FACE
EMBRYOLOGY AND ANATOMY

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Embryology

- Parietal and occipital bones derived from paraxial mesoderm.
- All other bones of skull and face are derived from neural crest.
- The pharyngeal arches arise from the dorsal and most cephalic portion of the embryo.
- Each pharyngeal arch is lined externally by ectoderm and internally by endoderm.
- Each arch contains a core of mesenchyme derived from mesoderm and neural crest tissue.

Embryology

- By the end of the 4th week of development, four pairs of pharyngeal arches are visible
- The fifth quickly regresses
- 1-4 and 6 form, but 6 is not visible
- Pharyngeal clefts are found on the ventral surface of the embryo, opposite the arches.
- They arise from ectoderm.
- The first pharyngeal cleft forms the external auditory meatus.
- The second through fourth clefts develop as a communicating invagination of the embryo.
- This will later close as mesenchyme fills the sinus.

Embryology

- Pharyngeal pouches arise from the endoderm.
- The first of four pouch pairs gives rise to the tympanic cavity, mastoid antrum, and the auditory tube.
- After birth the tympanic cavity invades the mastoid process.
- The apex of the pharyngo-tympanic tube is attached to the bone, fixed to the base of the skull between the greater wing of the sphenoid and the petrous temporal bone.
- The tensor veli palatini separates it from infra-temporal fossa.
- Some fibers of tensor are attached to the tube.

Embryology

- The oropharyngeal membrane develops in a cleft between the two parts of the first arch .
- It is composed of an outer layer of ectoderm and an inner layer of endoderm.
- This membrane eventually ruptures and produces an opening from the pharynx to the amniotic cavity.
- The first membrane forms the tympanic membrane.
- The other membranes regress.

Embryology

- The second pouch gives rise to the epithelial lining of the palatine tonsil.
- The third gives rise to the thymus (ventral wings of the pouches) and inferior parathyroid glands (dorsal wings of the pouches).
- The fourth gives rise to the superior parathyroid gland (dorsal wings of the pouches).

Embryology

- The structures of the pharyngeal arches arise from the mesoderm.
- The first pair of arches receives CN V_3.
- Muscles of mastication, anterior belly of digastric, myohyoid, tensor tympani, tensor veli palatini muscles; maxillary artery; malleus and incus.
- The second pair of arches receives CN VII.
- Muscles of facial expression, stapedius, posterior belly of digastric, stylohyoid muscles
- Hyoid and stapedial arteries
- Stapes, styloid process, lesser horn and superior portion of the body of the hyoid bone.

Embryology

- The third pair of arches receives CN IX.
- Stylopharyngeus muscle
- Common and internal carotid arteries
- Greater horn and inferior portion of the body of the hyoid bone.
- The fourth pair of arches receives CN X.
- Palatal and pharyngeal muscles as well as the cricothyroid muscle.
- Aortic arch (left) and first portion of subclavian artery (right)
- Laryngeal cartilage

Embryology

- The sixth pair of arches receives CN X.
- Muscles of the larynx
- Inferior constrictor, cricopharyngeus muscles
- Superior portion of the esophagous
- Pulmonary artery and ductus (left)
- Laryngeal cartilage.

Cervical plexus

- Ventral rami of C1-C4.
- Communicate with CN X-CN XII and the sympathetic chain.
- The ansa cervicalis is the loop formed by the cutaneous branches of C1-C3 (great auricular, lesser occipital, transverse cervical, and supraclavicular nerves).
- Muscular branches innervate the diaphragm and pre-vertebral muscles.

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Embryology

- The tongue arises from the floor of the pharynx. Innervation of the tongue is explained by its derivation from the first four arch pairs.
- The thyroid arises from the foramen cecum, located in the midline of the terminal sulcus between the anterior two-thirds and posterior one-third.
- The thyroid migrates along the path of the thyroglossal duct.

Palate

- The palate arises from the maxillary bone. The primary palate is the area of fusion of floor of the maxilla. It comprises the philtrum and the four incisor teeth.
- Fusion of the palatine shelf (plates) forms the secondary palate.
- CN V_2 innervates the maxillary teeth; CN V_3, mandibular teeth.

Palatal muscles

- The tensor veli palatini tense the soft palate and opens the mouth of the pharyngotympanic tube during yawning and swallowing.
- The levator veli palatini elevate the soft palate during yawning and swallowing. (Say “ah”)
- The palatoglossus elevates the posterior part of the tongue and draws the soft palate onto the tongue.
- The palatopharyngeus tenses the soft palate and pulls the walls of the pharynx superiorly, nateriorly, and medially during swallowing.
- The musculus uvulae shortens the uvula and pulls it superiorly.

Calvarium

- Parietal and temporal bones are paired; frontal, ethmoid, sphenoid, and occipital bones are not paired.
- Sagittal and coronal sutures intersect at the bregma (anterior fontanelle).
- Sagittal and lambdoidal sutures intersect at the lambda (posterior fontanelle).
- The pterion is the union of frontal, parietal, sphenoid, and temporal bones. It overlies the middle meningeal artery.

Calvarium

- The sphenoid ridge separates the anterior fossa and middle fossa. The sphenoid bone, however, lies in all fossae.
- The anterior fossa contains the crista galli (attachment of the falx cerebri) and the cribiform plate (CN I exit).
- The middle fossa contains the foramina of the opitc canal (CN II exit), superior orbital fissure (CN III, CN IV, CN V_1, and CN VI exit), foramen rotundum (CN V_2 exit), foramen ovale (CN V_1 exit) and the foramen spinosum.

Calvarium

- The internal carotid artery runs in the carotid canal in the middle fossa. Only a small portion of the canal opens through the foramen lacerum.
- The petrosal ridge separates the middle fossa and posterior fossa.
- The posterior fossa contains the foramen magnum through which pass the spinal cord, vertebral arteries, the spinal root of CN XI, the anterior and posterior spinal arteries, and the internal vertebral venous plexus.

Calvarium

- The posterior fossa also contains the jugular foramen through which pass CN IX-CN XI, the sigmoid sinus, and the petrosal sinus. CN VII and CN VIII pass through the internal acoustic meatus. CN XII passes through the hypoglossal canal.
- The dura has two layers around the brain but only one around the spinal cord.
- The falx cerebri, the falx cerebelli, tentorium cerebelli, and diaphragma sellae are dural openings in the skull.

Dura

- The outer layer of dura mater is firmly attached to the skull. It is continuous with the periosteum of the outer skull at the foramen magnum.
- The inner layer is continuous with the spinal dura mater at the foramen magnum. It is the meningeal layer.
- Within the cranium, the dura projects and partitions the brain. The falx cerebri runs from the crista galli to the tentorium cerebelli.
- The tentorium cerebelli is attached posteriorly to the occipital bone and laterally to the petrous parts of the temporal bone. The anterior and medial borders are free. The brainstem passes between them.

Dura

- The falx cerebelli is a midline projection of the dura in the posterior cranial fossa that attaches to the occipital crest of the occipital bone and to the tentorium cerebelli. It separates the cerebellar hemispheres.
- Venous spaces are formed between the layers of dura. Empty into the internal jugular veins via the jugular foramen.
- The arachnoid is a thin, avascular membrane against the dura. Fine trabeculae attach arachnoid to pia. Blood vessels travel in the space between pia and arachnoid. CSF is present in subarachnoid space.

Dura

Arterial supply of the dura mater:

- Anterior cranial fossa: anterior and posterior ethmoidals, internal carotid, branches from middle meningeal artery
- Middle cranial fossa: middle meningeal artery, accessory meningeal artery, ascending pharyngeal, recurrent lacrimal
- Posterior cranial fossa: occipital, vertebral, ascending pharyngeal

Dura

- Emmisary veins pass through the calvarium. These are veins of the scalp communicate with dural sinuses. They have no valves. Venous drainage from the skull itself occurs through diploic veins. They too lack valves and communicate with dural sinuses.
- Basivertebral veina drain vertebrae.
- Vertebral venous plexes lie within the vertebral canal external to the dura mater. Lack valves.
- Communicate with external plexes of intercostal veins, thoracic veins, lateral sacral veins.

Dura

- The superior saggital sinus receives CSF from the arachnoid. Drains to the confluens or the right transverse sinus.
- The straight sinus is formed by the great cerebral vein (of Galen).
- The inferior saggital sinus drains to the confluens or the left transverse sinus.
- The transverse sinuses drain to the sigmoid sinuses (which become the internal jugular veins as they exit the cranium).

Dura

- The bone which contains the cavernous sinus also contains the internal carotid arteries as well as CN VI on either side of the sinus. CN III, CN IV, and CN V_1 are located in the lateral wall of the sinus.
- The ophthalmic veins and pterygoid plexus communicate with the cavernous sinus and drains to the superior and inferior petrosal sinuses.

Dura

Innervation of the dura mater:

- Anterior cranial fossa: anterior and posterior ethmoidal nerves, maxillary and mandibular divisions of CN V
- Middle cranial fossa: maxillary and mandibular divisions of CN V
- Posterior cranial fossa: C2 and C3, CN X, CN XII
- Tentorium cerebelli: V_3

Scalp

- The scalp receives the three divisions of CN V, the dorsal and ventral rami of C2 and the dorsal ramus of C3.
- The third occipital supplies the area behind the lambda; the greater occipital supplies the area immediately anterior to the parietal and occipital suture line; the lesser occipital supplies the area of the parietal bone.
- The auriculo-temporal, zygomatico-temporal, supra-trochlear, and supra-orbital nerves supply those named areas of the scalp.

Scalp

- The supra-trochelar, supra-orbital, and superficial temporal arteries arise from the external carotid. The postrior auricular and occipital arteries arise from the internal carotid and supply the scalp. The arteries are extensively anastamosed.

Bones of the face

- The facial buttresses are bony arches joined by suture lines. They provide vertical and horizontal support.
- Vertical support is strong. The zygomatic-maxillary buttress laterally and the frontal process of the maxilla medially withstand vertical stresses associated with mastication.
- Horizontal support is weak and consists of the superior orbital rims, orbital floor, and hard palate.
- Frontal, lateral, and oblique forces tend to produce facial fractures.

Bones of the face

- Sutures found at borders of the sphenoid wings, pterygoid plate, and the zygomatic arch anchor the face to the skull. They prevent the bones of the face from being driven or displaced backward under the cranium.
- The weakest portions of the orbit are the floor and medial wall. Injury to the orbit threatens the optic nerve.

Anatomy of the face

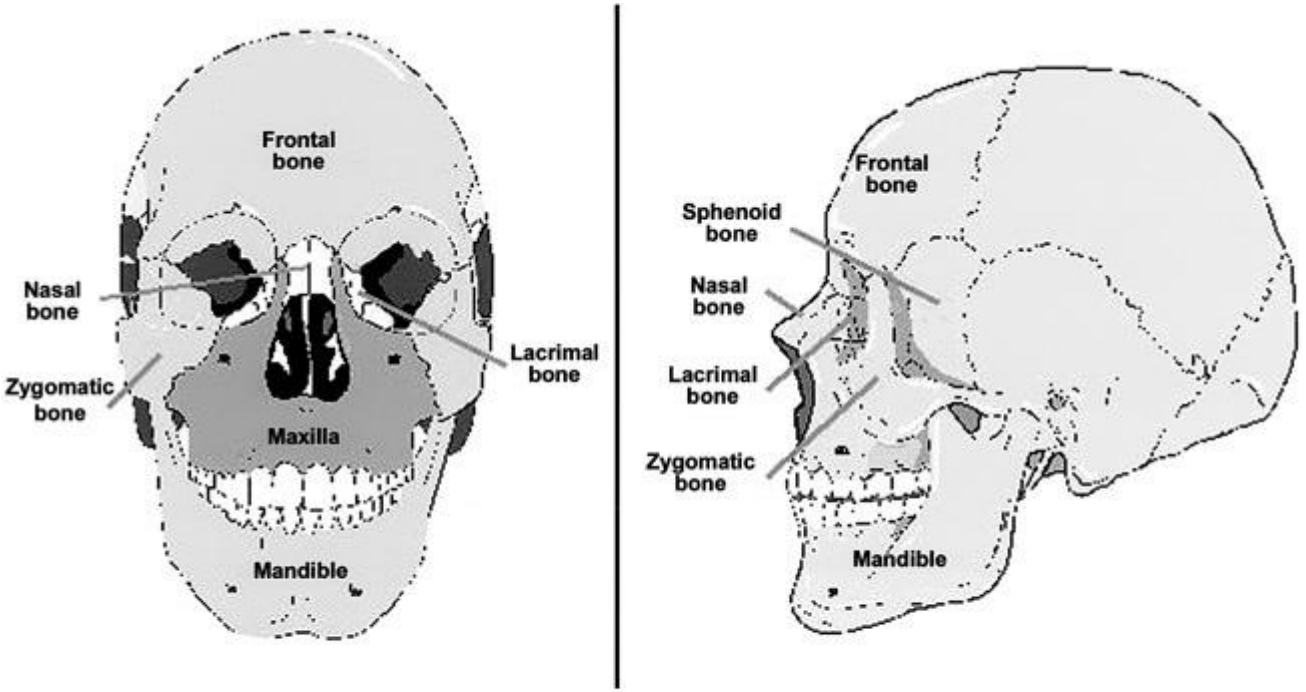

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Fig. 257-1 Accessed 05/05/2010

Orbit

- The sphenoid forms part of the medial, superior, and lateral walls of the orbit.
- Tenon's capsule forms the medial and lateral check and suspensory ligaments of the eye.
- The periosteum of the orbit blends with dura and is continuous with the orbital septa of the eyelids.
- CN II and the ophthalmic artery exit the optic canal. The artery gives rise to the central retinal artery and the ciliary arteries. Orbital branches are the lacrimal, anterior and posterior ethmoidal, supra-orbital, supra-trochlear, and dorsal arteries.

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Apex of orbit

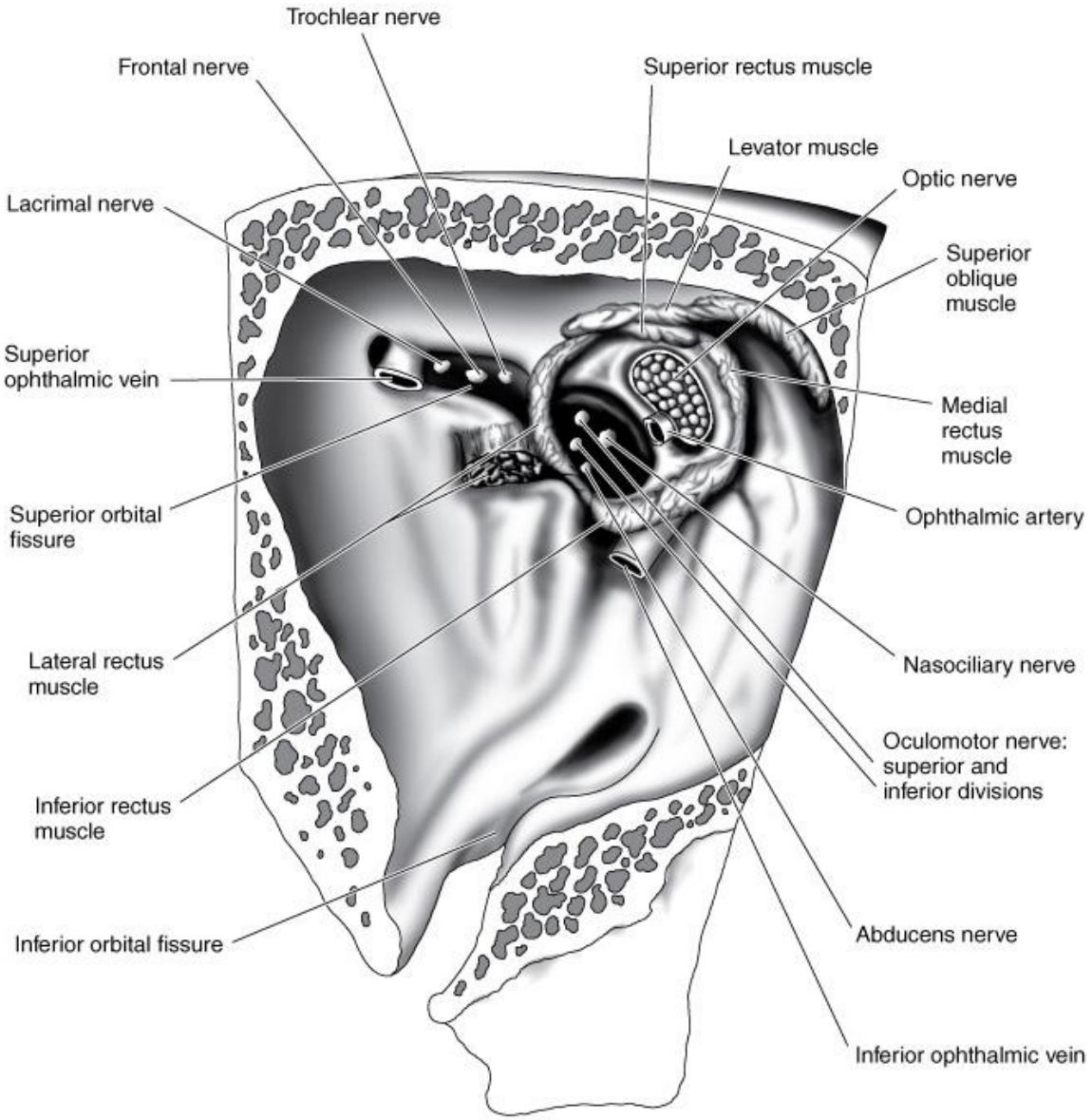
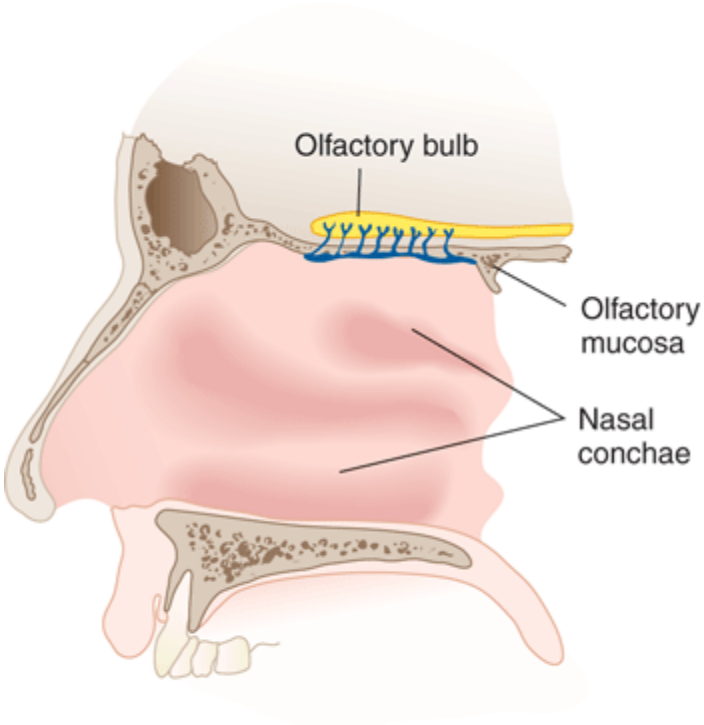


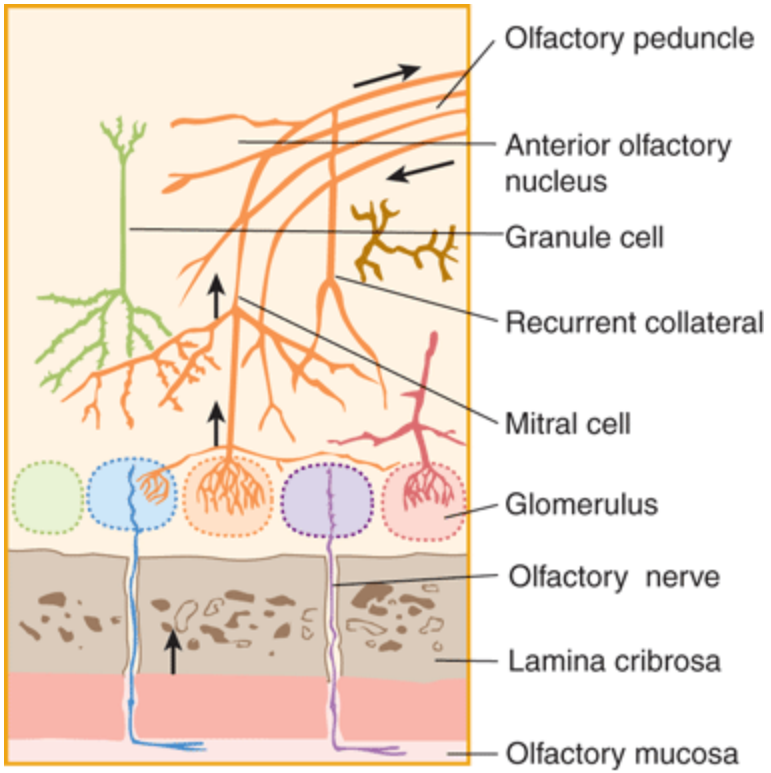
Fig. 1-3 Accessed 07/01/2010

Orbit

- CN III, CN IV, CN V_1, CN VI, and the superior ophthalmic vein pass through the superior orbital fissure. The vein is formed by the confluence of angular, supra-orbital, and supra-trochlear veins. It communicates with the pterygoid plexus and drains to the cavernous sinus.
- CN III connects with the ciliary ganglion.
- CN V_2 and the inferior ophthalmic vein pass through the inferior orbital fissure. The vein drains the eyelids.

Olfactory apparatus





Figs. 19-5 and 19-6 Accessed 07/01/2010

Olfactory syndromes

- Foster-Kennedy syndrome occurs when a meningioma in the olfactory groove compresses the olfactory and optic nerves. There is an inability to detect smells (ipsilateral), ipsilateral optic nerve atrophy and contralateral papilledema.
- Kallman's syndrome results as a failure of neurons to migrate to hypothalamic locations. There is an inability to detect smells (anosmia) and hypogonadism.

Nasal cavity and paranasal sinuses

- The vomer and the ethmoid are the major bones of the nose. The sphenoid (posteriorly), palatine (inferiorly) bound the vomer. The frontal bone is the superior boundary of the ethmoid. The ethmoid lies superior to the vomer. Cartilage attaches to both ethmoid and vomer to form the septum.
- The superior and middle turbinates (conchae) are part of the ethmoid. The inferior turbinate is a separate bone.

Nasal cavity and paranasal sinuses

- The frontal sinus drains to the middle meatus (fronto-nasal duct).
- The maxillary sinus drains superiorly to the middle meatus.
- The spheno-ethmoid recess lies superior to the superior meatus and receives drainage from the sphenoid sinus. The posterior portion of the ethmoid sinus drains to the superior meatus. The anterior and middle ethmoid sinuses drain to the middle meatus.
- The inferior meatus receives the nasolacrimal duct.

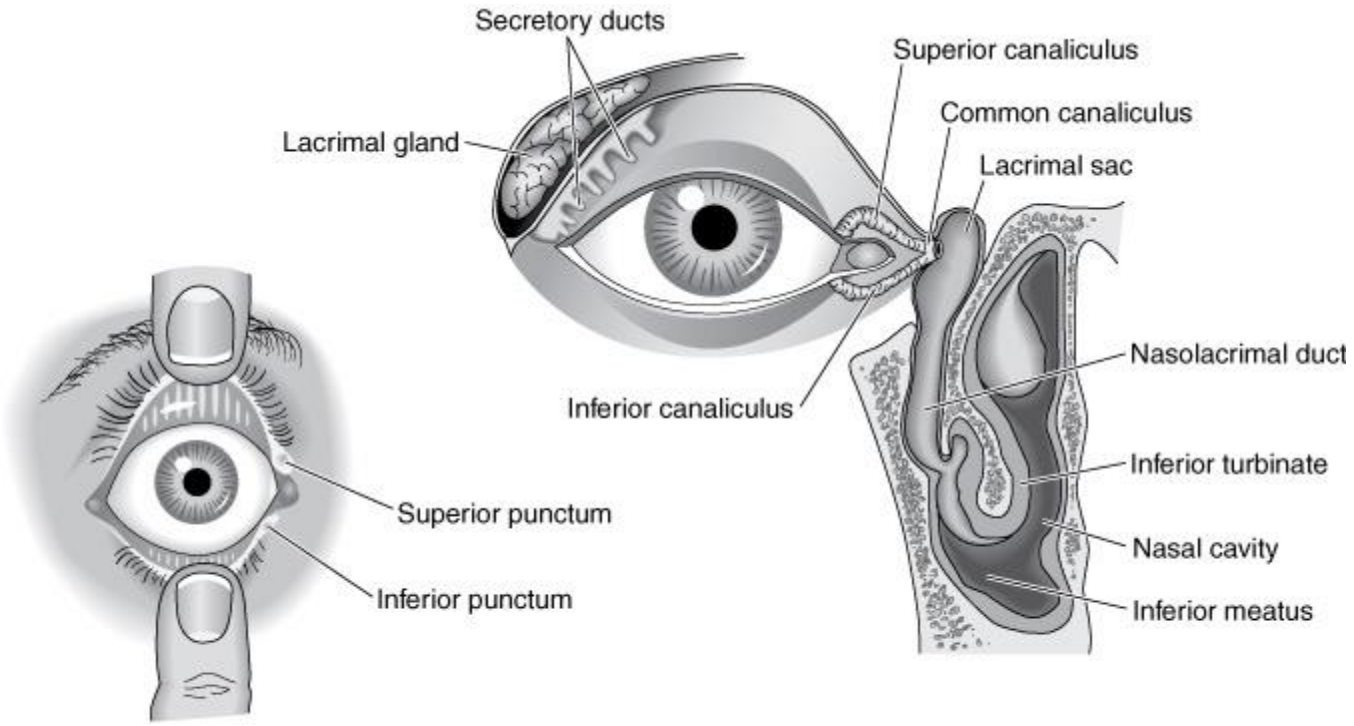
Nasal cavity and paranasal sinuses

- CN V_1 and CN V_2 innervate the parasnasal sinuses and nasal cavity.
- CN I innervates the roof, superior concha, and the superior portion of the septum.
- The sphenoplalatine artery is the major vessel supplying the nasal cavity and paranasal sinuses.
- The anterior and posterior ethmoidal arteries, and the septal branch of the superior labial also supply the paranasal sinuses.

Lacrimal apparatus

- The lacrimal gland is located in the upper, outer corner of the orbit.
- Innervated by the greater petrosal nerve (CN VII). The nerve joins the deep petrosal to form the nerve of the pterygoid canal.
- The lacrimal sac is located medially. Drains to the inferior meatus of the lateral nasal wall through the naso-lacrimal duct.

Lacrimal drainage



Source: Riordan-Eva P, Whitcher, JP: *Vaughan & Asbury's General Ophthalmology*, 17th Edition: http://www.accessmedicine.com

Fig. 1-24 Accessed 07/01/2010

Infra-temporal fossa

- The mandibular division of CN V is the only division that has motor fibers. Innervates the masseter, temporalis, pterygoids, tensor tympani, tensor veli palatini, myolohyoid, and the anterior belly of the digastric muscles.
- The lingual nerve provides general sensation to the anterior two-thirds of the tongue and is joined by the chorda tympani (branch of CN VII).
- The chorda tympani contains both taste fibers and parasympathetic fibers (to both submandibular and sublingual glands.
- The auriculo-temporal nerve (CN IX) carries parasympathetics to the parotid gland.

Infra-temporal fossa

- The maxillary artery is a terminal branch of the external carotid. It is the major artery to the deep structures of the face. May run superior to or deep to the lateral pterygoid muscle.
- The first portion of the artery lies deep to the mandible. All branches enter through a single foramen.
- The inferior alveolar artery (to the lower jaw) and the middle meningeal artery (major supply to dura and calvarium) arise from the maxillary artery.

Infra-temporal fossa

- The second portion of the maxillary artery lies either superior or deep to the lateral pterygoid muscle.
- All branches go to area muscles.
- The maxillary artery leaves the infra-temporal fossa through the spheno-maxillary fissure to enter the pterygopalatine fossa.
- The third portion of the maxillary artery is the sphenopalatine and supplies the nose and nasal cavity.

Pterygoid plexus

- Lies both superficial and deep to the lateral pterygoid muscle.
- Communicates with the cavernous sinus and the veins of the orbit.
- Forms the maxillary vein which joins the superficial temporal vein to form the retro-mandibular vein.
- The posterior division of the retro-mandibular vein joins the posterior auricular vein to form the external jugular vein.

Palate

- The maxilla and palatine bones form the hard palate.
- The levator veli palatini, palato-glossus, palato-pharngeus, and uvular muscles of the hard palate are innervated by CN X (pharyngeal branch). The tensor veli palatini is innervated by CN V_3.
- Sensory fibers to the palate arise from CN V_2. The greater petrosal nerve (CN VII) provides parasympathetics to the palatal glands.
- The greater and lesser palatine, spheno-palatine, facial, and ascending pharyngeal arteries supply the palate.

Vessels of the face

- The facial artery courses along the inferior surface of the mandible anterior to the masseter muscle and ascends to supply the labial arteries, nasal artery, and supra-trochlear and supra-orbital arteries.
- The facial vein communicates with the cavernous sinus through the veins of the orbit.
- The parotid gland lies anterior to the ear and is superficial to the masseter muscle. CN VII, the auriculo-temporal nerve, the external carotid artery, and the retro-mandibular vein traverse the parotid.
- The parotid duct crosses the masseter to pierce the buccinator to open opposite the second upper molar.

Muscles of the face

- The masseter and temporalis muscles are supplied by CN V. The temporalis muscle arises in part from overlying temporal fascia. Sensory branches of CN V exit cranial foramina about the orbit superiorly (V_1), inferiorly (V_2), and the neck of the mandible (V_3).
- Muscles of facial expression are the superficial sphincters and dilators of the openings of the head. Supplied by CN VII. The nerve exits the cranium at the stylomastoid foramen.
- The buccinator muscle (CN VII) keeps food from collecting in the oral vestibule.

Muscles acting on the tempero- mandibular joint

- The temporalis muscle elevates the mandible, closing the jaws. Posteriorly, more horizontal fibers retract the mandible. Innervated by CN V.
- The masseter elevates the mandible (acting in synergy with the medial pterygoid), closing the jaws. Innervated by CN V.
- The lateral pterygoid muscles (bilateral) protract the mandible and depress the chin. Acting unilaterally, it swings the jaw toward the contralateral side. Alternate unilateral contraction produces chewing movements. Innervated by CN V.

Muscles acting on the tempero- mandibular joint

- The medial pterygoid contributes to jaw protrusion; alternate unilateral contraction produces grinding movements. Innervated by CN V.
- The digastric depresses the mandible against resitance when infrahyoid muscles fix or depress the hyoid bone. Innervated by CN V and VII.
- The omohyoid fixes or depresses the hyoid bone. (Innervation from C1-3).
- The platysma depresses the mandible against resistance. Innervated by CN VII.

Movement of the tempero-mandibular joint

- Temporalis and masseter muscles are superficial. Involved with mastication.
- Lateral pterygoid assisted by medial pterygoid contols protrusion of the mandible.
- Posterior fibers of the temporalis, deep part of masseter, geniohyoid, and digastric muscles control retraction of mandible.
- Temporalis, masseter, and medial pterygoid elevate mandible.
- Digastric, geniohyoid, and mylohyoid muscles depress mandible.

Tempero-mandibular joint

- The latral temero-mandibular ligament strengthens the lateral aspect of the joint.
- The spheno-mandibular ligament descends from near the spine of the sphenoid to the lingula of the mandible and is the hinge on which the mandible is suspended.
- (The stylo-mandibular ligament is part of the parotid sheath that inserts on the angle of the mandible.)
- Both superior and inferior potions of the joint are lined by synovium.
- Upper compartment glides; lower compartment is a hinge joint.