LECTURE#3 (4/03/2025)

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ANATOMY & PHYSIOLOGY

Skeleton System

Skeletal system

The Skeleton

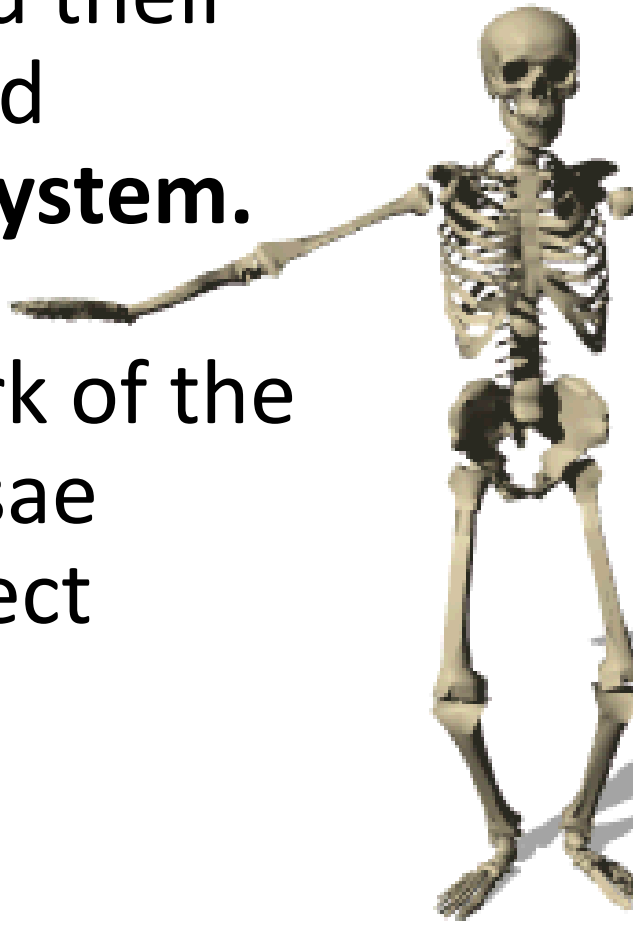
Learning Objectives

By the end of this section, we all will be able to:

- Define skeletal system
- Discuss the structure of various types of bones
- Identify the bones of axial & appendicular skeleton

Skeletal system

- The entire framework of bones and their cartilages, along with ligaments and tendons, constitutes the **skeletal system.**



- The skeleton is the bony framework of the body. It forms the cavities and fossae (depressions or hollows) that protect internal structures.

Skeletal System

206 bones in body when you are about 10 or 20.

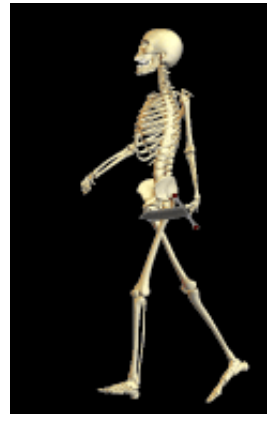
Functions of Bones

- **Support:** The skeleton serves as the structural framework for the body by supporting soft tissues and providing attachment points for the tendons of most skeletal muscles.
- ***Protection.*** The skeleton protects the most important internal organs from injury. For example, cranial bones protect the brain, vertebrae (backbones) protect the spinal cord, and the rib cage protects the heart and lungs

Functions of Bones

- ***Assistance in movement.*** Most skeletal muscles attach to bones; when they contract, they pull on bones to produce movement.

- ***Mineral homeostasis (storage and release).*** Bone tissue stores minerals, especially calcium and phosphorus, which contribute to the strength of bone. On demand, bone releases minerals into the blood to maintain critical mineral balances



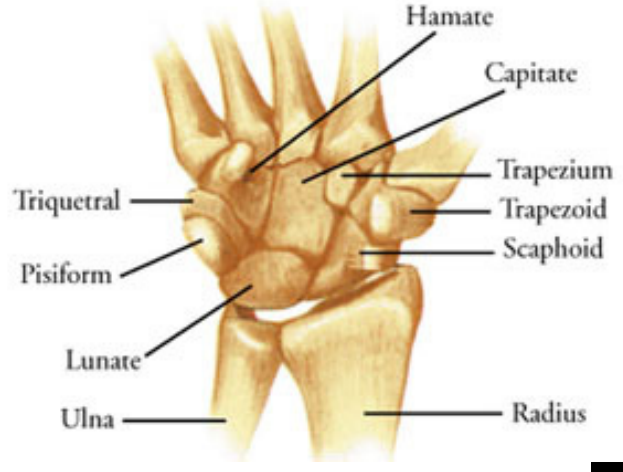
Functions of Bones

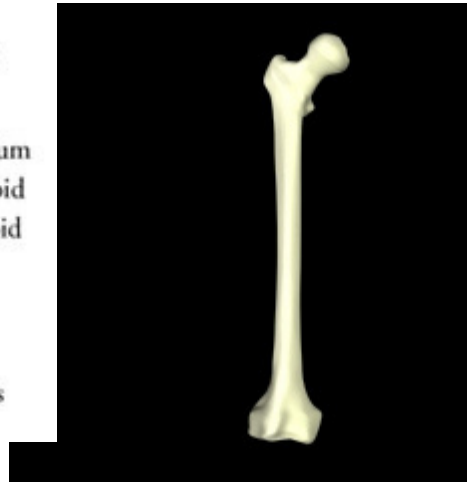
- ***Blood cell production.*** Within certain bones, a connective tissue called red bone marrow produces red blood cells, white blood cells, and platelets, a process called hemopoiesis.
- **Yellow bone marrow:** consists mainly of adipose cells, which store triglycerides. The stored triglycerides are a potential chemical energy reserve.

Classification of bones by shape

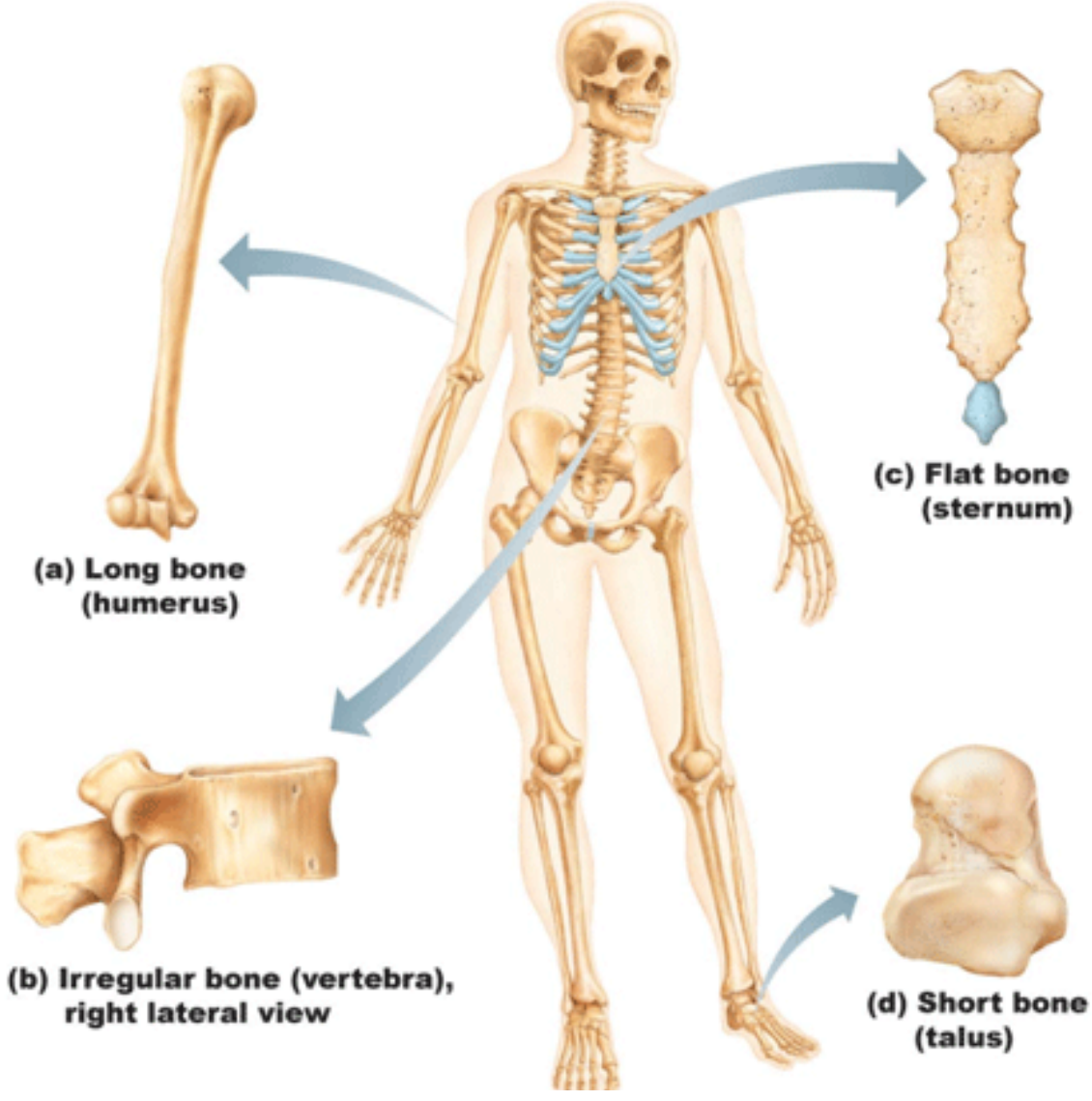
4 types of bones

- Long
- Short
- Flat
- Irregular
- Sesamoid



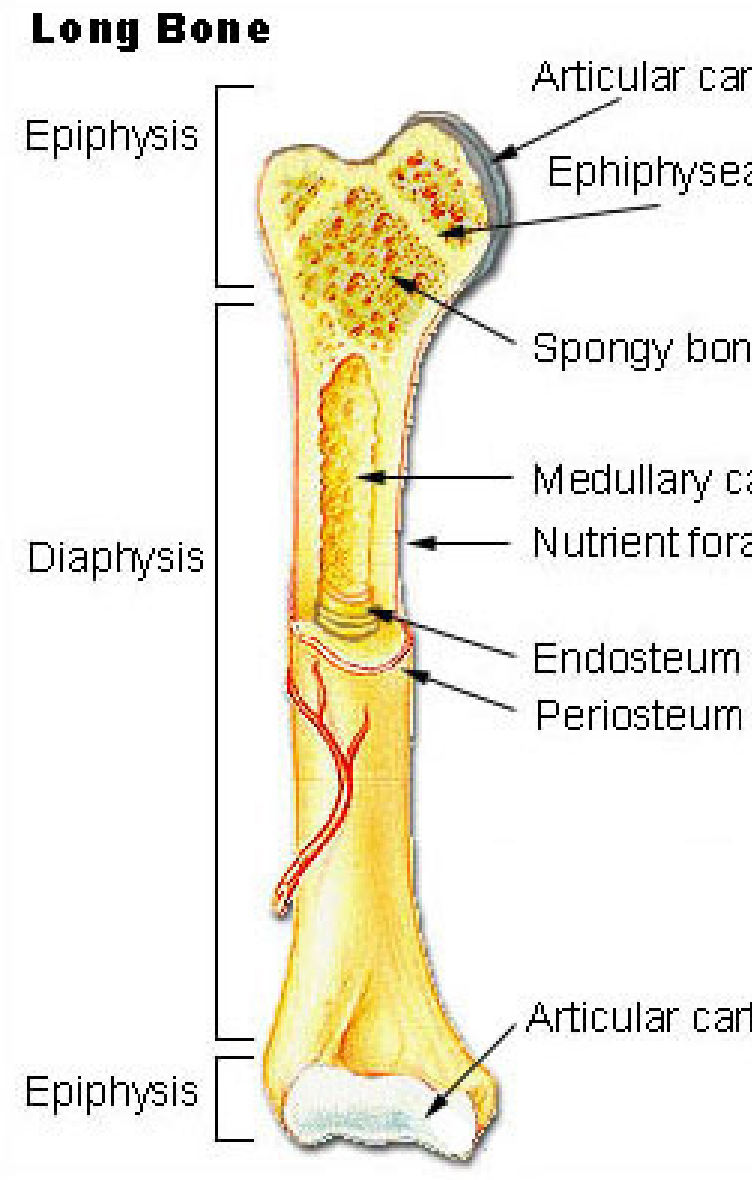


Classification of Bones



Long Bones

- **Much longer than they are wide.**
- **Consists of a shaft plus 2 expanded ends.**
- **All bones of the limbs except for the patella (kneecap), and the bones of the wrist and ankle.**

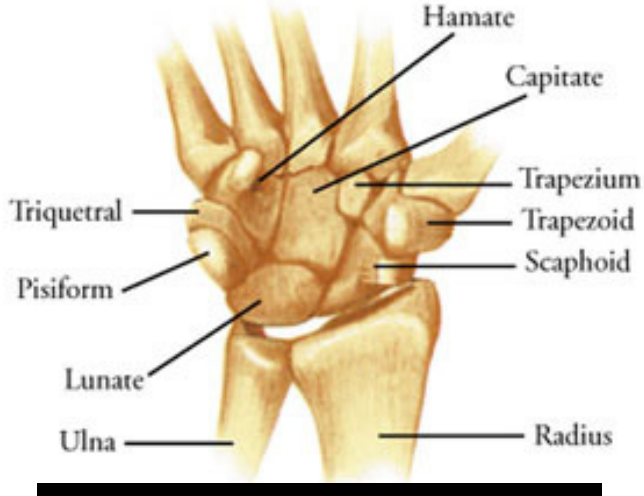


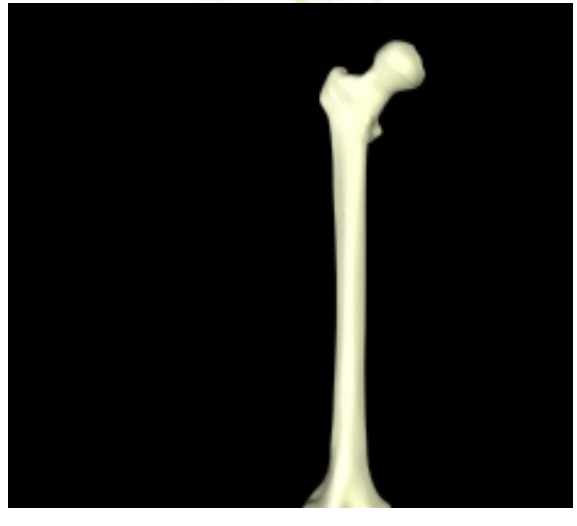
Features of Long Bones

- **Diaphysis**: shaft forms the long axis of the bone
  - Wall of compact bone surrounding a medullary (marrow) cavity
- **Epiphyses**: expanded bone ends
  - Articulates with another bone
  - Exterior made of a thin layer of compact bone
  - Interior made of spongy bone

Identify the types of bones

Find example of all types of bones



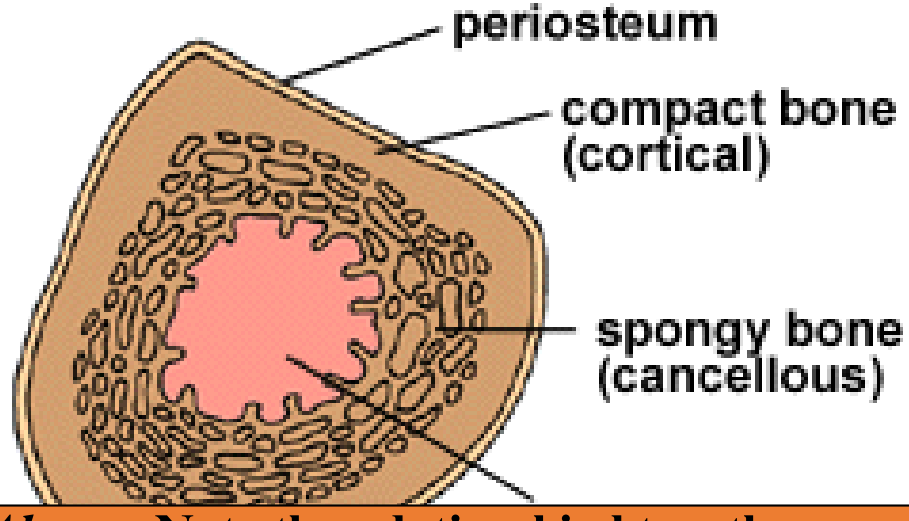


Bone Structure

- **Bones are organs. Thus, they're composed of multiple tissue types. Bones are composed of:**
  - **Fibrous connective tissue.**
  - **Cartilage.**
  - **Vascular tissue.**
  - **Lymphatic tissue.**
  - **Adipose tissue.**
  - **Nervous tissue**

Bone Structure

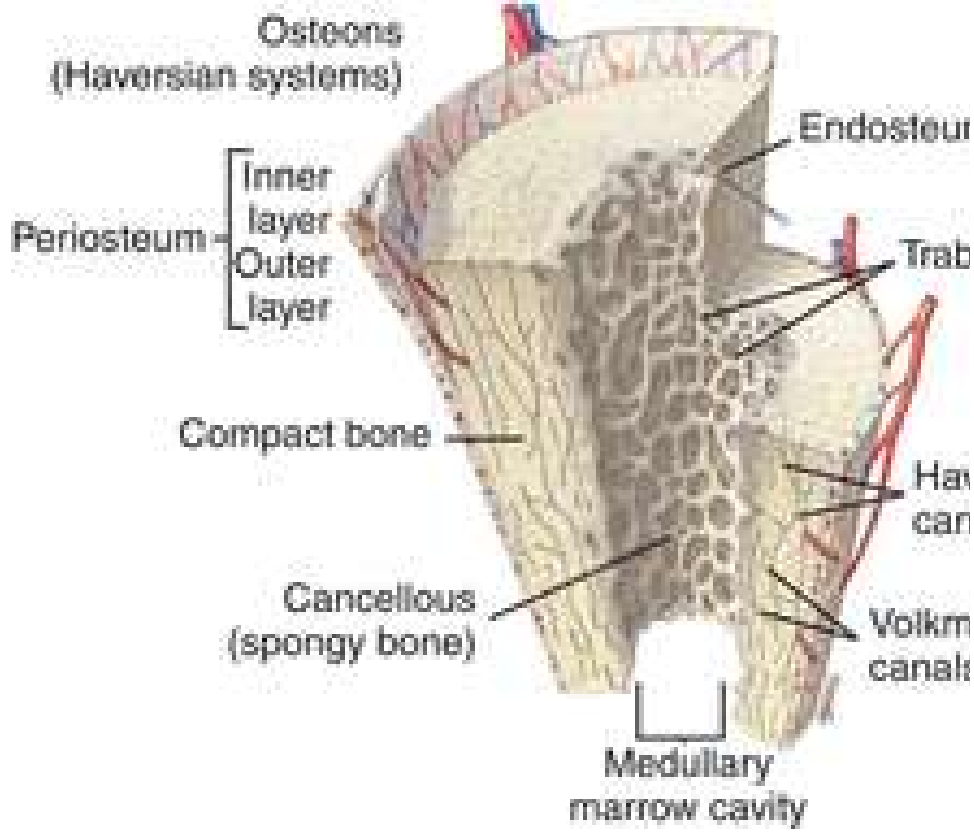
- **All bones consist of a dense, solid outer layer known as compact bone and an inner layer of spongy or cancellous bone**
- **Most bones contain both types.**
- **Bone is an extremely dynamic tissue!!!!**



Above: **Note the relationship btwn the compact and spongy bone.**
Below: **Close up of spongy bone.**

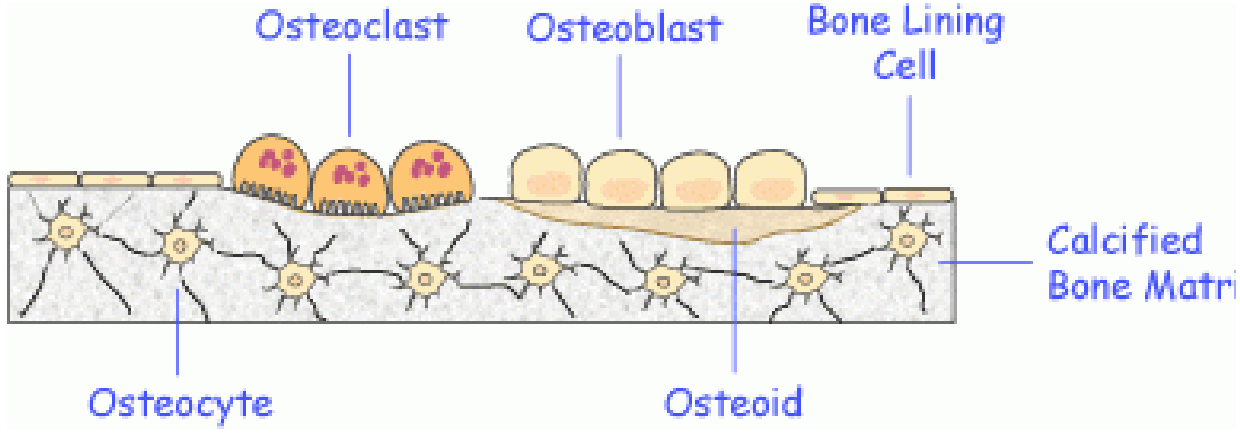
Compact Bone

- Consists of multiple cylindrical structural units known as <u>osteons</u> or <u>haversian systems</u>.
- **Compact & Spongy contains Osteocytes**



Microscopic Anatomy

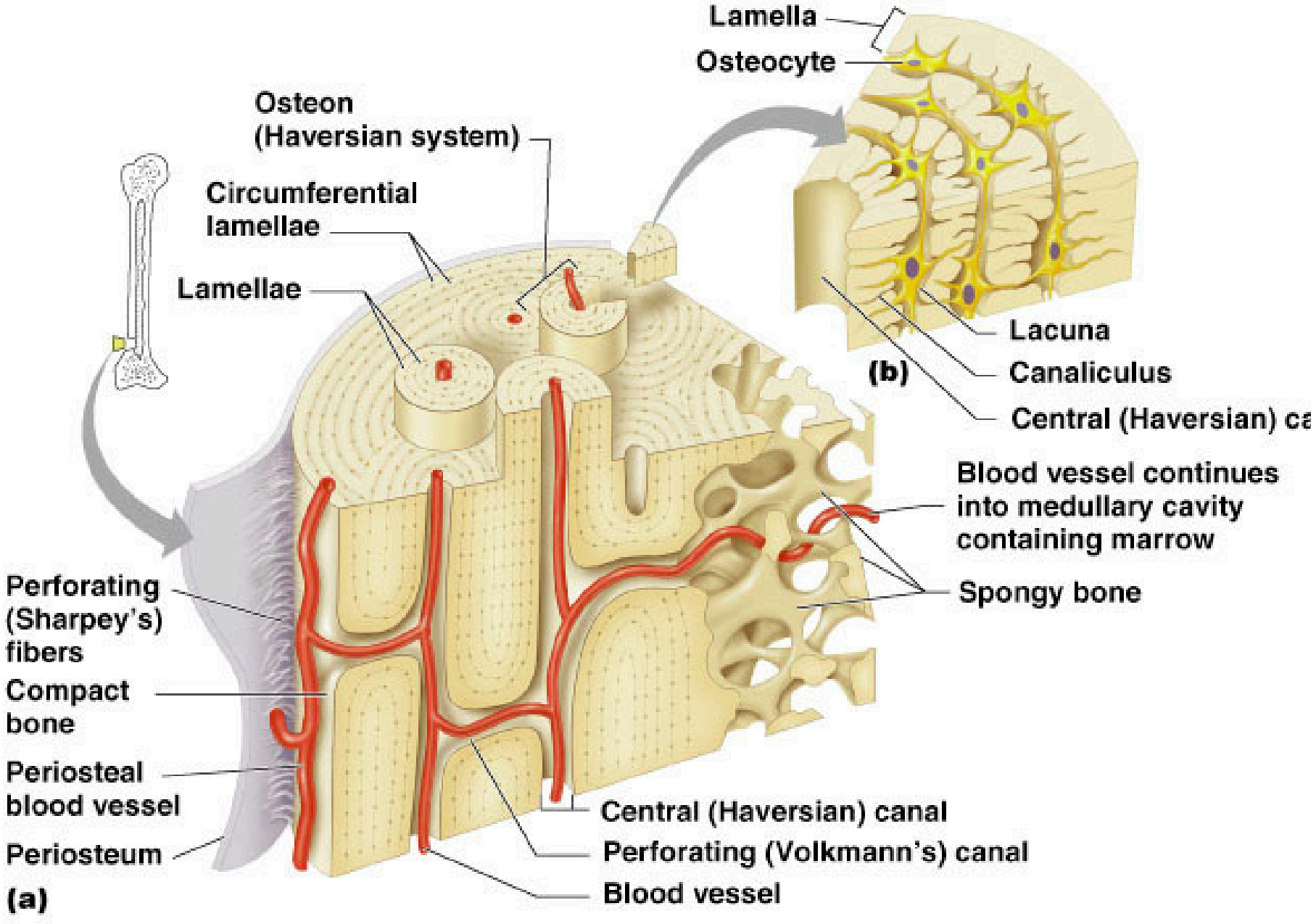
- **Bones---- hardest connective tissue**
- **Water 20%**
- **Organic Material 30-40%**
  - Matrix of collagen and glycoproteins forming osteoid (bone cells)
  - 1/3 of weight of bone
- **Inorganic material 40-50 %**
  - Calcium, Phosphorus and mineral salts
  - 95% of Ca++ in bone



Microscopic Structure of Compact Bone

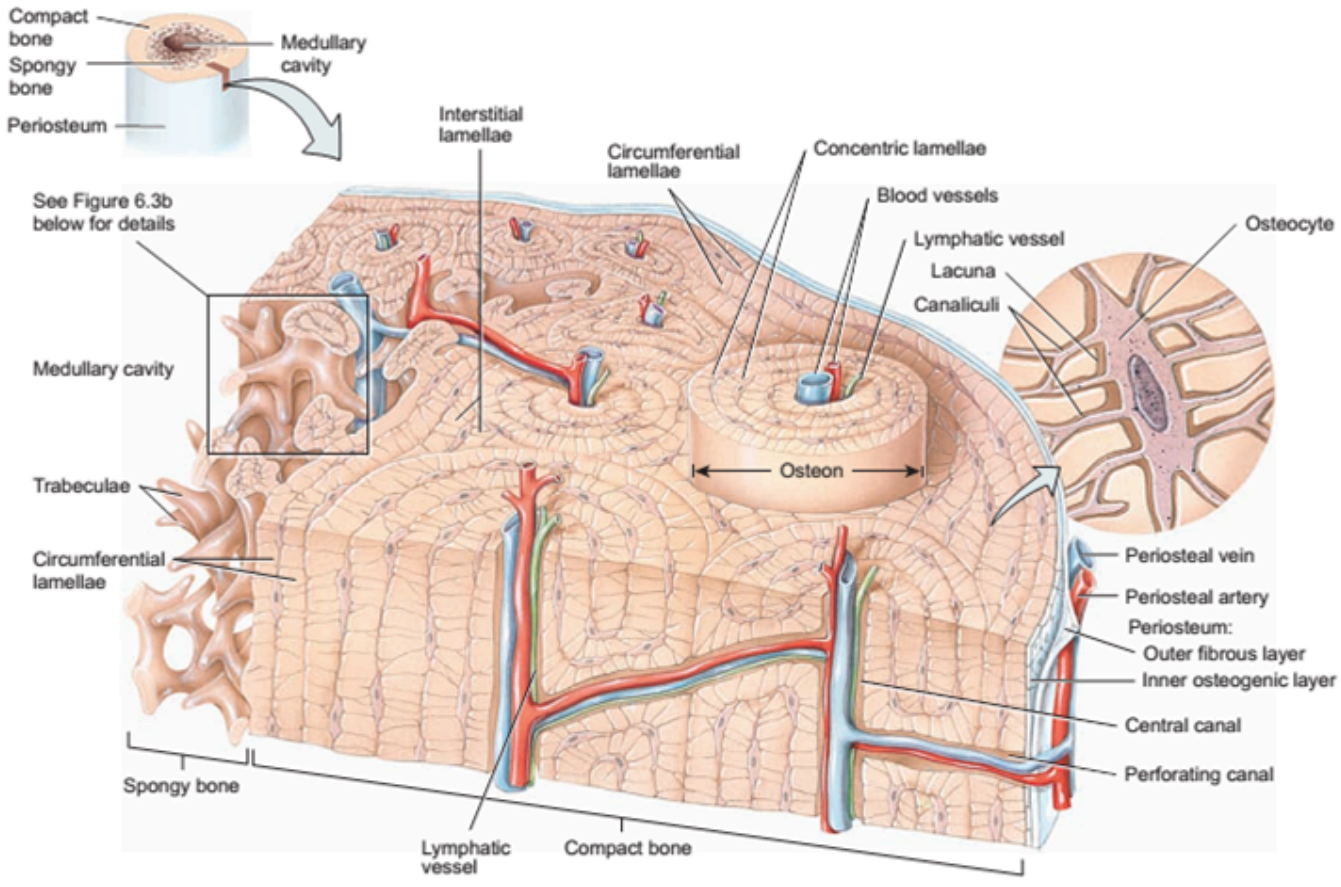
- Compact bone consists of closely packed osteons or haversian systems.
- The osteon consists of a central canal called the osteonic (haversian) canal, which is surrounded by concentric rings (lamellae) of matrix.
- Between the rings of matrix, the bone cells (osteocytes) are located in spaces called lacunae.

Osteons

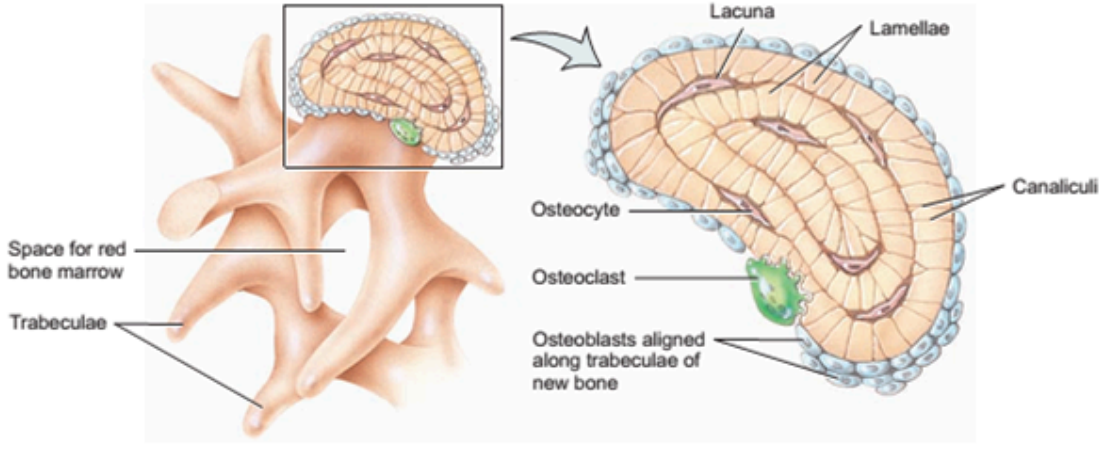

Lamella
Osteocyte
Osteon
(Haversian system)
Circumferential
lamellae
Lamellae
Lacuna
(b)
Canaliculus
Central (Haversian) ca
Blood vessel continues
into medullary cavity
containing marrow
Spongy bone
Perforating
(Sharpey's)
fibers
Compact
bone
Periosteal
blood vessel
Periosteum
(a)
Central (Haversian) canal
Perforating (Volkmann's) canal
Blood vessel

Microscopic Structure of Compact Bone

- Small channels (canaliculi) radiate from the lacunae to the osteonic (haversian) canal to provide passageways through the hard matrix.
- In compact bone, the haversian systems are packed tightly together to form what appears to be a solid mass.
- The osteonic canals contain blood vessels that are parallel to the long axis of the bone.
- These blood vessels interconnect, by way of perforating canals, with vessels on the surface of the bone.

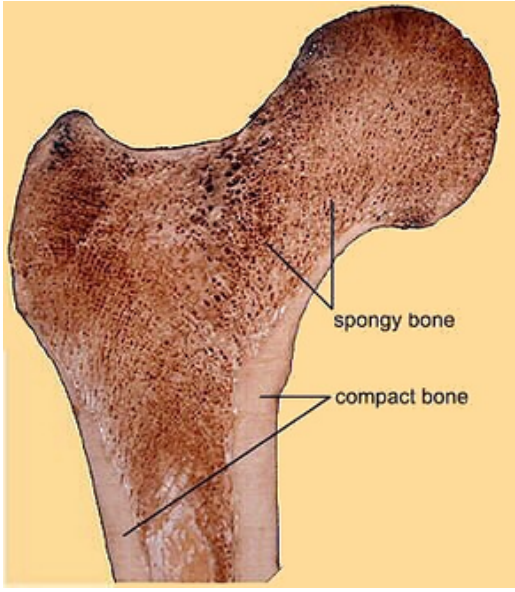


(a) Osteons (haversian systems) in compact bone and trabeculae in spongy bone



Microscopic Structure of **Spongy Bone**

- No osteons are present
- Lamellae are irregularly arranged into plates called trabeculae.
  - Small needle-like pieces of bone
  - Have a lot of open space between them
  - Filled with bone marrow.
- Trabeculae are interconnected by canaliculi.

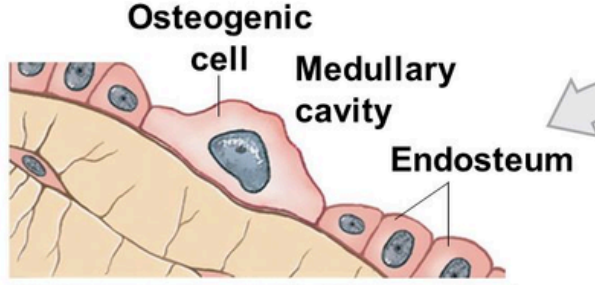


Bone Cells

Osteogenic cells: are found along the inner portion of the periosteum, in the endosteum, and in the
canals within bone that contain blood vessels
They are the only bone cells to undergo cell division; the resulting cells develop into osteoblasts.

Osteoblast
They synthesize and secrete collagen fibers and other organic components needed to build the extracellular matrix of bone tissue, and they initiate calcification.

Figure 6-4 Types of Bone Cells (Part 3 of 4).

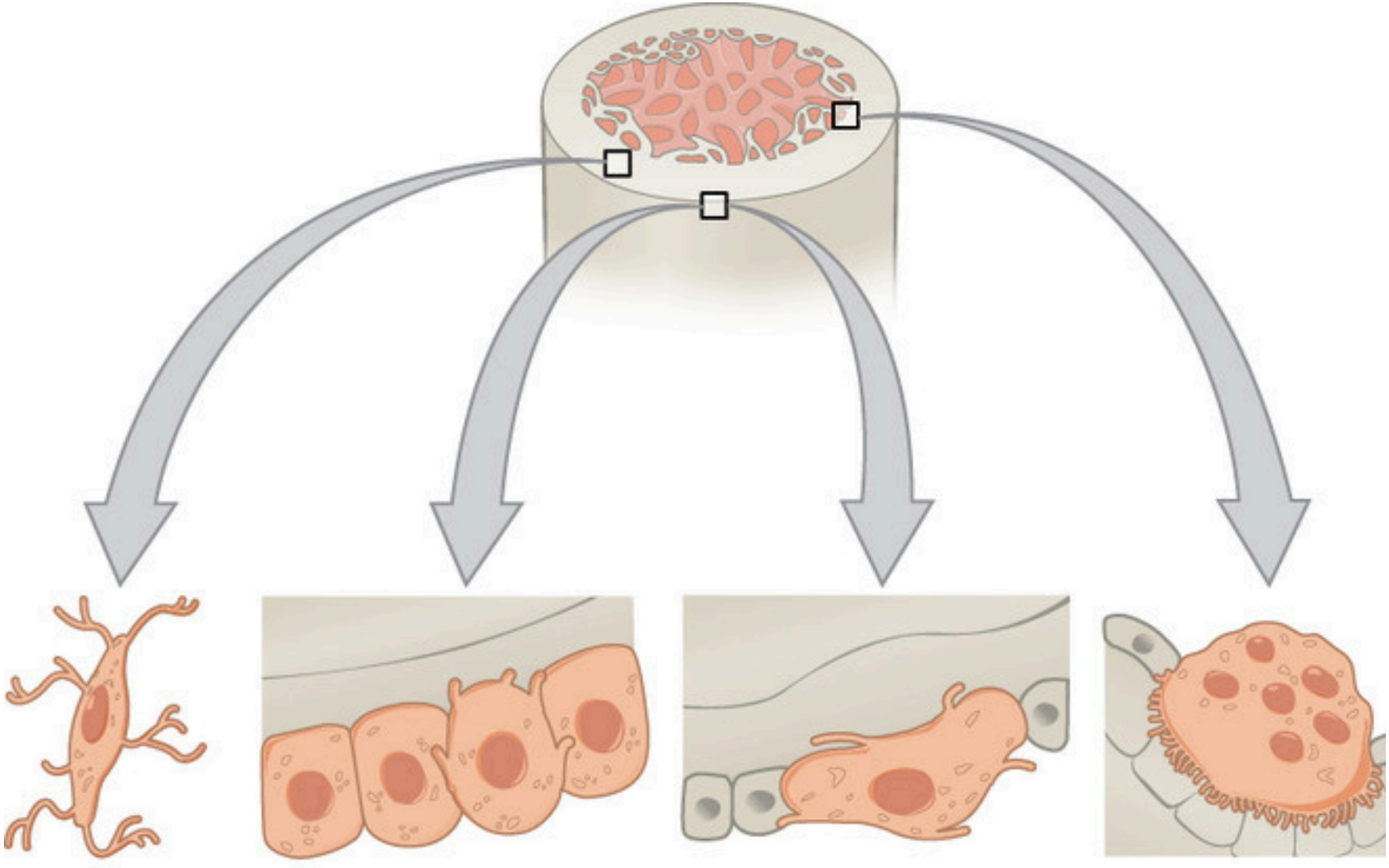


Osteogenic cell: Stem cell whose divisions produce osteoblasts

Bone Cells

- **Osteocyte** They develop from osteoblasts and live in Lacuna. They are mature bone cells, are the main cells in bone tissue and maintain its daily metabolism, such as the exchange of nutrients and wastes with the blood.

- **Osteoclast** large cells derived from the fusion of as many as 50 monocytes
- resorb or break down bone
  - “Digest” bone
  - Equilibrium between osteoblasts and osteoclasts maintains bone tissue



Osteocyte
(maintains bone tissue)

Osteoblast
(forms bone matrix)

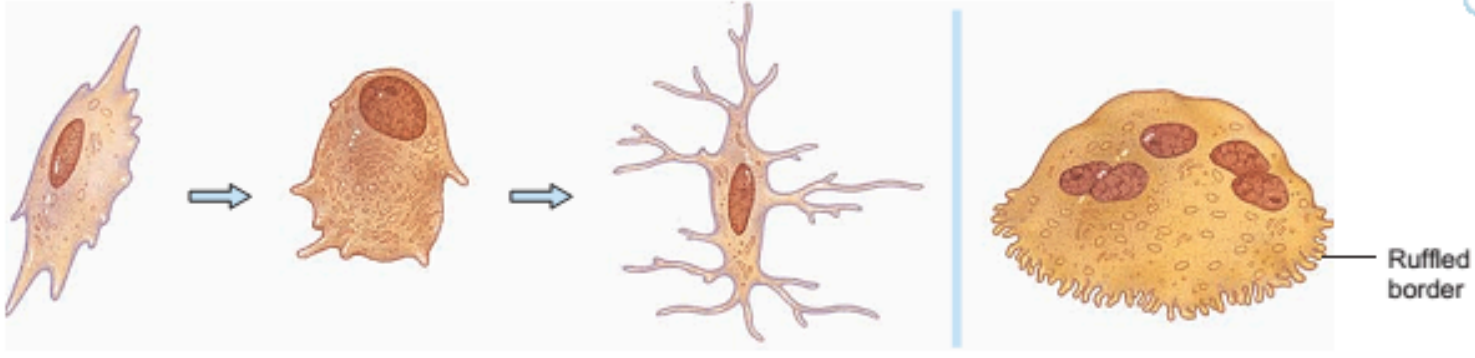
Osteogenic cell
(stem cell)

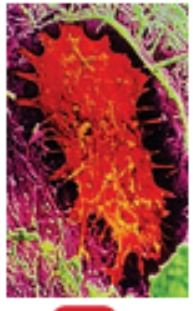
Osteoclast
(resorbs bone)

Bone Cells

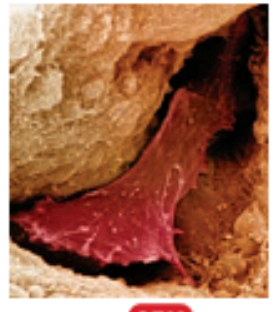
Figure 6.2 **Types of cells in bone tissue.**

Osteogenic cells undergo cell division and develop into osteoblasts, which secrete bone extracellular matrix.




SEM 1100x


SEM 9160x


SEM 5626x

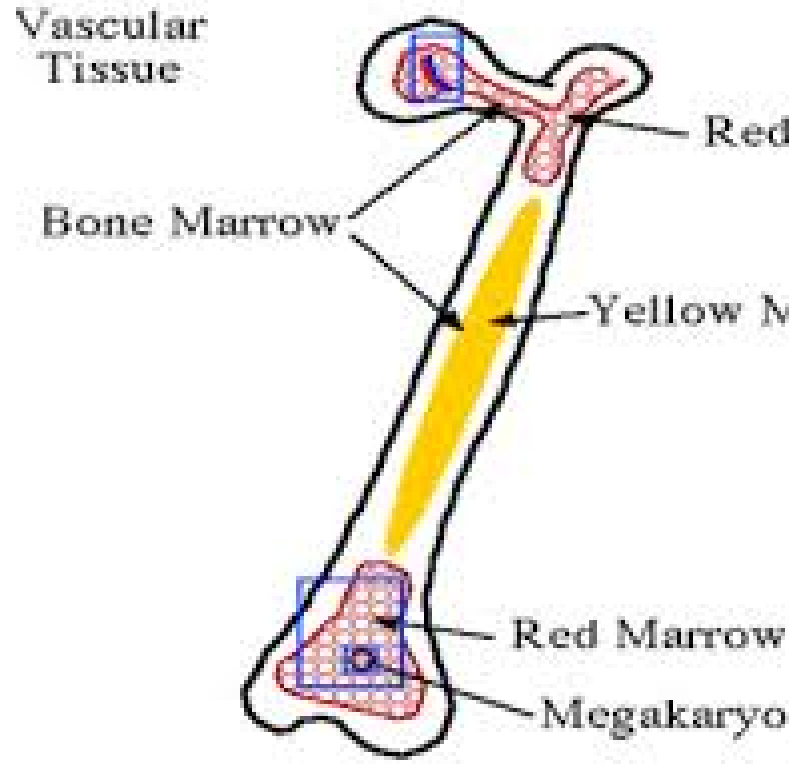
Classification of Bones by Function

- **Types of bone**
- **Compact bone** - Compact bone is dense and hard, especially protective exterior layer of the bone.
- Cancellous or **Spongy bone** - is inside the compact bone and is very porous (full of tiny holes). Made up of a web work of bone, the spaces are filled with red marrow which produce blood cells.

Bone Marrow

- Marrow
  - Netlike mass of connective tissue that fills the spaces of bone
    - Medullary cavities of long bones
    - Irregular spaces of spongy bone

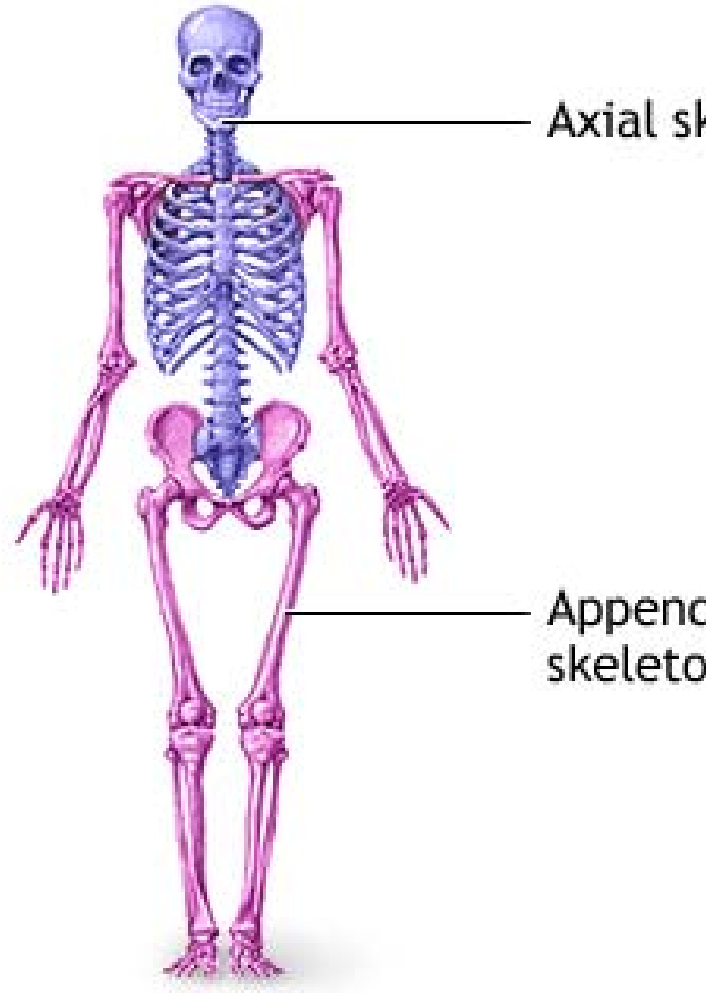
- Red Marrow
- Yellow



Division of Skeleton

206 BONES: These bones can be grouped in two divisions:

1. **Axial Skeleton**
2. **Appendicular Skeleton**

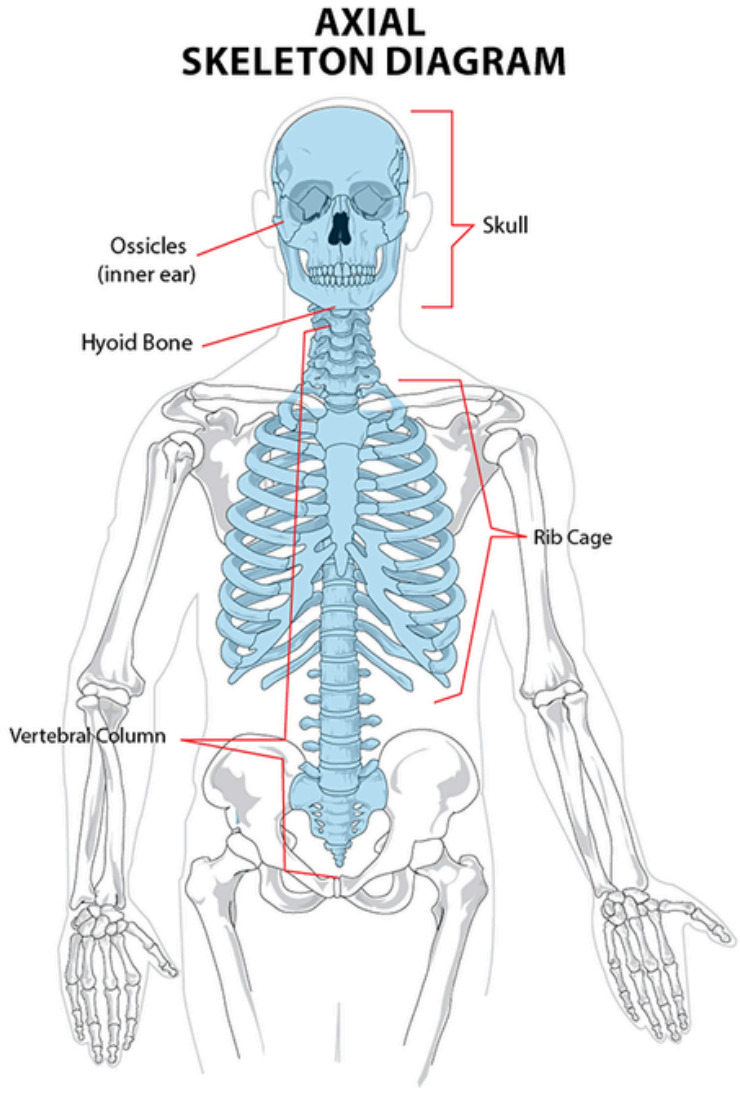


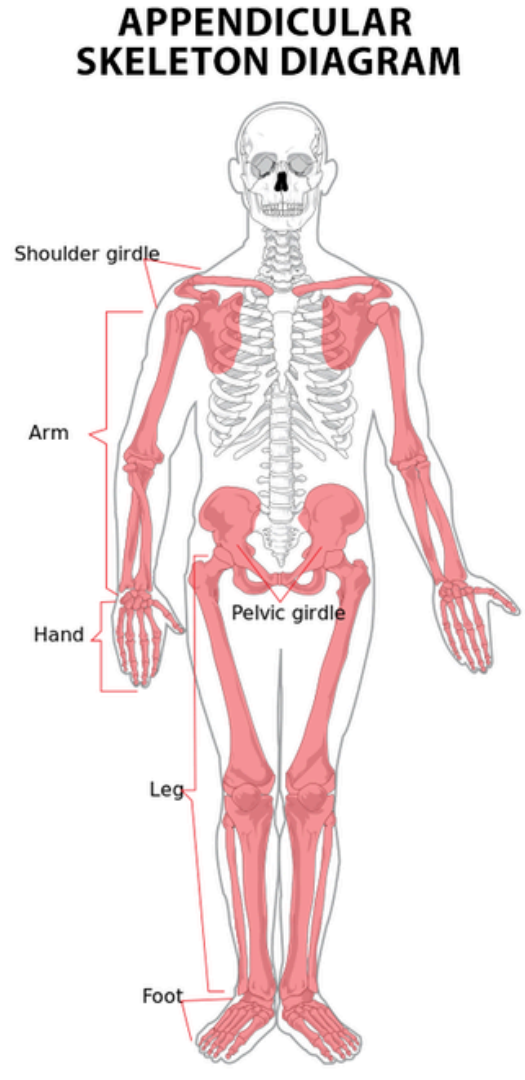
Axial Skeleton

- Skull
- Spine
- Thoracic Cage
- Hyoid bone
  and auditory ossicles

Division of Skeleton

- The 80 bones of the axial skeleton form the vertical axis of the body.
- The appendicular skeleton consists of 126 bones



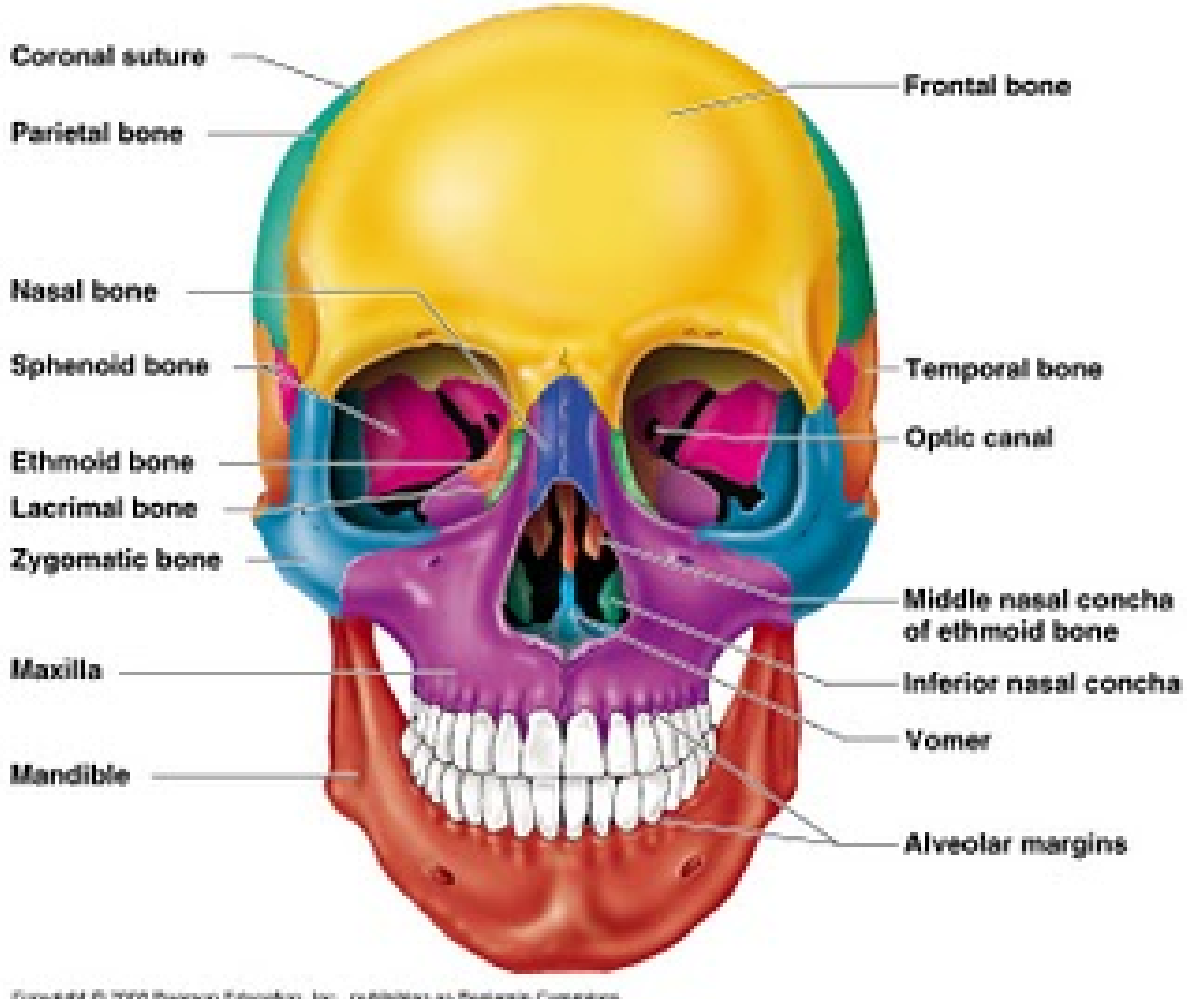


Axial Skeleton (80 bones)

- **Skull (28) consists of 8 cranial and 14 facial bones.**

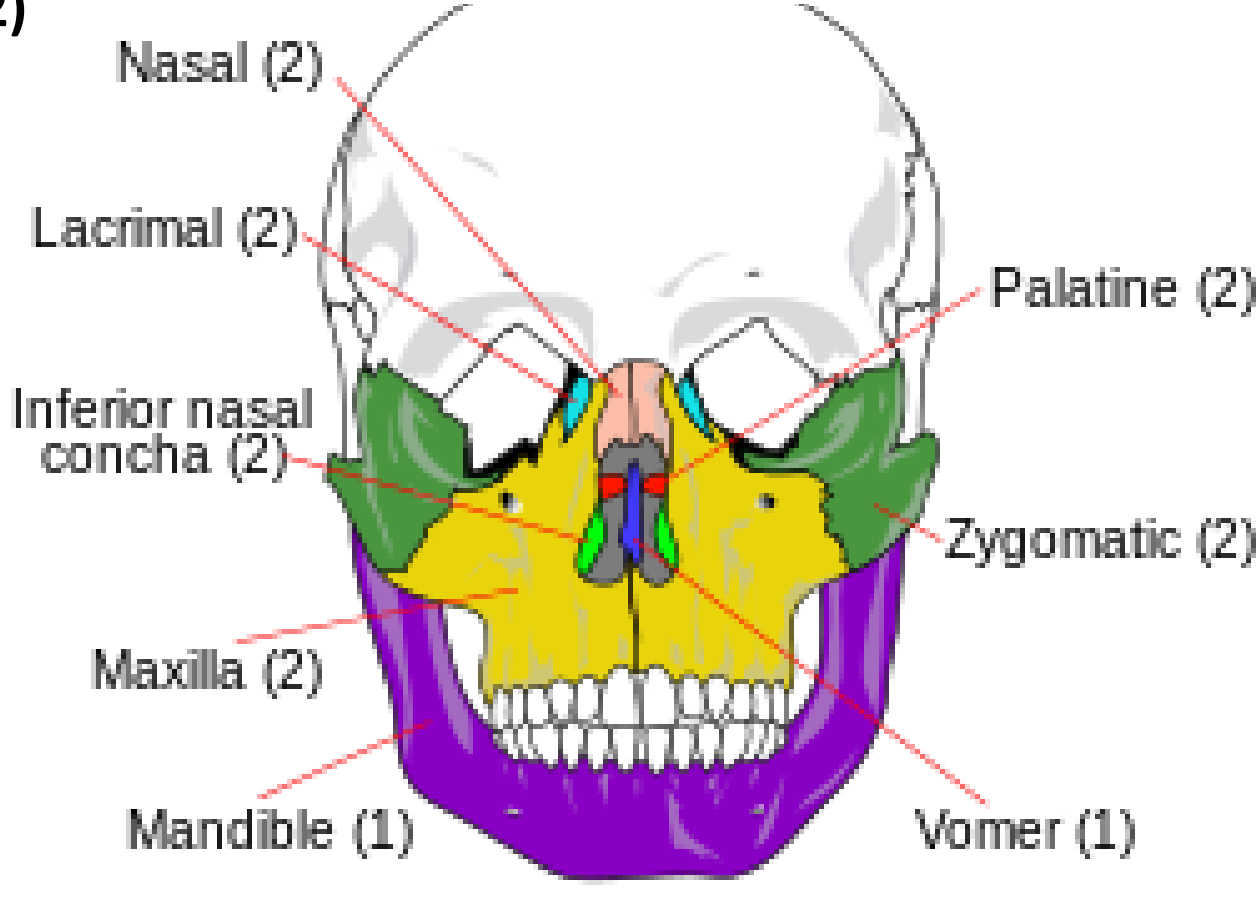
1. Cranium

- Frontal (1)
- Parietal (2)
- Temporal (2)
- Occipital (1)
- Ethmoid (1)
- Sphenoid (1)



2. Facial Bones 14

- (Maxilla (1) (originated as 2)
- Zygomatic (2)
- Mandible (1) (originated as 2)
- Nasal (2)
- Palatine (2)
- Inferior nasal conchae (2)
- Lacrimal (2)
- Vomer (1)

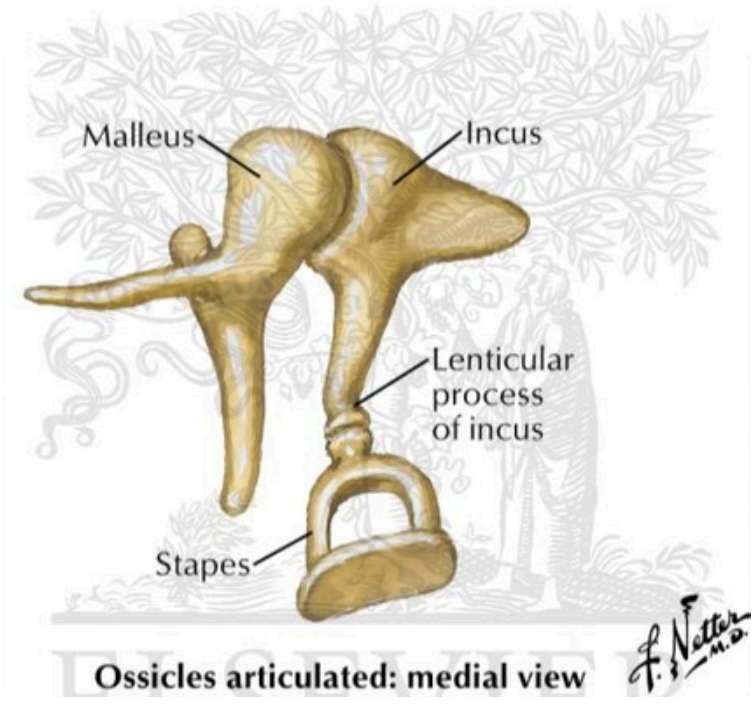


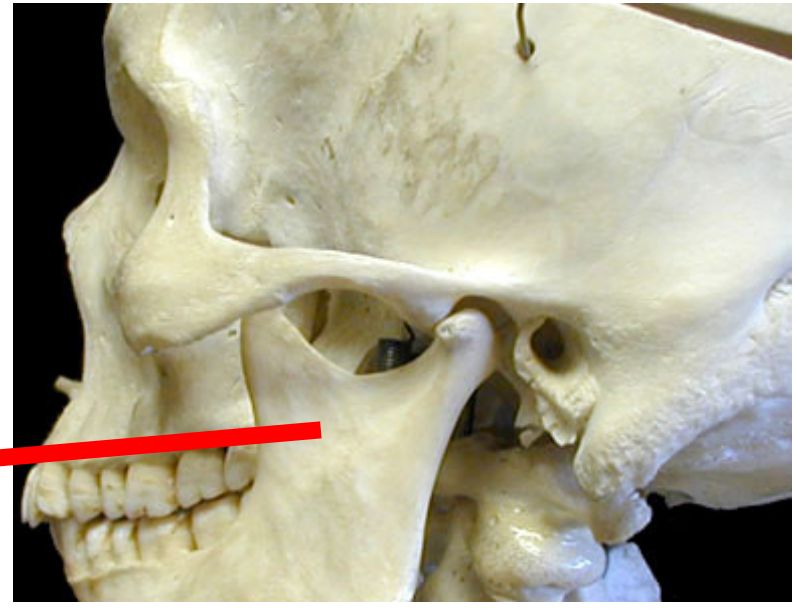
14 Facial Bones

Axial Skeleton Cont'd

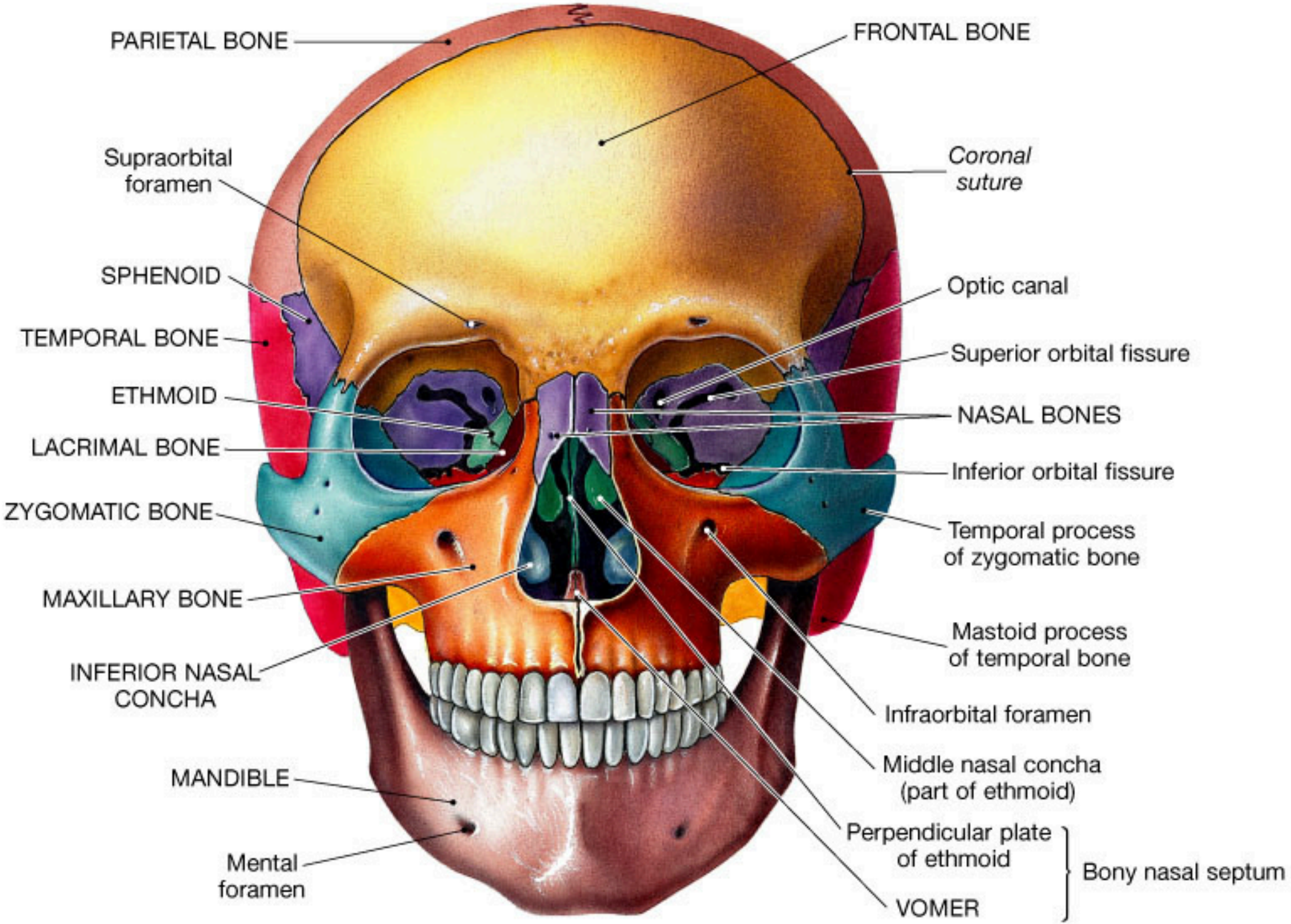
- Auditory Ossicles (6 bones)
- Malleus (2)
- Incus (2)
- Stapes (2)
- Hyoid (1)

  Total skull bones = 29

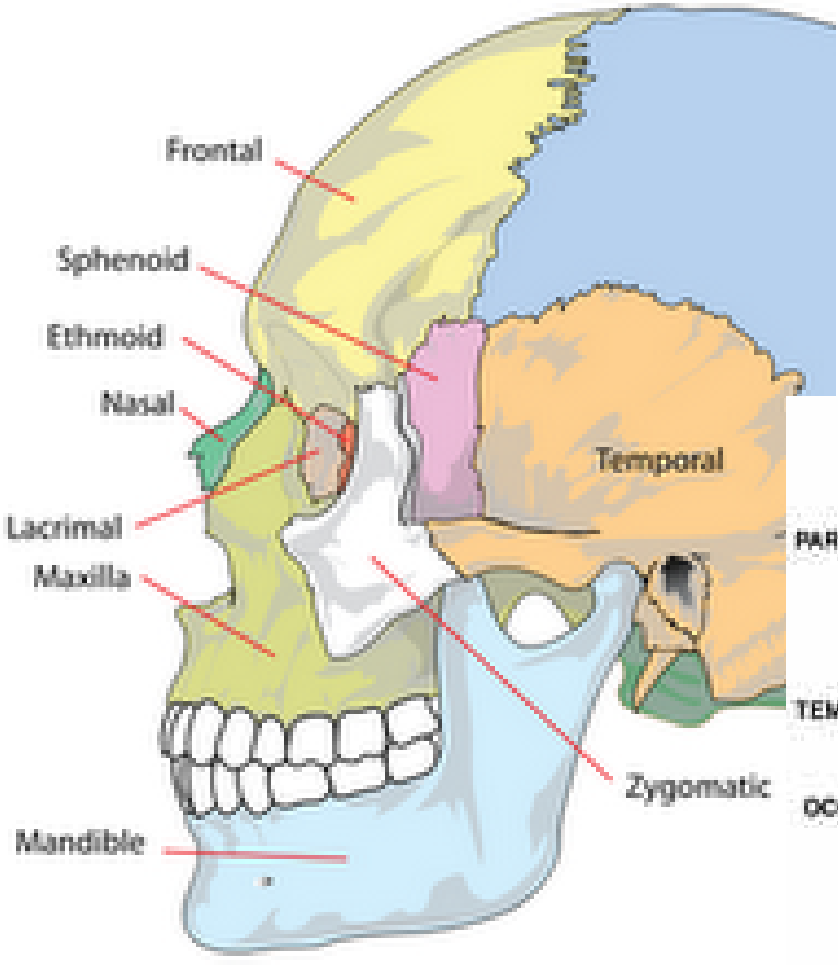


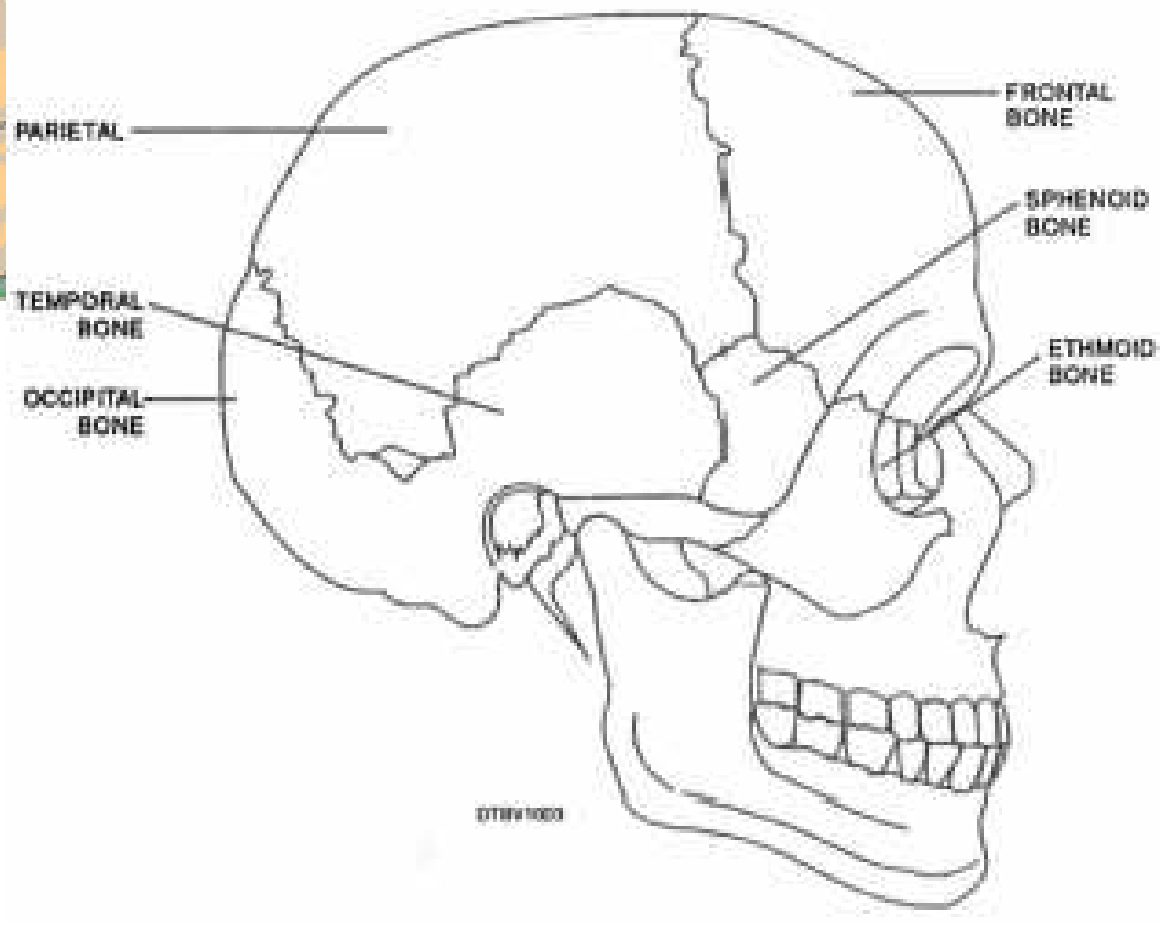


The Adult Skull

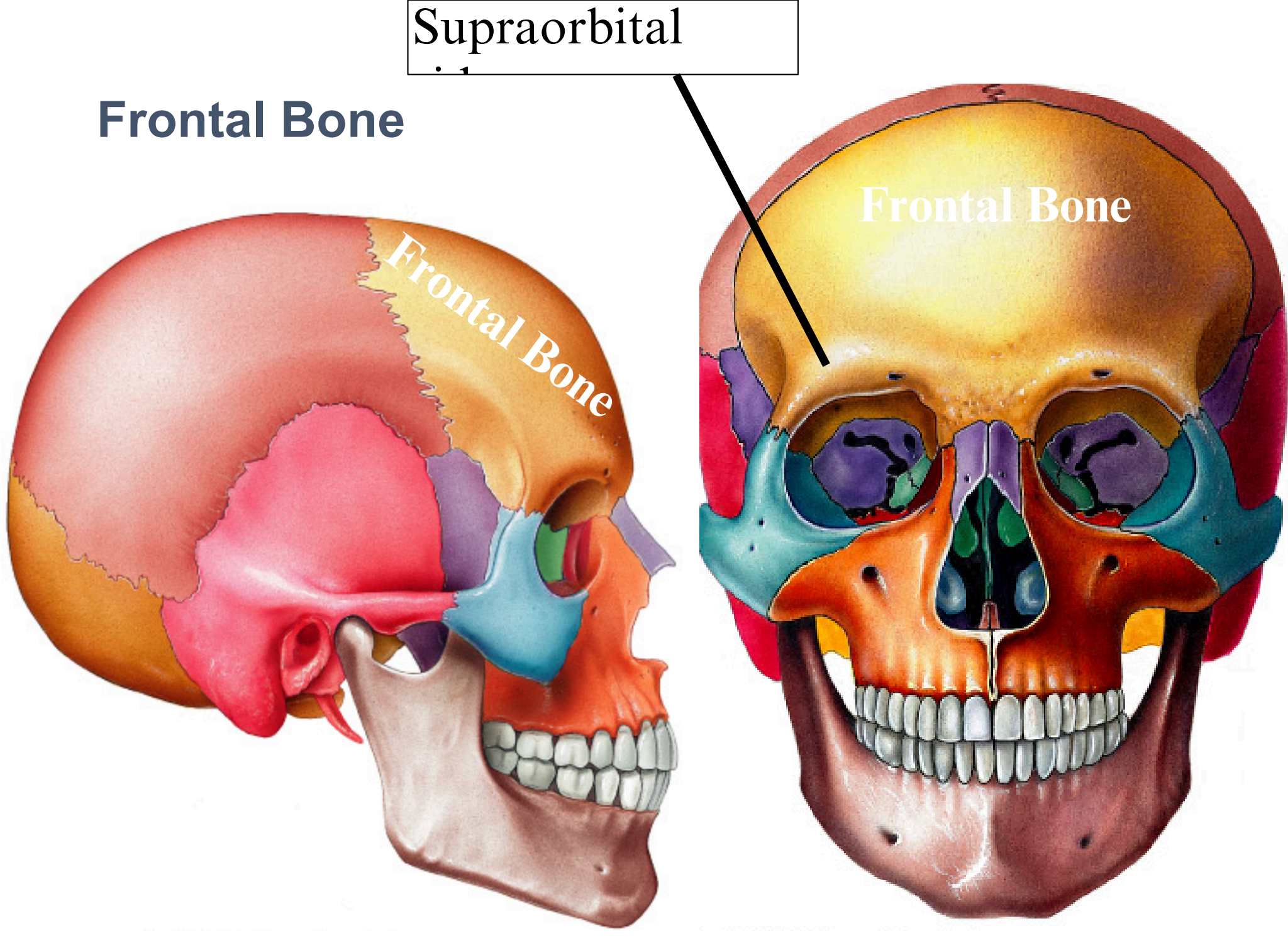


Skull (Cranial Bones)

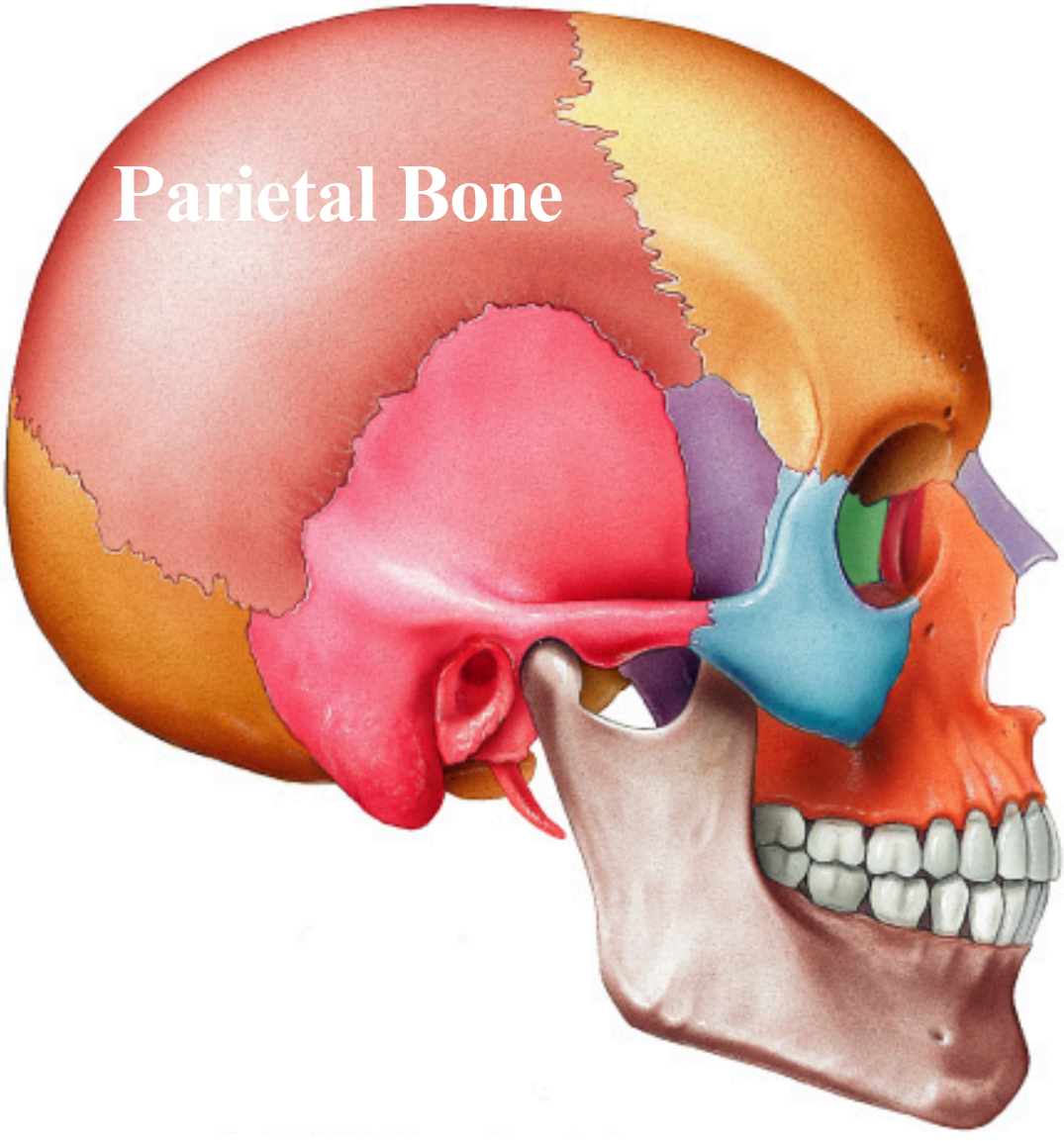


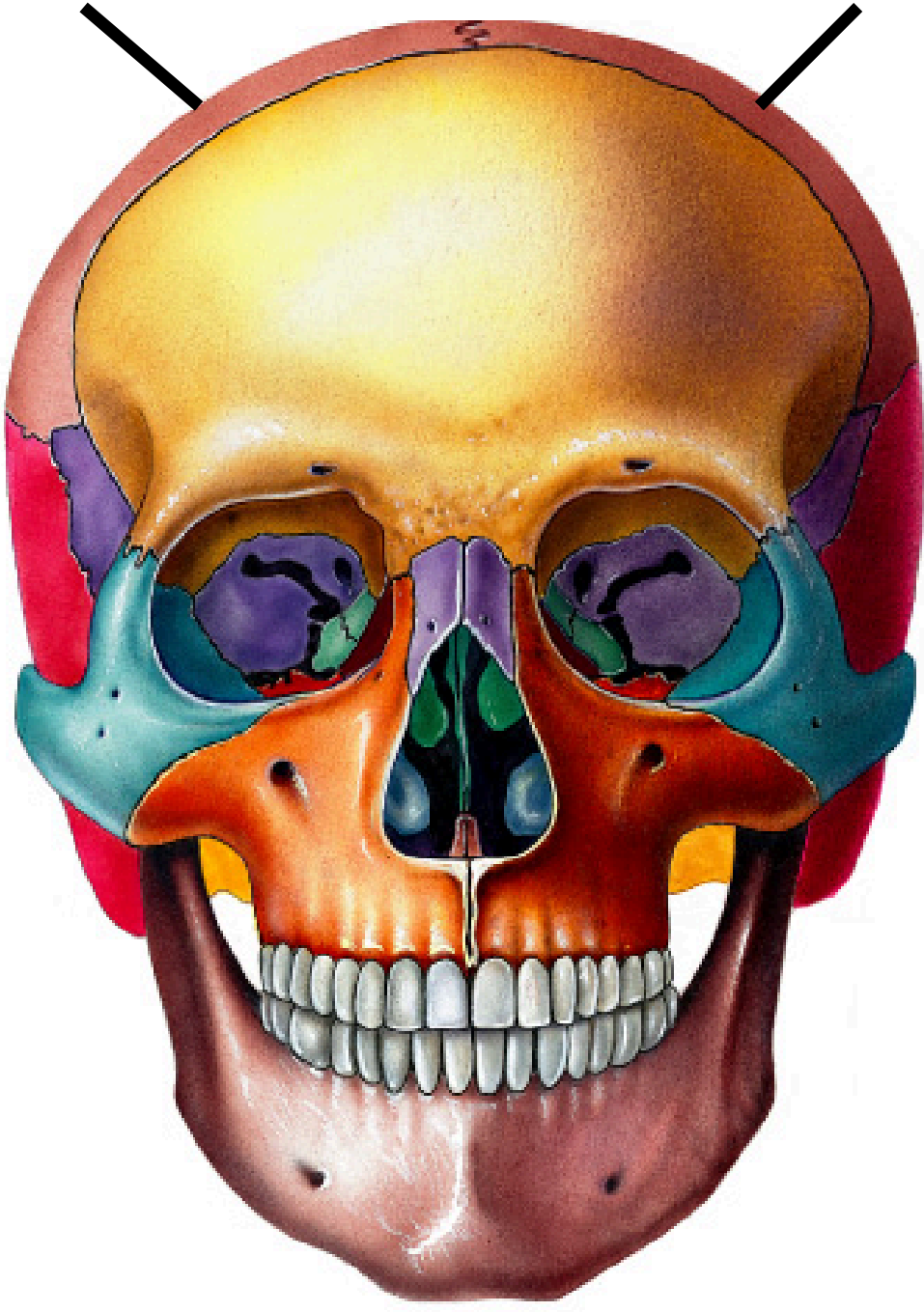


Frontal Bone

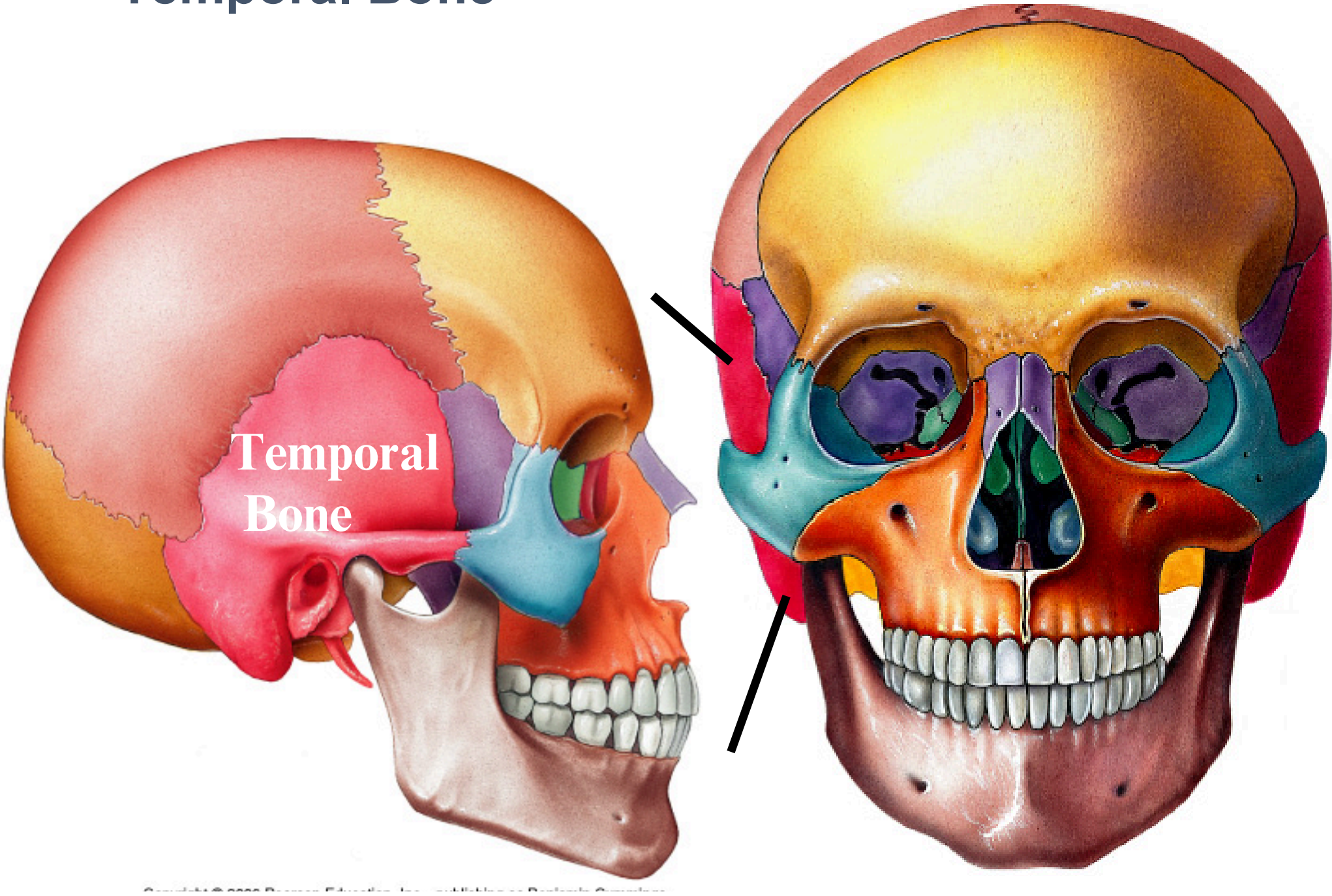


Parietal Bone

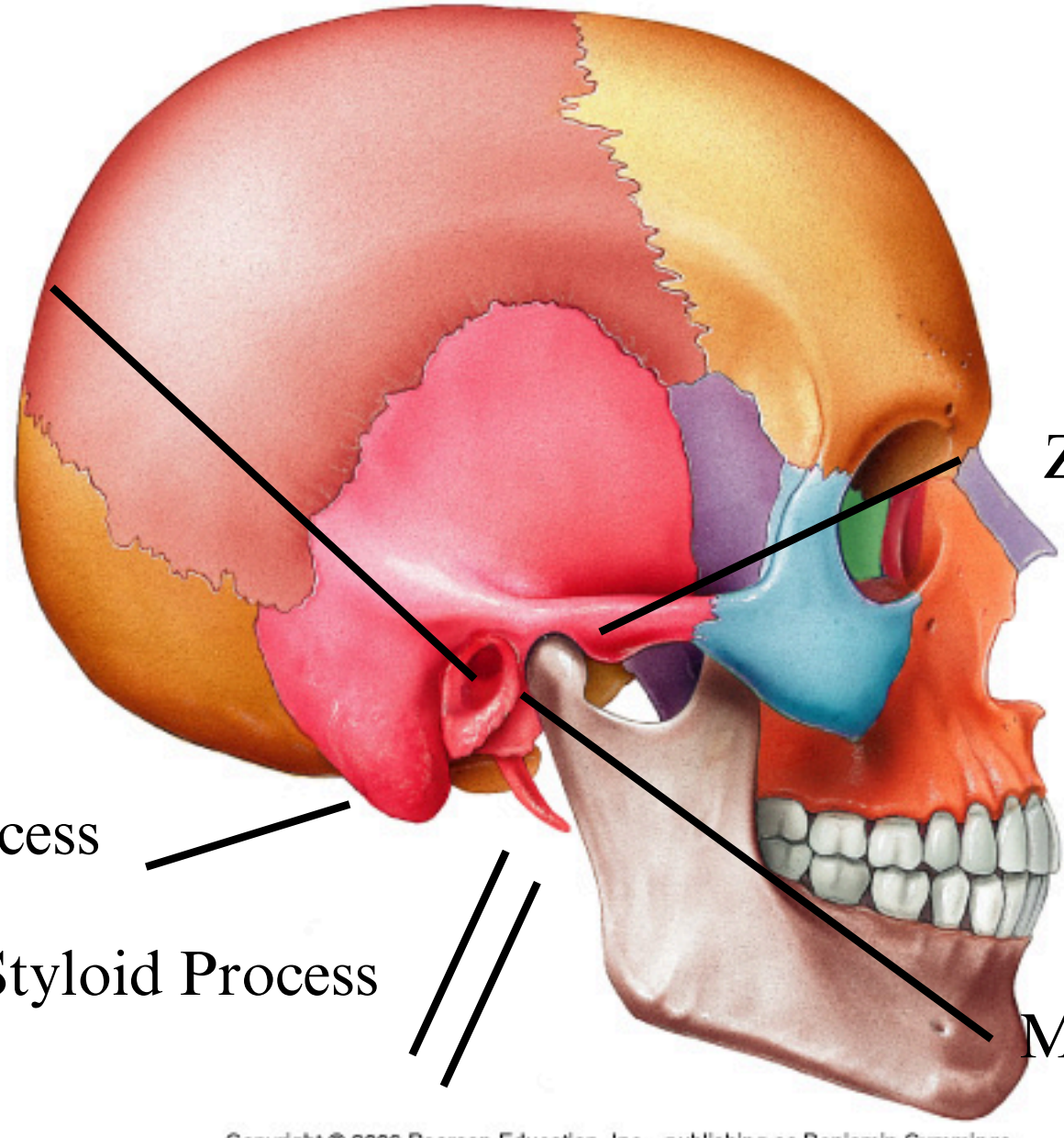




Temporal Bone



Temporal Bone

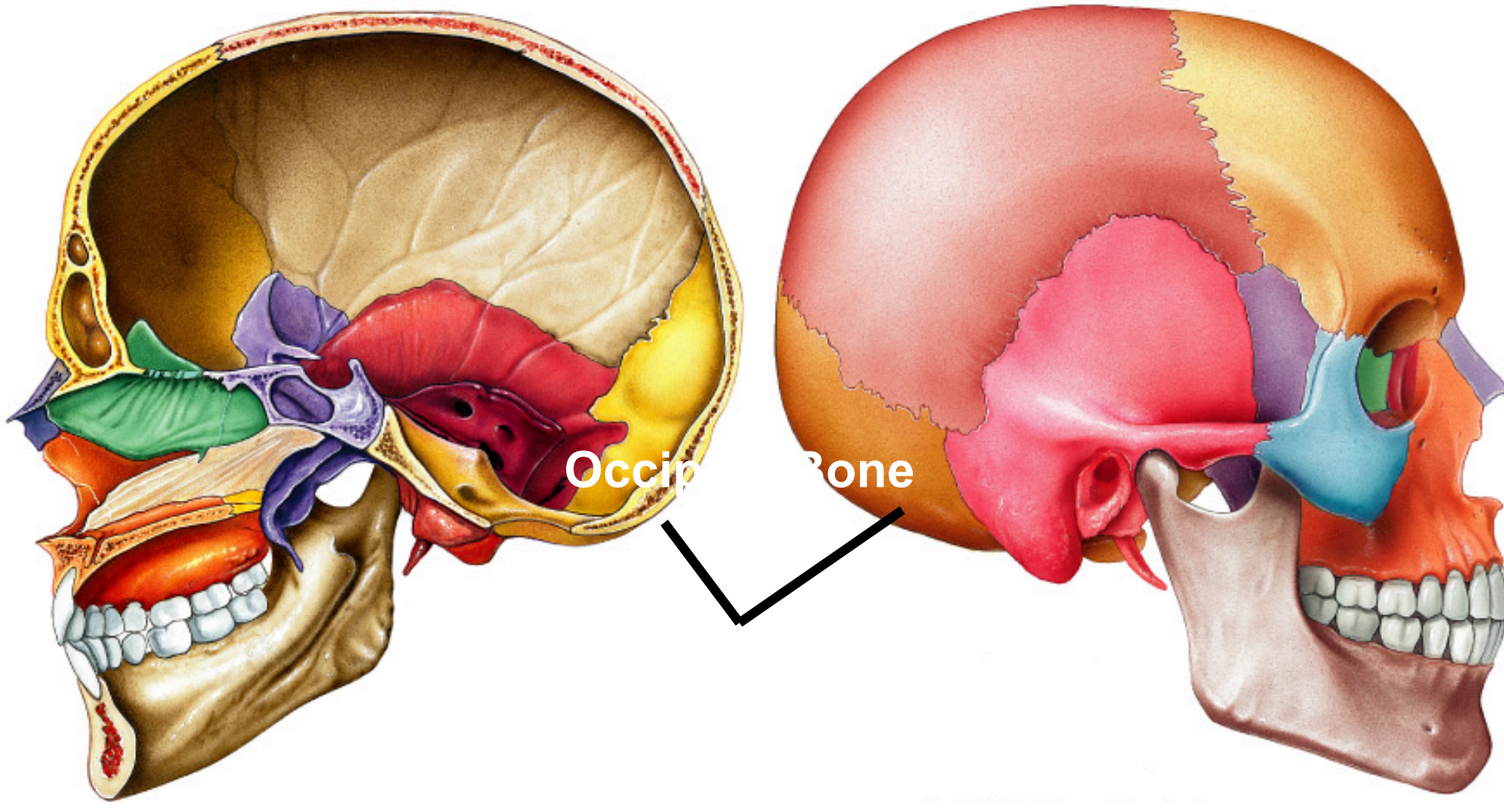


Temporal Bone

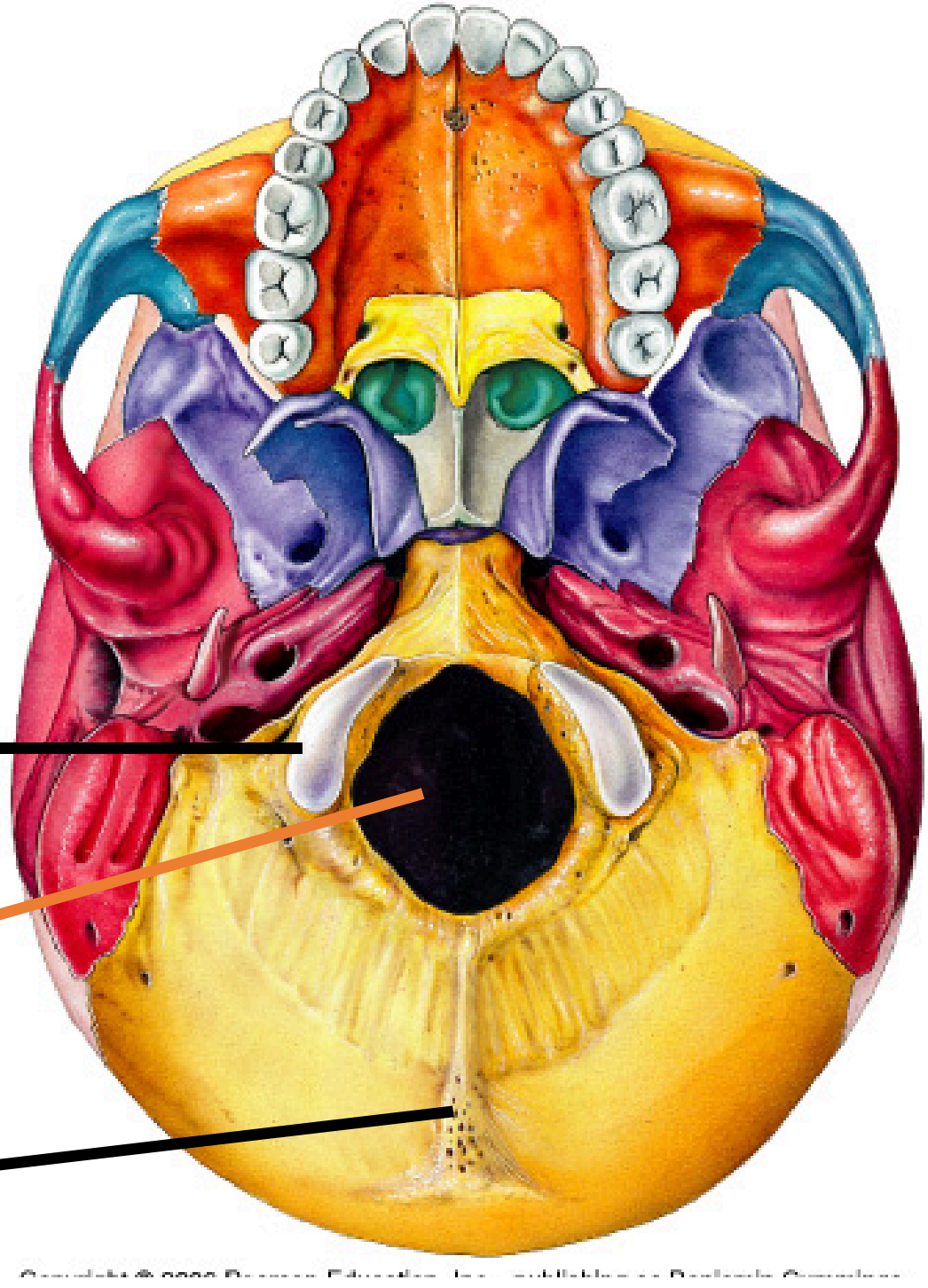
Divided into four parts:

- **Zygomatic process** – projection that articulates with zygomatic bone.
- **Mastoid process** – protuberance inferior and posterior to ear, muscle attachment. **Styloid process** – slender spike of bone extending inferior and anteriorly.
- **Squamous part** - thin fan shaped part that articulates with the parietal bone.
- **Petrous portion-** forms part of the base of the skull and contains organ of hearing.

Occipital Bone



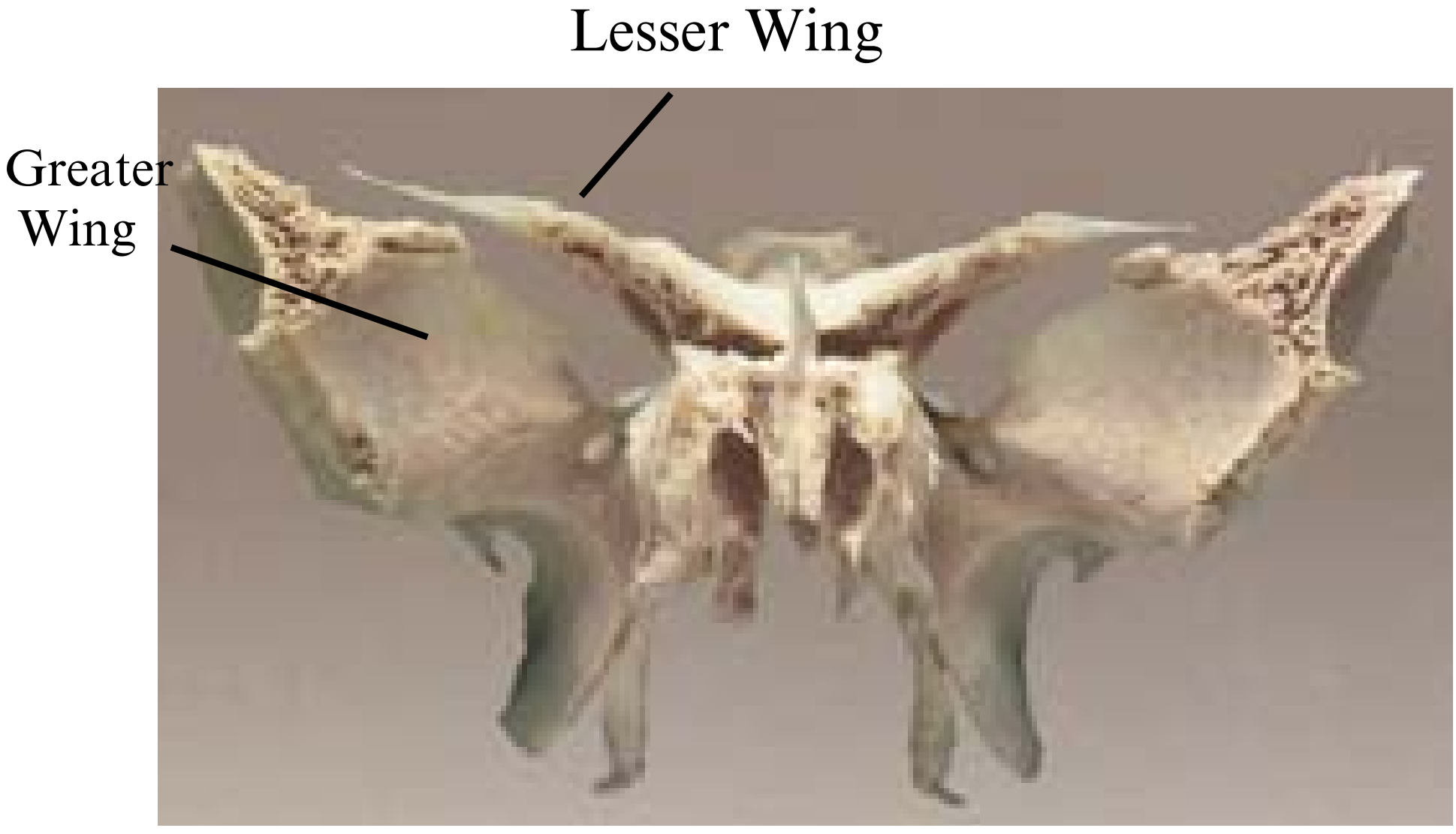
Occipital Bone



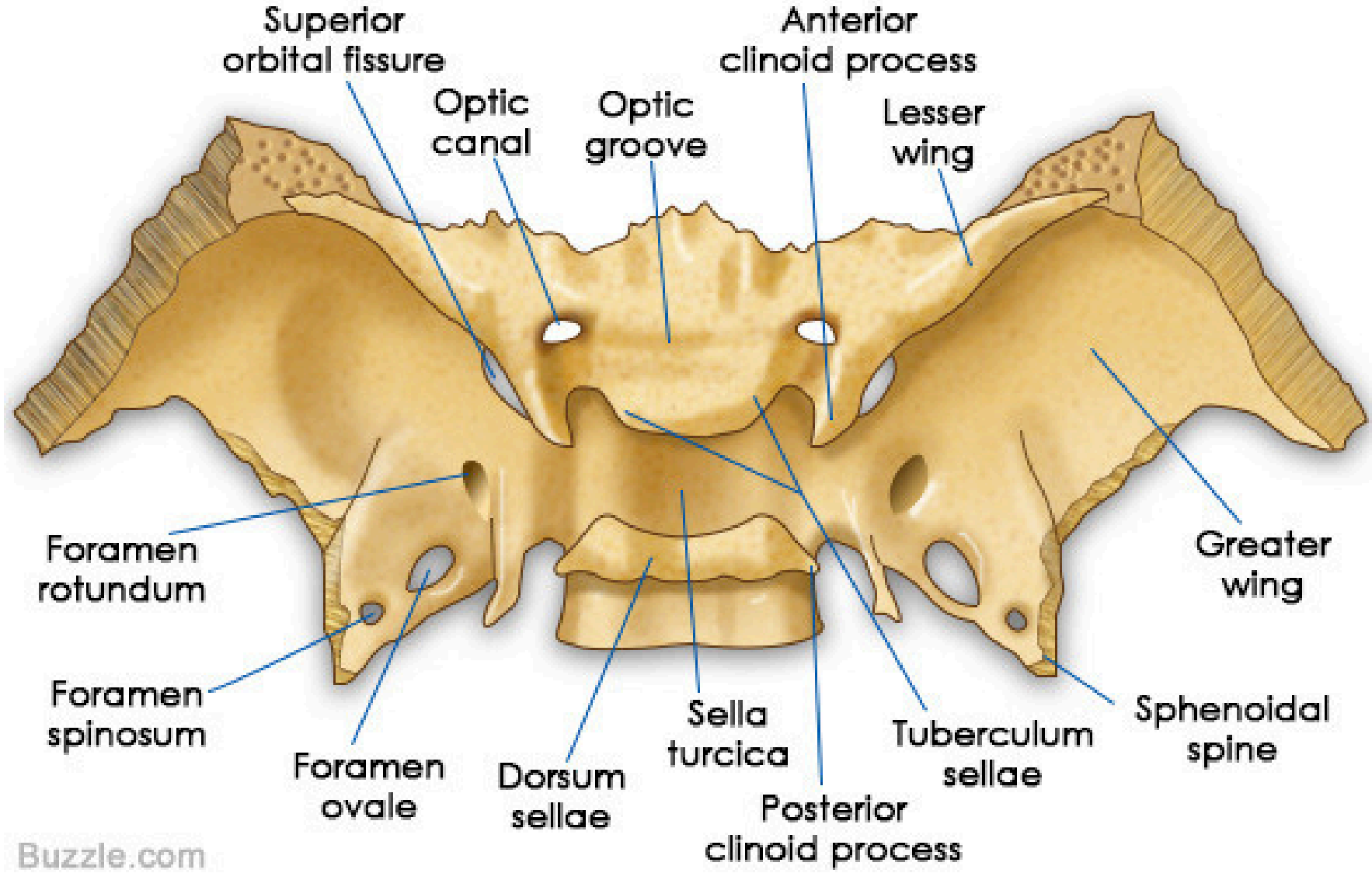
Sphenoid Bone

- Keystone of cranial floor.
- Resembles bat wings, lies deep and slightly superior to nose and throat, forms parts of orbital wall floor and posterior.
- **Greater wings** – lateral projection from body, forms lateral wall of orbit.
- **Lesser wings** – superior portion of sphenoid body, forms posterior orbital wall.
- **Sella turcica** –saddle shaped depression on superior surface of body, contains Pituitary gland (Hypophyseal gland).

Sphenoid Bone

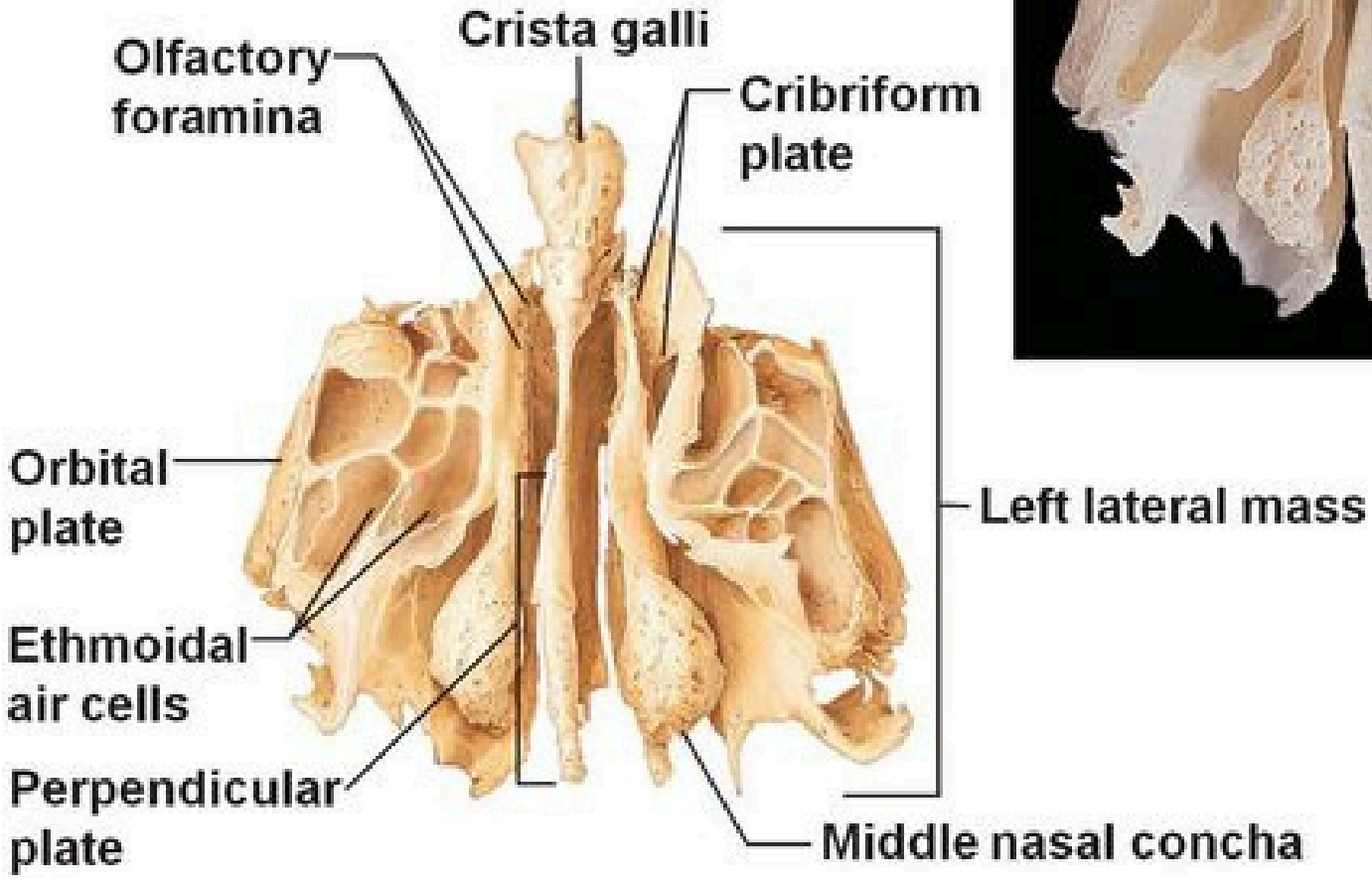


SUPERIOR VIEW

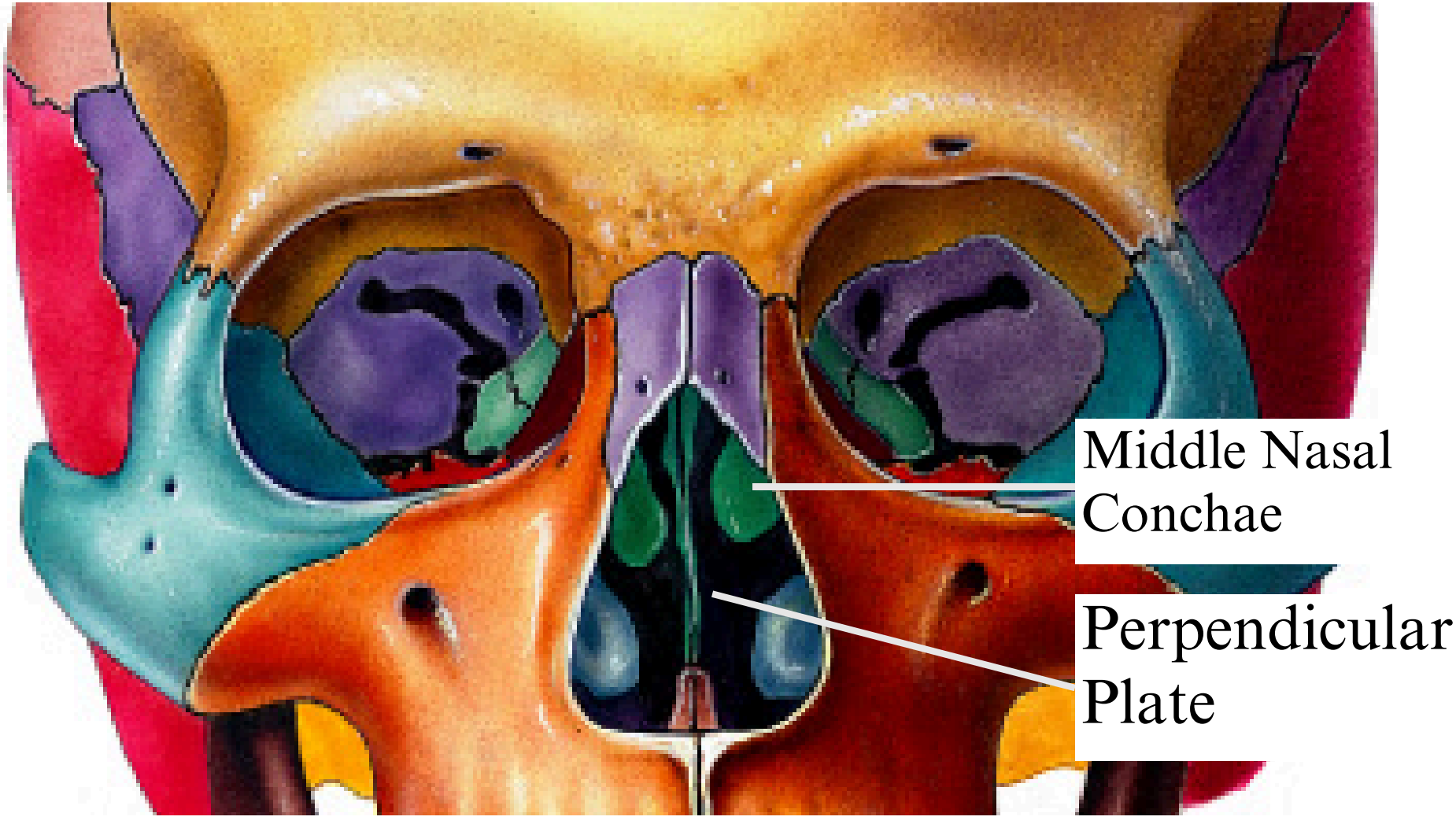


Ethmoid

- Irregular bone that makes up the anterior portion of cranial wall, medial wall of orbits, upper parts of nasal septum, lateral nasal roof.
- **Perpendicular plate** – forms upper part of nasal septum.
- **Nasal Conchae** – Upper and middle conchae or turbinated processes.
- **Horizontal (cribriform) plate** – passage of olfactory nerves through multiple openings.


Olfactory foramina
Crista galli
Cribriform plate
Orbital plate
Ethmoidal air cells
Perpendicular plate
Left lateral mass
Middle nasal concha

Ethmoid Bone



Facial Bones

Zygomatics

- Cheekbone, forms part of anterior and lateral surface of orbit.
- Temporal process – articulates with zygomatic process of temporal bone.

Lacrimals

- Posterior and lateral to nasal bones in median wall of orbits, forms lateral of nasal cavity.

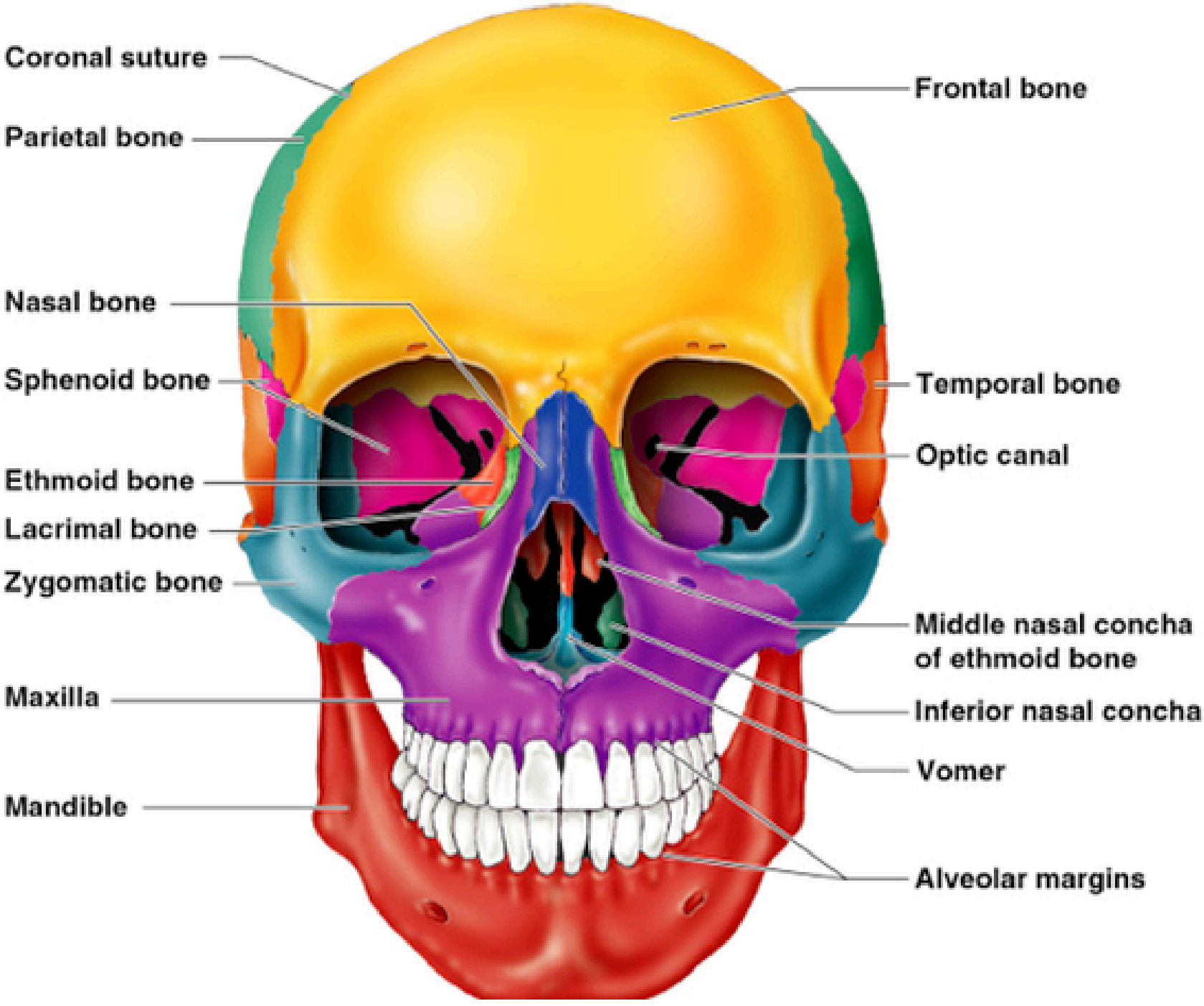
Palatines

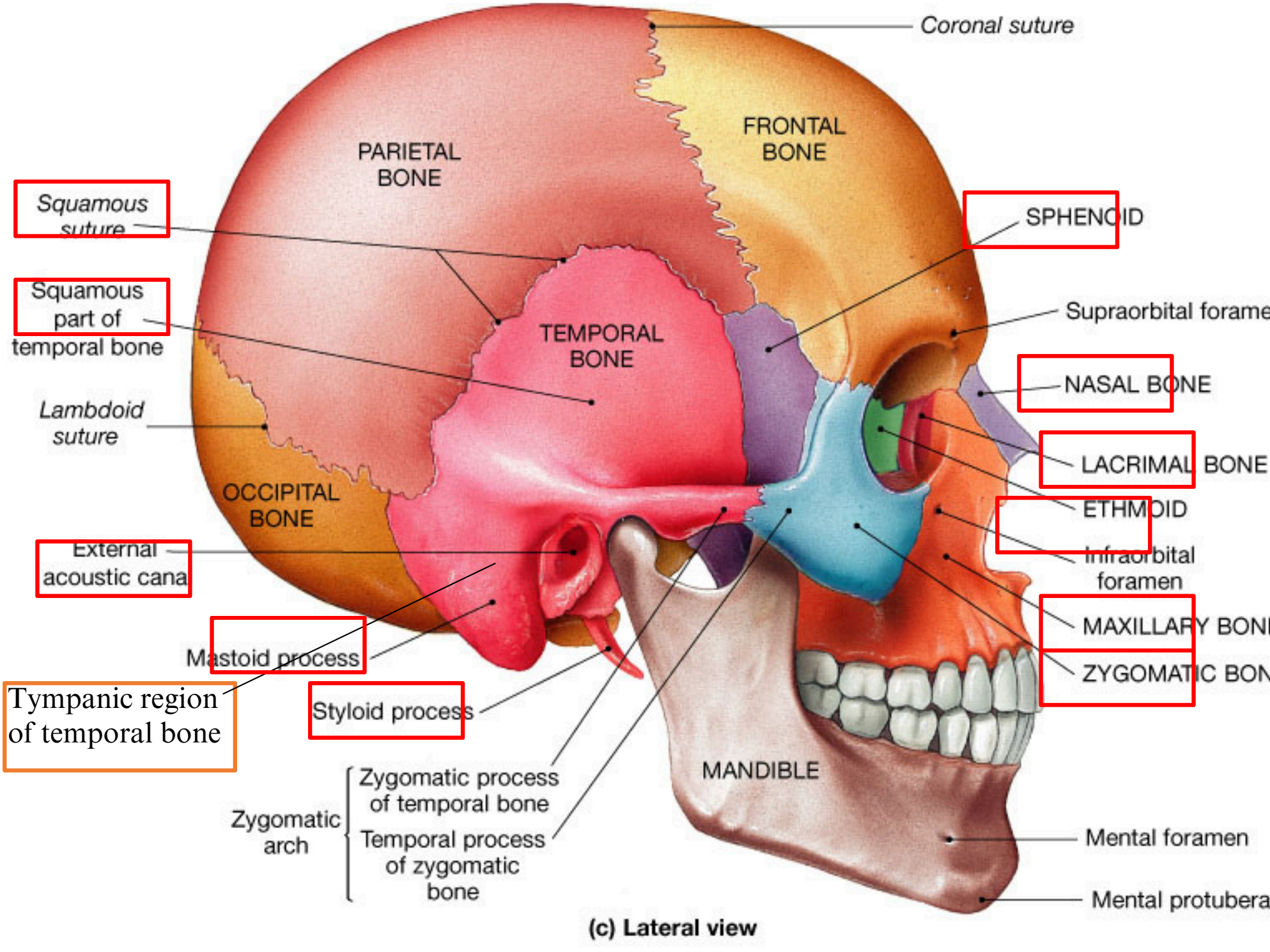
- Posterior portion of hard palate, inferior and lateral surface of nasal cavity, inferior surface of orbit.

Facial Bones

Nasal bones

- Superior portion of nasal cavity.
  Vomer
- Inferior and posterior nasal septum.
  Inferior Nasal Conchae
- Turbinated bones forms posterior of nasal cavity.

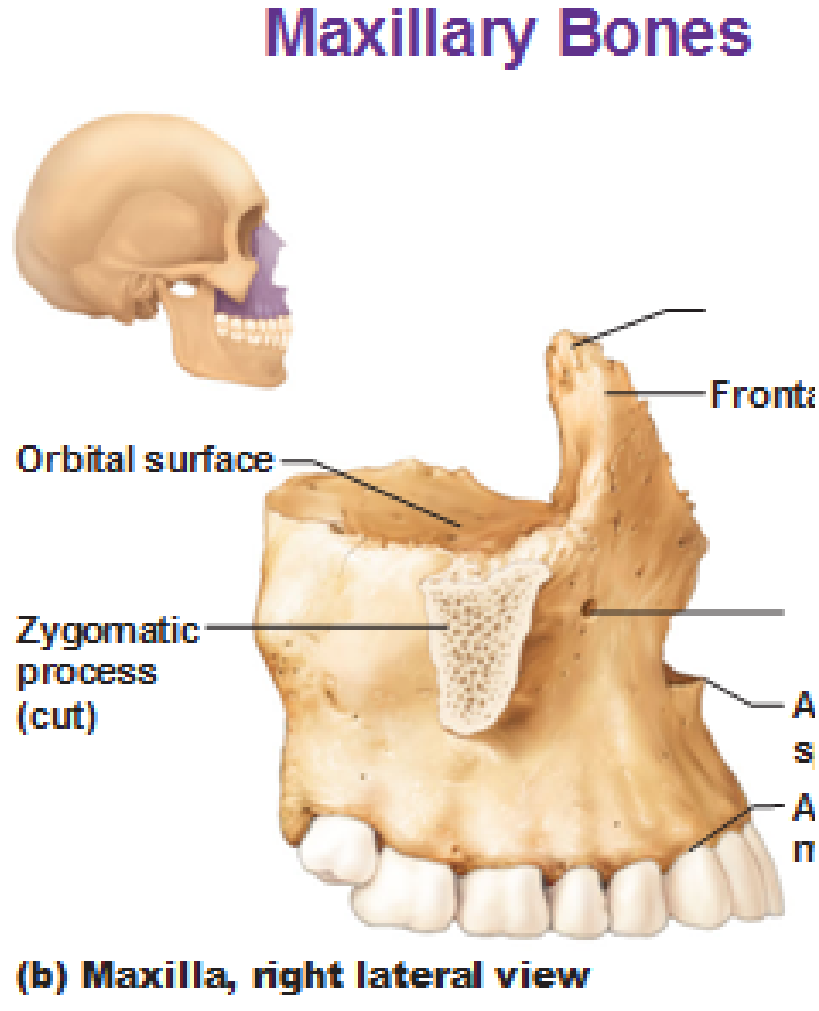

Coronal suture
Parietal bone
Nasal bone
Sphenoid bone
Ethmoid bone
Lacrimal bone
Zygomatic bone
Maxilla
Mandible
Frontal bone
Temporal bone
Optic canal
Middle nasal concha of ethmoid bone
Inferior nasal concha
Vomer
Alveolar margins

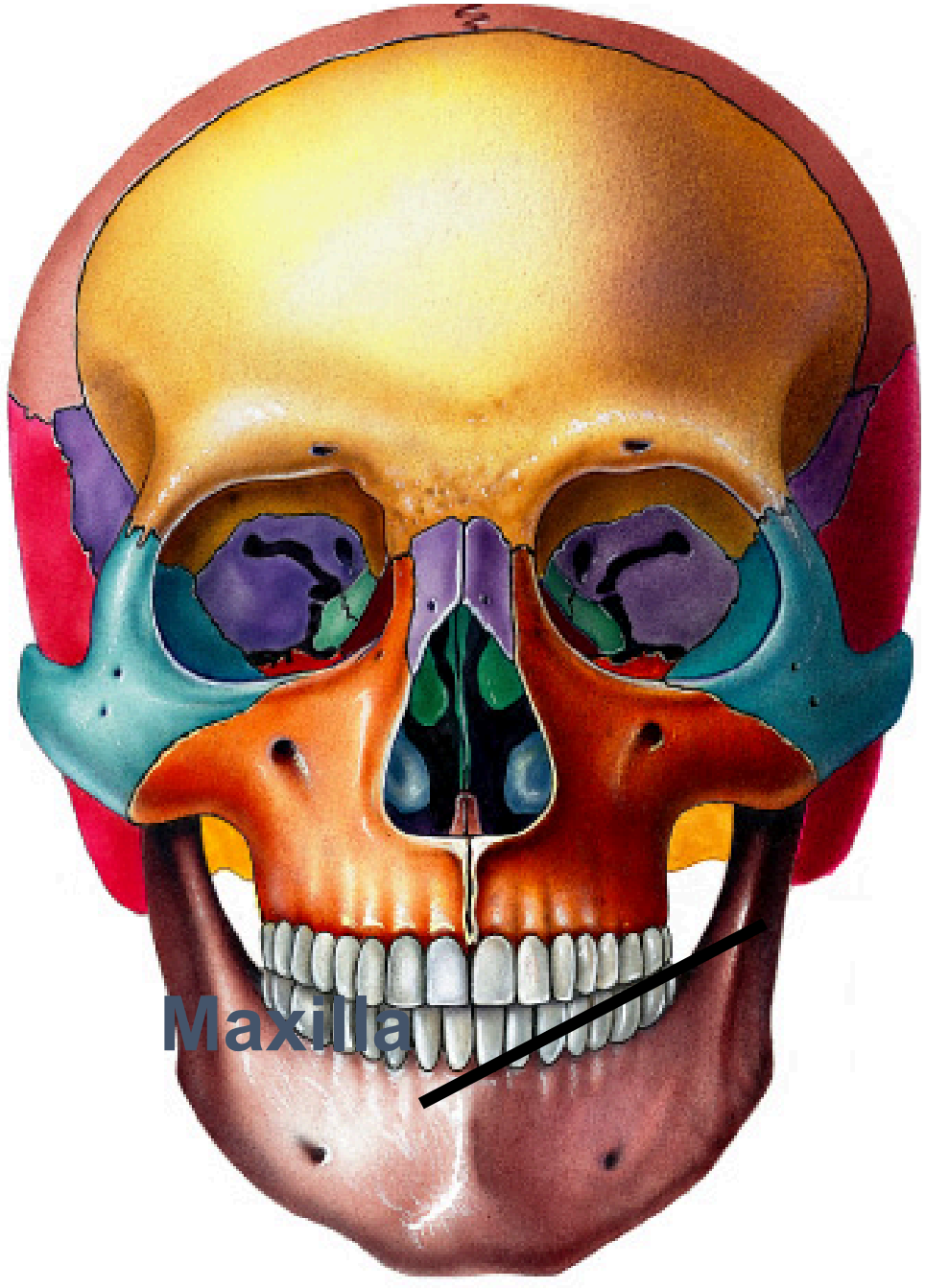


(c) Lateral view

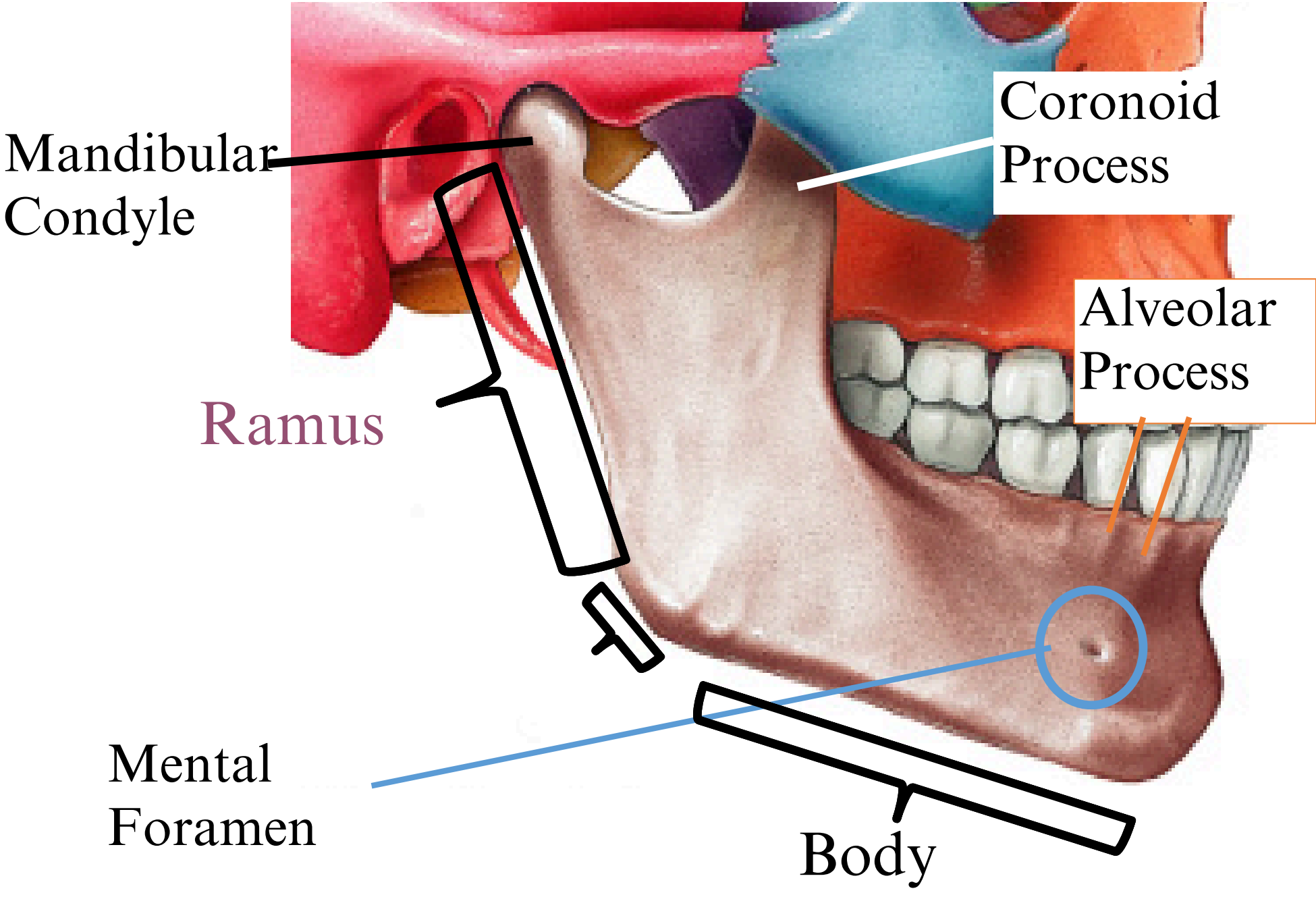
Maxillae or Upper Jaw

- **Upper jaw bones**, part of floor of orbit, anterior portion of roof of mouth and floor of nose and part of lateral walls of nasal cavity.
- **Alveolar ridge or process**-- carries teeth.
- **Maxillary Sinus**--- on each side lined with ciliated mucous membrane.



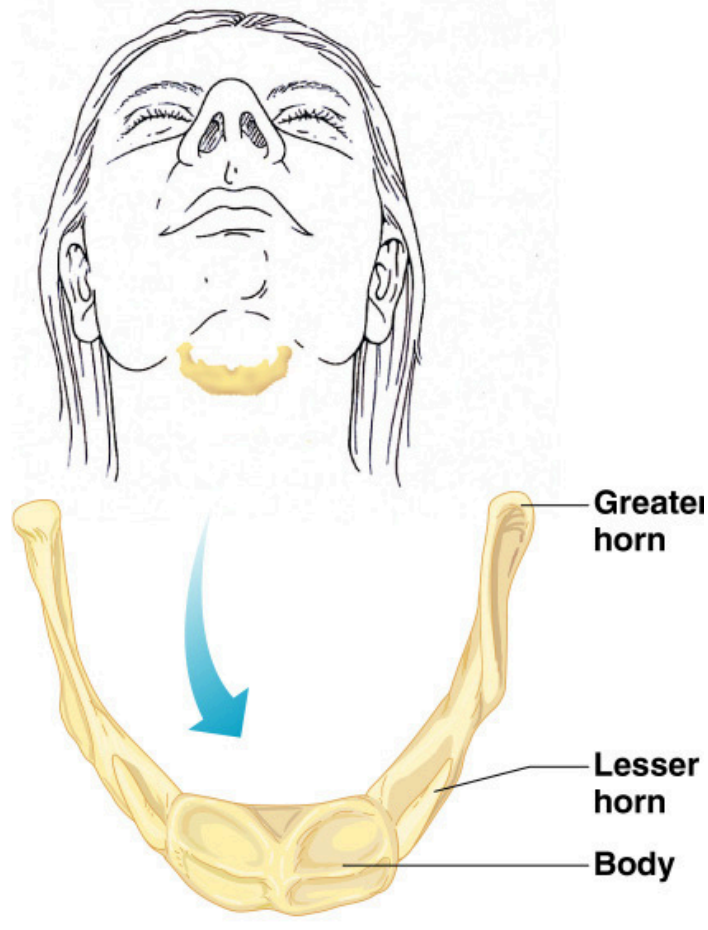

Maxilla

Mandible


Mandibular Condyle
Coronoid Process
Alveolar Process
Ramus
Mental Foramen
Body

The Hyoid Bone

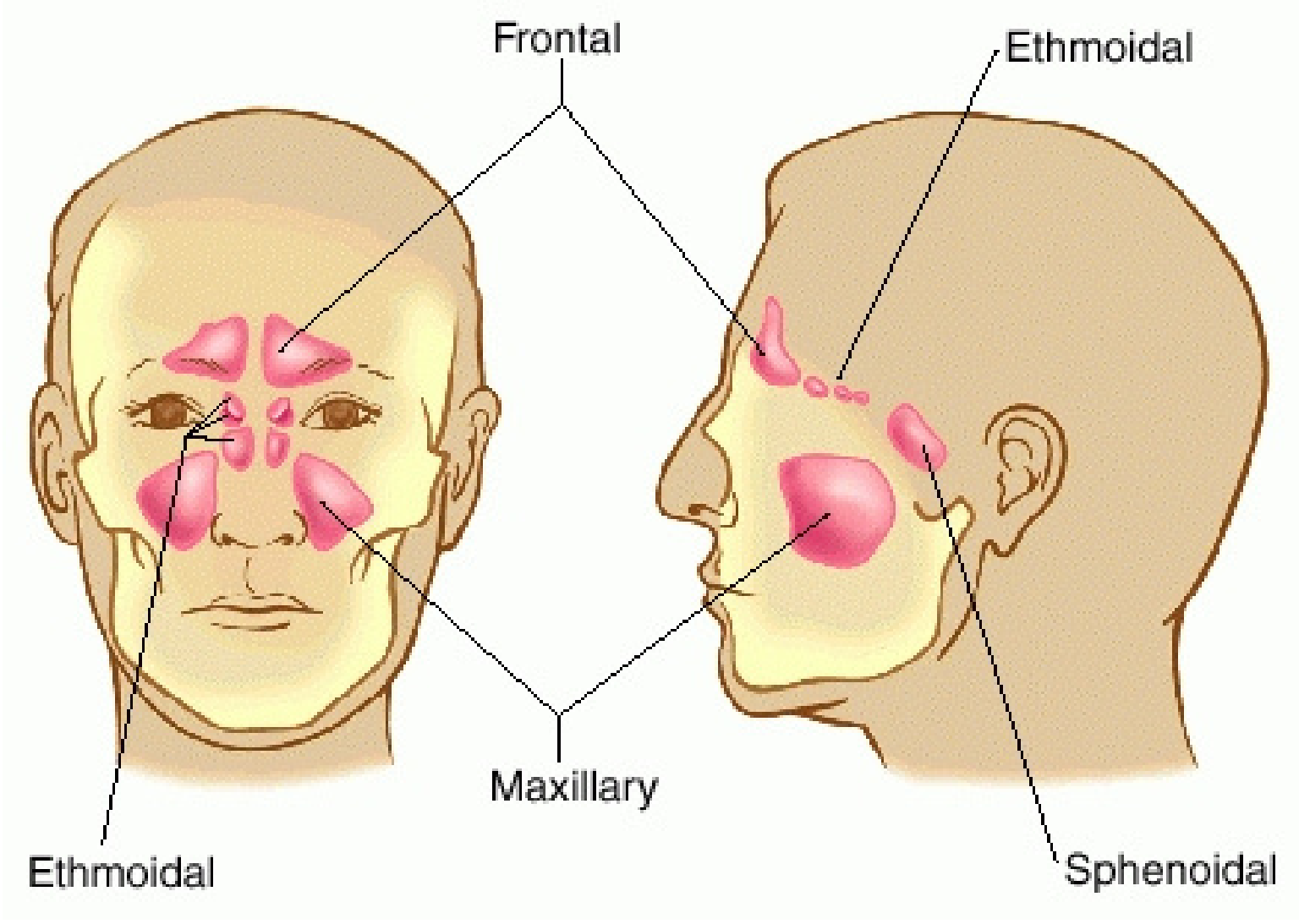
Horse shoe shape bone.
The only bone that does not articulate with another bone
Serves as a moveable base for the tongue



Paranasal Sinuses

- Hollow portions of bones surrounding the nasal cavity and includes:
- frontal, sphenoidal, ethmoidal, and maxillary.
- Function
  - Lighten the skull
  - Give resonance and amplification to voice

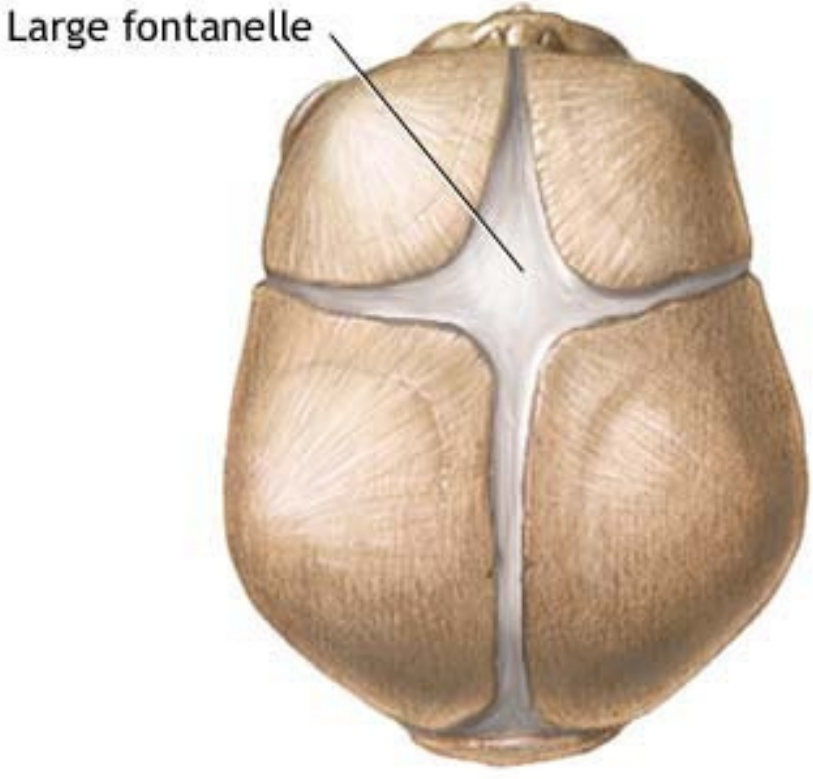
Paranasal Sinuses

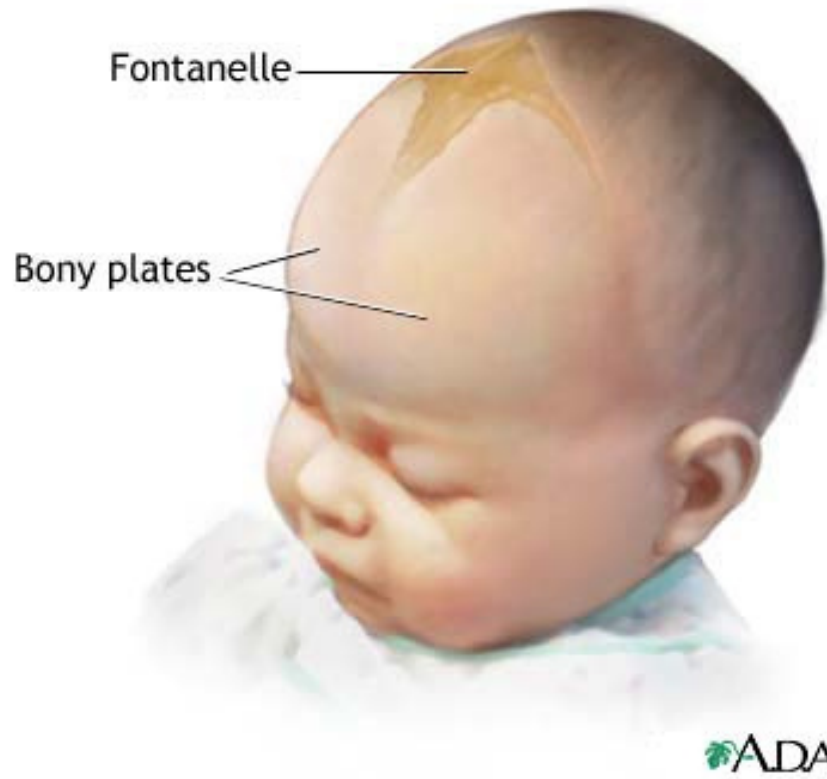


Fontanelles

- The medical term fontanel is a "soft spot" of the skull.
- The "soft spot" is soft precisely because the cartilage there has not yet hardened into bone between the skull bones.
- There are normally two fontanels, both in the midline of the skull, one (the anterior fontanel) well in front of the other (the posterior fontanel).
- The posterior fontanel closes first, at latest by the age of 8 weeks in a full-term baby.
- The anterior fontanel closes at 18 months of age on the average but it can close normally as early as 9 months.

Fontanels





Cranium

ntal bone

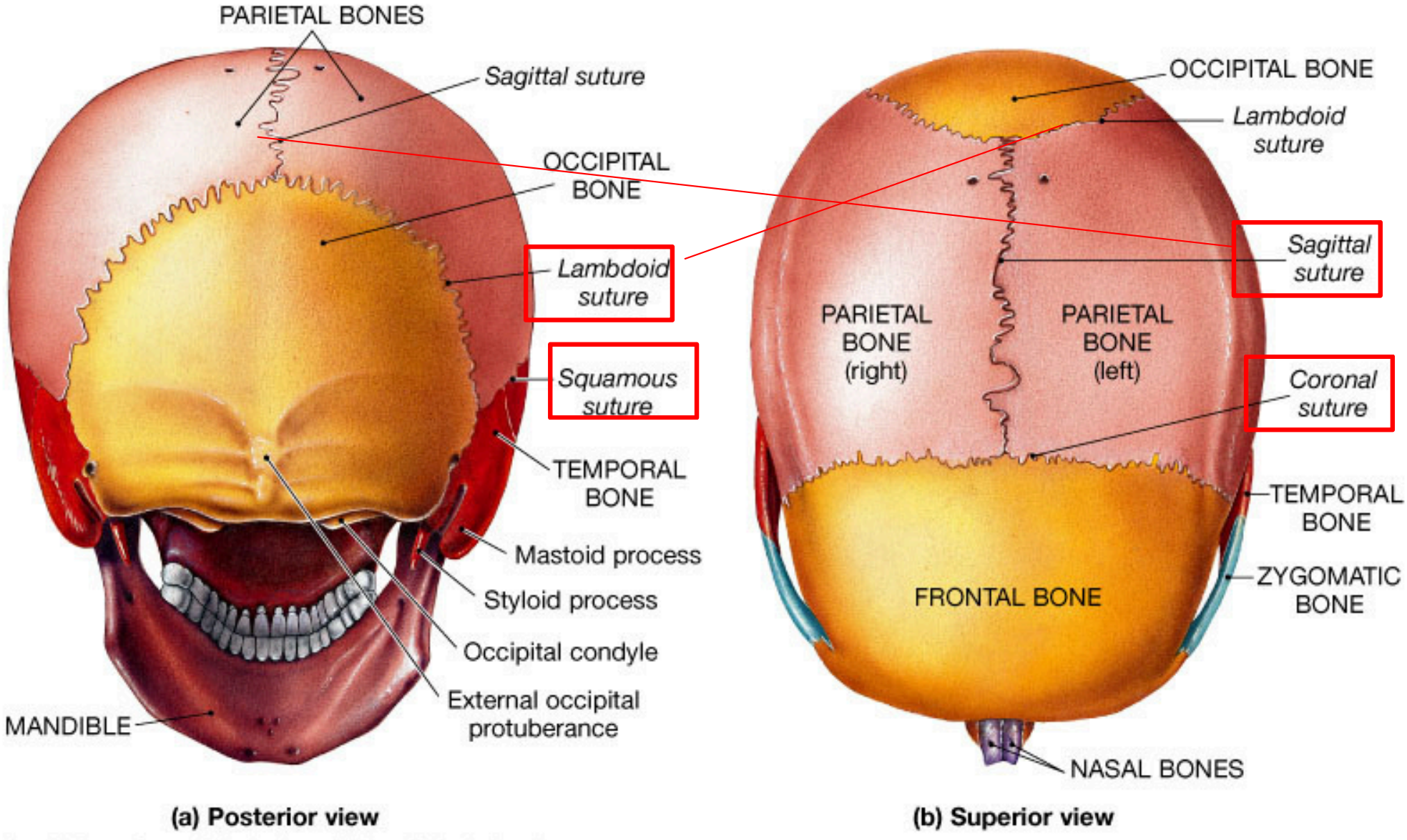
coronal sut

parietal bone

sagittal sutur

lamboid suture

occipital bone


PARIETAL BONES
Sagittal suture
OCCIPITAL BONE
Lambdoid suture
Squamous suture
TEMPORAL BONE
Mastoid process
Styloid process
Occipital condyle
External occipital protuberance
MANDIBLE
(a) Posterior view
OCCIPITAL BONE
Lambdoid suture
Sagittal suture
PARIETAL BONE (right)
PARIETAL BONE (left)
Coronal suture
TEMPORAL BONE
ZYGOMATIC BONE
FRONTAL BONE
NASAL BONES
(b) Superior view

Quick Review