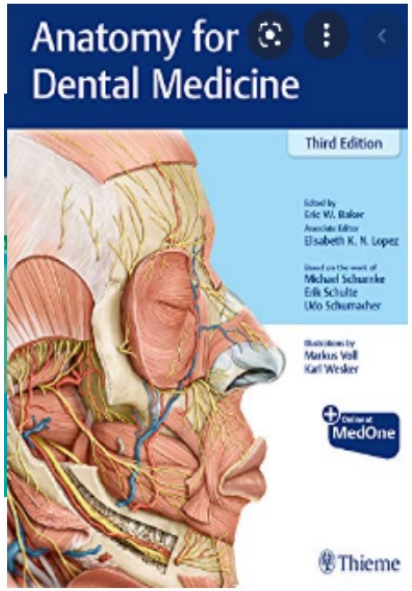
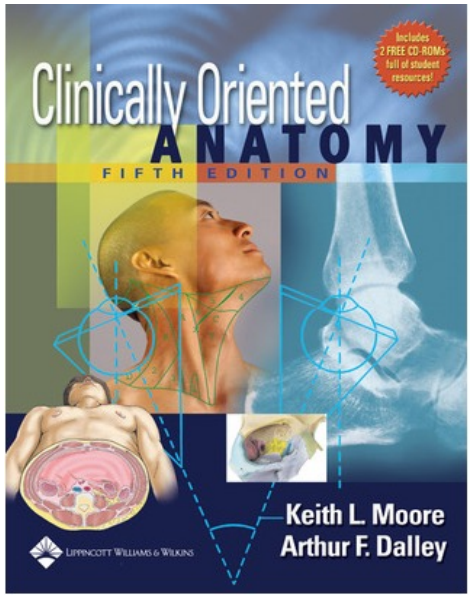
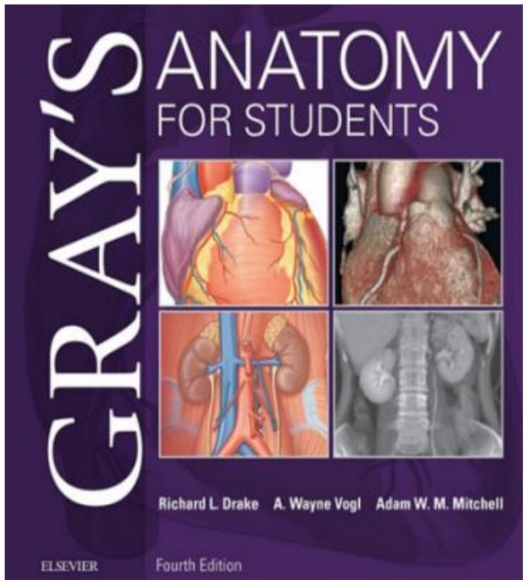
Nerves of the head and neck, overview

Omid Moztarzadeh

Literature:







Anatomy Standard

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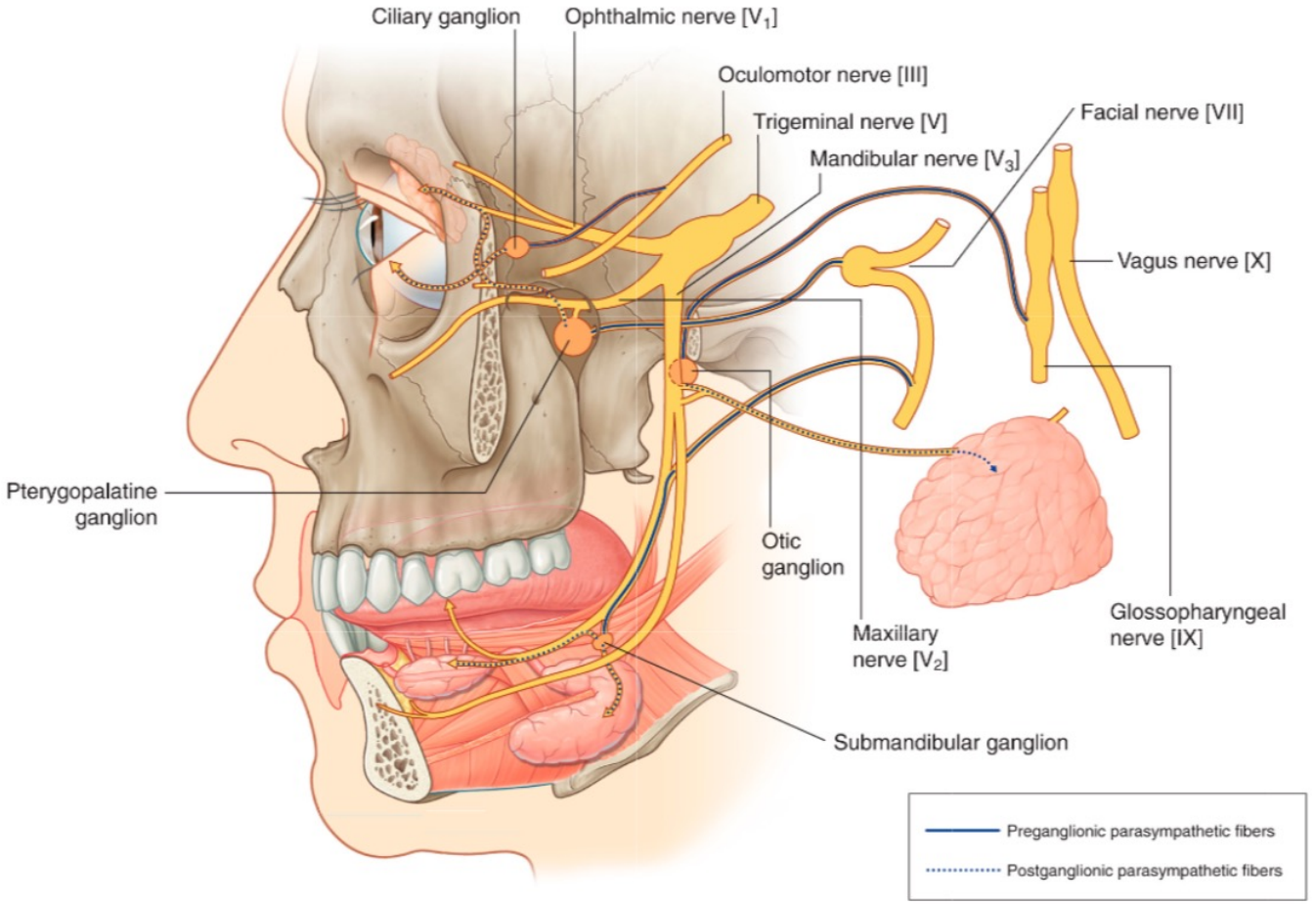
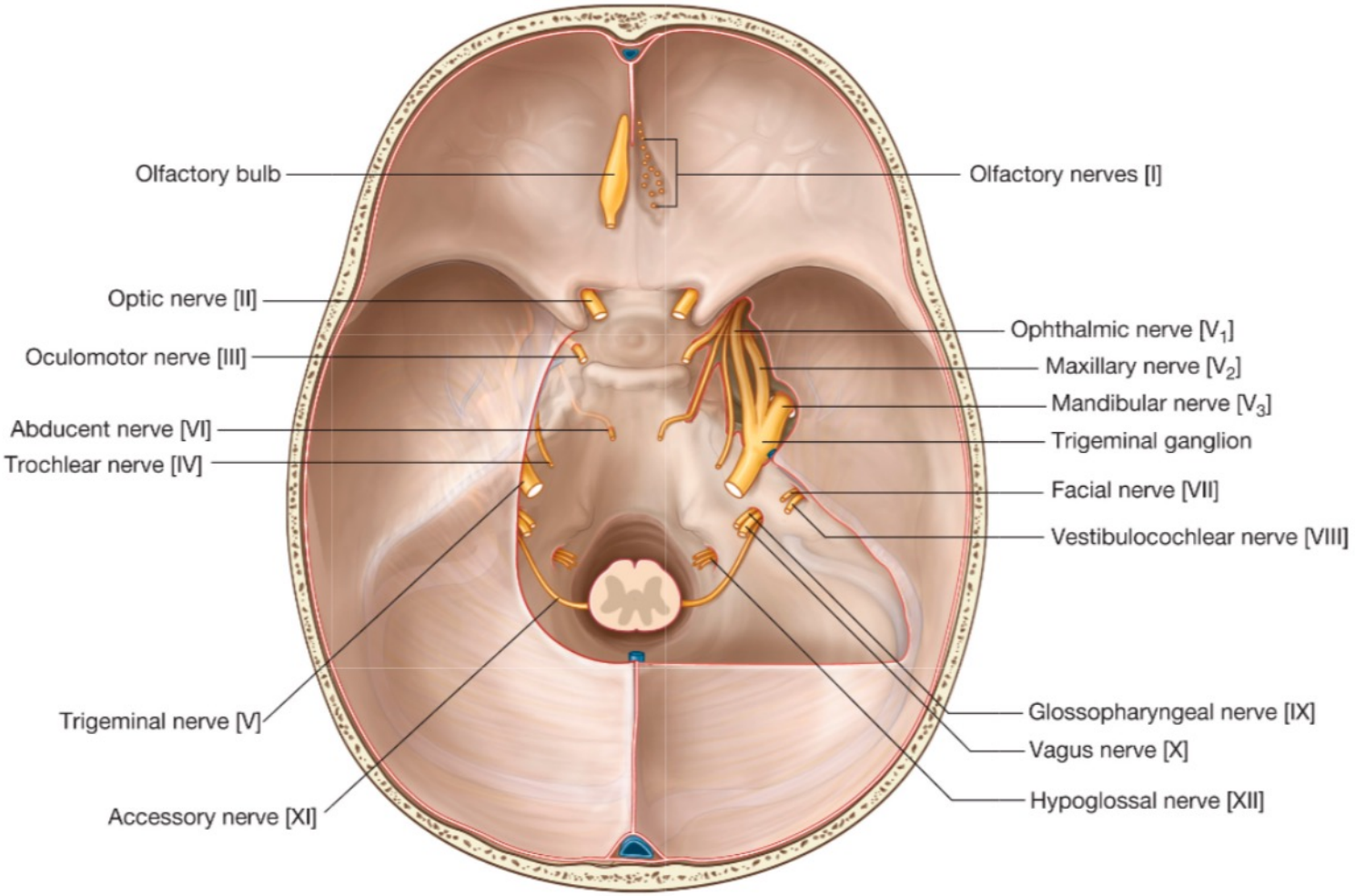
Cranial nerves

- There are twelve pairs of cranial nerves that exit the cranial cavity through foramina or fissures.
- All nerves except one, **the accessory nerve [XI]**, originate from the brain.
- All cranial nerves innervate structures in the head or neck. In addition, the **vagus nerve [X]** descends through the neck and into the thorax and abdomen where it innervates viscera.
- Parasympathetic fibers in the head are carried out of the brain as part of four cranial nerves—the **oculomotor nerve [III], the facial nerve [VII], the glossopharyngeal nerve [IX], and the vagus nerve [X].**
- Parasympathetic fibers in the **oculomotor nerve [III], the facial nerve [VII], and the glossopharyngeal nerve [IX]** destined for target tissues in the head leave these nerves, and are distributed with branches of the **trigeminal nerve [V].**
- The **vagus nerve [X]** leaves the head and neck to deliver parasympathetic fibers to the thoracic and abdominal viscera.

Cranial nerves and parasympathetic innervation



Cranial nerves exiting the cranial cavity



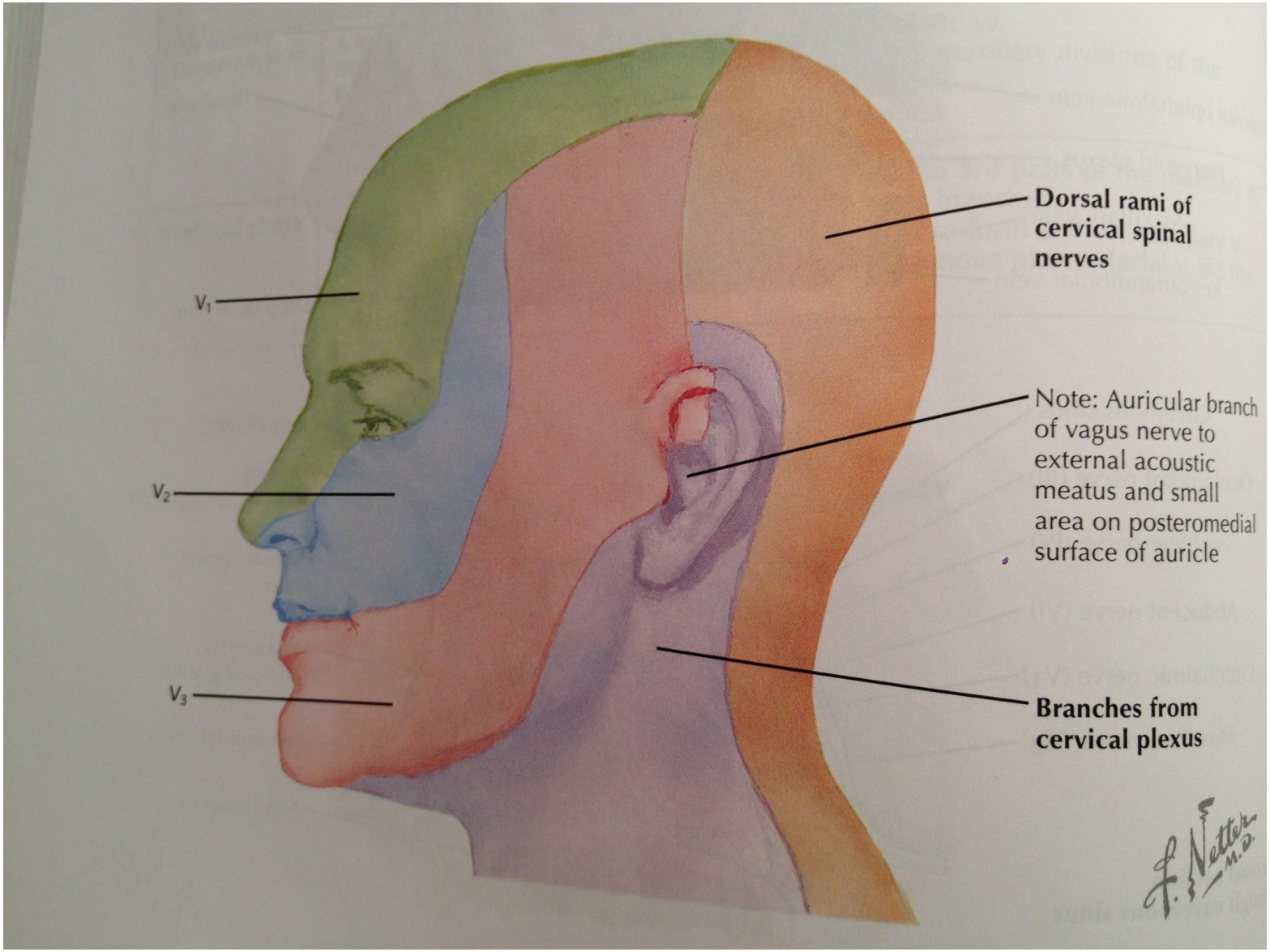
Cranial nerve functional components

Functional component	Abbreviation	General function	Cranial nerves containing component
General somatic afferent	GSA	Perception of touch, pain, temperature	Trigeminal nerve [V]; facial nerve [VII]; glossopharyngeal nerve [IX]; vagus nerve [X]
General visceral afferent	GVA	Sensory input from viscera	Glossopharyngeal nerve [IX]; vagus nerve [X]
Special afferent*	SA	Smell, taste, vision, hearing, and balance	Olfactory nerve [I]; optic nerve [II]; facial nerve [VII]; vestibulocochlear nerve [VIII]; glossopharyngeal nerve [IX]; vagus nerve [X]
General somatic efferent	GSE	Motor innervation to skeletal (voluntary) muscles	Oculomotor nerve [III]; trochlear nerve [IV]; abducent nerve [VI]; hypoglossal nerve [XII]
General visceral efferent	GVE	Motor innervation to smooth muscle, heart muscle, and glands	Oculomotor nerve [III]; facial nerve [VII]; glossopharyngeal nerve [IX]; vagus nerve [X]
Branchial efferent**	BE	Motor innervation to skeletal muscles derived from pharyngeal arch mesoderm	Trigeminal nerve [V]; facial nerve [VII]; glossopharyngeal nerve [IX]; vagus nerve [X]; accessory nerve [XI] (see Diogo R et al. *Nature* 2015;520:466–473)

Nerve	Component		Exit from skull	Function
	Afferent	Efferent		
Olfactory nerve [I]	SA		Cribriform plate of ethmoid bone	Smell
Optic nerve [II]	SA		Optic canal	Vision

Nerve	Component		Exit from skull	Function
	Afferent	Efferent		
Oculomotor nerve [III]		GSE, GVE	Superior orbital fissure	**GSE—**innervates levator palpebrae superioris, superior rectus, inferior rectus, medial rectus, and inferior oblique muscles **GVE—**innervates sphincter pupillae for pupillary constriction; ciliary muscles for accommodation of the lens for near vision
Trochlear nerve [IV]		GSE	Superior orbital fissure	Innervates superior oblique muscle
Abducent nerve [VI]		GSE	Superior orbital fissure	Innervates lateral rectus muscle

Nerve	Component		Exit from skull	Function
	Aff.	Eff.		
Trigeminal nerve [V]	GSA	BE	Superior orbital fissure—ophthalmic division [V_1] Foramen rotundum—maxillary nerve [V_2] Foramen ovale—mandibular division [V_3]	**GSA—**sensory from: **ophthalmic division [V_1]—** eyes, conjunctiva, orbital contents, nasal cavity, frontal sinus, ethmoidal cells, upper eyelid, dorsum of nose, anterior part of scalp, dura in anterior cranial fossa, superior part of tentorium cerebelli; **maxillary nerve [V_2]—**dura in middle cranial fossa, nasopharynx, palate, nasal cavity, upper teeth, maxillary sinus, skin covering the side of the nose, lower eyelid, cheek, upper lip; **mandibular division [V_3]—**skin of lower face, cheek, lower lip, anterior part of external ear, part of external acoustic meatus, temporal fossa, anterior two-thirds of tongue, lower teeth, mastoid air cells, mucous membranes of cheek, mandible, dura in middle cranial fossa **BE—**innervates temporalis, masseter, medial and lateral pterygoids, tensor tympani, tensor veli palatini, anterior belly of digastric, and mylohyoid muscles


V_1
V_2
V_3
Dorsal rami of cervical spinal nerves
Note: Auricular branch of vagus nerve to external acoustic meatus and small area on posteromedial surface of auricle
Branches from cervical plexus
F. Netter M.D.

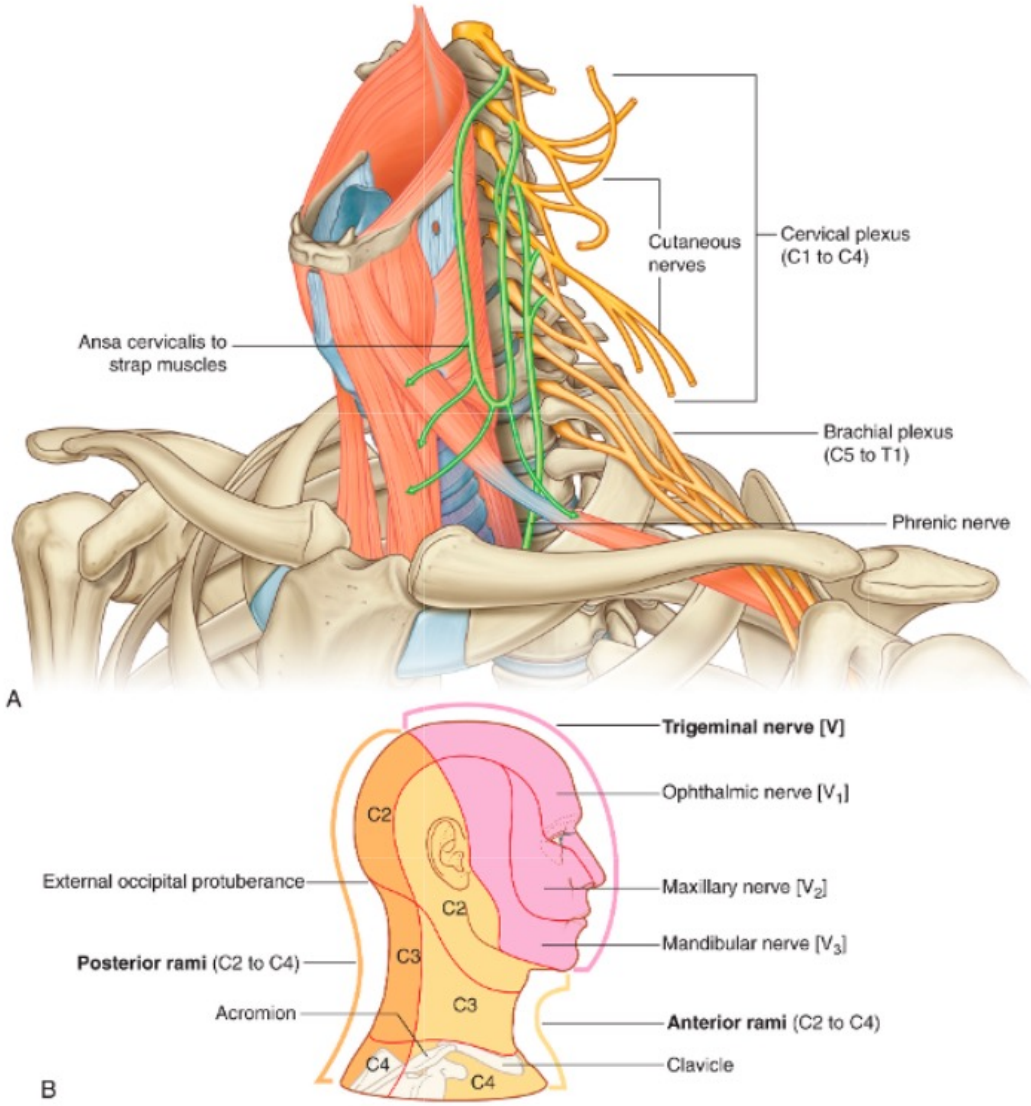
Nerve	Component		Exit from skull	Function
	Aff.	Eff.		
Facial nerve [VII]	GSA, SA	GVE, BE	Stylomastoid foramen (nerve leaves cranial cavity through internal acoustic meatus and gives rise to branches in the facial canal of the temporal bone prior to exiting through the stylomastoid foramen; these branches leave the skull through other fissures and canals.)	**GSA—**sensory from part of external acoustic meatus and deeper parts of auricle **SA—**taste from anterior two-thirds of tongue **GVE—**innervates lacrimal gland, submandibular and sublingual salivary glands, and mucous membranes of nasal cavity, hard and soft palates **BE—**innervates muscles of face (muscles of facial expression) and scalp derived from the second pharyngeal arch, and stapedius, posterior belly of digastric, stylohyoid muscles

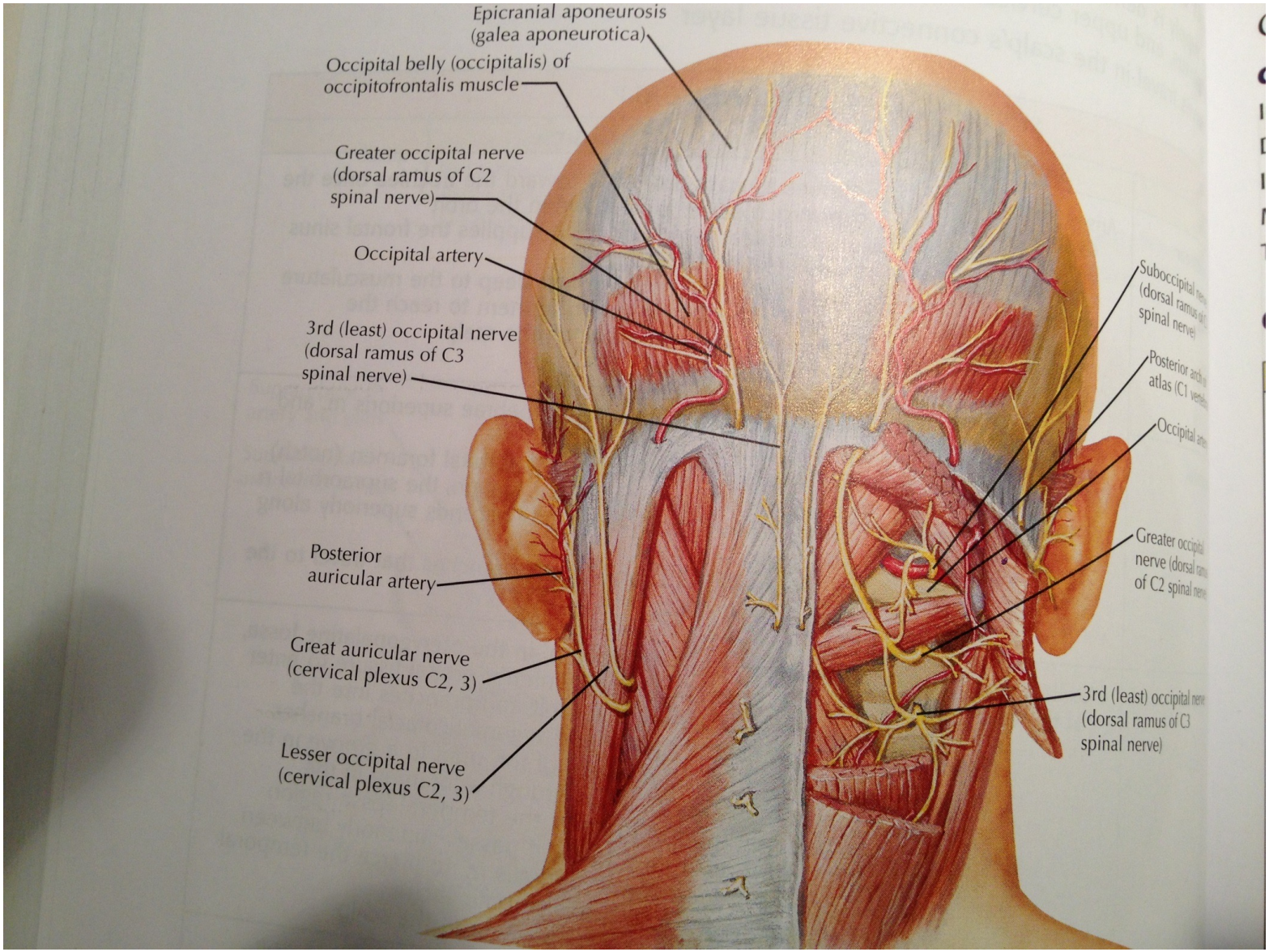
Nerve	Component Aff.	Component Eff.	Exit from skull	Function
Vestibulocochlear nerve [VIII]	SA		(Nerve leaves cranial cavity through internal acoustic meatus)	Vestibular division—balance Cochlear division—hearing
Glossopharyngeal nerve [IX]	GVA, SA, GSA	GVE, BE	Jugular foramen	**GVA—**sensory from carotid body and sinus **GSA—**posterior one-third of tongue, palatine tonsils, oropharynx, and mucosa of middle ear, pharyngotympanic tube, and mastoid air cells **SA—**taste from posterior one-third of tongue **GVE—**innervates parotid salivary gland **BE—**innervates stylopharyngeus muscle

Nerve	Component		Exit from skull	Function
	Aff.	Eff.		
Vagus nerve [X]	GSA, GVA, SA	GVE, BE	Jugular foramen	**GSA—**sensory from larynx, laryngopharynx, deeper parts of auricle, part of external acoustic meatus, and dura in posterior cranial fossa **GVA—**sensory from aortic body chemoreceptors and aortic arch baroreceptors, esophagus, bronchi, lungs, heart, and abdominal viscera of the foregut and midgut **SA—**taste from the epiglottis and pharynx **GVE—**innervates smooth muscle and glands in the pharynx, larynx, thoracic viscera, and abdominal viscera of the foregut and midgut **BE—**innervates one tongue muscle (palatoglossus), muscles of soft palate (except tensor veli palatini), pharynx (except stylopharyngeus), and larynx
Accessory nerve [XI]		BE	Jugular foramen	Innervates sternocleidomastoid and trapezius muscles [for classification as BE see Diogo R et al. *Nature* 2015;520:466–473.]
Hypoglossal nerve [XII]		GSE	Hypoglossal canal	Innervates hyoglossus, genioglossus, and styloglossus muscles and all intrinsic muscles of the tongue

Cervical spinal nerves

- There are eight cervical nerves **(C1 to C8):**
- C1 to C7 emerge from the vertebral canal **above** their respective vertebrae.
- **C8 emerges between vertebrae CVII and TI**
- The anterior rami of C1 to C4 form the **cervical plexus**. The major branches from this plexus supply the strap muscles, the diaphragm (phrenic nerve), skin on the anterior and lateral parts of the neck, skin on the upper anterior thoracic wall, and **skin on the inferior parts of the head**.
- The anterior rami of C5 to C8, together with a large component of the anterior ramus of T1, form the **brachial plexus**, which innervates the **upper limb.**


Cutaneous nerves
Cervical plexus (C1 to C4)
Ansa cervicalis to strap muscles
Brachial plexus (C5 to T1)
Phrenic nerve
A
Trigeminal nerve [V]
Ophthalmic nerve [V1]
C2
External occipital protuberance
C2
Maxillary nerve [V2]
Posterior rami (C2 to C4)
C3
Mandibular nerve [V3]
C3
Acromion
Anterior rami (C2 to C4)
C4
Clavicle
C4
B

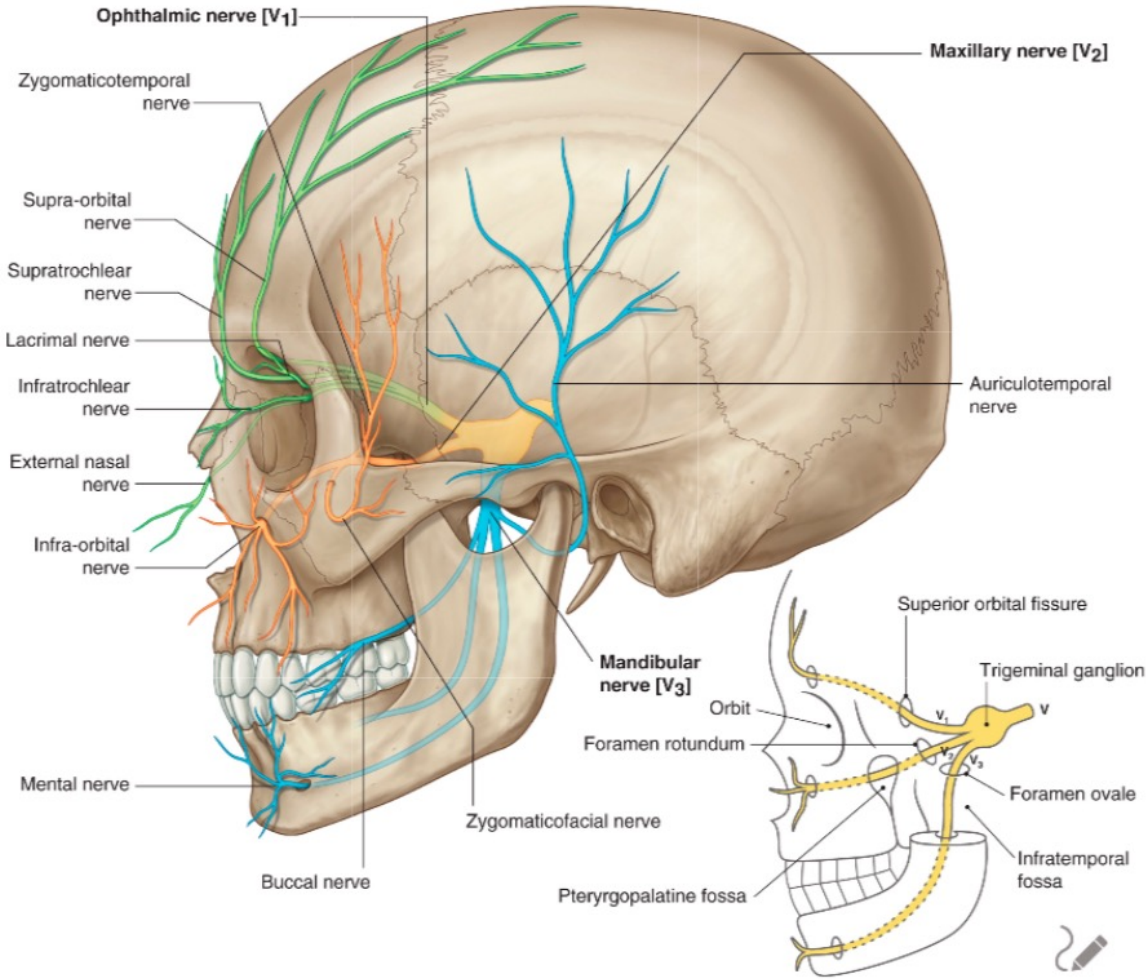

Epicranial aponeurosis (galea aponeurotica)
Occipital belly (occipitalis) of occipitofrontalis muscle
Greater occipital nerve (dorsal ramus of C2 spinal nerve)
Occipital artery
3rd (least) occipital nerve (dorsal ramus of C3 spinal nerve)
Posterior auricular artery
Great auricular nerve (cervical plexus C2, 3)
Lesser occipital nerve (cervical plexus C2, 3)
Suboccipital
(dorsal ramus
spinal nerve)
Posterior
atlas (C1
Occipital
Greater
nerve (dorsal
of C2 spinal
3rd (least) occipital
(dorsal ramus of C3
spinal nerve)

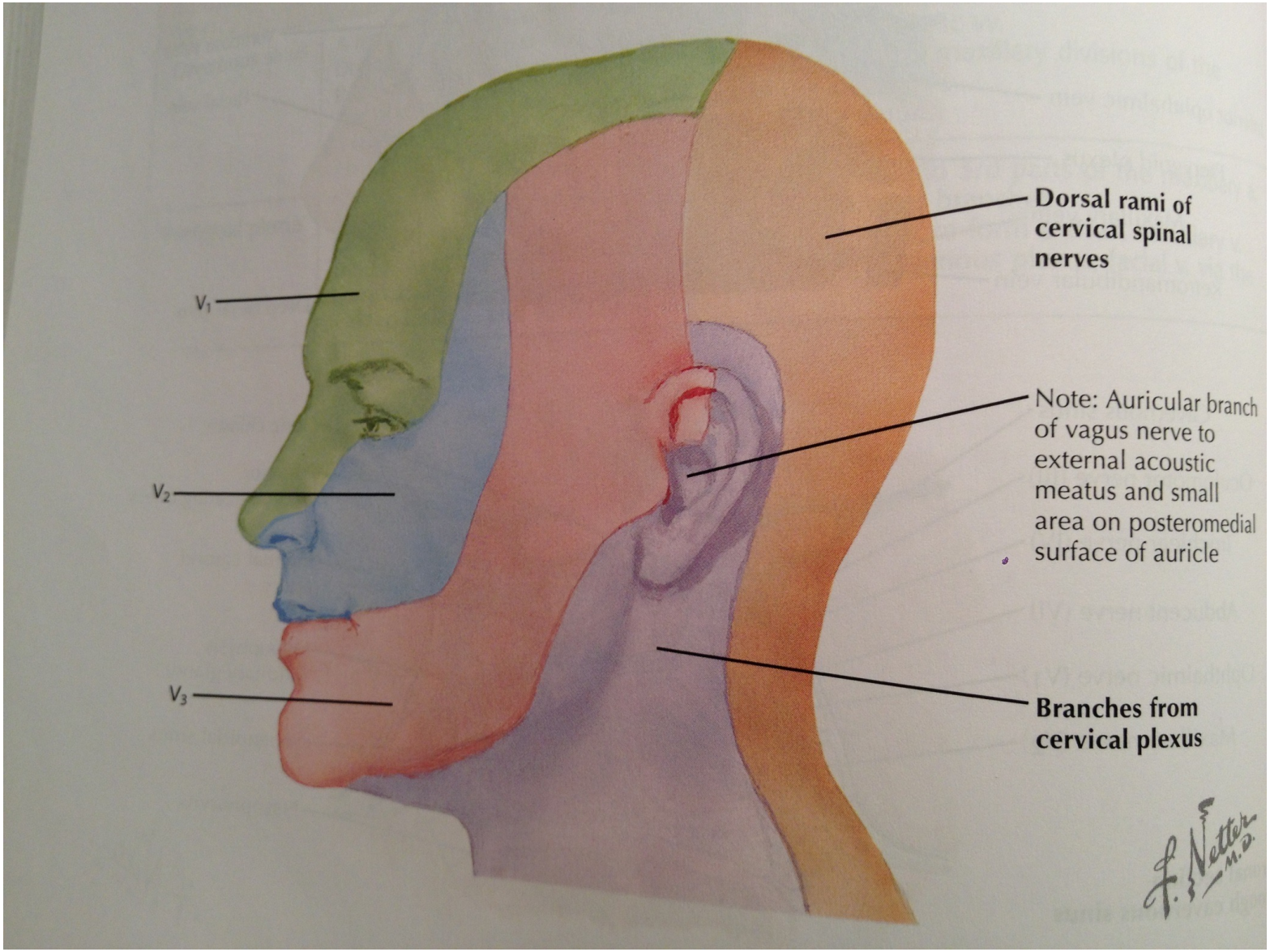
Cranial nerves

During development a cranial nerve becomes associated with each of the pharyngeal arches. Because the face is primarily derived from the first and second pharyngeal arches, innervation of neighboring facial structures is as follows:

- **The trigeminal nerve [V]** innervates facial structures derived from the **first arch.**
- **The facial nerve [VII]** innervates facial structures derived from the **second arch.**

The **trigeminal nerve [V]** divides into three major **divisions—the ophthalmic [V_1], maxillary [V_2], and mandibular [V_3]**—before leaving the middle cranial fossa. Each of these divisions passes out of the cranial cavity to innervate a part of the face, so most of the skin covering the face is innervated solely by branches of the trigeminal nerve [V]. The exception is a small area covering the angle and lower border of the ramus of the mandible and parts of the ear, where **the facial [VII], vagus [X], and cervical nerves** contribute to the innervation.

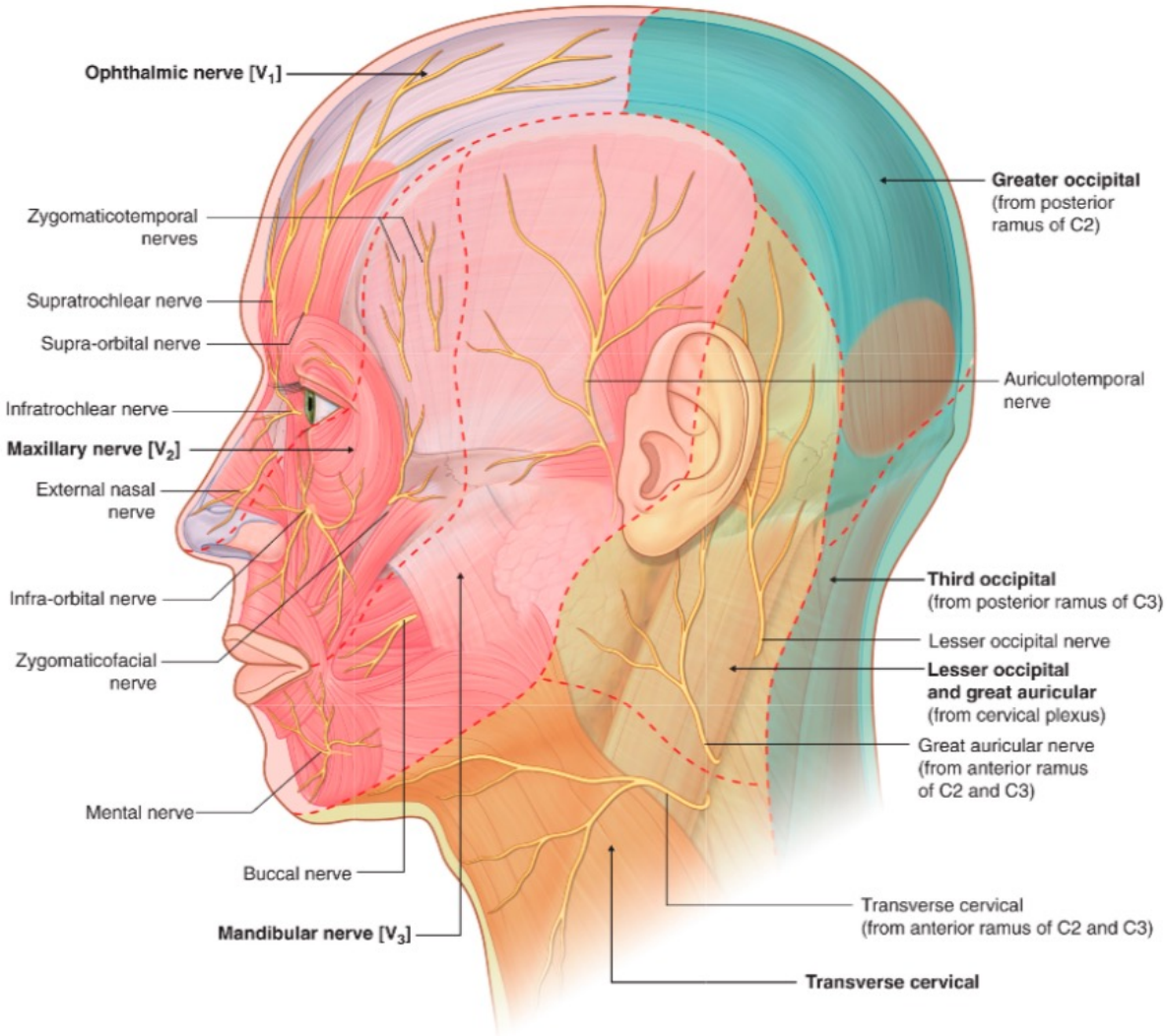


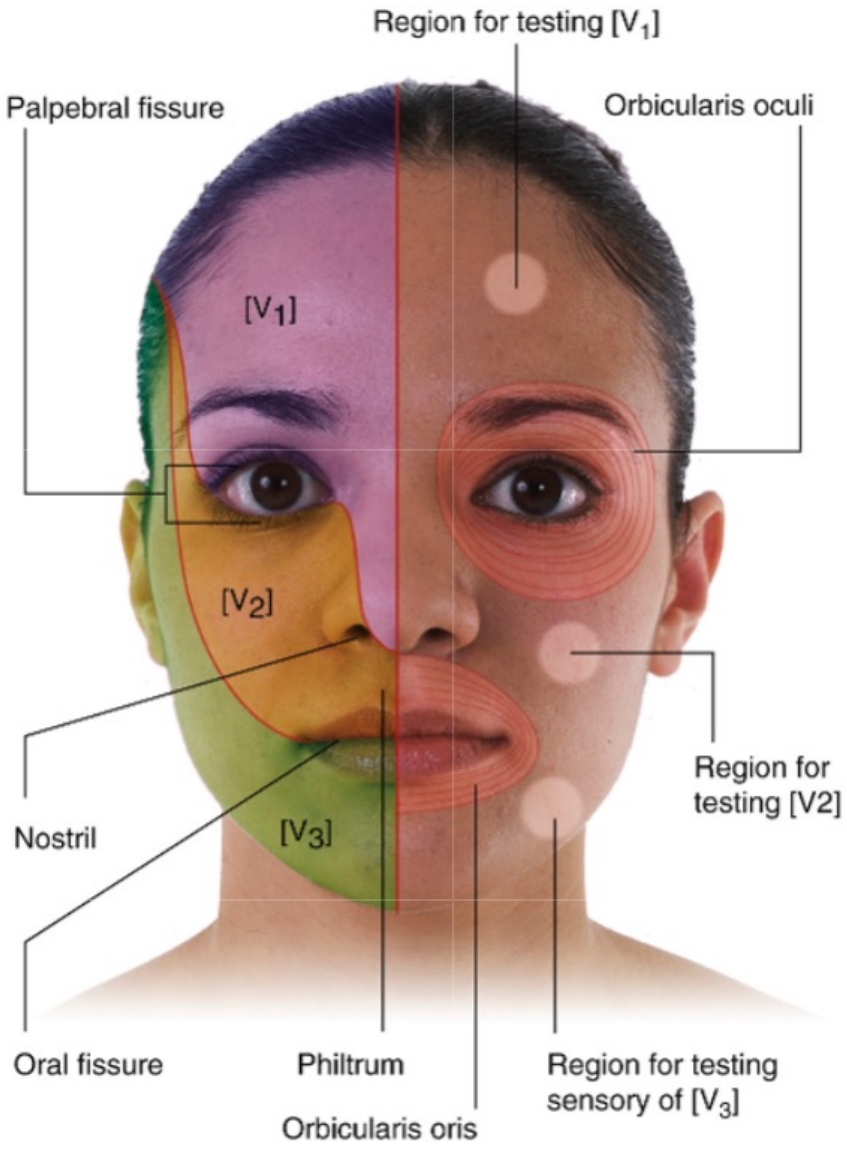

V_1
V_2
V_3
Dorsal rami of cervical spinal nerves
Note: Auricular branch of vagus nerve to external acoustic meatus and small area on posteromedial surface of auricle
Branches from cervical plexus
F. Netter M.D.

Ophthalmic nerve [V_1]:

The ophthalmic nerve [V_1] exits the skull through the superior orbital fissure and enters the orbit. Its branches that innervate the face include:

- the **supraorbital and supratrochlear nerves,** which leave the orbit superiorly and innervate the **upper eyelid, forehead, and scalp;**
- the **infratrochlear nerve**, which exits the orbit in the medial angle to innervate the **medial half of the upper eyelid, the skin in the area of the medial angle, and the side of the nose**;
- the **lacrimal nerve**, which exits the orbit in the lateral angle to innervate the **lateral half of the upper eyelid and the skin in the area of the lateral angle**; and
- the **external nasal nerve**, which supplies the **anterior part of the nose**




Region for testing [V1]
Palpebral fissure
Orbicularis oculi
[V1]
[V2]
Region for testing [V2]
Nostril
[V3]
Oral fissure
Philtrum
Orbicularis oris
Region for testing sensory of [V3]

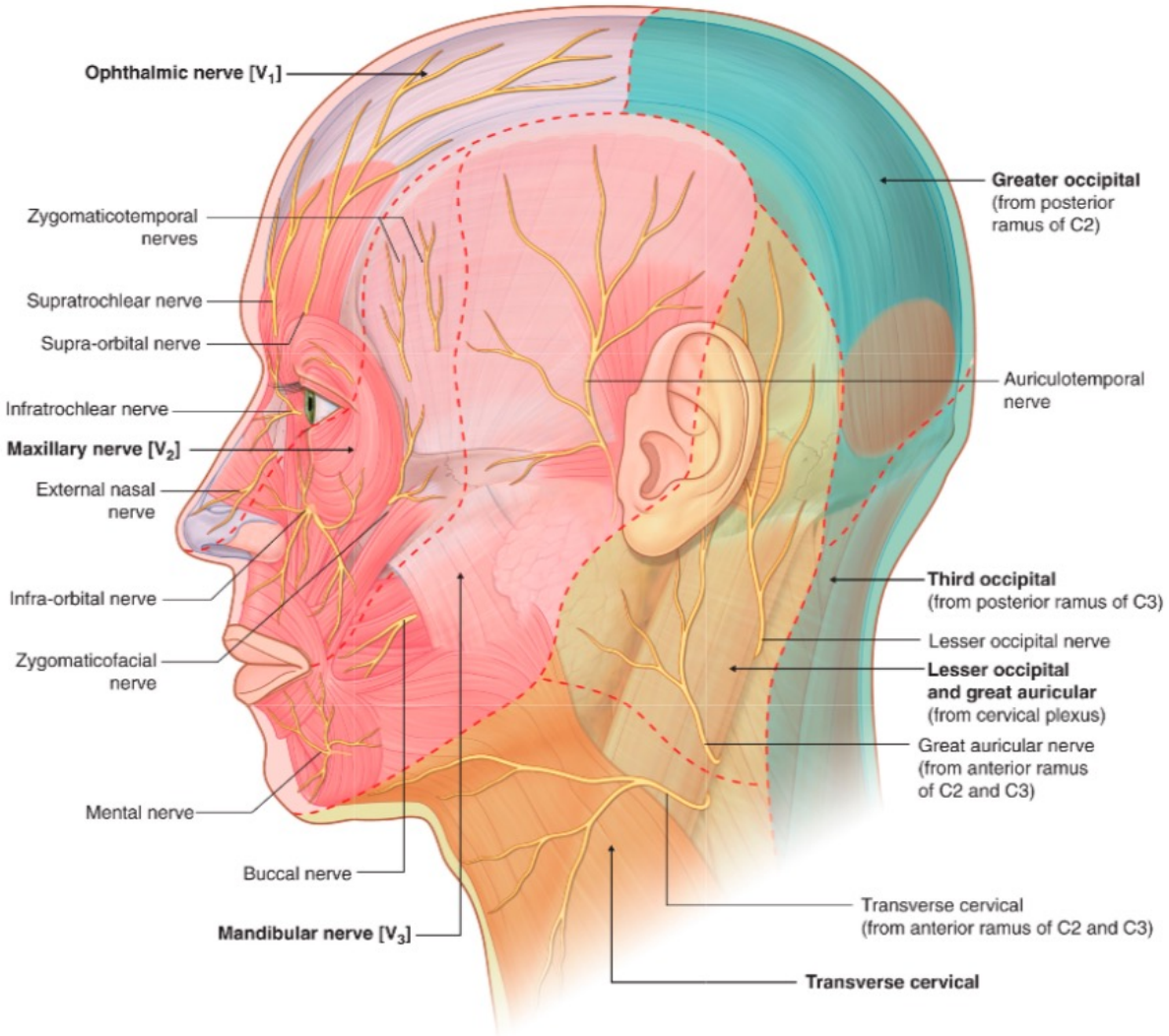
Maxillary nerve [V2]:

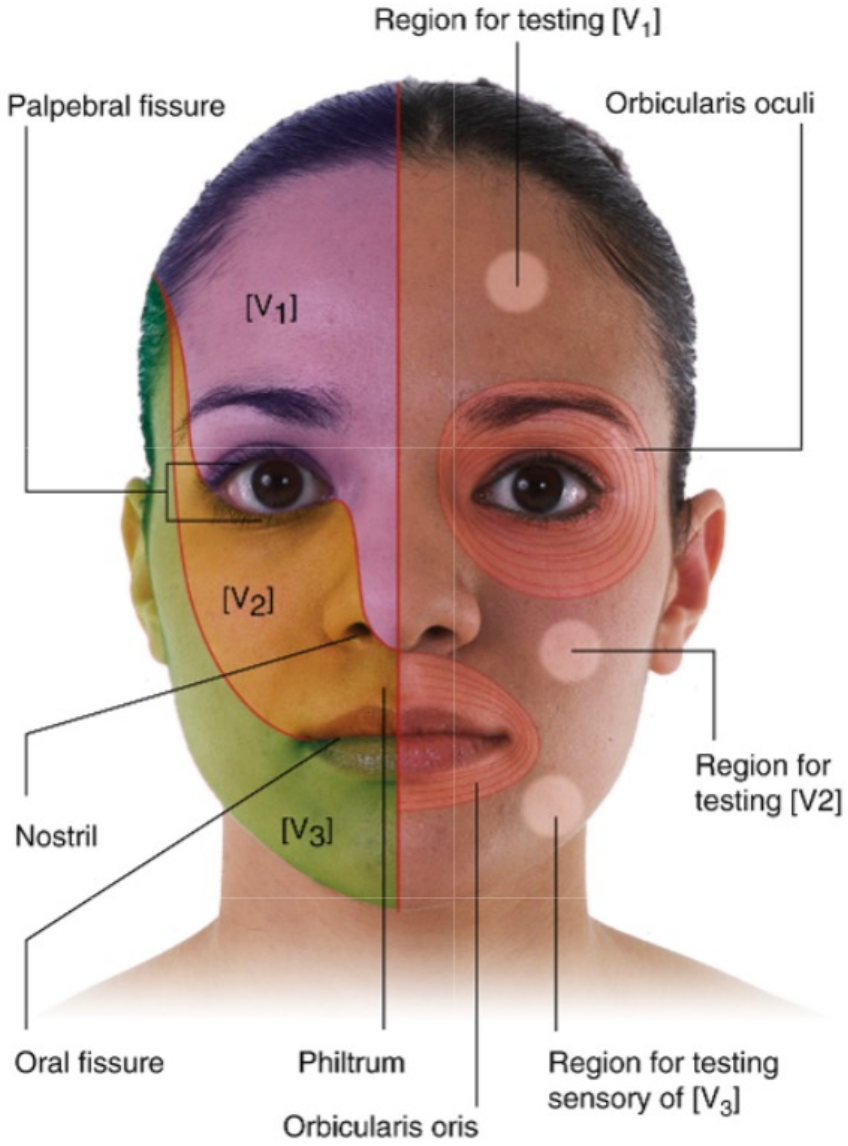
Exits the skull through the **foramen rotundum**. Branches that innervate the face include:

a small **zygomaticotemporal branch**, which exits the zygomatic bone and supplies a small area of the **anterior temple above the zygomatic arch;**

a small **zygomaticofacial branch**, which exits the zygomatic bone and supplies a small area of **skin over the zygomatic bone;** and

the large **infraorbital nerve**, which exits the maxilla through the infraorbital foramen and immediately divides into multiple branches to supply **the lower eyelid, cheek, side of the nose, and upper lip - pes anserinus minor**




Region for testing [V1]
Palpebral fissure
Orbicularis oculi
[V1]
[V2]
Region for testing [V2]
Nostril
[V3]
Oral fissure
Philtrum
Region for testing sensory of [V3]
Orbicularis oris

Mandibular nerve [V3]

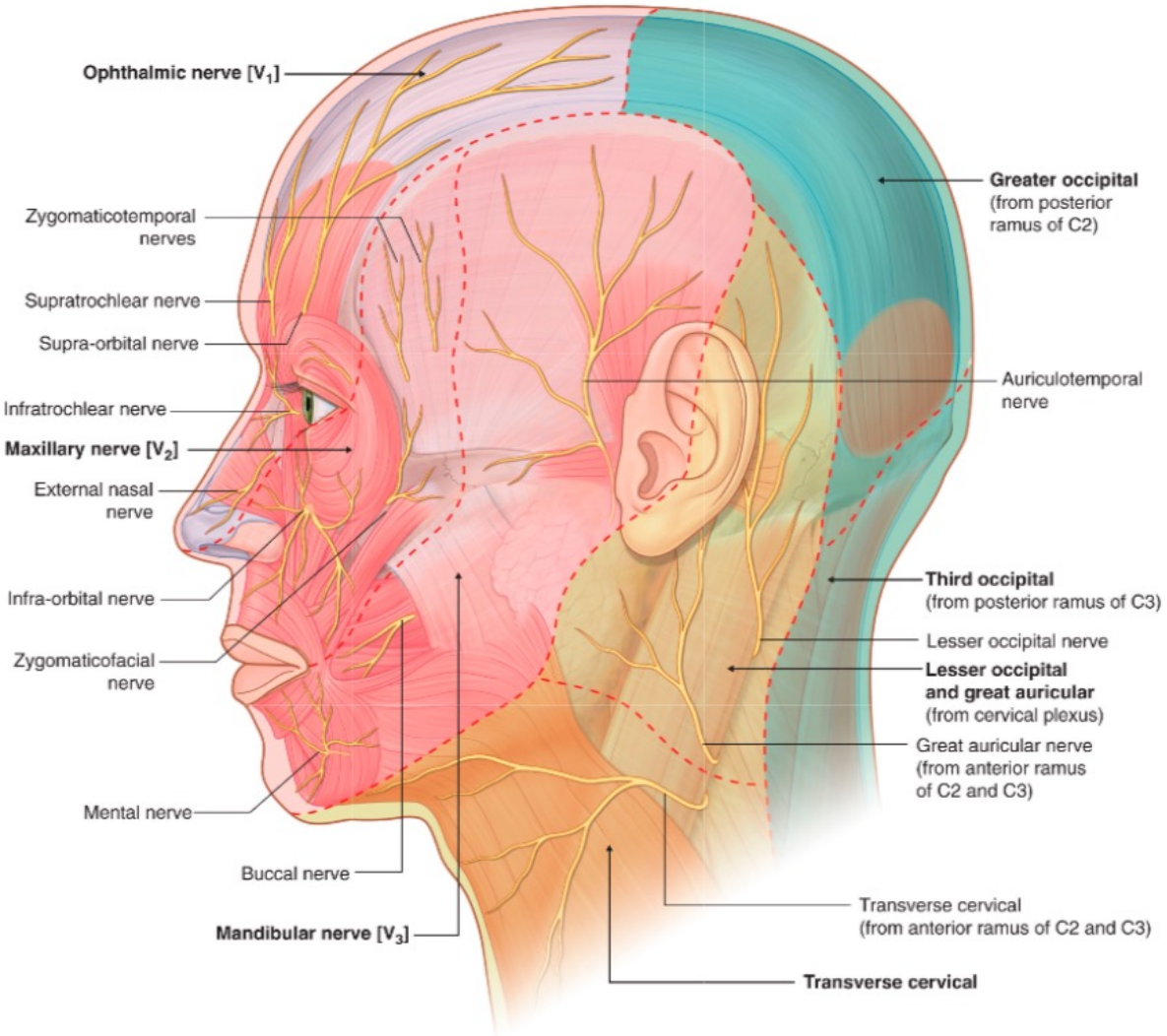
Exits the skull through the foramen ovale. Branches

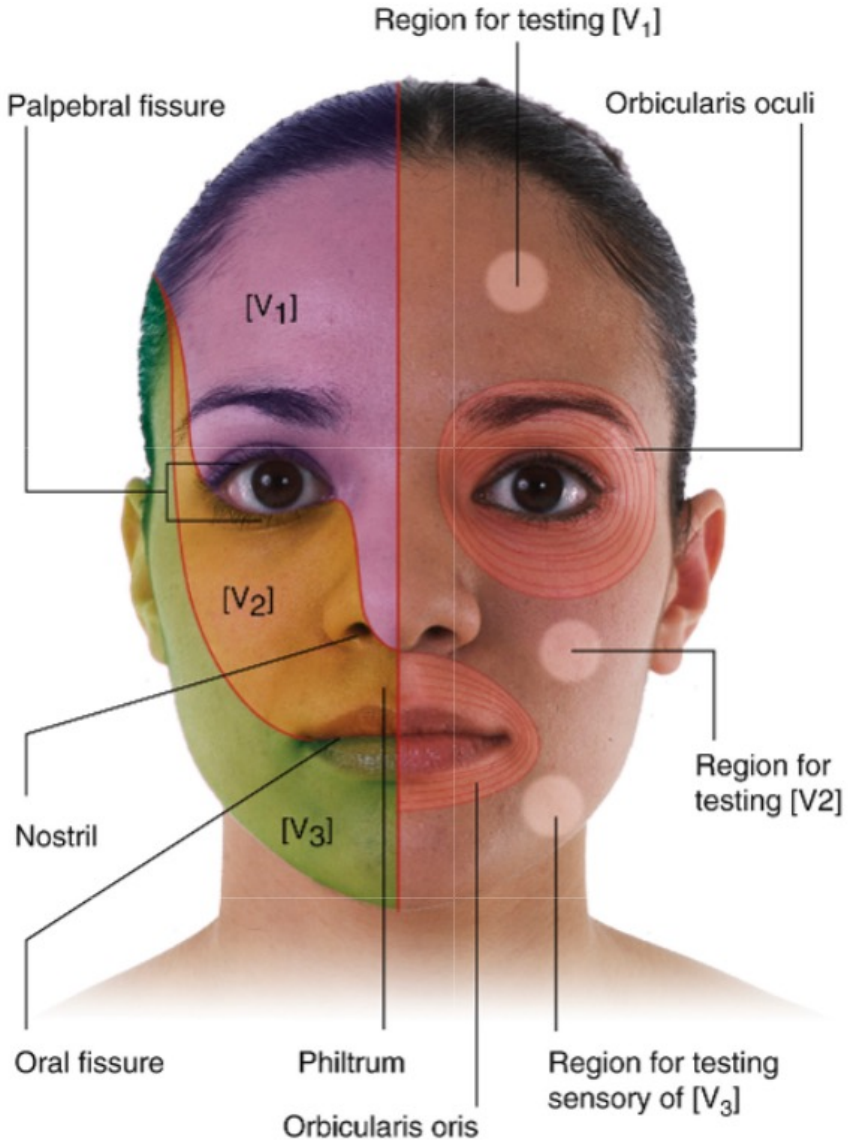
innervating the face include:

the **auriculotemporal nerve**, which enters the face just posterior to the temporomandibular joint, passes through the parotid gland, and ascends just anterior to the ear to supply **the external acoustic meatus, the surface of the tympanic membrane (eardrum), and a large area of the temple;**

the **buccal nerve**, which is on the surface of the buccinator muscle supplying the **cheek**; and

the **mental nerve**, which exits the mandible through the mental foramen and immediately divides into multiple branches to supply the **skin and mucous membrane of the lower lip and skin of the chin**




Region for testing [V1]
Palpebral fissure
Orbicularis oculi
[V1]
[V2]
Region for testing [V2]
Nostril
[V3]
Oral fissure
Philtrum
Region for testing sensory of [V3]
Orbicularis oris

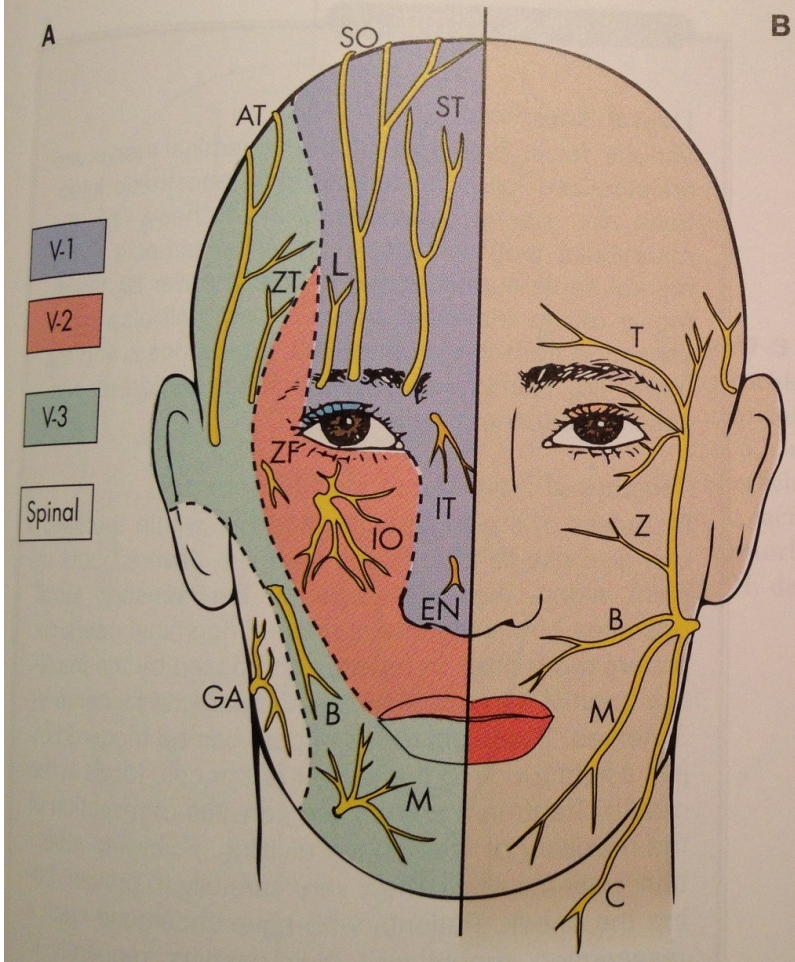
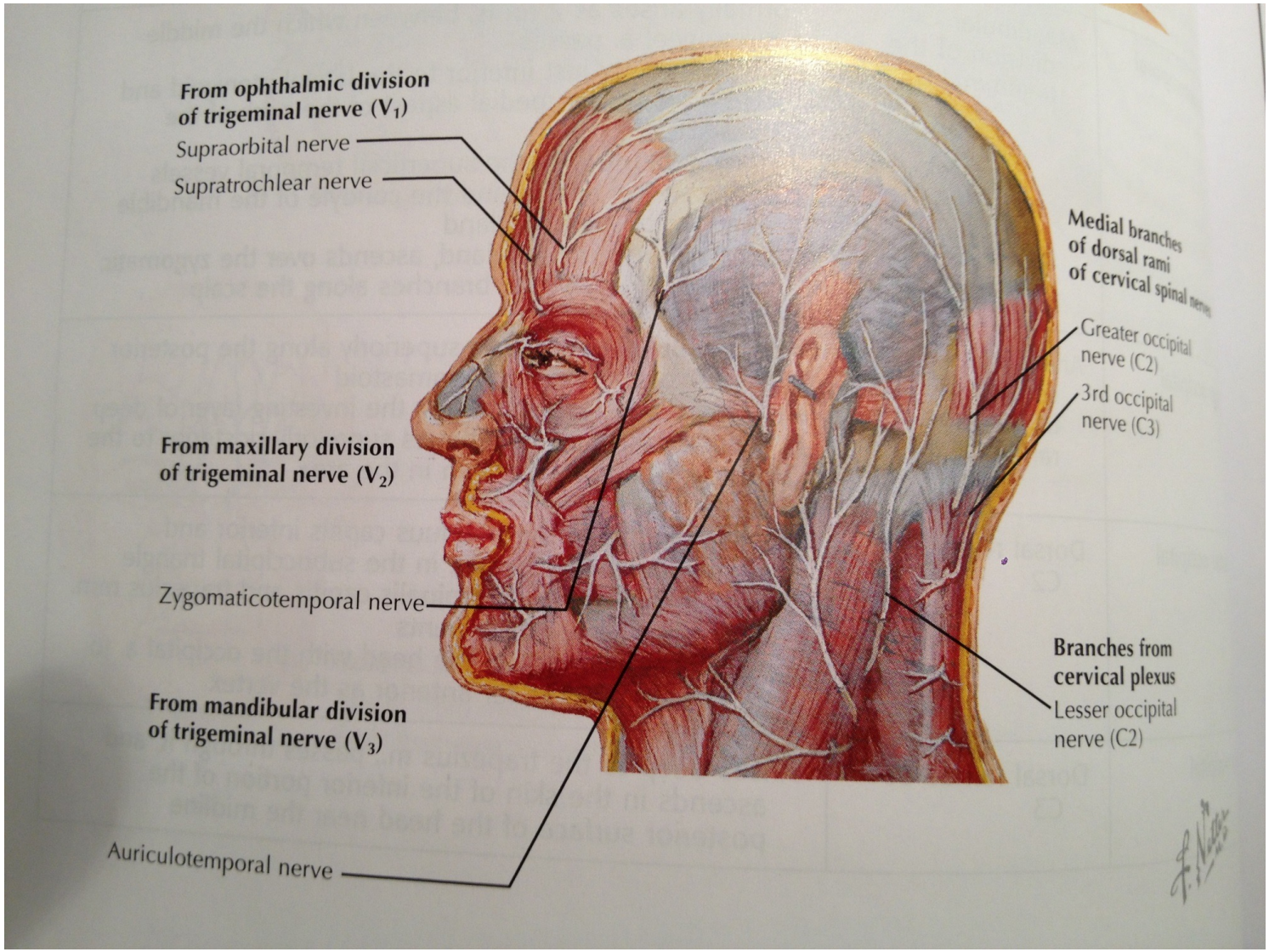


Figure 7-2 **A,** Cutaneous nerves of face. *V-1 (ophthalmic nerve): SO,* Supraorbital nerve; *ST,* supratrochlear nerve; *L,* lacrimal nerve; *IT,* infratrochlear nerve; *EN,* external nasal nerve. *V-2 (maxillary nerve): IO,* Infraorbital nerve. *V-3 (mandibular nerve): AT,* Auriculotemporal nerve; *B,* buccal nerve; *M,* mental nerve. *Spinal nerve: GA,* Great auricular nerve. **B,** Motor nerves to muscles of facial expression. *Facial branches of CN VII: T,* Temporal branches; *Z,* zygomatic branches; *B,* buccal branches; *M,* mandibular branches; *C,* cervical branches.


From ophthalmic division of trigeminal nerve (V_1)
Supraorbital nerve
Supratrochlear nerve
From maxillary division of trigeminal nerve (V_2)
Zygomaticotemporal nerve
From mandibular division of trigeminal nerve (V_3)
Auriculotemporal nerve
Medial branches of dorsal rami of cervical spinal nerves
Greater occipital nerve (C2)
3rd occipital nerve (C3)
Branches from cervical plexus
Lesser occipital nerve (C2)

Motor innervation

The muscles of the face, as well as those associated with the ear and the scalp, are derived from the **second pharyngeal arch.** The cranial nerve associated with this arch is the **facial nerve [VII]** and therefore branches of the facial nerve [VII] innervate all these muscles.

The facial nerve [VII] exits the posterior cranial fossa through the internal acoustic meatus. It passes through the temporal bone, giving off several branches, and emerges from the base of the skull through the stylomastoid foramen .

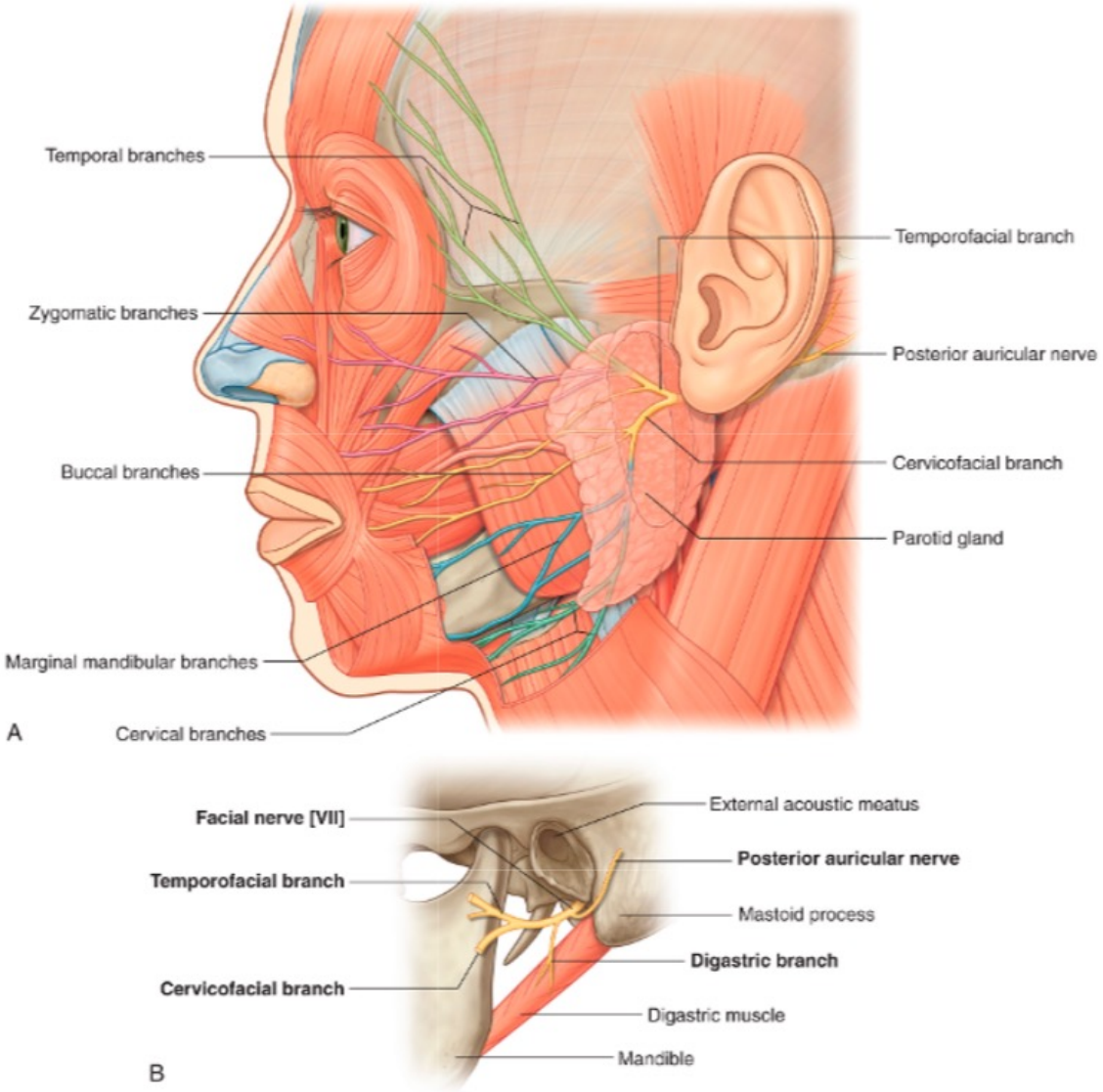
At this point it gives off the **posterior auricular nerve**. This branch passes upward, behind the ear, to supply the **occipital belly** of the occipitofrontalis muscle of the scalp and the **posterior auricular muscle** of the ear.

The main stem of the facial nerve [VII] then gives off another branch, which innervates the **posterior belly of the digastric muscle** and the **stylohyoid muscle**.

At this point, the facial nerve [VII] enters the deep surface of the parotid gland and forms the **parotid plexus.**

Five terminal groups of branches of the facial nerve [VII]-

the temporal, zygomatic, buccal, marginal mandibular, and cervical branches-emerge from the parotid gland



Facial nerve [VII]

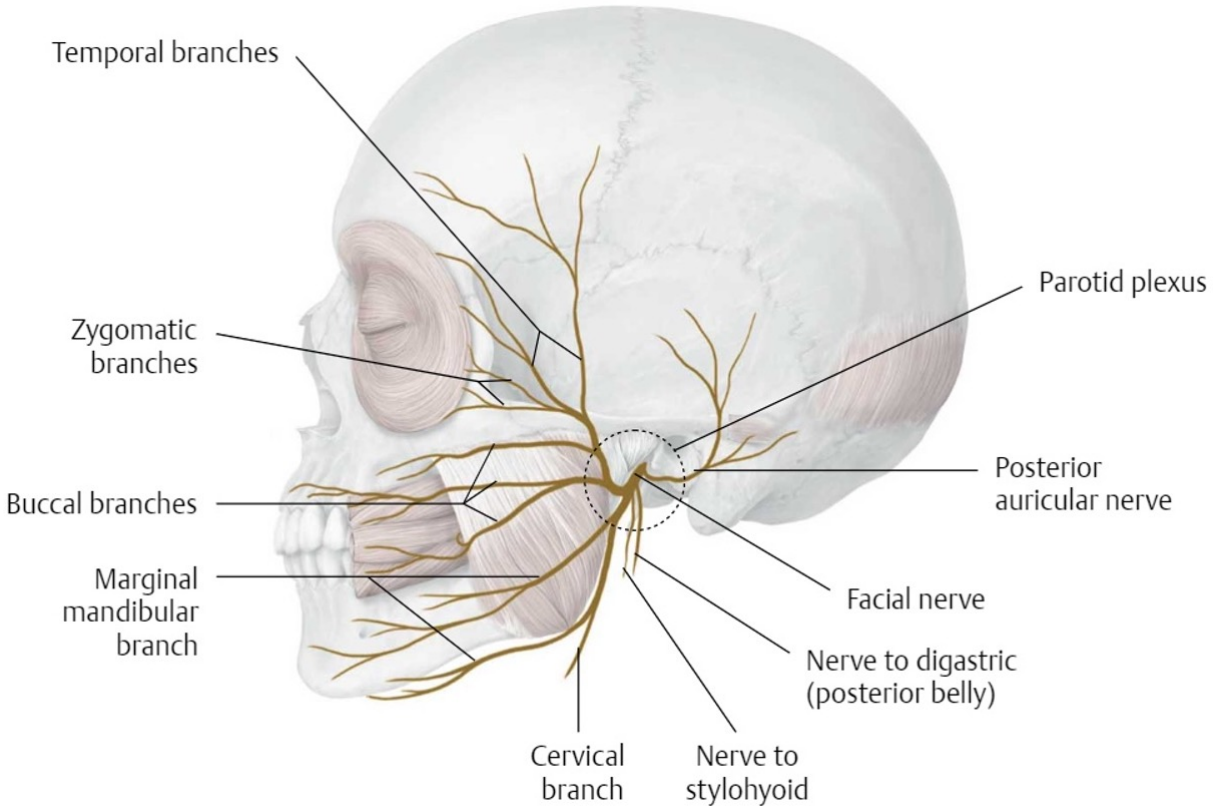
Temporal branches exit from the superior border of the parotid gland to supply muscles in the area of the **temple, forehead, and supra-orbital area**;

Zygomatic branches emerge from the anterosuperior border of the parotid gland to supply **muscles in the infra-orbital area, the lateral nasal area, and the upper lip;**

Buccal branches emerge from the anterior border of the parotid gland to supply muscles in the **cheek, the upper lip, and the corner of the mouth;**

Marginal mandibular branches emerge from the anteroinferior border of the parotid gland to supply **muscles of the lower lip and chin**;

Cervical branches emerge from the inferior border of the parotid gland to supply the **platysma**.



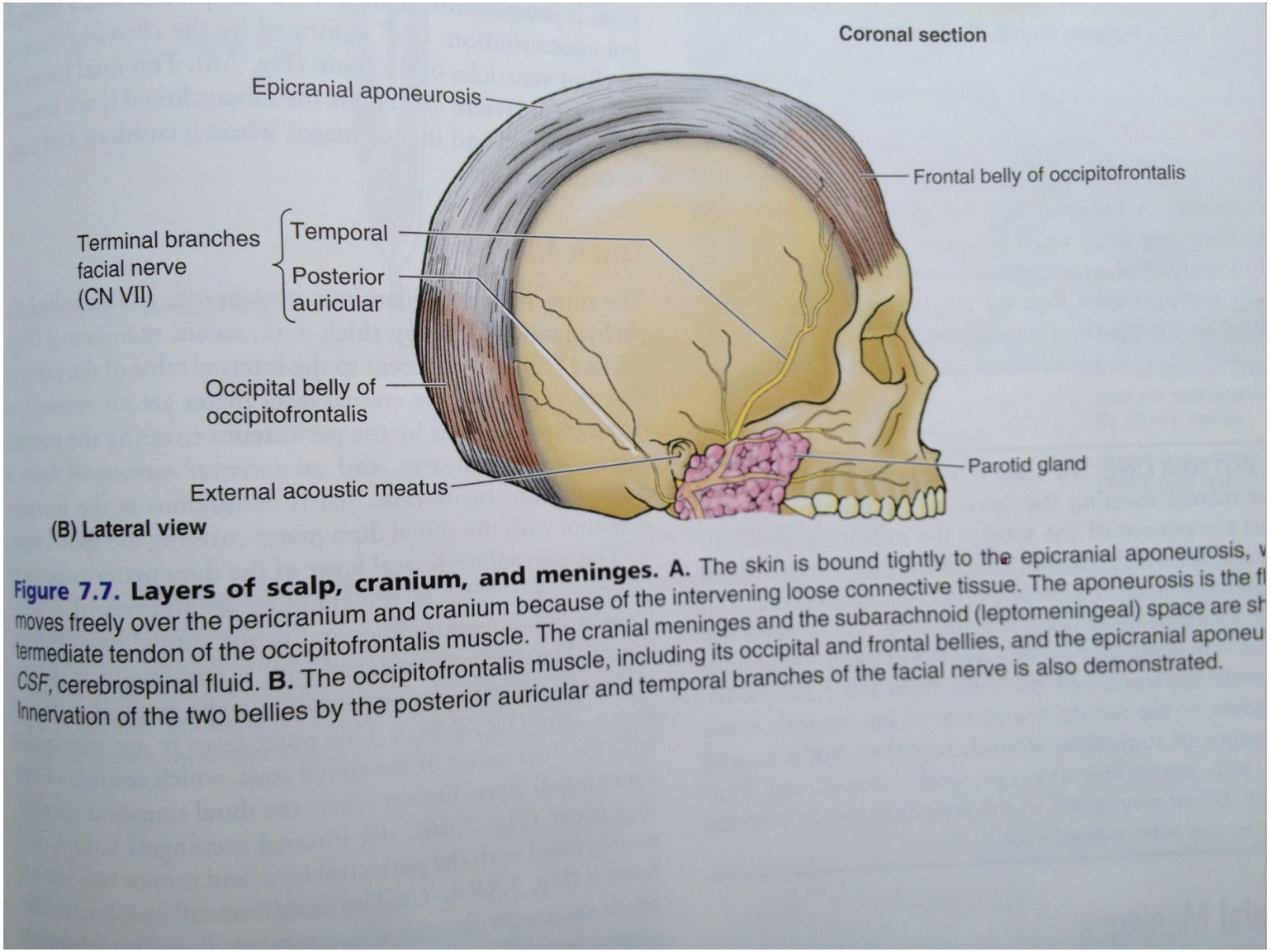


Figure 7.7. Layers of scalp, cranium, and meninges. A. The skin is bound tightly to the epicranial aponeurosis, v moves freely over the pericranium and cranium because of the intervening loose connective tissue. The aponeurosis is the fl termediate tendon of the occipitofrontalis muscle. The cranial meninges and the subarachnoid (leptomeningeal) space are sh *CSF*, cerebrospinal fluid. **B.** The occipitofrontalis muscle, including its occipital and frontal bellies, and the epicranial aponeu Innervation of the two bellies by the posterior auricular and temporal branches of the facial nerve is also demonstrated.