Head and Neck Anatomy: Part I – Bony Structures

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CE Credits: 2 hours
Intended Audience: Dentists, Dental Hygienists, Dental Assistants, Dental Students, Dental Hygiene Students, Dental Assistant Students
Date Course Online: 01/27/2022
Last Revision Date: N/A
Course Expiration Date: 01/26/2025
Cost: Free
Method: Self-instructional
AGD Subject Code(s): 10

Online Course: *www.dentalcare.com/en-us/professional-education/ce-courses/ce591*

Conflict of Interest Disclosure Statement

- Dr. LoPresti reports no conflicts of interest associated with this course. He has no relevant financial relationships to disclose.

Introduction

This course presents foundational facts and concepts regarding bony structures of the head and neck including the cranial bones (neurocranium) facial bones (viscerocranial bones) and their related openings, features and muscle attachments. It is essential for the dental professional to understand normal appearance and function as well as important landmarks during clinical examinations, when administering local anesthesia or for recognition of deviations of normal in identifying various medical conditions. This course will also cover the types of joints in the head and neck and the significance of their structure to normal function.

Please note this is Part I of a three-part series. To gain the full benefit of the concepts covered in this course, be sure to read Head and Neck Anatomy: Part II – Musculature (CE597) and Part III - Cranial Nerves (CE598)

Course Contents

Overview

While this course presents basic facts and concepts of head and neck anatomy it is not intended to replace an in-depth study of anatomy but is a guide to review the basics of anatomy as it relates to the dental field and assist the dental professional to recognize the normal anatomy of the head and neck. Muscles and nerves play a key role in many pathological conditions. As muscles are attached to the bones and the nerves pass through passages in the bones, the skeletal system provides fixed landmarks to describe symptoms even if not a source of the pathology. Various medical conditions first present in the head and neck as deviations of normal. Understanding important landmarks and anatomy are key to providing proper care and diagnosis. Part 1 of this 3-part series reviews the bony structures of the skull.

A note to the student – The study of head and neck anatomy is not a swashbuckling tale of mystery and adventure. It is full of terminology and should not be read as one would read a novel. It is easy to conflate the information if read all at once. The advantage of this type of course is that you can take breaks on occasion to allow what you have read to sink in before attacking yet another set of terms.

Words are not sufficient to understand this topic so referring to diagrams is absolutely necessary. Each section will have diagrams that highlight the areas discussed. There are also figures that include all the markings at the end of the text. These can be accessed with a button on each screen. Underlined words, if hovered over, will guide the reader to the diagrams that match that structure. In practice skulls are three-dimensional so, if possible, a skull is recommended to the supplement the diagrams. However, the quality of the plastic skulls available varies considerably and not all structures will be found on even the most expensive of them, but even with their limitations they are a big help in fully understanding and appreciating structures from various aspects inside and outside the skull to fully understand structures in head and neck anatomy head and neck anatomy.

Download Practice Diagrams

Learning Objectives

Upon completion of this course, the dental professional should be able to:

- Possess foundational knowledge of the bony structures of the head and neck.
- Identify important anatomic landmarks of the bones of the head and neck.
- Understand the types of joints in the head and neck and the significance of their structure to normal function.

Glossary of Directional Terms

anterior – Towards the front of the body.

deep/internal – Away from the surface of the body.

distal – Towards the end of a structure.

inferior – Towards the ground.

lateral – The direction from the midline to the outer border of the body.

medial – The direction from the outer border of the body towards the midline.

posterior – Towards the back of the body.

proximal – Towards the beginning of a structure.

superficial/external – Towards the surface of the body.

superior – Towards the sky.

Articulations

Bones are joined by articulations. These come in different types and have different functions. In the head and neck, we find a number of different types of joints each of which is adapted for the function of that joint. The following is a description of the types of joints found in the area along with where they are found in the head and neck.

Synostoses – These joints are immovable bony unions. They seem not to be joints at all as they look like one continuous piece of bone. These are found between a number of bones in the skull. One example is the union of the two maxillary bones, the junction of which is not discernable in many areas.

Sutures – These joints are characterized by a complex interlocking of bone but with a small space that is secured by connective tissue. These joints are also common in the skull and the important ones will be discussed later. The parietal bones are joined in the midline by a suture.

Symphysis – These slightly movable joints have fibrocartilage between the bone surfaces. They exhibit slight movement and are found between the cervical vertebrae except for the atlanto occipital and atlantoaxial joints to be discussed in the next section.

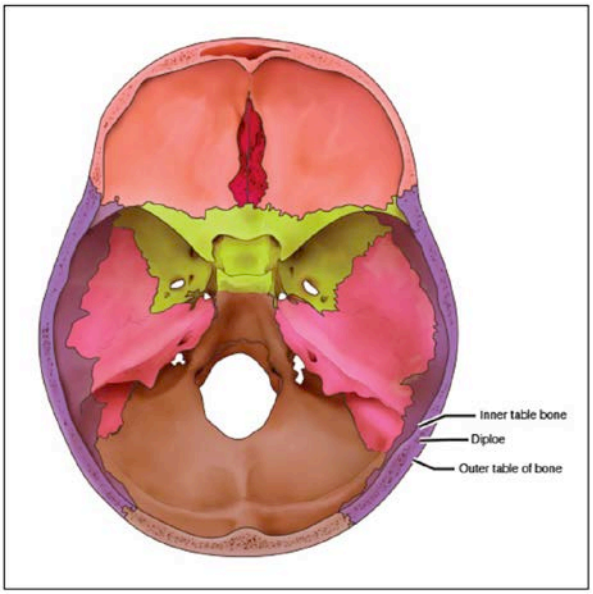
Synovial Joints – Synovial joints are freely moving joints that are held together with connective tissue. This tissue will form a capsule that is filled with a lubricating fluid called synovial fluid. To further lessen the friction within the joint the joint surfaces will be covered in hyaline cartilage which is very smooth compared to bone. The movement allowed at each joint is a function of the shape of the articular surfaces and any ligaments that act to limit the motion in a particular direction. Synovial joints are classified by the types of movements they allow. There are four of these in the skull. They are described below:

- **Temporomandibular Joints** – These account for half of the synovial joints in the skull as there is both one on the right and one on the left although as they are both attached to the mandible, they are not completely independent of one another. They are classified as ginglymoarthrodial which is a big, hard to pronounce word, that describes a joint that has both gliding and hinge components. While the TMJ is a course by itself it basically has two compartments separated by a piece of fibrocartilage called the meniscus. The upper compartment allows for the gliding motion and the lower compartment for the rotational movement.
- **Atlanto Occipital Joint** – This is the joint between the atlas (the first cervical vertebra) and the occipital bone which as we will see is at the base of the skull. It is a condyloid joint which allows for movement in two directions, rotation in the sagittal and coronal (frontal) planes. This allows one to nod and tilt the head from side to side.
- **Atlantoaxial Joint** – This joint is found between the atlas (C1) and the axis (C2) and is a pivot joint which allows only rotational movement. This allows the rotation of the head around the neck allowing one to say no without words.

Bone Markings Overview

No bones in the body have the simplified shape of dog treat bones especially the bones of the head and neck many of which have very complex shapes. The configuration of a bone depends on its function. Bones surrounding important organs like the brain, eyes and hearing/equilibrium apparatus are shaped to protect, while bones that are not necessary for protection are often paper thin. Bones that encase the brain also have to allow for passage of nerves and blood vessels into and out of the cranium. Areas where muscles attach are thicker to be able to anchor the muscle without breaking. As each bone is discussed in the course, we will discuss the various depressions, openings and protrusions found on that particular bone.

Skull Overview



The skull has two basic divisions based on whether the bone is involved in encasing the brain or not. The bones that make up the brain enclosure are termed cranial bones or the neurocranium, and the rest of the bones are considered facial or viscerocranial bones. Some cranial bones contribute to what the layperson might consider parts of the face but that is not the way they are divided by anatomists.

The bones that make up the cranial vault are known as flat bones. This type of bone consists of three layers with inner and outer tables of compact bone sandwiching the diploe which is a thin layer of spongy bone. These lack the marrow cavities found in long bones.

As bone is heavy and the head must be supported by the neck the bones are thickened where necessary for strength but in areas where there is no stress on them, they are less robust. To further lighten the skull there are also bones with membrane lined hollow areas within them. These areas are known as sinuses. All but one of these sinuses drain into the nasal cavity and will be discussed when examining the specific bones that contain them.

In addition, there are areas of the skull that have multi-bone depressions. That are referred to often in anatomic descriptions. These depressions are known under the general term of fossa. One set is found at the base of the skull and can be only visualized with the brain removed. They can be seen in Appendix D though they are not labeled as such the three hollows are clear. The anterior one is simply called the anterior cranial fossa, the middle one is the middle cranial fossa and predictably the posterior one is called the posterior cranial fossa.

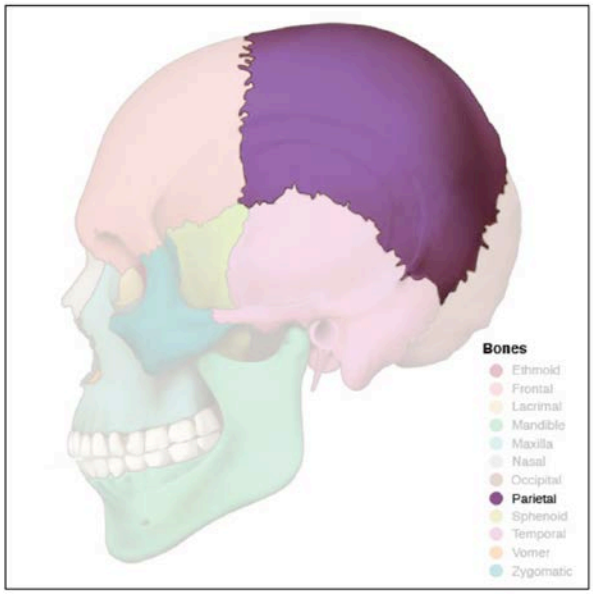
The other set, while they can be seen on a lateral view of the skull is best understood with a diagram showing the inferior view of the skull (Appendix C). There is an indentation of the side of the skull that extends from the temporal lines completely down to the inferior border of the skull. It is divided into three spaces. The space above the zygomatic arch (This is unlabeled but is where area where the pink and aqua bones meet in Appendix B) is the temporal fossa and below that is found the infratemporal fossa or sometimes referred to as the infratemporal space. Deep to the infratemporal space is another depression known as the pterygopalatine fossa or sphenopalatine fossa. This cone shaped area is difficult to see in two-dimensional diagrams but is found between the medial and lateral pterygoid plates and the maxilla. It is a passageway that connects various parts of the face and skull so will be mentioned often in discussions of nerve and blood vessel pathways.

Bones of the Head

Cranial Bones - The Neurocranium

There are eight bones considered to be part of the neurocranium. There are four unpaired bones: the ethmoid, sphenoid, frontal and the occipital and 2 pairs of bones: the temporals and parietals. These bones surround the brain in all directions. The bones that form the dome over the brain are flat bones which does not mean they are flat but rather that they have a consistent thickness. The bones that are found at the base of the brain make up the cranial base. These bones have inconsistent shapes and contain openings for blood vessels and nerves to pass into and out of the brain case.

Parietal Bones

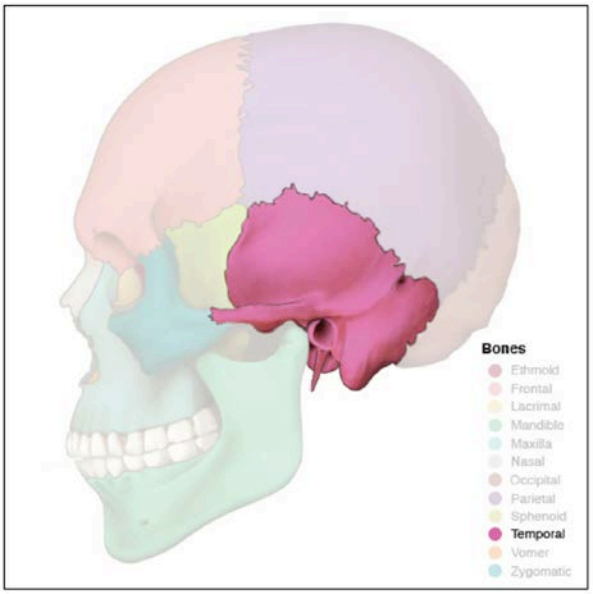


The paired parietal bones form much of the cranial vault and articulate with all the other flat bones of the skull.

Sutures – In birth, the junctions between the flat bones of the skull cannot be fused in order for the baby to pass through the birth canal. This leaves uncalcified areas present to allow for head growth. These are known as the anterior and posterior fontanelles or in common parlance, “soft spots.” As these calcify, they leave behind prominent sutures between the partial bone and the other flat bones. These sutures have names and can be seen in the diagrams. The sagittal suture is found between the left and right parietal bones, the lambdoid suture is between the occipital bone and the two parietal bones, the coronal suture is between the frontal bone and the parietal bones and on each side there is a squamosal suture between the parietal bone and the temporal bone.

Markings – Besides the sutures the superior and inferior temporal lines are found on the parietal bone. The superior line is the origin of the connective tissue that surrounds the temporalis muscle and the inferior line is the superior limit of the muscle attachment for the temporalis muscle. This origin of this muscle is quite large and the lines extend anteriorly onto the frontal bone and inferiorly onto the temporal bone.

Temporal Bones



Unlike the parietal bones the paired temporal bones do not touch each other and they not only form part of the calvarium but also form part of the base of the skull. This important bone houses the auditory and equilibrium organs; has articulation points, the mandibular fossae, for the temporomandibular joints which are the only synovial joints in the skull; contains the mastoid air cells located within the mastoid process which is the point of insertion of the large sternocleidomastoid muscle. Let us look at the temporal bone in more depth.

Parts – There are five parts that can be found in the temporal bone. The flat bone portion of the temporal bone is termed the squamous

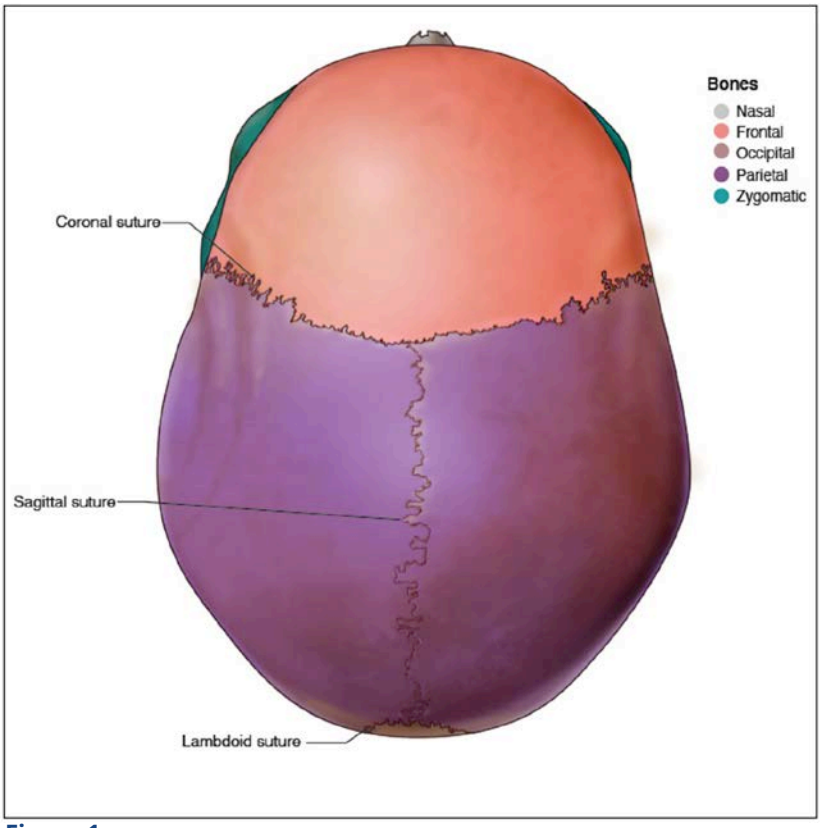
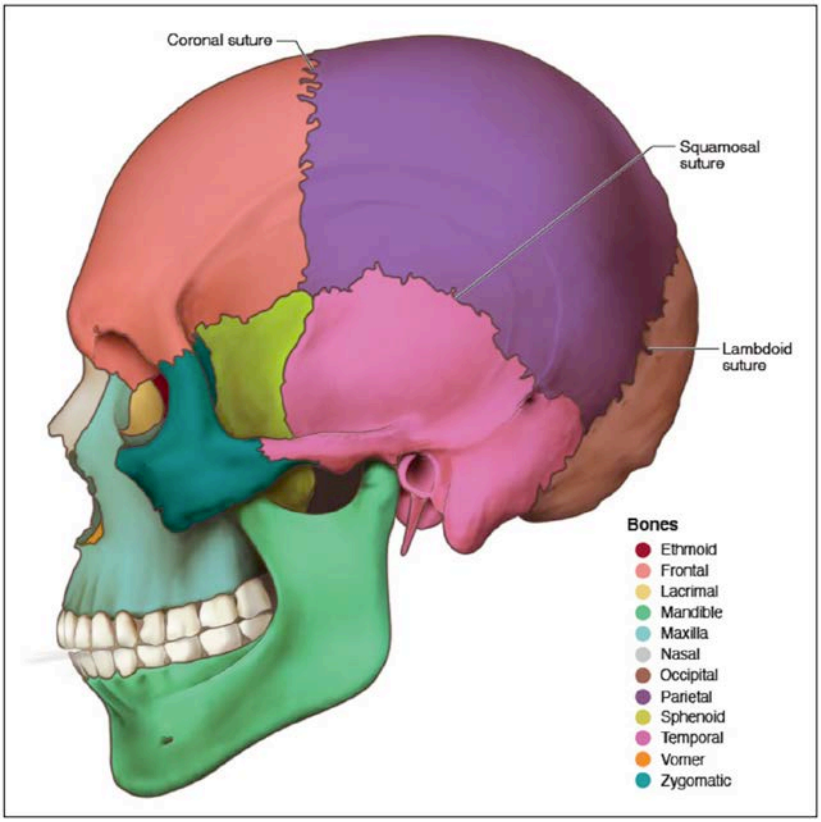


Figure 1.



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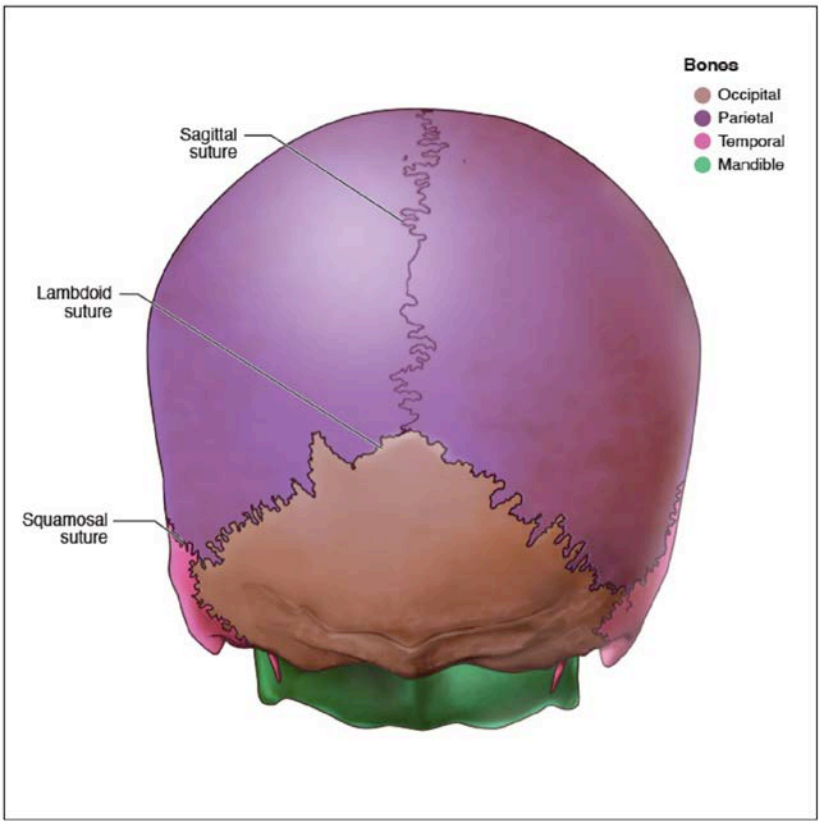
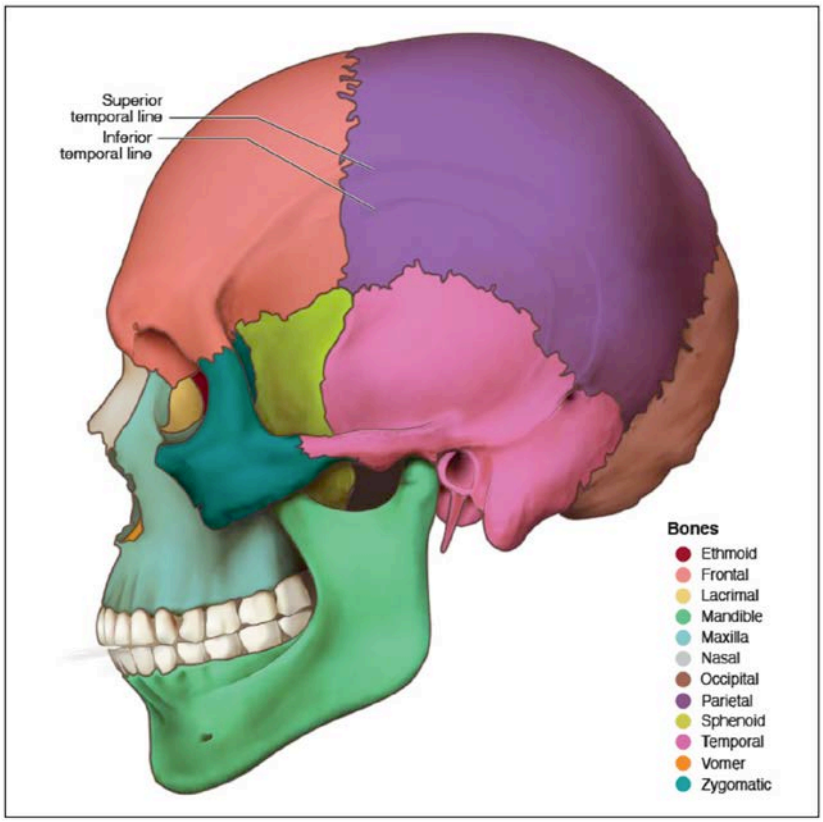


Figure 3.



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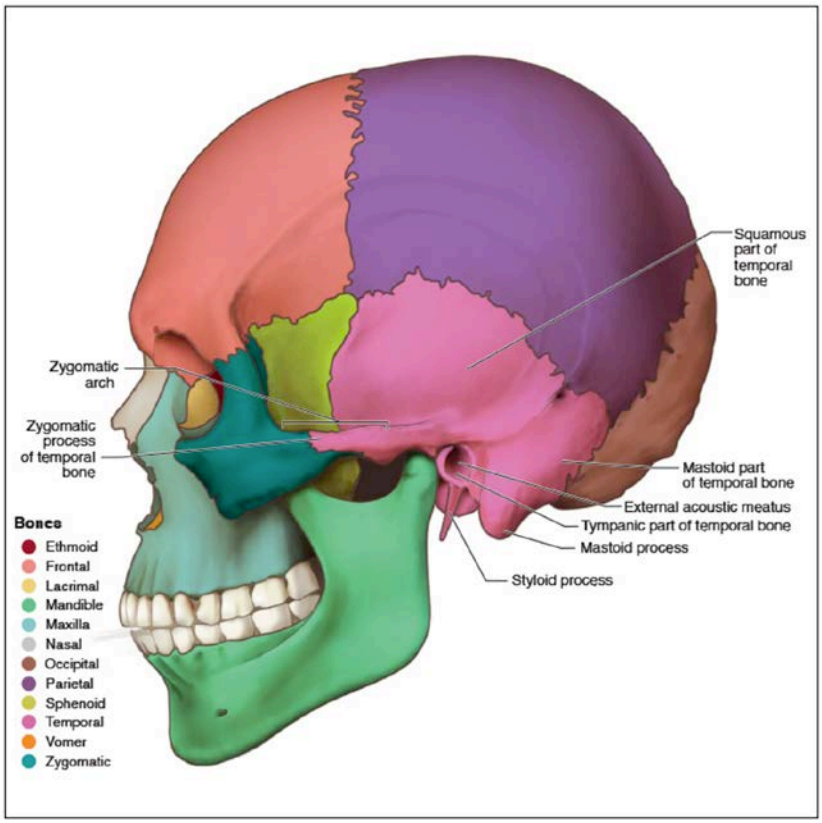


Figure 5.

part of the bone. The horizontal portion of the bone that is part of the skull base is the petrous portion. This part houses the inner ear and acts to separate the middle and posterior cranial fossae. These two parts to combine to form most of the middle cranial fossa.

From a lateral view or inferior view of the skull we can also see the large mastoid part of the bone which is mainly made up of the mastoid process mentioned earlier. This hollow area drains into the middle ear unlike other sinuses in the skull which drain into the nasal cavity.

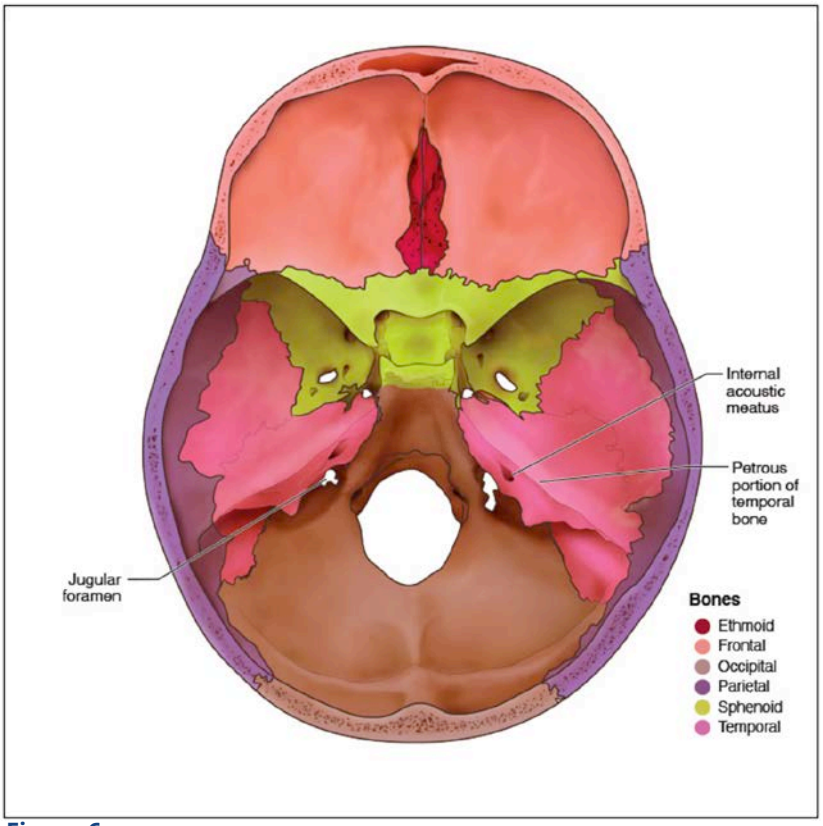
Just anterior to the mastoid part of the bone is the large opening of the external acoustic meatus (canal) which along with the styloid process are the main landmarks of the tympanic part of the bone.

Anteriorly the temporal bone has a process that is important to dental professionals known as the zygomatic process as it articulates with the zygomatic bone to form the zygomatic arch. It is on this process that the articular surface for the mandible is found.

Openings – The largest opening it the external acoustic meatus (canal) which is the tunnel that acts to funnel air vibrations to the tympanic membrane to start the sensing of auditory stimuli. There is also a passageway for nerves found between the mastoid and styloid processes known logically as the stylomastoid foramen. There is also a passage for the 7th and 8th cranial nerves to leave the cranium found in the petrous portion of the bone known as the internal acoustic meatus (canal).

In addition to the nerve exits, the internal carotid arteries which supply much of the arterial blood to the brain pass through the petrous portion of the temporal bone and the main drainage through the internal jugular vein passes through an opening between the temporal and occipital bones known as the jugular foramen.

Muscle attachments – As mentioned earlier the sternocleidomastoid muscle attaches to the mastoid process and the temporalis muscle has a broad insertion that includes portions of the temporal bone. In addition, the styloid



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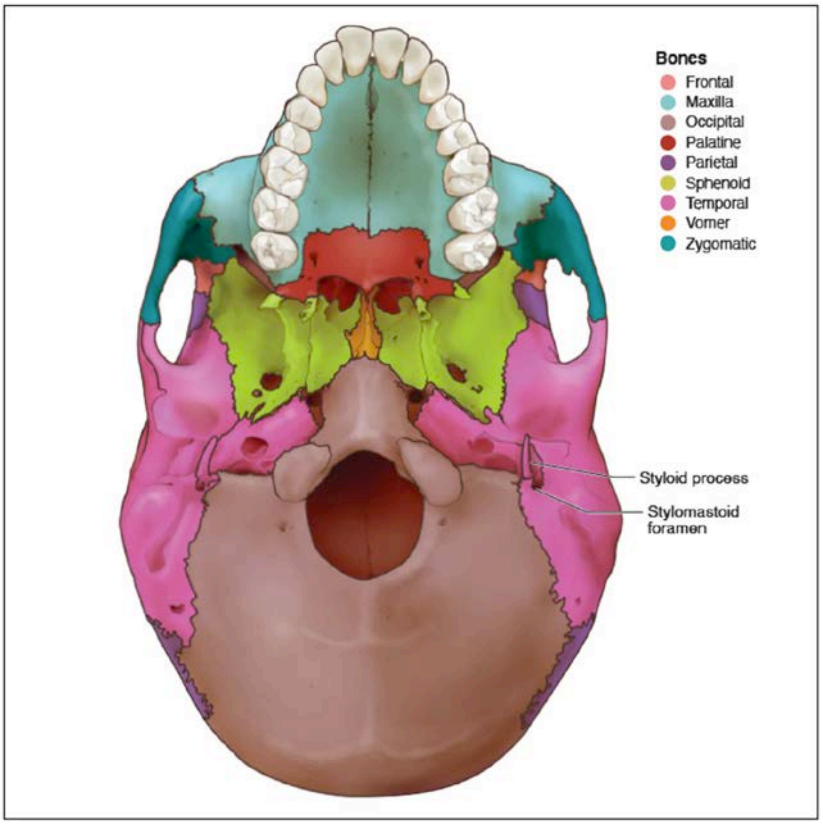
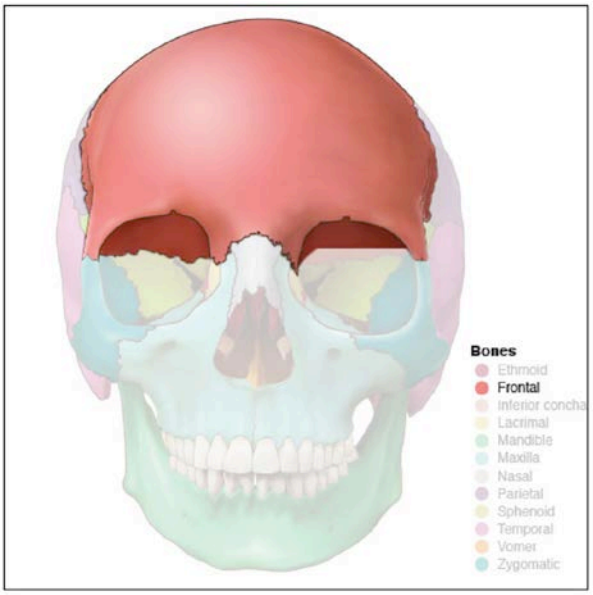


Figure 7.

process is an attachment point for both the stylopharyngeus muscle and importantly to the proper functioning of the temporomandibular joint (TMJ), the stylomandibular ligament attaches to that process also.

Frontal Bone



The frontal bone is the cranial bone that extends from the superior border of the orbits to the coronal suture. As it makes up the upper 1/3 or the face it articulates with a number of facial bones. This bone contains a paranasal sinus.

Markings – The superciliary arch is a thickened area extending superiorly from the supra-orbital margin to help protect the eye There is also a pair of rounded protrusions in the bone above the brow lines each known as a frontal eminence. They vary in size by the individual and are generally more prominent in males.

Openings – There is small notch in the margin of each orbit with an associated opening to allow nerves and blood vessels passage. These are known as the supraorbital foramina or notches.

Occipital Bone

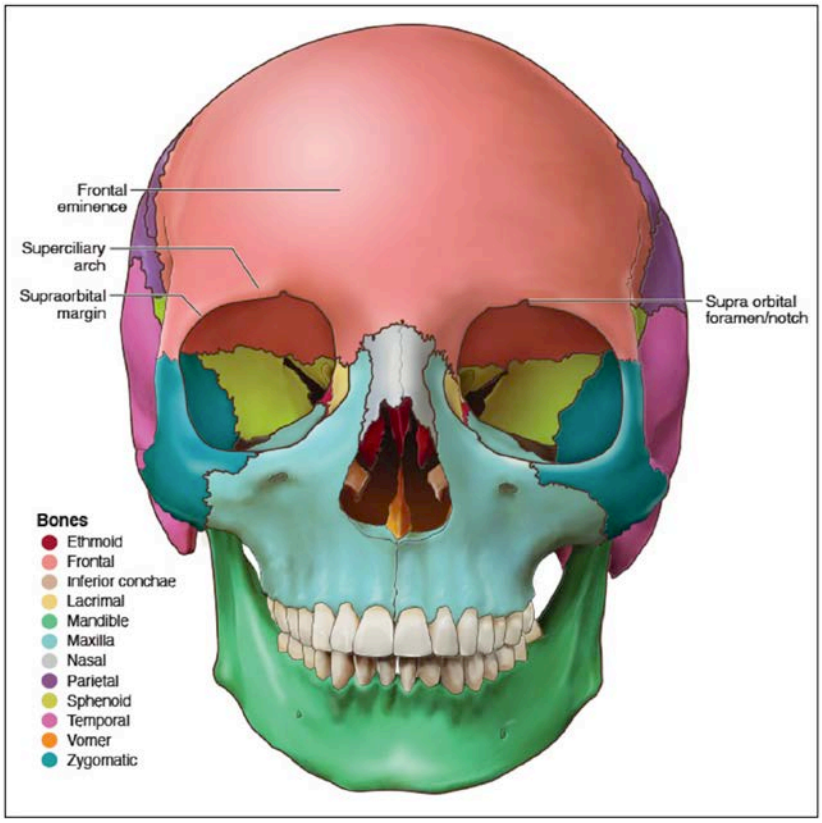
The occipital bone is the cranial bone that forms the posterior part of the calvarium and also is the articulation point with the bones of the neck. Therefore, it has a pair of

condyles, the occipital condyles found on the inferior surface that articulate with the atlas as discussed earlier.

Parts – The two main parts of the occipital bone are the squamous part which is the flat bone part that forms the posterior part of the calvarium and the basilar part which is the part that connects the bone to the sphenoid bone.

Markings – The markings on the external surface of the occipital bone are all involved with attachments of the ligaments and large muscles that are necessary to hold the head erect. If you look at a lateral view of the skull you can see that the greater mass of the skull is anterior to the occipital condyle. To counteract this weight difference the muscles at the back of the neck must be strong enough to resist the head falling forward. This is why when you read too much anatomy and start to nod off your head falls forward. These markings include the external occipital protuberance, the nuchal lines, and the external occipital crest.

The internal surface of the occipital bone forms much of the posterior cranial fossa which contains the cerebellum and brain stem. The depression to house the cerebellum is named appropriately the cerebellar fossa. There is also a groove along the border with the temporal bone to accommodate the large



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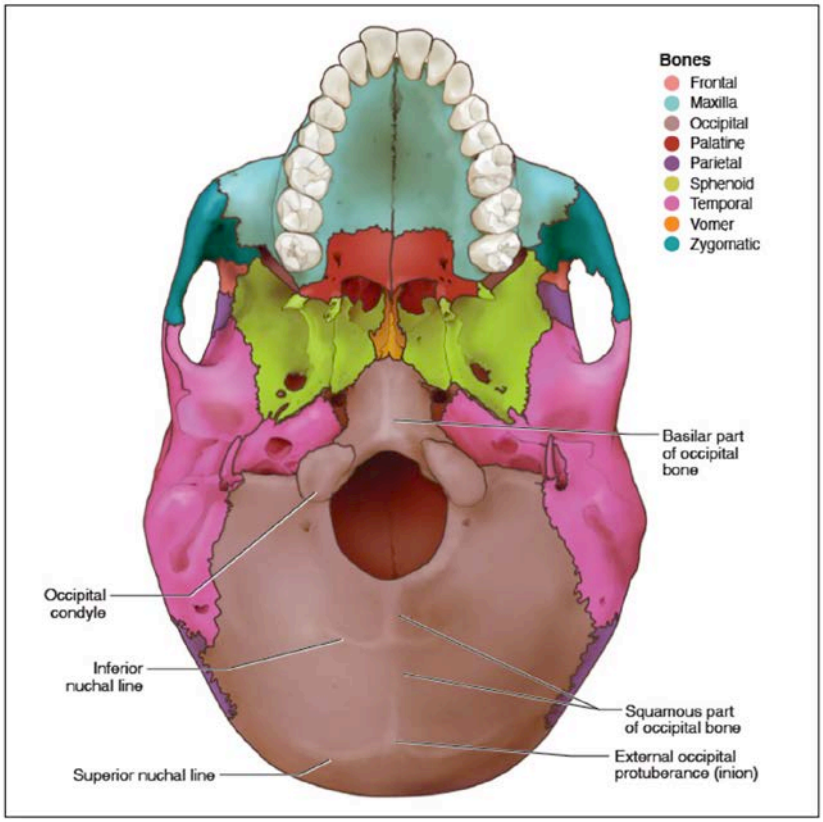


Figure 9.

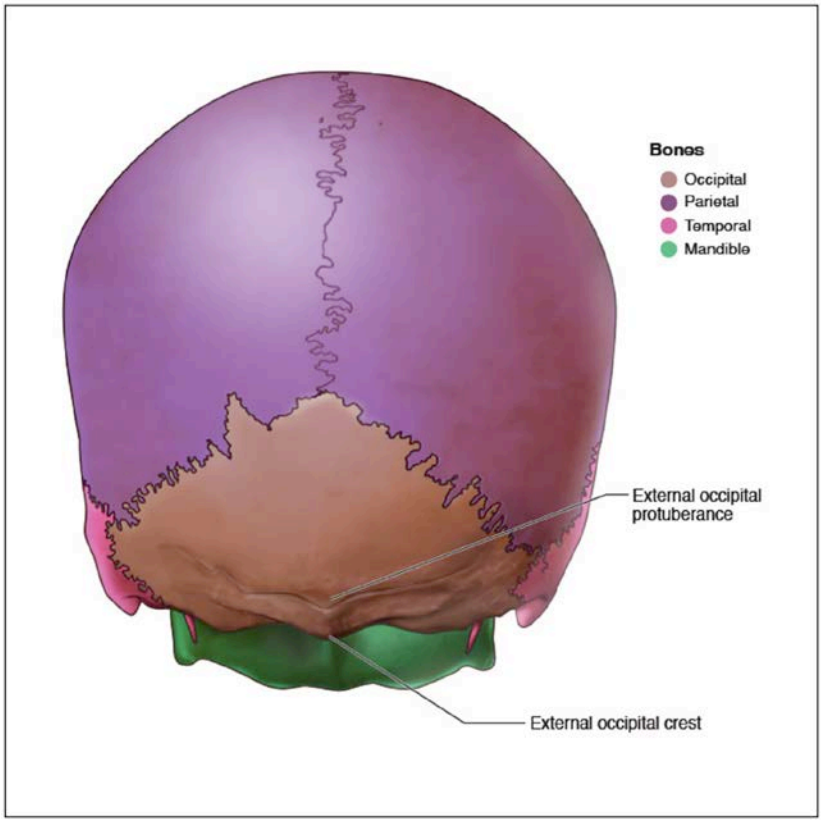


Figure 10.

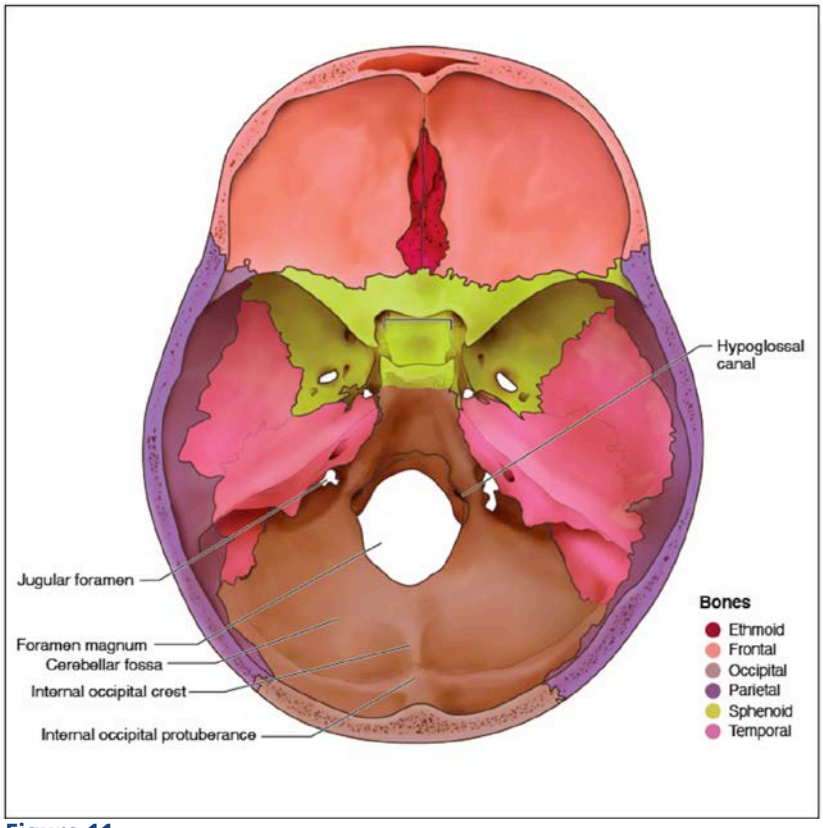
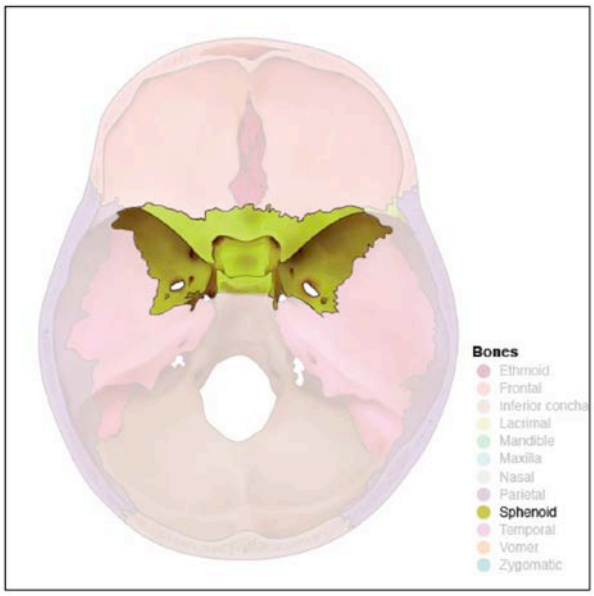


Figure 11.

sigmoid sinus which drains venous blood from the brain into the jugular vein which begins at the aforementioned jugular foramen. There are also attachment points for the connective tissue coverings of the brain. These raised areas are the internal occipital crest and the internal occipital protuberance.

Openings – The largest foramen in the skull is located in the occipital bone. The foramen magnum is the opening for the spinal cord to attach to the brain stem. The basilar artery which supplies blood to the brain also passes through this opening. There are also foramina found in the base of the occipital condyles. These openings allow passage of the cranial nerve XII, the hypoglossal nerve and are like many things labeled in a logical manner as the hypoglossal canals. We have already noted that the jugular foramen is found at the junction of the occipital and temporal bones.

Sphenoid Bone



The sphenoid bone has a complex shape that is often compared with a butterfly having two wings on each side, a central body and a couple of extensions inferiorly that might be considered the legs. It is the central bone of the cranium and thus articulates with all of the cranial bones and in addition articulates with the zygomatic, vomer and palatine bones of the facial skeleton. It also has many foramina to allow the passage of nerves and blood vessels. It is one of seven bones found in the orbit and makes up much of the posterior wall of that structure. In addition, the sphenoid contains one of the paranasal sinuses.

Parts – As mentioned above the sphenoid bone has a very complex shape. The centrally located body of the sphenoid contains the sphenoid paranasal sinus. It also has an indentation on the cranial surface that encases the hypophysis (also known as the pituitary gland). This indentation, known collectively as the sella turcica consists of three sections, a raised part at the anterior end, the tuberculum sellae; a depression in the middle where the gland sits, the hypophysial fossa; and a raised part posteriorly known as the dorsum sellae.

Starting at the centrally located body the lesser wings project outwards to from the posterior part of the anterior cranial fossa. The greater wings are found in the middle cranial fossa.

Openings – There are a number of openings in the sphenoid bone. Three of them are associated with passage of the three roots of the trigeminal nerve. The first division, the ophthalmic nerve, exits through the superior orbital fissure along with cranial nerves II, IV and VI. The second division, the maxillary nerve, passes through the foramen rotundum. The third division of the trigeminal, the mandibular nerve, passes through the foramen ovale. Another important opening is the optic canal which allows for passage of the optic nerve which carries visual information from the retina to the brain.

There are also a number of openings that lie at the junction of the sphenoid bone and other bones. The largest of these is the inferior orbital fissure found where the sphenoid, the maxilla, the palatine bone and the zygomatic bone meet. This does not open into the cranial cavity as the other openings do but rather connects the orbit to the pterygopalatine fossa. Structures that pass through there include the maxillary nerve, artery and vein which change name at the border to the infraorbital nerve, artery and vein.

The foramen lacerum is found at the junction point of the sphenoid, temporal and occipital bones. This is an odd foramen as it is closed

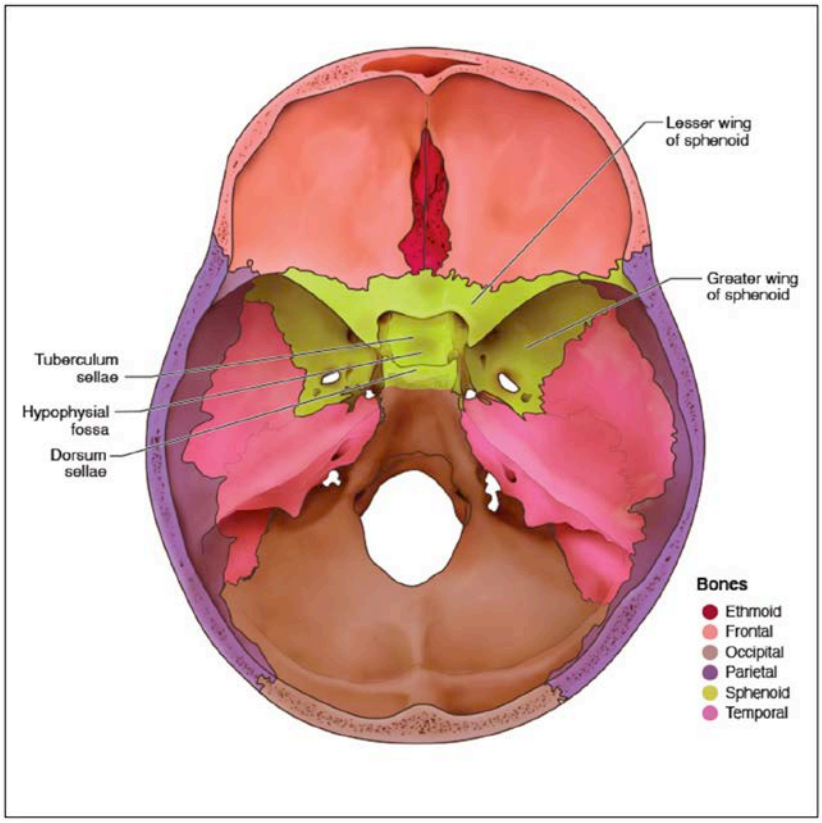


Figure 12.

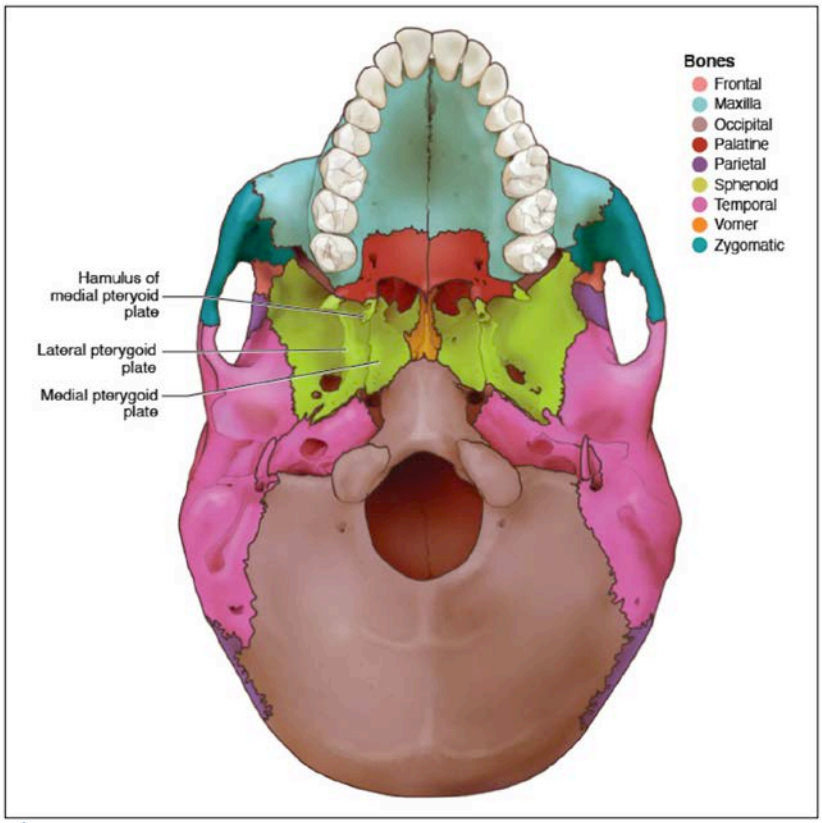


Figure 13.

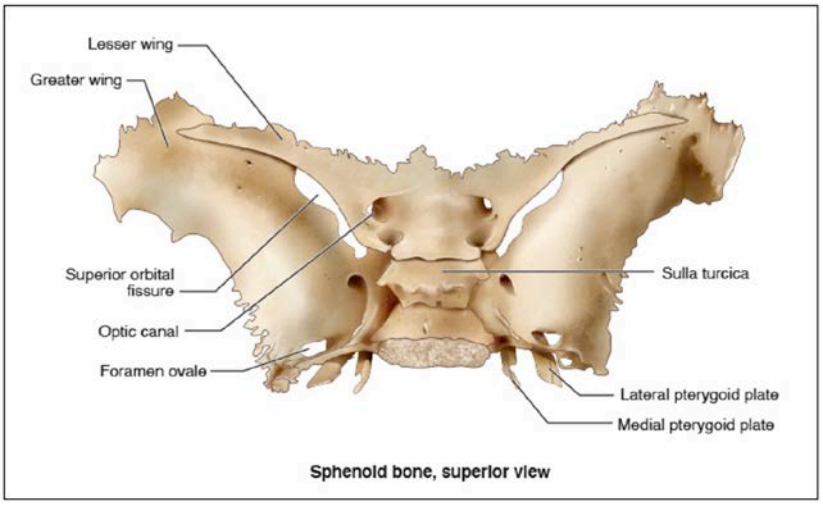


Figure 14.

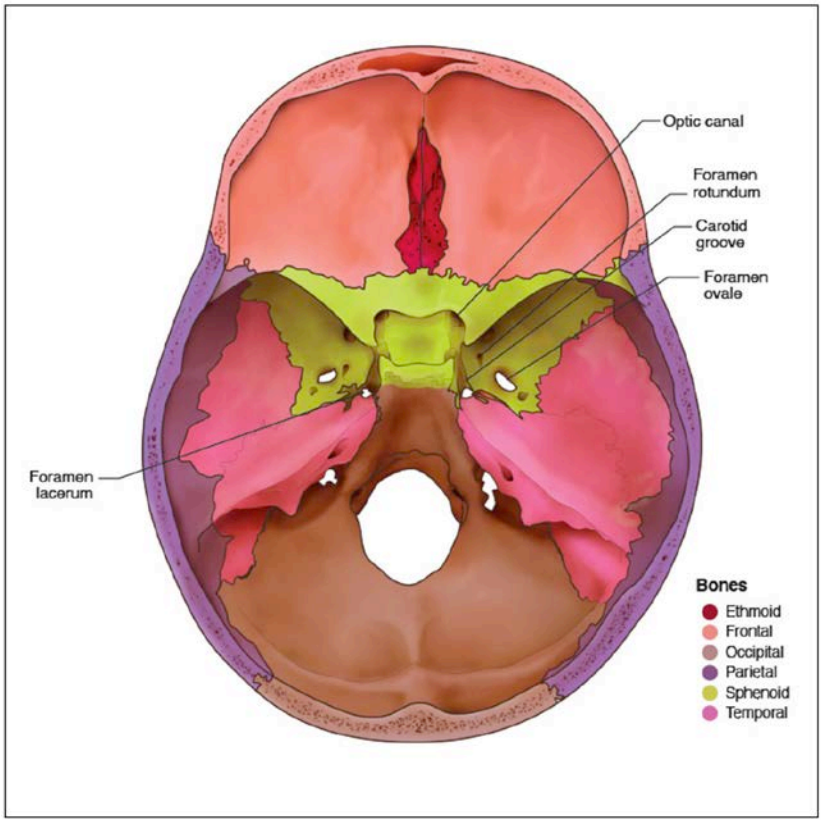
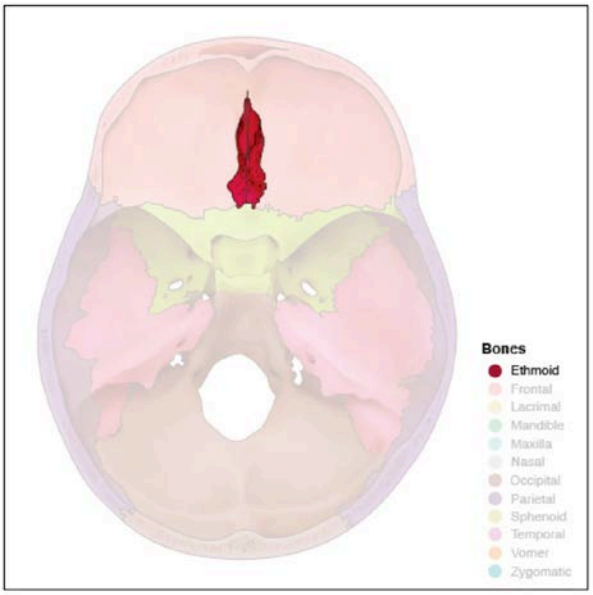


Figure 15.

superiorly by the carotid artery which passes directly over it and is mostly sealed with connective tissue. Only minor blood vessels and a small nerve pass through it despite its size. The carotid continues over the sphenoid bone and forms the carotid groove just anterior to the foramen lacerum.

Muscle attachments – The lateral pterygoid plate plays an important role in the stomatognathic system being an attachment point for both the lateral pterygoid muscle and confusingly enough the medial pterygoid muscle also. There are four muscles of mastication so these two muscles comprise half of the muscles of mastication.

Ethmoid Bone



Like the sphenoid bone the ethmoid bone has a very complex shape. Unlike the sphenoid, though, it contributes little to the cranial cavity but mostly to the facial structure. The superior portion is found midline in the anterior cranial fossa. Projecting inferiorly into face are three extensions that form the superior portion of the nasal cavity and part of the medial wall of the orbit. The two lateral extensions contain the ethmoid air cells which like all paranasal sinuses drain into the nasal cavity.

Parts – The superior portion where the three extensions connect, which is the part of the ethmoid bone forming the cranium, is known as the cribriform plate. This plate has numerous holes in it through which fibers of the first cranial nerve, the olfactory nerve pass. These are known as the olfactory foramina. Running between the foramina is a ridge of bone known as the crista galli. This acts as an anchoring point for the dura mater that passes between the left and right cerebral hemispheres.

Projecting inferiorly from the cribriform plate in the midline is the perpendicular plate of the ethmoid bone. This acts as part of the dividing wall between the two nasal passages.

The two projections laterally and inferiorly are the lateral masses of the ethmoid. The lateral wall of this section of the bone forms part of the medial wall of the orbit. The medial wall is separated from the lateral wall mostly by air filled cavities surrounded by thin plates of bone. The lateral wall is more complex than the medial wall as contains projections known as the concha or turbinates. The superior nasal concha and middle concha are part of the ethmoid bone. They project into the nasal cavity to help ensure that the air brought in through the nose is warmed by the surface blood vessels and filtered by the mucus made in the respiratory epithelium. By projecting into the cavity, they lessen the amount of open space and act to cause air turbulence which helps bring all the air in contact with the surface. Each of these conchae extend from the wall and project inferiorly leaving a space between it and the lateral wall of the nasal cavity. Each of these spaces is known as a meatus and named for the concha that forms it, so the superior concha forms the superior meatus.

Openings – The openings for cranial nerve I, the olfactory foramina were discussed earlier. The other openings are for drainage and empty in those area found in the individual meatus (This is meant as a plural. Believe it or not the plural of meatus is meatus) and an area superior and posterior to the superior meatus known as the sphenoethmoidal recess. This is continuous with the superior meatus and the sphenoidal sinus and the posterior ethmoid air cells drain into these areas. The middle meatus drains the remaining paranasal sinuses: the anterior ethmoid, the frontal and the maxillary. The

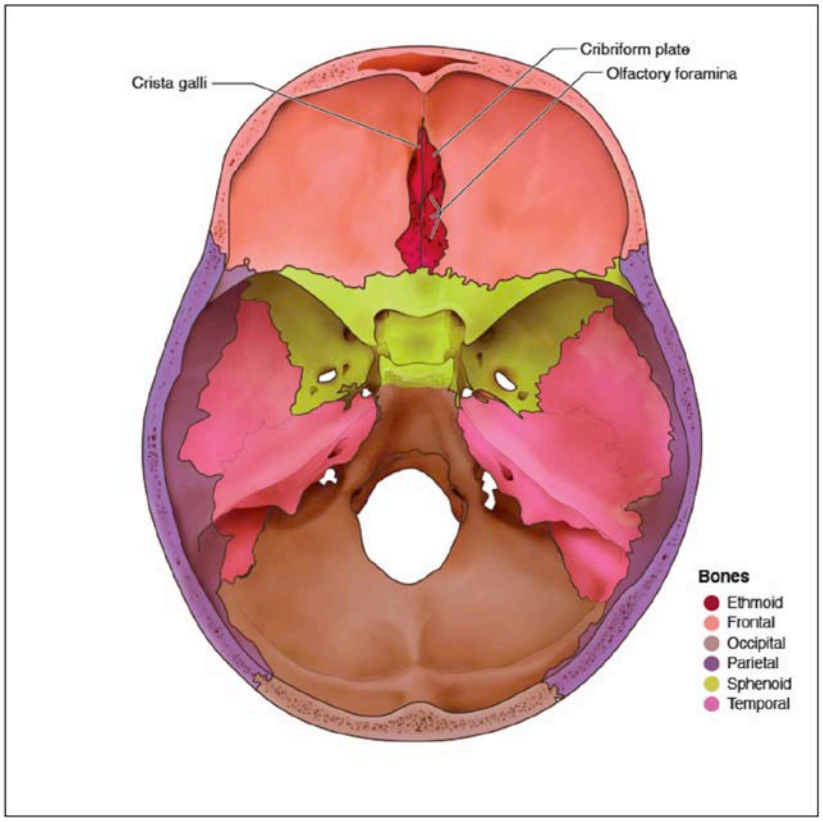


Figure 16.

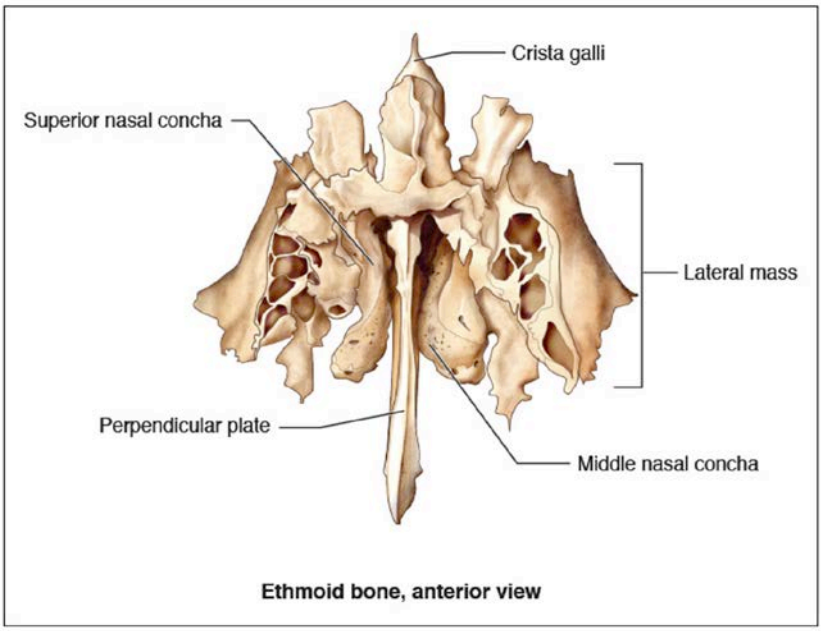


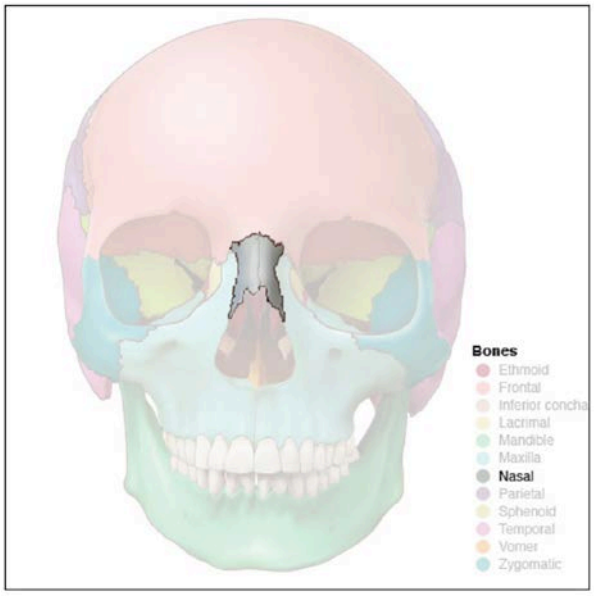
Figure 17.

inferior meatus is formed by a different bone and will be discussed with the inferior concha bone which forms it.

Facial Bones - Viscerocranium

The facial skeleton consists of six paired bones and two bones that are single bones for a total of 14. These bones are not involved with surrounding and protecting the brain but rather surround the openings for the proximal structures of the digestive and respiratory systems. These bones are the most important ones in dentistry since the mandible and maxilla house the teeth and the mandible is the moving bone in the jaw. In addition, the attachment points for many important muscles are found facial bones.

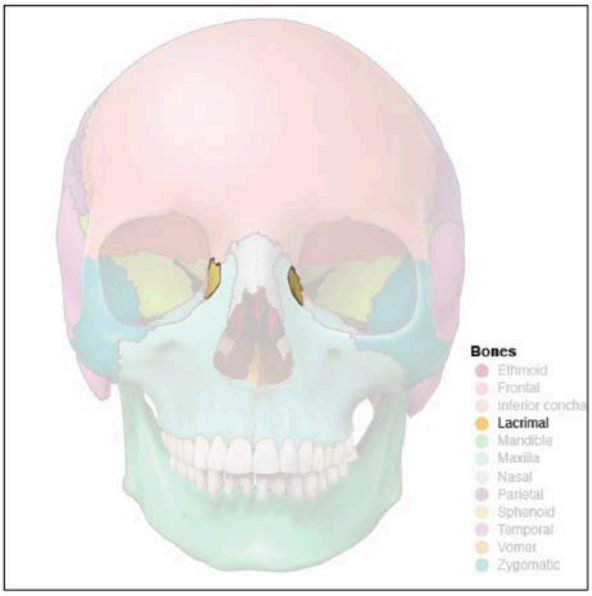
Nasal Bones



The paired nasal bones are found straddling the midline of the face bounded superiorly by the frontal bone and laterally by the maxilla. They form the bridge of the nose.

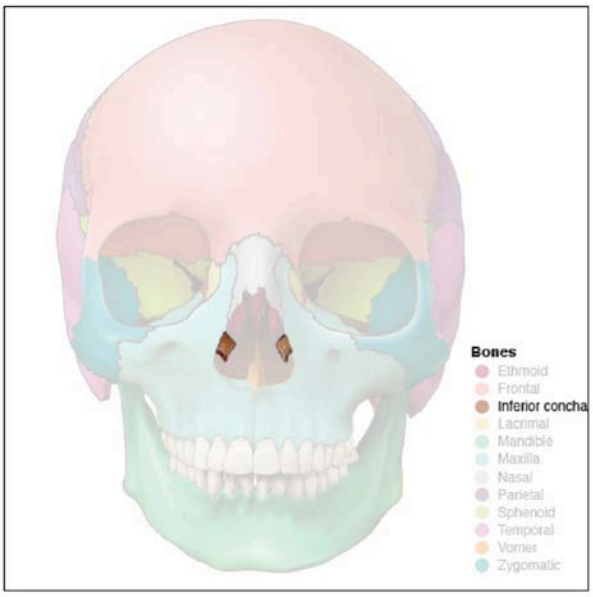
Lacrimal Bones

The paired lacrimal bones are found at the medial-anterior border of the orbit sandwiched between the maxilla and the ethmoid bone antero-posteriorly and superiorly with the frontal bone. Inferiorly it articulates with the maxilla and the inferior concha bone. It forms some of the medial wall of the orbit and a small part of the lateral wall of the nasal cavity.



Openings – The lacrimal bone along with the maxilla forms a large opening, the nasolacrimal canal, which comprises much of the orbital surface of this bone. This canal contains the nasolacrimal duct which drains tears from the eye. Tears are constantly formed to cleanse the eye and need to be drained continually. This duct then drains into the nasal cavity through an opening into the inferior meatus.

Inferior Concha Bones



The two inferior concha bones make up the inferior lateral wall of the nasal cavity. The inferior concha are the largest of the three

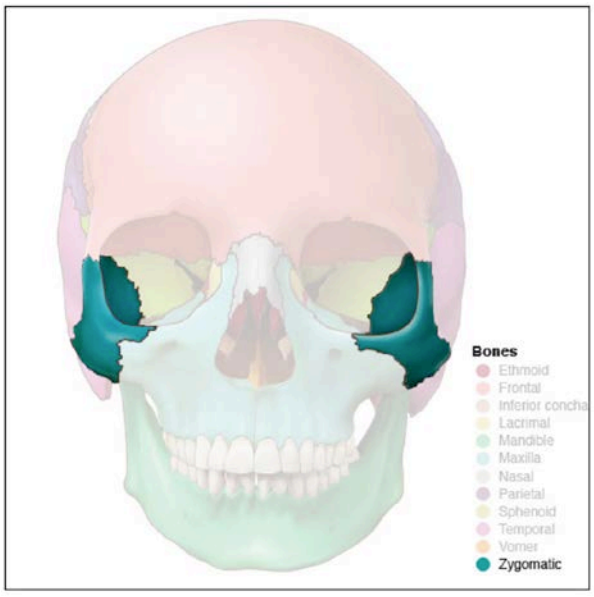
protrusions into the nasal cavity as they are near the base of the pyramidal shaped cavity. Between the concha and the walls of the nasal cavity is the inferior meatus.

Vomer

The vomer is a triangular shaped bone that widens both at the base and the posterior part. It is found in the midline and makes up the inferior portion of the bony nasal septum articulating with the ethmoid bone which composes the superior part of the bony septum. Both bones articulate with the septal cartilage which forms the anterior portion of the nasal septum that gives the human nose its final shape.

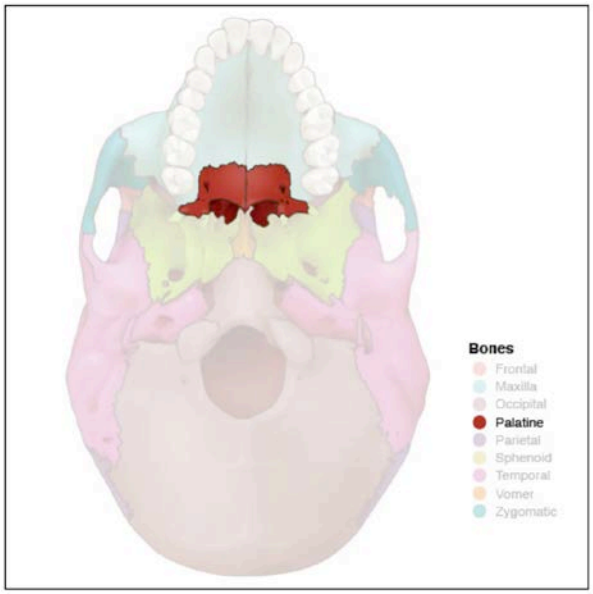
Zygomatic Bones

The two zygomatic bones form the central portion of the zygomatic arch and provide a large mass of bone at the lateral wall of the orbit. They articulate with the zygomatic process of the temporal bone posteriorly, the zygomatic process of the frontal bone superiorly and the zygomatic process of the maxilla medially. The border between the temporal and infratemporal spaces is defined by the arch with temporal space being superior and the infratemporal space being inferior to the arch. The zygomatic arch buttresses the side of the face while allowing structures to pass behind it and acting as an attachment point for muscles.



Muscle attachments – The zygomatic arch acts as the origin of the masseter muscle which is a powerful muscle of mastication. The zygomaticus major and minor muscles also originate from the zygomatic arch.

Palatine Bones



A common mistake that most anatomy students make when studying the palatine bones is thinking that they make up the entire palate. While the two fused L-shaped bones contribute to the palate, they only form the posterior section, as the palate is primarily formed by the maxilla. Besides the horizontal plates that

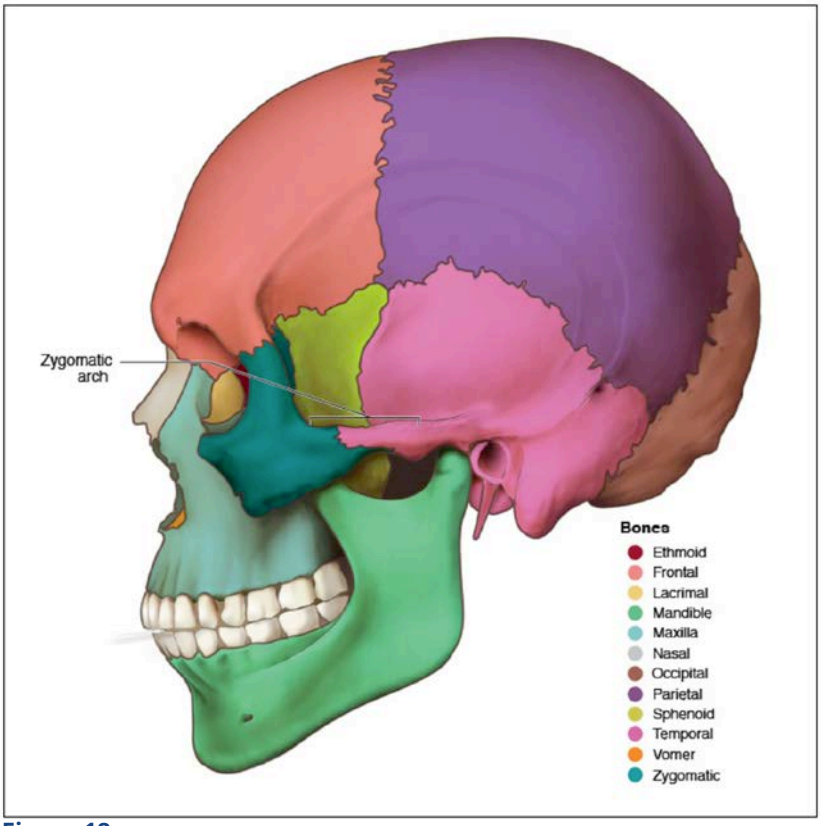


Figure 18.

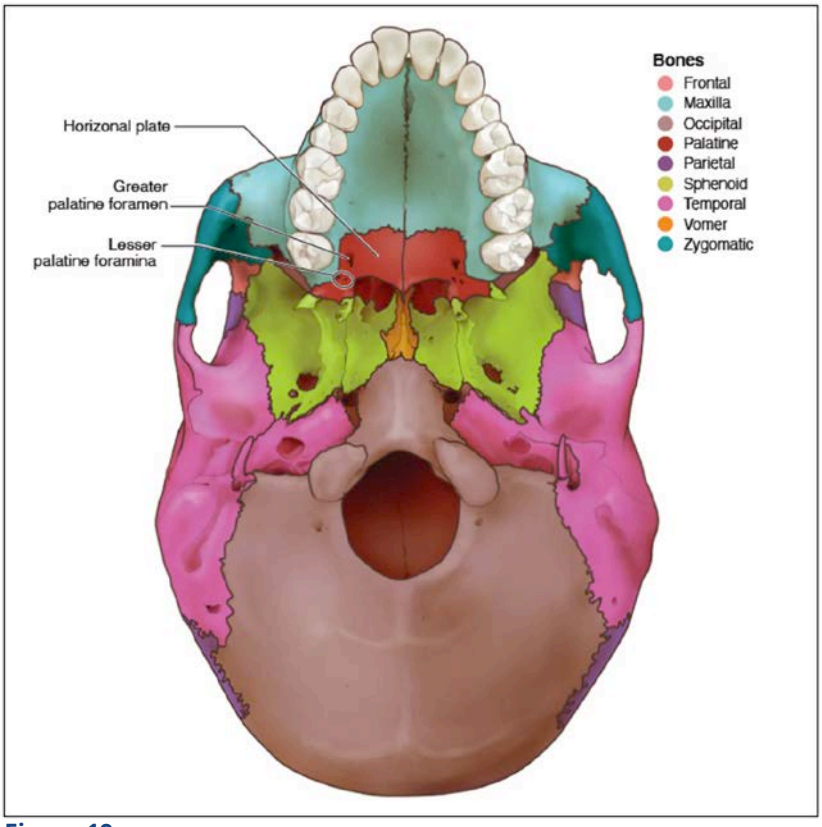


Figure 19.

form the palate there are vertical extensions that extend from the lateral borders of the horizontal plates forming the L-shape. This vertical portion forms the posterior part of the lateral wall of the nasal cavity articulating with the inferior concha bone; another part forms a very small part of the orbital floor between the ethmoid and maxillary bones. It also articulates with the sphenoid bone posterior to the medial pterygoid plate and actually shares some of the attachment of the medial pterygoid muscle.

Openings – The lesser palatine foramen are contained completely within the palatine bone and are accessory foramina to the larger, more anterior greater palatine foramina. The greater palatine foramen and the bony canal that leads to it are found as a space between the maxillary bone and the palatine bone.

Maxillary Bones

The two maxillary bones which combined are often just referred to as the maxilla is a complex bone that not only, as mentioned previously, forms most of the palate, but houses the upper teeth, contributes to the floor of the orbit, and forms much of the mid face. The union of the left and right maxillary bones occurs by ossified sutures in the midline. Between the plates of bone forming the palate and the plate forming the mid face is the largest sinus cavity in the skull. This sinus extends over the premolars and molars in the adult and superiorly to the base of the orbit. Sinus congestion is common in this sinus as it drains into the middle meatus which is superior to the majority of the cavity. Therefore, unlike the other paranasal sinuses gravity works against drainage of fluid from the cavity.

Parts – The central portion of the maxilla that makes up the mid face is referred to as the body. The body has several extensions referred to as processes. The vertical extension that passes between the nasal and lacrimal bones articulates with the frontal bone also and is named the frontal process. The extension to articulate with the zygomatic bone is known logically as the zygomatic process of the maxilla. Very logically the processes forming the palate are known as the palatal processes. These processes meet at the palatine suture. The maxilla also has a process that houses the roots of the upper teeth called the alveolar processes. The alveolar process only forms when the teeth do and will resorb in areas where the teeth are removed. There are prominences in the bone where the tooth roots are. These form fossa between them. The most important of these are the incisive fossa between the roots of the central and lateral incisors and the canine fossa between the roots of the lateral incisor and the canine.

Openings – The maxilla forms the anterior boundary of the inferior orbital fissure with the sphenoid forming the posterior boundary and the zygomatic bone forming the lateral boundary. Leading from the inferior orbital foramen anteriorly there is a groove carrying blood vessels and nerves which eventually enter the infraorbital canal that runs through the maxilla in the floor of the orbit. The canal terminates at the face as the infraorbital foramen. Anteriorly on the palate, immediately posterior to the central incisors, is another opening called the incisive foramen or alternatively the nasopalatine foramen. This is actually a single opening at the confluence of the two incisive canals which are also referred to as the nasopalatine canals.

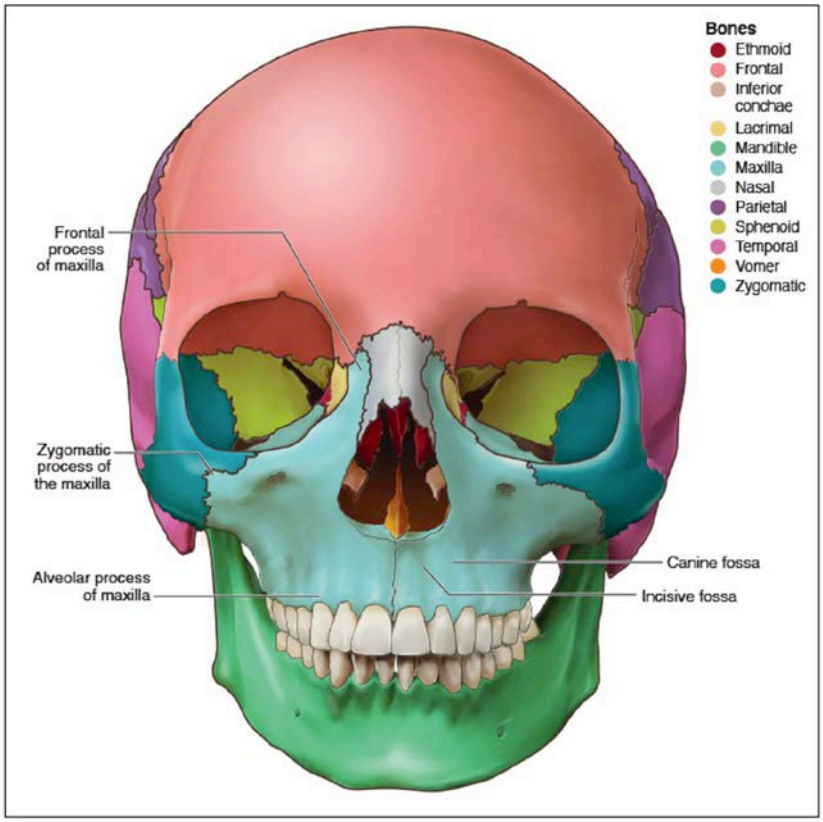


Figure 20.

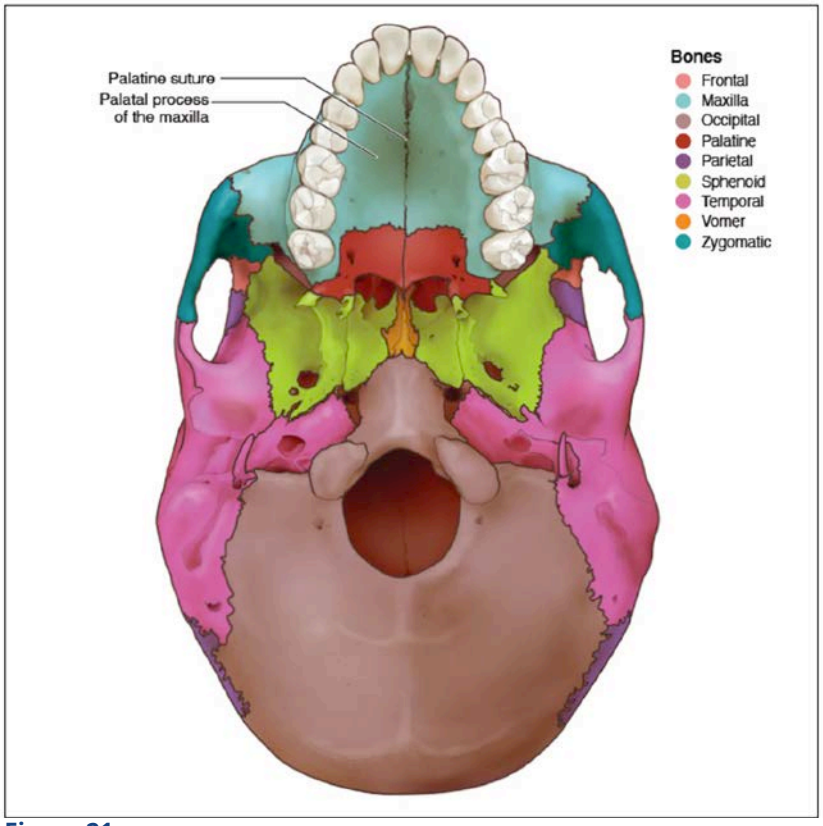


Figure 21.

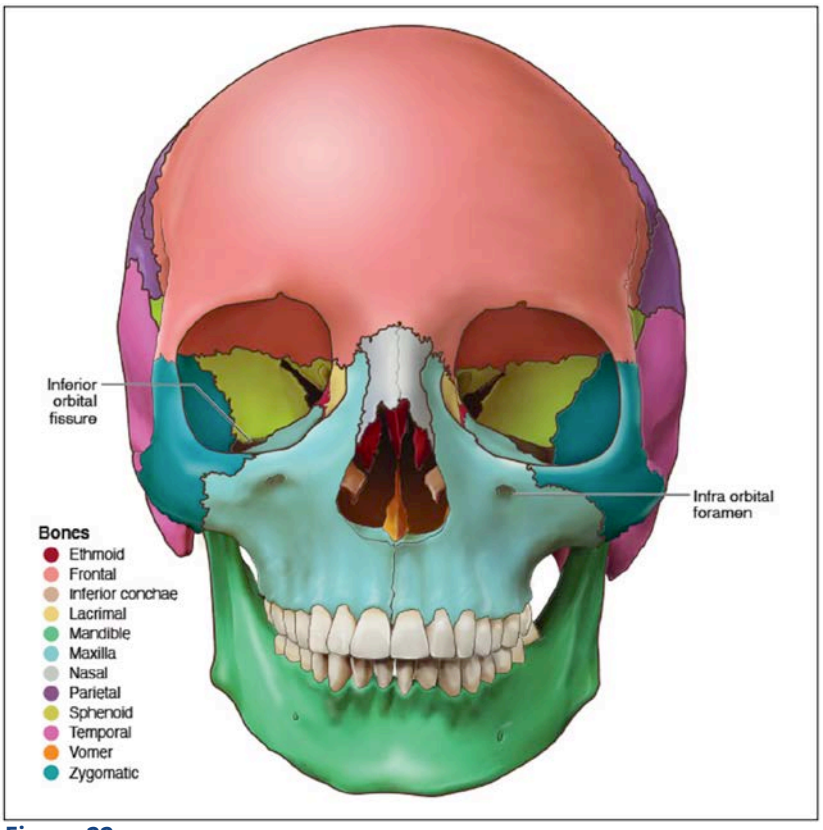


Figure 22.

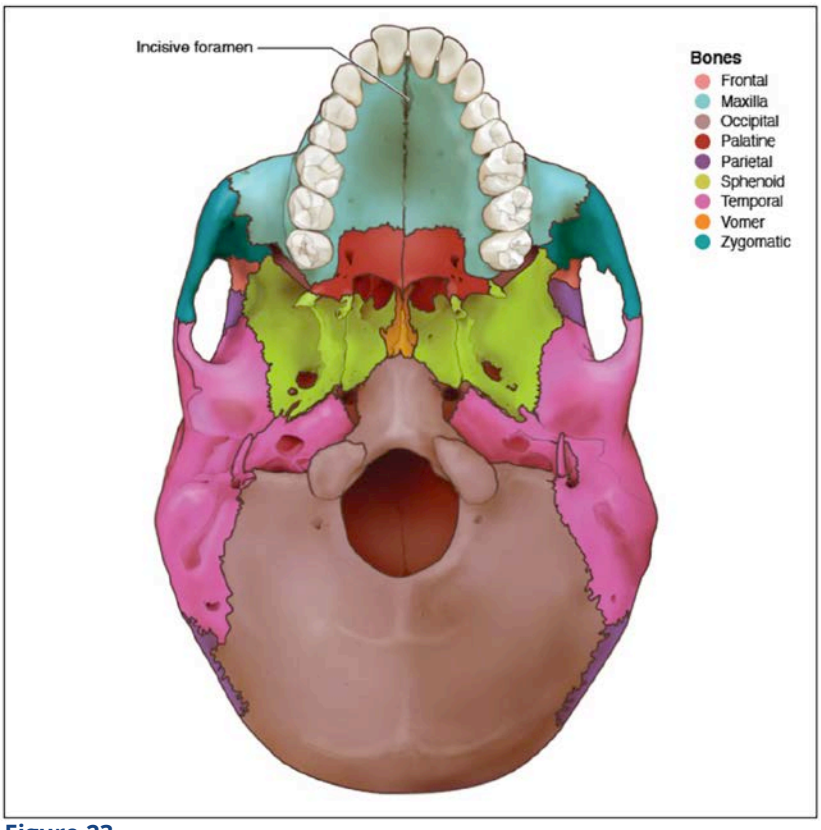
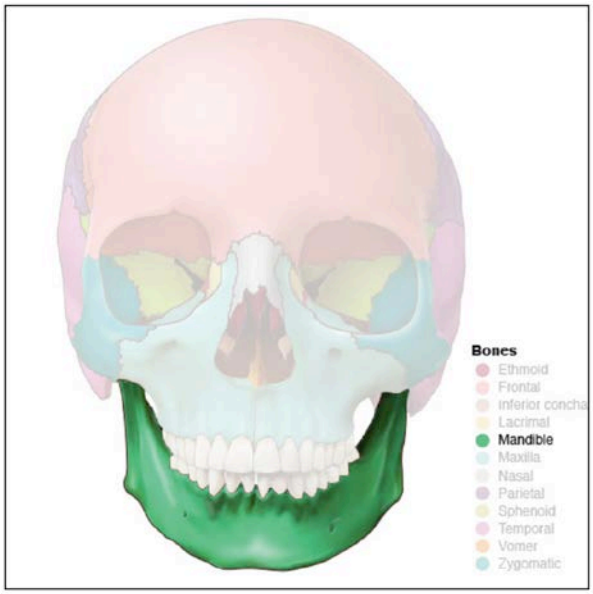


Figure 23.

Embryologic formation – The histologic formation of the maxillary bones are notable in that they form not from two primordial processes but three. The premaxilla forms a triangular shaped section centrally from canine to canine with the apex a short distance into the palate. It arises from the same fetal tissue that forms the nose while the rest of the maxilla is formed by the fetal maxillary processes that form the rest of the bone. The palate is formed when the two palatal shelves which form on either side of the developing nasal cavity join the premaxilla. This occurs at about 8 weeks in utero at a stage when bones have not yet developed. Failure of these processes to join properly is the cause of cleft lips and palates depending on where the failure occurs. This explains why cleft lips and clefts of the anterior palate are in the area of the canines rather than in the midline while clefts in the more posterior sections of the palate are in the midline.

Mandible



The mandible is the only freely moving bone in the skull and makes up the entire lower face. It has joints on both sides of the head with the temporal bone. It houses the lower teeth and this combination of teeth and movement allows mastication. Being unsupported by other bones it has thick cortical plates and dense spongy bone to resist the forces created on it by the strong muscles of mastication. Even so some bending of the bone occurs when opening wide.

Parts – The mandible has a horizontal section that is known as the body. The superior surface of the body which houses the teeth is called the alveolar process just as in the maxilla. Like the maxilla this is dependent on teeth being present and if the teeth are removed this area of the mandible resorbs, weakening the bone considerably over time. On either side of the midline along the inferior border are protuberances known as the mental tubercles. Starting from these tubercles an initially faint line runs obliquely along the mandible to the vertical section becoming more prominent as it proceeds more posteriorly and superiorly. This is known as the external oblique line. It acts as an attachment for several muscles, the most important being the buccinator. There is a corresponding line internally known as the internal oblique line by the radiography department but the anatomists generally refer to it as the mylohyoid line which is the attachment point for the mylohyoid muscle that forms the floor of the mouth. On either side of the midline on the inferior and lingual portion of the bone are two projections known as the genial tubercles which act as muscle attachment points.

The vertical portion of the mandible is known as the ramus. The area where the ramus and body meet is known as the angle of the mandible. The ramus itself splits at its superior extent into two processes. The anterior process known as the coronoid process is the attachment point for the temporalis muscle. The posterior process is known as the condylar process as it ends at the mandibular condyle which is the articular surface (above) of the bone. Attached anterior at the superior end of the process is the lateral pterygoid muscle. Between the two processes is a notch known as the mandibular notch or is some texts as the sigmoid notch.

Openings – There are two important openings in the mandible and they are connected by and internal canal known as the mandibular canal. The proximal end of the canal is the mandibular foramen which is located on

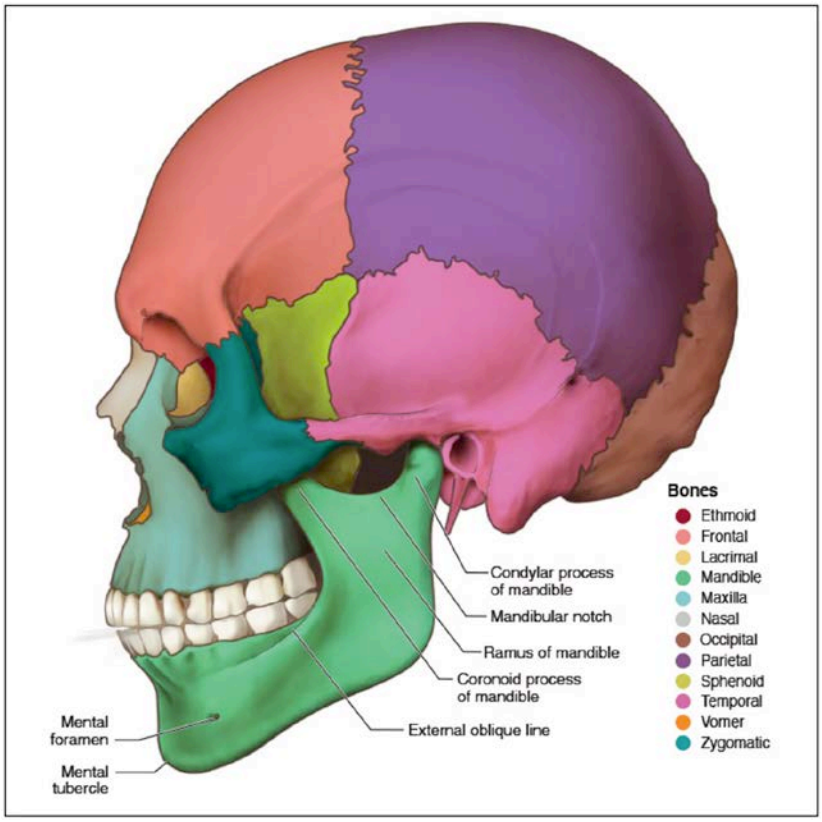


Figure 24.

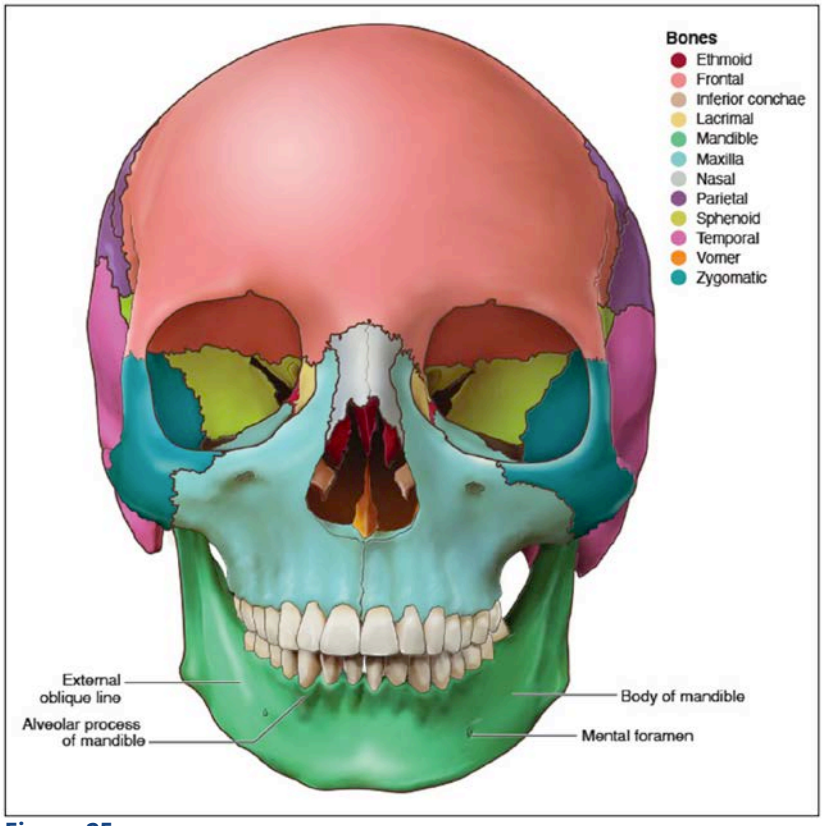


Figure 25.

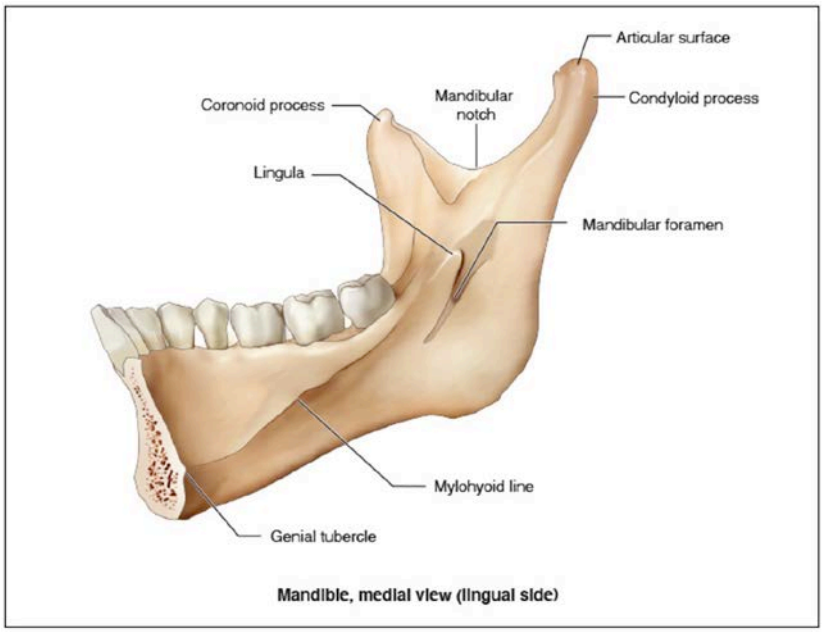


Figure 26.

the inner surface of the ramus centered between the body and the mandibular notch superior-inferiorly and aligned with the depth of the notch. It is the point where the inferior alveolar nerve enters the mandible and as such is the area where local anesthesia can be administered to anesthetize all the hard tissues of the body of the mandible plus some of the soft tissue. At this point there is also a bony projection, the lingula, that covers the medial side of the opening and attaches one of the ligaments that stabilizes the temporomandibular joint (TMJ).

At the other end of the canal is the mental foramen. This allows passage of the nerve and blood vessels that supply the soft tissues of the chin, lip and the buccal gingiva of the lower anterior teeth. You can often palpate this on yourself.

Temporomandibular Joint

The TMJ is a synovial joint. All synovial joints have a capsule composed of dense, irregular connective tissue on the outer surface and what is known as a synovial membrane on the inner surface. The outer capsule stabilizes the joint by limiting movement and as the fibers are interwoven forms an impervious shell around the joint. The synovial membrane has cells that make synovial fluid which is about the consistency of an egg white and acts as a lubricant for the joint. To further reduce friction the mandibular condyle and the mandibular fossa are both covered in smooth hyaline cartilage.

The articular capsule is not the only connective tissue that limits movement of the joint. The stylomandibular ligament extends from the styloid process to the inferior-posterior surface of the mandible. This ligament angles posteriorly from the mandible it limits forward movement of the joint. A second ligament, the sphenomandibular ligament runs from the spine of the sphenoid bone vertically to the lingula which is located, as mentioned previously, on the inner surface of the ramus where the mandibular foramen is found. This ligament runs vertically so limits the downward movement of the mandible. The last important ligament of the joint is the temporomandibular ligament which runs from the zygomatic process of the temporal bone back to the posterior portion of the condylar process. Given that it is angled posteriorly as it descends to the mandible it limits movement of the joint in a posterior as well as inferior direction.

There are also bone limits to the movement as the condyle sits in a hollow, the articular fossa. The posterior wall of the fossa is known

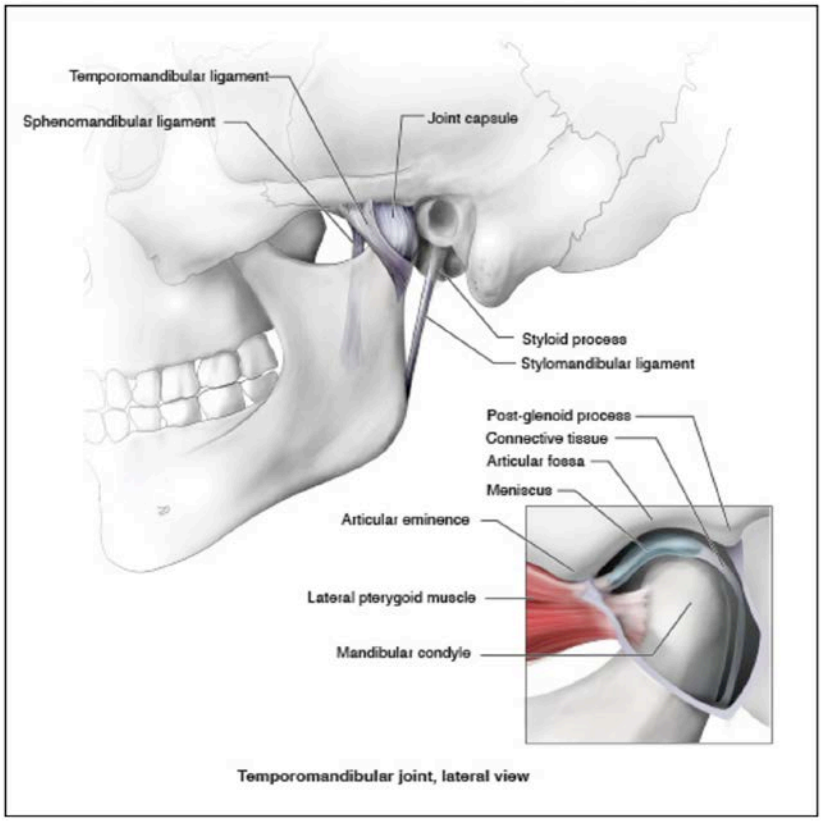


Figure 27.

as the post-glenoid process as the other name for the mandibular fossa is the glenoid fossa. Anterior to the fossa is the articular eminence which is not so much a stop as a hinderance. As we will soon see the mandible slides down this process during opening. However, if the limiting structures do not work properly the condyle can get across the eminence and the person will not be able to close as the eminence now acts to limit posterior movement. To return the condyle to the fossa one must push the mandible both inferiorly and posteriorly simultaneously.

One last piece of the puzzle is there is articular cartilage found between the two bones. Known as the meniscus, this is a tough piece of fibrocartilage that is draped over the condyle with extensions on the medial and lateral to prevent it dislodging in those directions. Posteriorly it is connected by connective tissue to the joint capsule which is firmly attached the temporal bone and anteriorly it is connected to the superior head of the lateral pterygoid muscle. As the mandible is moved anteriorly the cartilage is pulled by the muscle and the posterior connective tissue which was like a loose rope gets tauter. This limits the movement of the cartilage anteriorly. Keeping the cartilage centered on the condyle takes some coordination between the structures pulling on and limiting movement of both structures and often goes awry.

To tie this together one must realize that the lower compartment of the joint behaves like a normal condyloid joint and can both rotate in a horizontal axis around the joint but also vertically thus allowing one to protrude one side by pulling it down the articular eminence (upper compartment movement) while the other side stays in the fossa but rotates (lower compartment movement). Opening generally combines both the lower compartment rotation and the upper compartment translation. To fully understand the TMJ you must understand the muscles that move it also but that is outside the scope of this section but will be covered in the section on muscles.

Neck Bones

To complete this topic, we now have to discuss the bones of the neck. Most of these bones are vertebrae but the one that is not is both unique and important to the oral cavity.

Hyoid Bone

The hyoid bone is unlike any other bone in the human body as it has no articulation with another bone. It is a u-shaped bone that mirrors the mandibular body and is positioned deep to that larger bone. It functions as the attachment point for the muscles that control the tongue. The tongue, which is mainly a muscle covered with epithelium, is anchored mainly to the hyoid bone. Movement of the tongue in the superior/inferior and the anterior/posterior directions is related to the movement of the hyoid in those directions. The muscles attached to the hyoid are divided into the suprahyoid and infrahyoid groups depending on the placement of their origins. These muscles attached to the hyoid are all important to the proper movement of the tongue and epiglottis during swallowing and speaking.

Anatomically the main central part of the hyoid is known as the body (above) and projecting superiorly are two superiorly placed projections. The smaller more anterior one is known as the lesser cornu and the one at the posterior extent of the bone is the greater cornu. The cornu, like many structures, are also referred to by another name. In this case they are the greater and lesser horns of the hyoid.

The Cervical Vertebrae

The cervical vertebrae act to support the skull, allow for movement of the head on the neck and some movement of the neck itself, in addition to protecting the spinal cord. Humans have seven cervical vertebrae which is also true of virtually all mammal species, except the manatee and two species of sloths, which only have 6. We will discuss the first two vertebra in detail but the next five are very similar in appearance and will be lumped together under the heading of typical cervical vertebra. All cervical vertebrae have a large central foramen known as the vertebral foramen to allow passage of the spinal cord and two laterally known as the transverse foramen to allow passage of the vertebral blood vessels. The two vertebral arteries are especially important as at the base of the skull they merge to form the single basilar artery which supplies the brain stem and cerebellum with blood and then splits into the two posterior cerebral arteries that join with branches of the internal carotid artery to supply the cerebrum. In addition, between adjacent vertebrae there is a passageway to allow spinal nerves to pass from the spinal cord to the body.

Atlas (C1)

The uppermost cervical vertebra atlas (C1) articulates with the occipital bone superiorly and the second cervical vertebra, the axis, inferiorly. The bone is unique among all vertebrae in that it is the only one without a body to support the weight placed on it. The body of a vertebra is located in the sagittal plane but is placed anteriorly in the bone. Rather than the centrally placed mass of bone it has two lateral support points that articulate with the occipital condyles. These lateral masses as they a called have a concave articular surface to accept the convex condyle. As condylar joints are biaxial the head is allowed to rotate in the superior/inferior direction which produces the yes movement and in the medial/lateral direction which results in tilting the head towards the shoulder.

In addition to the atlas being unique by lacking a body it is also the only vertebra that lacks a spinous process. Furthermore, it has a unique articulation point with the second cervical vertebra, the axis. The articular surface for the dens faces the vertebral foramen and is bounded from it by ligaments which keep the axis in place. We will discuss this further in the following section.

Axis (C2)

The axis is a more conventional vertebra in that it has a body centered in the anterior part of the bone and a like other cervical vertebrae it has a bifid spinous process posteriorly. However, the body is only conventional on the inferior surface where it articulates with C3. The superior surface has a circular projection called the dens that articulates with the atlas.

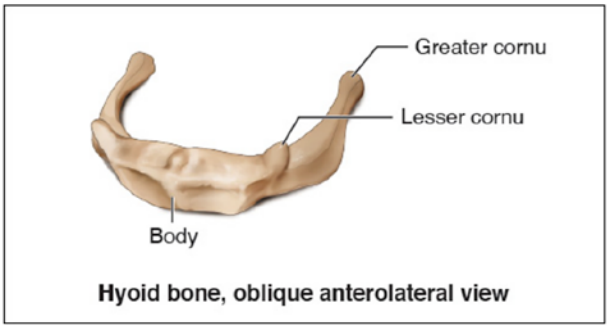


Figure 28.

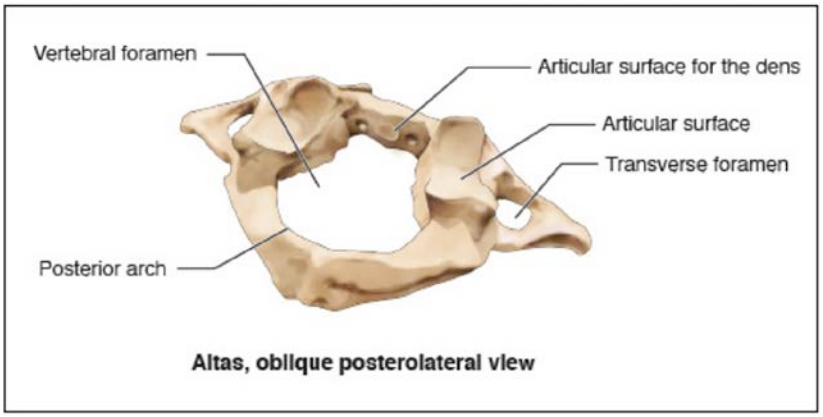


Figure 29.

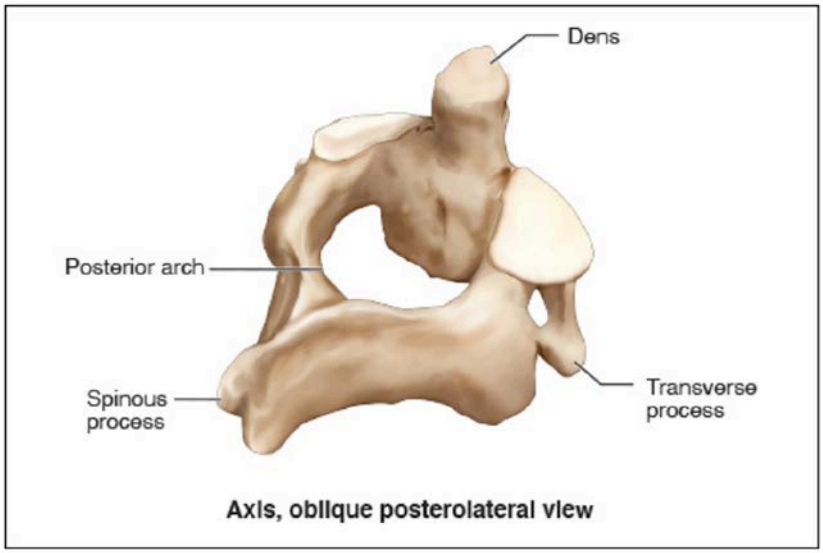


Figure 30.

Held in place by ligaments this forms a type of joint known as a pivot joint which allows rotation in one axis. This translates to lateral and medial rotation of the head which is the rotational motion used to indicate no.

Typical Cervical Vertebrae

While they become larger and the spinous processes become more longer as we proceed from C3-C7 all of these vertebrae have very similar features and can be considered together. They all have a body with the transverse foramina flanking them. Posterior to the foramina are articular surfaces or facets which are shaped to allow some flexibility in moving the vertebrae to change the curvature of the spine at that level. The articular surfaces are joined by the posterior arch composed of bony processes called the lamina which join at the location of the bifid spinous process though C7 does not bifurcate like C2-C6 as it is a transitional form having that attribute in common with the thoracic vertebra which have a more bulbous spinous process without a bifurcation.

Summary

The head and neck area has uniquely shaped bones which are unlike those found in the appendicular skeleton. There are many immovable joints between the bones in the skull which act to protect and define the cranial and facial cavities. These immovable bones are important attachment areas for muscles and ligaments that move the head, the mandible and create facial expressions. Knowing the location of bones makes understanding the muscles in the head and neck easier. The bones also have numerous openings in them to allow passage of nerves and blood vessels plus drain the sinus cavities. Knowing where these are also is a great help in understanding the complex pathways taken by the nerves to provide the dense sensory innervation of the head. Bony landmarks are therefore immensely important in locating the proper areas for delivery of local anesthetic before doing painful procedures in the oral cavity.

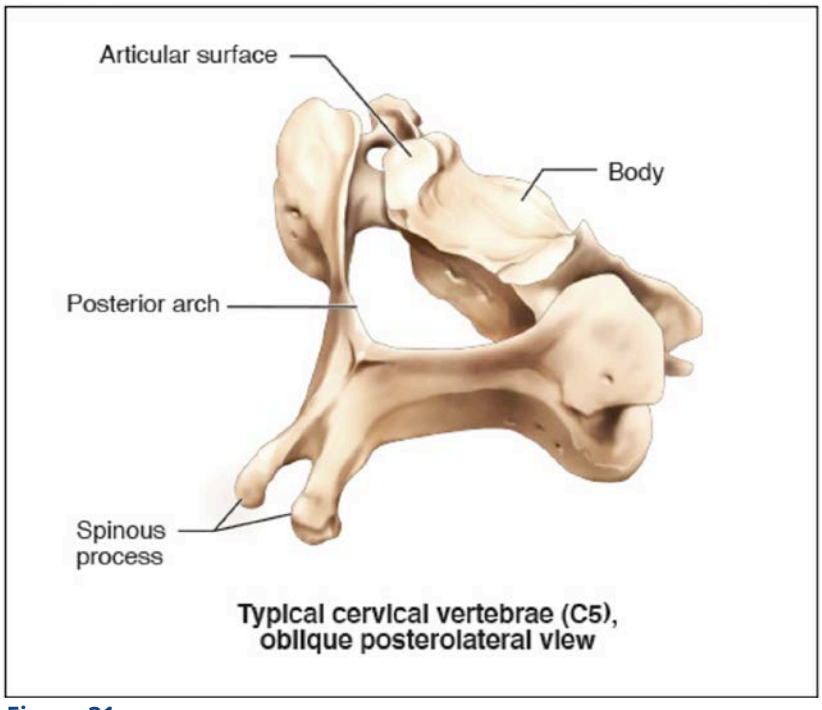
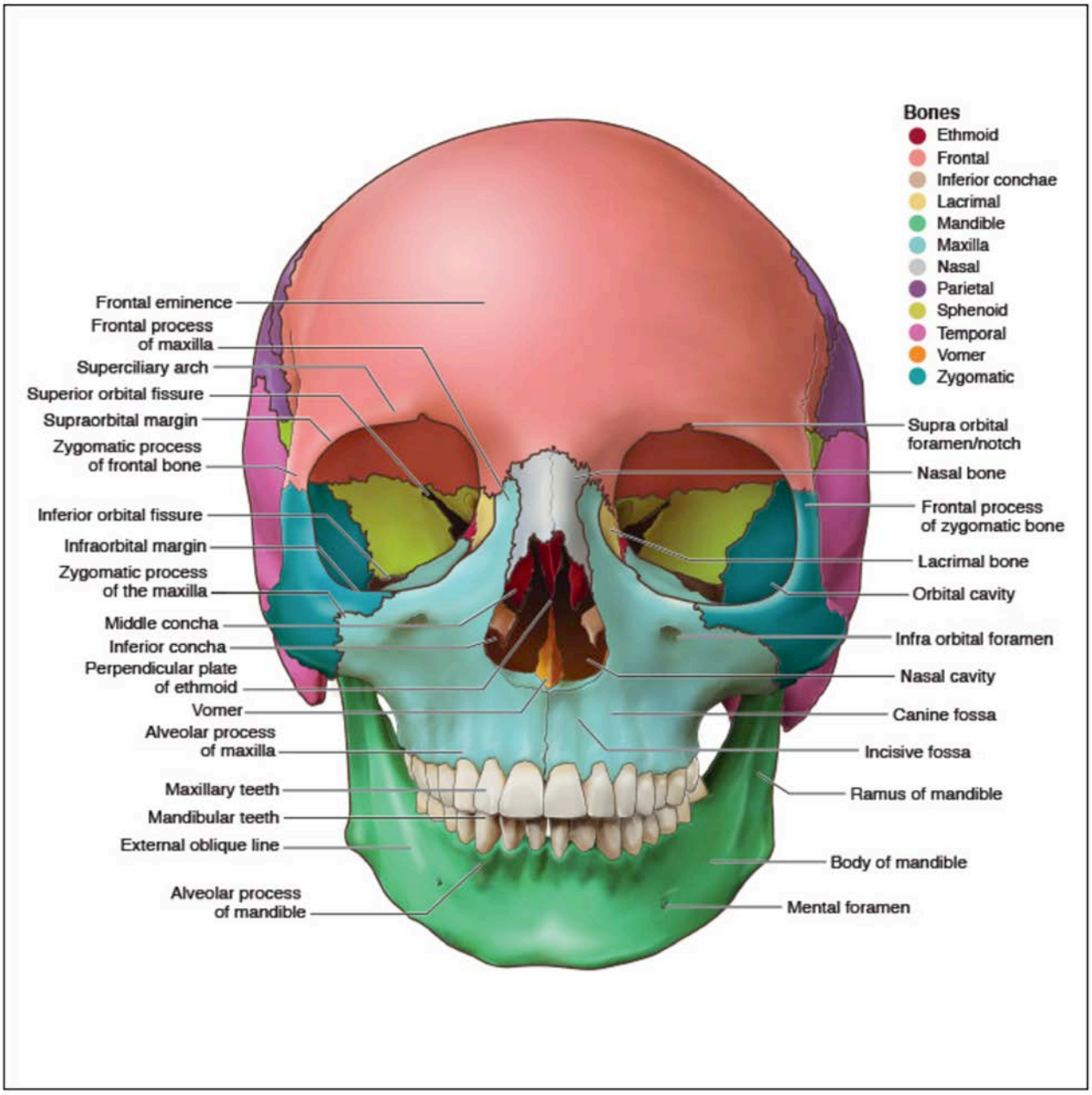
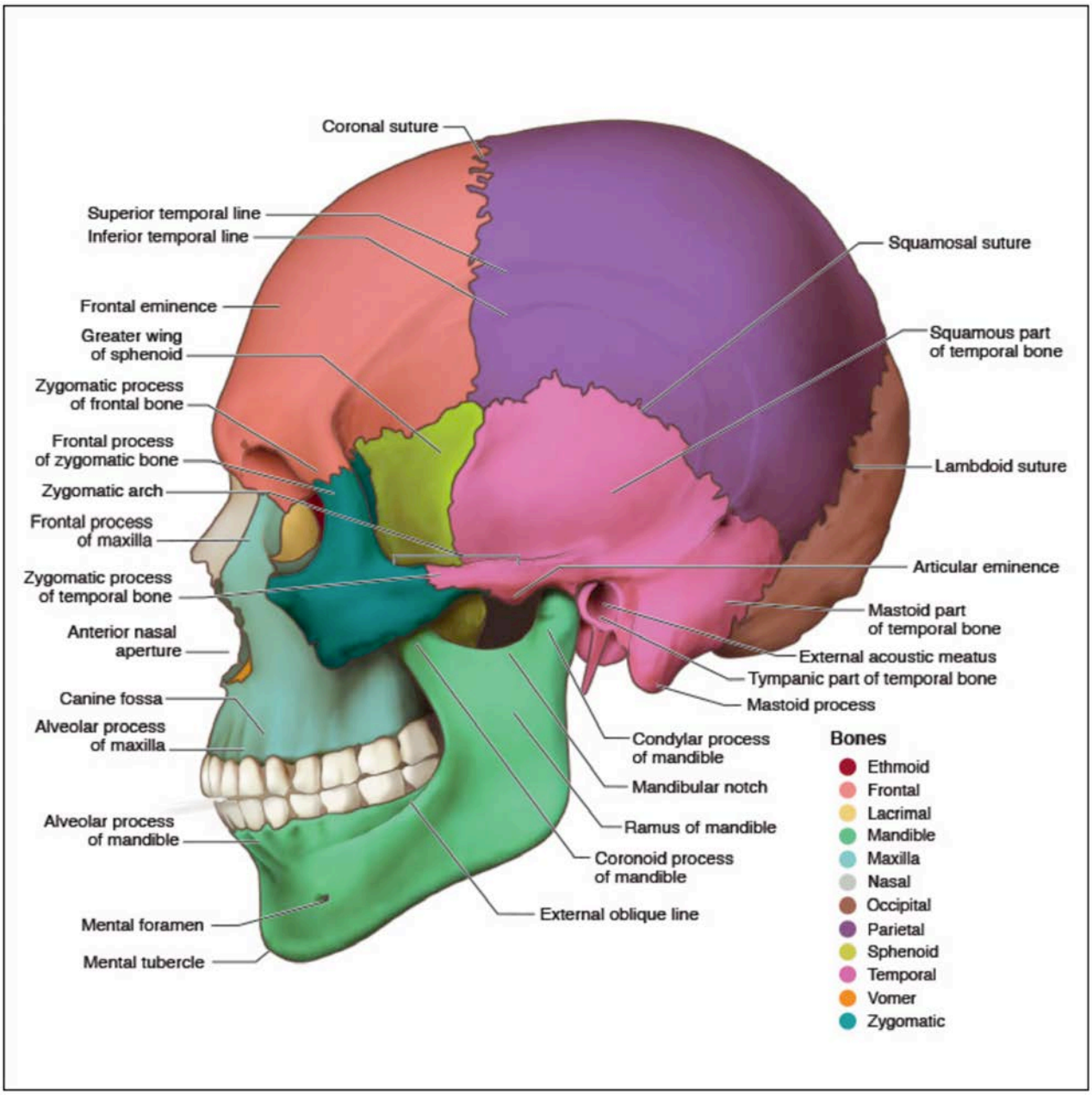


Figure 31.

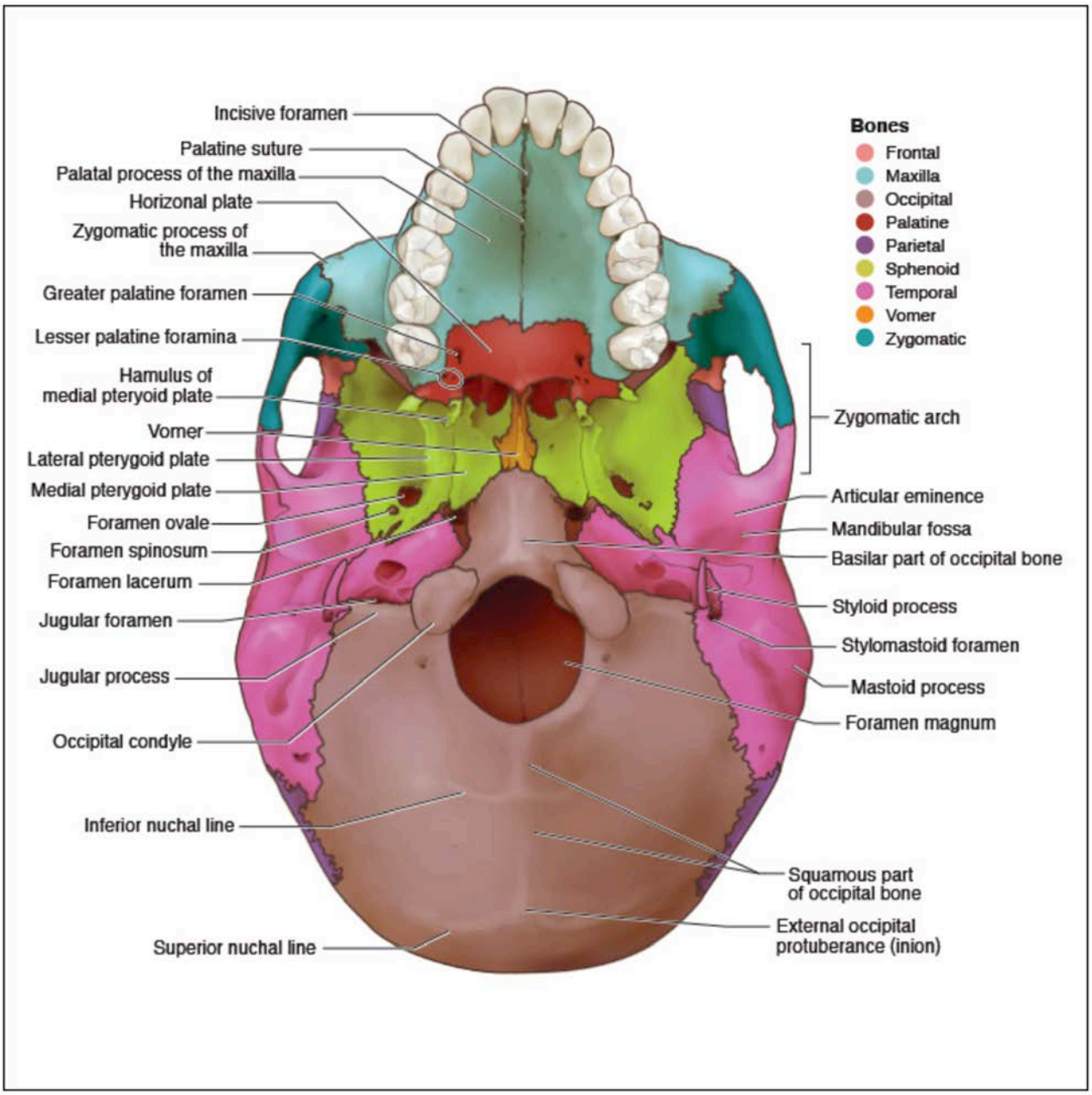
Appendix A


Bones
Ethmoid
Frontal
Inferior conchae
Lacrimal
Mandible
Maxilla
Nasal
Parietal
Sphenoid
Temporal
Vomer
Zygomatic
Frontal eminence
Frontal process of maxilla
Superciliary arch
Superior orbital fissure
Supraorbital margin
Zygomatic process of frontal bone
Inferior orbital fissure
Infraorbital margin
Zygomatic process of the maxilla
Middle concha
Inferior concha
Perpendicular plate of ethmoid
Vomer
Alveolar process of maxilla
Maxillary teeth
Mandibular teeth
External oblique line
Alveolar process of mandible
Supra orbital foramen/notch
Nasal bone
Frontal process of zygomatic bone
Lacrimal bone
Orbital cavity
Infra orbital foramen
Nasal cavity
Canine fossa
Incisive fossa
Ramus of mandible
Body of mandible
Mental foramen

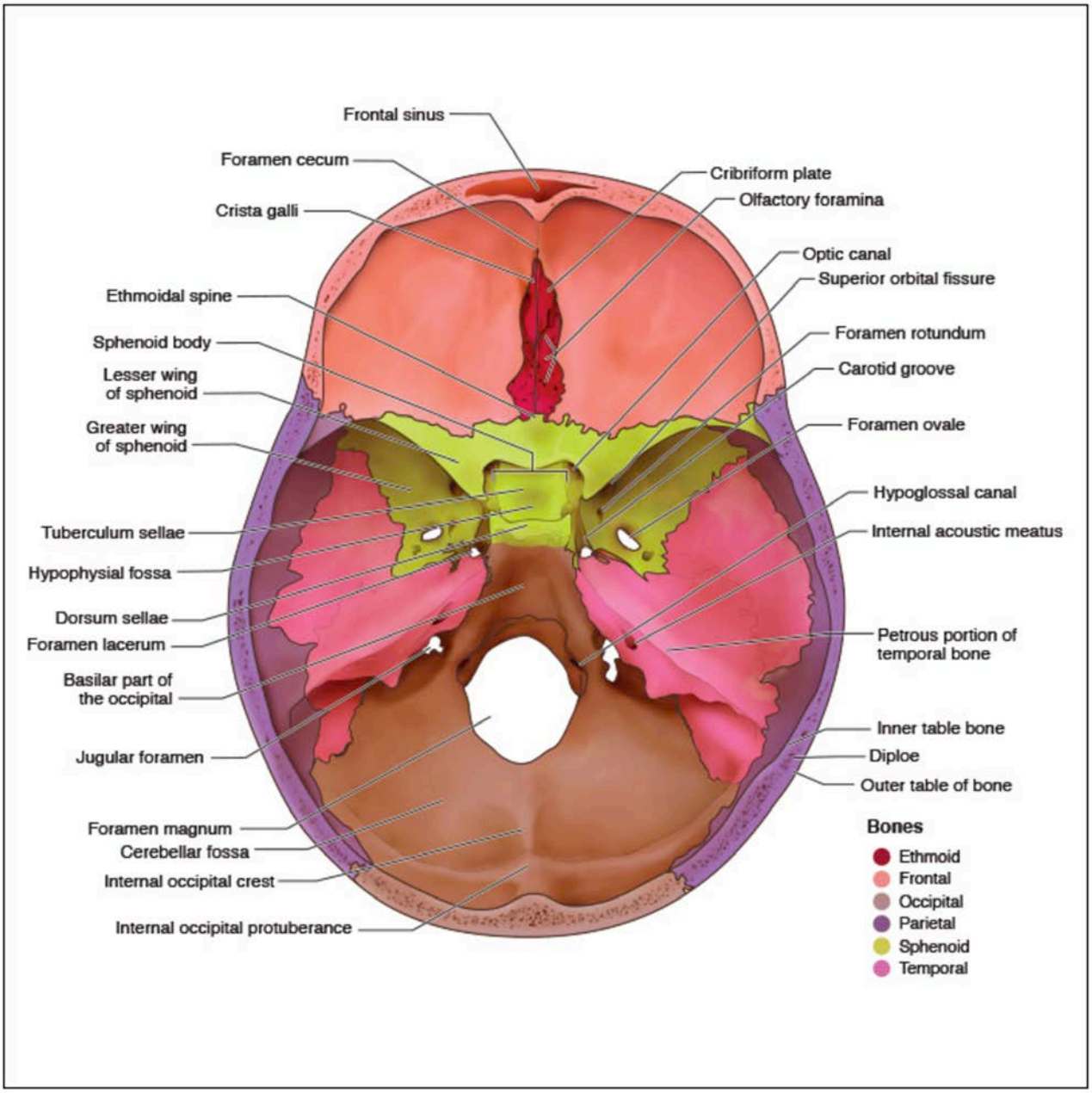
Appendix B


Coronal suture
Superior temporal line
Inferior temporal line
Frontal eminence
Greater wing of sphenoid
Zygomatic process of frontal bone
Frontal process of zygomatic bone
Zygomatic arch
Frontal process of maxilla
Zygomatic process of temporal bone
Anterior nasal aperture
Canine fossa
Alveolar process of maxilla
Alveolar process of mandible
Mental foramen
Mental tubercle
Squamosal suture
Squamous part of temporal bone
Lambdoid suture
Articular eminence
Mastoid part of temporal bone
External acoustic meatus
Tympanic part of temporal bone
Mastoid process
Condylar process of mandible
Mandibular notch
Ramus of mandible
Coronoid process of mandible
External oblique line
Bones
Ethmoid
Frontal
Lacrimal
Mandible
Maxilla
Nasal
Occipital
Parietal
Sphenoid
Temporal
Vomer
Zygomatic

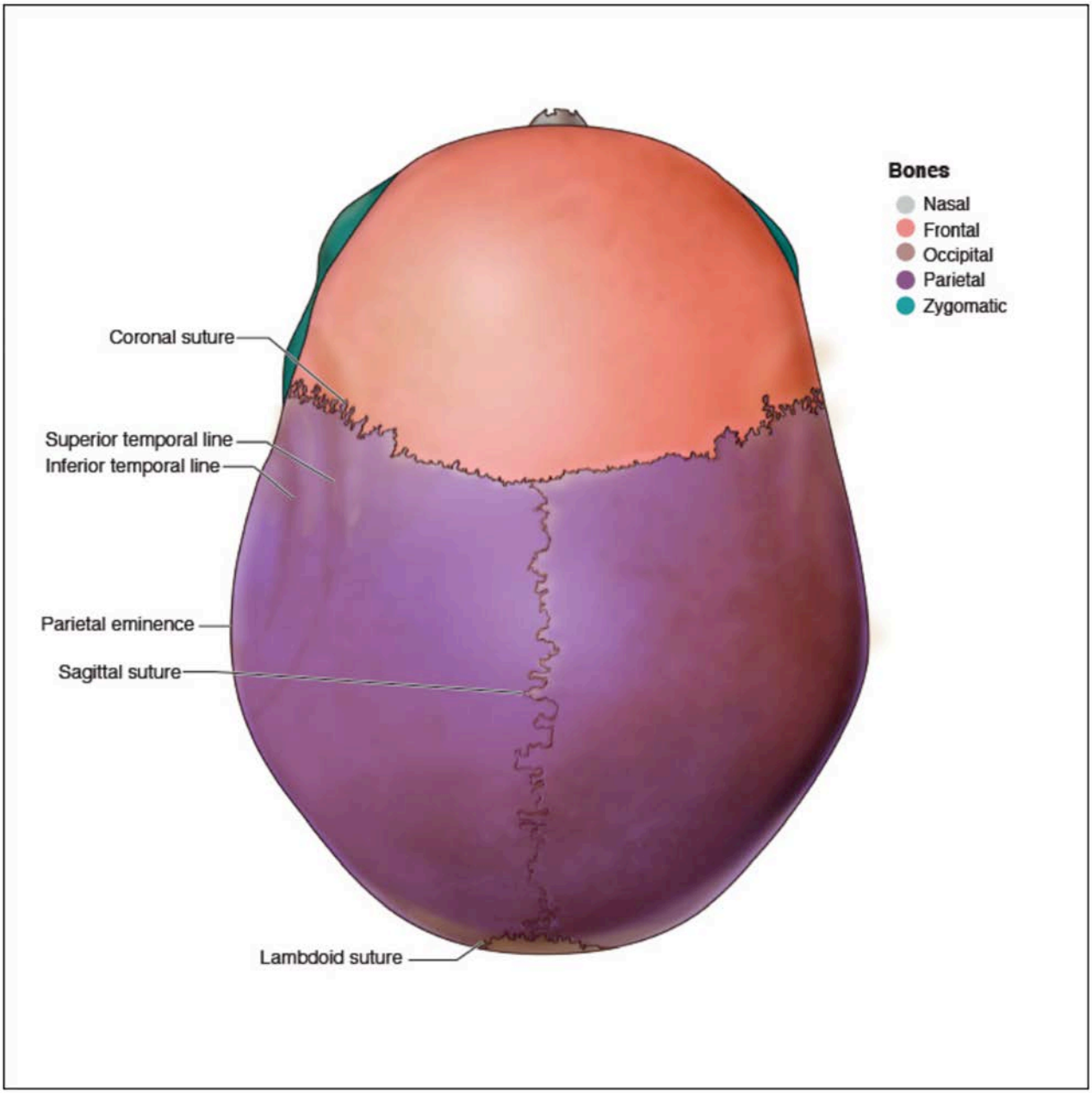
Appendix C


Incisive foramen
Palatine suture
Palatal process of the maxilla
Horizonal plate
Zygomatic process of the maxilla
Greater palatine foramen
Lesser palatine foramina
Hamulus of medial pteryoid plate
Vomer
Lateral pterygoid plate
Medial pterygoid plate
Foramen ovale
Foramen spinosum
Foramen lacerum
Jugular foramen
Jugular process
Occipital condyle
Inferior nuchal line
Superior nuchal line
Bones
Frontal
Maxilla
Occipital
Palatine
Parietal
Sphenoid
Temporal
Vomer
Zygomatic
Zygomatic arch
Articular eminence
Mandibular fossa
Basilar part of occipital bone
Styloid process
Stylomastoid foramen
Mastoid process
Foramen magnum
Squamous part of occipital bone
External occipital protuberance (inion)

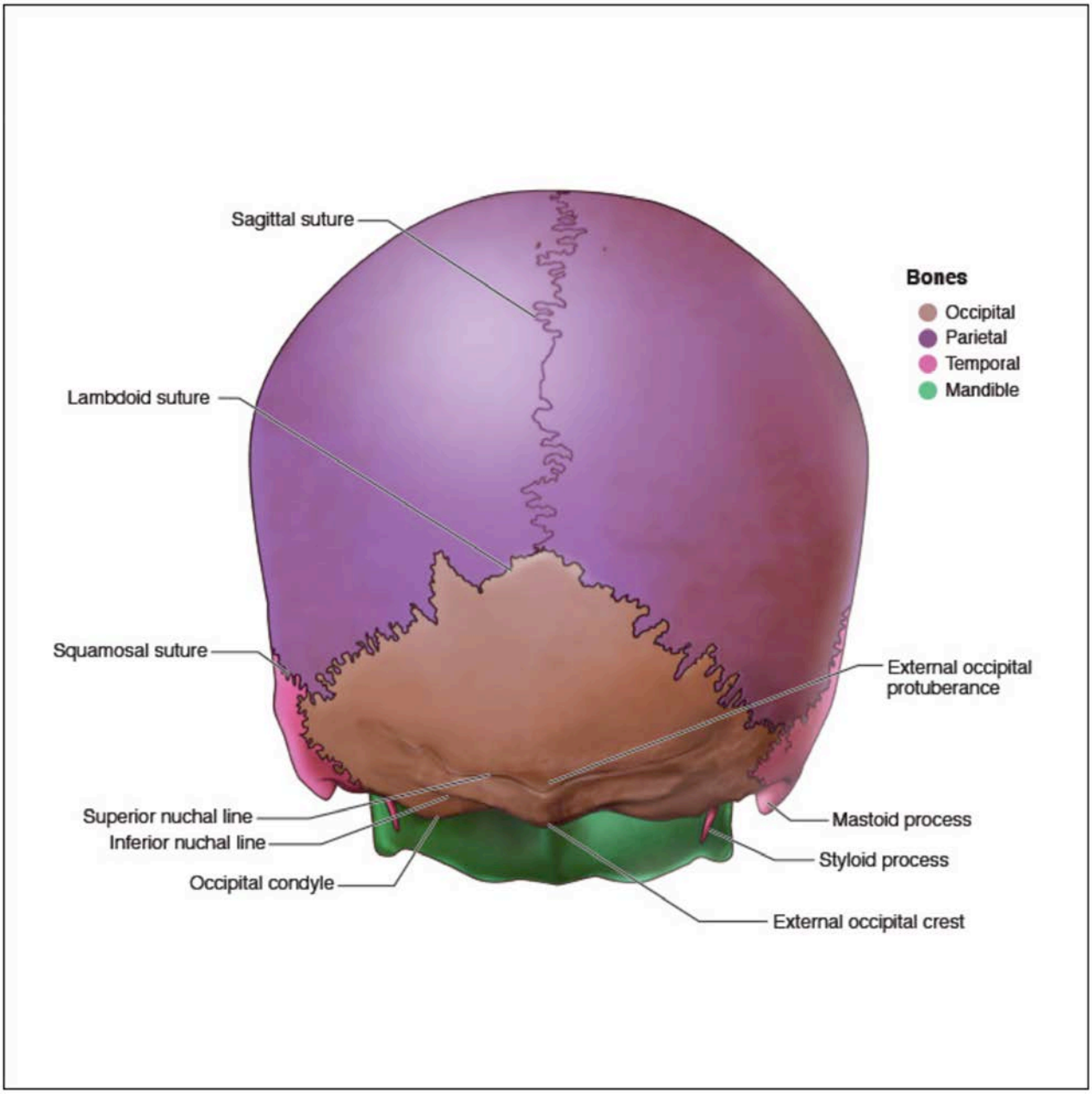
Appendix D


Frontal sinus
Foramen cecum
Crista galli
Ethmoidal spine
Sphenoid body
Lesser wing of sphenoid
Greater wing of sphenoid
Tuberculum sellae
Hypophysial fossa
Dorsum sellae
Foramen lacerum
Basilar part of the occipital
Jugular foramen
Foramen magnum
Cerebellar fossa
Internal occipital crest
Internal occipital protuberance
Cribriform plate
Olfactory foramina
Optic canal
Superior orbital fissure
Foramen rotundum
Carotid groove
Foramen ovale
Hypoglossal canal
Internal acoustic meatus
Petrous portion of temporal bone
Inner table bone
Diploe
Outer table of bone
Bones
Ethmoid
Frontal
Occipital
Parietal
Sphenoid
Temporal

Appendix E


Bones
Nasal
Frontal
Occipital
Parietal
Zygomatic
Coronal suture
Superior temporal line
Inferior temporal line
Parietal eminence
Sagittal suture
Lambdoid suture

Appendix F


Sagittal suture
Lambdoid suture
Squamosal suture
Superior nuchal line
Inferior nuchal line
Occipital condyle
Bones
Occipital
Parietal
Temporal
Mandible
External occipital protuberance
Mastoid process
Styloid process
External occipital crest

Course Test Preview

To receive Continuing Education credit for this course, you must complete the online test. Please go to: *www.dentalcare.com/en-us/professional-education/ce-courses/ce591/test*

1. The temporomandibular joint is the only freely articulating joint in the skull. The mandibular condyle which is part of the joint articulates with the _____.

A. articular fossa of the temporal bone
B. coronoid notch of the mandible
C. maxillary tuberosity of the maxilla
D. pterygoid fovea of the mandible

2. Which is the largest nasal concha?

A. Superior
B. Middle
C. Inferior
D. They are all the same size

3. The paranasal sinuses are cavities within bones of the skull that are connected to openings in the nasal cavity. Which of the following bones has a paranasal sinus in it?

A. Mandible
B. Nasal
C. Sphenoid
D. Zygomatic

4. The nasal cavity is divided into two separate cavities by the nasal septum. The two main bones that make up the bony nasal septum are the _____.

A. ethmoid and inferior concha
B. ethmoid and vomer
C. nasal and sphenoid
D. vomer and inferior concha

5. The maxilla is a large complex bone that houses the maxillary teeth. In what process are the teeth found?

A. Alveolar
B. Frontal
C. Palatal
D. Zygomatic

6. The mandible is an important bone in dentistry. The portion of the mandible that forms a synovial joint is generally known as the _____.

A. angle
B. body
C. condyle
D. ramus

7. A prominent zygomatic arch is currently in fashion seen as a thing of beauty. What two bones make up the majority of this structure?

A. maxillary and zygomatic
B. sphenoid and zygomatic
C. temporal and zygomatic
D. temporal and maxilla

8. Which of the following bones articulates with the frontal, occipital, ethmoid and lacrimal bones among others?

A. Nasal
B. Sphenoid
C. Temporal
D. Zygomatic

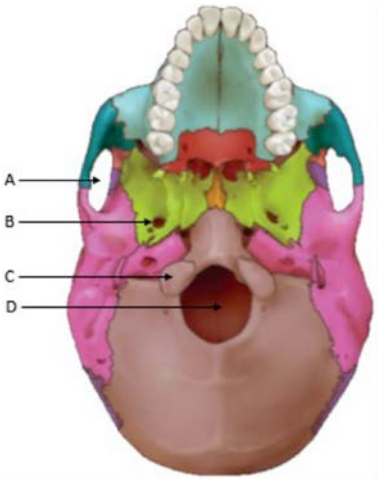
9. Rotating the head is possible and produces the "no" movement. The joint that allows this movement is composed of which two bones?

A. Atlas and occipital
B. Atlas and axis
C. Axis and occipital
D. Mandible and hyoid

10. The auditory organ is protected within which bone?

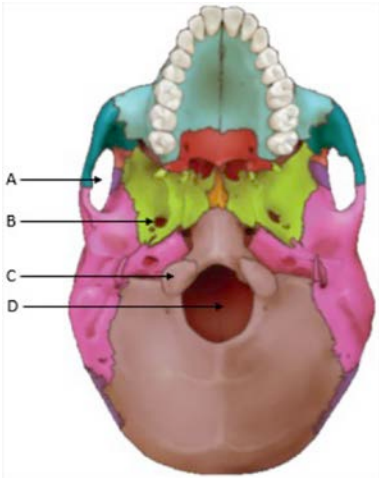
A. Frontal
B. Maxilla
C. Sphenoid
D. Temporal

11. The third division of the trigeminal, the mandibular nerve, passes through the *foramen ovale*, labeled ____ below.



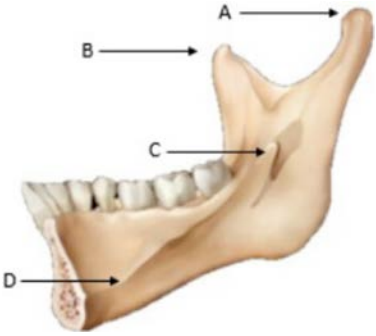
A. A
B. B
C. C
D. D

12. The *occipital condyle*, labeled ____ below, is found on the inferior surface of the occipital bone and articulates with the atlas.



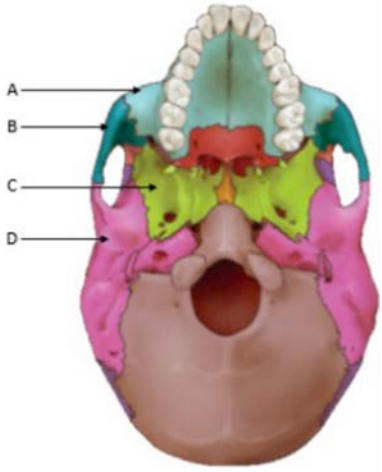
A. A
B. B
C. C
D. D

13. The ramus itself splits at its superior extent into two processes. The anterior process known as the *coronoid process*, labeled ____ below, and is the attachment point for the temporalis muscle.



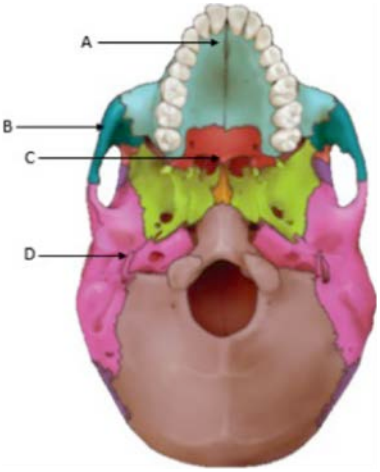
A. A
B. B
C. C
D. D

14. The zygomatic bone forms the central portion of the zygomatic arch and provides a large mass of bone at the lateral wall of the orbit and is labeled below as ____?



A. A
B. B
C. C
D. D

15. The *styloid process*, labeled ____ below, is an attachment point for both the stylopharyngeus muscle and the stylomandibular ligament, and is important to the proper functioning of the temporomandibular joint (TMJ).



A. A
B. B
C. C
D. D

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About the Author

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Dr. LoPresti has a BA from Amherst College and a DMD from Boston University Henry M. Goldman School of Dental Medicine. He has been an adjunct Professor teaching anatomy for over 20 years and is currently employed by MCPHS University Forsyth School of Dental Hygiene. In addition, he has practiced general dentistry both in private practice and FQHC dental centers. Most interestingly, he is the consulting dentist for the Roger Williams Park Zoo in Providence, RI. For the past 6 years, Dr. LoPresti has been a CODA site visitor for allied health.

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