

# The Skull

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## Readings:

Gray's Anatomy for Students by Drake et al.: pages 842-843; 855-872

## Lecture outline:

1. Skull overview
2. Specific bones and external skull features in anterior, lateral, posterior, and inferior views.
3. External features of infant skull, compared to adult skull: fontelles, metopic suture, molding
4. Locations, borders, and features of anterior, middle, and posterior cranial fossae.
5. General locations of dural venous sinuses and impressions on internal surfaces of skull.
6. Location and features of occipital bone.
7. Location and features of sphenoid bone: a) features related to sella turcica and hypophyseal fossa; b) course of internal carotid artery in cavernous sinus.
8. Location and features of temporal bone: squamous and petrous portions of temporal bone; a) course of middle meningeal artery on internal surface of temporal bone; b) location and orientation of auditory apparatus in temporal bone; c) course of internal carotid artery in carotid canal.
9. Bony features of the orbit.
10. Location and features of the ethmoid bone
11. Skull landmarks and foramina in anterior, lateral, inferior, and internal views.
12. Radiographic features of skull.

## Objectives:

On completion of study of texts, lecture material, and dissection laboratory material, you should be able to:

1. Identify the major bones of the skull and the portions of the bones visible from anterior, posterior, superior, inferior, and lateral views.
2. Identify the sutures between bones of the skull and the fontanelles located at junctions of the sutures.
3. Describe the borders of the anterior, middle, and posterior cranial fossae and the bones that form the limits of the fossae.
4. Identify key features of the occipital, sphenoid, and temporal bones.
5. Explain the location and projection on the skull surface of the course of the middle meningeal artery and the significance of the pterion.
6. Explain the location of middle and inner ear structures in the petrous portion of the temporal bone.
7. Describe the course of the internal carotid artery in relation to features on a skull. Recognize the impressions of the internal carotid artery on the bones of the skull.
8. Identify the bony features related to the orbit and its borders.
9. Identify major features of the ethmoid bone, especially related to the nasal cavity and paranasal sinuses.
10. Explain major landmarks, fossae, and foramina and anatomical structures passing through, over, or next to these bony features.
11. Recognize features of the skull on radiographic images.

Illustrations are adapted from:

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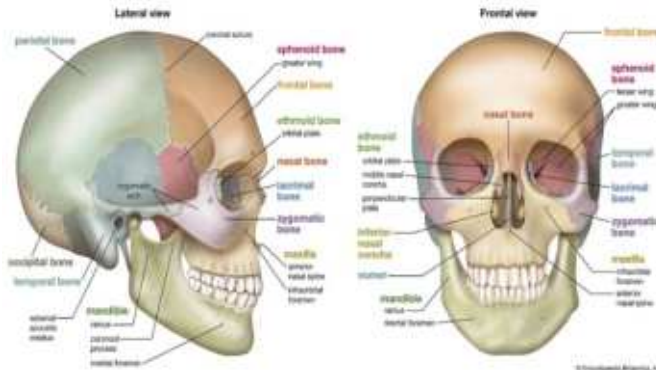
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# The Skull

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## Slide 1: Surface anatomy

This slide shows the outline structures of the skull. In particular, the slide shows the surface anatomy. Review this slide at the end of the lecture and envision skulls in the anatomy laboratory

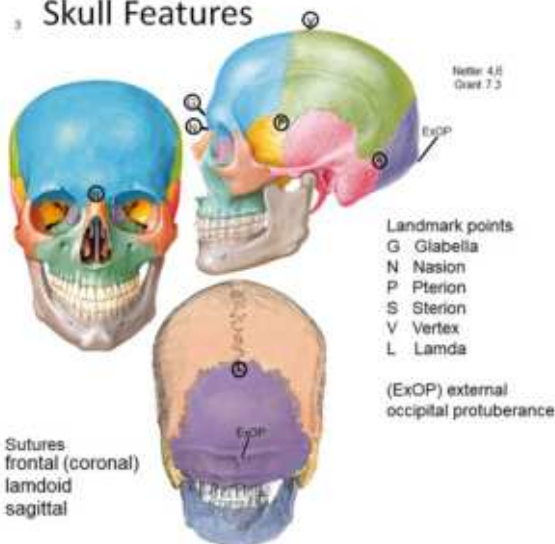
## The skull (introduction)



- 2 major divisions:
  - Cranium (neurocranium) (vault and base of skull)
  - Face (viscerocranium)
- Support:
  - structures of face
  - some structures of neck
- Protection:
  - brain
  - brainstem
  - upper spinal cord

Netter 15

## Skull Features



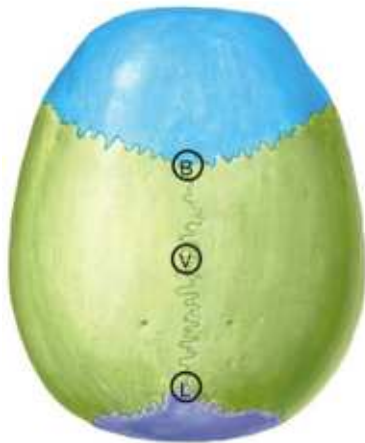
### Bones (22)

- Frontal
- Zygomatic
- Maxilla
- Nasal
- Lacrimal
- Palatine
- Ethmoid
- Inferior concha
- Parietal
- Temporal
- Sphenoid
- Occipital
- Vomer
- Mandible

**Slide 3: Anterior and lateral views:** frontal, parietal, temporal, sphenoid, zygomatic, nasal, and lacrimal bones and mandible. *In orbits:* ethmoid and palatine bones, and orbital surfaces of sphenoid, zygomatic and maxilla. *In nasal opening:* vomer and inferior concha. **Sutures** (articulations between bones of skull) at contacts between bones: frontal (coronal) between frontal and 2 parietal bones; lambdoid (*posterior view*) resembles the Greek letter **lambda** (!) between occipital and 2 parietal bones; **sagittal** between parietal bones ends at lambdoid suture. *In lateral view:* greater wing of sphenoid bone between temporal and frontal bones. Teeth insert in alveolar processes of maxilla and mandible. Head of mandible (condyloid process)

articulates at mandibular fossa to form temporomandibular joint on temporal bone, anterior to external auditory meatus. **Craniometric landmarks:** **glabella** (bulge on frontal bone above nasion); **nasion** (depressed point where nasal bones join frontal bone above ridge of nose); **external occipital protuberance** on occipital bone; **asterion** at union of temporal, occipital, and parietal bones; and **pterion**, where greater wing of sphenoid meets frontal, parietal, and temporal bones. **Vertex** – topmost point on skull. **External occipital protuberance** can be palpated through the scalp at middle of superior nuchal line.

## • Calvaria



Netter 9

Top of skull

- Frontal bone (1)
- Parietal bones (2)
- Upper part of occipital bone (1)

Sutures  
frontal (coronal)  
sagittal  
lambdoid

Landmark points

- (B) Bregma
- (L) Lambda
- (V) Vertex

**Slide 4: Calvaria** (this word is singular) is top of skull, “skull-cap” of neurocranium. Anterior end: portion of frontal bone; posterior: part of occipital bone; parietal bones form sides. Landmark points are located where these bones join at sutural lines. **Bregma** is anterior point at junction of frontal and 2 parietal bones. **Vertex** is highest point on skull, located just posterior to bregma. **Lambda** is also visible in this view.



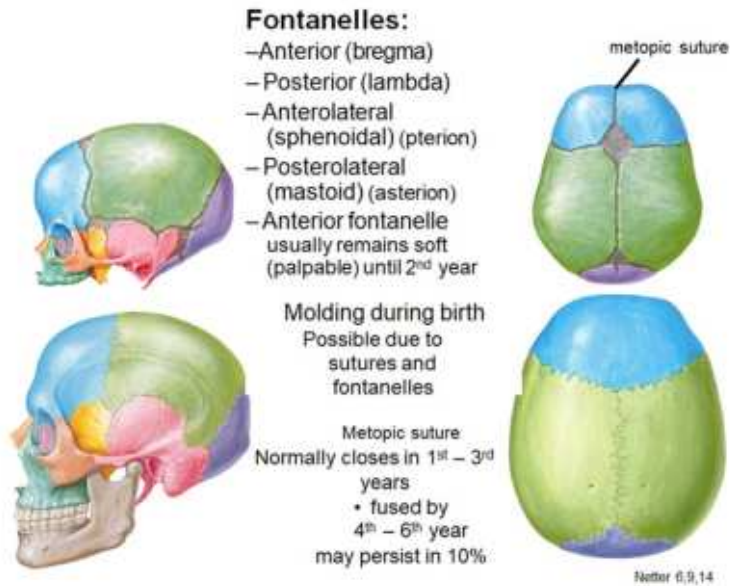
- Bones
  - Occipital
  - Parietal
  - Temporal
  - Sphenoid
  - Zygomatic
  - Maxilla
  - Palatine
  - Vomer

Foramina (plural of foramen)  
convey blood vessels and/or nerves

Netter 10

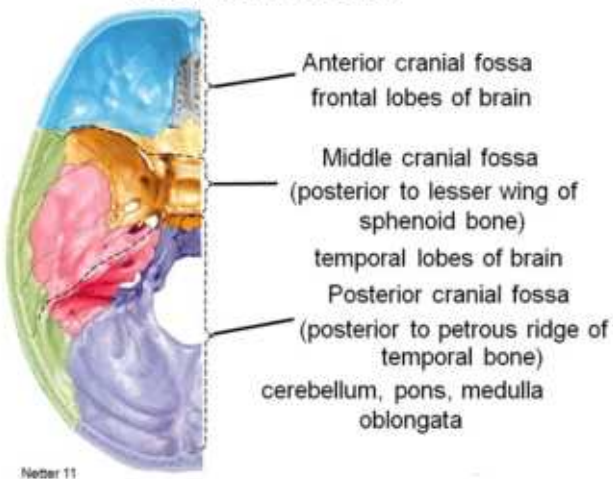
**Slide 5: From inferior view: Base of skull:** bones: occipital, parietal, temporal, sphenoid, zygomatic, maxilla, palatine, and vomer. Numerous foramina in base of skull permit passage of nerves and vessels out of and into skull.

6



**Slide 6:** Sutures connecting bones of the skull are joints and not fusions of bones. In an infant, bones have not grown to full size; sutures are wider, with connective tissue membranes in the spaces and **fontanelles** (“soft spots”) at junctions of sutures. This permits “molding”, a transient movement of bones of the calvaria during birth. The anterior fontanelle usually remains soft (palpable) through year 2 and can be used to assess hydration in an infant. A **metopic suture** between frontal bones normally closes in 1-3 years, with complete fusion

## Cranial Fossae



**Slide 7:** *Calvaria and brain removed, as well as dura mater lining spaces:* floor of cranial cavity (skull base from inside view).

Cranial cavity divided into **3 cranial fossae**:

**Anterior cranial fossa** holds the frontal lobes of the brain.

**Middle cranial fossa** posterior to lesser wing of sphenoid bone holds temporal lobes of brain. **Posterior cranial fossa** posterior to petrous ridge of temporal bone, is location of pons and medulla oblongata of brainstem and cerebellum.



## Anterior cranial fossa



- Superior orbital plate  
– frontal bone
- Frontal crest  
– frontal bone
- Superior sagittal sinus (anterior extent)
- Cribriform plate
- Crista galli

**Slide 8: Floor of anterior cranial fossa:** primarily superior orbital plates of frontal bone and cribriform plate of ethmoid bone between these. Crista galli is ridge along midline (resembles rooster's comb). Frontal crest anterior to crista galli with end of superior sagittal sinus (venous sinus in superior edge of falx cerebri).

## Middle Cranial fossae



- Lesser wing - sphenoid bone
  - Greater wing - sphenoid bone
  - Squamous portion - temporal bone
  - Petrous ridge - temporal bone
  - Middle meningeal A (impressions)
  - Course of internal carotid A
- Sella turcica:**  
 Hypophyseal fossa (F)  
 Anterior clinoid process (A)  
 Tuberculum sellae (T)  
 Chiasmatic sulcus (S)  
 Posterior clinoid process (P)  
 Dorsum sellae (D)

**Slide 9: Middle cranial fossa** between lesser wing of sphenoid bone anteriorly and petrous ridge of temporal bone posteriorly. **Sella turcica** (Turkish saddle): **Hypophyseal fossa** on body of sphenoid bone contains pituitary gland (hypophysis). **Tuberculum sellae** is anterior ridge with pair of **anterior clinoid processes**. **Dorsum sellae** is posterior with pair of **posterior clinoid processes**. **Chiasmatic sulcus** is groove between anterior clinoid processes for optic chiasm from optic canals with optic nerves from orbits. On squamous (flat) portion of temporal bone, impressions of **middle meningeal artery** follow a course up

from foramen spinosum. Last part of course of internal carotid artery can be seen passing foramen lacerum and turning anteriorly next to sella turcica, then turning upward just posterior to anterior clinoid process on each side.

10

## Posterior cranial fossae

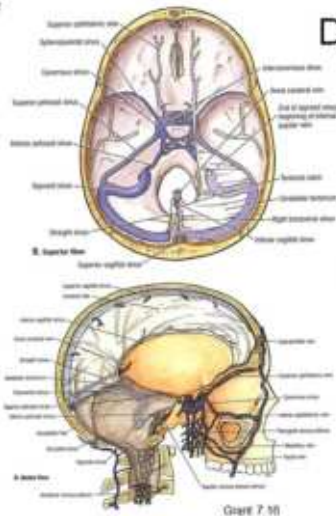


- Petrous ridge - temporal bone
- Body-sphenoid bone
- Occipital bone
- Clivus
- Foramen magnum
- Internal occipital protuberance
- Posterior meningeal A (impressions)
- Grooves for:
  - superior petrosal sinus
  - inferior petrosal sinus
  - sigmoid sinus
  - superior sagittal sinus (end)

**Slide 10: Posterior cranial fossa** is deeper and posterior to petrous ridge of temporal bone and body of sphenoid bone, surrounded by occipital, parietal and temporal bones. **Clivus** is flat part of sphenoid bone and anterior part of occipital bone, sloping down from sella turcica to foramen magnum, the large opening for end of brainstem and top of spinal cord. **Internal occipital protuberance** is in middle of internal occipital crest on posterior wall. Impressions for superior sagittal, occipital, sigmoid, and inferior petrosal sinuses end at jugular foramen. Superior petrosal sinus is located along petrous ridge of the temporal bone.

11

## Dural venous sinuses



- Reflections of layers of dura form passages for venous blood
- Bony impressions:
  - petrosal:**
    - superior and inferior petrosal
  - occipital:**
    - transverse
    - sigmoid
- In falx cerebri:
  - superior and inferior sagittal
- In tentorium cerebelli:
  - straight
  - transverse
  - superior petrosal
- Cavernous sinus

**Slide 11: Dural reflections** form blood sinuses draining brain and meninges. Impressions are seen on bones of skull. **Superior sagittal sinus** lies along midline of calvaria. **Superior and inferior petrosal, occipital, transverse, and sigmoid sinuses** are in posterior cranial fossa. **Inferior sagittal sinus** in bottom edge of the falx cerebri connects via **straight sinus** to the transverse sinus, sigmoid sinus, and internal jugular vein, on left. Superior sagittal sinus connects directly to transverse sinus, sigmoid sinus, and internal jugular vein on right. Inferior and superior petrosal sinuses connect with **cavernous sinus**, surrounding sella turcica.

12

## Occipital bone

- Posterior of skull
- Surrounds foramen magnum
  - anterior: basilar part
  - posterior: squamous part
- External:
  - superior and inferior nuchal lines
  - external occipital protuberance
- Articulates with:
  - sphenoid bone
  - temporal and parietal bones
- Jugular foramen (interosseous)
- Articular condyles; C1 vertebra
  - Condylar canal (intraosseous)
- Hypoglossal canal

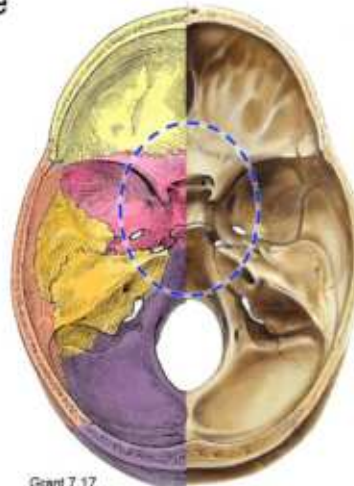


**Slide 12: Occipital bone** has basilar part anterior to foramen magnum and posterior squamous part. **Superior and inferior nuchal lines** on outer surface are attachment sites of various neck muscles. **External occipital protuberance** is midpoint of superior nuchal line. Basilar portion articulates with sphenoid bone. Squamous part articulates with temporal and parietal bones. **Jugular foramen** is between occipital and temporal bones. **Articular condyles** contact C1 vertebra. **Hypoglossal canal**, with hypoglossal nerve (CN XII), is *in* foramen magnum, and should not be confused with condylar canal.

13

## Sphenoid bone

- Middle of skull base
- Body
  - sella turcica
- Greater and lesser wings
- Articulations
  - frontal
  - parietal
  - temporal
  - occipital
  - ethmoid
- End of carotid canal at foramen lacerum
- Important foramina

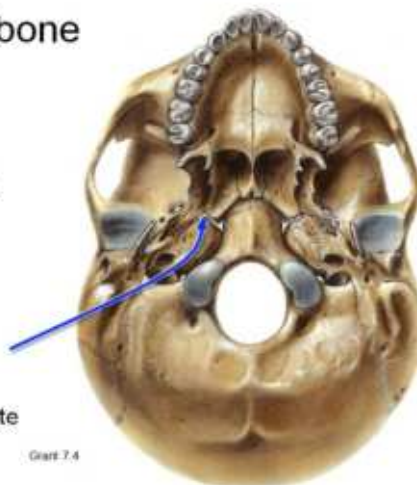


**Slide 13: Sphenoid bone**, in midline, articulates with frontal, parietal, temporal, occipital bones, and ethmoid bone (*not visible in this view into cranial cavity*). Sphenoid is “keystone” of base of skull, wedged in among several bones. Sphenoid bone has many foramina and openings, including: **superior orbital fissure**, **foramen rotundum**, **foramen ovale**, **foramen spinosum**, **foramen lacerum**, **optic canal**, and **pterygoid canal**.

14

## Sphenoid bone

- Pterygoid process:
  - lateral pterygoid plate
  - medial pterygoid plate
    - hamulus
- Important foramina
  - foramen ovale
  - foramen spinosum
- Pterygoid canal
  - in pterygoid process, at medial pterygoid plate

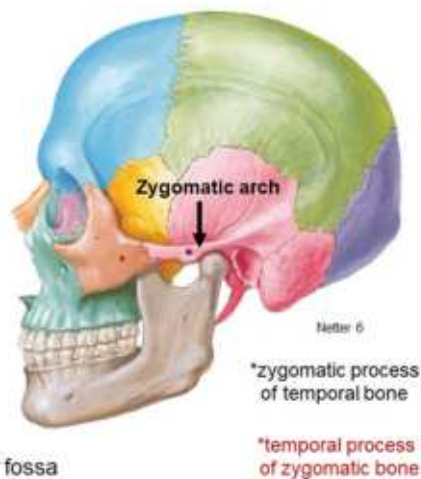


**Slide 14: Inferior view:** sphenoid bone has pterygoid process with **lateral and medial pterygoid plates**. **Medial pterygoid plate** has hamulus, prominent hook-like projection on its end. Important foramina in the sphenoid bone are identifiable in inferior view: **foramen ovale**, **foramen spinosum**. **Pterygoid canal** (*not quite visible in this view*) near superior end of medial pterygoid plate is directed anteriorly into body of sphenoid (see arrow).



## 15 Temporal bone

- Squamous portion
- Mastoid process
- Styloid process
- Tympanic portion (@ external acoustic meatus)
- Articulates with:
  - occipital
  - parietal
  - greater wing of sphenoid
  - zygomatic
- Temporomandibular joint (TMJ)
  - Movable synovial joint with head of mandible at mandibular fossa



**Slide 15: Temporal bone: temporomandibular joint** at mandibular fossa with head of mandible. 5 parts of temporal bone: squamous portion (flat portion), tympanic portion, styloid process, mastoid process, and zygomatic process. Zygomatic process of temporal bone articulates with temporal process of zygomatic bone, in front, to form **zygomatic arch**.

## 16 Temporal bone

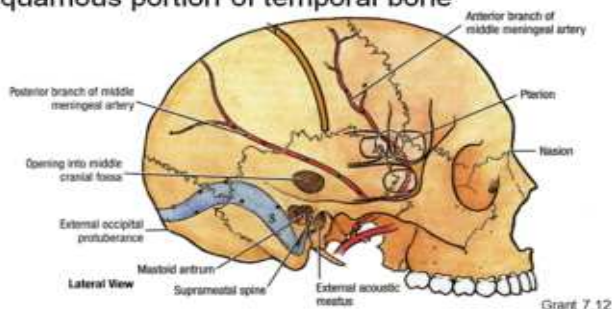
- Petrus portion (ridge)
  - Superior petrosal sinus
  - Arcuate eminence
  - Tegmen tympani
  - Carotid canal (intraosseus)
- from Posterior cranial fossa
  - Internal acoustic meatus
  - Sigmoid sinus
  - Jugular foramen (interosseus)
- Squamous portion (middle cranial fossa)
  - Middle meningeal artery (impression)



**Slide 16: Petrous portion of temporal bone** contains internal carotid artery in **carotid canal**; **superior petrosal venous sinus** leaves groove on surface; **internal acoustic meatus** on posterior side; **arcuate eminence** and **tegmen tympani** are on anterior side; **greater** and **lesser petrosal nerves** on anterior side, each with opening or hiatus; **sigmoid venous sinus** leads to **jugular foramen**. **Squamous portion of temporal bone** forms part of lateral wall of middle cranial cavity. Branches of **middle meningeal artery** from **foramen spinosum** in floor leave impressions on temporal bone.

## 17 Middle meningeal artery at pterion

- From maxillary A in infratemporal fossa
- Through foramen spinosum
- Along greater wing of sphenoid and squamous portion of temporal bone



**Slide 17: The middle meningeal artery** passes from **foramen spinosum** along the squamous portion of the temporal bone and the greater wing of the sphenoid bone. Its anterior branch passes at the **pterion**. This is a critical point on the skull, since the pterion is a very thin part of the lateral wall. A skull fracture here could lead to tearing of the artery, major bleeding accumulating between the skull and dura



## 18 Petrous ridge of temporal bone

- Hiatus and groove for greater petrosal N (br of CN VII)
  - toward end of carotid canal in petrous ridge
- Hiatus for lesser petrosal N (br of CN IX)
  - toward foramen ovale
- Internal acoustic meatus
  - Vestibulocochlear N (CN VIII)
  - Facial N (CN VII)
    - geniculum of facial nerve
- Arcuate eminence (AE)
  - anterior semicircular canal
- Tegmen tympani (T)
  - roof over tympanic cavity (middle ear)



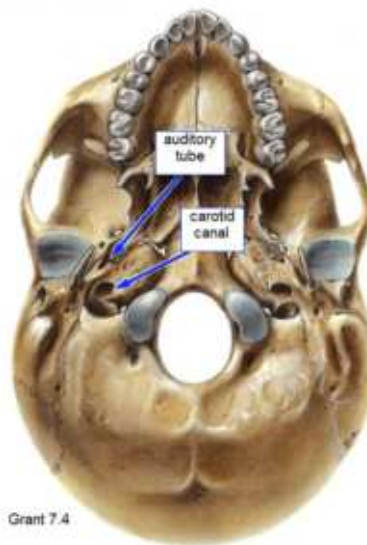
**Slide 18:** Cranial nerves VII and VIII enter posterior side of petrous portion of temporal bone through **internal acoustic meatus**. **Facial nerve** (CN VII) passes crosses through ridge and then bends posterior and downward at **geniculum of the facial nerve**. **Geniculate ganglion**, sensory ganglion for facial nerve, is located here. **Greater petrosal nerve** out through small hiatus and in groove on anterior side, past carotid canal and anterior to foramen lacerum. **Arcuate eminence** on anterior side (see AE in upper figure) contains anterior semicircular canal. **Tegmen tympani**,

roof of tympanic cavity, is just lateral to this location (T in both figures).

## Temporal bone – basal side

19

- Zygomatic process
  - Articular tubercle
- Mandibular fossa
- Tympanic portion
- Petrotympenic fissure
- Petrous portion
- Auditory tube
- Carotid canal
- Styloid process
- Stylomastoid foramen
- Mastoid process
- Mastoid notch
- Occipital groove
- Jugular foramen

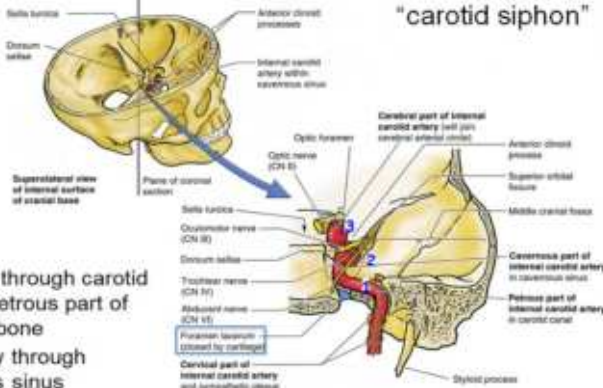


**Slide 19: Inferior view:** **Zygomatic process** and **petrous portion of temporal bone**. **Stylomastoid foramen** is between styloid and mastoid processes. Chorda tympani nerve exits through **petrotympanic fissure** carrying taste nerve fibers to tongue. **Auditory tube** (arrow) connects middle ear (tympanic cavity) and pharynx. Adjacent to mastoid process are **mastoid notch**, **occipital groove**, and **jugular fossa**.

**Mandibular fossa** is at posterior end of zygomatic arch.

20

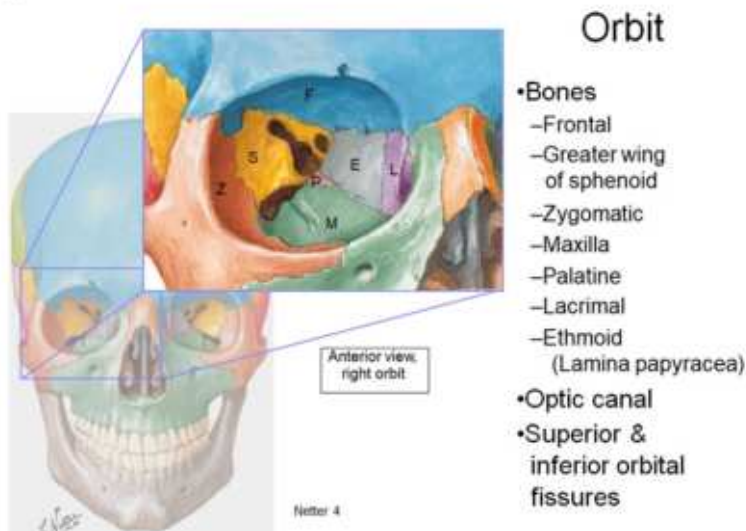
## Course of internal carotid artery "carotid siphon"



- 1) Medially through carotid canal in petrous part of temporal bone
- 2) Anteriorly through cavernous sinus
- 3) Past anterior clinoid process of sphenoid bone

**Slide 20: Internal carotid artery** passes up from neck to **carotid canal** in underside of the petrous part of temporal bone; travels in canal medially and somewhat anteriorly toward posterior end of **cavernous sinus**; turns anteriorly at side of sella turcica; turns superiorly at anterior end of sella; almost immediately turns posteriorly and superiorly again. This **S-shaped** course is often called "carotid siphon" by clinicians.

21

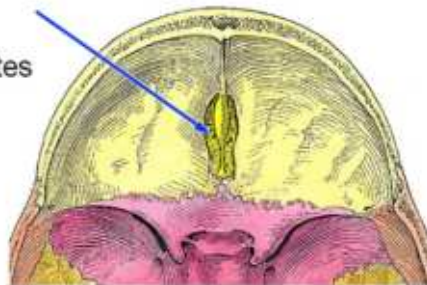


**Slide 21: Anterior view: In right orbit:** Parts of frontal, sphenoid, zygomatic, maxilla, palatine, lacrimal, and ethmoid bones. **Optic canal** through sphenoid bone conveys optic nerve (CN II) and ophthalmic artery. **Superior orbital fissure** is lateral to optic canal and permits passage of ophthalmic division of trigeminal nerve (CN V1), oculomotor nerve (CN III), trochlear nerve (CN IV), abducent nerve (CN VI), as well as the superior ophthalmic vein. **Inferior orbital fissure** conveys maxillary nerve (CN V2) and inferior ophthalmic vein.

22

## Ethmoid bone

- In anterior fossa, between orbital plates of frontal bone
- Crista galli
- Cribriform plate
  - (Olfactory bulbs)
- Related features:
  - Anterior, on frontal bone:
    - foramen cecum
    - frontal crest
  - Posterior, on sphenoid bone:
    - ethmoidal spine



**Slide 22:** Part of ethmoid bone in anterior cranial fossa, between 2 orbital plates of frontal bone. Vertical projection from ethmoid bone is **crista galli** where falx cerebri is attached. At either side, 2 **cribriform plates** of multi-perforated bone. **Ethmoidal spine**, small point on sphenoid bone is posterior to crista galli.

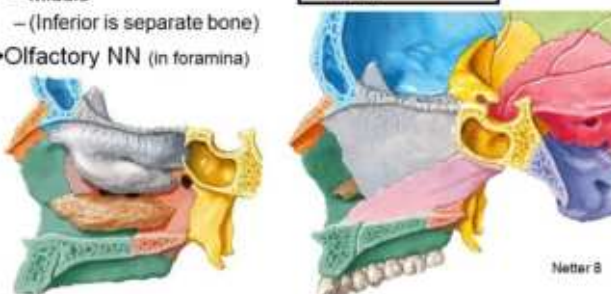
23

## Ethmoid bone

- Crista galli
- Perpendicular plate
- Conchae
  - Superior
  - Middle
  - (Inferior is separate bone)
- Olfactory NN (in foramina)

Articulates with

- Frontal
- Sphenoid
- Maxilla
- Palatine
- Lacrimal
- Vomer



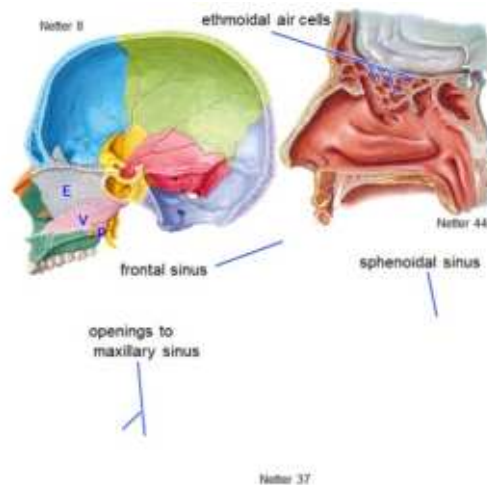
**Slide 23: Perpendicular plate of ethmoid bone (right figure)** contributes to formation of nasal septum that divides nasal cavity. **Superior and middle conchae** are projections from ethmoid bone on lateral walls of nasal cavity (*left figure*). **Inferior concha** is a separate bone. Cribriform plates at roof of nasal cavity have multiple foramina for olfactory nerves (collectively, these are CN I). Olfactory bulbs and stalks (second nerves in sensory pathway for sense of smell) are depressions on either side of the crista galli on superior side of cribriform plates in anterior cranial fossa.



24

## Paranasal sinuses

- Pneumatized bone (paranasal sinuses)
  - ethmoidal air cells
  - frontal
  - sphenoidal
  - maxillary (openings inferior to middle concha)
- Nasal septum (3 parts)
  - perpendicular plate of ethmoid (E)
  - perpendicular plate of palatine (P)
  - Vomer (V)

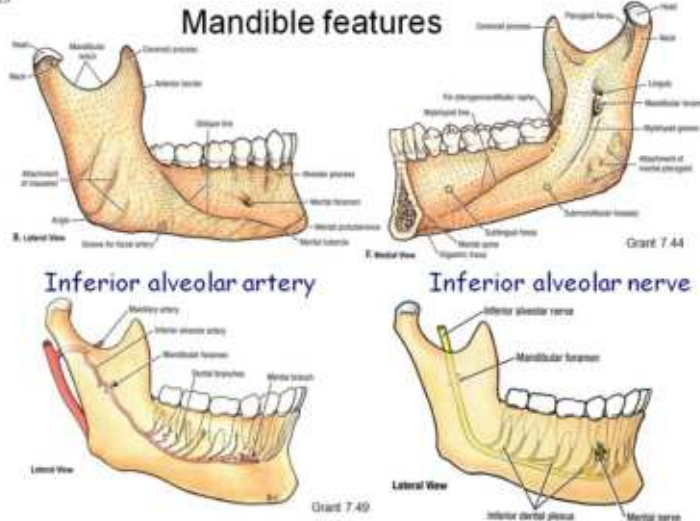


**Slide 24:** In sagittal sections: Bones of skull around nasal cavity are pneumatized, containing air-filled spaces. **Paranasal sinuses** are found in frontal bone, sphenoid bones, maxilla, and ethmoid bone.

**Perpendicular plate of ethmoid (E in upper left figure), perpendicular plate of palatine bone (P), and vomer (V) form nasal septum.** Paranasal sinuses include ethmoidal air cells, frontal sinus, sphenoidal sinus, and maxillary sinus; all lined with mucosa, have openings into nasal cavity at various locations.

25

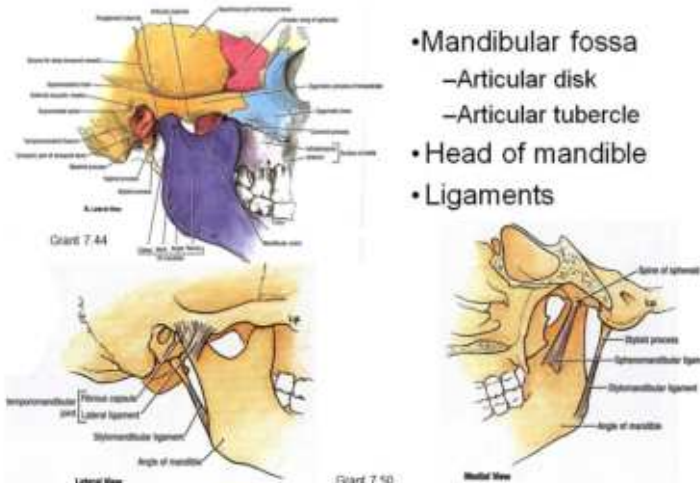
## Mandible features



**Slide 25:** Mandible has vertical **ramus** with **head** and **neck**, **mandibular notch**, and **coronoid process**. Ramus meets body at **angle of mandible**. Lower teeth are embedded in **alveolar process** of body. **Mental protuberance** helps to form prominence of chin. Mental nerve (terminal branch of CN V3) exits **mental foramen**. **Mylohyoid line**, **mental spine**, and **fossae** for sublingual and submandibular glands are on medial side. **Lingula** is small bony projection next to **mandibular foramen**, opening of **mandibular canal** with inferior alveolar nerve and artery to supply teeth.

26

## Temporomandibular joint (TMJ)



- Mandibular fossa
  - Articular disk
  - Articular tubercle
- Head of mandible
- Ligaments

**Slide 26:** Head of mandible fits into mandibular fossa on inferior side of temporal bone to form **temporomandibular joint (TMJ)**, just anterior to external acoustic meatus. Anterior to TMJ, **coronoid process** is attachment site of temporalis muscle on mandible. The sphenomandibular ligament is attached to the spine of the sphenoid and the lingula on the mandible. Mandibular foramen is covered by end of the **sphenomandibular ligament**, attached at lingula. **Stylomandibular ligament** extends from styloid process of temporal bone down to angle of mandible.



27

### Landmarks and foramina

1. Supraorbital foramen  
- CN V1
2. Infraorbital foramen  
- CN V2
3. Mental foramen  
- CN V3
4. Zygomaticofacial foramen  
- zygomaticofacial branch of CN V2
5. Piriform aperture
6. Perpendicular plate of ethmoid bone
7. Vomer
8. Canine fossa
9. Mental protuberance between mental tubercles



Grant 7.1

**Slide 27:** From a frontal view, locate the following features (with contents, etc., also listed here):

1. supraorbital foramen: supraorbital N (branch of CN V1)
2. infraorbital foramen: infraorbital N (branch of CN V2)
3. mental foramen: mental N (branch of CN V3)  
(Note that these 3 foramina are vertically aligned, indicated by the red dotted line at the right of the picture.)
4. zygomaticofacial foramen: zygomaticofacial branch of CN V2
5. piriform aperture: the anterior opening to the nasal cavity
6. perpendicular plate of ethmoid bone, forming part of the nasal septum in the midline

7. vomer bone
8. canine fossa, just posterior and superior to the canine teeth in the maxilla on each side
9. mental protuberance, located at the joining of the mental tubercles on the mandible

28

### Landmarks and foramina

1. Superior temporal line
2. Inferior temporal line
3. Zygomatic arch
4. Styloid process
5. Mastoid process
6. Canine fossa
7. Zygomaticotemporal foramen – branch of CN V<sub>2</sub>
8. Zygomaticofacial foramen – branch of CN V<sub>2</sub>
9. Mental foramen – mental nerve (branch of CN V<sub>3</sub>)
10. Mastoid foramen – branch of occipital A. to dura & emissary V to sigmoid sinus



Grant 7.2

**Slide 28:** From a lateral view, locate:

- superior temporal line
- inferior temporal line
- zygomatic arch
- styloid process on temporal bone
- mastoid process on temporal bone
- canine fossa on maxilla
- zygomaticotemporal foramen (*arrow*), on posterior of frontal process of zygomatic bone (zygomaticotemporal branch of CN V<sub>2</sub>)
- zygomaticofacial foramen (zygomaticofacial branch of CN V<sub>2</sub>)
- mental foramen with mental nerve (branch of CN V<sub>3</sub>)
- mastoid foramen conveys branch of occipital artery to the dura and an emissary vein to the sigmoid sinus

29

## Landmarks

1. Zygomatic arch
2. Lateral and medial pterygoid plates
3. Hamulus of medial pterygoid plate
4. Choanae
5. Vomer
6. Mandibular fossa
7. Spine of sphenoid
8. Styloid process
9. Occipital condyles
10. Mastoid process
11. Mastoid notch
12. Occipital groove
13. Inferior and superior nuchal lines
14. External occipital protuberance



Grant 7.4

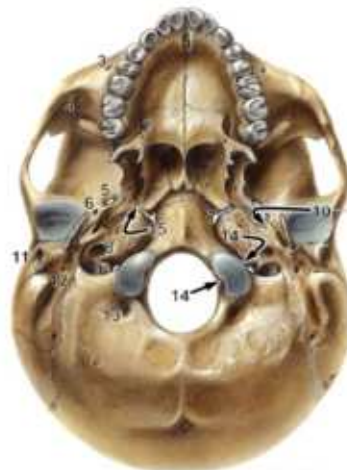
**Slide 29:** From a frontal view, locate the following features (with contents, etc., also listed here):

1. supraorbital foramen: supraorbital N (branch of CN V1)
2. infraorbital foramen: infraorbital N (branch of CN V2)
3. mental foramen: mental N (branch of CN V3) (Note that these 3 foramina are vertically aligned, indicated by the red dotted line at the right of the picture.)
4. zygomaticofacial foramen: zygomaticofacial branch of CN V2
5. piriform aperture: the anterior opening to the nasal cavity
6. perpendicular plate of ethmoid bone, forming part of the nasal septum in the midline
7. vomer bone
8. canine fossa, just posterior and superior to the canine teeth in the maxilla on each side
9. mental protuberance, located at the joining of the mental tubercles on the mandible

30

## Foramina

1. Incisive foramen
2. Greater and lesser palatine foramina
3. Infraorbital foramen
4. (Zygomaticotemporal foramen)
5. Foramen ovale
6. Foramen spinosum
7. Foramen lacerum
8. Carotid canal
9. Jugular foramen
10. Auditory tube (arrow)
11. External acoustic meatus
12. Stylomastoid foramen
13. Condylar canal
14. Hypoglossal canal (arrows)
15. Pterygoid canal (arrow)



Grant 7.4

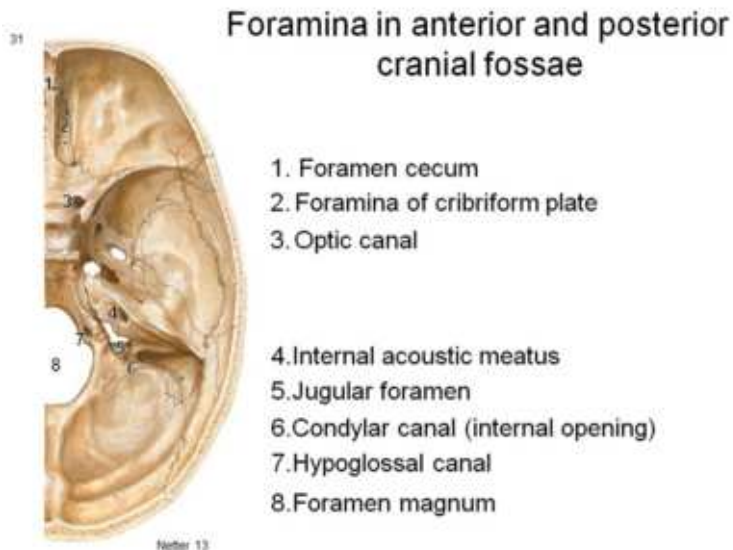
**Slide 30:** From the inferior side of the skull locate the following foramina (also listed are their contents):

1. incisive foramen in the maxilla: nasopalatine N and sphenopalatine A and V
2. greater and lesser palatine foramina: greater and lesser palatine N, A, and V
3. infraorbital foramen: infraorbital N (branch of CN V2)
4. zygomaticotemporal foramen: zygomaticotemporal N (branch of CN V2)
5. foramen ovale: mandibular N (branch of CN V3)
6. foramen spinosum: middle meningeal A
7. foramen lacerum: cartilage covers

over the passage of the internal carotid A as it exits from the medial end of the carotid canal

8. carotid canal: internal carotid A and its sympathetic nerve plexus
9. jugular foramen: internal jugular V and CN IX, CN X, CN XI
10. auditory tube (indicated by single arrow): this bony tube contains the pharyngotympanic tube connecting the middle ear with the pharynx

11. external acoustic meatus; for the auditory canal, leading to the eardrum (tympanic membrane)
12. stylomastoid foramen: facial N (CN VII)
13. condylar canal: emissary vein from the sigmoid sinus to suboccipital veins
14. hypoglossal canal (indicated by the opposing arrows): hypoglossal nerve (CN XII)
15. pterygoid canal (indicated by arrow) (not quite visible in this slide): nerve of the pterygoid canal, a mixed nerve with both sympathetic and parasympathetic fibers (and maybe taste fibers from the palate). The greater petrosal nerve passes through the edge of foramen lacerum carrying parasympathetic nerve fibers and joins the deep petrosal nerve from the plexus of sympathetic nerves around the carotid artery. This forms the nerve of the pterygoid canal (Vidian's nerve).

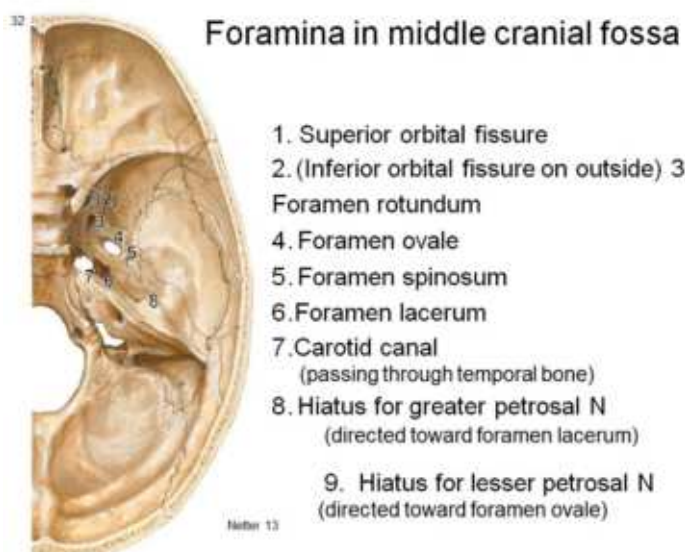


suboccipital veins

7. hypoglossal canal: hypoglossal N (CN XII)
8. foramen magnum: spinal cord, vertebral arteries, and meninges

**Slide 31:** In the anterior and posterior cranial fossa, locate:

1. foramen cecum: emissary vein, during fetal life, but now only a blind opening
2. foramina of the cribriform plate: olfactory nerves (collectively, CN I)
3. optic canal: optic N (CN II) and the ophthalmic artery (branch of the internal carotid artery)
4. internal acoustic meatus: facial N (CN VII), vestibulocochlear N (CN VIII), small internal auditory A
5. jugular foramen: internal jugular vein starts here, CN IX, CN X, CN XII
6. internal opening of condylar canal: emissary vein from the sigmoid sinus to



**Slide 32:** In the middle cranial fossa, locate:

1. superior orbital fissure: cranial nerves III, IV, VI, ophthalmic division of CN V, ophthalmic veins
2. inferior orbital fissure is not visible here. It conveys infraorbital nerve (branch of CN V2), infraorbital artery and vein, zygomatic branches of CN V2
3. Foramen rotundum: maxillary N (CN V2)
4. foramen ovale: mandibular N (CN V3)
5. foramen spinosum: middle meningeal sphenoid emissary foramen: emissary vein to pterygoid plexus of veins



- 
- 6 Foramen lacerum: on superior side; Foramen lacerum is covered over in the living skull by a connective tissue membrane, but the internal carotid artery passes just beneath it on its way toward the cavernous sinus.
  7. carotid canal: internal carotid A and its sympathetic nerve plexus
  8. hiatus for greater petrosal nerve and hiatus for lesser petrosal nerve: nerves, as indicated by their names.

## Slide 33:

## Summary:

## Foramina and Apertures in Cranial Fossae and Their Contents

Foramina/Apertures	Contents
<b>Anterior Cranial Fossa</b>	
Foramen cecum	Nasal emissary vein ( <i>in 1% of population</i> )
Foramina in cribriform plate	Axons of olfactory nerve cells in olfactory epithelium
Anterior and posterior ethmoidal foramen	Anterior and posterior ethmoidal vessels and nerves
<b>Middle Cranial Fossa</b>	
Optic canals	Optic nerves (CN II), ophthalmic arteries
Superior orbital fissure	Ophthalmic veins, ophthalmic nerve (CN V1), CN III, CN IV, CN VI, sympathetic nerves
Foramen rotundum	Maxillary nerve (CN V2) ( <i>provides passage to inferior orbital fissure</i> )
Foramen ovale	Mandibular nerve (CN V3), lesser petrosal nerve, accessory meningeal artery
Foramen spinosum	Middle meningeal artery and vein, meningeal branch of CN V3
Foramen lacerum (closed by cartilage)	Internal carotid artery and its accompanying sympathetic and venous plexuses pass ACROSS foramen lacerum area, which is closed by cartilage in life ( <i>greater petrosal nerve crosses above &amp; anterior</i> )
Hiatus of greater petrosal nerve	Greater petrosal nerve, petrosal branch of middle meningeal artery
Hiatus of lesser petrosal nerve	Lesser petrosal nerve
<b>Posterior cranial Fossa</b>	
Foramen magnum	Medulla and meninges, vertebral arteries, spinal roots of CN XI, dural veins, anterior and posterior spinal arteries
Jugular foramen	CN IX, CN X, CN XI, superior bulb of internal jugular vein, inferior petrosal sinus, sigmoid sinus, meningeal branches of ascending pharyngeal and occipital arteries
Hypoglossal canal	Hypoglossal nerve (CN XII)
Condylar canal	Emissary vein passing from sigmoid sinus to vertebral veins in neck
Mastoid foramen	Mastoid emissary vein from sigmoid sinus, meningeal branch of occipital artery

34

## Frontal (PA) radiograph

- Air densities:
  - nasal cavity
  - paranasal sinuses
- Water densities:
  - muscles
  - blood vessels
  - brain
  - connective tissue
- Bone densities



Should be able to identify: frontal sinuses, ethmoidal air cells, maxillary sinuses, zygomatic arches, nasal conchae, angle of mandible, margins of orbit

Netter 5

**Slide 34:** Even internal features of skull can be recognized in plain radiographs. On frontal radiograph of skull, you should be able to identify paranasal sinuses by their air densities within bone. Muscles, brain, and blood vessels supplying them can be visible as water densities. You should also be able to see zygomatic arches, nasal conchae, mandible, and margins of orbits.

35

## Lateral radiograph

- Air densities:
  - nasal cavity
  - paranasal sinuses
  - pharynx, larynx, trachea
- Water densities:
  - muscles
  - blood vessels
  - brain
  - connective tissue
- Bone densities



Should be able to identify: hypophyseal fossa, sphenoidal sinus, hard palate, angle of mandible, spinous processes of cervical vertebra and Yoric.

Netter 7

**Slide 35:** On lateral radiograph of skull, you should be able to recognize air densities in nasal cavity, paranasal sinuses, pharynx, larynx, and trachea. You should be able to identify bony features, including hypophyseal fossa, sphenoid sinus, hard palate, angle of mandible, anterior and posterior clinoid processes spinous processes of cervical vertebra, and other features



37

## Diseases (injuries) of the skull

### Skull Base Disorders:

The skull base is the area of the skull that separates the brain from other facial structures. Diseases affecting the skull base can include:

#### •Tumors:

•benign and malignant tumors can occur in the skull base, including acoustic neuromas, meningiomas, and chondrosarcomas.

#### •Vascular processes:

•These involve abnormal blood vessels, such as aneurysms, arterial venous malformations, and cavernous malformations.

#### •Infections:

•Skull base osteomyelitis (infection of the bone) can arise from chronic, inadequately treated infections, potentially leading to neurological complications.

#### •Congenital disorders:

•These are birth defects like Chiari malformation and basilar invagination

3. These involve abnormal blood vessels, such as aneurysms, arterial venous malformations, and cavernous malformations.

4. Infections:

5. Skull base osteomyelitis (infection of the bone) can arise from chronic, inadequately treated infections, potentially leading to neurological complications.

6. Congenital disorders:

7..These are birth defects like Chiari malformation and basilar invagination

### Skull Base Disorders:

The skull base is the area of the skull that separates the brain from other facial structures. Diseases affecting the skull base can include:

1. Tumors:

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2. Vascular processes:

38

## Meningioma



**Origin:** They arise from the meninges, specifically the arachnoid layer.

**Prevalence:** They are the most common type of primary brain tumor, particularly in adults.

**Growth Rate:** Most are slow-growing, but some can be more aggressive.

**Benign vs. Malignant:** The majority are benign (80-90%), but a smaller percentage are atypical or malignant

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# Tol Tech VH Dissector

[Skull](#)

[Skull Frontal](#)

[Side view](#)

[Posterior view](#)

[Inferior view](#)

[Superior view](#)