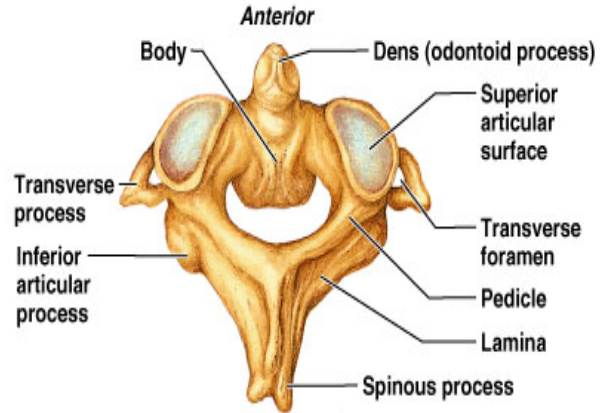
- Has a body and spinous process
- **Dens** (odontoid process) projects superiorly
 - Acts as a pivot for rotation of the atlas and skull
 - Participates in rotating the head from side to side



(a) Superior view of atlas (C₁)



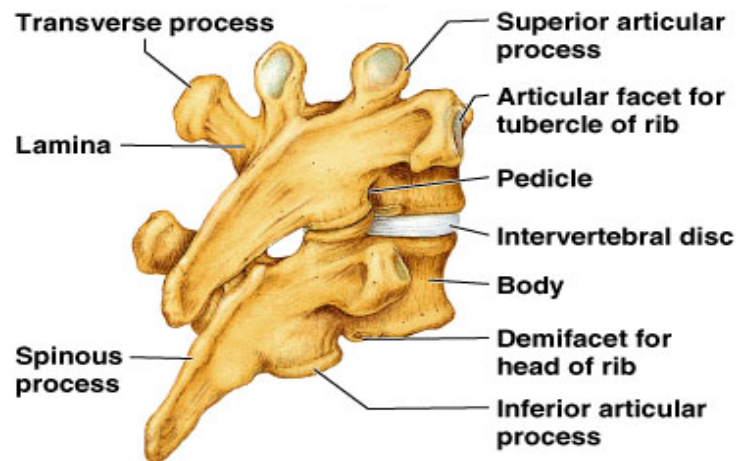
(b) Inferior view of atlas (C₁)



(c) Superior view of axis (C₂)

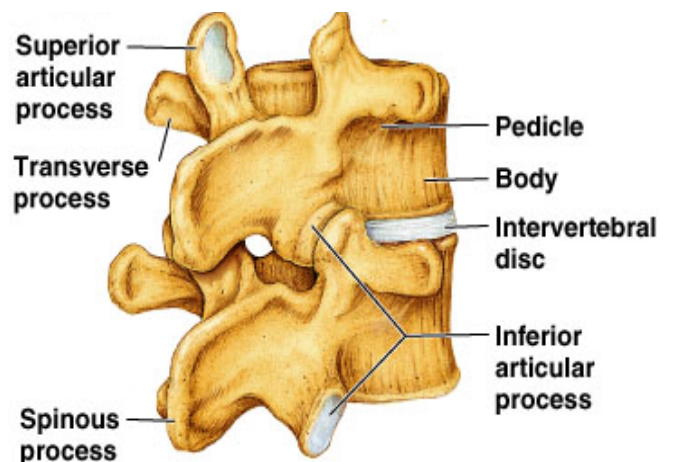
Thoracic Vertebrae (T₁–T₁₂)

- All articulate with ribs
- Have heart-shaped bodies from the superior view
- Articulation with ribs
- Spinous processes are long and point inferiorly
- Vertebral foramen are circular
- Transverse processes articulate with tubercles of ribs
- Superior articular facets point posteriorly
- Inferior articular processes point anteriorly
- Allows rotation and prevents flexion and extension



Lumbar Vertebrae (L₁–L₅)

- Bodies are thick and robust
- Transverse processes are thin and tapered
- Spinous processes are thick and blunt and point posteriorly
- Vertebral foramina are triangular
- Superior and inferior articular facets directly medially
- Allows flexion and extension—rotation prevented



Sacrum (S₁–S₅)

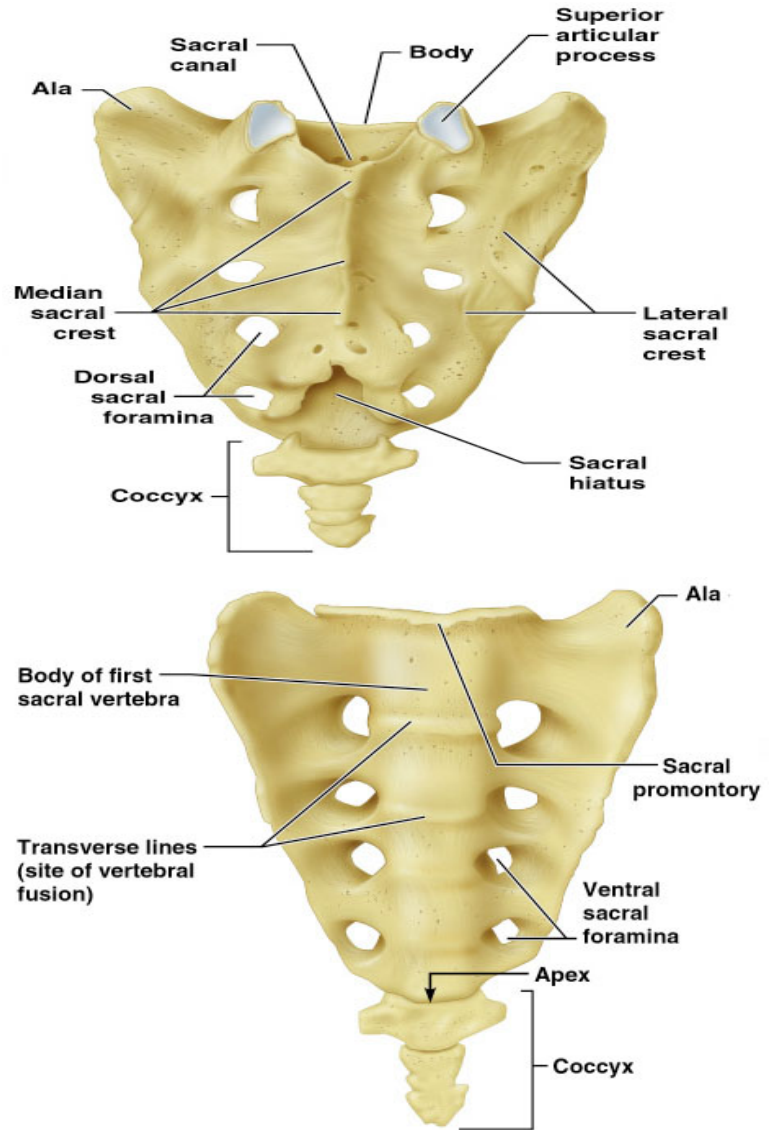
- Shapes the posterior wall of pelvis
- Formed from 5 fused vertebrae
- Superior surface articulates with L₅
- Inferiorly articulates with coccyx
- **Sacral promontory**
 - Where the first sacral vertebrae bulges into pelvic cavity
 - Center of gravity is 1 cm posterior to sacral promontory
- **Ala**—develops from fused rib elements
- **Sacral foramina**
- **Ventral foramina**
 - Passage for ventral rami of sacral spinal nerves
- **Dorsal foramina**
 - Passage for dorsal rami of sacral spinal nerves

Coccyx

- Is the “tailbone”
- Formed from 3–5 fused vertebrae
- Offers only slight support to pelvic organs

The Thoracic Cage

- Forms the bony framework of the chest
- Components
 - Thoracic vertebrae—posteriorly
 - Ribs—laterally
 - Sternum and costal cartilage—anteriorly
- Protects thoracic organs
- Supports shoulder girdle and upper limbs
- Provides attachment sites for many muscles of the back

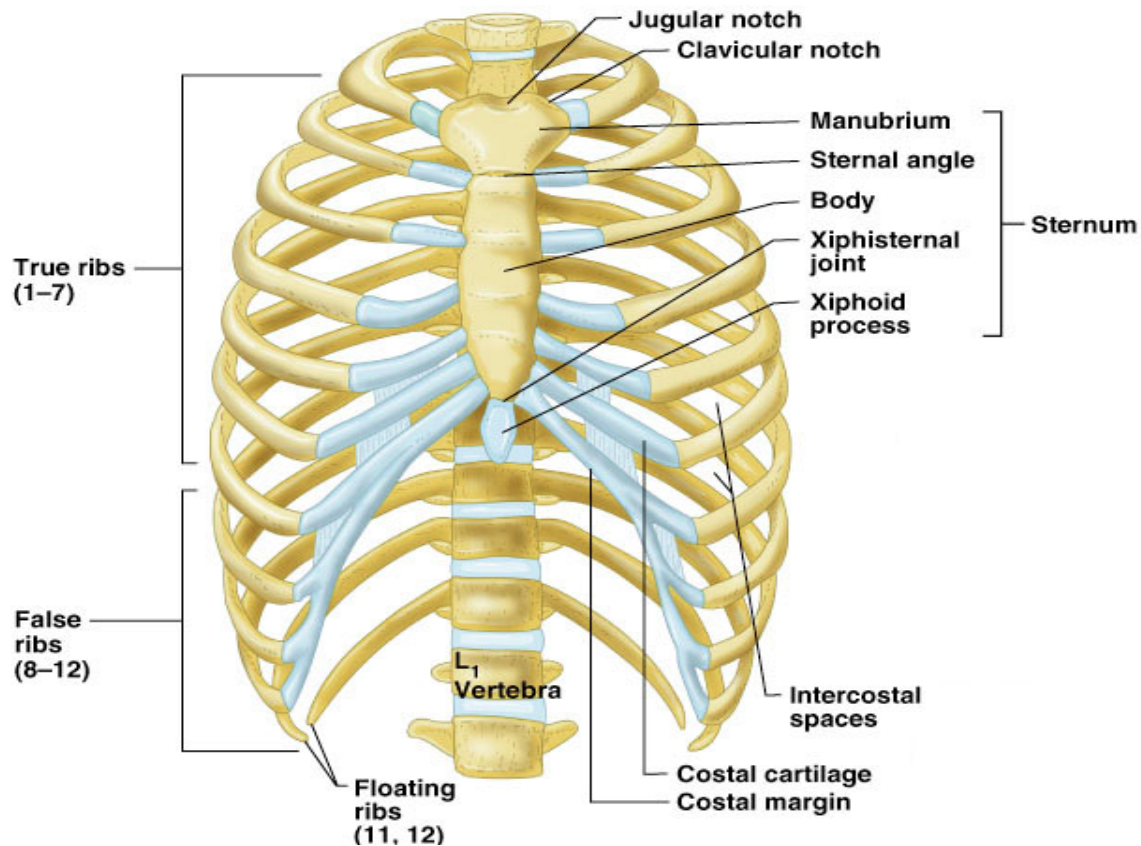


Sternum

- Formed from three sections
 - **Manubrium**—superior section
 - Clavicular notches articulate with medial end of clavicles
 - **Body**—bulk of sternum
 - Sides are notched at articulations for costal cartilage of ribs 2–7
 - **Xiphoid process**—inferior end of sternum
 - Ossifies around age 40
- Anatomical landmarks
 - **Jugular notch**
 - Central indentation at superior border of the manubrium
 - **Sternal angle**
 - A horizontal ridge where the manubrium joins the body
 - **Xiphisternal joint**
 - Where sternal body and xiphoid process fuse
 - Lies at the level of the 9th thoracic vertebra

Ribs

- All ribs attach to vertebral column posteriorly
- **True ribs**—superior seven pairs of ribs
- **False ribs**—inferior five pairs of ribs
- Ribs 11–12 are known as **floating ribs**



Disorders of the Axial Skeleton

- **Cleft palate**
 - A common congenital disorder
 - Right and left halves of palate fail to fuse medially
- **Stenosis of the lumbar spine**
 - Narrowing of the vertebral canal
 - Can compress roots of spinal nerves
- Abnormal spinal curvatures
 - **Scoliosis**—an abnormal lateral curvature
 - **Kyphosis**—an exaggerated thoracic curvature
 - **Lordosis**—an accentuated lumbar curvature; “swayback”

The Axial Skeleton Throughout Life

- Membrane bones begin to ossify in second month of development
- Bone tissue grows outward from ossification centers
- **Fontanelles** - Unossified remnants of membranes
- Many bones of the face and skull form by intramembranous ossification
- Endochondral bones of the skull
 - Occipital bone
 - Sphenoid bone
 - Ethmoid bones
 - Parts of the temporal bone

- Aging of the axial skeleton
 - Water content of the intervertebral discs decreases
 - By age 55, loss of a few centimeters in height is common
 - Thorax becomes more rigid
 - Bones lose mass with age

