# ANATOMY

Bones Of The Head

# Skull

**Contents**

# The Skull

- The skull is a bony structure that supports the face and forms a **protective cavity** for the brain. It is comprised of many bones, formed by intramembranous ossification, which are joined together by **sutures** (fibrous joints). These joints fuse together in adulthood, thus permitting brain growth during adolescence.
- The bones of the skull can be divided into two groups: those of the **cranium** (which can be subdivided the skullcap known as the calvarium, and the cranial base) and those of the **face**.

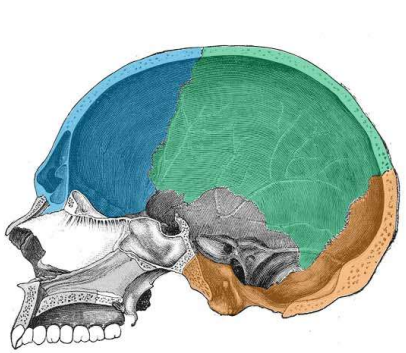
# The Skull

**The Cranium**

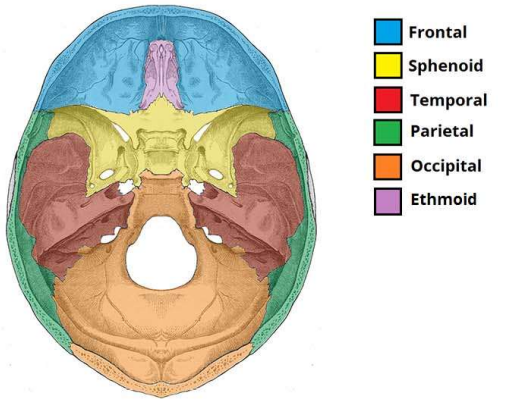
- The **cranium** (also known as the neurocranium), is formed by the superior aspect of the skull. It encloses and protects the brain, meninges and cerebral vasculature.
- Anatomically, the cranium can be subdivided into a **roof** (known as the calvarium), and a **base:**
- **Calvarium:** Comprised of the frontal, occipital and two parietal bones.
- **Cranial base:** Comprised of six bones – the frontal, sphenoid, ethmoid, occipital, parietal and temporal bones. These bones are important as they provide an articulation point for the 1st cervical vertebra (atlas), as well as the facial bones and the mandible (jaw bone).

# The Skull

Bones of Calvarium and Cranial Base



a) Bones of the calvarium




b) Bones of the cranial base

# The Skull

**The Face**

- The **facial skeleton** (also known as the viscerocranium) supports the soft tissues of the face. In essence, they determine our facial appearance.
- It consists of 14 individual bones, which fuse to house the orbits of the eyes, nasal and oral cavities, as well as the sinuses. The frontal bone, typically a bone of the calvaria, is sometimes included as part of the facial skeleton.

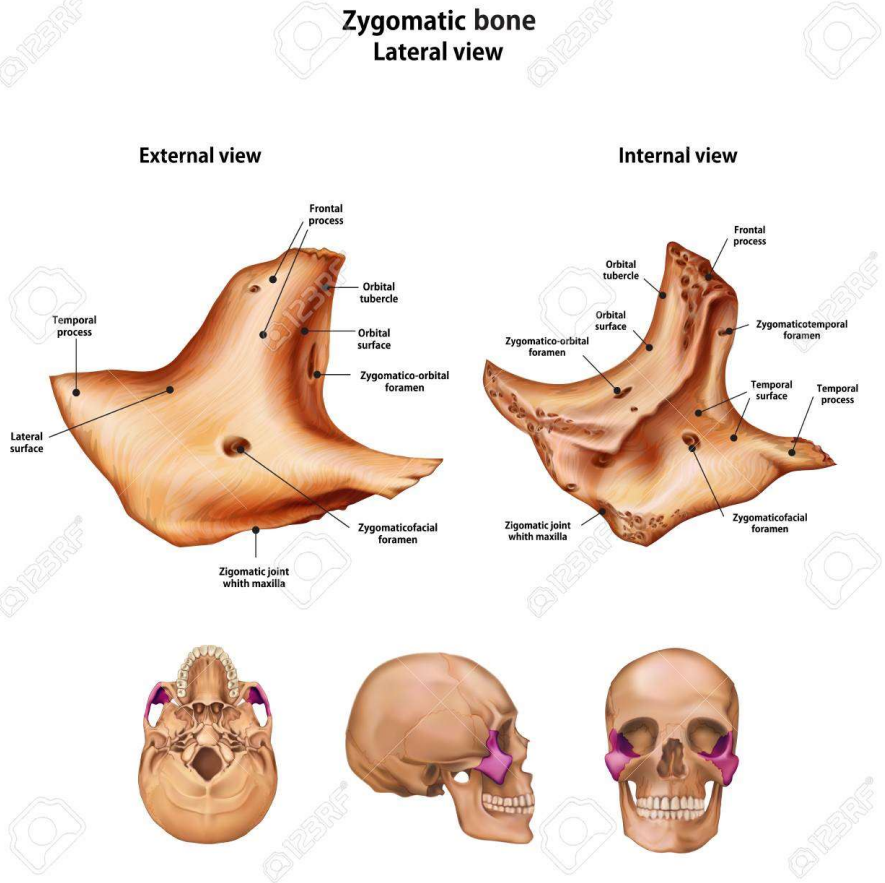
# The Skull

The facial bones are:

- **Zygomatic (2) –** Forms the cheek bones of the face, and articulates with the frontal, sphenoid, temporal and maxilla bones.
- **Lacrimal (2)** – The smallest bones of the face. They form part of the medial wall of the orbit.
- **Nasal (2)** – Two slender bones, located at the bridge of the nose.
- **Inferior nasal conchae (2)** – Located within the nasal cavity, these bones increase the surface area of the nasal cavity, thus increasing the amount of inspired air that can come into contact with the cavity walls.
- **Palatine (2)** – Situated at the rear of oral cavity, and forms part of the hard palate.
- **Maxilla (2) –** Comprises part of the upper jaw and hard palate.
- **Vomer –** Forms the posterior aspect of the nasal septum.
- **Mandible (jaw bone)** – Articulates with the base of the cranium at the temporomandibular joint (TMJ).

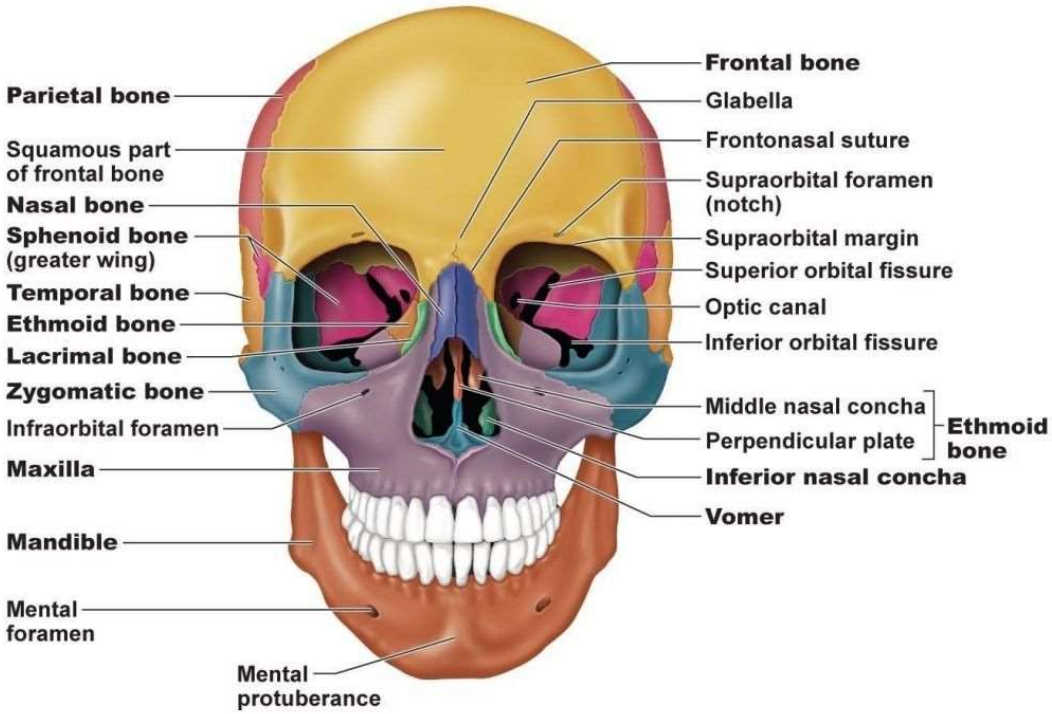
# Skull Bone

Zygomatic Bone



# The Skull

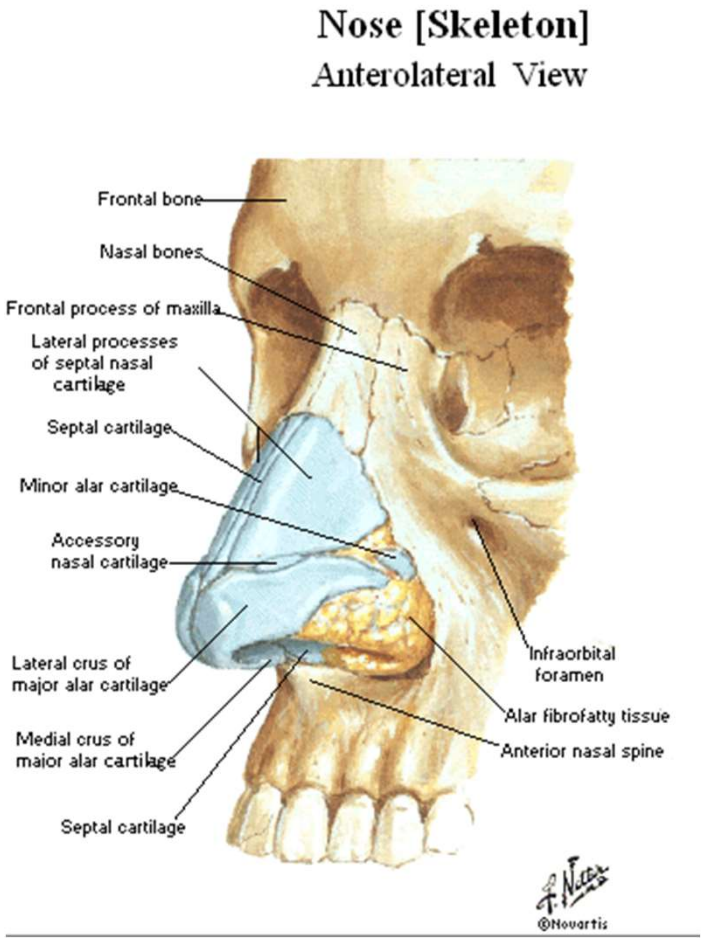
Lacrimal Bone




**(a) Anterior view of skull**

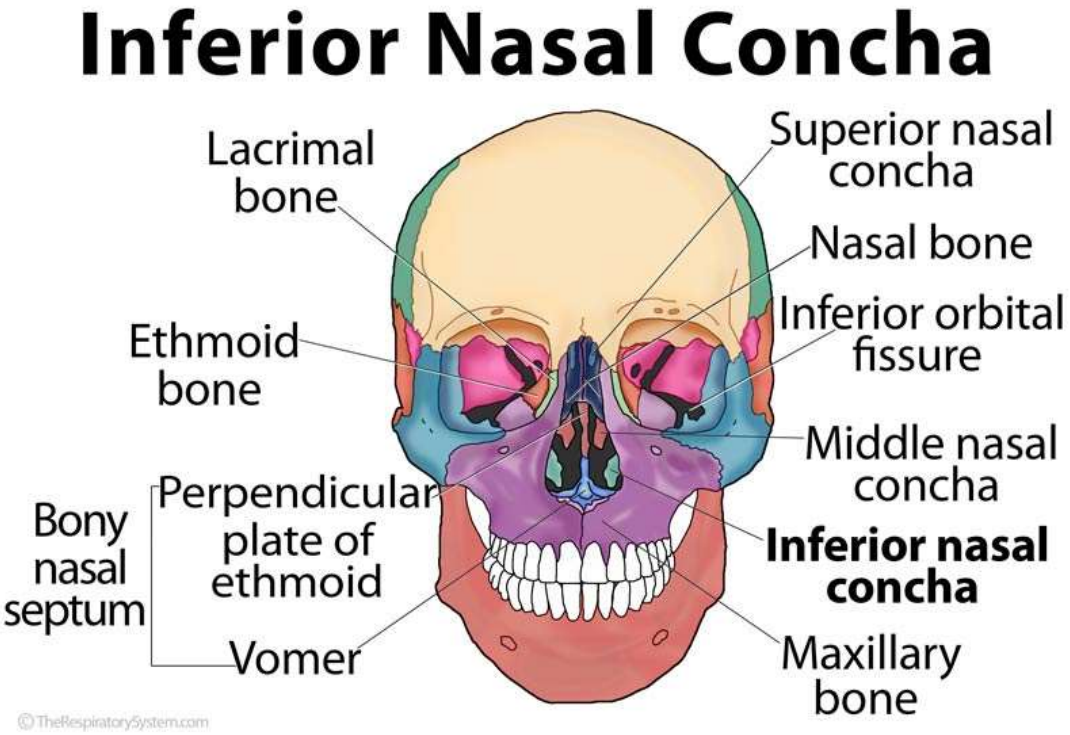
# The Skull

Nasal Bone



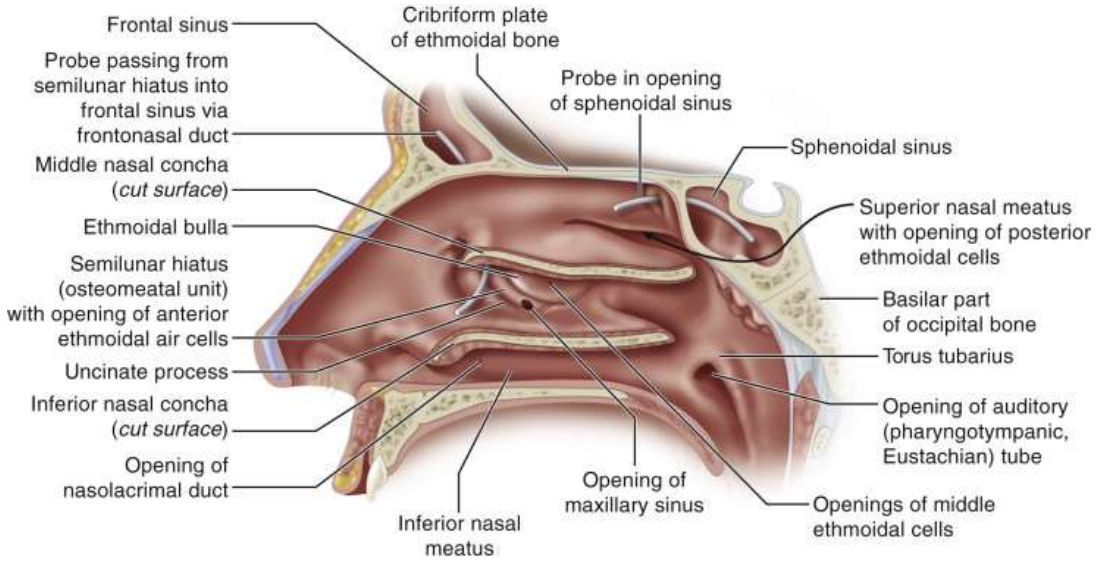
# The Skull

Inferior Nasal Concha



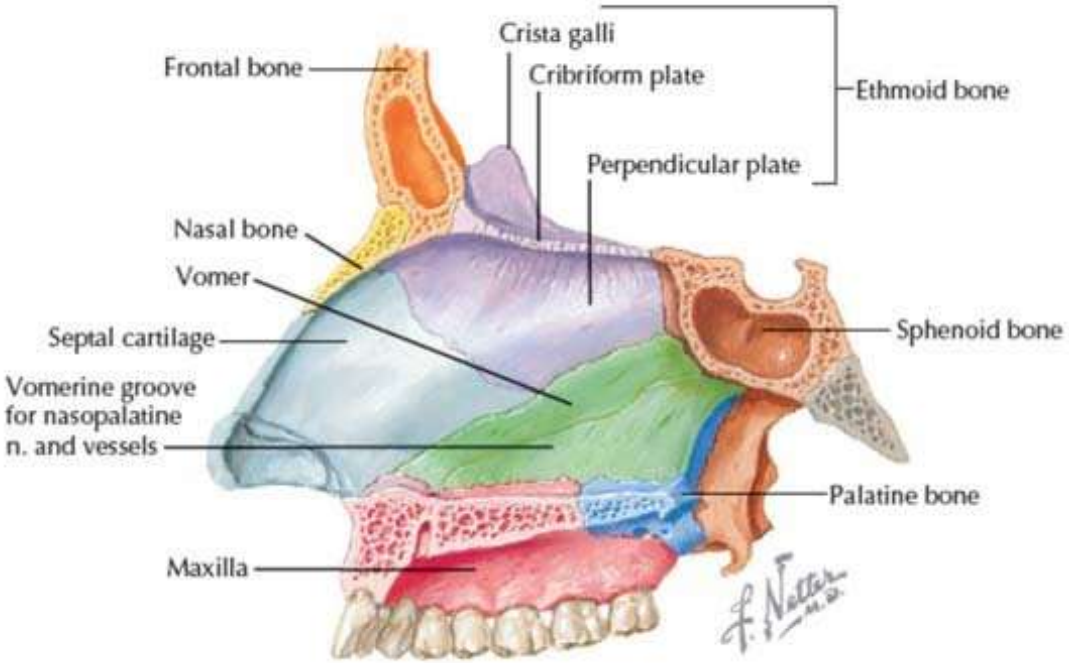
# The Skull

Inferior Nasal Concha



# The Skull

Palatine Bone



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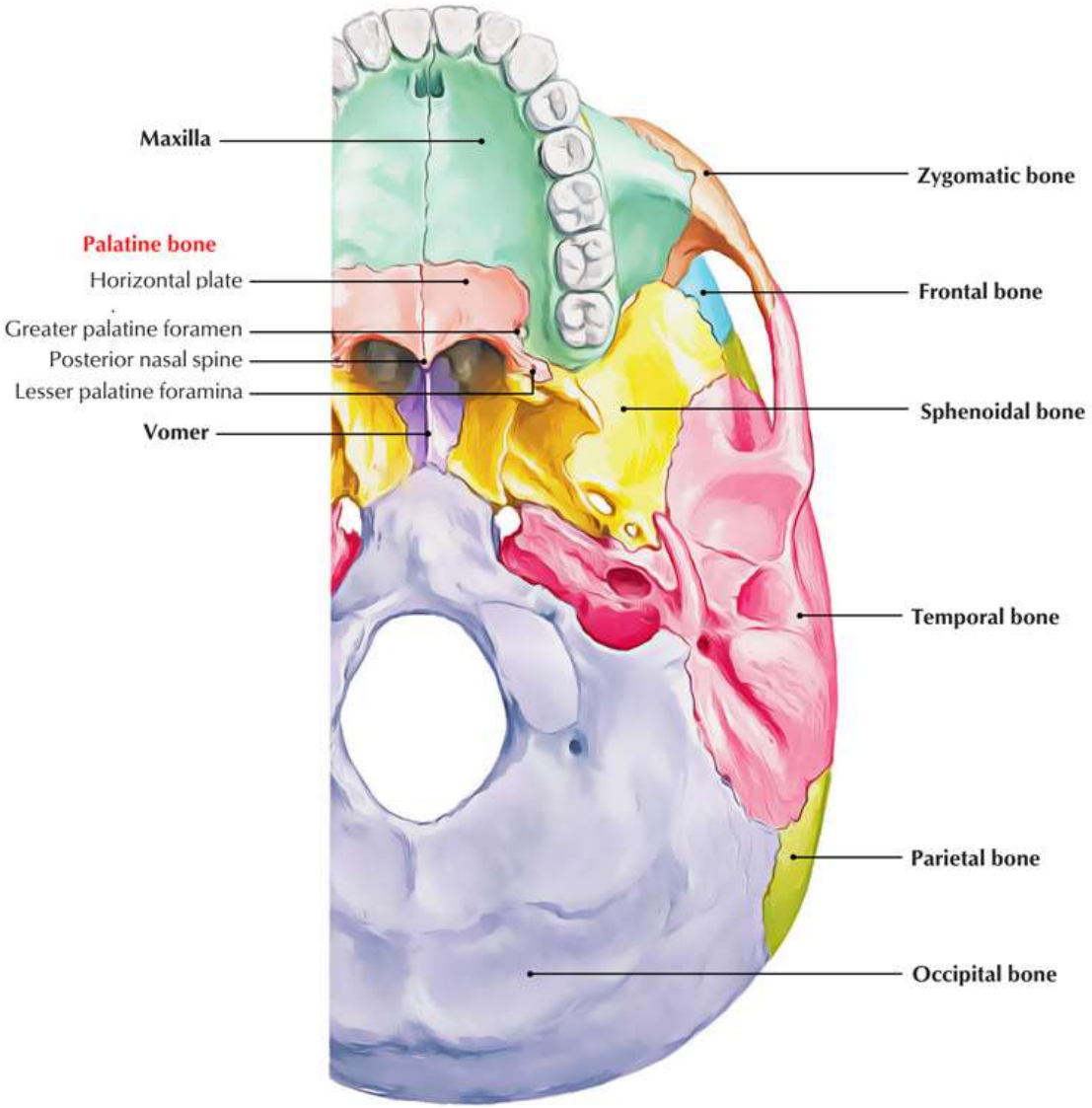
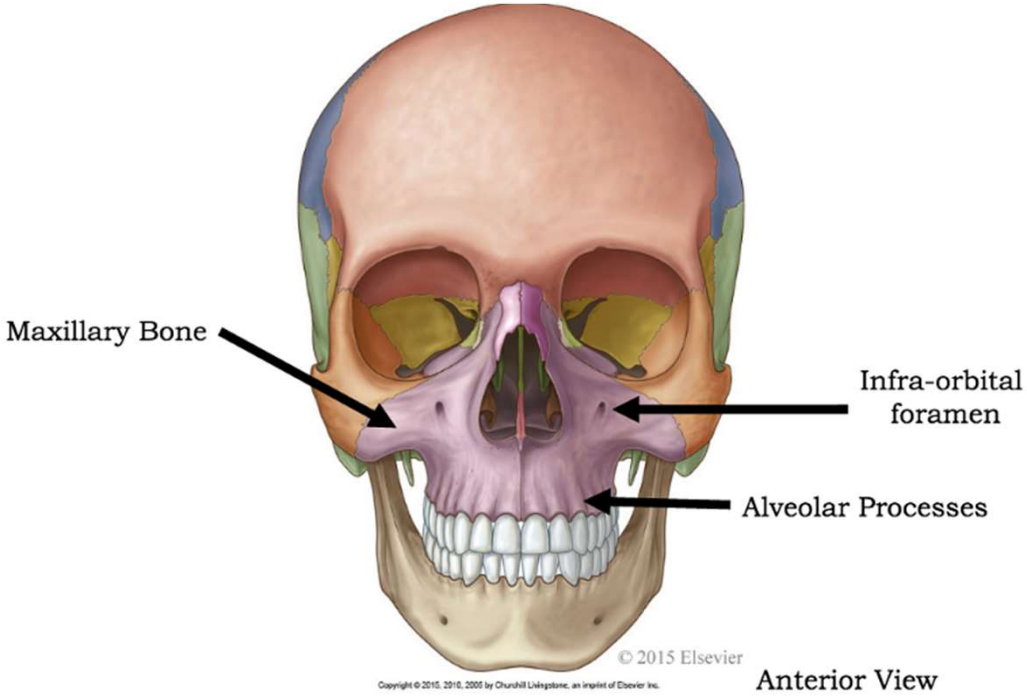
## Palatine Bon



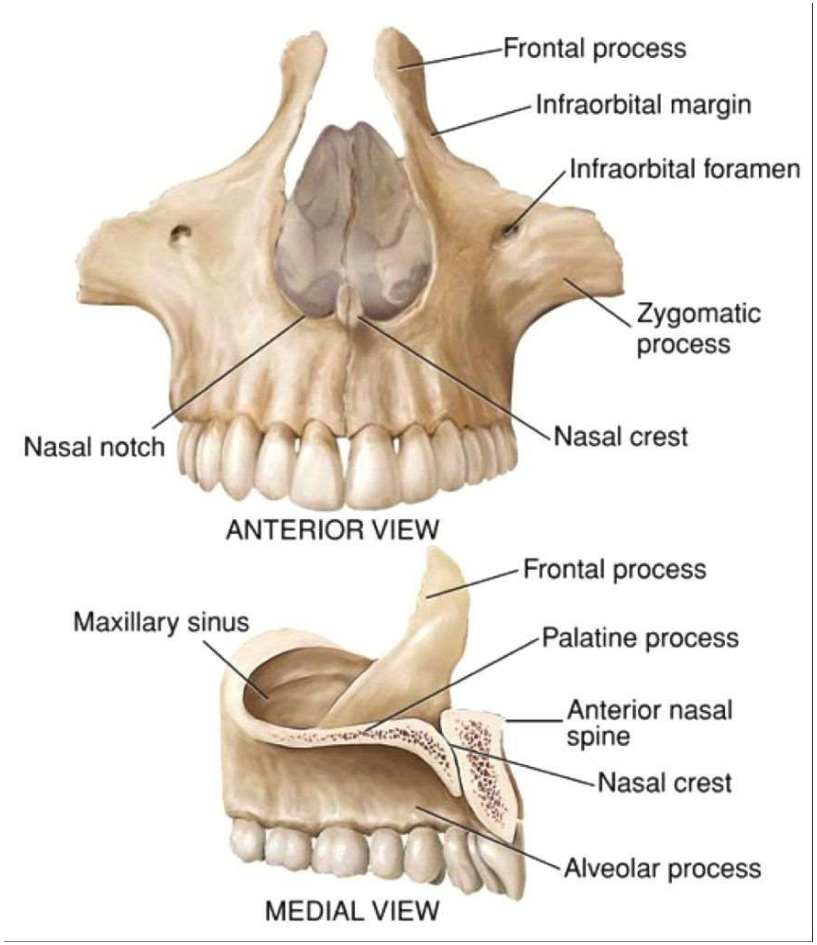
# The Skull

Maxilla



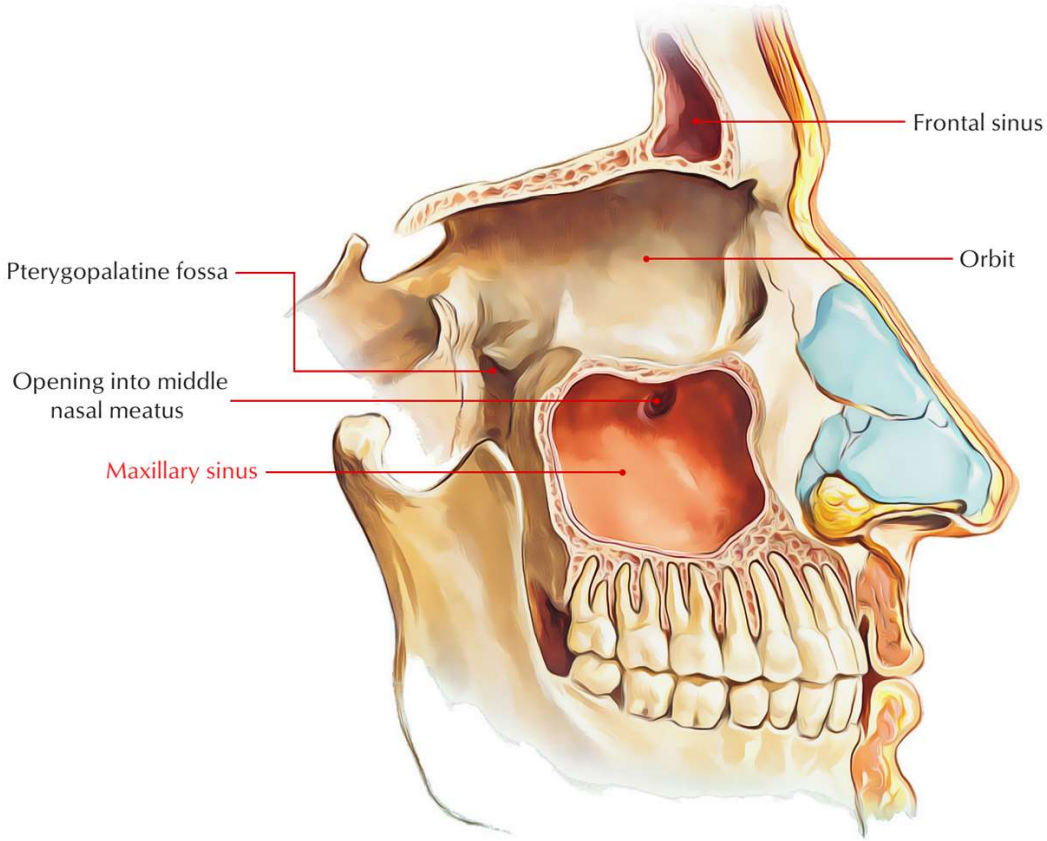
# The Skull

The Maxilla



# The Skull

## Maxillary Bone



# The Skull

**Sutures of the Skull**

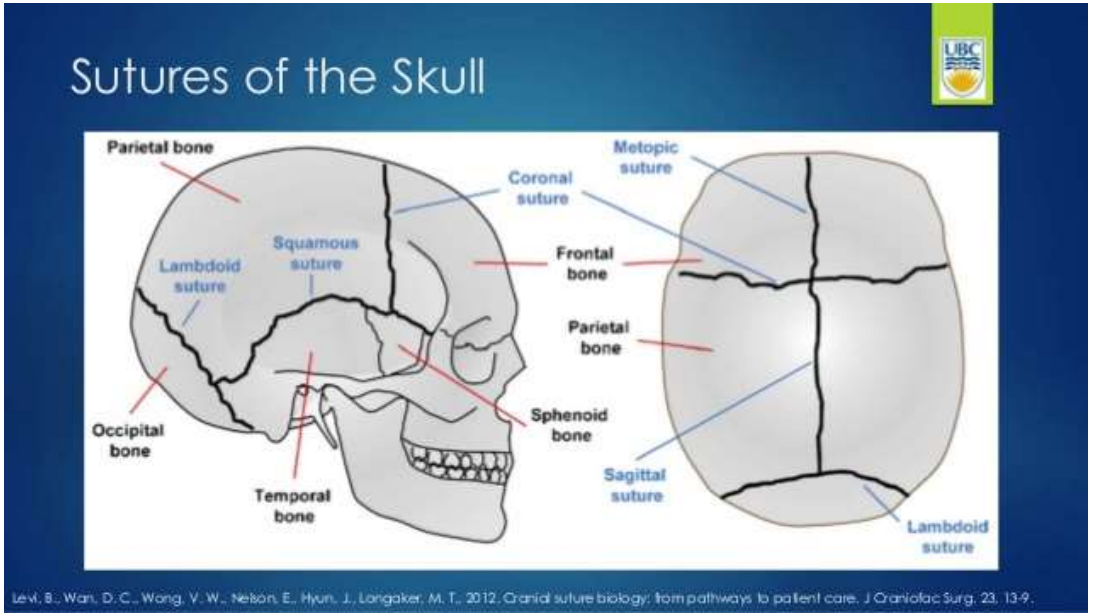
- Sutures are a type of fibrous joint that are unique to the skull. They are immovable, and fuse completely around the age of 20.

# The Skull

- Sutures are of clinical importance, as they can be points of potential weakness in both childhood and adulthood. The main sutures in adulthood are:
- **Coronal suture** which fuses the frontal bone with the two parietal bones.
- **Sagittal suture** which fuses both parietal bones to each other.
- **Lambdoid suture** which fuses the occipital bone to the two parietal bones

# The Skull

Sutures of the Skull

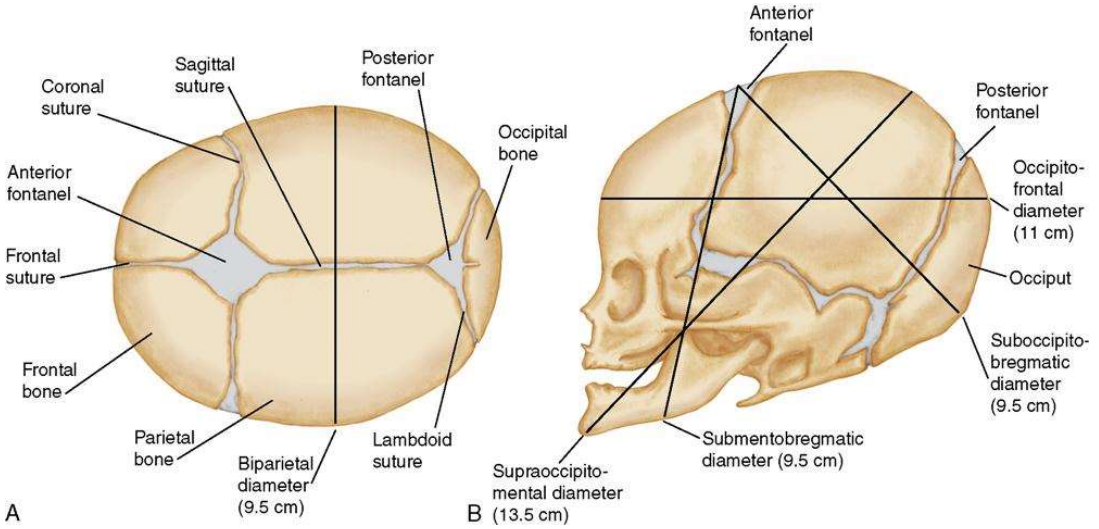


# The Skull

In neonates, the incompletely fused suture joints give rise to membranous gaps between the bones, known as fontanelles. The two major fontanelles are the **frontal fontanelle** (located at the junction of the coronal and sagittal sutures) and the **occipital fontanelle** (located at the junction of the sagittal and lambdoid sutures).

# The Skull

Fontanels



# The Skull

**Clinical Relevance: Cranial Fractures**

- The majority of skull fractures result from blunt force or penetrating **trauma**, and can produce numerous signs and symptoms. The clinical features may be obvious, such as visible injuries and bleeding. There are also subtle signs of fracture, such as clear fluid draining from the ears and nose (cerebrospinal fluid leak indicative of base of skull fracture), poor balance and confusion, slurred speech and a stiff neck.

There are certain areas of the skull that are natural points of weakness:

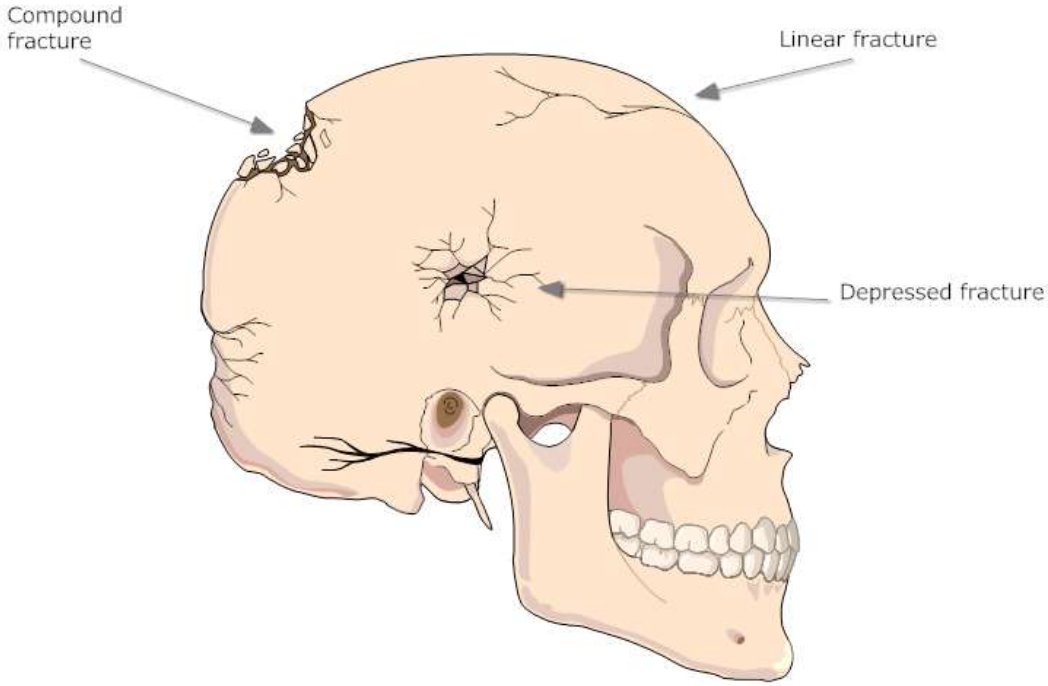
- **The pterion:** a 'H-shaped' junction between temporal, parietal, frontal and sphenoid bones. The thinnest part of the skull. A fracture here can lacerate the middle meningeal artery (anterior branch), resulting in a extradural haematoma.
- **Anterior cranial fossa:** Depression of skull formed by frontal, ethmoid and sphenoid bones.
- **Middle cranial fossa:** Depression formed by sphenoid, temporal and parietal bones.
- **Posterior cranial fossa:** Depression formed by squamous and mastoid temporal bone, plus occipital bone.

# The skull

- **Depressed** – fracture of the bone with depression of the bone inwards. They occur as a result of a direct blow, causing skull indentation, with possible underlying brain injury.
- **Linear** – a simple break in the bone, traversing its full thickness. They have radiating (stellate) fracture lines away from the point of impact. The most common type of cranial fracture.
- **Basal skull** – affects the base of the skull. They characteristically present with bruising behind the ears, known as Battle's sign (mastoid ecchymosis) or bruising around the eyes/orbits, known as Raccoon eye's.
- **Diastatic** – fracture that occurs along a suture line, causing a widening of the suture. They are most often seen in children.

# The Skull

Clinical Relevance



# The Skull

**Clinical Relevance: Facial Fractures**

- Facial fractures are common and generally **trauma** related, i.e. road traffic collisions, fights and falls. They are often associated with clinical features such as profuse bleeding, swelling, deformity and anaesthesia of the skin. The **nasal bones** are most frequently fractured, due to their prominent position at the bridge of the nose.
- A **maxillofacial fracture** is one that affects the maxillae bones. This requires a trauma with a large amount of force. Facial fractures affecting the maxillary bones can be identified using the Le Fort classification, depending on the bones involved, ranging from 1 to 3 (most serious).

# ANATOMY

Bones of the Head

# The Bony Orbit

**Contents**

# The Bony Orbit

- The bony orbits (or eye sockets) are bilateral and symmetrical **cavities** in the head. They enclose the eyeball and its associated structures.
- In this article, we shall look at the borders, contents and clinical correlations of the bony orbit.

# The Orbit

**Borders and Anatomical Relations**

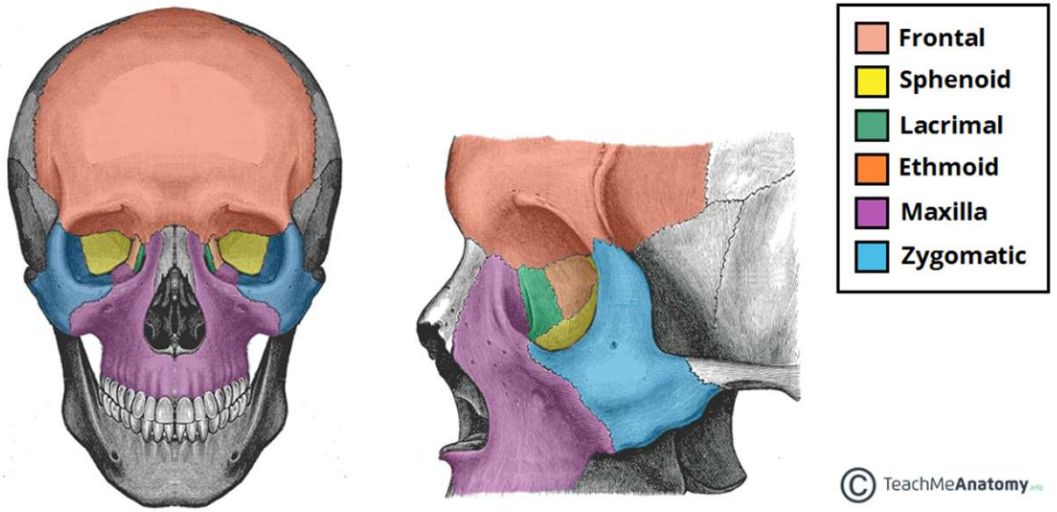
- The orbit can be thought of as a **pyramidal** structure, with the apex pointing posteriorly and the base situated anteriorly. The boundaries of the orbit are formed by seven bones.
- It is also important to consider the anatomical relations of the orbital cavity – this is clinically relevant in the spread of infection, and in cases of trauma.

The borders and anatomical relations of the bony orbit are as follows:

- **Roof** (superior wall) – Formed by the frontal bone and the lesser wing of the sphenoid. The frontal bone separates the orbit from the anterior cranial fossa.
- **Floor** (inferior wall) – Formed by the maxilla, palatine and zygomatic bones. The maxilla separates the orbit from the underlying maxillary sinus.
- **Medial wall** – Formed by the ethmoid, maxilla, lacrimal and sphenoid bones. The ethmoidbone separates the orbit from the ethmoid sinus.
- **Lateral wall** – Formed by the zygomatic bone and greater wing of the sphenoid.
- **Apex** – Located at the opening to the optic canal, the optic foramen.
- **Base** – Opens out into the face, and is bounded by the eyelids. It is also known as the orbital rim.

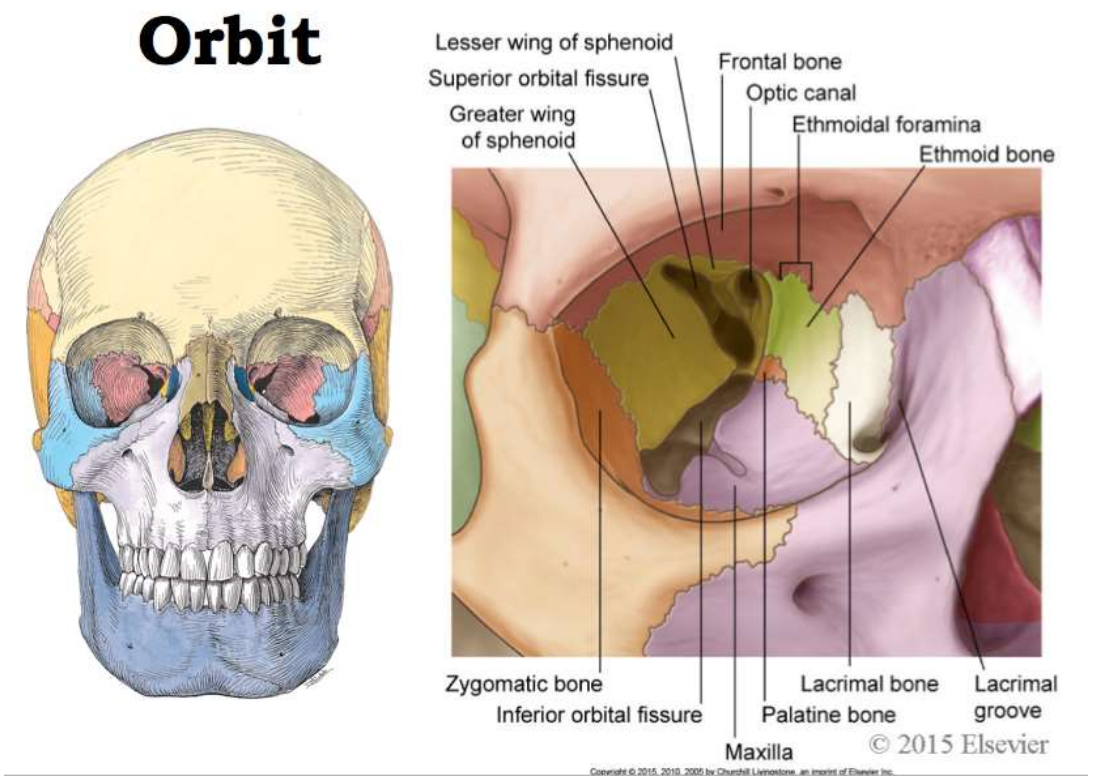
# Orbit

Borders



# The Orbit

Borders



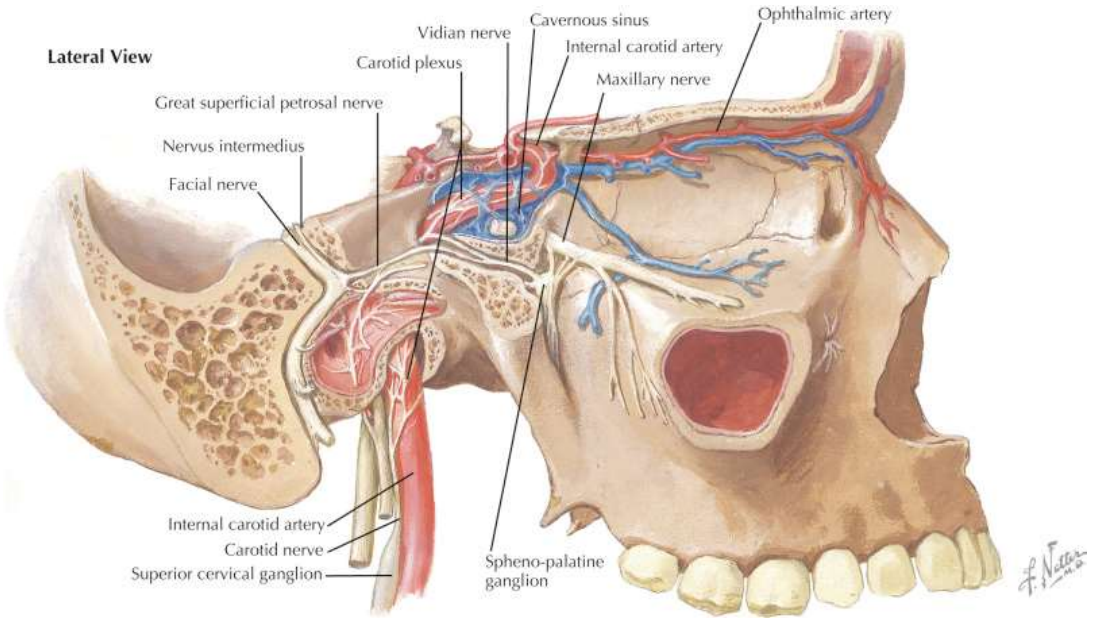
# The Orbit

**Contents**

- The bony orbit contains the **eyeballs** and their associated structures:
- **Extra-ocular muscles** – These muscles are separate from the eye. They are responsible for the movement of the eyeball and superior eyelid.
- **Eyelids** – These cover the orbits anteriorly.
- **Nerves**: Several cranial nerves supply the eye and its structures; optic, oculomotor, trochlear, trigeminal and a bducens nerves.
- **Blood vessels**: The eye receives blood primarily from the ophthalmic artery. Venous drainage is via the superior and inferior ophthalmic veins.
- Any space within the orbit that is not occupied is filled with **orbital fat**. This tissue cushions the eye, and stabilises the extraocular muscles.

# The Orbit

Ophthalmic Artery

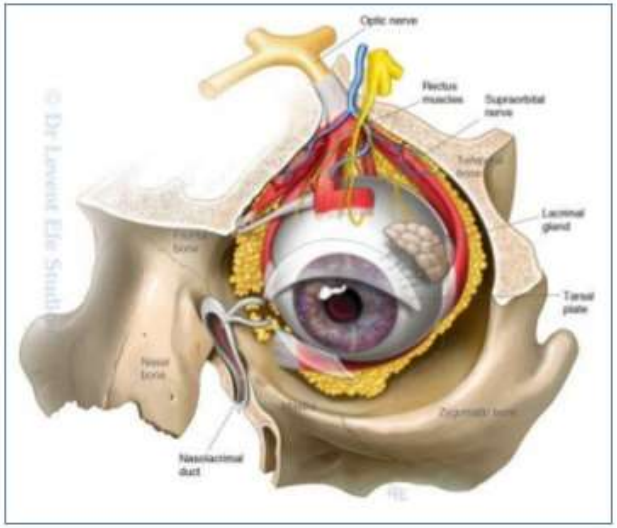


# The Orbit

Contents

- The eye balls,
- extra ocular muscles,
- nerves,
- vessels,
- fat,
- and most of the lacrimal apparatus
- with the optic nerve as its stem
- Volume: 30 cc

## Orbital contents



# The Orbit

**Pathways into the Orbit**

There are three main pathways by which structures can enter and leave the orbit:

- **Optic canal** – transmits the optic nerve and ophthalmic artery.
- **Superior orbital fissure –** transmits the lacrimal, frontal, trochlear (CN IV), oculomotor (CN III), Nasociliary and abducens (CN VI) nerves. It also carries the superior ophthalmic vein.
- **Inferior orbital fissure** – transmits the zygomatic branch of the maxillary nerve, the inferior ophthalmic vein, and sympathetic nerves.

# The Orbit

**Clinical Relevance: Fractures of the Bony Orbit**

- There are two major types of orbital fractures:
- **Orbital rim fracture** – This is a fracture of the bones forming the outer rim of the bony orbit. It usually occurs at the sutures joining the three bones of the orbital rim – the maxilla, zygomatic and frontal.
- **'Blowout' fracture** – This refers to partial herniation of the orbital contents through one of its walls. This usually occurs via blunt force trauma to the eye. The medial and inferior walls are the weakest, with the contents herniating into the ethmoid and maxillary sinuses respectively.
- Any fracture of the orbit will result in intraorbital pressure, raising the pressure in the orbit, causing **exophthalmos** (protrusion of the eye). There may also be involvement of surrounding structures, – e.g haemorrhage into one of the neighbouring sinuses.

# ANATOMY

Bones Of Head

# Ethmoid Bone

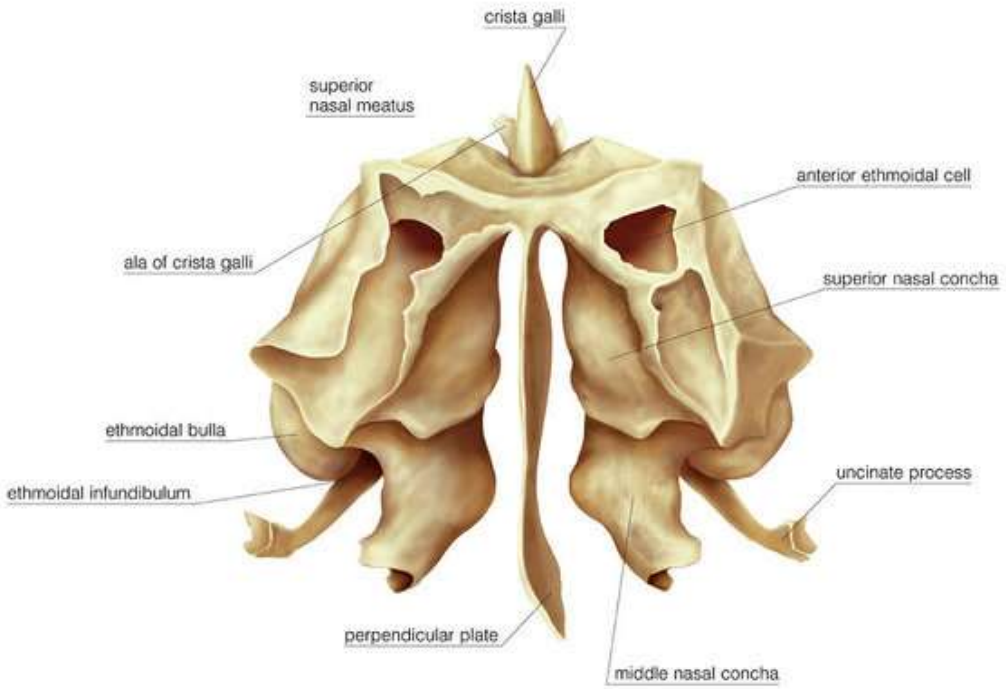
**Contents**

# Ethmoid Bone

- The **ethmoid bone** is a small unpaired bone, located in the midline of the anterior cranium – the superior aspect of the skull that encloses and protects the brain.
- The term 'ethmoid' originates from the Greek '*ethmos',* meaning sieve. This is reflected in its lightweight, **spongy** structure.
- In this article, we shall look at the anatomy of the **ethmoid bone** – its location, relations and structure.

# The Skull

Ethmoid Bone



# The Skull

Ethmoid Bone

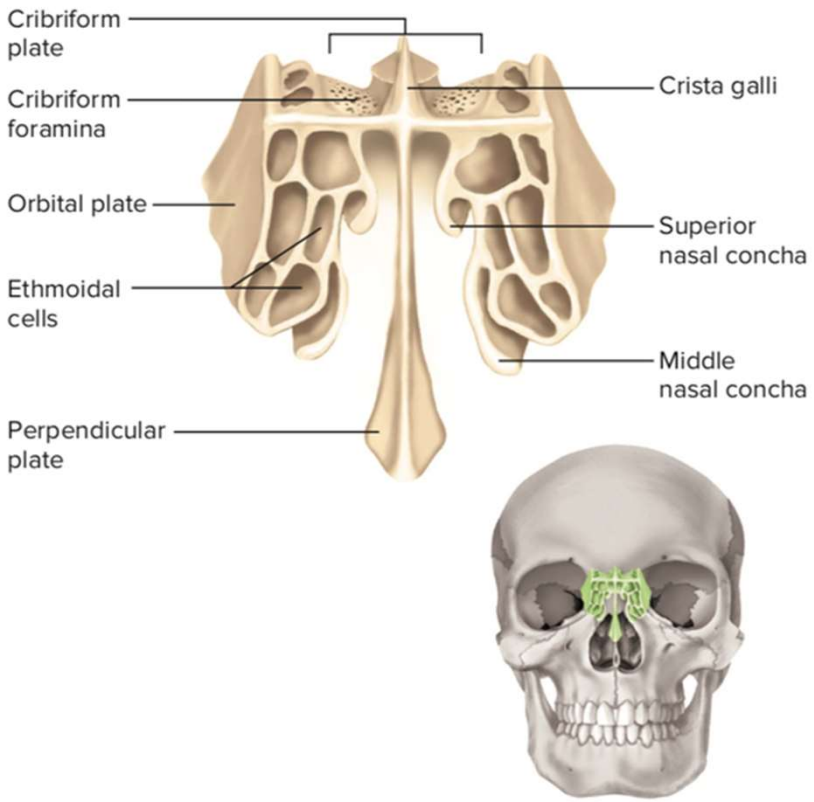


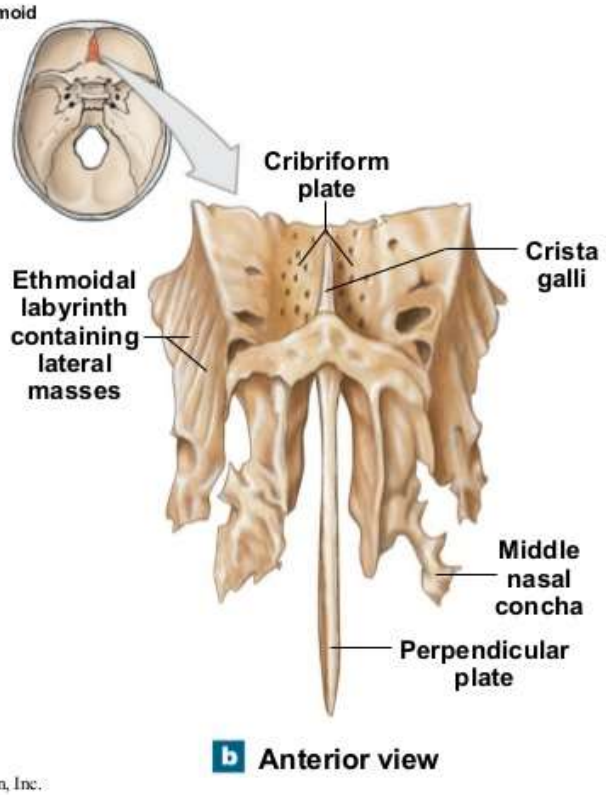

**FIGURE 8.12 The Ethmoid Bone (Anterior View).** AP|R

? *List five bones that articulate with the ethmoid bone.*

# The Skull

Ethmoid Bone

Figure 6.10b The Ethmoid



# Ethmoid Bone

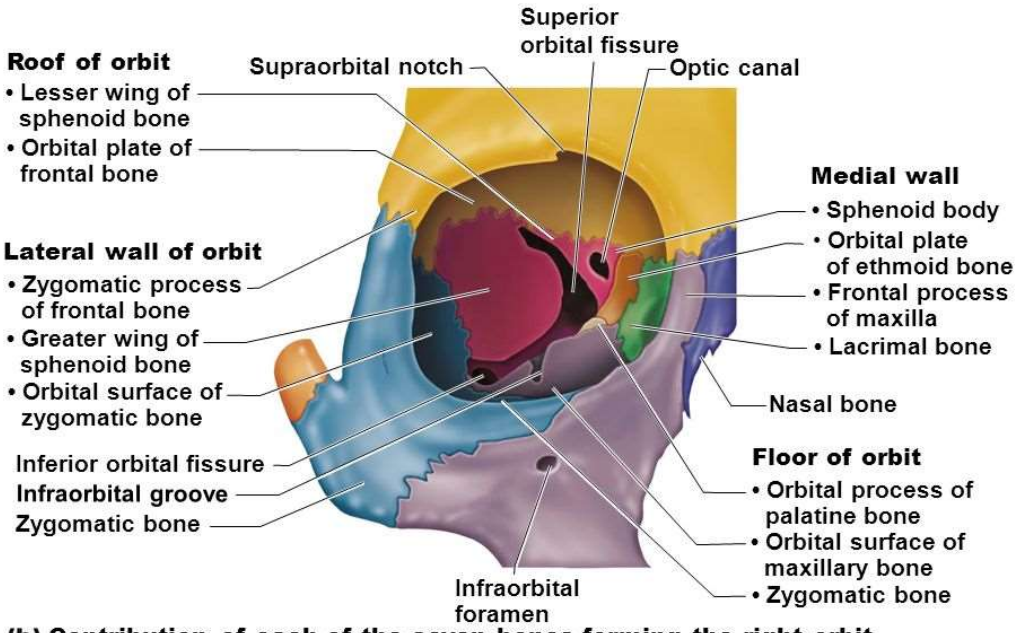
**Anatomical Structure**

- The ethmoid bone is one of the 8 bones of the cranium. It is situated at the roof of the **nasal cavity**, and between the two orbital cavities.
- It contributes to the medial wall of the orbit and forms part of the **anterior cranial fossa**, where it separates the nasal cavity (inferiorly) from the cranial cavity (superiorly). It also forms a significant portion of the nasal septum and lateral nasal wall.
- The **olfactory nerve** (CN I) has a close anatomical relationship with the ethmoid bone. Its numerous nerve fibres pass through the cribriform plate of the ethmoid bone to innervate the nasal cavity with the sense of smell.

# Ethmoid Bone

Structure

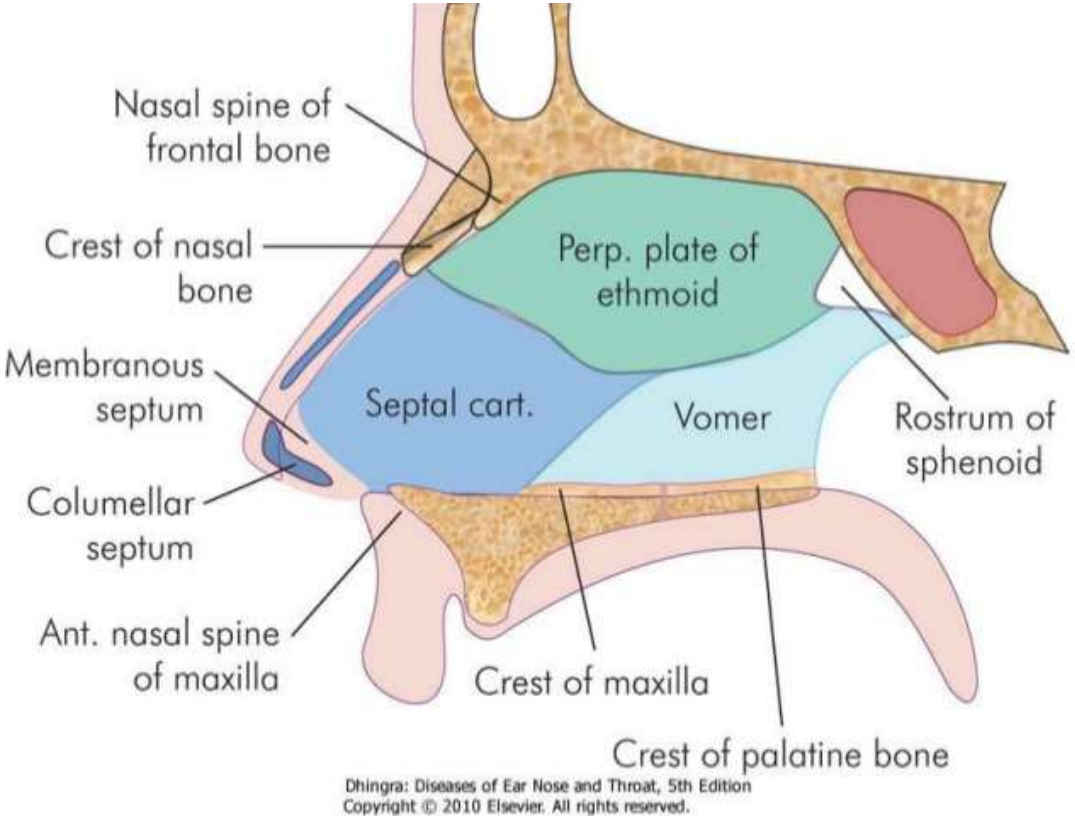
Figure 7.12b Bones that form the orbits.




**(b) Contribution of each of the seven bones forming the right orbit**

# Ethmoid Bone

Nasal septum



# Ethmoid Bone

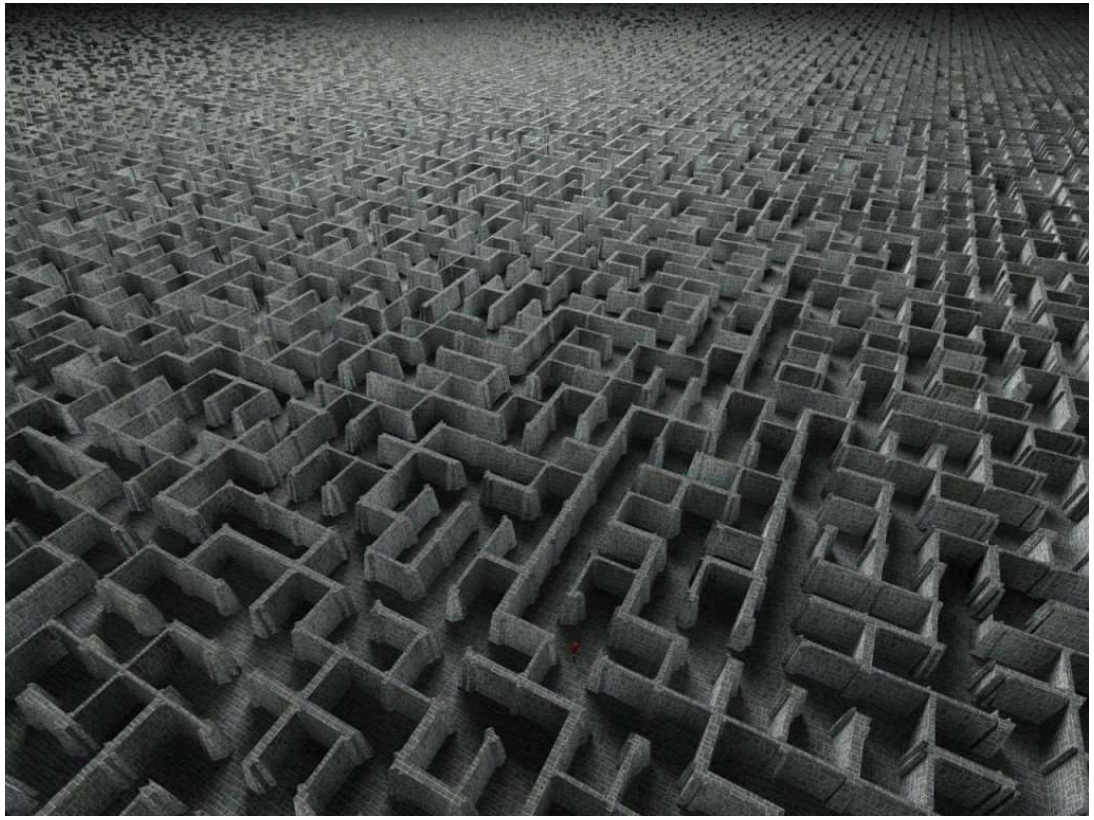
- The ethmoid bone is made up of three parts – the cribriform plate, the perpendicular plate and the ethmoidal labyrinth.
- The **cribriform plate** forms the roof of the nasal cavity. It is pierced by numerous olfactory nerve fibres, which gives it a sieve-like structure. Projecting superiorly from the cribriform plate is the crista galli, which provides an attachment point for the falx cerebri (sheet of dura mater that separates the two cerebral hemispheres).
- Another projection of bone descends from the cribriform plate – the **perpendicular plate**. It forms the superior two-thirds of the nasal septum.
- Lastly, the ethmoid bone contains two **ethmoidal labyrinths**. These are large masses located at either side of the perpendicular plate, which contain the ethmoidal air cells (sinuses). Two sheets of bone form each labyrinth:

# Ethmoid Bone

- Lastly, the ethmoid bone contains two **ethmoidal labyrinths**. These are large masses located at either side of the perpendicular plate, which contain the ethmoidal air cells (sinuses). Two sheets of bone form each labyrinth:
- **Orbital plate** – the lateral sheet of bone, which also forms the medial wall of the orbit
- **Medial sheet** – forms the upper lateral wall of the nasal cavity, from which the superior and middle conchae extend into the nasal cavity.

# Ethmoid Bone

Labrynth



# Ethmoid Bone

**Articulations**

- The ethmoid bone articulates with 13 others:
- **Paired** – Nasal bones, Maxillae, Lacrimal bones, Palatine bones, Inferior conchae.
- **Unpaired** – Frontal, Vomer and Sphenoid bones.

# Ethmoid Bone

**Clinical Relevance – Ethmoid Fracture**

- The ethmoid bone can be fractured in cases of facial trauma – most commonly hitting the dashboard in a collision, or a fall from height. Some signs and symptoms of fracture are related to the anatomy of the ethmoid bone:
- **Fracture of cribriform plate** – branches of the olfactory bulb may be sheared. This may cause anosmia (loss of sense of smell).
- **Fracture of the labyrinth** – may allow communication between the nasal cavity and the orbit. It is then possible for air to enter the orbit and cause orbital emphysema.

# Ethmoid Bone

**Clinical Relevance – CSF Rhinorrhoea**

- A fracture to the cribriform plate may allow communication between the nasal cavity and the central nervous system. Consequently, cerebrospinal fluid (CSF) can enter the nasal cavity and drain out from the nose. This manifests clinically as a clear watery discharge from one side of the nose – and is known as **CSF rhinorrhoea**.
- The leaks normally stop spontaneously and can be managed conservatively, however surgery is sometimes required. Spontaneous CSF rhinorrhoea can also occur due to congenital or acquired defects in the ethmoid bone.

# ANATOMY

Bones of Head

# MANDIBLE

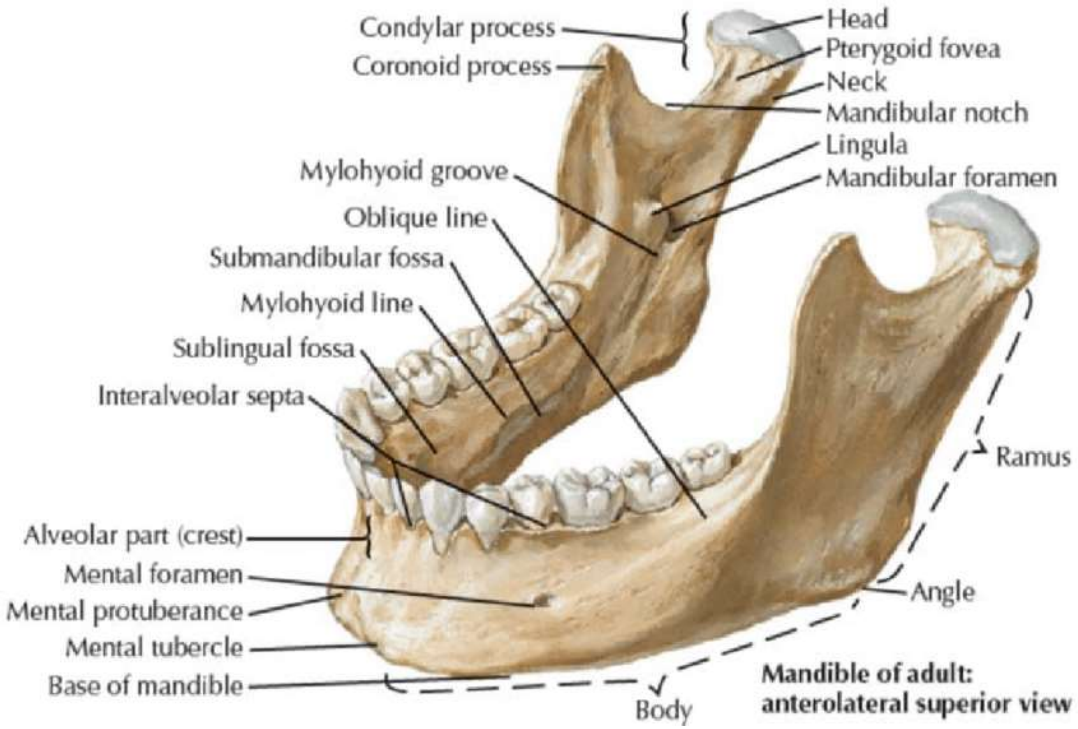
**Contents**

# The Mandible

- The **mandible**, located inferiorly in the facial skeleton, is the largest and strongest bone of the face.
- It forms the lower jaw and acts as a receptacle for the lower teeth. It also articulates on either side with the temporal bone, forming the **temporomandibular joint**.
- In this article, we will look at the anatomy and clinical importance of the mandible.

# The Mandible

Anatomy



# The Mandible

## Anatomical Structure

- The mandible consists of a horizontal **body** (anteriorly) and two vertical **rami** (posteriorly). The body and the rami meet on each side at the angle of the mandible.

# The Mandible

**Body**

The body of the mandible is curved, and shaped much like a horseshoe. It has two borders:

- **Alveolar border (superior)** – contains 16 sockets to hold the lower teeth.
- **Base (inferior)** – site of attachment for the digastric muscle medially
- The body is marked in the midline by the **mandibular symphysis**. This is a small ridge of bone that represents the fusion of the two halves during development. The symphysis encloses a triangular eminence – the mental protuberance, which forms the shape of the chin.
- Lateral to the mental protuberance is the **mental foramen** (below the second premolar tooth on either side). It acts as a passageway for neurovascular structures.

# The Mandible

**Rami**

There are two **mandibular rami**, which project perpendicularly upwards from the angle of the mandible. Each ramus contains the following bony landmarks:

- **Head** – situated posteriorly, and articulates with the temporal bone to form the temporomandibular joint.
- **Neck** – supports the head of the ramus, and site of attachment of the lateral pterygoid muscle.
- **Coronoid process** – site of attachment of the temporalis muscle
- The internal surface of the ramus is also marked by the **Mandibular foramen**, which acts as a passageway for neurovascular structures.

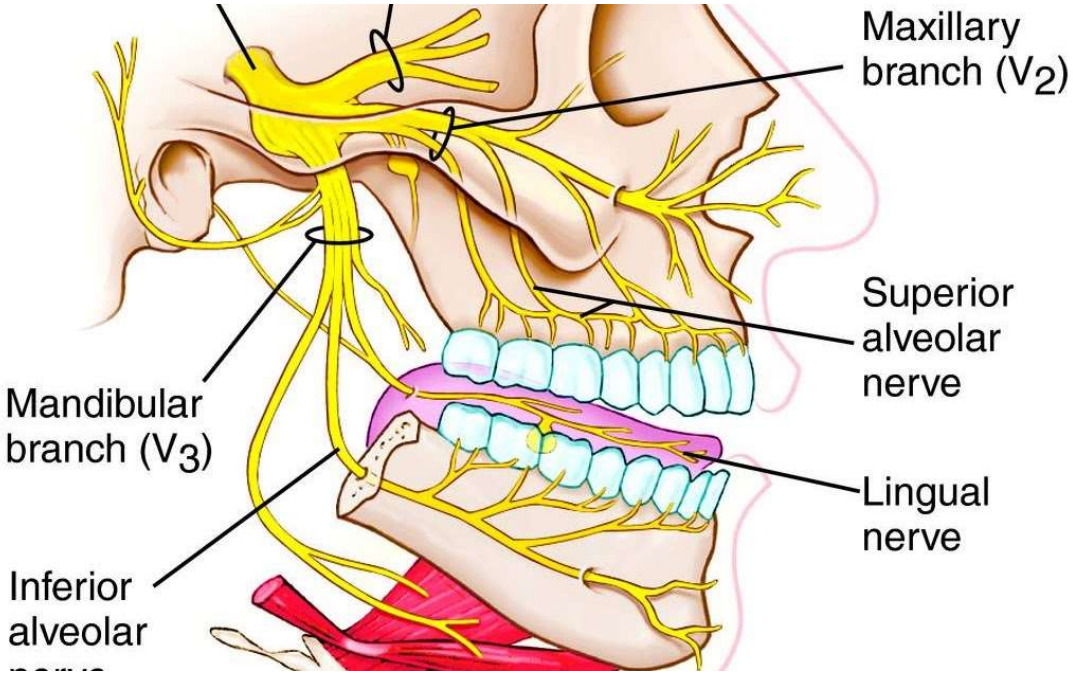
# The Mandible

**Foramina**

- A foramen refers to any opening through which neurovascular structures can travel. The mandible is marked by two foramina.
- The **mandibular foramen** is located on the internal surface of the ramus of the mandible. It serves as a conduit for the inferior alveolar nerve and inferior alveolar artery. They travel through the mandibular foramen, into the mandibular canal, and exit at the mental foramen.
- The **mental foramen** is positioned on the external surface of the mandibular body, below the second premolar tooth. It allows the inferior alveolar nerve and artery to exit the mandibular canal. When the inferior alveolar nerve passes through the mental foramen, it becomes the mental nerve (innervates the skin of the lower lip and the front of the chin).

# The Mandible

Foramina



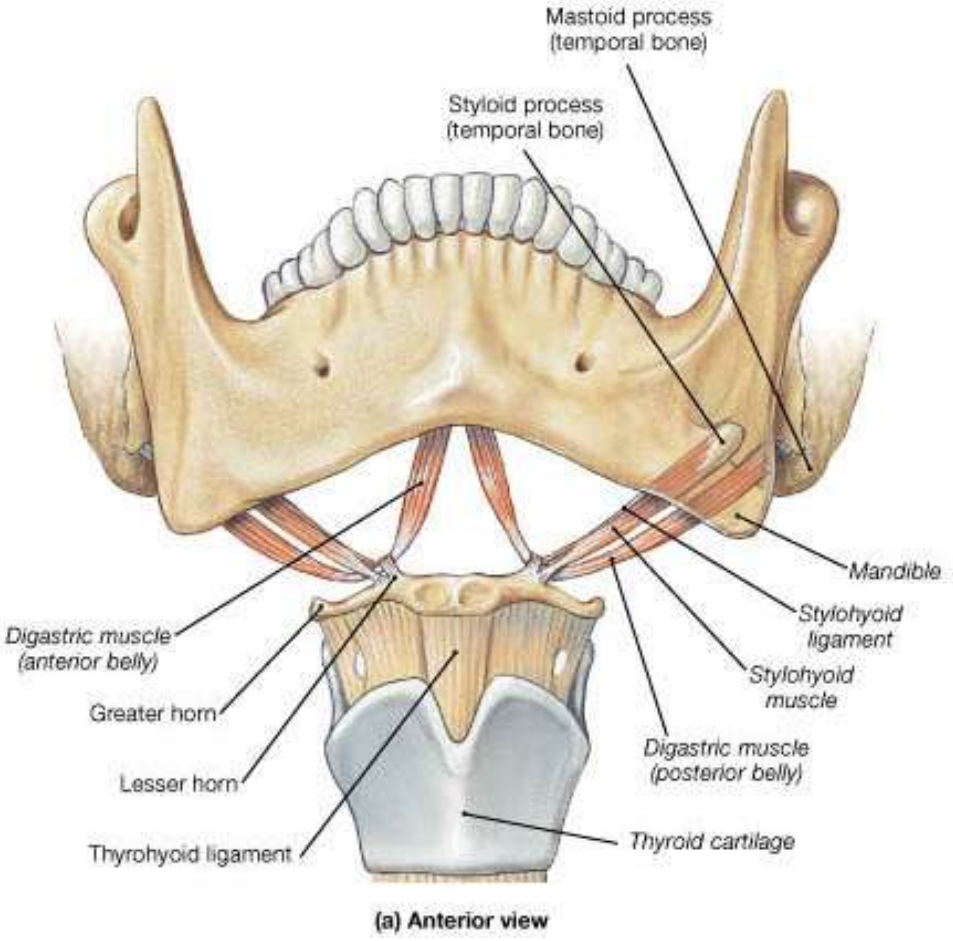
# The Mandible

**Muscular Attachments**

- The mandible serves as the attachment point for the various muscles, including the strong muscles of mastication.
- **Mandibular body:**
  - External (lateral) surface – mentalis, buccinator, platysma, depressor labii inferioris, depressor anguli oris.
  - Internal (medial) surface – genioglossus, geniohyoid, mylohyoid and digastric.
- **Mandibular rami** – masseter, temporalis, medial pterygoid and lateral pterygoid.
- The temporalis muscle attaches to the **coronoid process**, and the masseter attaches to the rami. The lateral pterygoid inserts into the neck of the mandible, and the medial pterygoid inserts into the ramus near the angle of the mandible.

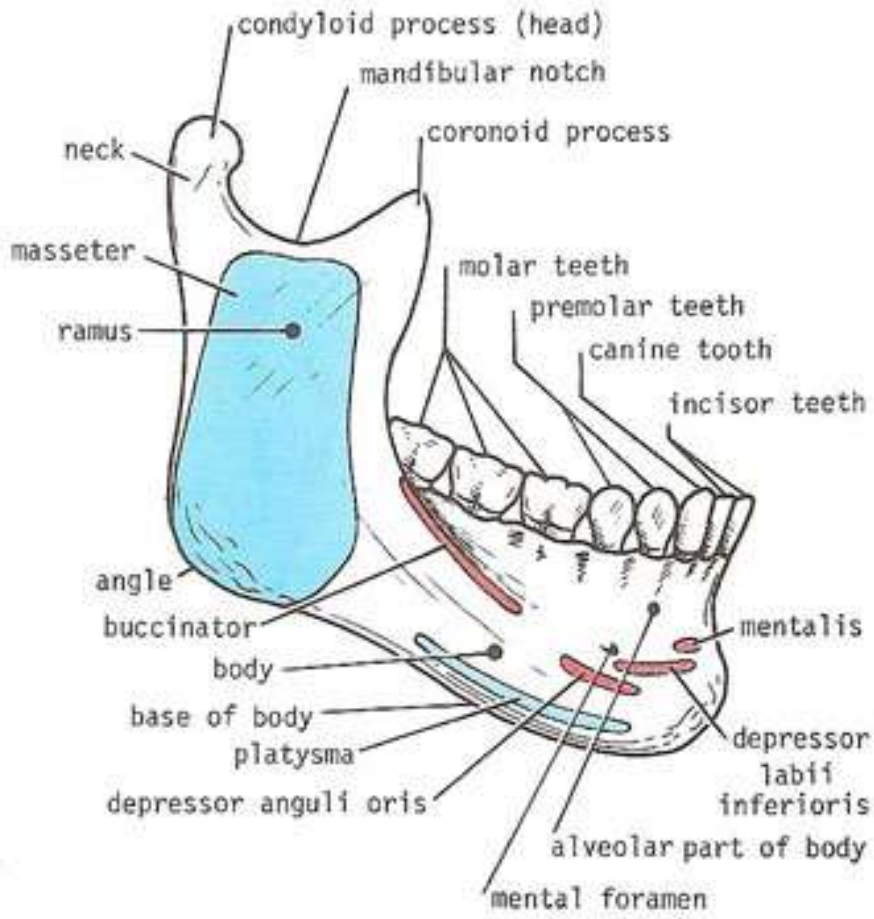
# The Mandible

Attachment



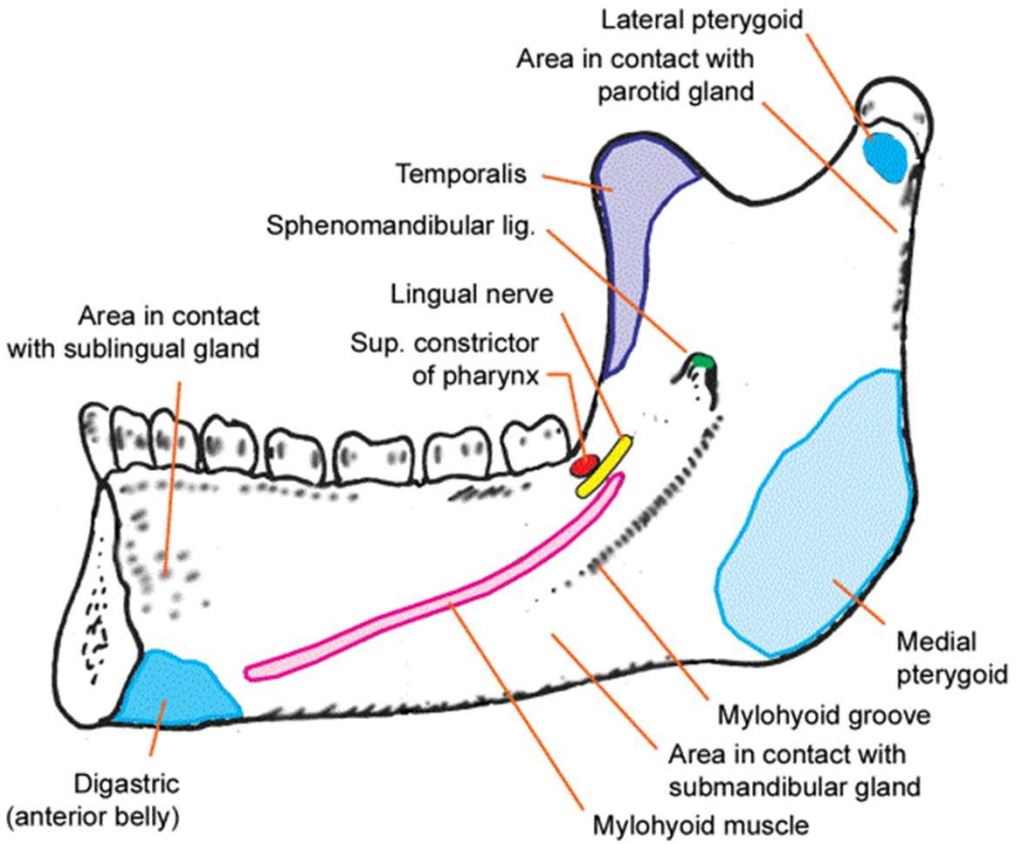
# Mandible

Muscle Attachment



# Mandible

Muscle Attachment



# The Mandible

**Articulations**

- The mandible articulates with the Temporal bone to form the Temporomandibular joint

# The Mandible

**Clinical Relevance: Fractures of the Mandible**

- A **mandibular fracture** rarely occurs in isolation. Much like fractures of the pelvic brim, a fracture on one side is frequently associated with a fracture on the contralateral side.
- Therefore, if one fracture is observed, another should be searched for. For example, a fractured neck of the mandible is often observed in conjunction with a fracture of the contralateral mandibular body.

The characteristics of mandibular fractures are as follows:

- Fractures of the **coronoid process** are uncommon and usually singular.
- Fractures of the **neck of the mandible** are often transverse and usually accompanied with dislocation of the temporomandibular joint.
- Fractures of the **angle of the mandible** are usually oblique and may involve the alveolus of the 3rd molar.
- Fractures of the **body of the mandible** frequently pass through the canine tooth.

# ANATOMY

Bones of Head

# SPHENOID BONE

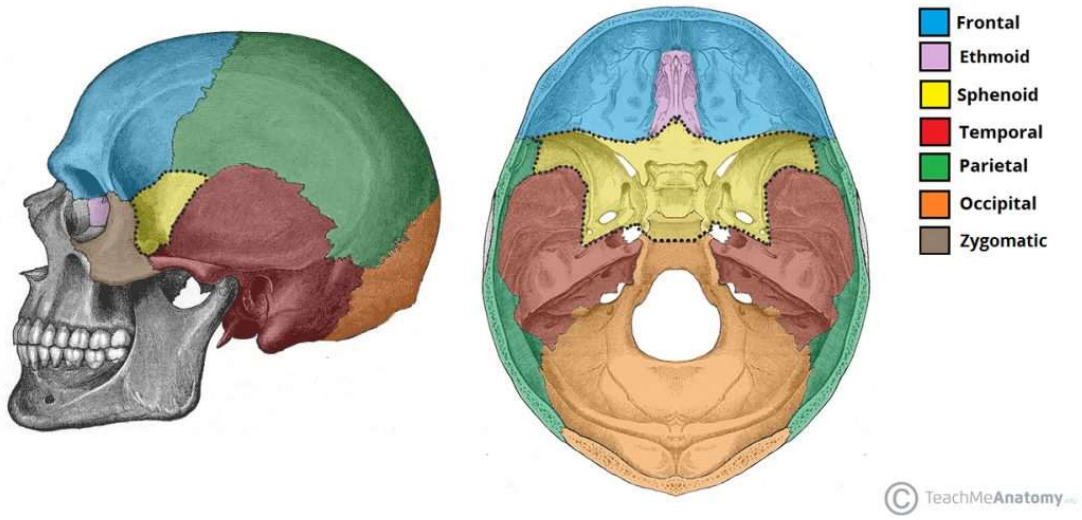
**Contents**

# SPHENOID BONE

- The **sphenoid bone** is one of the eight bones that make up the cranium – the superior aspect of the skull that encloses and protects the brain.
- Its name is derived from the Greek *'sphenoeides',* to mean wedge-shaped.
- In this article, we shall look at the anatomy of the **sphenoid bone** – its location, structure, and clinical significance.

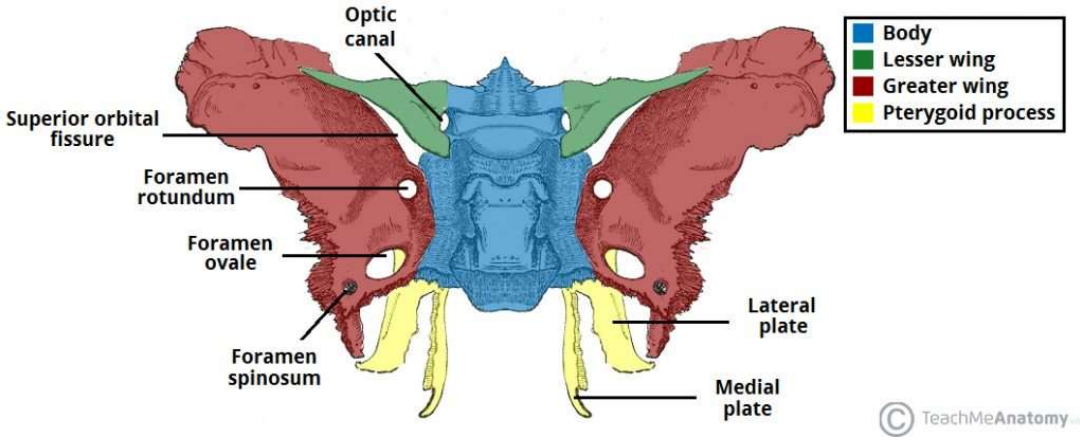
# Sphenoid Bone

Structure



# Sphenoid Bone

Anatomy



# SPHENOID BONE

- **Anatomical Structure**
- The sphenoid bone is said to be '**butterfly-shaped**'. It consists of a body, paired greater wings and lesser wings, and two pterygoid processes.

# SPHENOID BONE

**Body**

- The body lies at the centre of the sphenoid bone, and is almost completely cubical in shape.
- It contains the **sphenoidal sinuses**, which are separated by a septum – meaning that the sphenoid body is essentially hollow. The body articulates with the ethmoid bone anteriorly, and it is here that the sinuses open up into the nasal cavity.

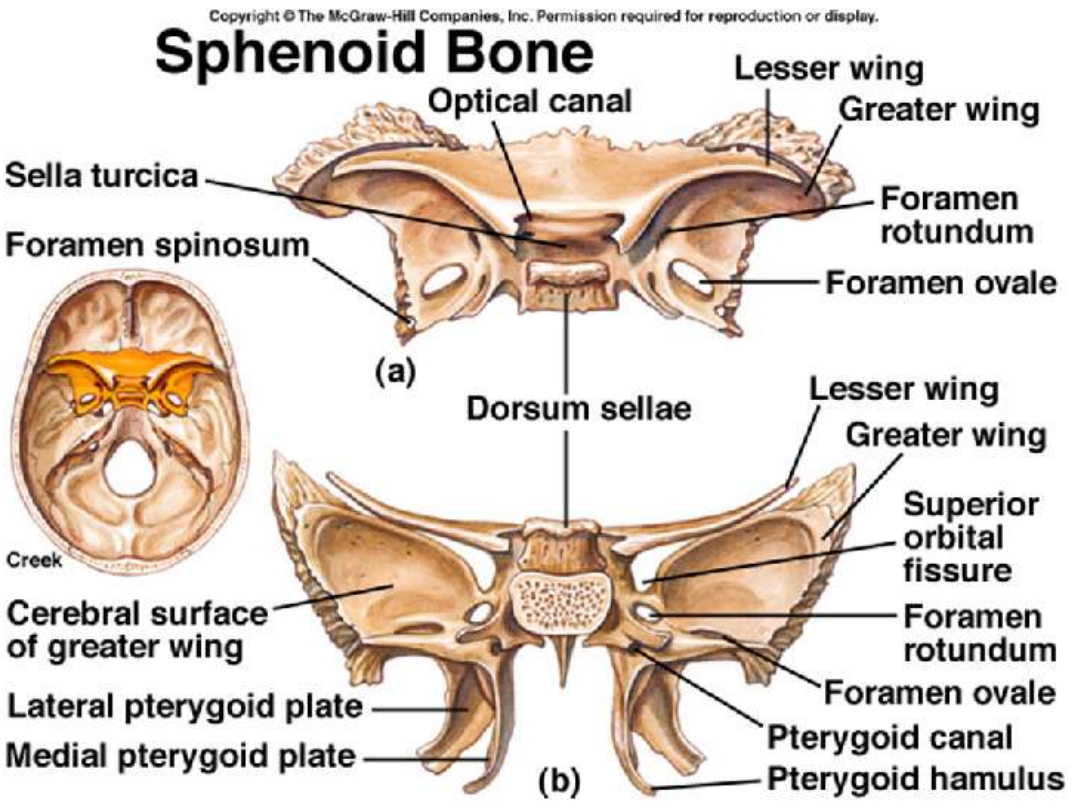
# Sphenoid Bone

Body

- The superior surface of the sphenoid body contains some important bony landmarks:
- **Sella turcica** – a saddle-shaped depression. It has three parts:
  - *Tuberculum sellae* – forms the anterior wall of the sella turcica, and the posterior aspect of the chiasmatic groove.
  - *Hypophyseal fossa* – the deepest part of the sella turcica, where the pituitary gland is located.
  - *Dorsum sellae* – forms the posterior wall of the sella turcica.
- **Chiasmatic groove** – a sulcus formed by the optic chiasm (where the optic nerves partially cross).
- The sella turcica is surrounded by the anterior and posterior **clinoid processes**. The anterior clinoid processes arise from the sphenoidal lesser wings, while the posterior clinoid processes are the superolateral projections of the dorsum sellae. They serve as attachment points for the **tentorium cerebelli**, a membranous sheet that divides the brain.

# Sphenoid Bone

Structure



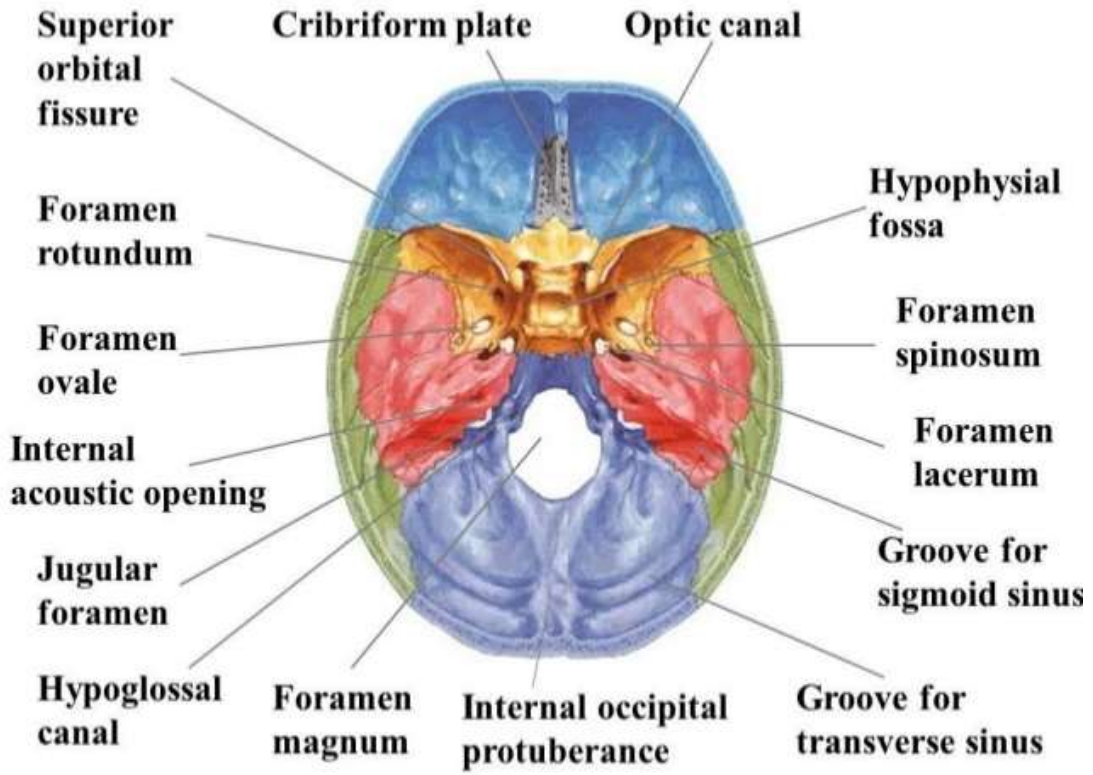
# SPHENOID BONE

**Greater Wing**

- The **greater wing** extends from the sphenoid body in a lateral, superior and posterior direction. It contributes to three parts of the facial skeleton:
- Floor of the middle cranial fossa
- Lateral wall of the skull
- Posterolateral wall of the orbit
- There are three **foramina** present in the greater wing – the Foramen Rotundum, Foramen Ovale and Foramen Spinosum. They conduct the maxillary nerve, mandibular nerve and middle meningeal vessels respectively.

# Sphenoid

Structure



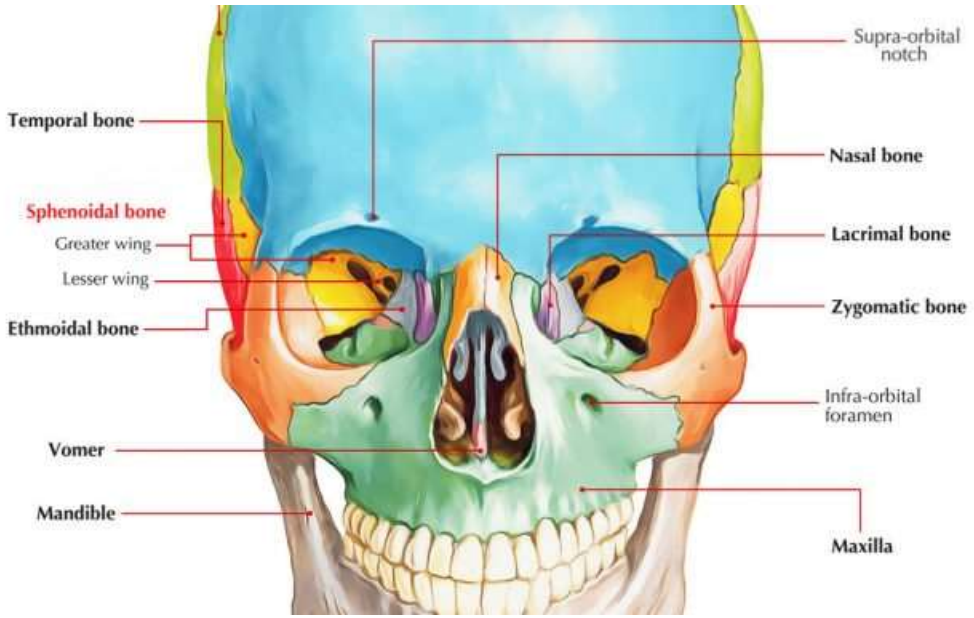
# SPHENOID BONE

**Lesser Wing**

- The **lesser wing** arises from the anterior aspect of the sphenoid body in a superolateral direction. It separates the anterior cranial fossa from the middle cranial fossa.
- It also forms the lateral border of the **optic canal** – through which the optic nerve and ophthalmic artery travel to reach the eye. The medial border of the optic canal is formed by the body of the sphenoid.
- There is a 'slit-like' gap between the lesser and greater wings of the sphenoid – the **superior orbital fissure**. Numerous structures pass through here to reach the bony orbit.

# Sphenoid Bone

Lesser Wing



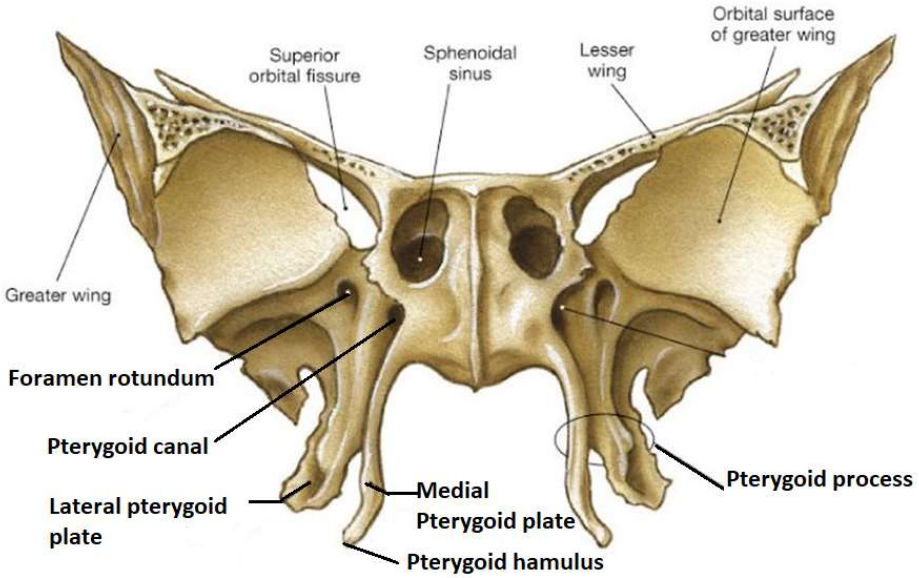
# SPHENOID BONE

**Pterygoid Process**

- The pterygoid process descends inferiorly from the point of junction between the sphenoid body and the greater wing. It consists of two parts:
- **Medial pterygoid plate** – supports the posterior opening of the nasal cavity.
- **Lateral pterygoid plate** – site of origin of the medial and lateral pterygoid muscles

# Sphenoid Bone

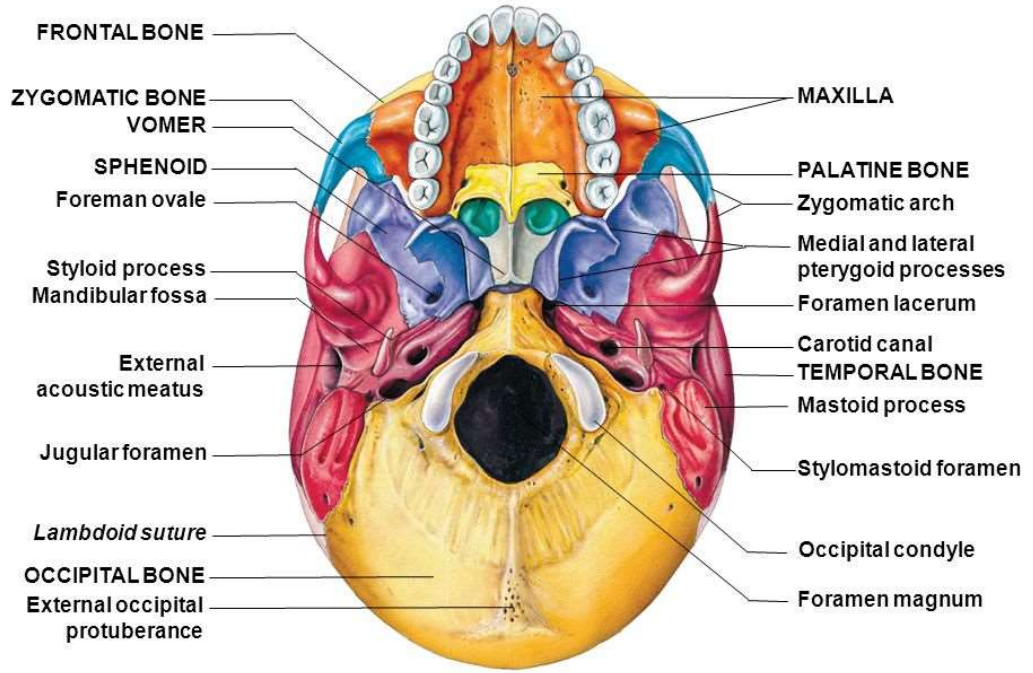
Pterygoid Process



# Sphenoid Bone

Pterygoid Process

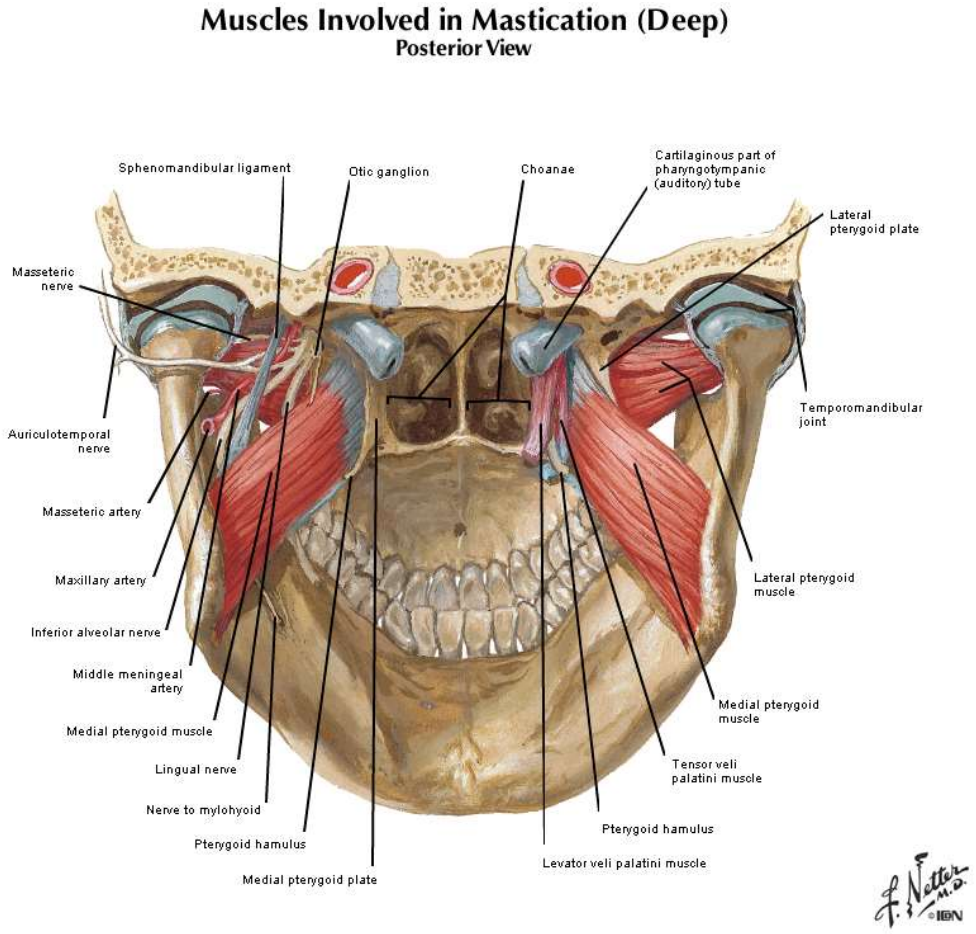
Figure 7-3e The Adult Skull




e Inferior view

# Sphenoid Bone

Pterygoid Plate



# SPHENOID BONE

**Muscular Attachments**

- The lateral and medial pterygoid muscles which form some of the muscles of mastication originate from the **lateral pterygoid plate of the sphenoid bone.**

# SPHENOID BONE

**Articulations**

- The sphenoid is an **unpaired** bone. It sits anteriorly in the cranium, and contributes to the Middle Cranial fossa, the lateral wall of the skull, and the floor and sides of both orbits.

It has articulations with twelve other bones:

- **Unpaired bones** – Occipital, vomer, ethmoid and frontal bones.
- **Paired bones** – Temporal, Parietal, Zygomatic and Palatine bones.

# SPHENOID BONE

**Clinical Significance – Transsphenoidal Surgery**

- The sphenoid bone shares a close anatomical relationship with the **Pituitary Gland**. Indeed, the pituitary can be accessed surgically by passing instruments through the Sphenoid bone and sinus.
- This type of surgery is known as **endoscopic trans-sphenoidal surgery** (ETSS), and is the usual treatment of choice for pituitary adenomas. It allows for the surgical management of pituitary pathology without the need for a more extensive craniotomy.

# ANATOMY

Bones of the Head

# THE TEMPORAL BONE

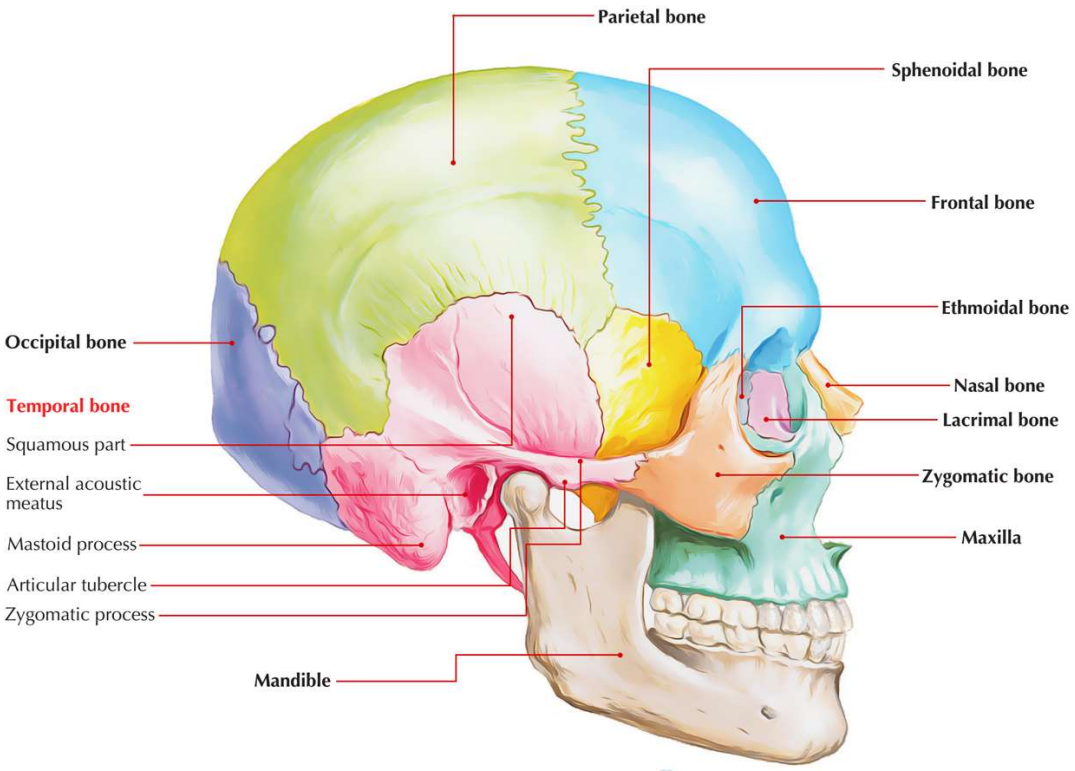
**Contents**

# THE TEMPORAL BONE

- The temporal bone contributes to the lower **lateral** walls of the skull. It contains the middle and inner portions of the ear, and is crossed by the majority of the **cranial nerves.** The lower portion of the bone articulates with the **mandible**, forming the temporomandibular joint of the jaw.
- In this article, we shall look at the different parts of the temporal bone, their articulations, and any clinical correlations.

# Temporal Bone

Anatomy



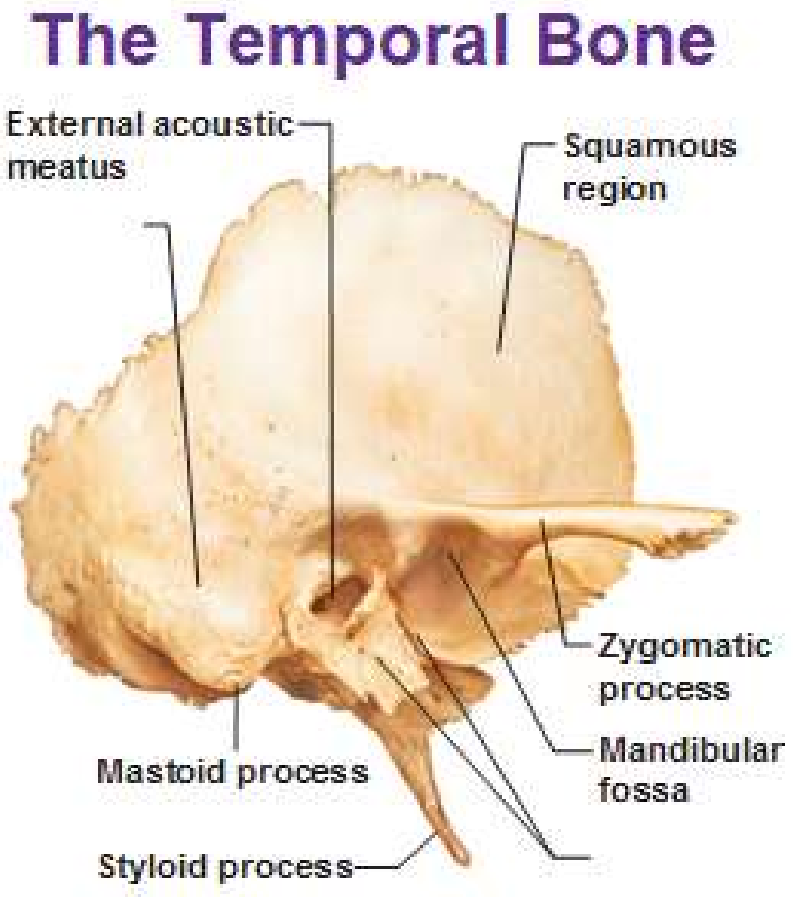
# THE TEMPORAL BONE

**Anatomical Structure**

- The temporal bone itself is comprised of **five** constituent parts. The squamous, tympanic and Petromastoid parts make up the majority of the bone, with the zygomatic and styloid processes projecting outwards.

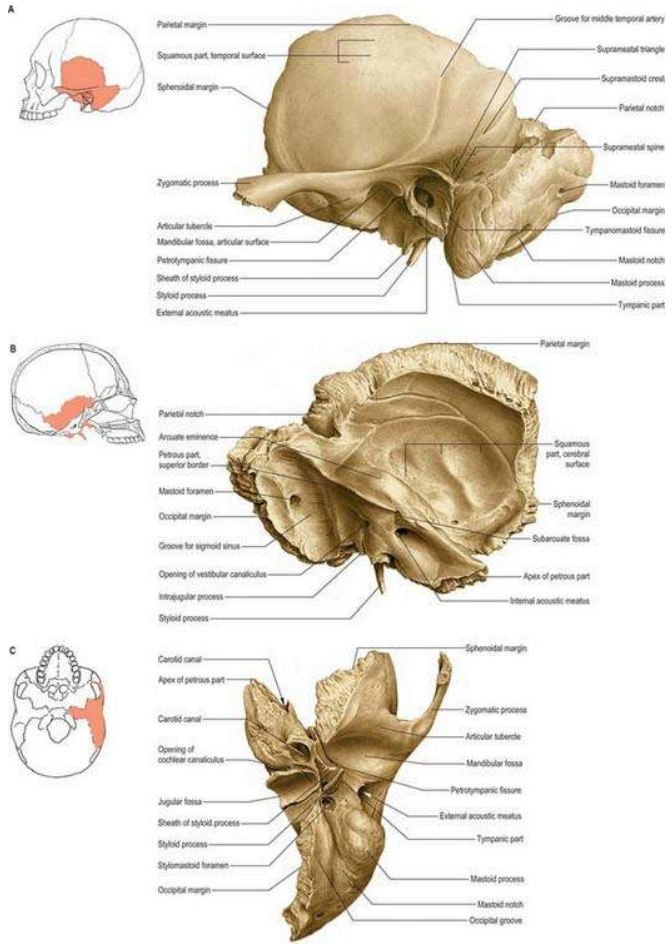
# Temporal Bone

Anatomy



# Temporal Bone

Anatomy



# THE TEMPORAL BONE

**Squamous**

- Also known as the squama temporalis, this is the largest part of the temporal bone. It is **flat**and plate-like, located superiorly. The outer facing surface of the squamous bone is **convex** in shape, forming part of the temporal **fossa**.
- The lower part of the squamous bone is the site of origin of the **temporalis** muscle
- The bone articulates with the **sphenoid** bone anteriorly, and **parietal** bone laterally

# THE TEMPORAL BONE

**Zygomatic Process**

- The **zygomatic process** arises from the lower part of the squama temporalis. It projects anteriorly, articulating with the temporal process of the zygomatic bone. These two structures form the **zygomatic arch** (palpable as 'cheek bones').
- One of the zygomatic processes' attachments to the temporal bone forms the **articular tubercle** – the anterior boundary of the mandibular fossa, part of the temporomandibular joint
- The **masseter** muscles attaches some fibres to the lateral surface of the zygomatic process.

# THE TEMPORAL BONE

**Tympanic**

- The tympanic part of the temporal bone lies **inferiorly** to the squamous, and **anteriorly** to the petromastoid part.
- It surrounds the external auditory **opening**, which leads into the external auditory meatus of the external ear.

# THE TEMPORAL BONE

**Styloid Process**

- The styloid process located immediately underneath the opening to the auditory meatus. It acts as an **attachment** point for muscles and ligaments, such as the stylomandibular ligament of the TMJ.

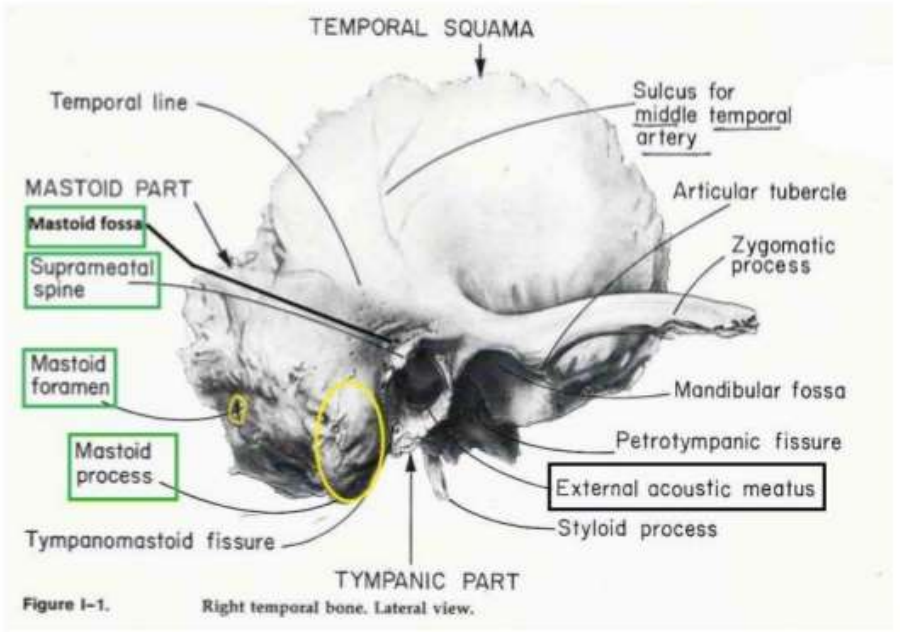
# THE TEMPORAL BONE

**Petromastoid**

- This portion of the temporal bone is located **posteriorly**. It can be split into a mastoid and petrous parts. On a lateral view of the temporal bone.
- There are two items of note on the mastoid. The first is the **mastoid process**, an inferior projection of bone, palpable just behind the ear. It is a site of attachment for many muscles, such as the **sternocleidomastoid**.
- Also of clinical importance are the **mastoid air cells**. These are **hollowed** out areas within the temporal bone. They act as a **reservoir** of air, equalising the pressure within the middle ear in the case of **auditory tube** dysfunction. The mastoid air cells can also become infected, known as **mastoiditis**.
- The **petrous** part is pyramidal shaped, and lies at the base of temporal bone. It contains the inner ear.

# Temporal Bone

Petromastoid part



# THE TEMPORAL BONE

**Muscular Attachments**

- The temporal bone serves as a point of attachment for many muscles. Due to the involvement of the temporal bone in forming the temporomandibular joint (i.e. joint of the jaw) some fibres from muscles of mastication such as the temporalis and masseter muscles attach to the temporal bone. In addition to this the mastoid process of the temporal bone is a major site of muscle attachment. Some key muscular attachments are outlined in the table below.

# Temporal Bone

Muscular Attachments

| Muscle | Site of Attachment | Description |
|---|---|---|
| Temporalis | Originates from the lower part of squamous | Muscle of mastication |
| Masseter | Lateral zygomatic surface | Muscle of mastication |
| Sternocleidomastoid | Mastoid process | Superficial muscle of the neck. Involved in rotation of head and flexion of neck. Important landmark for the anterior and posterior cervical triangles. |
| Posterior belly of digastric | Mastoid process | A suprahyoid muscle. Involved in processes such as swallowing. |
| Splenius capitis | Mastoid process | Strap-like muscle in the back of the neck. Involved in movements such as shaking the head. |

# THE TEMPORAL BONE

**Articulations**

- A major articulation of the temporal bone is with the mandible (i.e. jaw bone) to form the temporomandibular joint which is covered in detail here.
- The squamous part of the temporal bone also articulates with the sphenoid bone anteriorly and the parietal bone laterally.
- The zygomatic process of the temporal bone also articulates with the zygomatic bone to form the zygomatic arch (i.e. cheekbones).

# THE TEMPORAL BONE

**Clinical Relevance: Mastoiditis**

- Middle ear infections (otitis media) can spread to the mastoid air cells. Due to their porous nature, they are a suitable site for pathogenic **replication**.
- The mastoid process itself can get infected, and this can spread to the **middle cranial fossa**, and into the brain, causing **meningitis**.
- If mastoiditis is suspected, the pus must be drained from the air cells. When doing so, care must be taken not the damage the nearby facial nerve.

# THE TEMPORAL BONE

**Clinical Relevance: Temporal Bone Fractures**

- The temporal bone is relatively strong, and thus it is usually only fractured as a result of **blunt trauma** to the skull.
- It has a varied presentation. Ear-related disorders are commonly seen, such as vertigo or hearing loss. As the **facial nerve** travels through the temporal bone, it can be damaged, with paralysis resulting. Other symptoms include bleeding from the ear and bruising around the mastoid process.

# THE TEMPORAL BONE

**Clinical Relevance: Fractures of the Pterion**

- Where the temporal, parietal, frontal and sphenoid bones meet, the skull is at its weakest, and susceptible to fracture. This point is known as the **pterion**.
- The middle meningeal artery (MMA) supplies the **skull** and the **dura mater** (the outer membranous layer covering the brain). It travels underneath the pterion, thus a fracture of the skull at the **pterion** can injure or completely lacerate the MMA.
- Blood will then collect in between the dura mater and the skull, causing a dangerous increase in intra-cranial pressure. This is known as an **extradural haematoma.**
- The increase in **intracranial** pressure causes a variety of symptoms; nausea, vomiting, seizures, bradycardia and limb weakness. It is treated by **diuretics** in minor cases, but surgical intervention is required in cases of major haemorrhage.

# ANATOMY

Bones of the HEAD

# Nasal Skeleton

**Content**

- 1 Anatomical Structure
  - 1.1 External Nasal Skeleton
  - 1.2 Internal Nasal Septum
- 2 Clinical Relevance: Nasal Fracture

# Nasal Skeleton

- The nasal skeleton is a combination of bone and cartilage which forms both what we can see as the external nose and the internal nasal septum – which divides the two nasal cavities of the head.
- Here we will discuss the anatomy of the nasal skeleton and its component bones.

# Nasal Skeleton

**Anatomical Structure**

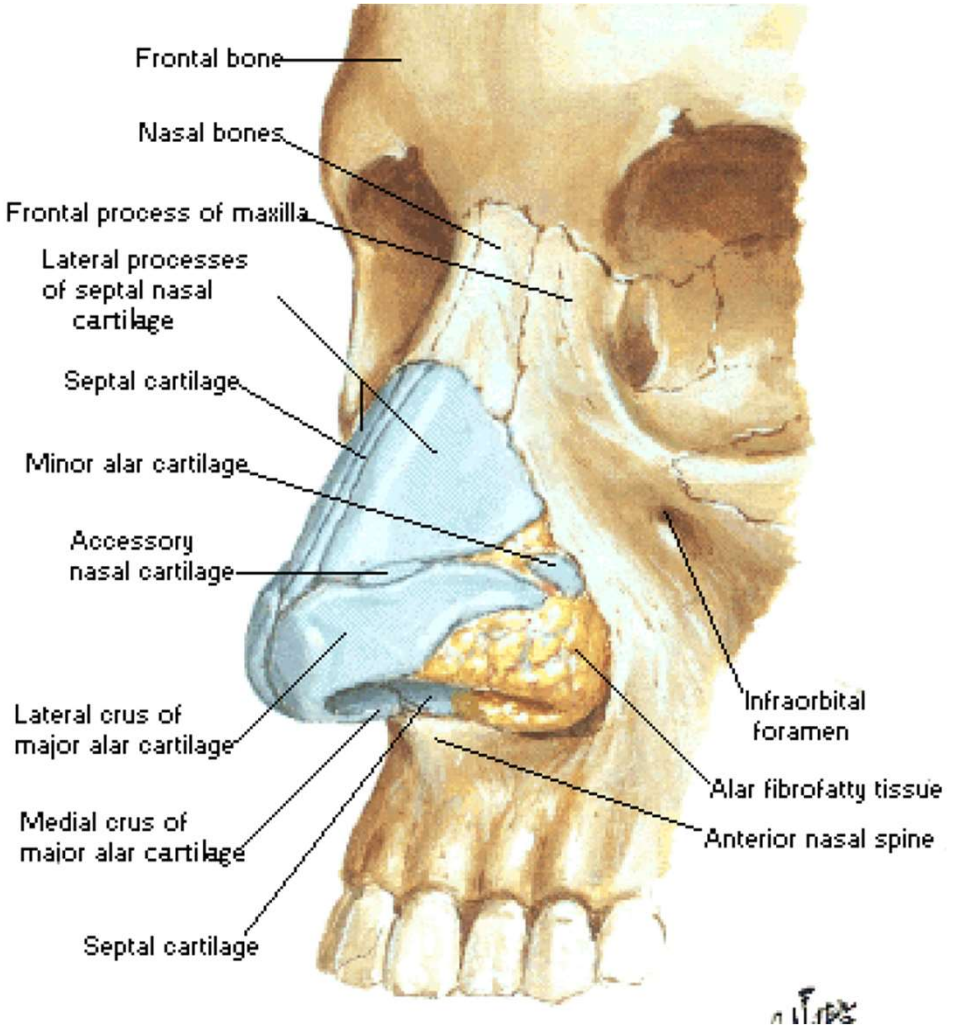
- The skeleton of the nose is formed by three types of tissue; bone, cartilage and fibro-fatty tissue. When looking at the scaffolding of the nose, it is useful to divide the structures into two parts; the **external nasal skeleton** and **internal nasal septum**.

# Nasal Skeleton

External Nasal Structure

The **external skeleton** extends the nasal cavities onto the front of the face . It is partly formed
by the **nasal** and **maxillary** bones, which are situated superiorly. The inferior portion of the nose is made up of hyaline cartilages; lateral, major alar, minor alar, and the cartilaginous **septum**. The lateral and major alar cartilages are the largest, and contribute the most to the shape of the nose here. The minor alar cartilages vary in number, there are usually 3 or 4 on each side.

# Nasal Skeleton



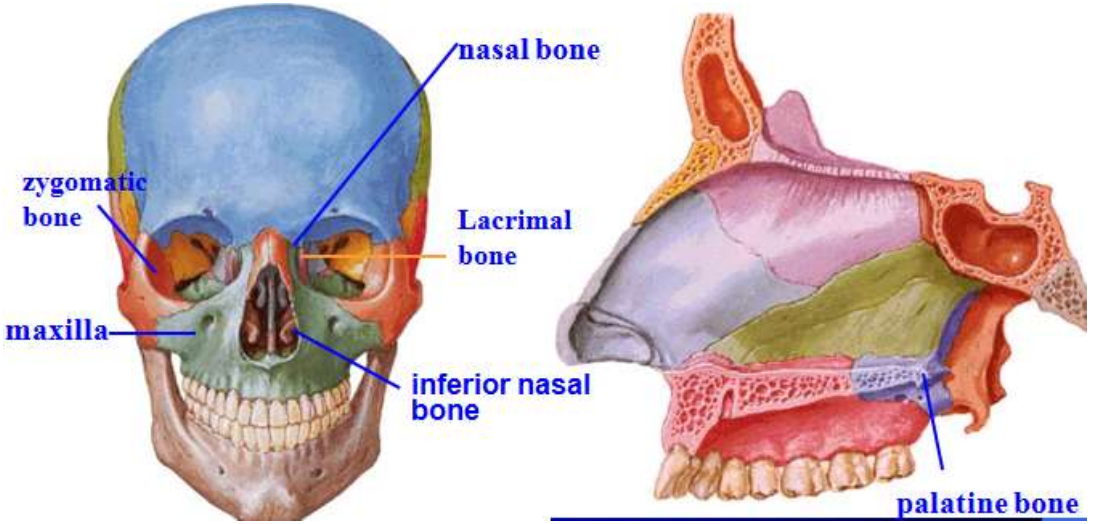
# Nasal Skeleton

**Internal Nasal Septum**

- The internal **nasal septum** separates the nasal cavity into two nostrils. The bones that contribute to the nasal septum can be divided into:
- **Paired bones**: Nasal, Maxillary and Palatine bones
- **Unpaired bones**: Ethmoid and Vomer bones.
- In addition to the bones of the nose, the septal and greater alar cartilages also constitute part of the nasal septum.
- The **ethmoid** contributes to the central portion of nasal septum. It is one of the most complex bones in the human body, and its structure is beyond the scope of this article, however more information can be found here. The anterior and posterior parts are formed by the **septal cartilage** and **vomer** bone respectively.
- The **floor** of the nasal cavity is formed by the hard palate, separating it from the oral cavity. The **hard palate** consists of the **palatine bone** posteriorly, and the palatine process of the **maxilla** anteriorly. The cribriform plate of the ethmoid bone forms the roof of the nasal cavity.

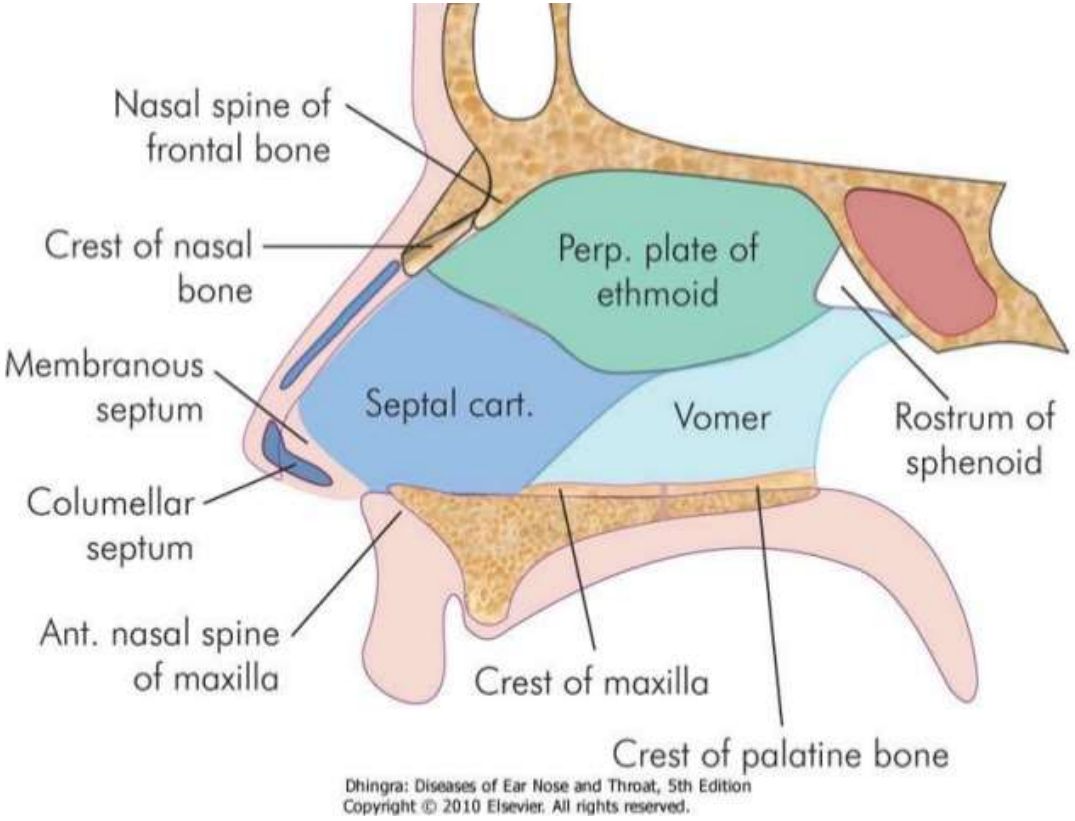
# Nasal Skeleton

Nasal Septum



# Nasal Skeleton

Nasal septum



# Nasal Skeleton

**Clinical Relevance: Nasal Fracture**

- Due to the **prominence** of the external nasal skeleton, nasal fractures are common – the most common facial fracture. Fractures usually occur as a result of **blunt trauma** to the nose. A common sequela of nasal fractures is **permanent deformity**, due to disruption of the bone and cartilage.

# ANATOMY

Bones of the Head

# Cranial Foramina

**Contents**

# Cranial Foramina

- A **foramen** (pl. foramina) is an opening that allows the passage of structures from one region to another.
- In the skull base, there are numerous foramina that transmit cranial nerves, blood vessels and other structures – these are collectively referred to as the **cranial foramina**.
- In this article, we shall look at some of the major cranial foramina, and the structures that pass through them.

# Cranial Foramina

**Cranial Nerve Foramina**

- The foramina of the skull are most commonly considered in the context of the cranial nerves. In this section, we will discuss the foramina that transmit cranial nerves.

# Cranial Foramina

**Cribriform Foramina**

- The cribriform foramina refer to numerous perforations in the **cribriform plate** of the **ethmoid bone**. They connect the **anterior cranial fossa** with the **nasal cavity**.
- These foramina allow the passage of axons of the olfactory nerve from the olfactory epithelium of the nose into the anterior cranial fossa where they communicate with the **olfactory bulb**.

# Cranial Foramina

**Optic Canal and Foramen**

- The **optic canal** permits the passage of the optic nerve (CN II) and the ophthalmic artery into the bony orbit.
- It is bounded medially by the body of the sphenoid, and laterally by the **lesser wing** of the sphenoid bone

# Cranial Foramina

**Superior Orbital Fissure**

- The **superior orbital fissure** is a cleft that opens anteriorly into the orbit, and enables communication between the cavernous sinus and the apex of the orbit
- It is bordered superiorly by the lesser wing and inferiorly by the greater wing of the **sphenoid bone**.
- It transmits several structures that are listed below (from superior to inferior):
- Lacrimal nerve
- Frontal nerve – branch of ophthalmic nerve of trigeminal nerve (CN V)
- Superior ophthalmic vein
- Trochlear nerve (CN IV)
- Superior division of the Oculomotor nerve (CN III)
- Nasociliary nerve – branch of ophthalmic nerve of trigeminal nerve (CN V)
- Inferior division of the Oculomotor nerve (CN III)
- Abducens nerve (CN VI)
- A branch of the Inferior ophthalmic vein

# Cranial Foramina

**Foramen Rotundum**

- The **foramen rotundum** is located at the base of the greater wing of the sphenoid, inferior to the superior orbital fissure.
- It provides a connection between the middle cranial fossa and the pterygopalatine fossa. The **maxillary nerve** (branch of the trigeminal nerve, CN V) passes through this foramen.

# Cranial Foramina

**Foramen Ovale**

- The foramen ovale is another opening located at the base of the greater wing of the sphenoid.
- It is positioned posterolaterally to the foramen rotundum within the middle cranial fossa. It conducts the **mandibular nerve** (branch of the trigeminal nerve, CN V) and the accessory meningeal artery.

# Cranial Foramina

**Internal Acoustic Meatus**

- The **internal acoustic meatus** is a bony passage located within the petrous part of the temporal bone.
- The canal connects the posterior cranial fossa and the inner ear, transporting neurovascular structures to the auditory and vestibular apparatus.
  The **facial** and **vestibulocochlear** nerves pass through the internal acoustic meatus, alongside the vestibular ganglion and labyrinthine artery.

# Cranial Foramina

**Jugular Foramen**

- The **jugular foramen** is formed anteriorly by the petrous part of the temporal bone and posteriorly by the occipital bone.
- It can be considered as three separate compartments with their respective contents:
- **Anterior** – contains the inferior petrosal sinus (a dural venous sinus).
- **Middle** – transmits the glossopharyngeal nerve, vagus nerve and cranial part of the accessory nerve.
- **Posterior** – contains the sigmoid sinus, and transmits meningeal branches of occipital and ascending pharyngeal arteries.

# Cranial Foramina

**Hypoglossal Canal – CN XII**

- The hypoglossal canal is located in the **occipital bone**, through which the **hypoglossal nerve (CN XII)** passes to exit the posterior cranial fossa.

# Cranial Foramina

**Foramen Magnum**

- The **foramen magnum** is the largest of the cranial foramina.
- It lies in the occipital bone within the posterior cranial fossa, and allows the passage of the **medulla** and meninges, the vertebral arteries, the anterior and posterior spinal arteries and the dural veins.
- The spinal division of the **accessory nerve** ascends through the foramen magnum to join the cranial division. Once combined, the completed nerve exits through the jugular foramen as described above.

# Cranial Foramina

**Foramen Spinosum**

- The **foramen spinosum** is located within the middle cranial fossa, laterally to the foramen ovale.
- It allows the passage of the Middle Meningeal Artery, the middle meningeal vein and the meningeal branch of CN $V_3$.

# CRANIAL FORAMINA

| Foramen | Structures Conducted | Cranial Fossa | Cranial Bone |
|---|---|---|---|
| **Cribriform foramina in cribriform plate** | • Olfactory nerve *(CN I)*<br>• Anterior ethmoidal nerves | Anterior cranial fossa | Ethmoid bone |
| **Optic canal** | • Optic nerve *(CN II)*<br>• Ophthalmic artery | Middle cranial fossa | Sphenoid bone |
| **Superior orbital fissure** | • Lacrimal nerve<br>• Frontal nerve- branch of ophthalmic nerve of trigeminal nerve *(CN V)*<br>• Superior ophthalmic vein<br>• Trochlear nerve *(CN IV)*<br>• Superior division of the oculomotor nerve *(CN III)*<br>• Nasociliary nerve- branch of ophthalmic nerve *(CN V1)*<br>• Inferior division of the oculomotor nerve *(CN III)*<br>• Abducens nerve *(CN VI)*<br>• A branch of the Inferior ophthalmic vein | Middle cranial fossa | Sphenoid bone |
| **Foramen rotundum** | • Maxillary branch of trigeminal nerve *(CN V)* | Middle cranial fossa | Sphenoid bone |
| **Foramen ovale** | • Mandibular branch of trigeminal nerve *(CN V)* | Middle cranial fossa | Sphenoid bone |
| **Foramen spinosum** | • Middle meningeal artery<br>• Middle meningeal vein<br>• Meningeal branch of CN V3 | Middle cranial fossa | Sphenoid bone |
| **Internal acoustic meatus** | • Facial nerve *(CN VII)*<br>• Vestibulocochlear nerve *(CN VIII)*<br>• Vestibular ganglion<br>• Labyrinthine artery | Middle cranial fossa | Petrous part of temporal bone |
| **Jugular foramen** | • Glossopharyngeal nerve *(CN IX)*<br>• Vagus nerve *(CN X)*<br>• Accessory nerve *(CN XI)*<br>• Jugular bulb<br>• Inferior petrosal and sigmoid sinuses | Posterior cranial fossa | Anterior aspect: Petrous portion of the temporal<br>Posterior aspect: Occipital bone |
| **Hypoglossal canal** | • Hypoglossal nerve *(CN XII)* | Posterior cranial fossa | Occipital bone |
| **Foramen magnum** | • Vertebral arteries<br>• Medulla and meninges<br>• CN XI (spinal division)<br>• Dural veins<br>• Anterior and posterior spinal arteries | Posterior cranial fossa | Occipital bone |