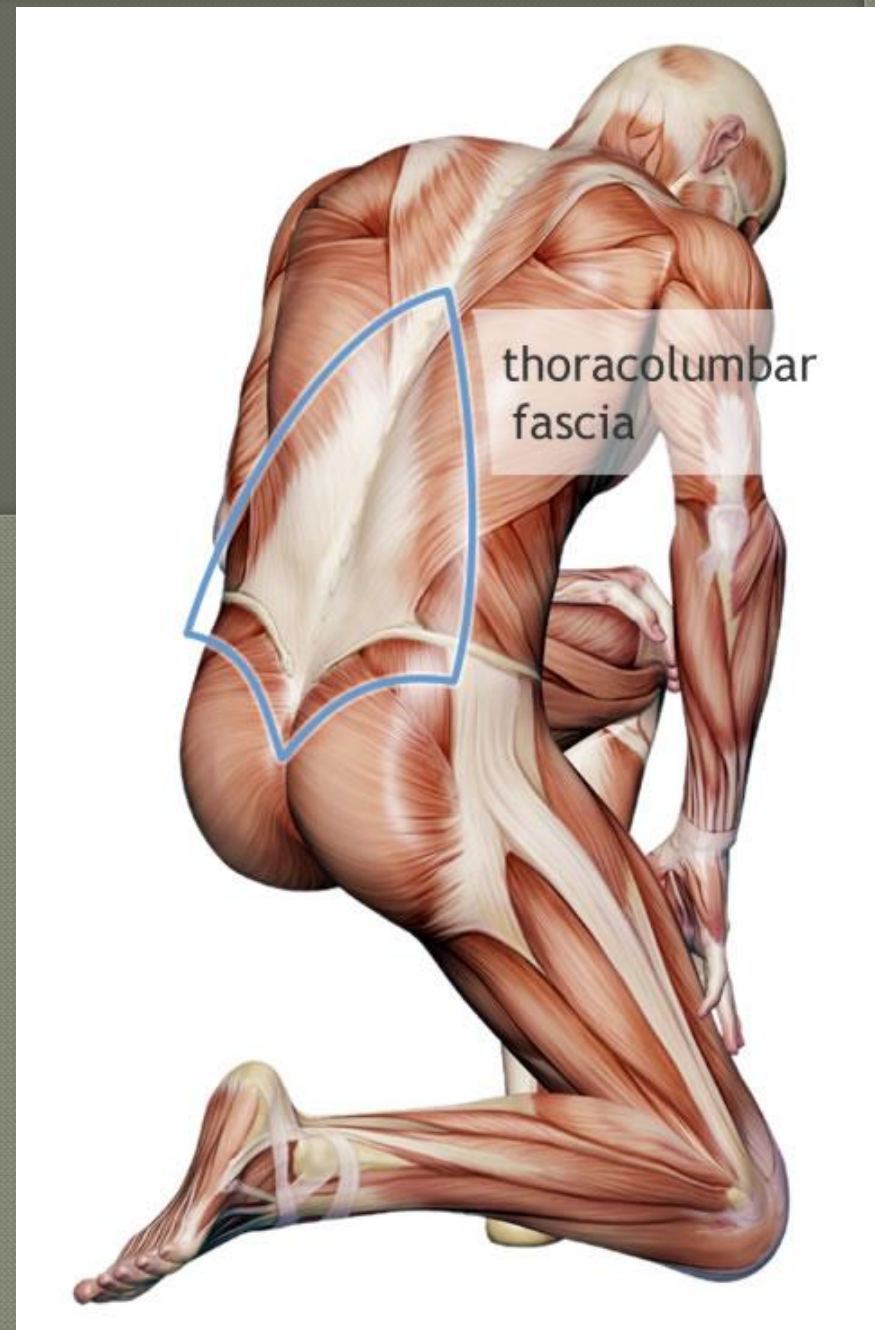


Anatomy of The Musculoskeletal System

Dr. Nabil khouri MD, MSc, Ph.D



What we will study!

The Skeletal system “Objectives”

Skeletal system: is made of Bones that is a *hard* supporting tissue

Bones are used to make up the skeleton

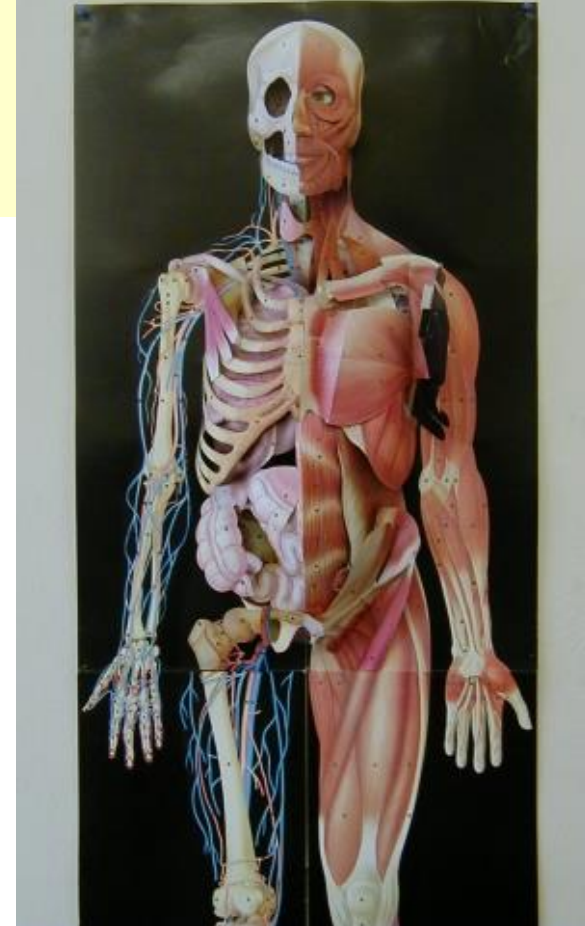
Found in many forms including:

“small, large, long, short and flat”

Bones are held together by Joints which allow and/or restrict movements.

Movements are performed by Muscle upon their contractions

Muscle is made of muscular tissue



Objectives

- Divisions of the Skeleton
- Classification of Bones
- Major bony landmarks

Bones: Forms In the skeleton and are arranged into Axial and appendicular groups

• Vertebral Column	26
• Axial skeleton	
• Skull	22
• Hyoid bone	1
• Ribs and sternum	25
•	-----
• Appendicular skeleton	
• Upper Extremities	64
• Lower Extremities	62
•	-----
• Auditory bones	6
•	-----
• The total number of bones	206

Function of Bones

- **support (eg: pelvis, legs)**
- **protect (eg: skull, vertebrae)**
- **mineral storage (eg: calcium, phosphate, inorganic component)**
- **movement (eg: walk, grasp objects)**
- **blood-cell formation (eg: red bone marrow)**
- **Cellular components include**
 - **Osteoblasts: secrete organic part of bone matrix = osteoid**
 - **Osteocytes: mature bone cells, maintain bone matrix**

Divisions of the Skeleton

- **The Axial skeleton**
 - The skull
 - The sternum
 - The ribs
 - The vertebral column
- **The appendicular skeleton**
 - Upper extremities
 - Lower extremities
 - The shoulder girdle
 - The pelvic girdle

Classification of Bones

Types of Bone

- 1). Long bones
- 2). Short bones.
- 3). Flat bone:
- 4). Irregular bones
- 5). Sesamoid bones are special short bones:
Ex: patella



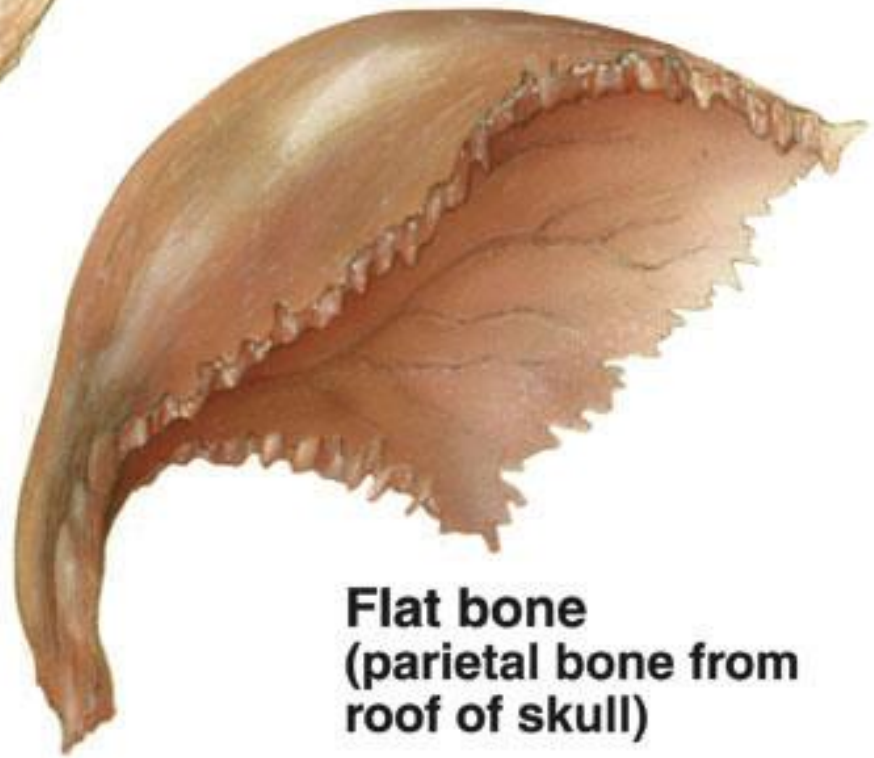
**Long bone
(femur or thighbone)**



**Irregular bone
(sphenoid bone
from skull)**



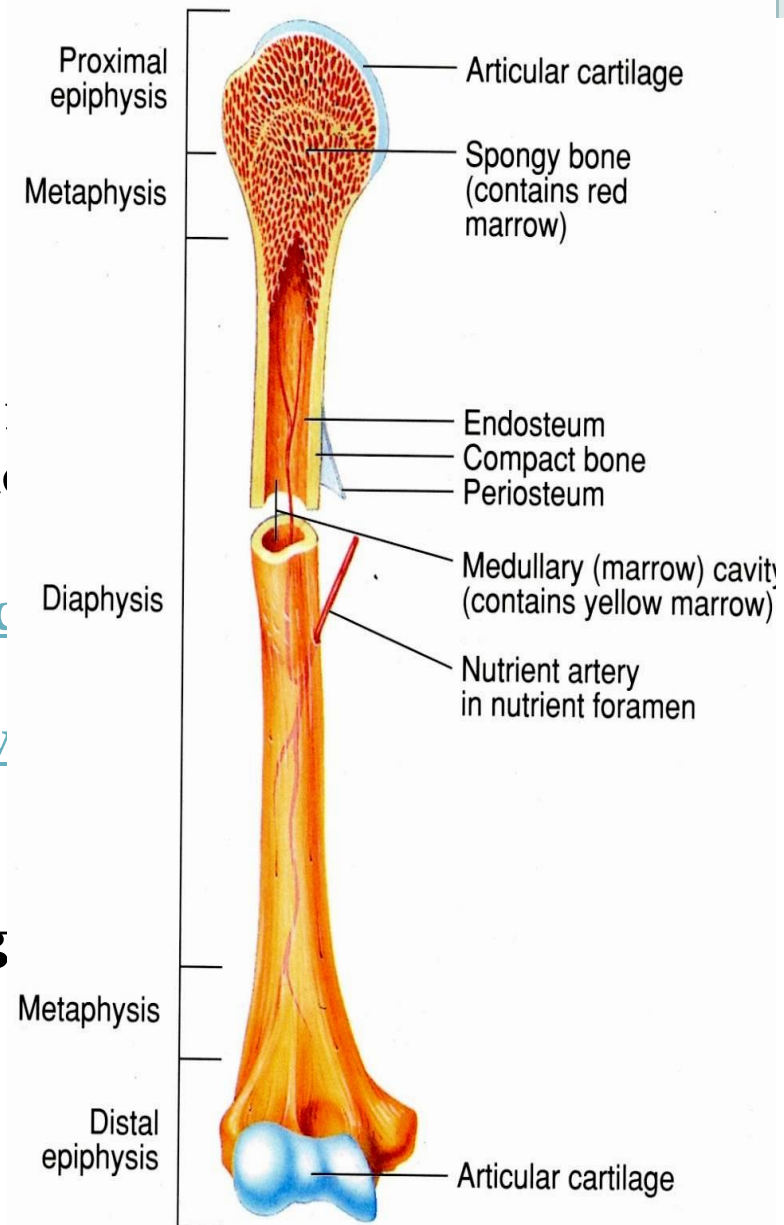
**Short bone
(carpal or wrist bone)**



**Flat bone
(parietal bone from
roof of skull)**

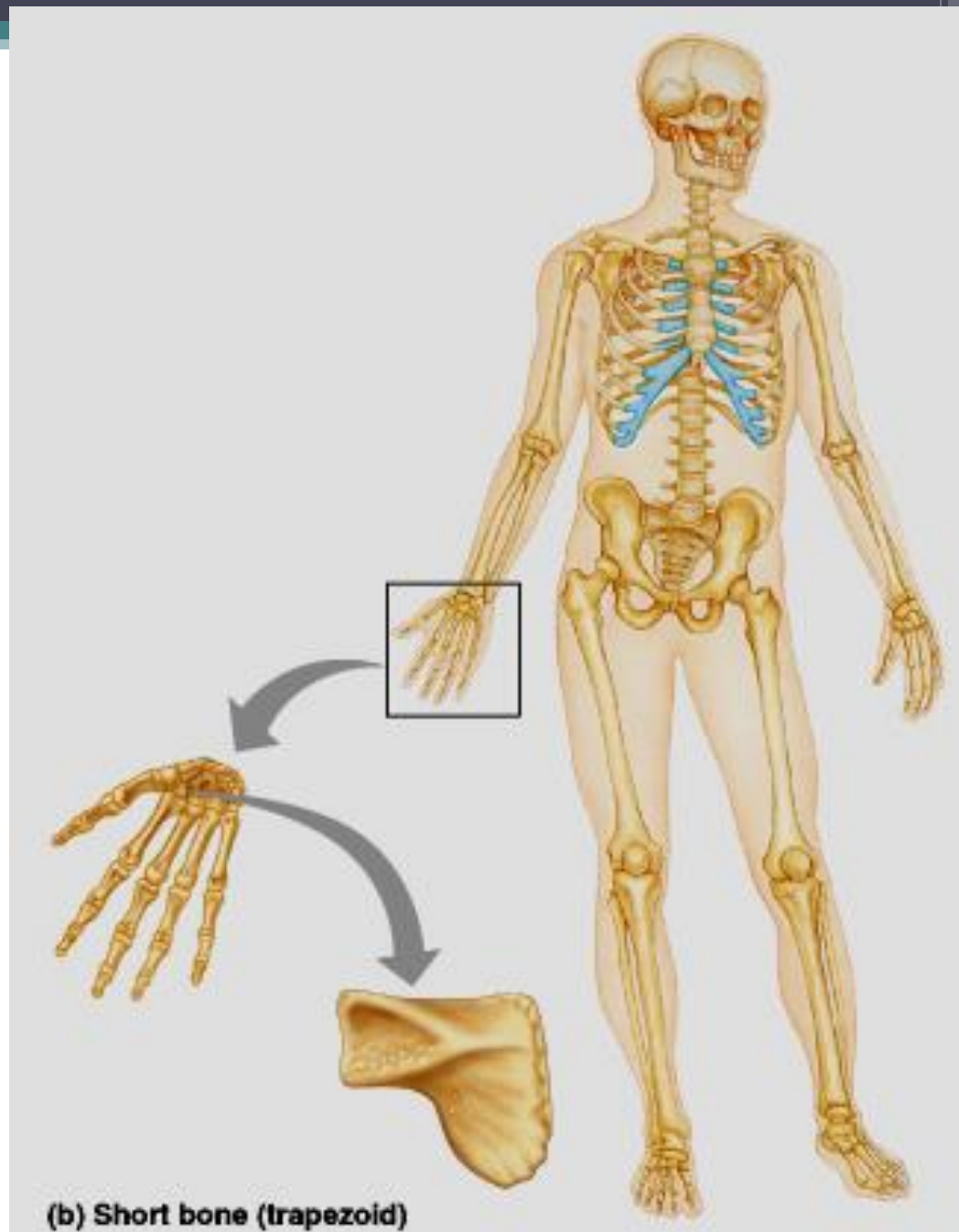
Long Bones

- **Long bones** are characterized by having one shaft (the **Diaphysis**) that is much greater in length than width and two extremities (epiphysis).
- They are comprised mostly of **compact bone** and lesser amounts of **marrow**, which is located within the **medullary cavity**, and **spongy bone**.
- Most bones of the limbs, including those of the **fingers** and **toes**, are long bones.



Short bones

- Cube-shaped bones of the wrist and ankle
- Bones that form within tendons (e.g., patella)

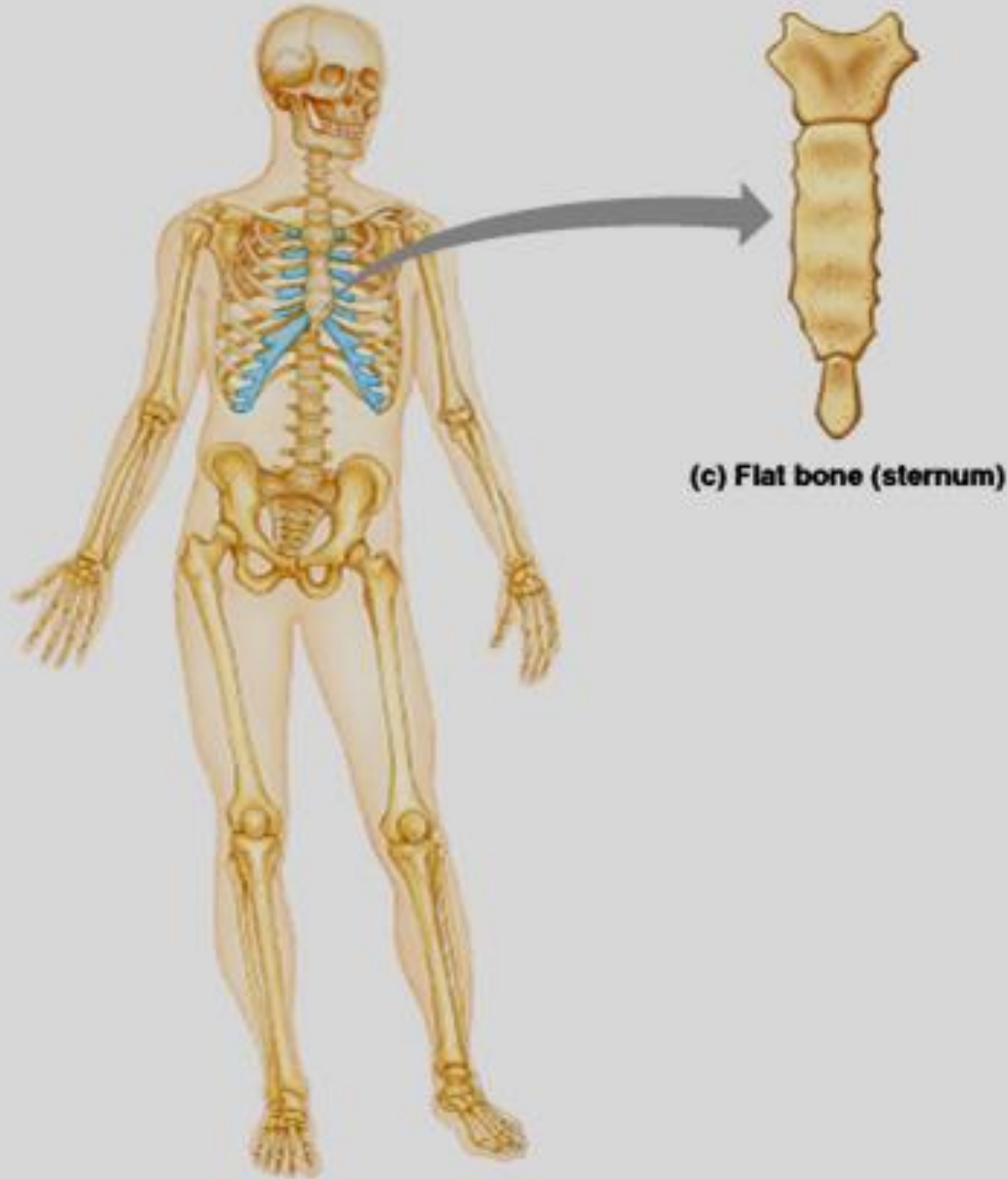


Short bones

- Short bones are roughly cube-shaped, and have only a thin layer of compact bone surrounding a spongy interior .
- The bones of the wrist and ankle are short bones, as are the sesamoid bones .

Flat bones

- Thin, flattened, and a bit curved (e.g., sternum, and most skull bones)

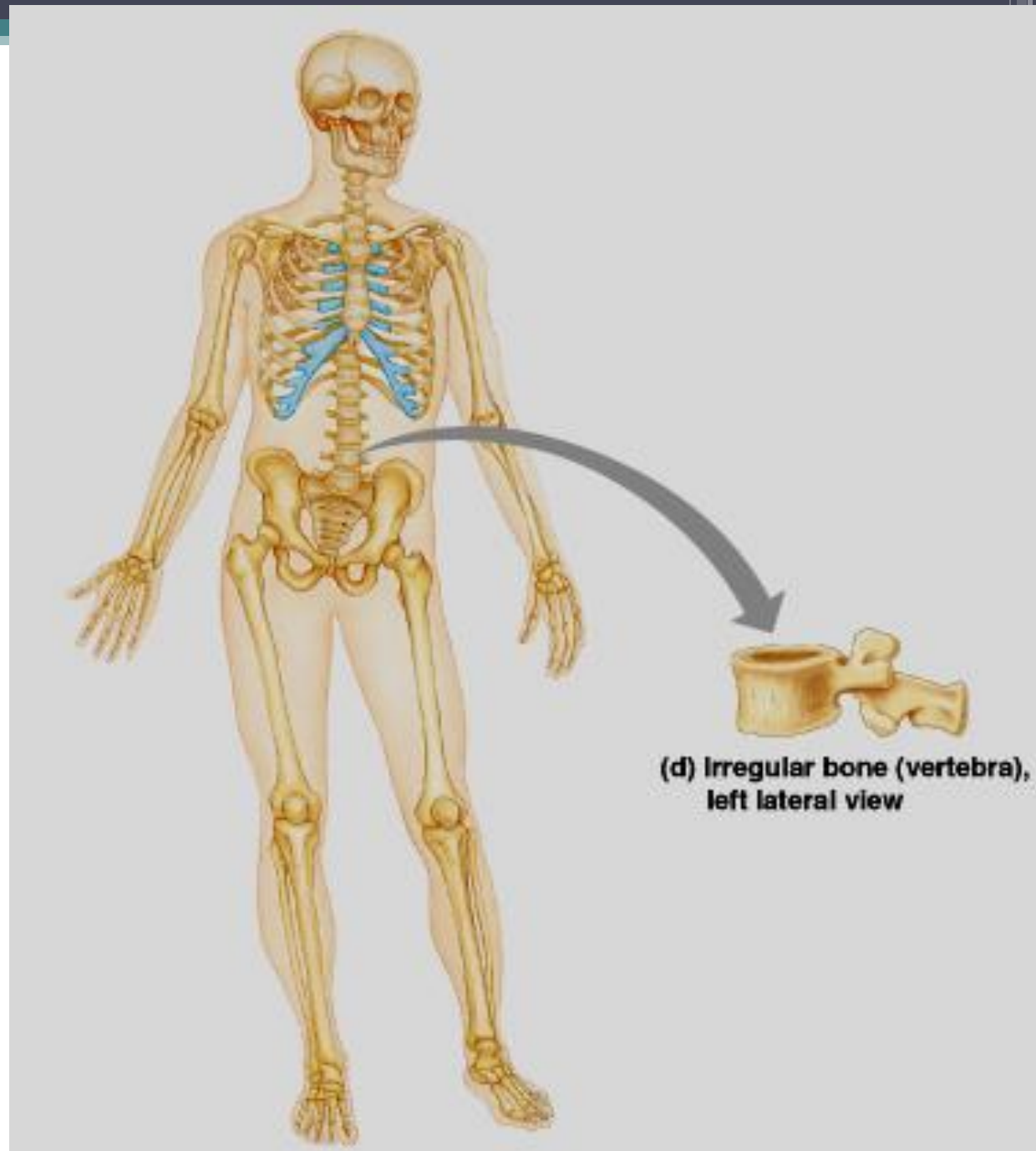


Flat bones

- Flat bones are thin and generally curved, with two parallel layers of compact bones sandwiching a layer of spongy bone .
- Most of the bones of the skull are flat bones, as is the sternum .

Irregular bones

- bones with complicated shapes
- (e.g., vertebrae and hip bones)



Irregular bones

- Irregular bones do not fit into the above categories .
- They consist of thin layers of compact bone surrounding a spongy interior.
- As implied by the name, their shapes are irregular and complicated .
- The bones of the spine and hips are irregular bones .

Surface Features of the Bone

- 1). **Projections that form joints**
 - a). **Head**: The proximal articular end of the bone
 - b). **Facet**: A small, flattened articular surface
 - c). **Condyle**: A large, rounded articular process
 - d). **Ramus**: An arm-like branch off the body of a bone

Surface Features of the Bone

2). Sites of muscle & ligament attachment.

- a). **Tuberosity**: A projection or bump with a roughened surface
- b). **Crest**: A prominent elevation or ridge
- c). **Trochanter**: A specific tuberosities located on specific bones “Femur”
- d). **Line**
- e). **Tubercle**: A projection or bump with a roughened surface, generally smaller than a tuberosity
- f). **Epicondyle**: A projection near to a condyle but not part of the joint.
- g). **Spine**: A relatively long, thin projection or bump
- h). **Process**: A relatively large projection or prominent bump.(gen.)

Surface Features of the Bone

3). Openings that allow blood vessels and nerves to pass

- a). Meatus: A short canal
- b). Fissure
- c). Foramen: An opening through a bone.
- d). Sinus: Pocket (cavity) like structure within the cranial bone
- e). Canal: A long, tunnel-like foramen, usually a passage for notable nerves or blood vessels

Surface Features of the Bone

4). **Depressions**

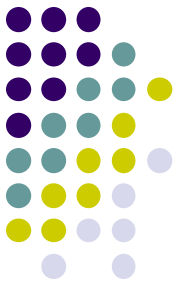
- a). **Fossa:** A broad, shallow depressed area
- b). **Grove**
- c). **Notch:** A small depression

Skeletal System

Axial skeleton

Dr. Nabil khouri

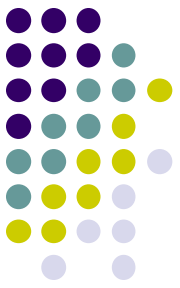
The Axial Skeleton

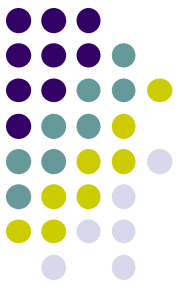


- **Eighty bones segregated into three regions**
 - **Skull**
 - **Vertebral column**
 - **Bony thorax**

The Skull

- The skull, the body's most complex bony structure, is formed by the cranium and facial bones
- Cranium – protects the brain and is the site of attachment for head and neck muscles
- Facial bones
 - Supply the framework of the face, the sense organs, and the teeth
 - Provide openings for the passage of air and food
 - Anchor the facial muscles of expression

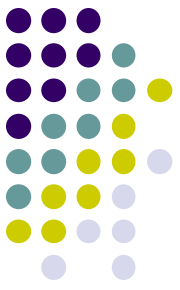




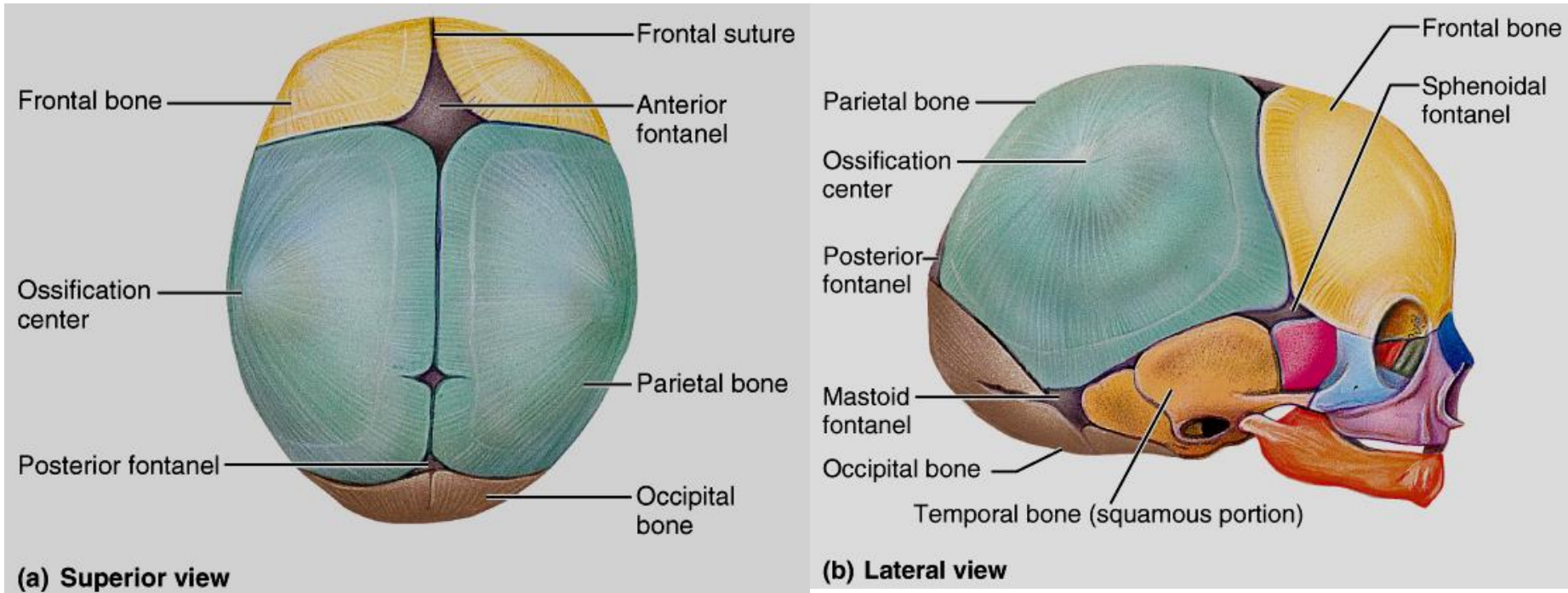
Anatomy of the Cranium

- Eight cranial bones – two parietal, two temporal, and one each frontal, occipital, sphenoid, and ethmoid
- Cranial bones are thin and remarkably strong for their weight

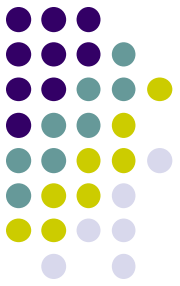
Developmental Aspects of the Skeleton: Neonatal Fetal Skull



- Skull bones such as the mandible and maxilla are unfused

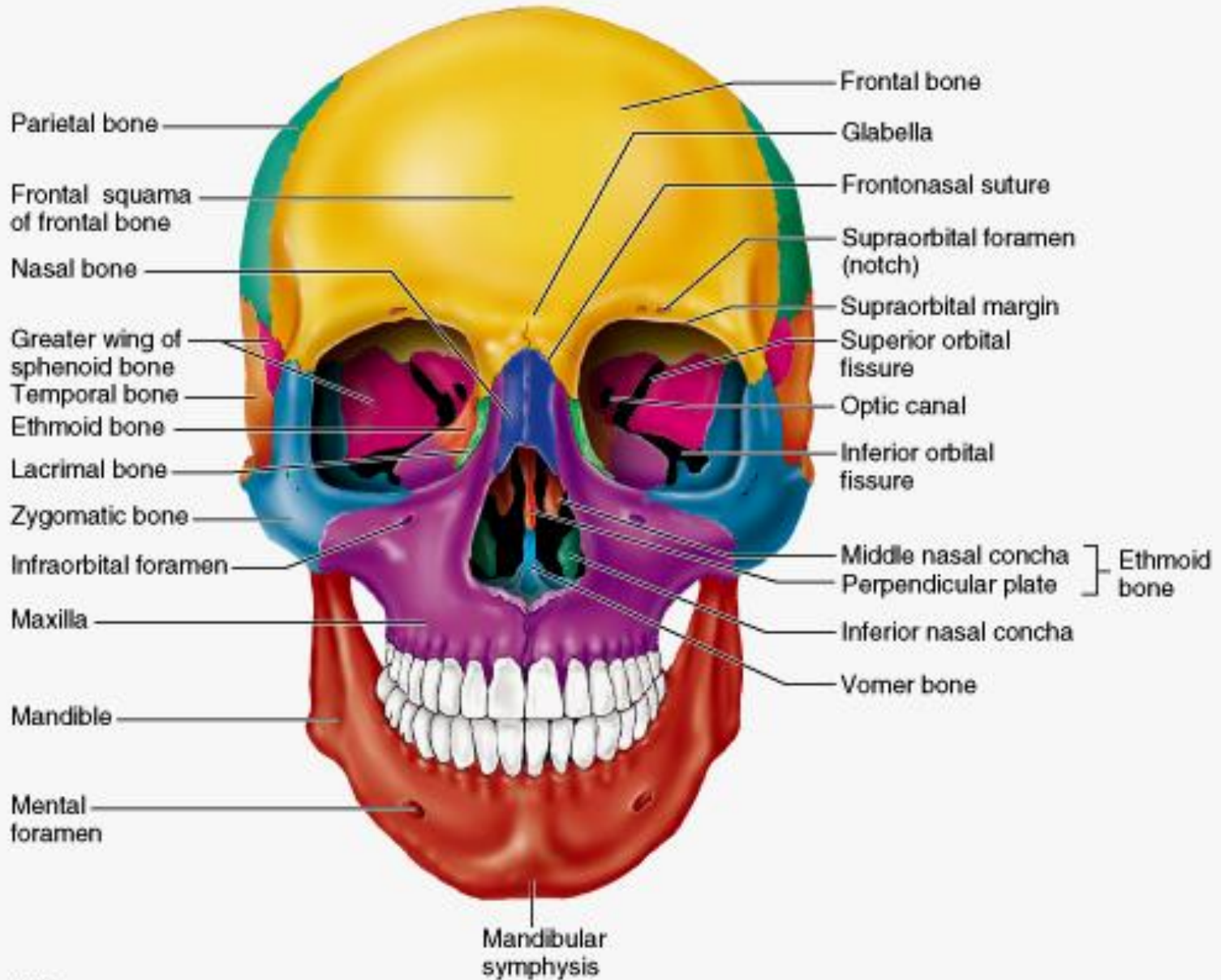
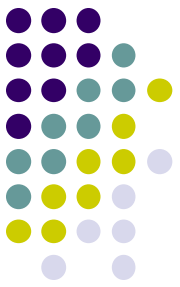


Frontal Bone



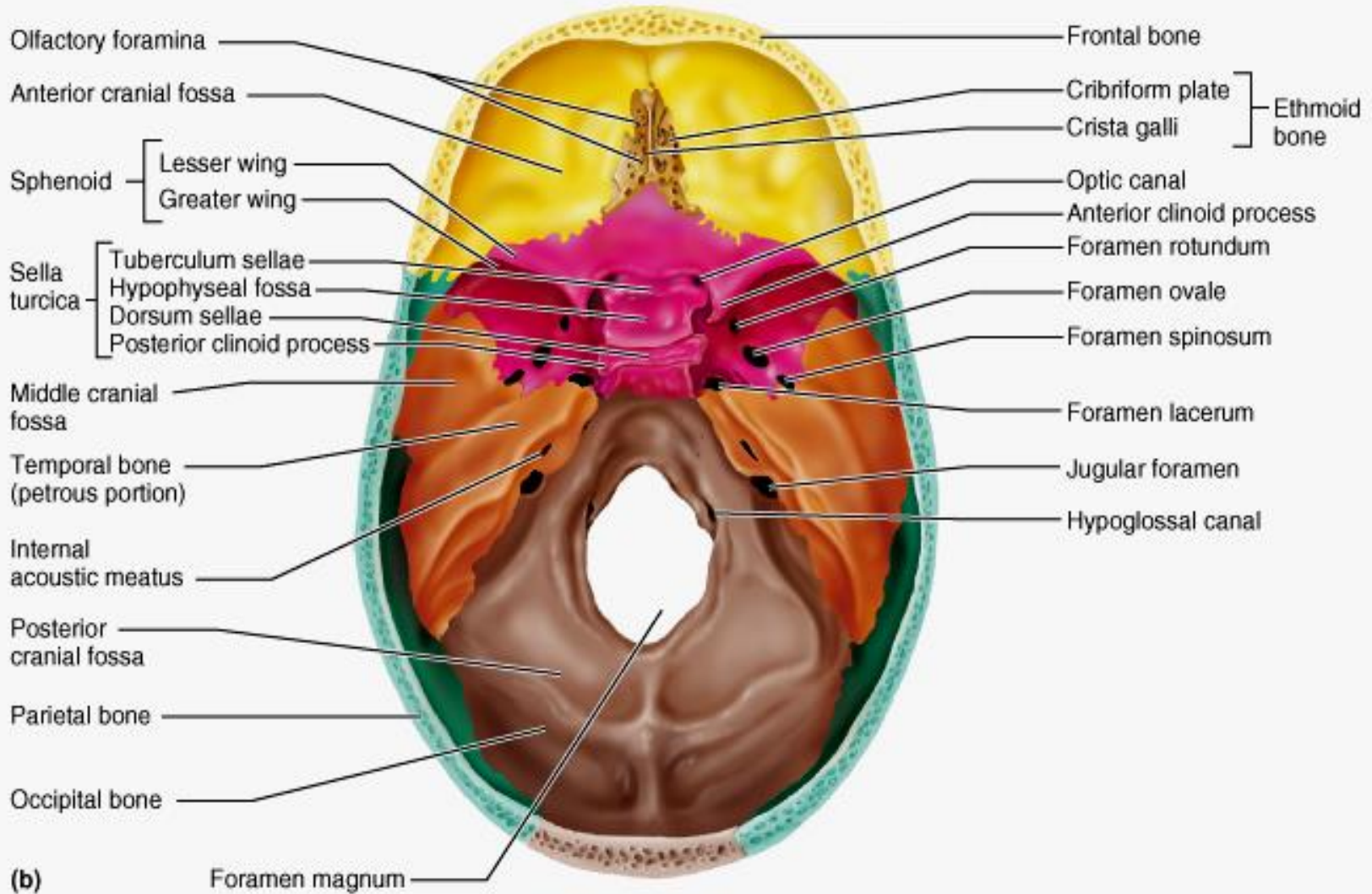
- Forms the anterior portion of the cranium
- Articulates posterior with the parietal bones via the coronal suture
- Major markings include the supra-orbital margins, the anterior cranial fossa, lateral and medial process and the frontal sinuses

Skull – Anterior View

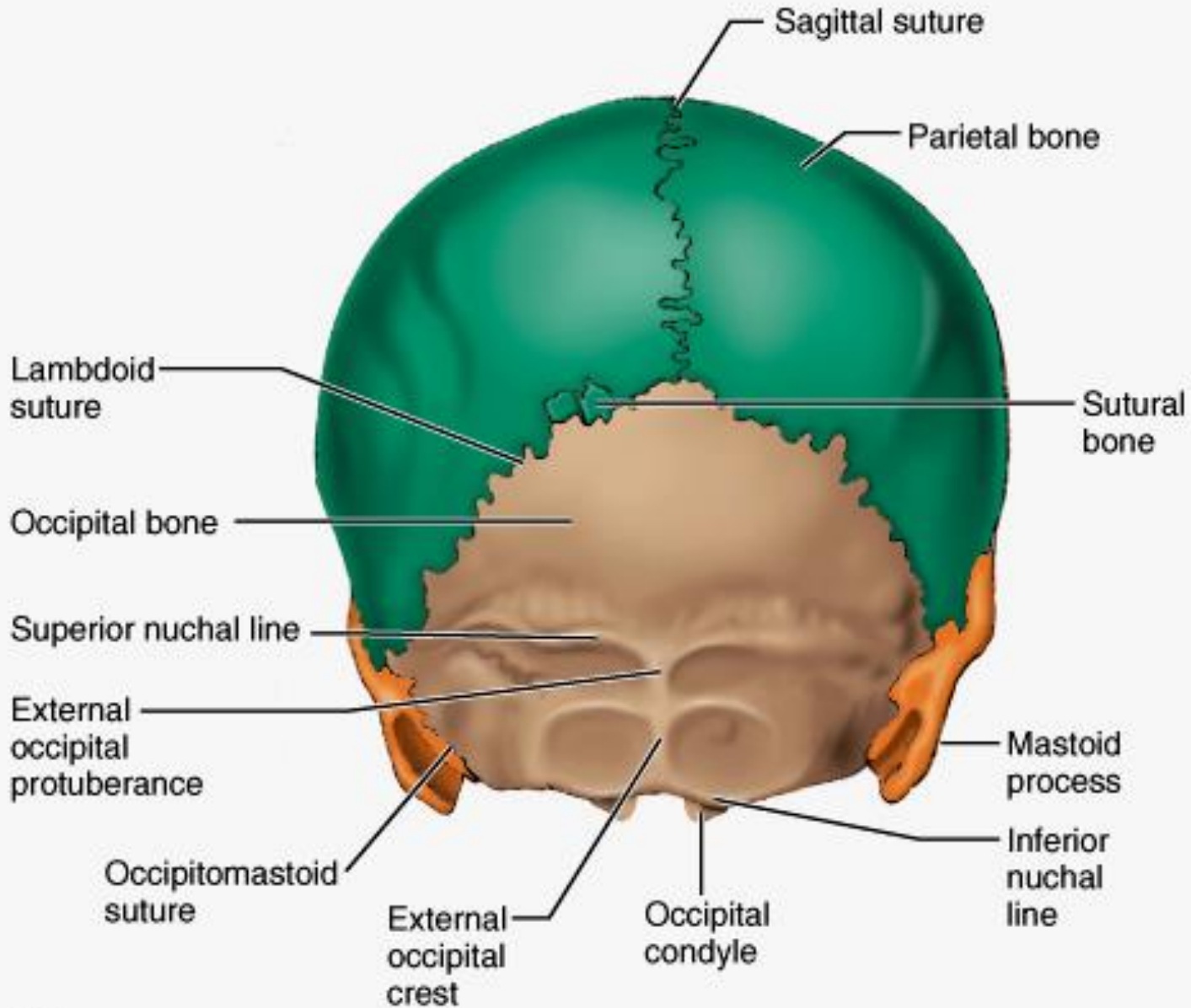
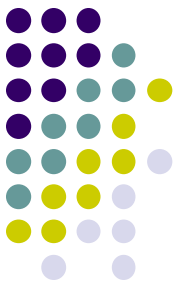


(a)

Occipital Bone and Its Major Markings

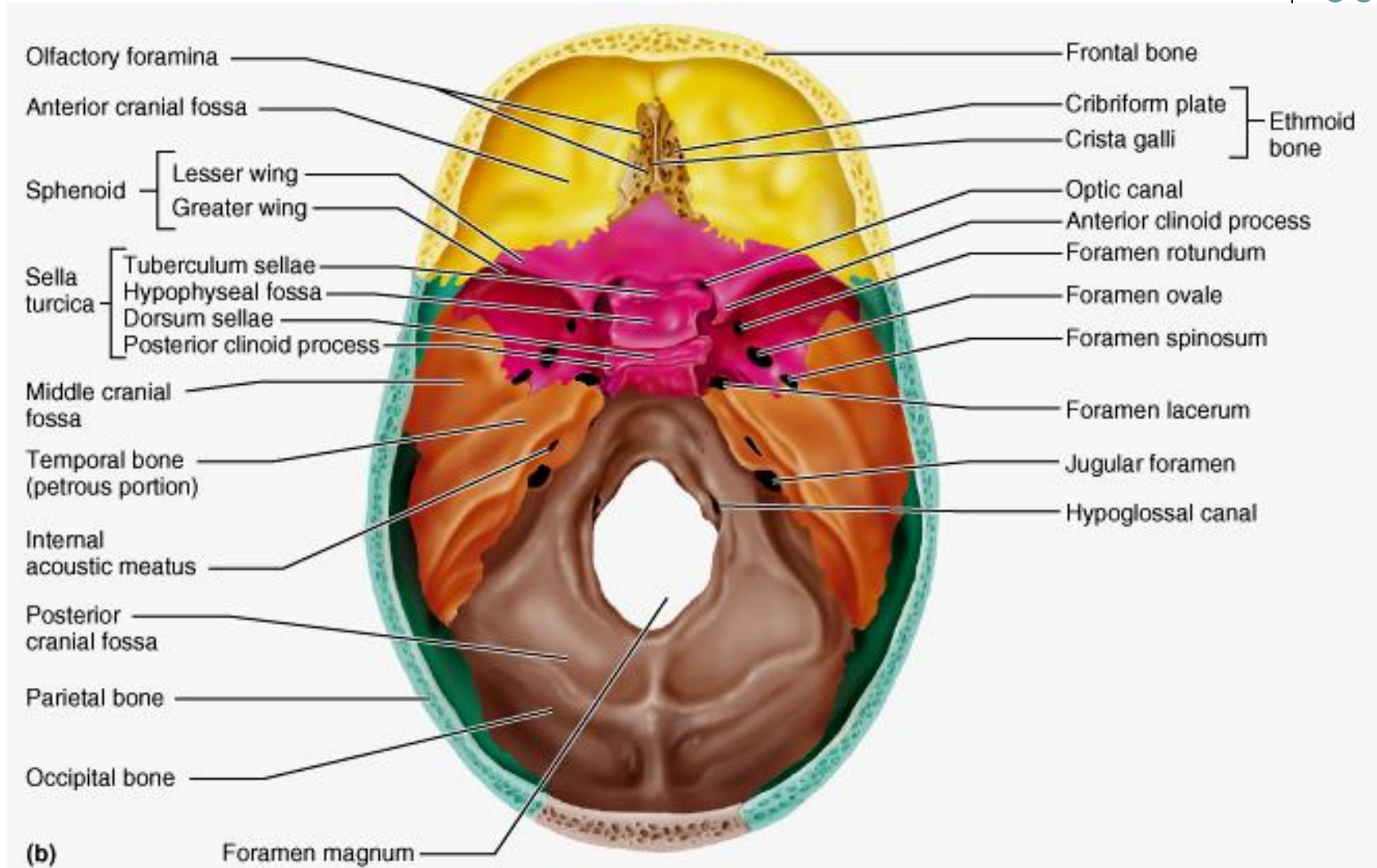


Skull – Posterior View



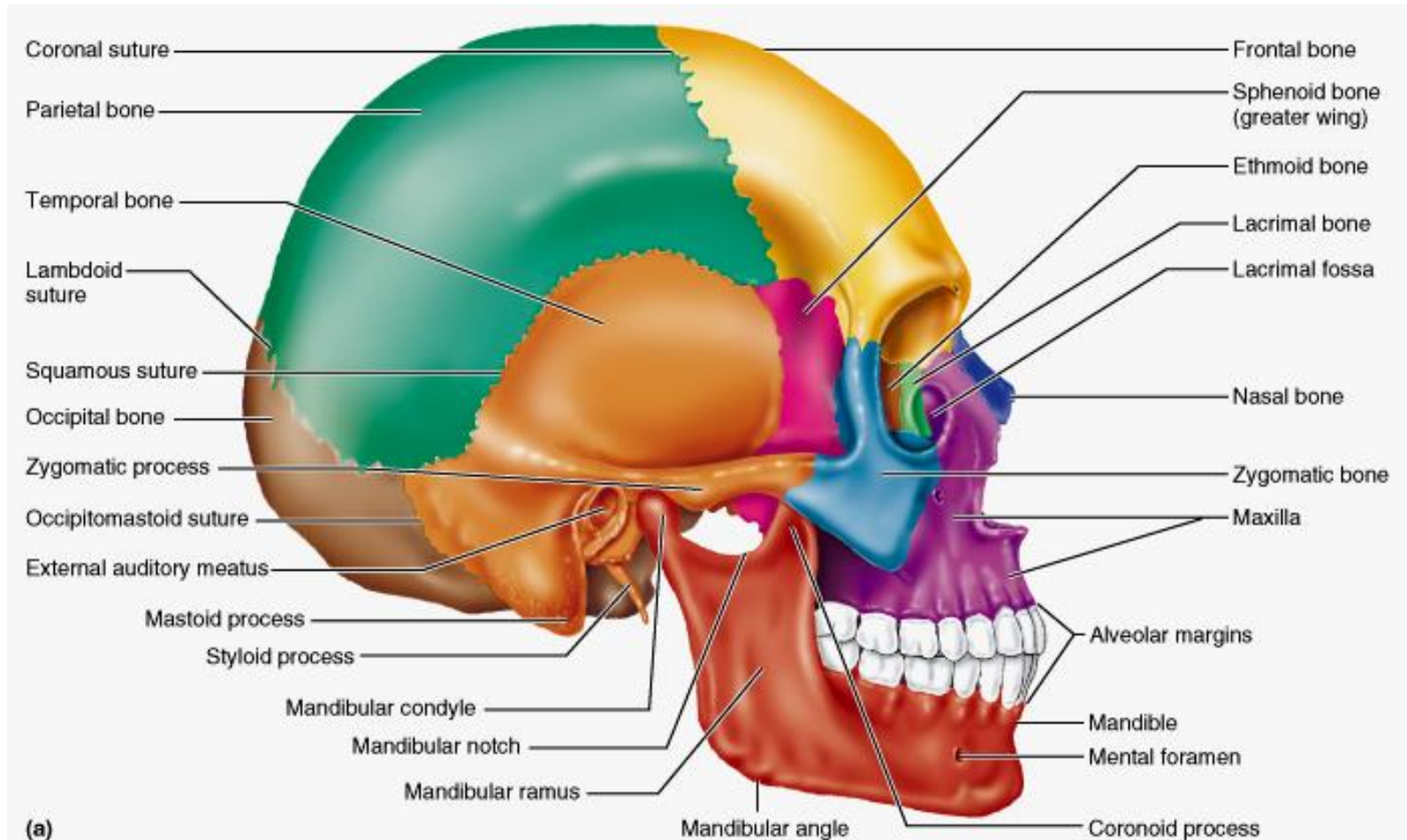
(b)

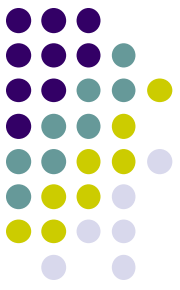
Occipital Bone and Its Major Markings



Parietal Bones and Major Associated Sutures

- Form most of the superior and lateral aspects of the skull

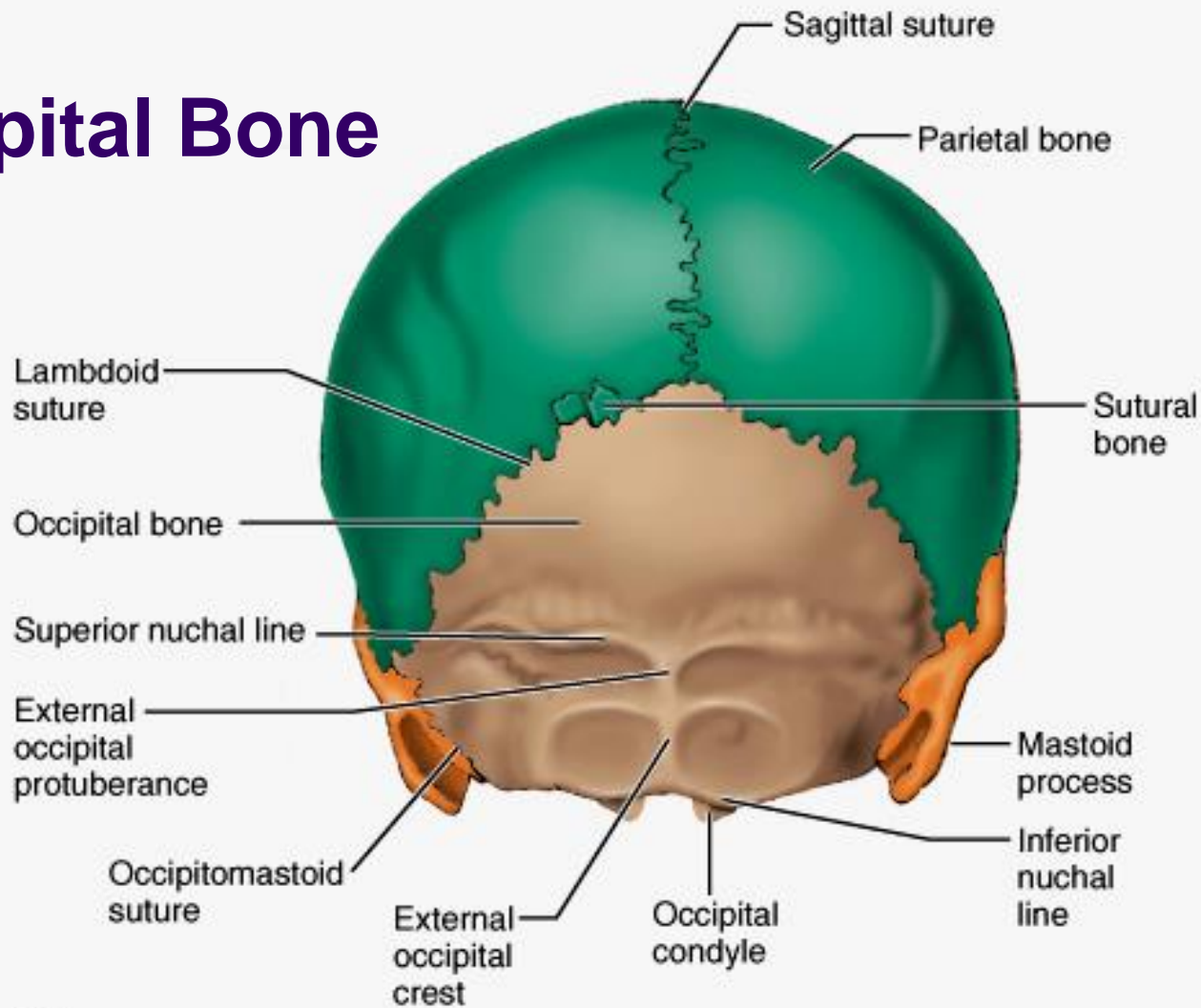




Parietal Bones and Major Associated Sutures

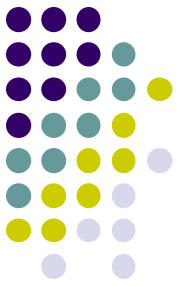
- Four sutures mark the articulations of the parietal bones
 - Coronal suture – articulation between parietal bones and frontal bone anteriorly
 - Sagittal suture – where right and left parietal bones meet superiorly
 - Lambdoid suture – where parietal bones meet the occipital bone posteriorly
 - Squamosal or squamous suture – where parietal and temporal bones meet

Occipital Bone

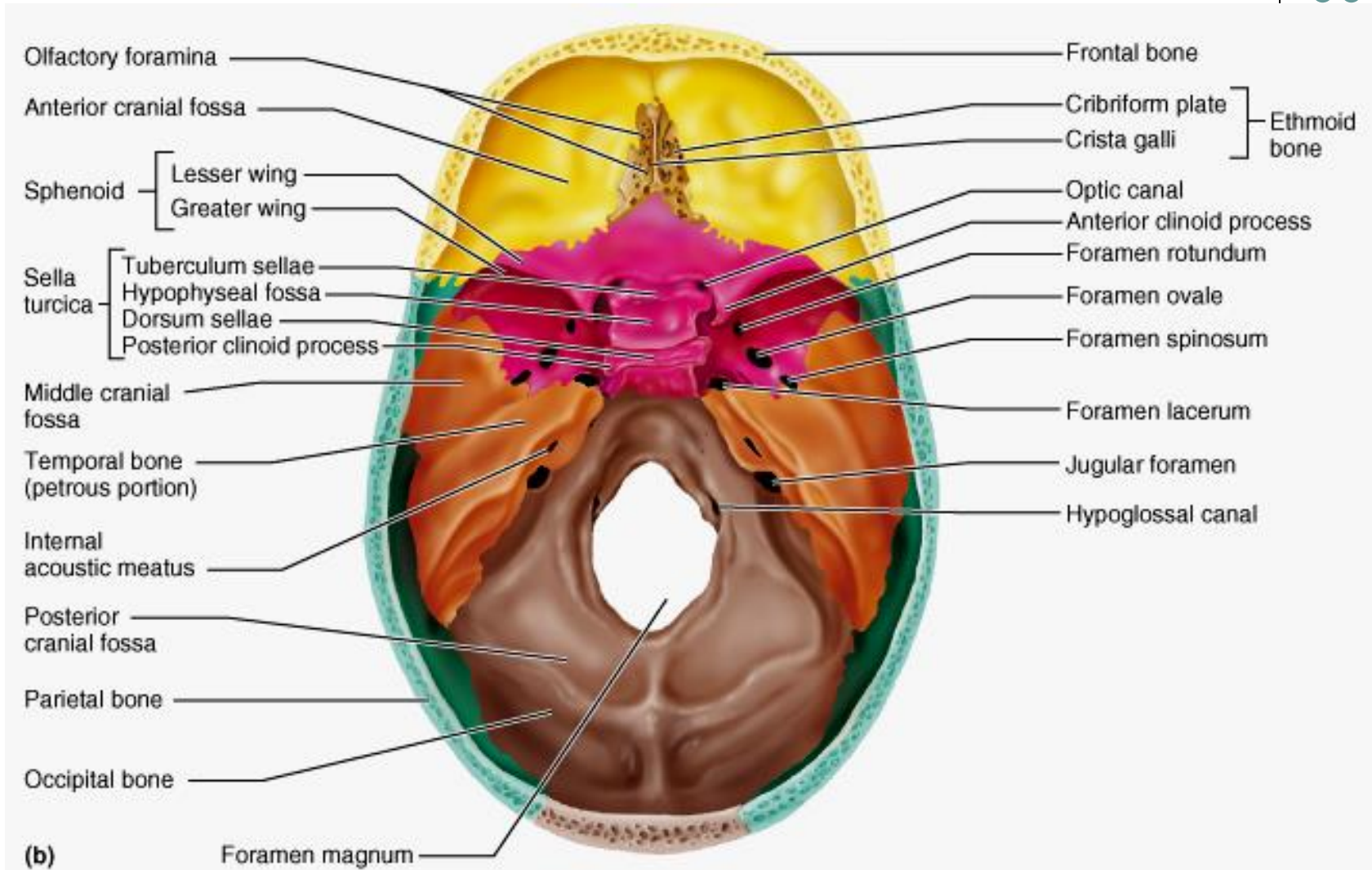


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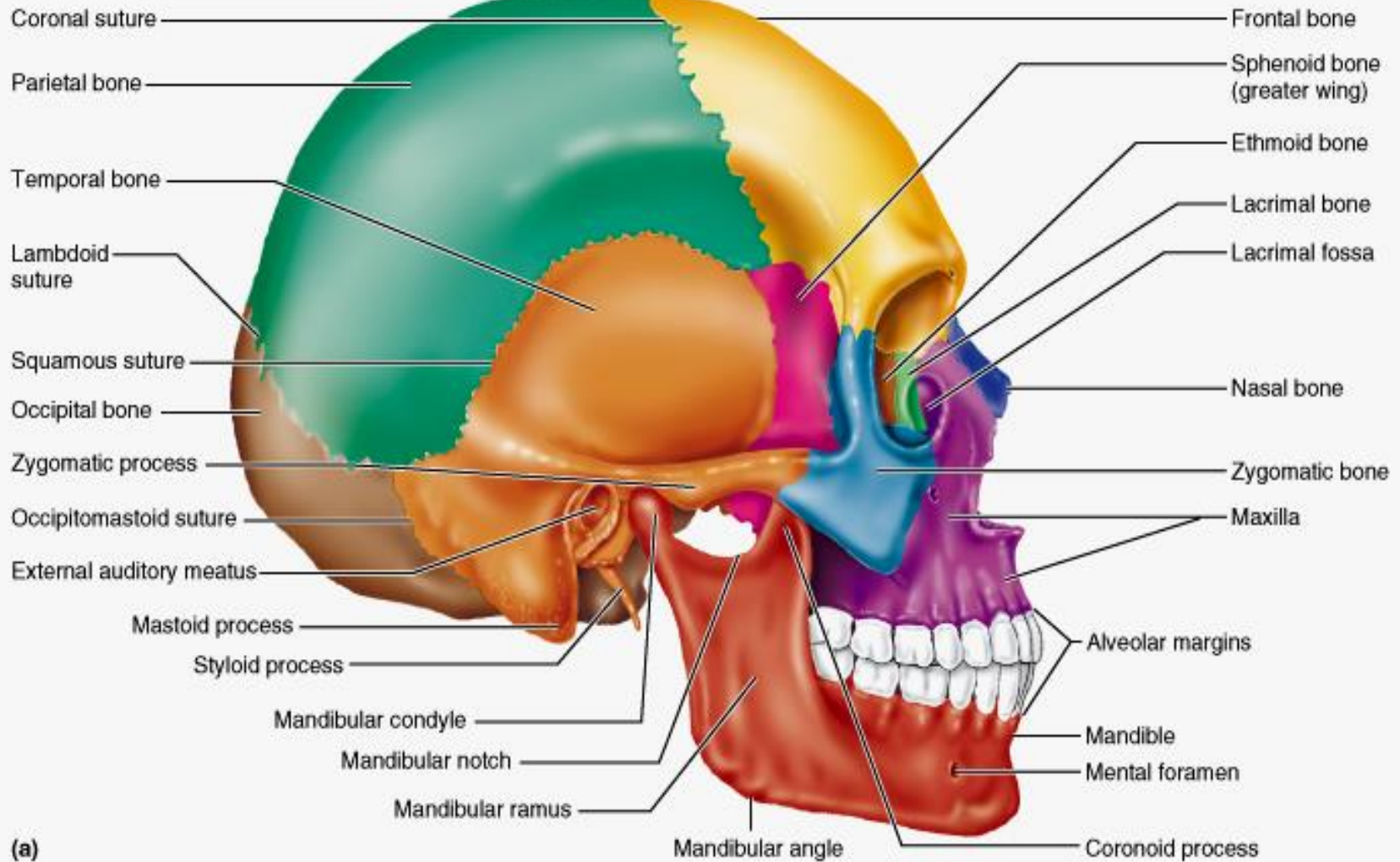
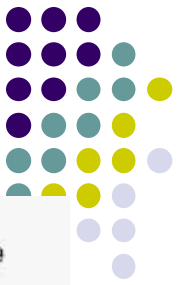
- Forms most of skull's posterior wall and base
- Major markings include the posterior cranial fossa, foramen magnum, occipital condyles, and the hypoglossal canal



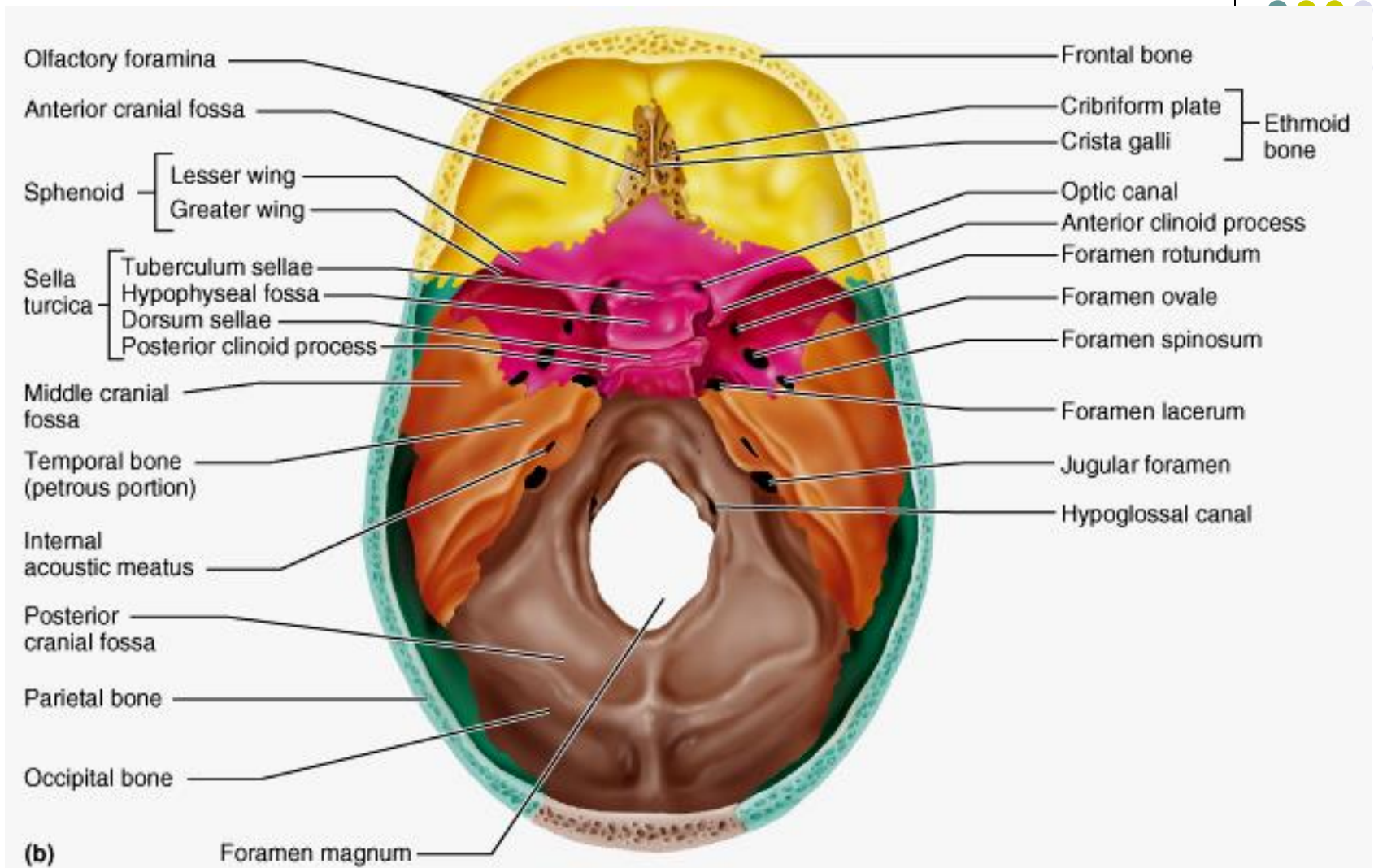
Occipital Bone and Its Major Markings



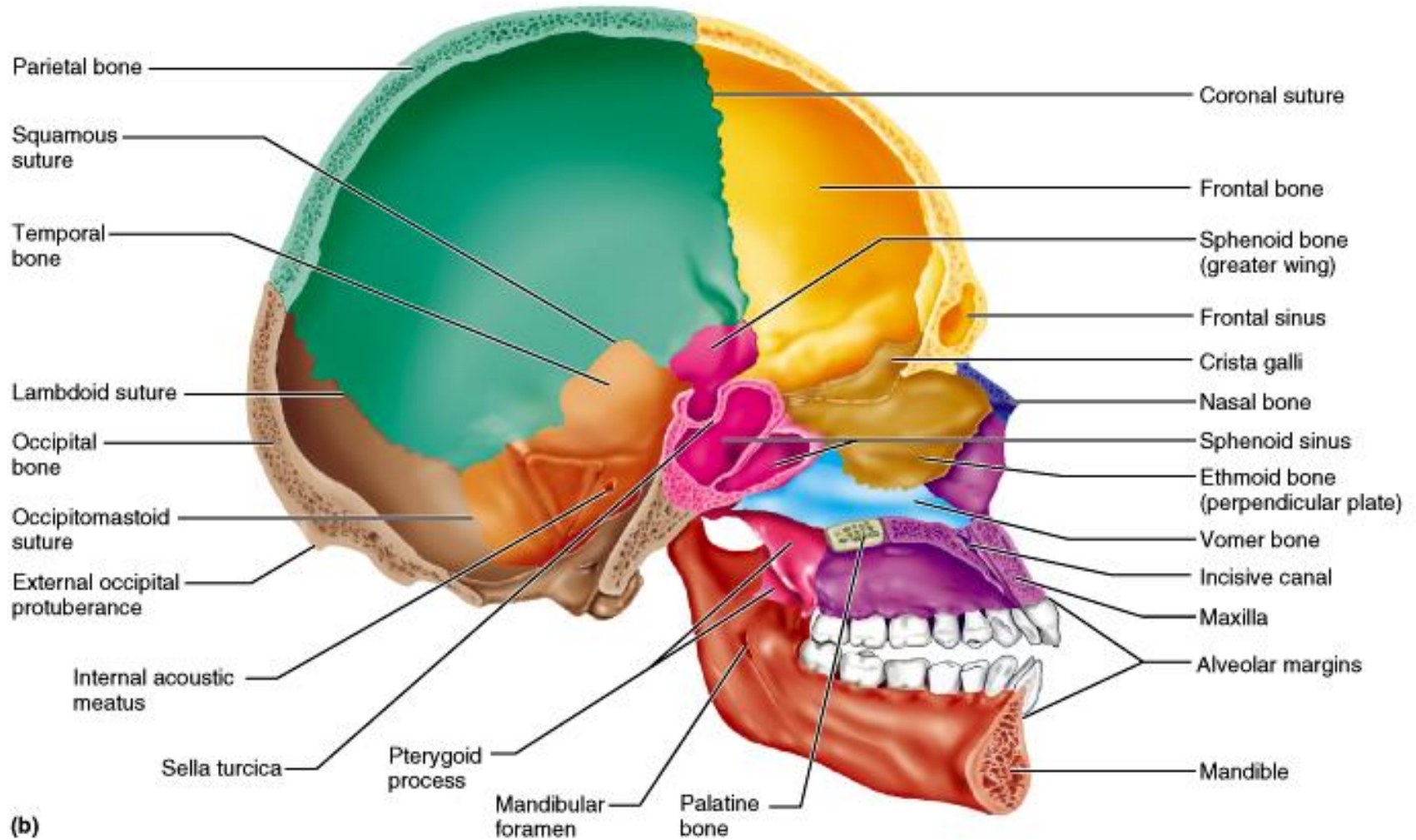
Lateral View of the Skull



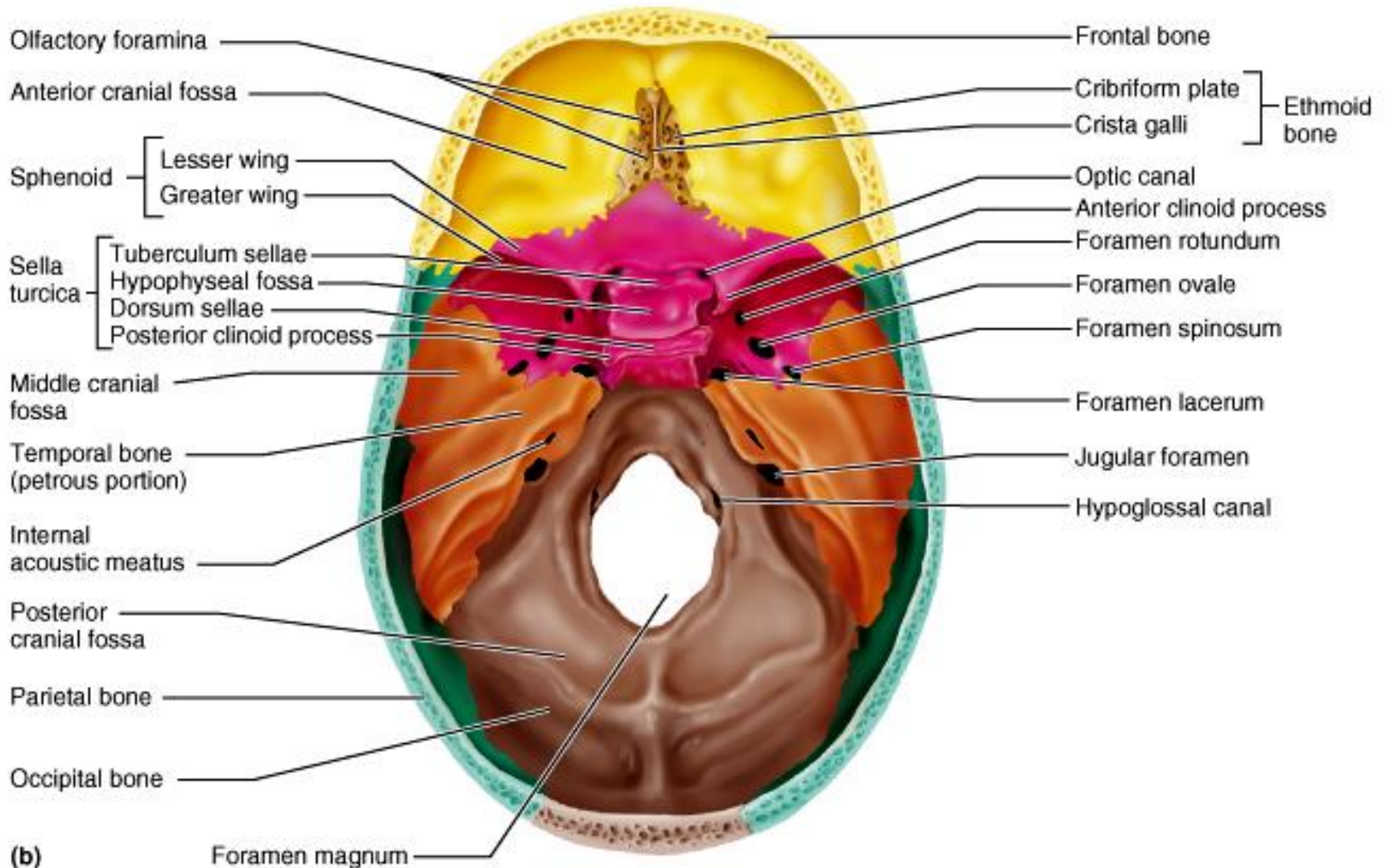
Occipital Bone and Its Major Markings



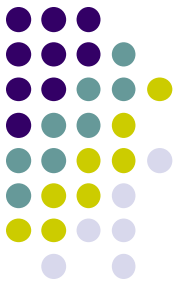
Interior Lateral View of the Skull



Superior view of the skull base

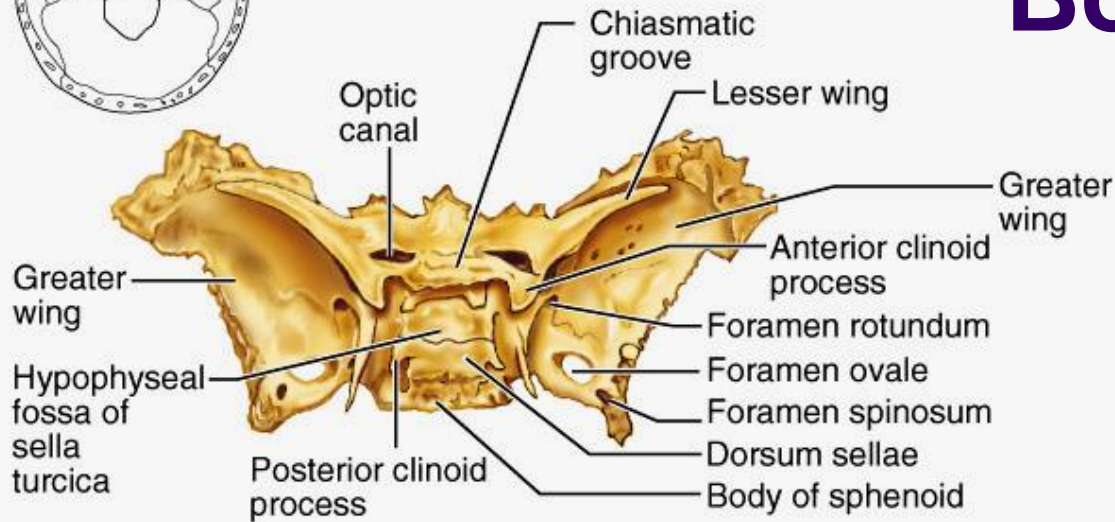
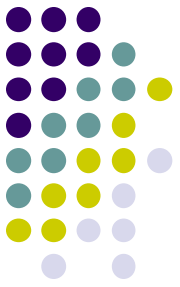


Sphenoid Bone

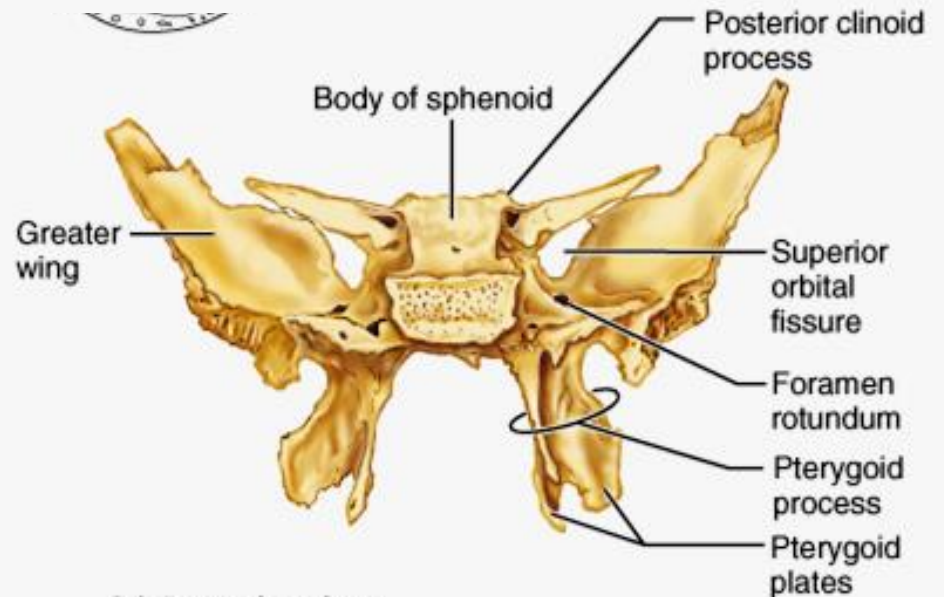


- **Butterfly-shaped bone that spans the width of the middle cranial fossa**
- **Forms the central wedge that articulates with all other cranial bones**
- **Consists of a central body, greater wings, lesser wings, and pterygoid processes**
- **Major markings: the sella turcica, hypophyseal fossa, and the pterygoid processes**
- **Major openings include the foramina rotundum, ovale, and spinosum; the optic canals; and the superior orbital fissure**

Sphenoid Bone

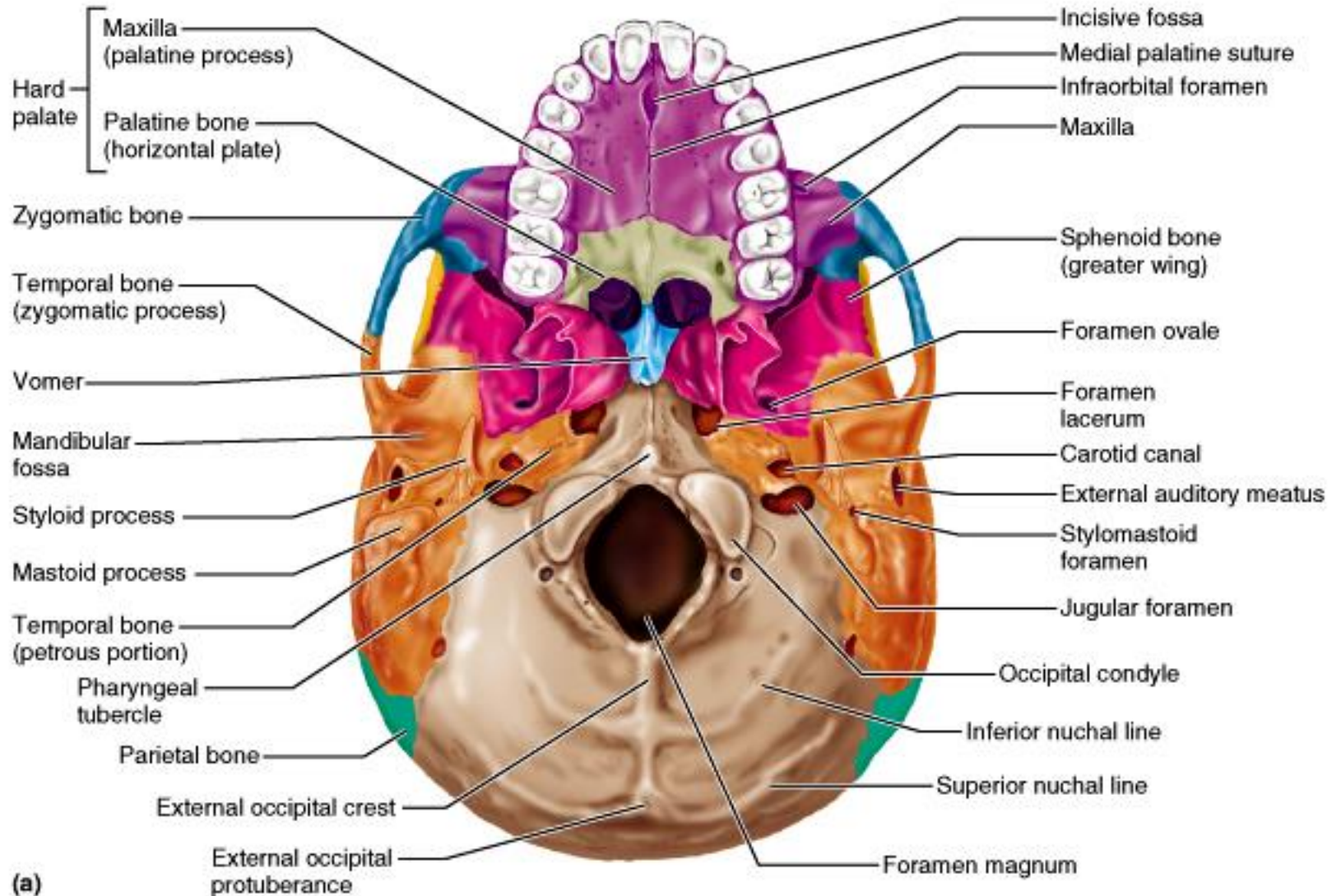


(a) Superior view

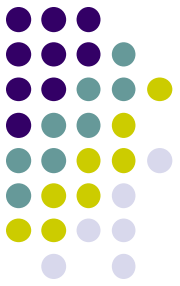


(b) Posterior view

Inferior View of the Skull Base

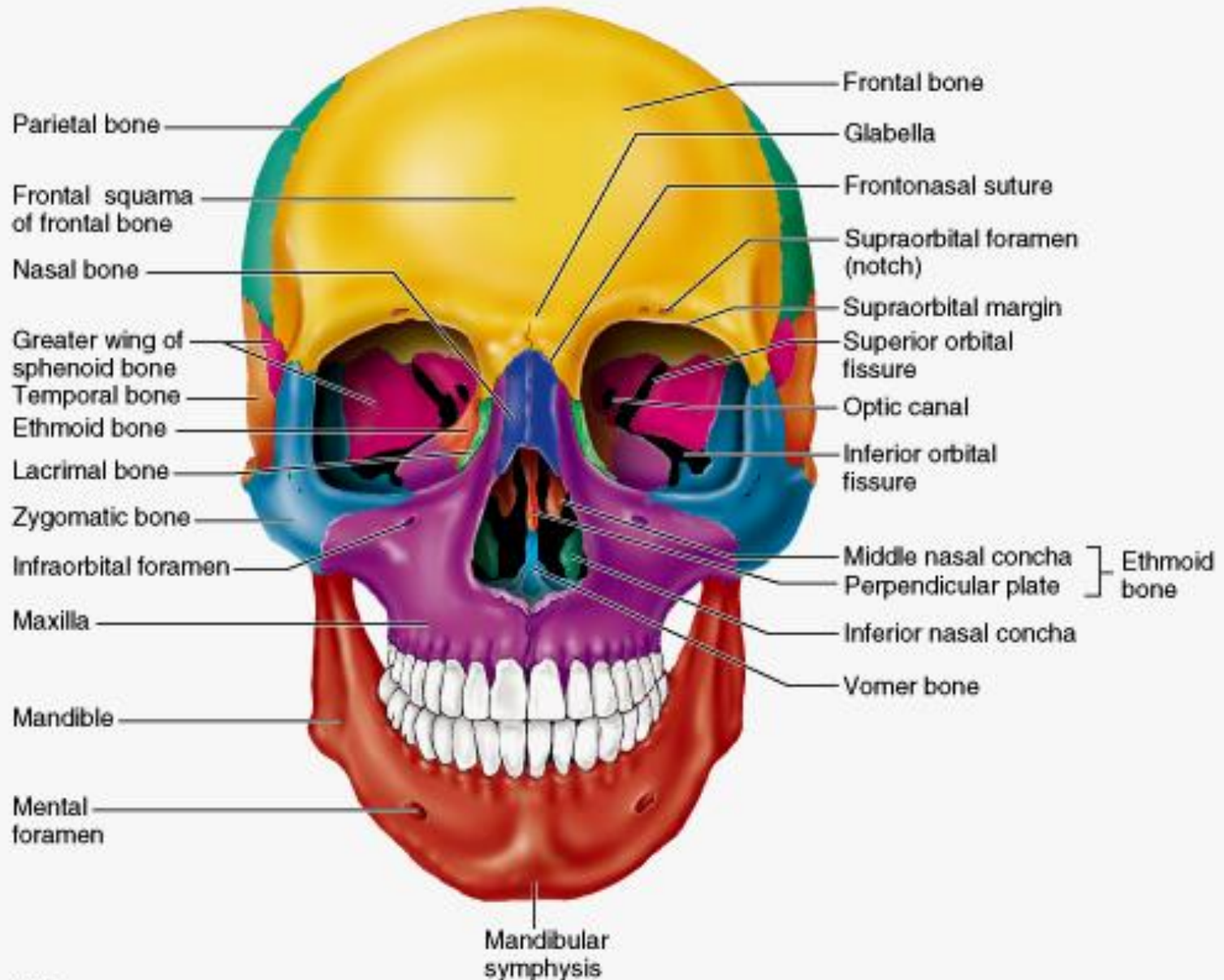
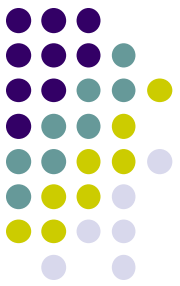


Facial Bones



- Fourteen bones of which only the mandible and vomer are unpaired
- The paired bones are the Maxillae, Zygomatic bones, nasal bones, lacrimal bones, palatine bones, and inferior conchae

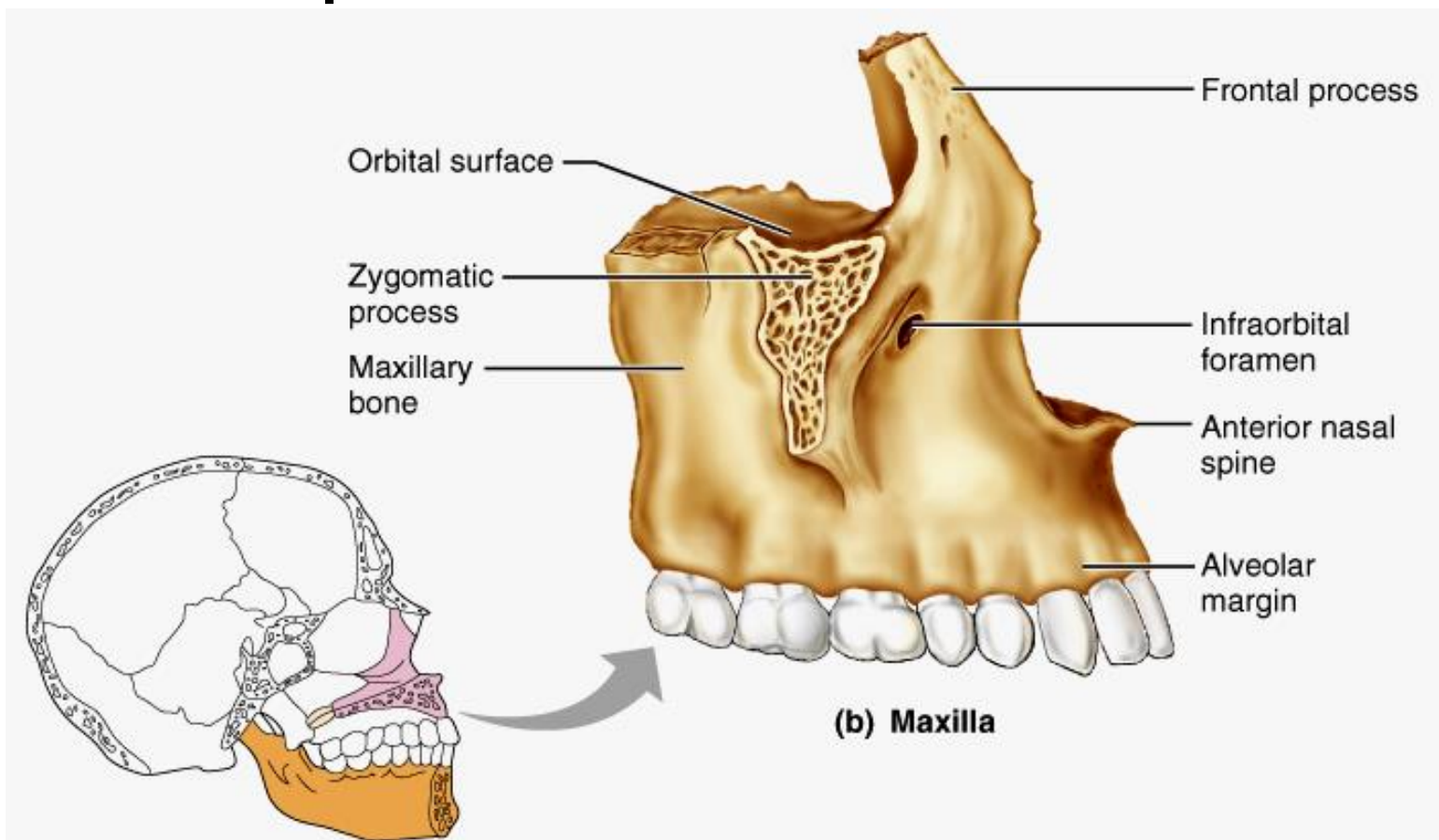
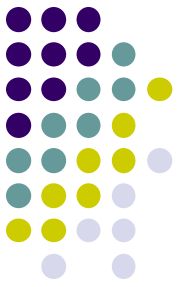
Skull – Anterior View, The maxilla bone



(a)

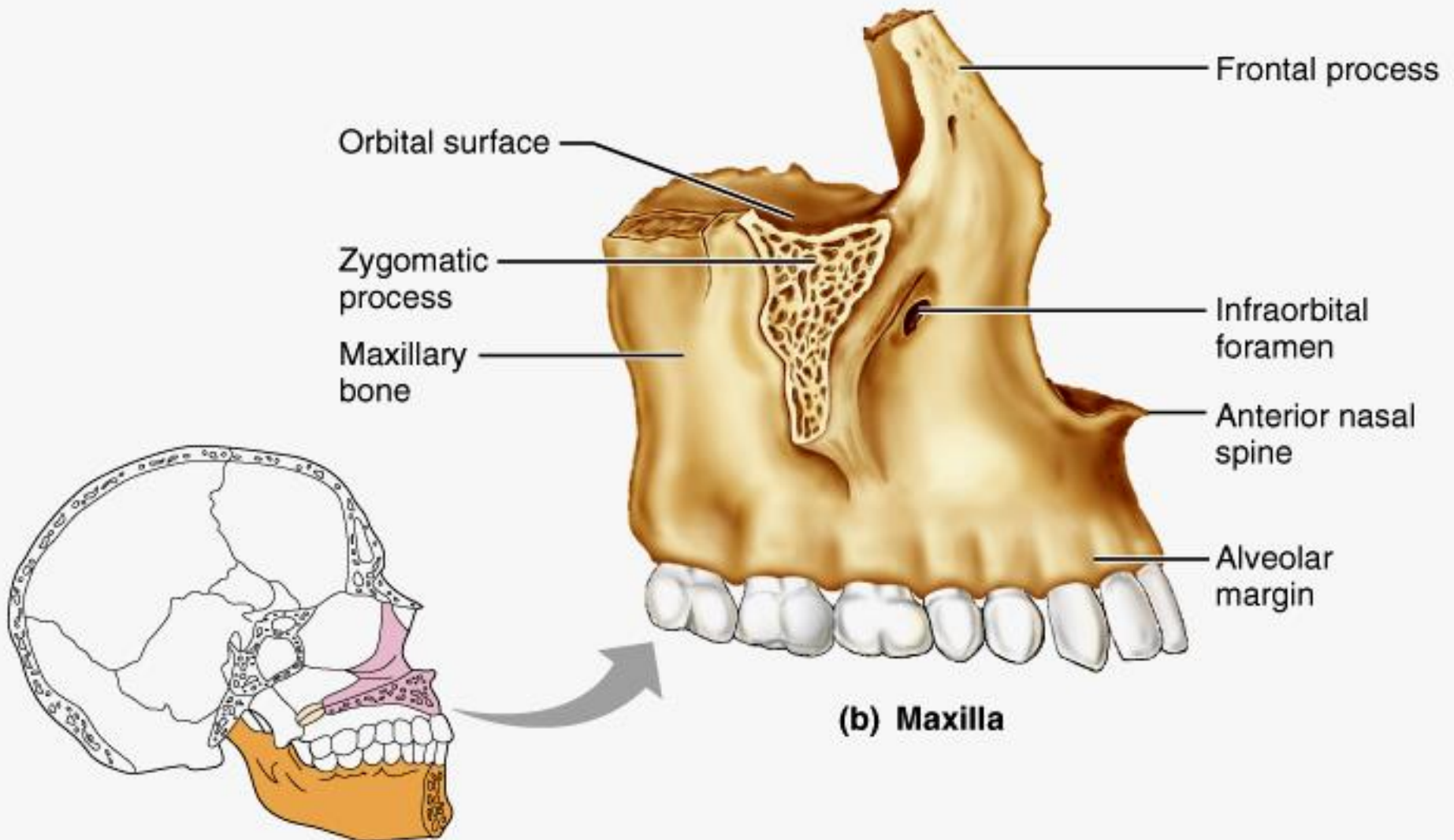
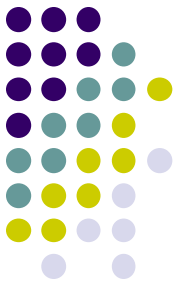
Maxillary Bones

- Facial keystone bones that articulate with all other facial bones, except the mandible
- Medially fused bones that make up the upper jaw and the central portion of the facial skeleton

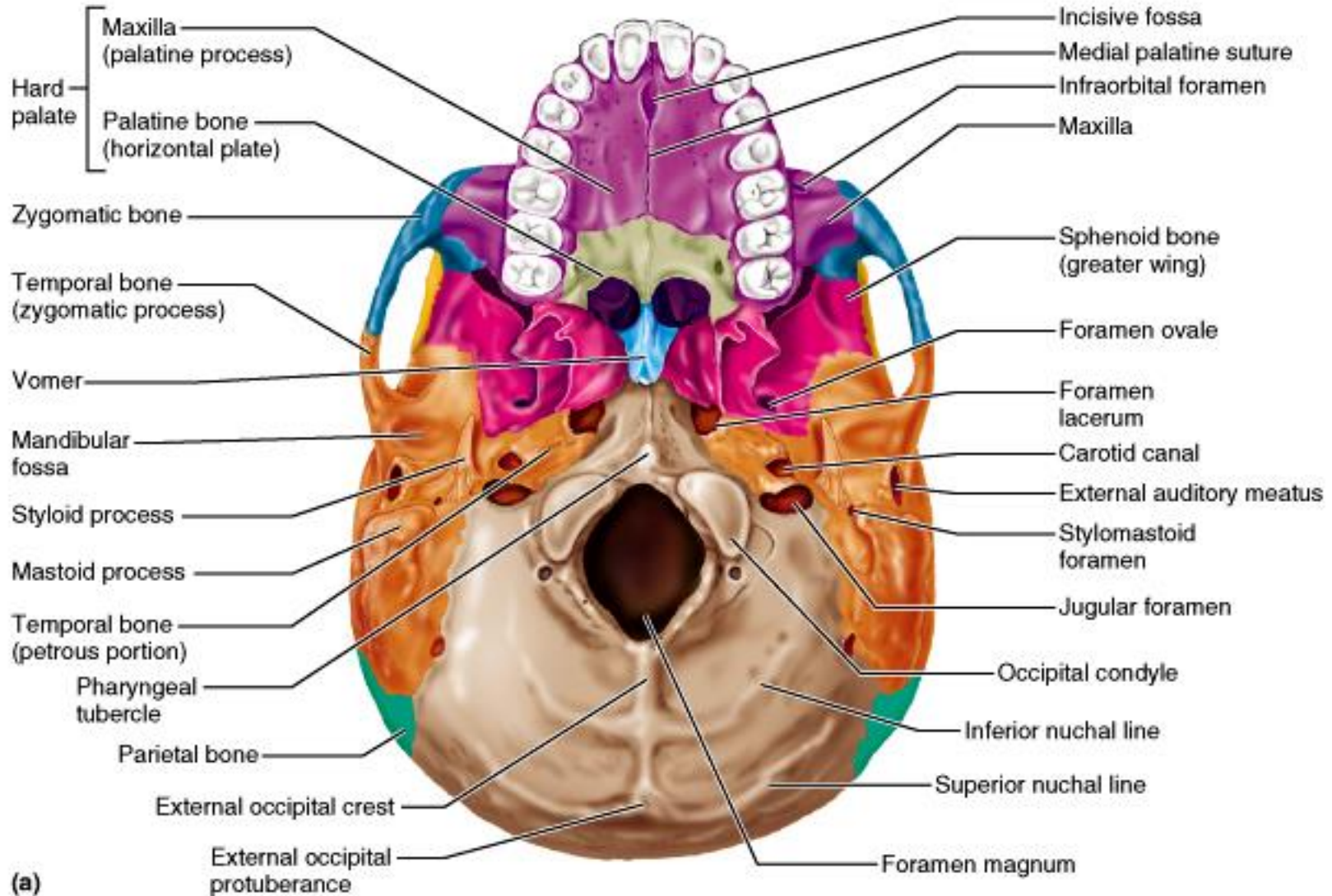


Maxillary Bones

- Their major markings include palatine, frontal, and zygomatic processes, the alveolar margins, inferior orbital fissure, and the maxillary sinuses



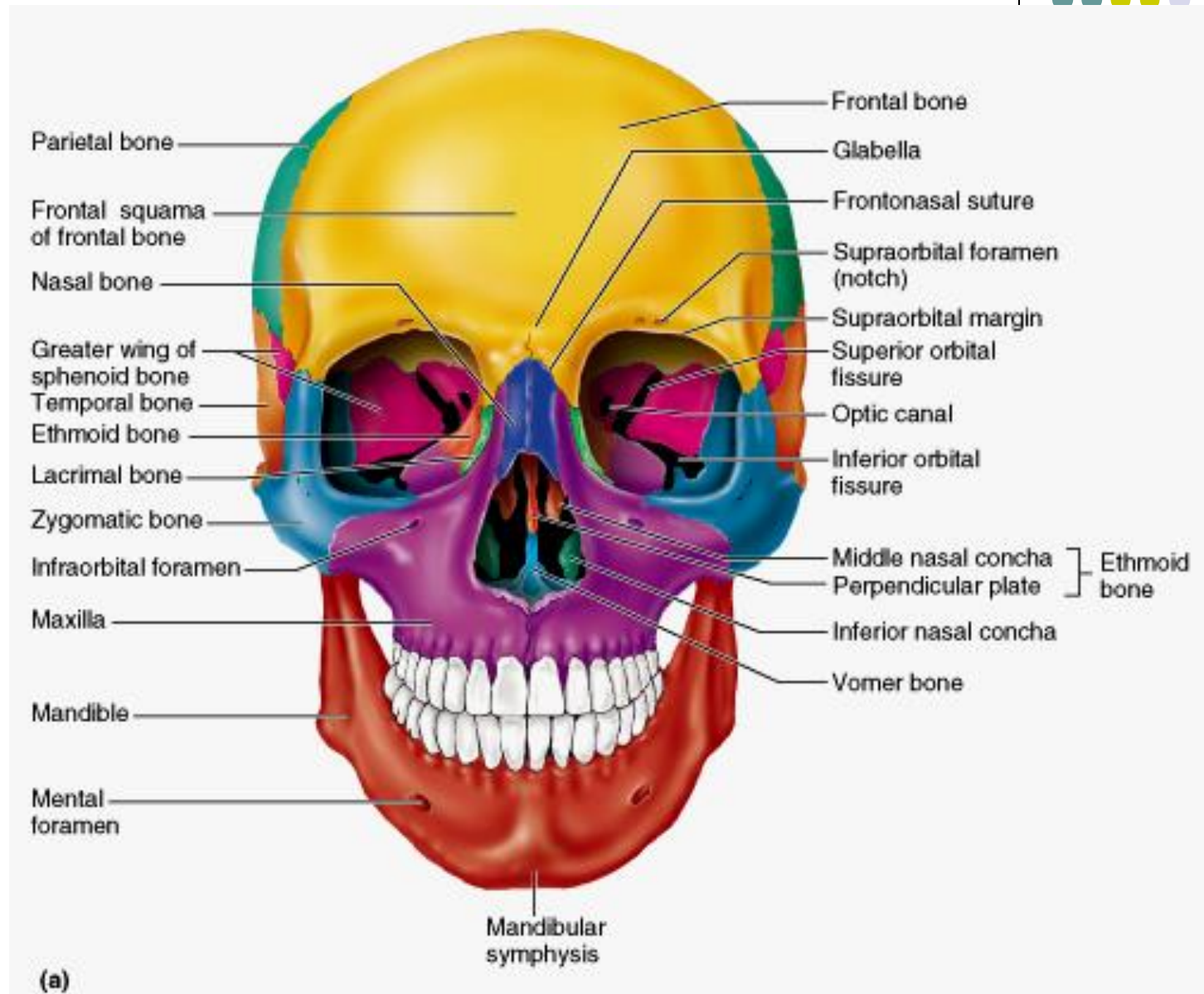
Inferior View of the Skull Base :Maxilla



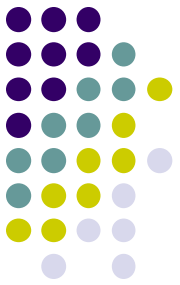
Zygomatic Bones



- Irregularly shaped bones (cheekbones) that form the prominences of the cheeks and the inferolateral margins of the orbits



Nasal Cavity

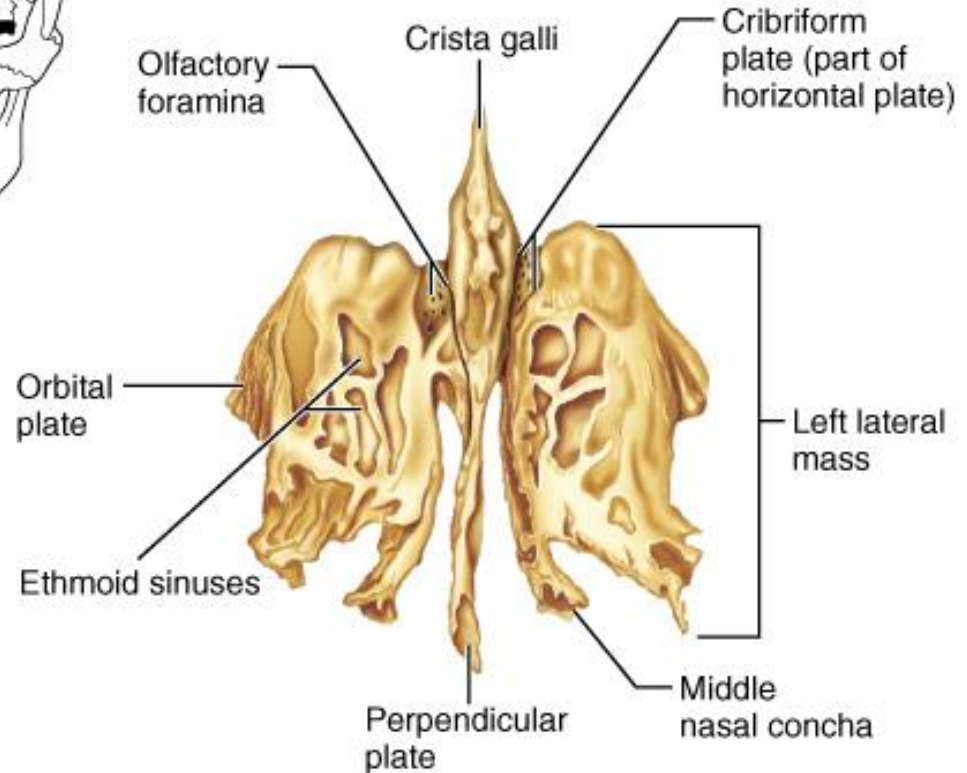


- **Constructed of bone and hyaline cartilage**
- **Roof – formed by the cribriform plate of the ethmoid**
- **Lateral walls – formed by the superior and middle conchae of the ethmoid, the perpendicular plate of the palatine, and the inferior nasal conchae**
- **Floor – formed by palatine process of the maxillae and palatine bone**

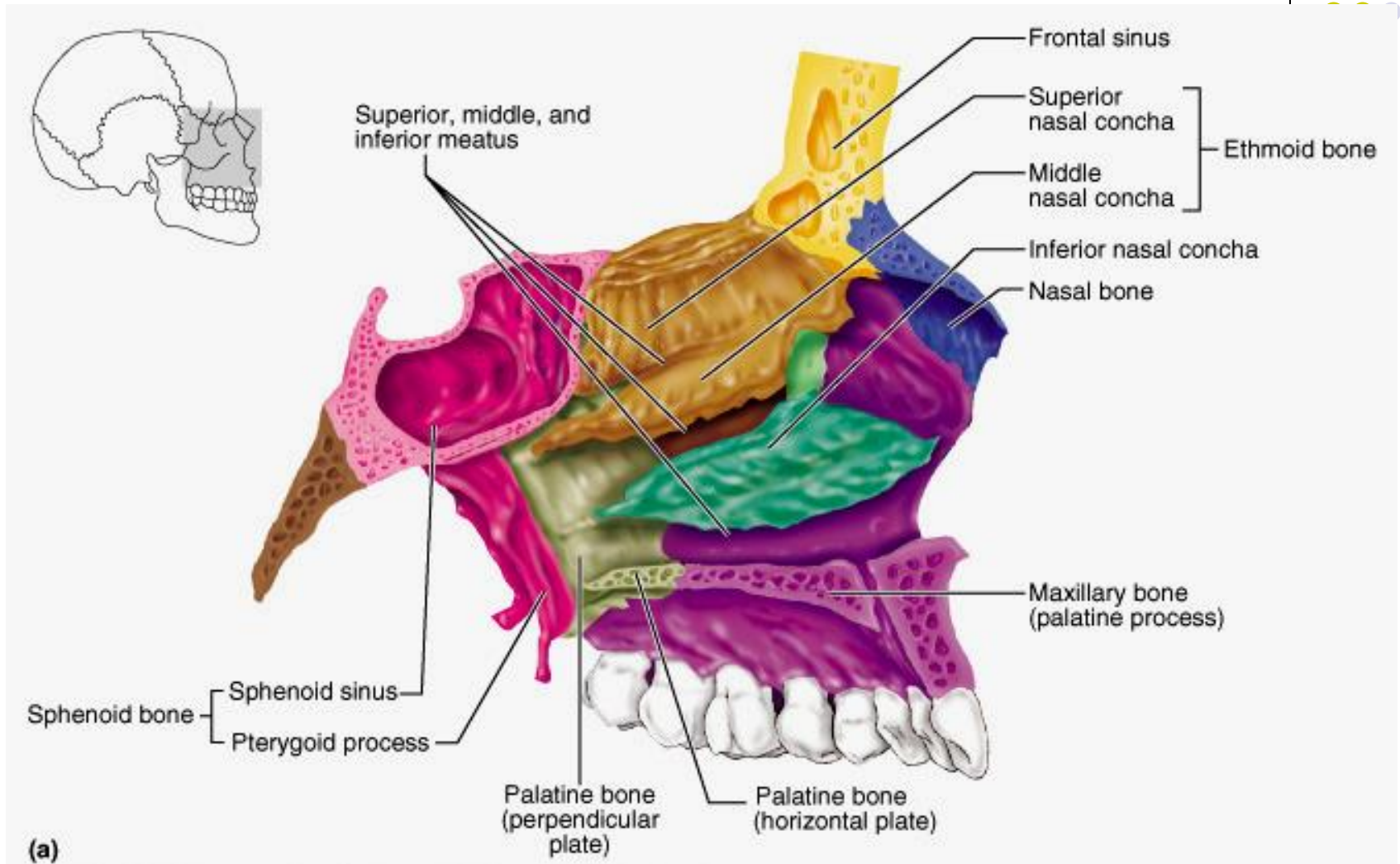
Ethmoid Bone



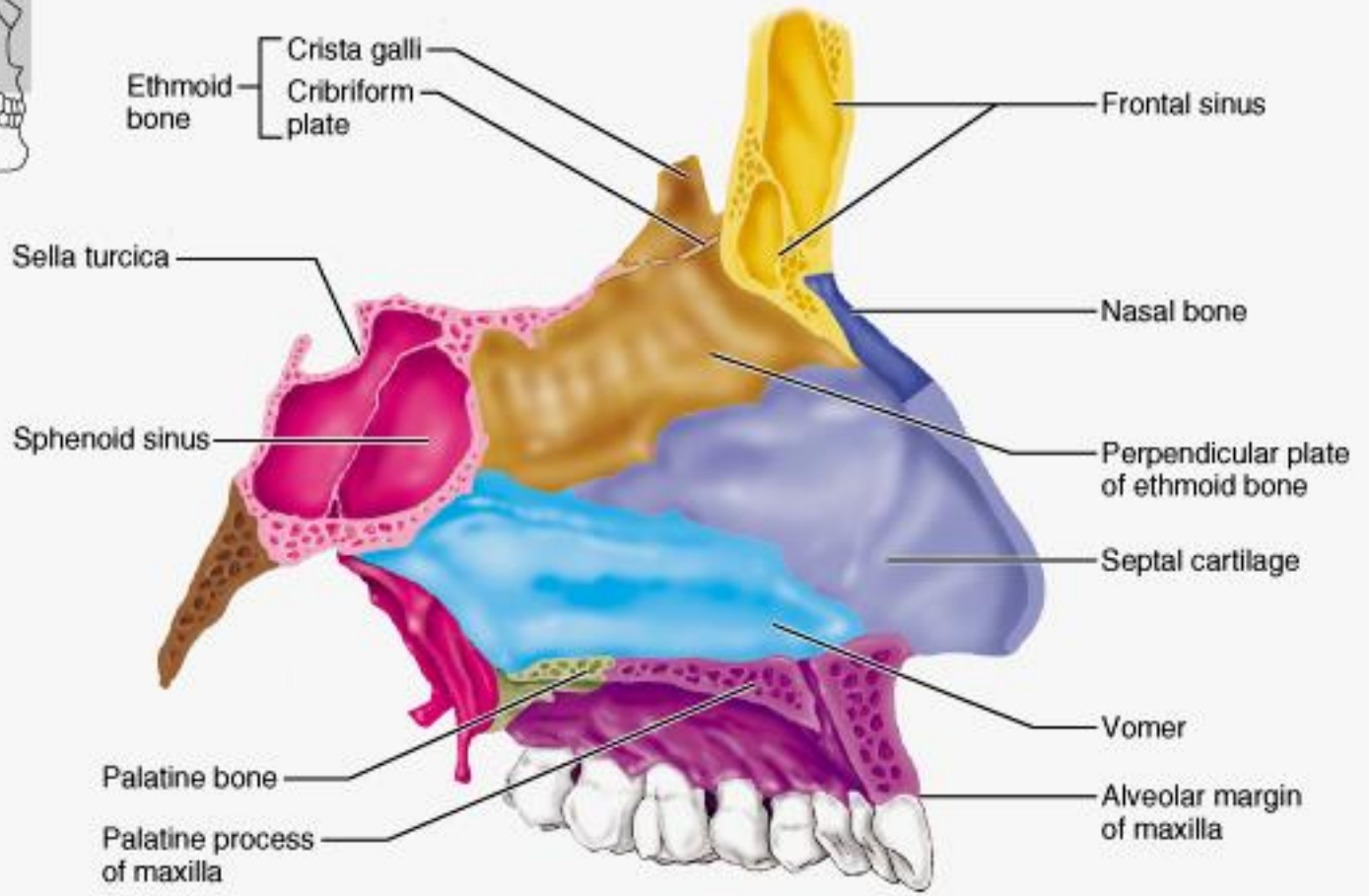
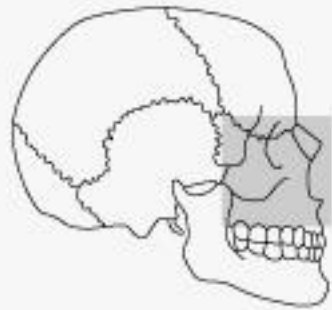
- **Most deep of the skull bones; lies between the sphenoid and nasal bones**
- **Forms most of the bony area between the nasal cavity and the orbits**
- **Major markings include the cribriform plate, crista galli, perpendicular plate, nasal conchae, and the ethmoid sinuses**



Nasal Cavity

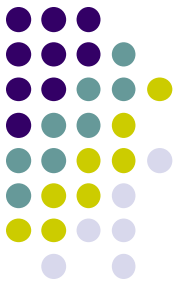


Nasal Cavity



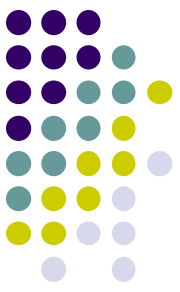
(b)

Other Facial Bones



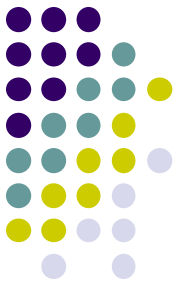
- **Nasal bones** – thin medially fused bones that form the bridge of the nose
- **Lacrimal bones** – contribute to the medial walls of the orbit and contain a deep groove called the lacrimal fossa that houses the lacrimal sac
- **Palatine bones** – two bone plates that form portions of the hard palate, the posterolateral walls of the nasal cavity, and a small part of the orbits
- **Vomer** – plow-shaped bone that forms part of the nasal septum
- **Inferior nasal conchae** – paired, curved bones in the nasal cavity that form part of the lateral walls of the nasal cavity

Nasal Cavity

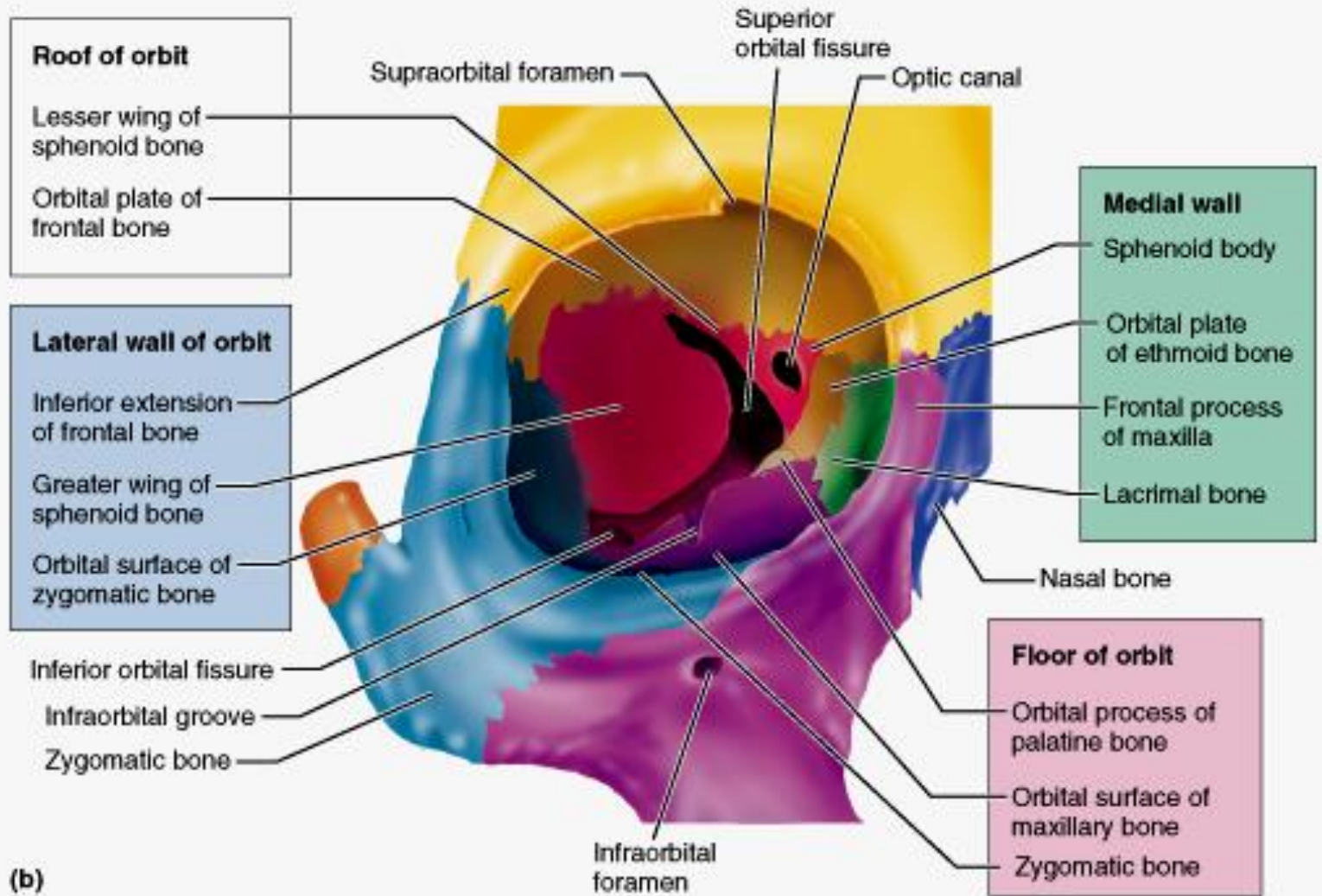
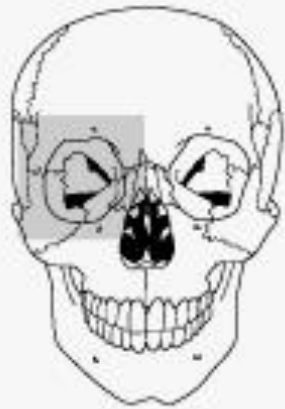


- **Constructed of bone and hyaline cartilage**
- **Roof – formed by the cribriform plate of the ethmoid**
- **Lateral walls – formed by the superior and middle conchae of the ethmoid, the perpendicular plate of the palatine, and the inferior nasal conchae**
- **Floor – formed by palatine process of the maxillae and palatine bone**

The Orbits



- Bony cavities in which the eyes are firmly encased and cushioned by fatty tissue
- Formed by parts of seven bones – frontal, sphenoid, zygomatic, maxilla, palatine, lacrimal, and ethmoid

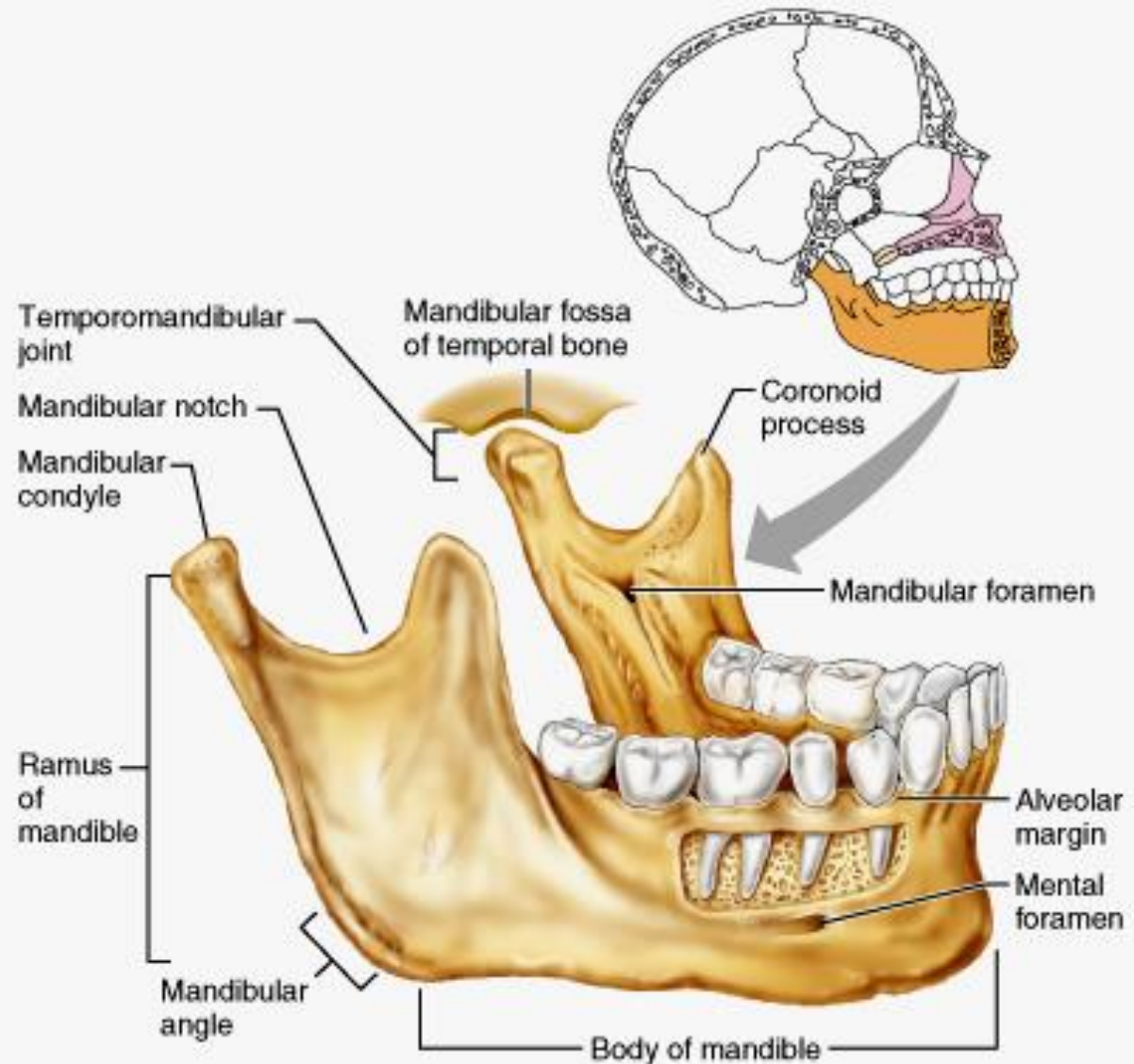


(b)

The Mandible



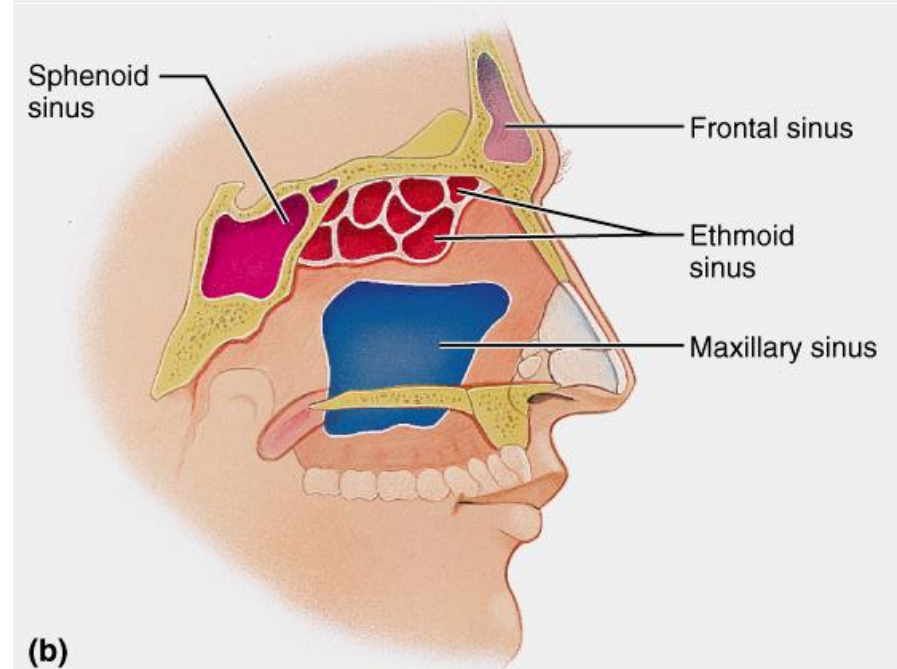
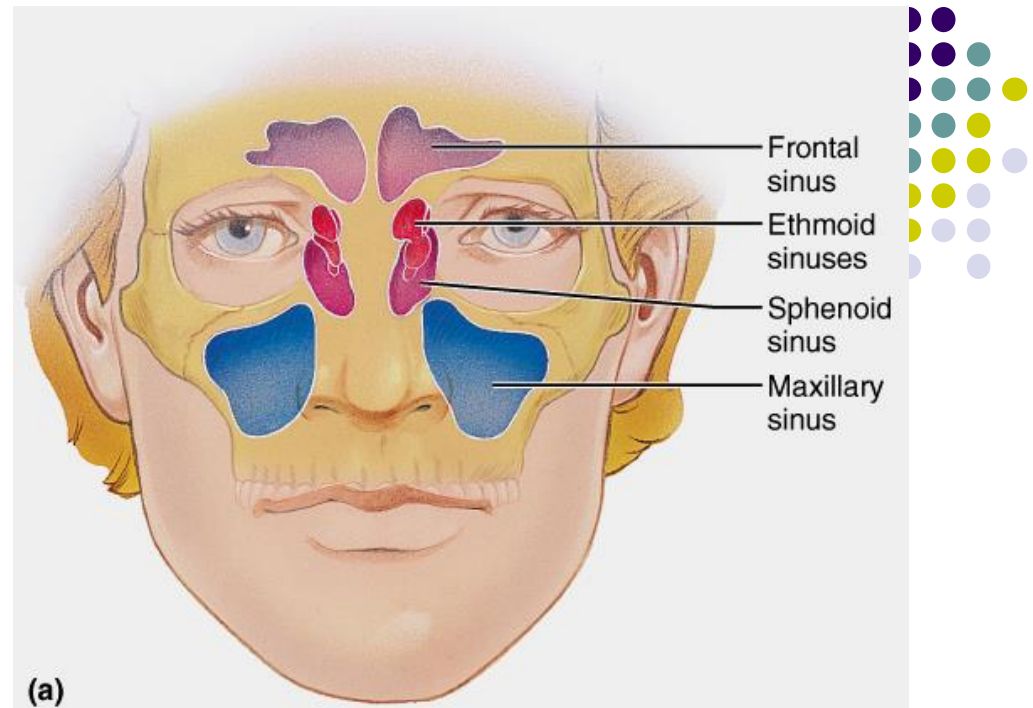
- The mandible (lower jawbone) is the largest, strongest bone of the face
- Its major markings include the coronoid process, mandibular condyle, the alveolar margin, and the mandibular and mental foramina



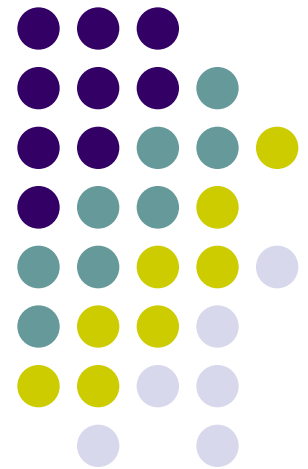
(a) Mandible

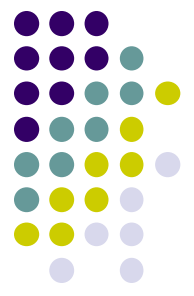
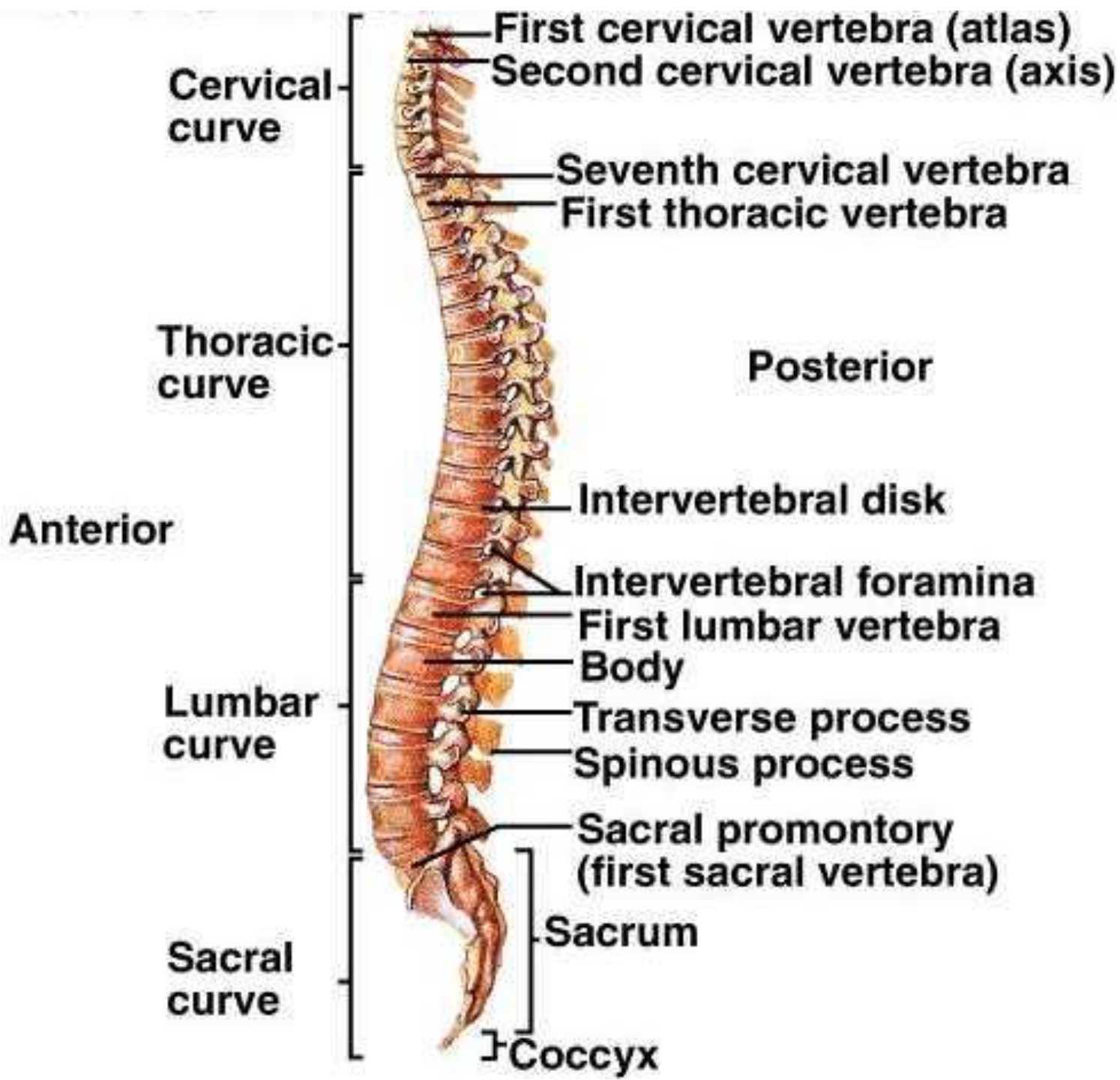
Paranasal Sinuses

- **Mucosa-lined, air-filled sacs found in five skull bones – the frontal, sphenoid, ethmoid, and paired maxillary bones**
- **Air enters the paranasal sinuses from the nasal cavity and mucus drains into the nasal cavity from the sinuses**
- **Lighten the skull and enhance the resonance of the voice**

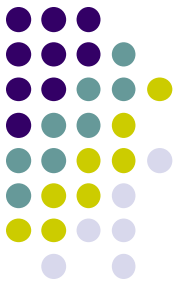


Vertebral column





Curvature of vertebral column



Cervical and lumbar :

concave posterior, concave posterior, develop during the fetal period, due to difference in IV disc thickness

cervical - infant hold head

lumbar - infant walk and assume upright position,

prominent in female.

Thoracic and sacral;

primary, develop during fetal period, difference between ant and post parts of the vertebra

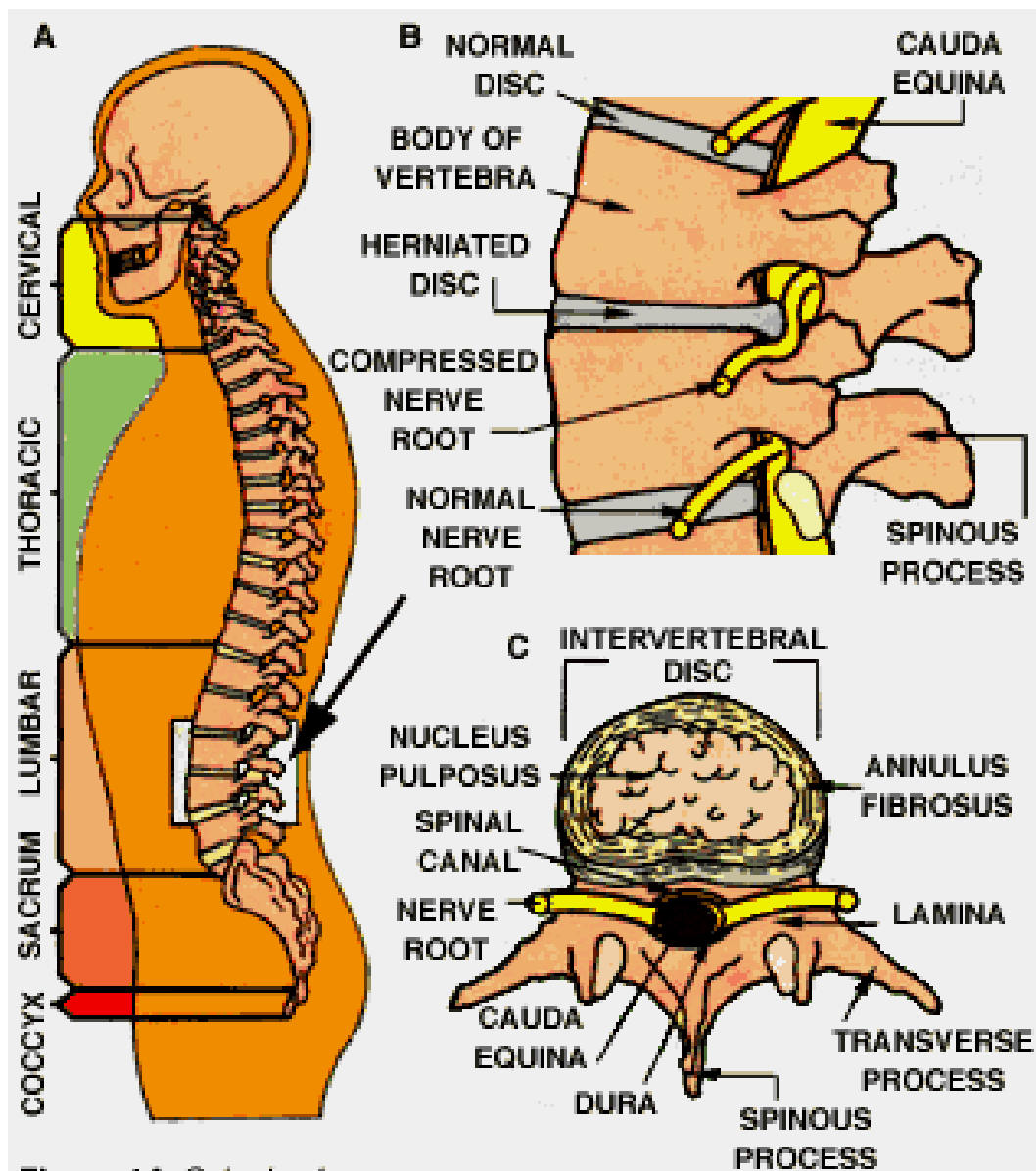
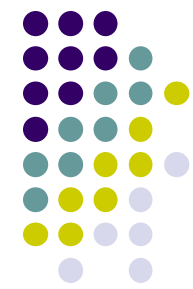


Figure 1A Spinal column

Figure 1B Enlargement of lumbar spine—A normal disc does not touch nerve roots

Figure 1C Normal lumbar vertebra and intervertebral disc



Abnormal curvature



Kyphosis:

abnormal increase in thoracic curv. Erosion of anterior vertebral part.

Lordosis:

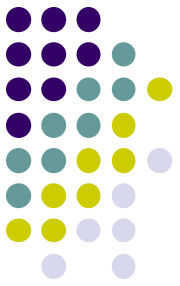
(hollow back) anterior rotation of pelvis abnormal increase in lumbar curvature (pregnancy)

Scoliosis:

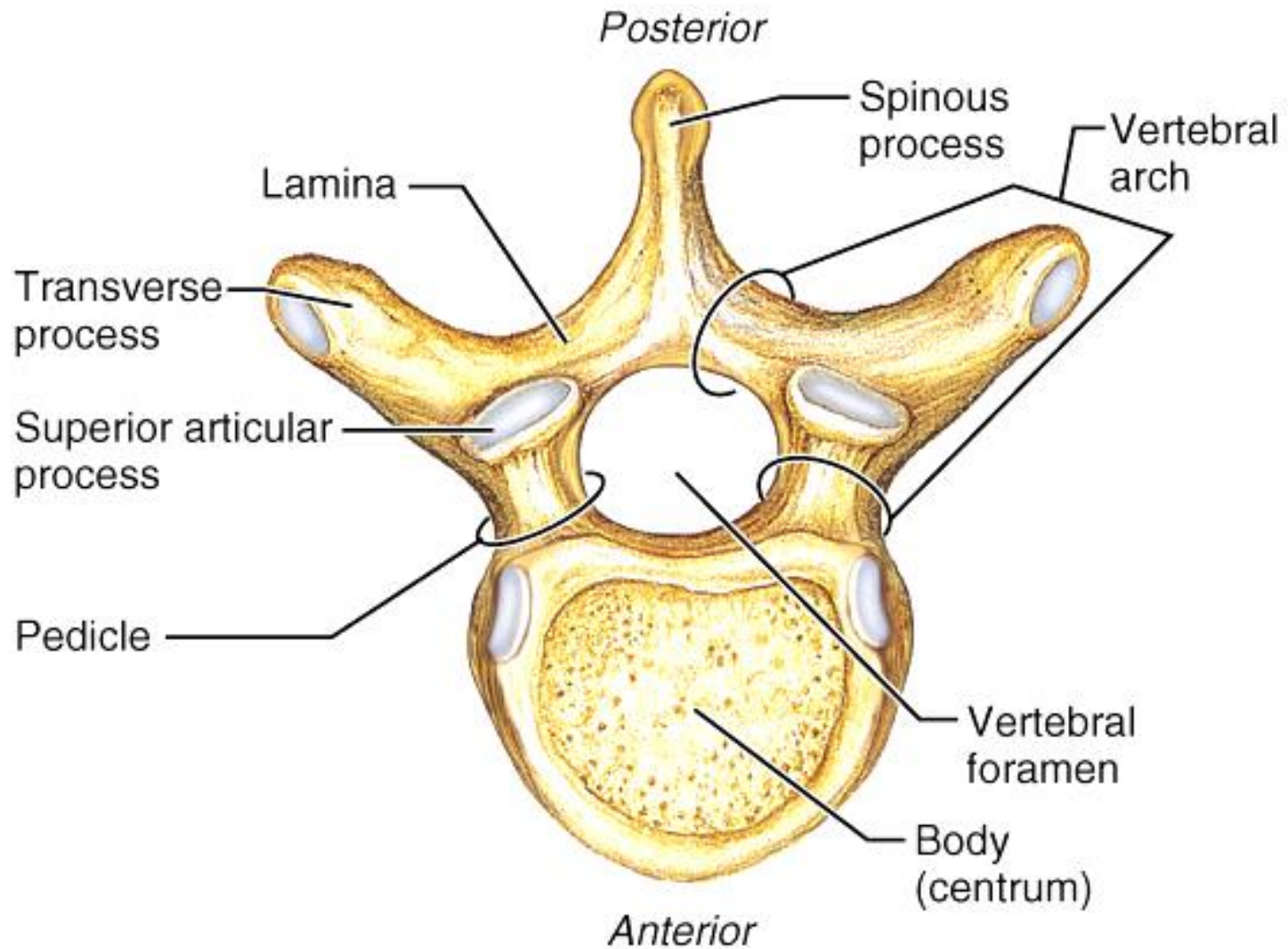
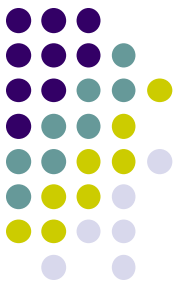
(Crooked or curved back) abnormal lateral curvature and rotation of the back (appears between ages of 10-15)

General Structure of Vertebrae

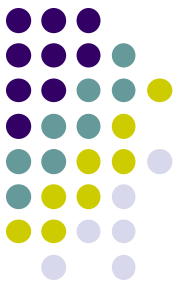
- **Body or centrum – disc-shaped, weight-bearing region**
- **Vertebral arch – composed of pedicles and laminae that, along with the centrum, encloses the vertebral foramen**
- **Vertebral foramina – make up the vertebral canal through which the spinal cord passes**



General Structure of Vertebrae



- **Spinous process project posteriorly, and transverse processes project laterally**
- **Superior and inferior articular processes – protrude superiorly and inferiorly from the pedicle-lamina junctions**
- **Intervertebral foramina – lateral openings formed from notched areas on the superior and inferior borders of adjacent pedicles**



Cervical Vertebrae

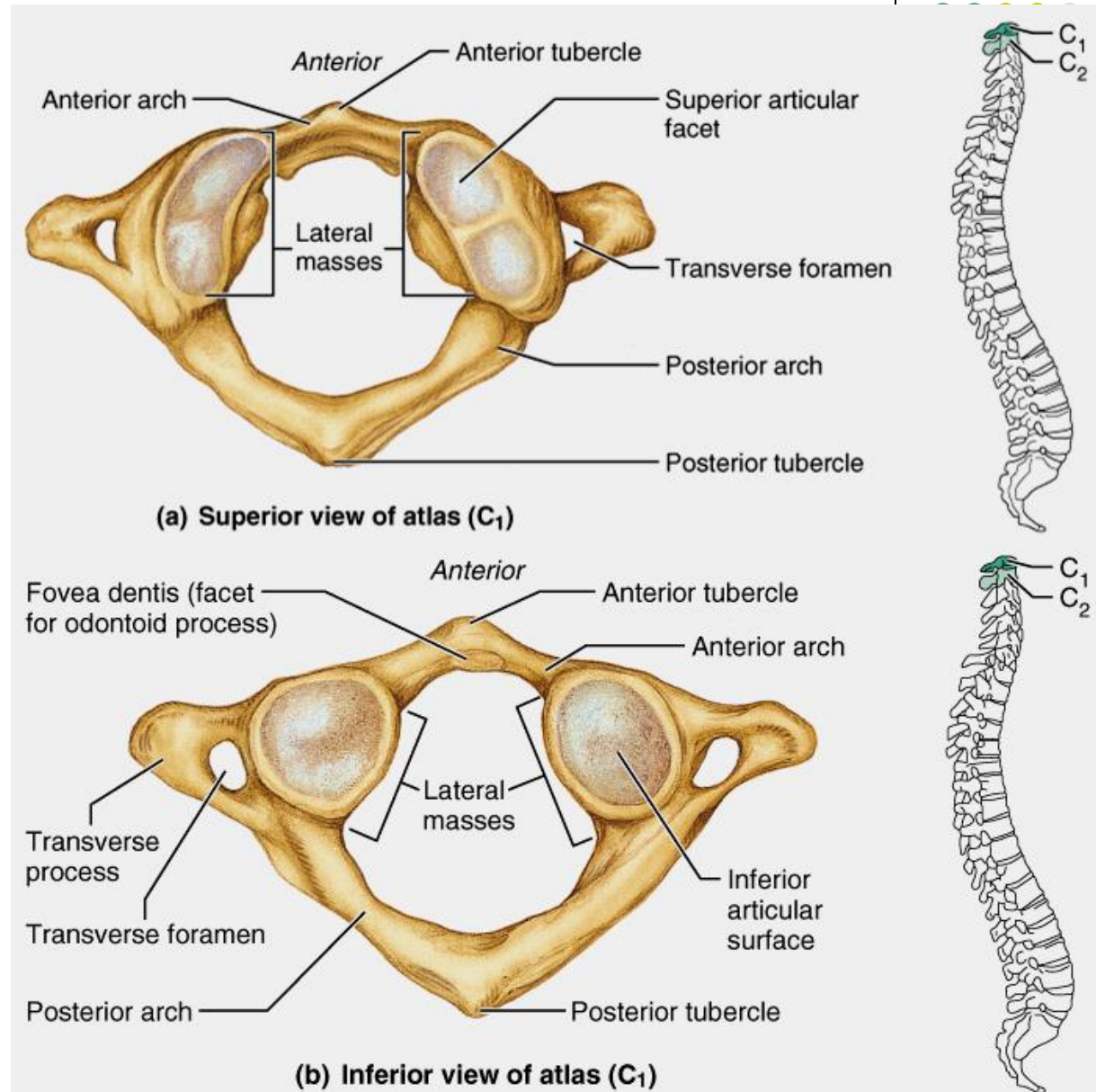


- **Seven vertebrae (C₁-C₇) are the smallest, lightest vertebrae**
- **C₃-C₇ are distinguished with an oval body, short spinous processes, and large, triangular vertebral foramina**
- **Each transverse process contains a transverse foramen**

Cervical Vertebrae: Atlas (C₁)

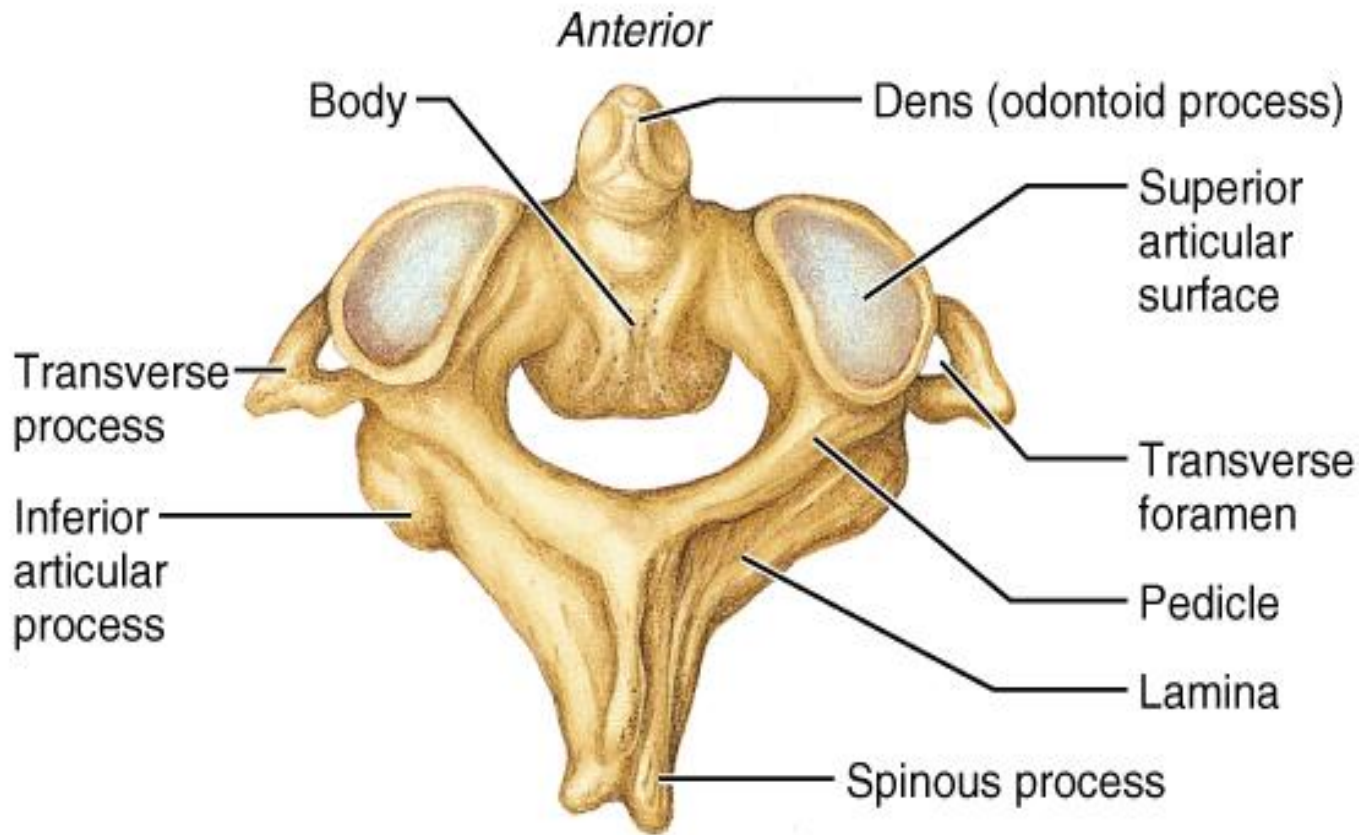
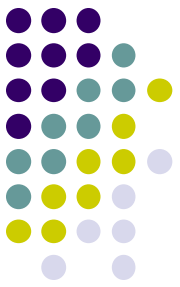


- Has no body and no spinous process
- Consists of anterior and posterior arches, and two lateral masses
- The superior surface of lateral masses articulate with the occipital condyles



Cervical Vertebrae: The Axis (C₂)

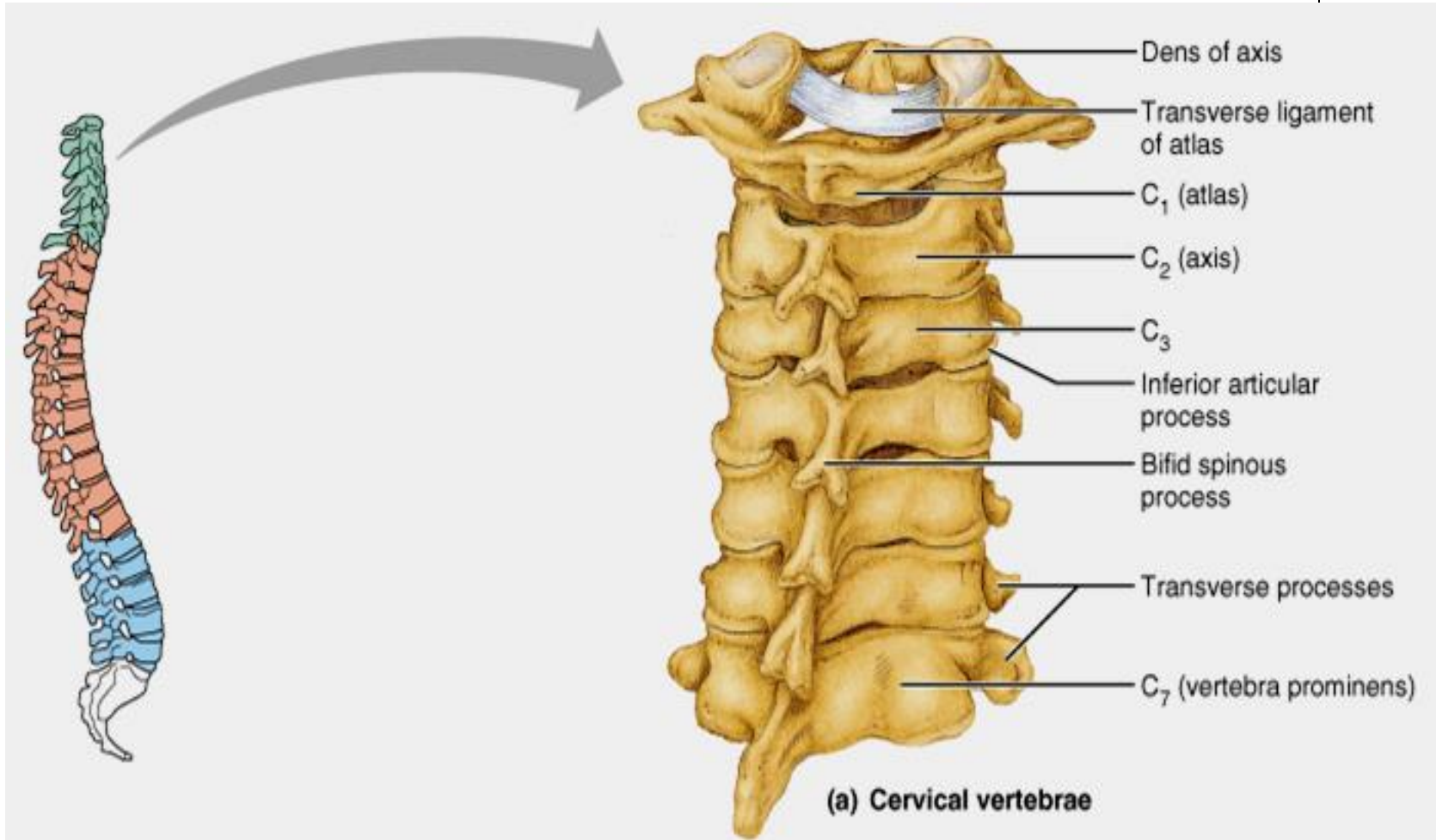
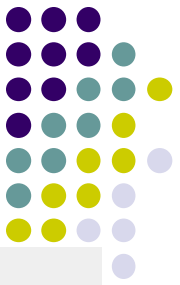
- The axis has a body, spine, and vertebral arches as do other cervical vertebrae



(c) Superior view of axis (C₂)



Cervical Vertebrae: The Atlas (C₂)

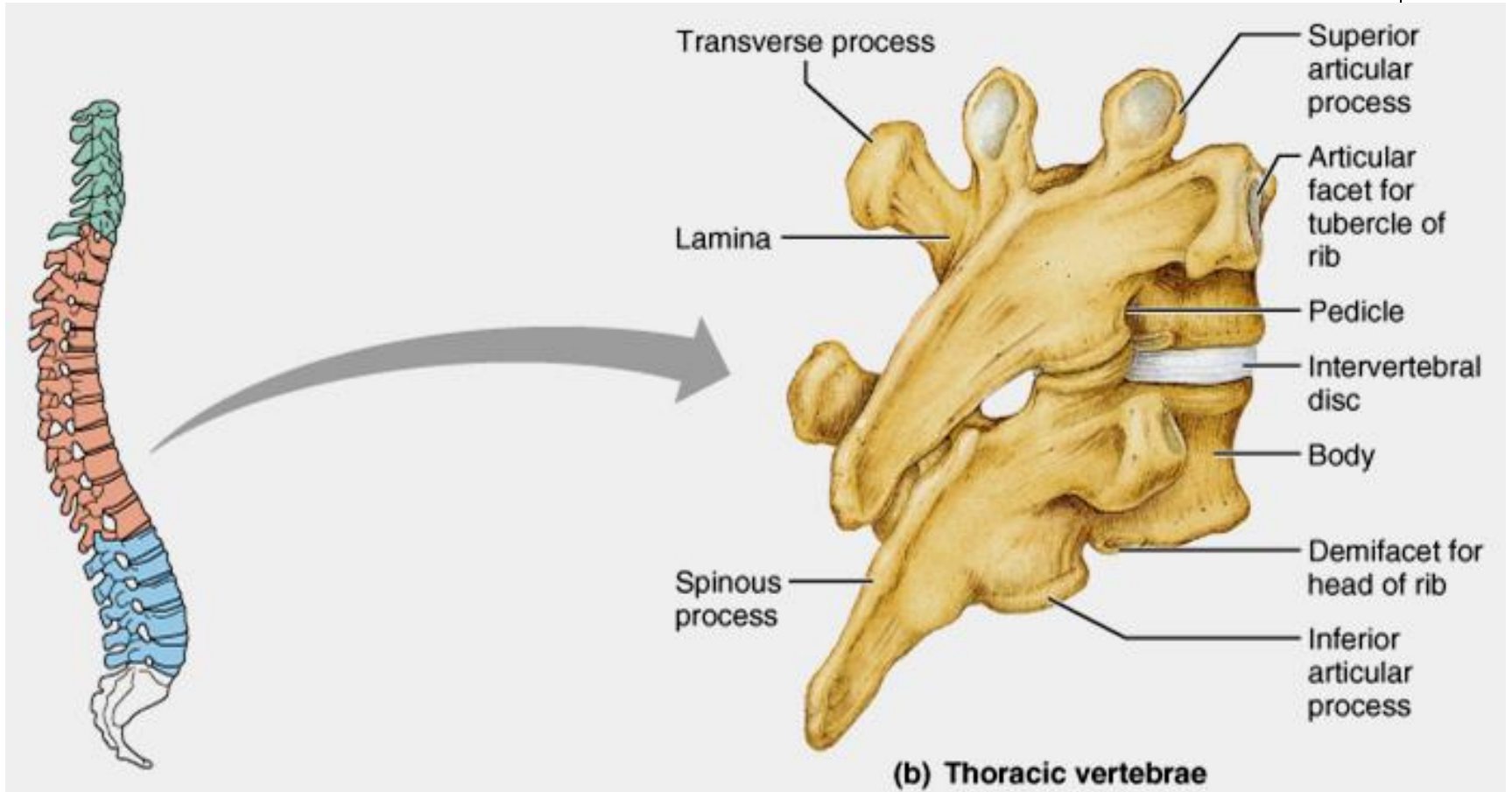
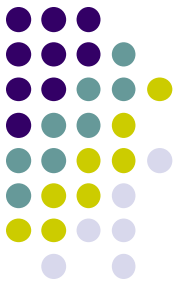


Thoracic Vertebrae



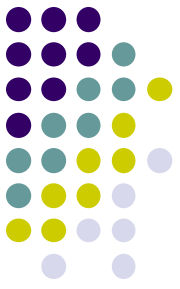
- **There are twelve vertebrae (T₁-T₁₂) all of which articulate with ribs**
- **Major markings include two facets and two demifacets on the heart-shaped body, the circular vertebral foramen, transverse processes, and a long spinous process**
- **The location of the articulate facets prevent flexion and extension, but allow rotation of this area of the spine**

Thoracic Vertebrae

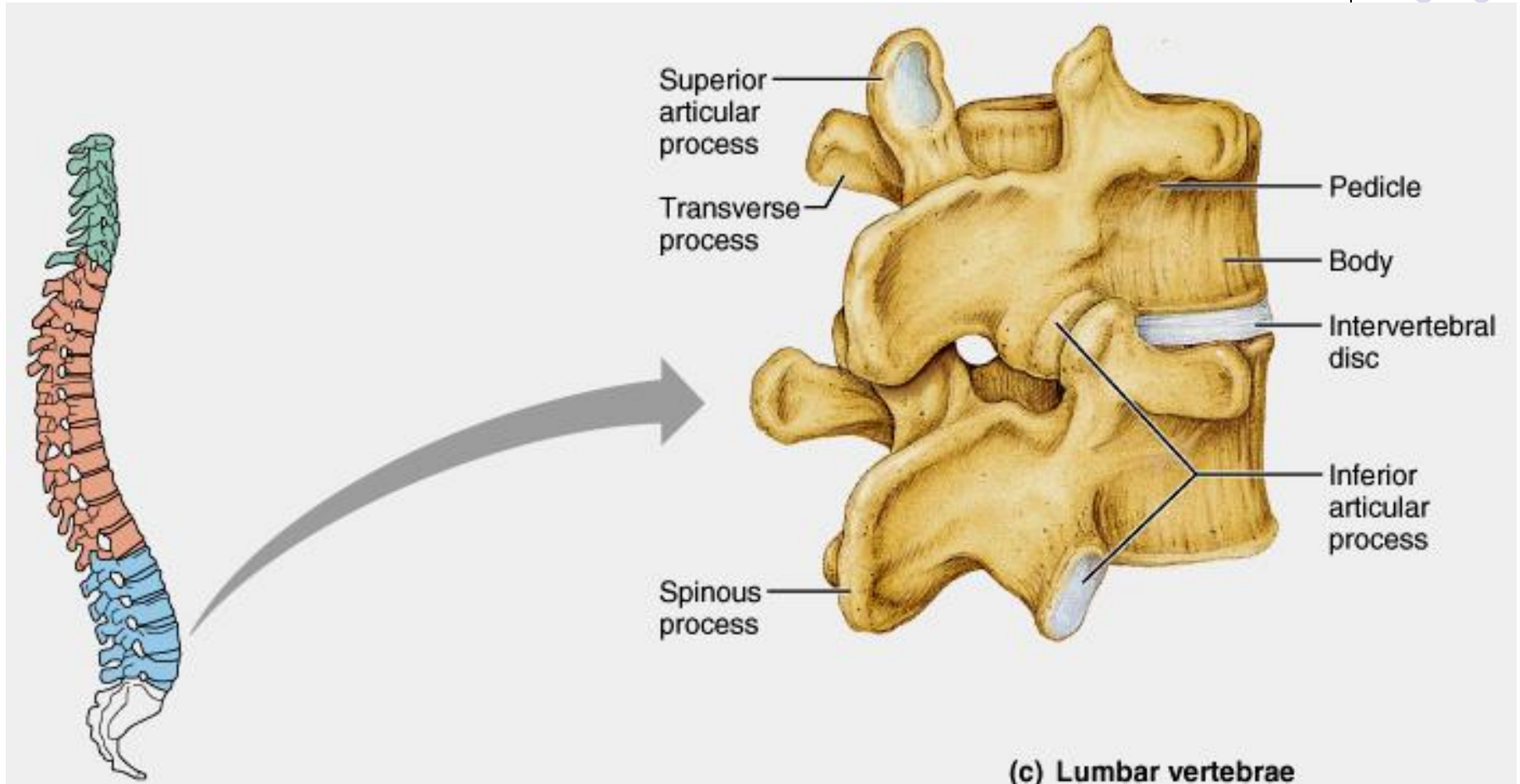
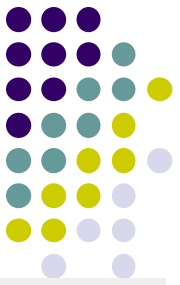


Lumbar Vertebrae

- **The five lumbar vertebrae (L₁-L₅) are located in the small of the back and have an enhanced weight-bearing function**
- **They have short, thick pedicles and laminae, flat hatchet-shaped spinous processes, and a triangular-shaped vertebral foramen**
- **Orientation of articular facets lock the lumbar vertebrae together to provide stability**



Lumbar Vertebrae

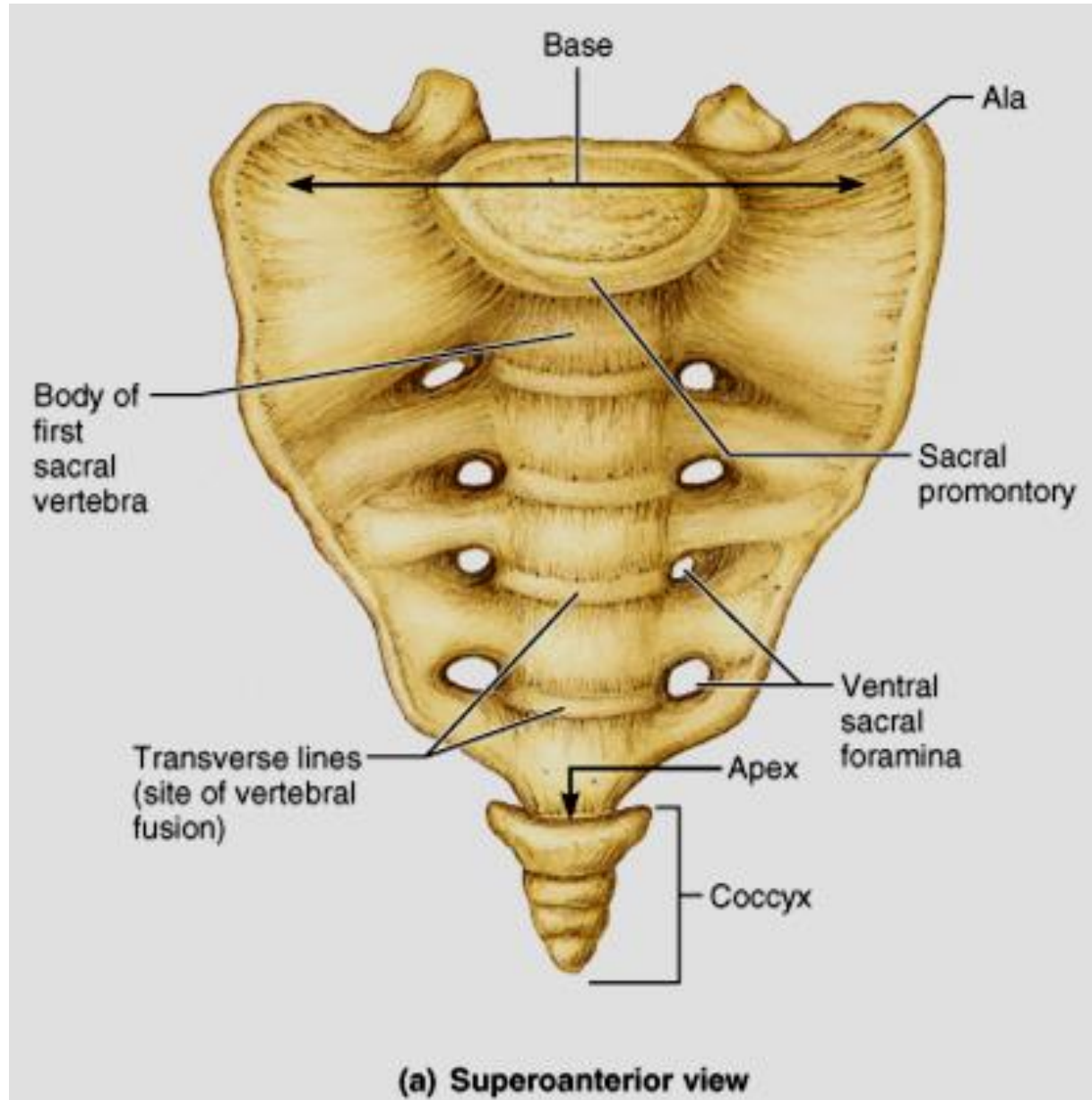
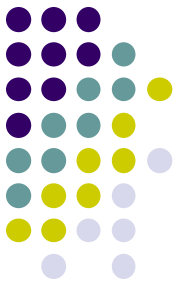


Sacrum and Coccyx

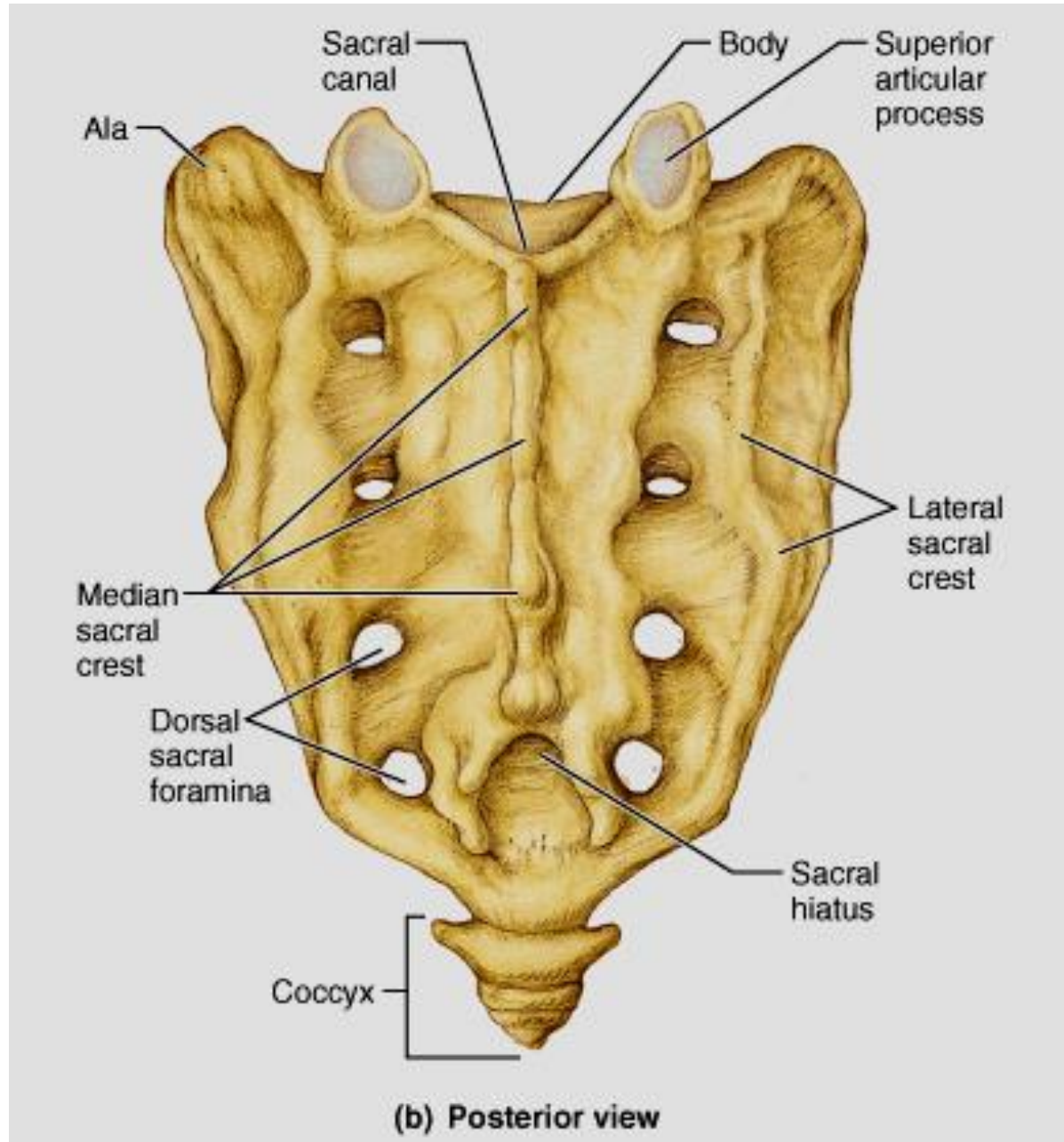
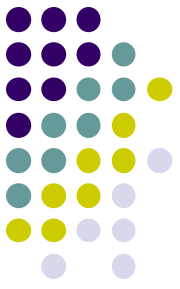


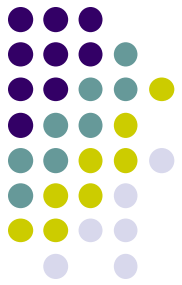
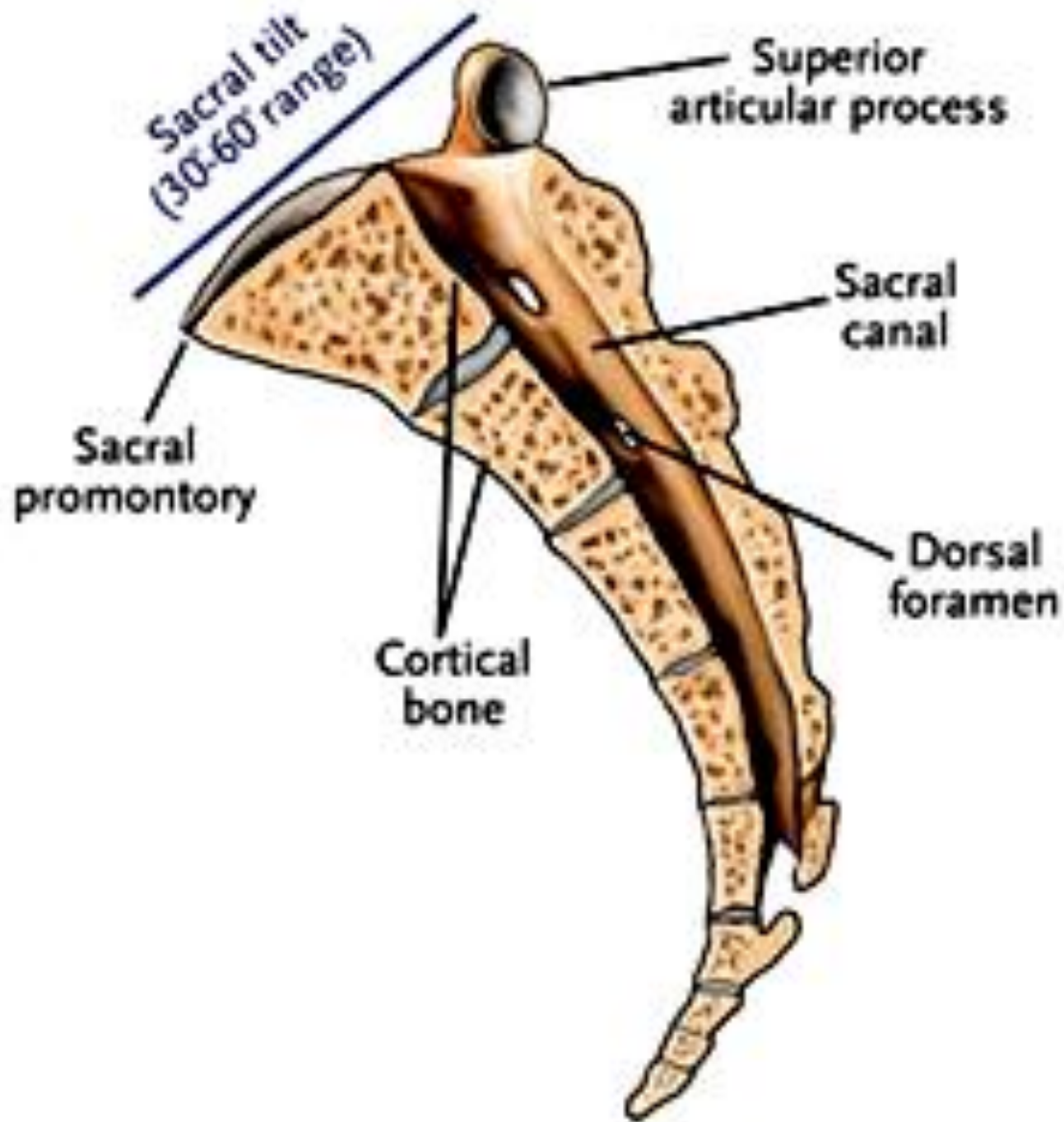
- **The sacrum**
 - Consists of five fused vertebrae (S_1 - S_5), which shape the posterior wall of the pelvis
 - It articulates with L_5 superiorly, and with the auricular surfaces of the hip bones
 - Major markings include the sacral promontory, transverse lines, alae, dorsal sacral foramina, sacral canal, and sacral hiatus
- **Coccyx (Tailbone)**
 - The coccyx is made up of four (in some cases three to five) fused vertebrae that articulate superiorly with the sacrum

Sacrum and Coccyx



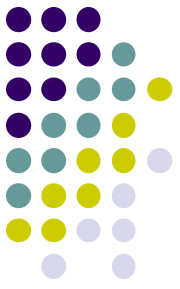
Sacrum and Coccyx



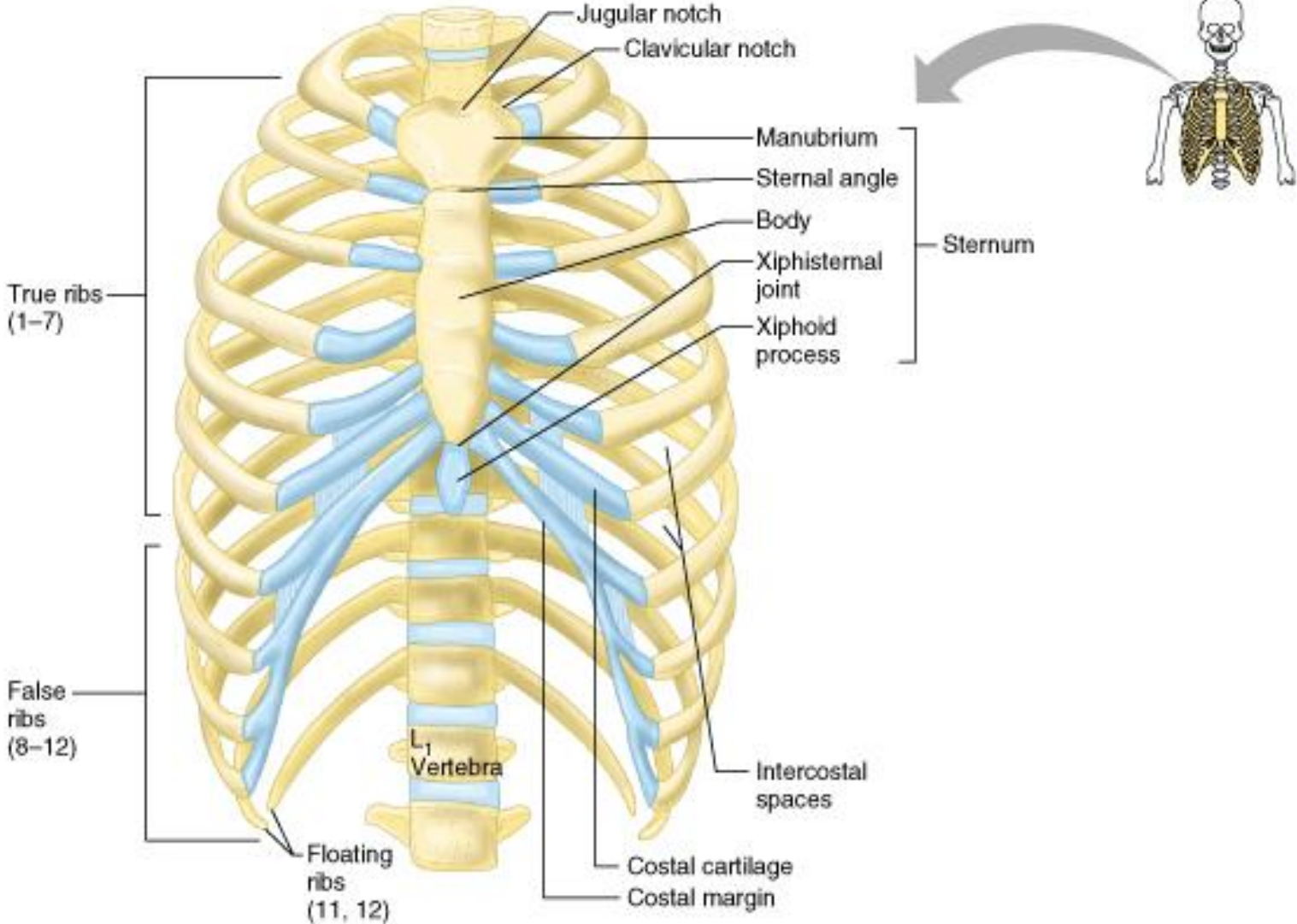


Ribs

- **There are twelve pair of ribs forming the flaring sides of the thoracic cage**
- **All ribs attach posteriorly to the thoracic vertebrae**
- **The superior 7 pair (true, or vertebrosteral ribs) attach directly to the sternum via costal cartilages**
- **Ribs 8-10 (false, or vertebrocondral ribs) attach indirectly to the sternum via costal cartilage**
- **Ribs 11-12 (floating, or vertebral ribs) have no anterior attachment**



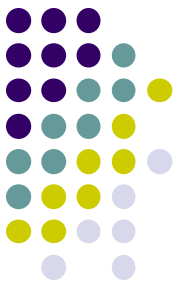
Ribs



(a)



Structure of a Typical True Rib



- **Bowed, flat bone consisting of a head, neck, tubercle, and shaft**

