Cranial Nerve Modalities represent the seven specific functional components transmitted within the cranial nerves, including afferent (sensory) as well as efferent (motor) modalities. Although each cranial nerve may transmit one to several modalities, none carry all of them; thus, each cranial nerve possesses specific modalities that are responsible for receiving sensory input from receptors or delivering output from its motor component. An additional component, general proprioception (GP), is generally understood, if not specified, as sensory input from within the muscles innervated by those cranial nerves.

Motor Modalities:
General somatic efferent (GSE) represents motor innervation to skeletal muscles developed from somites.

General visceral efferent (GVE) represents motor fibers to skeletal muscles of branchiogenic origin (pharyngeal arch origin).

Sensory Modalities:
General somatic afferent (GSA) represents general sensation (touch, pressure, temperature, pain) from the skin about the anterior face and lateral head.
General visceral afferent (GVA) represents general sensation from the viscera, generally perceived as pressure and/or pain.

Special somatic afferent (SSA) represents special sensation from the eye (vision) and the ear (auditory and equilibrium).

Special visceral afferent (SVA) represents visceral sensations of smell (olfaction) and taste (gustatory).

CRANIAL NERVES

Twelve pairs of cranial nerves originate in the brain, leave its surface, and pass through certain foramina of the skull to be distributed in and about the head and neck. One cranial nerve, the vagus, continues into the thorax and abdomen to innervate some of the viscera. The cranial nerves are named and numbered sequentially with roman numerals, progressing rostrally to caudally:

I. Olfactory
II. Optic
III. Oculomotor
IV. Trochlear
V. Trigeminal
VI. Abducens
VII. Facial
VIII. Vestibulocochlear
IX. Glossopharyngeal
X. Vagus
XI. Accessory
XII. Hypoglossal

Three figures appearing earlier in the book can be reviewed to observe the relative positions of the cranial nerves emerging from the brain (Figs. 17-3 and 17-4) and their relative positions in the floor of the cranial vault (Fig. 9-2).

As explained earlier, peripheral nerves consist of several nerve fiber types specific for their function. Typically, each peripheral nerve contains somatic and visceral components, each with afferent and efferent fibers.

Peripheral nerves emanating from the brain (known as cranial nerves) are more complex than those arising from the spinal cord, since these nerves serve special sensory functions—such as hearing, seeing, smelling, and tasting—in addition to supplying special skeletal muscles of branchiomeric origin.

The cranial nerves, then, carry certain components in addition to the general somatic and general visceral components carried by spinal nerves, designated as special somatic afferent, special visceral afferent, and special visceral efferent.

CRANIAL NERVE MODALITIES

General somatic afferent (GSA)—General sensation in function. For example, the trigeminal nerve serves much of the skin and the mucous membranes of the face, whereas the facial, glossopharyngeal, and vagus nerves serve the area of the ear with general sensation.

General somatic efferent (GSE)—General motor in function to skeletal muscles. This grouping is carried by the oculomotor, trochlear, abducent, and hypoglossal nerves innervating musculature derived from somites.

General visceral afferent (GVA)—General sensation from the viscera included in the facial, glossopharyngeal, and vagus nerves.

General visceral efferent (GVE)—Visceral motor (parasympathetic) to the viscera. Only four cranial nerves transmit parasympathetic fibers: the oculomotor, facial, glossopharyngeal, and vagus nerves.

Special somatic afferent (SSA)—Special sensory in function from the eye and ear. The cranial nerves carrying this component are the optic and vestibulocochlear nerves.

Special visceral afferent (SVA)—Special sensory in function from the viscera. These fibers are associated with the special senses of smell, carried in the olfactory nerve; and taste, transmitted in the facial, glossopharyngeal, and vagus nerves. An easy way to remember the difference between SSA and SVA fibers is that for SVA fibers to be activated, the material has to be dissolved in a fluid (saliva or mucus).

Special visceral efferent (SVE)—Special motor to the branchiomeric musculatures. This component is carried to the muscles derived from the pharyngeal arches and is transmitted by the nerves of those arches: the trigeminal, facial, glossopharyngeal, accessory (contributions to the pharyngeal plexus), and vagus nerves.

As with the typical spinal nerve, cell bodies of afferent nerve fibers of cranial nerves are located in sensory ganglia outside the central nervous system, that is, outside the brain. Central processes of these
fibers pass via the cranial nerves into the brain to terminate on neurons that relay impulses for processing, sorting out, and coordinating the information before initiation of a motor response that may or may not be at a conscious level.

All of the interconnections and workings of the brain are extremely complicated and beyond the scope of this text. Readers who want more information about this subject are referred to standard textbooks of neuroanatomy.

Each of the 12 cranial nerves is described in the following sections, including information on the location of the cell bodies, the components carried, connections with other nerves, and finally the distribution and function. A summary of this information is presented in tabular form in Table 18-1.

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Components</th>
<th>Cell Bodies</th>
<th>Peripheral Distribution</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>I Olfactory</td>
<td>SVA</td>
<td>Olfactory epithelial cells</td>
<td>Olfactory nerves</td>
<td>Smell</td>
</tr>
<tr>
<td>II Optic</td>
<td>SSA</td>
<td>Ganglion cells of retina</td>
<td>Rods and cones</td>
<td>Vision</td>
</tr>
<tr>
<td>III Oculomotor</td>
<td>GSE</td>
<td>Nucleus III</td>
<td>Levator palpebrae; recti: superior, medial, inferior; and inferior oblique Ciliary ganglion—Ciliary body—Sphincter pupillae</td>
<td>Eye movement; Contraction of pupil and accommodation; Kinesthetic sense</td>
</tr>
<tr>
<td></td>
<td>GVE</td>
<td>Edinger-Westphal nucleus</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>GP</td>
<td>Mesencephalic nucleus V</td>
<td>Ocular muscles</td>
<td></td>
</tr>
<tr>
<td>IV Trochlear</td>
<td>GSE</td>
<td>Nucleus IV</td>
<td>Superior oblique</td>
<td>Ocular movement; Kinesthetic sense</td>
</tr>
<tr>
<td></td>
<td>GP</td>
<td>Mesencephalic nucleus V</td>
<td>Superior oblique</td>
<td></td>
</tr>
<tr>
<td>V Trigeminal</td>
<td>GSA</td>
<td>Trigeminal ganglion</td>
<td>Ophthalmic, maxillary, and mandibular divisions to mucous membranes and skin of face and head</td>
<td>General sensation; Mastication</td>
</tr>
<tr>
<td></td>
<td>SVE</td>
<td>Motor nucleus V</td>
<td>Temporalis, masseter, pterygoids, anterior belly of digastric, mylohyoid, tensors palatini and tympani</td>
<td></td>
</tr>
<tr>
<td></td>
<td>GP</td>
<td>Mesencephalic nucleus V</td>
<td>Muscles of mastication</td>
<td>Kinesthetic sense</td>
</tr>
<tr>
<td>VI Abducens</td>
<td>GSE</td>
<td>Nucleus VI</td>
<td>Lateral rectus</td>
<td>Eye movement; Kinesthetic sense</td>
</tr>
<tr>
<td></td>
<td>GP</td>
<td>Mesencephalic nucleus V</td>
<td>Lateral rectus</td>
<td></td>
</tr>
<tr>
<td>VII Facial</td>
<td>SVE</td>
<td>Motor nucleus VII</td>
<td>Muscles of facial expression, stapedius, stylohyoid, post, belly of digastric</td>
<td>Facial expression; Secretomotor</td>
</tr>
<tr>
<td></td>
<td>GVE</td>
<td>Salivatory nucleus</td>
<td>Greater petrosal—pterygopalatine ganglion—nasal mucosa, lacrimal gland; chorda tympani—lingual nerve, submandibular ganglion—submandibular, sublingual glands</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SVA</td>
<td>Geniculate ganglion</td>
<td>Chorda tympani—lingual nerve—taste buds anterior two-thirds tongue</td>
<td>Taste</td>
</tr>
<tr>
<td></td>
<td>GVA</td>
<td>Geniculate ganglion</td>
<td>Greater petrosal, chorda tympani</td>
<td>Visceral sensation</td>
</tr>
<tr>
<td></td>
<td>GSA</td>
<td>Geniculate ganglion</td>
<td>Auricular branch—ear and mastoid</td>
<td>Cutaneous sensation</td>
</tr>
</tbody>
</table>

Table 18-1 Cranial Nerves (continued)
Cell bodies of the olfactory nerve, the nerve of smell, are found in the olfactory mucosa situated over the superior nasal concha. Axons of the olfactory nerve pass through the cribriform plate of the ethmoid bone to terminate in the olfactory bulb, which is connected to the brain by the olfactory tract, technically a part of the brain (Fig. 18-1 and Tables 18-1 and 18-5).

**Summary Bite.** SVA is the only modality carried by the olfactory nerve.

Cell bodies of the optic nerve, the nerve of sight, are located in the ganglionic layer of cells composing the retina. Axons of these cells are gathered into bundles that leave the bulb of the eye as the optic nerve, passing posteriorly through the orbit to exit through the optic foramen. Here the axons join the optic nerve of the opposite side, forming the optic chiasma. Optic tracts continue from the chiasma to enter the base of
Anosmia results following a unilateral lesion either within the olfactory epithelium or within the olfactory nerve, causing the patient to experience complete loss of the sense of smell on the side of the lesion.

The oculomotor nerve exits the brain near the cerebral peduncle (Fig. 18-2 and Tables 18-1 and 18-5).

The oculomotor nerve serves all of the extrinsic muscles of the eye, excluding the superior oblique and the lateral rectus muscles, with general somatic efferent innervation. A specialized group of autonomic motor cells in the oculomotor nucleus within the brain is termed the Edinger–Westphal nucleus. These are preganglionic parasympathetic neurons whose fibers are destined for the ciliary ganglion within the orbit. Postganglionic fibers from the ciliary ganglion pass to the orb via short ciliary nerves and on to the ciliary body and sphincter pupillae muscles of the eye (see Table 18-2).

The oculomotor nerve exits the brain near the medial side of the cerebral peduncle, passes through the free and attached borders of the tentorium cerebelli, and then passes through the lateral wall of the cavernous sinus to enter the superior orbital fissure for distribution. While in the cavernous sinus, contributions from the carotid plexus are communicated to the oculomotor nerve. These communications are the postganglionic sympathetic fibers from the superior cervical ganglion destined for the dilator pupillae muscle of the eye.

Once in the orbit, the oculomotor nerve divides into superior and inferior divisions, facilitating innervation of the extraocular muscles. The ciliary ganglion

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**Clinical Considerations**

**Anosmia**

Anosmia results following a unilateral lesion either within the olfactory epithelium or within the olfactory nerve, causing the patient to experience complete loss of the sense of smell on the side of the lesion.

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**III. OCULOMOTOR NERVE**

Summary Bite. GSE, GVE, and GP (general proprioception to the extraocular muscles for kinesthetic sense) are the modalities carried by the oculomotor nerve.

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*Figure 18-1. I. Olfactory nerve.*
Changes in the longitudinal dimension of the optical axis will cause images to be focused either anterior (myopia) or posterior (hyperopia) to the retina. This is usually the result of changes in the refractive elements of the eye, notably the cornea, which experiences a slight change in shape. There may also occur an alteration in the dimension of the orb. Often, both processes occur as a function of aging. These conditions can be diagnosed and treated with prescription-ground glasses that can optically correct for the alteration in the longitudinal dimension of the optical axis.

Multiple Sclerosis (MS)

Multiple sclerosis is one of the demyelinating diseases that affects the optic nerve but not the other cranial nerves. This is because the myelin surrounding the optic nerves is produced by glial cells rather than by Schwann cells, as in other cranial nerves.

Detached Retina

The 10-layered retina is loosely attached to the choroid layer of the orb and is retained in that position by the vitreous body. Sudden jolts absorbed in the orbit may detach the retina, causing a medical emergency. The detached retina is sightless but sight can usually be restored by surgical reattachment of the retina.

Cataract

Cataract is an age-related condition where the lens loses its transparency and becomes clouded, causing blurred vision. It is the major cause of poor vision and blindness throughout the world. Modern techniques now permit surgical placement of plastic lenses, resulting in restored vision.

Presbyopia

Presbyopia is associated with aging. It results from the inability of the eye to focus on close objects (accommodation), which is related to the lens becoming less elastic, thus light cannot be focused properly on the retina.
is suspended from the inferior division by the parasympathetic motor root of the ganglion. Additional communications to the ganglion are from the nasociliary nerve, a branch of the ophthalmic division of the trigeminal nerve. These communications are purely sensory, passing through the ganglion without synapsing there. Thus, these somatic sensory nerves reach their destination in the orb by way of the short ciliary nerves. Postganglionic sympathetic fibers may also communicate with the ganglion in a fashion similar to that of the nasociliary nerve; however, these sympathetic fibers are destined for the dilator pupillae muscle. The functions of these intrinsic muscles of the eye are detailed in Chapter 10.

Proprioceptive fibers of the extraocular muscles are carried in the oculomotor nerve, then transmitted to the ophthalmic division of the trigeminal nerve to join it in the orbit, or via communications while it passes through the walls of the cavernous sinus. Terminations of these fibers are described in the section on the trigeminal nerve (Fig. 18-3 and Tables 18-1, 18-2, and 18-5).

**Clinical Considerations**

**Oculomotor Nerve Injury**

Injury to the oculomotor nerve will result in palsy on the ipsilateral side with dilated pupil and ptosis. Additionally, the bulb of the eye will turn down and out with a concomitant inability to move the eye either up or down; moreover, the pupillary reflex will be lost.
IV. TROCHLEAR NERVE

Summary Bite. GSE and GP (general proprioception fibers to the extraocular muscle for kinesthetic sense) are the modalities carried by the trochlear nerve.

The trochlear nerve, the smallest of the cranial nerves, supplies the superior oblique muscle of the eye with motor innervation. This is the only cranial nerve originating on the dorsal surface of the brainstem. From there, it passes around the midbrain to pierce the tentorial dura, thus entering the cavernous sinus. While coursing through the wall of the cavernous sinus, the trochlear nerve communicates with the carotid plexus and the ophthalmic division of the trigeminal nerve. Proprioceptive fibers from the superior oblique muscle are thought to communicate with the ophthalmic nerve at that point. On entering the orbit through the superior orbital fissure, the nerve terminates in the superior oblique muscle, which it provides with motor innervation (Fig. 18-3 and Tables 18-1 and 18-5).

Trochlear Nerve Injury

The trochlear nerve provides motor innervation only to the superior oblique muscle. When this cranial nerve is injured, the superior oblique muscle on the ipsilateral side will be paralyzed, causing the eyeball to rotate outward, resulting in double vision.

V. TRIGEMINAL NERVE

Summary Bite. GSA, SVE, and GP (general proprioception fibers to the muscles of mastication for kinesthetic sense) are the modalities carried by the trigeminal nerve.

The largest of the cranial nerves, the trigeminal nerve serves much of the face, the teeth and supporting structures, most of the anterior portion of the oral cavity, and the mucous membranes of the head with cutaneous sensation. Also, it provides motor innervation...
tion to the muscles of mastication. The nerve has two roots emanating from the pons. The larger, sensory root, which lies lateral to the motor root, contains the central processes of the neurons whose cell bodies are found in the trigeminal (semilunar) ganglion, the sensory ganglion of the trigeminal nerve. This ganglion is located under the cover of the dura in a pocket (the Meckel cave) on the trigeminal impression located near the apex of the petrous portion of the temporal bone. Peripheral processes of the sensory neurons located in the flat, semilunar-shaped ganglion are gathered in three separate bundles. These bundles leave the ganglion as the ophthalmic, maxillary, and mandibular divisions of the trigeminal nerve. The motor root courses beneath the trigeminal ganglion, proceeds medial to the sensory root, and the two leave the skull via the foramen ovale and then join each other to form the mandibular division of the trigeminal nerve. Thus, the mandibular division is mixed in function. The ophthalmic and maxillary divisions are purely sensory, and they leave the cranial vault via the superior orbital fissure and foramen rotundum, respectively.

The four parasympathetic ganglia of the head are in close association with the trigeminal nerve, although, functionally, these ganglia are not part of the trigeminal nerve. Postganglionic parasympathetic fibers arising in these ganglia are transmitted to the structures they serve by joining branches of the trigeminal nerve for distribution. The parasympathetic ganglia, the preganglionic motor root, and the associated divisions of the trigeminal nerve are listed in Table 18-2 (Figs. 18-4 through 18-7 and Tables 18-1 and 18-3 through 18-5).

**OPHTHALMIC NERVE V₁**

**Summary Bite.** GSA is the only modality carried by the ophthalmic division of the trigeminal nerve.

The ophthalmic nerve supplies the bulb and conjunctiva of the eye, the lacrimal gland, the skin of the forehead and nose, and the mucous membranes of the paranasal sinuses with sensory innervation. The ophthalmic nerve leaves the superior aspect of the trigeminal ganglion, then lies in the lateral wall of the cavernous sinus as it courses to the orbit (Fig. 18-4 and Tables 18-3 and 18-5). Along the way, tentorial branches are supplied to the tentorium. Just before

![Figure 18-4. V. Trigeminal nerve, ophthalmic division. Note the communications to the ciliary ganglion from the nasociliary nerve.](image-url)
Figure 18-5. V. Trigeminal nerve, maxillary division.

Figure 18-6. Pterygopalatine ganglion and connections.
entering the orbit through the superior orbital fissure, the nerve divides into three separate nerves: the lacrimal, frontal, and nasociliary nerves. In its course, the ophthalmic nerve communicates with the carotid plexus in the cavernous sinus and with other cranial nerves represented in the orbit. However, discussion of these communications is not warranted here.

**Lacrimal Nerve**
The lacrimal nerve, the smallest branch of the ophthalmic division, runs along the lateral rectus muscle distributing to the lacrimal gland and adjacent conjunctiva. It then exits the orbit to be distributed to the skin of the lateral aspect of the upper eyelid (Fig. 18-4). While in the orbit, it communicates with the zygomaticotemporal branch of the zygomatic nerve of the maxillary division of the trigeminal nerve, which is carrying postganglionic parasympathetic fibers communicated to it from the pterygopalatine ganglion. These parasympathetic fibers are then transmitted to the lacrimal gland via the lacrimal nerve, thus providing it with secretomotor innervation (see Table 18-2).

**Frontal Nerve**
The frontal nerve, the largest branch of the ophthalmic nerve, divides shortly after entering the superior aspect of the orbit into a smaller supratrochlear and a larger supraorbital nerve. The former passes medial to the latter as the nerves course anteriorly above the levator palpebrae superioris muscle (Fig. 18-4). The supratrochlear nerve bends to pass superior to the pulley of the superior oblique muscle. Here it provides sensory innervation to the conjunctiva and skin of the medial aspect of the upper eyelid before leaving the orbit to turn upward to supply the skin over the forehead. The supraorbital nerve continues forward to exit the orbit at the supraorbital notch. While passing the notch, it sends a filament...
### Table 18-3  Trigeminal Nerve—Sensory Components

<table>
<thead>
<tr>
<th>Division of Trigeminal Nerve</th>
<th>Modality</th>
<th>Nerve Branch(es)</th>
<th>Foramen of Passage</th>
<th>Associated Parasympathetic Ganglion/Nerve</th>
<th>Sensory Region Served</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ophthalmic (V1)</td>
<td>GSA</td>
<td>Lacrimal</td>
<td>Exits Superior orbital fissure</td>
<td>Zygomaticotemporal of V2, delivers post. para. from pterygo-palatine ganglion (VII) for lacrimal gland (GVE)</td>
<td>Lacrimal gland, adjacent conjunctiva, lateral aspect of skin of upper eyelid</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Frontal</td>
<td>Exits Superior orbital fissure</td>
<td>Zygomaticotemporal of V2, delivers post. para. from pterygo-palatine ganglion (VII) for lacrimal gland (GVE)</td>
<td>Conjunctiva and skin of the medial portion of the eye and skin over the forehead</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Supratrochlear</td>
<td>Exits Superior orbital fissure</td>
<td>Zygomaticotemporal of V2, delivers post. para. from pterygo-palatine ganglion (VII) for lacrimal gland (GVE)</td>
<td>Filament to frontal sinus, upper eyelid, forehead, and scalp</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Supraorbital</td>
<td>Exits Superior orbital fissure</td>
<td>Zygomaticotemporal of V2, delivers post. para. from pterygo-palatine ganglion (VII) for lacrimal gland (GVE)</td>
<td>Filament to frontal sinus, upper eyelid, forehead, and scalp</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nasociliary</td>
<td>Exits Superior orbital fissure</td>
<td>Zygomaticotemporal of V2, delivers post. para. from pterygo-palatine ganglion (VII) for lacrimal gland (GVE)</td>
<td>Filament to frontal sinus, upper eyelid, forehead, and scalp</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Long ciliary</td>
<td>Ciliary ganglion (III) &amp; possibly post. sym. from carotid plexus (GVE)</td>
<td>Postganglionic sympathetic to dilatator pupillae</td>
<td>Orb. cornea</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Posterior ethmoidal</td>
<td>Orb. cornea</td>
<td>Postganglionic sympathetic to dilatator pupillae</td>
<td>Orb., cornea</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Anterior ethmoidal</td>
<td>P.E. foramen—ethmoidal, sphenoidal, frontal sinuses</td>
<td>Orb. cornea</td>
<td>P.E. foramen—ethmoidal, sphenoidal, frontal sinuses</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Internal nasal</td>
<td>Orb. cornea</td>
<td>P.E. foramen—ethmoidal, sphenoidal, frontal sinuses</td>
<td>Orb. cornea</td>
</tr>
<tr>
<td></td>
<td></td>
<td>External nasal</td>
<td>Orb. cornea</td>
<td>P.E. foramen—ethmoidal, sphenoidal, frontal sinuses</td>
<td>Orb. cornea</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Infratrochlear</td>
<td>Orb. cornea</td>
<td>P.E. foramen—ethmoidal, sphenoidal, frontal sinuses</td>
<td>Orb. cornea</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maxillary (V2)</td>
<td>GSA</td>
<td>Pterygopalatine ganglion (VII) delivers post. para. secretomotor fibers to zygomatico-temporal nerve for distribution to lacrimal nerve to lacrimal gland (GVE)</td>
<td>Skin of the cheek</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Zygomatic</td>
<td>Exits Rotundum</td>
<td>Pterygopalatine ganglion (VII) delivers post. para. secretomotor fibers to zygomatico-temporal nerve for distribution to lacrimal nerve to lacrimal gland (GVE)</td>
<td>Skin of the cheek</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Zygomaticofacial</td>
<td>Delivers secretomotor fibers to lacrimal nerve for lacrimal gland</td>
<td>Pterygopalatine ganglion (VII) delivers post. para. secretomotor fibers to zygomatico-temporal nerve for distribution to lacrimal nerve to lacrimal gland (GVE)</td>
<td>Skin of the cheek</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Zygomatico-temporal</td>
<td>Delivers secretomotor fibers to lacrimal nerve for lacrimal gland</td>
<td>Pterygopalatine ganglion (VII) delivers post. para. secretomotor fibers to zygomatico-temporal nerve for distribution to lacrimal nerve to lacrimal gland (GVE)</td>
<td>Skin of the cheek</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maxillary (V2)</td>
<td>GSA</td>
<td>Pterygopalatine ganglion (VII) delivers post. para. secretomotor fibers to zygomatico-temporal nerve for distribution to lacrimal nerve to lacrimal gland (GVE)</td>
<td>Skin of the cheek</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Orbital</td>
<td>Enters Inferior orbital fissure</td>
<td>Delivers secretomotor fibers to lacrimal nerve for lacrimal gland</td>
<td>Skin of the cheek</td>
</tr>
</tbody>
</table>

(continued)
<table>
<thead>
<tr>
<th>Division of Trigeminal Nerve</th>
<th>Modality</th>
<th>Nerve Branch(es)</th>
<th>Foramen of Passage</th>
<th>Associated Parasympathetic Ganglion/Nerve</th>
<th>Sensory Region Served</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greater palatine</td>
<td></td>
<td>Exits Greater palatine</td>
<td>Pterygopalatine ganglion (VII) delivers post. para. secretomotor fibers to small glands of the nasal cavity, pharynx, and palate (GVE)</td>
<td>Adjacent soft palate, hard palate, gingiva, mucous membranes anteriorly to incisor teeth (communicates with nasopalatine)</td>
<td></td>
</tr>
<tr>
<td>Lesser palatine</td>
<td></td>
<td>Exits Lesser palatine</td>
<td>Delivers secretomotor fibers to glands of soft palate</td>
<td>Soft palate, tonsil, and uvula. (Many of the afferents were communicated from facial nerve)</td>
<td></td>
</tr>
<tr>
<td>Posterior superior nasal branches</td>
<td></td>
<td>Exits Sphenopalatine</td>
<td>Delivers secretomotor fibers to glands of nasal cavity</td>
<td>Nasal cavity supplying mucous memb. of sup. and middle conchae, median nasal septum and ethmoid sinus. Major trunk is nasopalatine</td>
<td></td>
</tr>
<tr>
<td>Nasopalatine</td>
<td></td>
<td>Exits Incisive canal</td>
<td>Delivers secretomotor fibers to glands of nasal cavity</td>
<td>Between septum and mucous memb. to incisive canal. Serves anterior palate as far laterally as cuspid. (Communicates with greater palatine nerve)</td>
<td></td>
</tr>
<tr>
<td>Pharyngeal br.</td>
<td></td>
<td>Enters Pharyngeal canal</td>
<td>Delivers secretomotor fibers to glands of nasopharynx and sphenoid sinus</td>
<td>Enters pharyngeal canal. Serves m. memb. and nasopharynx to auditory tube</td>
<td></td>
</tr>
<tr>
<td>Posterior superior alveolar*</td>
<td></td>
<td>Enters Poster or superior alveolar</td>
<td></td>
<td>Sometimes branched. Passes over max. tuberosity to serve m. memb. of cheek and adjacent gingiva. Enters P.S.A.F to distribute to max. sinus and to roots of 3 max. molars (except mesial buccal root of 1st molar)</td>
<td></td>
</tr>
</tbody>
</table>

Table 18-3 Trigeminal Nerve—Sensory Components (continued)

Maxillary (V2)  GSA  Infraorbital  This nerve is a continuation of the maxillary nerve into the floor of the orbit via the inferior orbital fissure and exiting the skull at the infraorbital foramen  

Middle superior alveolar*  |  |  |  | Lateral wall of max.sinus, enters mesial buccal root of 1st molar and all roots of premolars  |
Anterior superior alveolar*  |  |  |  | Anterior max. sinus, and roots of anterior teeth, and twigs to floor of nasal cavity serving inferior meatus, and adjacent m. membrane  |

Inferior palpebral brs.  Exits Infraorbital  |  |  |  | Skin and conjunctiva of the lower eyelid  |
External nasal brs.  Exits Infraorbital  |  |  |  | Skin about the lateral aspect of the nose  |

(continued)
### Table 18-3 Trigeminal Nerve—Sensory Components

<table>
<thead>
<tr>
<th>Division of Trigeminal Nerve</th>
<th>Modality</th>
<th>Nerve Branch(es)</th>
<th>Foramen of Passage</th>
<th>Associated Parasympathetic Ganglion/Nerve</th>
<th>Sensory Region Served</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior</td>
<td>Exits Infraorbital</td>
<td>Skin and mucous memb. of the upper lip</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labial brs.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mandibular (V₃)</td>
<td>GSA</td>
<td>Sensory root</td>
<td>Exits Ovale</td>
<td>Sensory and motor roots join outside the skull (F. ovale) to form a mixed nerve. Some branches are sensory, some motor, whereas some are mixed</td>
<td>Dura and mastoid air cells</td>
</tr>
<tr>
<td>From trunk</td>
<td>Enters Spinosum</td>
<td>Skin of cheek over buccinator muscle passes through buccinator muscle to serve buccal mucosa and adjacent gingiva. (May communicate with facial nerve for distribution purposes)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recurrent</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meningeal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>From anterior division</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buccal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Articular br. to TMJ</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>From:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Masseteric nerve b</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>From posterior division</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lingual</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inferior</td>
<td>Enters</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alveolar</td>
<td>Mandibular</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mental</td>
<td>Exits</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mental</td>
<td>Mental</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auriculo-temporal</td>
<td>Otic ganglion (IX) communicates post. para fibers for distribution to the parotid gland (GVE)</td>
<td>Distribute superficial temporal nerves over skin of temple. Articular brs. to TMJ secretomotor fibers from otic ganglion to parotid gland</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

GSA indicates general somatic afferent; GVE, general visceral efferent; TMJ, temporomandibular joint.

*Posterior, middle, and anterior superior alveolar nerves communicate, forming a dental plexus before innervating the teeth.

*The masseteric nerve from the anterior division is a mixed nerve. Its sensory fibers are the articular branches to the TMJ.
Cranial Nerves

Chapter 18

Table 18-4 Trigeminal Nerve—Motor Components

<table>
<thead>
<tr>
<th>Division of Trigeminal Nerve</th>
<th>Modality</th>
<th>Nerve Branch</th>
<th>Motor to Muscles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mandibular (V3)</td>
<td>SVE</td>
<td>Sensory and motor roots of the trigeminal nerve exit the foramen ovale and then join to form the trunk of the nerve, which then divides into anterior and posterior divisions. Some nerves are sensory, some motor, and some mixed. Only motor components are presented.</td>
<td></td>
</tr>
<tr>
<td>From Trunk</td>
<td></td>
<td>Nerve to medial pterygoid</td>
<td>Medial pterygoid</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nerve to tensor tympani</td>
<td>Tensor tympani</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nerve to tensor veli palatini</td>
<td>Tensor veli palatini</td>
</tr>
<tr>
<td>From Anterior Division</td>
<td></td>
<td>Deep temporal nerves</td>
<td>Temporalis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(anterior and posterior)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lateral pterygoid nerve</td>
<td>Lateral pterygoid</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Masseteric nerve</td>
<td>Masseter</td>
</tr>
<tr>
<td>From Posterior Division</td>
<td></td>
<td>Mylohyoid nerve</td>
<td>Mylohyoid</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nerve to anterior digastric</td>
<td>Anterior digastric</td>
</tr>
</tbody>
</table>

SVE indicates special visceral efferent.

into the frontal sinus. The nerve supplies sensory innervation to the upper lid, forehead, and scalp as far posteriorly as the lambdoidal suture.

Nasociliary Nerve

The nasociliary nerve enters the orbit between the lateral rectus muscle and the oculomotor nerve. It then passes obliquely over the optic nerve to the medial wall of the orbit, where its terminal branch enters the anterior ethmoidal foramen (Fig. 18-4). Just before entering the foramen, the nasociliary nerve gives off an infratrochlear branch, which courses anteriorly along the medial wall of the orbit and exits at its medial margin. Along the way, the branch provides sensory innervation to the conjunctiva, eyelid, lacrimal sac, caruncula, and side of the nose. Anterior and posterior ethmoidal branches enter the same-named foramina to supply the ethmoidal, sphenoidal, and frontal sinuses. The anterior ethmoidal nerve continues along the ethmoid bone to enter the nasal cavity. Internal nasal branches arising from it innervate the mucous membranes of the nasal cavity. The anterior ethmoidal nerve continues anteriorly to exit the nasal cavity at the inferior border of the nasal bone as the external nasal branch, providing general sensation to the ala and globe of the nose.

While in the orbit, the nasociliary nerve sends long ciliary nerves to the eyeball as the nerve crosses the optic nerve. Other short filaments pass to the ciliary ganglion, establishing a close association with this parasympathetic ganglion. The long ciliary nerves and those filaments that pass to the ganglion and on to the eyeball, as part of the short ciliary nerves are purely sensory and are destined for the iris and cornea. Postganglionic sympathetic fibers communicate to the ophthalmic nerve from the carotid plexus while passing through the cavernous sinus, or they may accompany the long ciliary nerves or the short filaments to the ganglion and on to the eyeball via the short ciliary nerves. These postganglionic sympathetic fibers are destined for the dilator pupillae muscle within the iris.

Maxillary Nerve V2

Summary Bite. GSA is the only modality carried by the maxillary division of the trigeminal nerve.

The maxillary nerve, the second division of the trigeminal nerve, is purely sensory and serves the skin of the side of the nose; cheek; eyelids; mid-face; nasopharynx; tonsil; palate; maxillary sinus; and gingiva, teeth, and associated structures of the upper jaw. The nerve exits the cranial vault via the foramen rotundum after passing through the posterior portion of the cavernous sinus. From the foramen rotundum, the nerve courses through the pterygopalatine fossa to enter the floor of the orbit at the inferior orbital fissure. Here, the nerve becomes known as the infraorbital nerve, enters the infraorbital canal, and then
Chapter 18
Cranial Nerves

293

Cranial Nerve Modality Assessment Technique Perceived Dysfunction

I Olfactory SVA Patient is asked to differentiate distinct odors (coffee, vanilla) with eyes covered. Test each side independently. Damage such as an ethmoid fracture may result in anosmia (loss of sense of smell).

II Optic SSA Eye charts are used to assess visual acuity. Visual fields are determined by examining when patient observes an object moving from lateral to medial. Ophthalmoscope used for observing retina, optic disc, and blood vessels. Damage to the retina usually results in blindness to the affected eye. Damage beyond the optic chiasma will present partial visual losses.

III Oculomotor GSE Patient is asked to follow with his or her eyes the examiner’s finger as it moves up and down vertically and medially and laterally. Watch for crossing of eyes during convergence. Damage to this modality may cause paralysis of all extraocular muscles except the superior oblique and lateral rectus. This produces lateral strabismus and inability to look vertically. Also ptosis (eyelid drooping). GVE Examine patient for pupillary reflex with light shining on and off in each eye. Damage to this modality will produce lack of pupillary reflex, dilated pupils, and lack of changes in pupil at close focus.

IV Trochlear GSE Analysis of function is performed during testing of the oculomotor nerve. Damage to this nerve causes double vision and inability to rotate the eye inferolaterally.

V Trigeminal Ophthalmic division (V1) Test for corneal reflex with whisp of cotton. Prick forehead with pin (pain), apply warm and cold objects (temperature). Damage to this division will inhibit the corneal reflex and will reduce or inhibit sensation over the (V1) zone.

Maxillary division (V2) Stroke sensory zone of (V2) with eyes closed (light touch), prick with pin (pain), apply warm and cold objects (temperature). Damage to this division will reduce or inhibit sensation over the (V2) zone.

Mandibular division (V3) Stroke sensory zone of (V3) with eyes closed (light touch), prick with pin (pain), apply warm and cold objects (temperature). Damage in this modality may cause paralysis of the muscles of mastication, thus causing the jaw to deviate same side as the lesion.

VI Abducens GSE Analysis of function is performed during testing of the oculomotor nerve. Damage to this nerve causes double vision and paralysis of the lateral rectus muscle, thus the eye remains rotated medially on the affected side.

VII Facial SVA Test for taste for sweet and salty on anterior 2/3 of tongue. Damage to this modality will reduce or inhibit the sensation of taste on the anterior 2/3 of the tongue. GVE Observe tearing with pungent fumes (ammonia). Damage to this modality will reduce or inhibit the ability to secrete tears from the affected side. Mucus production in the nasal cavity and salivary gland secretions from the submandibular and sublingual glands is more difficult to evaluate.

Table 18-5 Cranial Nerves—Clinical Testing

<table>
<thead>
<tr>
<th>Cranial Nerve</th>
<th>Modality</th>
<th>Assessment Technique</th>
<th>Perceived Dysfunction</th>
</tr>
</thead>
<tbody>
<tr>
<td>I Olfactory</td>
<td>SVA</td>
<td>Patient is asked to differentiate distinct odors (coffee, vanilla) with eyes covered. Test each side independently.</td>
<td>Damage such as an ethmoid fracture may result in anosmia (loss of sense of smell).</td>
</tr>
<tr>
<td>II Optic</td>
<td>SSA</td>
<td>Eye charts are used to assess visual acuity. Visual fields are determined by examining when patient observes an object moving from lateral to medial. Ophthalmoscope used for observing retina, optic disc, and blood vessels.</td>
<td>Damage to the retina usually results in blindness to the affected eye. Damage beyond the optic chiasma will present partial visual losses.</td>
</tr>
<tr>
<td>III Oculomotor</td>
<td>GSE</td>
<td>Patient is asked to follow with his or her eyes the examiner’s finger as it moves up and down vertically and medially and laterally. Watch for crossing of eyes during convergence.</td>
<td>Damage to this modality may cause paralysis of all extraocular muscles except the superior oblique and lateral rectus. This produces lateral strabismus and inability to look vertically. Also ptosis (eyelid drooping).</td>
</tr>
<tr>
<td>GVE</td>
<td>Examine patient for pupillary reflex with light shining on and off in each eye. Observe and compare contractions and dilations in affected and unaffected eyes.</td>
<td>Damage to this modality will produce lack of pupillary reflex, dilated pupils, and lack of changes in pupil at close focus.</td>
<td></td>
</tr>
<tr>
<td>IV Trochlear</td>
<td>GSE</td>
<td>Analysis of function is performed during testing of the oculomotor nerve.</td>
<td>Damage to this nerve causes double vision and inability to rotate the eye inferolaterally.</td>
</tr>
<tr>
<td>V Trigeminal</td>
<td>GSA</td>
<td>Test for corneal reflex with whisp of cotton. Prick forehead with pin (pain), apply warm and cold objects (temperature).</td>
<td>Damage to this division will inhibit the corneal reflex and will reduce or inhibit sensation over the (V1) zone.</td>
</tr>
<tr>
<td>Ophthalmic division (V1)</td>
<td>GSA</td>
<td>Stroke sensory zone of (V2) with eyes closed (light touch), prick with pin (pain), apply warm and cold objects (temperature).</td>
<td>Damage to this division will reduce or inhibit sensation over the (V2) zone.</td>
</tr>
<tr>
<td>Maxillary division (V2)</td>
<td>GSA</td>
<td>Stroke sensory zone of (V3) with eyes closed (light touch), prick with pin (pain), apply warm and cold objects (temperature).</td>
<td>Damage to this division will reduce or inhibit sensation over the (V3) zone.</td>
</tr>
<tr>
<td>Mandibular division (V3)</td>
<td>SVE</td>
<td>Ask patient to clench jaws, open, then move jaw side to side with resistance. Muscle strength in the temporalis and masseter should be compared from side to side by palpation.</td>
<td>Damage in this modality may cause paralysis of the muscles of mastication, thus causing the jaw to deviate same side as the lesion.</td>
</tr>
<tr>
<td>VI Abducens</td>
<td>GSE</td>
<td>Analysis of function is performed during testing of the oculomotor nerve.</td>
<td>Damage to this nerve causes double vision and paralysis of the lateral rectus muscle, thus the eye remains rotated medially on the affected side.</td>
</tr>
<tr>
<td>VII Facial</td>
<td>SVA</td>
<td>Test for taste for sweet and salty on anterior 2/3 of tongue.</td>
<td>Damage to this modality will reduce or inhibit the sensation of taste on the anterior 2/3 of the tongue.</td>
</tr>
<tr>
<td>GVE</td>
<td>Observe tearing with pungent fumes (ammonia).</td>
<td>Damage to this modality will reduce or inhibit the ability to secrete tears from the affected side. Mucus production in the nasal cavity and salivary gland secretions from the submandibular and sublingual glands is more difficult to evaluate.</td>
<td></td>
</tr>
</tbody>
</table>
### Chapter 18 Cranial Nerves

**Table 18-5 Cranial Nerves—Clinical Testing (continued)**

<table>
<thead>
<tr>
<th>Cranial Nerve</th>
<th>Modality</th>
<th>Assessment Technique</th>
<th>Perceived Dysfunction</th>
</tr>
</thead>
<tbody>
<tr>
<td>SVE</td>
<td>Observe symmetry of face when asked to close eyes, frown, smile, whistle, raise eyebrows. Look for flacid sagging of face.</td>
<td>Damage to this modality, such as in stroke, causes a paralysis of the muscles of facial expression, which causes the face to sag and an inability to make facial expressions on the affected side.</td>
<td></td>
</tr>
<tr>
<td>VIII GSA</td>
<td>Test with a tuning fork by air and bone conduction.</td>
<td>Loss of hearing by air conduction indicates a lesion or damage to the middle ear. Loss by bone conduction indicates nerve deafness.</td>
<td></td>
</tr>
<tr>
<td>GSA (SP)</td>
<td>Test walking a straight line, dizziness. Watch for rapid eye movements.</td>
<td>Damage to the vestibular division elicits dizziness, nausea, vomiting, and uncontrolled rapid eye movement.</td>
<td></td>
</tr>
<tr>
<td>IX GVA</td>
<td>Test for gag reflex and swallowing and position of the uvula during this procedure. Test touch reception on the posterior 1/3 of the tongue.</td>
<td>Damage to this modality would reduce or inhibit the gag reflex and produce difficulty in swallowing. It would also reduce or inhibit general sensation on the posterior 1/3 of the tongue. Sensation to the carotid body and sinus would also be lost, thereby altering blood pressure and oxygen tension in the bloodstream.</td>
<td></td>
</tr>
<tr>
<td>SVA</td>
<td>Test for bitter and sour taste on the posterior 1/3 of the tongue and on circumvallate papillae.</td>
<td>Damage to this modality would reduce or inhibit the sense of taste over the posterior 1/3 of the tongue and on the circumvallate papillae.</td>
<td></td>
</tr>
<tr>
<td>GVE</td>
<td>Observe saliva flow from the parotid duct.</td>
<td>Damage to this modality would reduce or inhibit saliva secretion from the parotid gland.</td>
<td></td>
</tr>
<tr>
<td>X Vagus</td>
<td>Have patient elevate the palate by saying “aahhh,” swallow, and speak.</td>
<td>Damage to this component will prevent the palate from being elevated and will make swallowing and speech difficult.</td>
<td></td>
</tr>
<tr>
<td>XI Accessory</td>
<td>Have patient shrug shoulders and rotate head against resistance.</td>
<td>Damage to this modality would reduce or inhibit the movement of the head and shoulders.</td>
<td></td>
</tr>
<tr>
<td>XII Hypoglossal</td>
<td>Have patient protrude and retract tongue.</td>
<td>Damage to this nerve will cause the tongue to deviate toward the affected side on protrusion, and that side will appear shrunken and wrinkled.</td>
<td></td>
</tr>
</tbody>
</table>

GSA, general somatic afferent; GSE, general somatic afferent; GVE, general visceral efferent; SP, special proprioception; SSA, special somatic afferent; SVA indicates special visceral afferent; SVE, special visceral efferent.

*Note that some modalities associated with certain cranial nerves are not represented in this table because some areas of the head and neck receive overlapping innervation from more than one cranial nerve, thus complicating definitive testing. For example, the area about the ear/auditory meatus receives sensory innervation from several cranial nerves in addition to contributions from the cervical plexus, thereby making assessment extremely difficult.*

*Because there is close association and intermingling of nerve fibers of the glossopharyngeal, vagus, and accessory nerves, it is difficult to distinguish the affected nerve in clinical testing procedures. However, the gag reflex is generally considered the definitive test for glossopharyngeal nerve damage.*

*Although the vagus nerve serves visceral structures in the thorax and abdomen, the contents of the table are restricted to its functions in the head and neck.*

*This assumes that the SVE component of the accessory nerve that serves the sternocleidomastoid and trapezius muscles is from the cranial root of the accessory nerve. Remember that the SVE component of the vagus is also part of the cranial root of the accessory nerve. Therefore, damage to this root would affect both areas served by the vagus and the accessory nerves.*
exits on the face through the infraorbital foramen (Figs. 18-5 and 18-6 and Tables 18-3 and 18-5).

Along its route, the maxillary nerve provides several branches in the cranial vault, pterygopalatine fossa, and orbit, as well as on the face. While in the cranial vault, its middle meningeal nerve supplies the dura. Several branches also arise from the nerve as it traverses the pterygopalatine fossa.

Zygomatic Nerve
The zygomatic nerve, the first branch to arise from the maxillary nerve while it traverses the pterygopalatine fossa, passes into the orbit and divides into the zygomaticofacial and zygomaticotemporal nerves. Both of these nerves enter the zygomatic bone and exit it through the like-named foramina on its external surface (Fig. 18-5). The zygomaticofacial nerve exits on the face, providing sensation for the cheek. The zygomaticotemporal nerve exits in the temporal fossa to distribute to the skin of the side of the forehead. Before leaving the orbit, the zygomaticotemporal nerve supplies a branch to the lacrimal nerve. This communication is a postganglionic parasympathetic fiber derived from cranial nerve VII, passed to the zygomatic nerve from the pterygopalatine ganglion (see Table 18-2).

The pterygopalatine ganglion lies in close association with the maxillary nerve within the pterygopalatine fossa and is connected to it via two pterygopalatine nerves (Fig. 18-6).

Pterygopalatine Nerves
The pterygopalatine nerves are part of the maxillary nerve rather than part of the pterygopalatine ganglion, although they serve as functional communications to the ganglion by permitting the passage of postganglionic parasympathetic fibers from the ganglion to the nerve trunk for distribution to the lacrimal gland (Fig. 18-6 and Table 18-2).

Additional postganglionic parasympathetic fibers are communicated from the pterygopalatine ganglion to branches of the maxillary nerve destined for glands in the palate and nasal cavity, where these parasympathetic fibers serve secretomotor function.

There are several branches of the maxillary nerve that appear to originate from the ganglion but actually are branches of the two pterygopalatine nerves. These branches emerge after the pterygopalatine nerves have passed through the ganglion. They are the orbital, palatine, posterior superior nasal, and pharyngeal branches.

Orbital Branches
The orbital branches enter the orbit to supply the periorbita and the posterior ethmoidal and sphenoidal sinuses.

Greater Palatine Nerve
The greater palatine nerve leaves the ganglion to enter and descend in the pterygopatine canal, finally to emerge on the palate through the greater palatine foramen (Fig. 18-6).

The greater palatine nerve serves the anterior border of the soft palate, hard palate, gingiva, and mucous membranes of this region as far anteriorly as the incisive teeth, where it communicates with the nasopalatine nerve.

In its descent in the pterygopalatine canal, posteriorinferior nasal branches are given off, innervating the inferior concha and the middle and inferior meatuses.

The greater palatine nerve splits while in the canal to form a lesser palatine nerve, which exits on the palate through two or three like-named foramina serving the soft palate, tonsil, and uvula (Fig. 18-6).

Many of the afferents to this region are from the facial nerve communicated to the lesser palatine nerve through the pterygopalatine ganglion by way of the greater petrosal nerve and the nerve of the pterygoid canal. These nerves are described with the facial nerve.

Posterior Superior Nasal Branches
Posterior superior nasal branches enter the nasal cavity from the sphenopalatine foramen to supply the mucous membrane over the middle and superior conchae, the median nasal septum, and the ethmoidal sinus (Fig. 18-6).

One of these branches, the nasopalatine nerve, is larger than the others and continues anteriorly between the median nasal septum and the mucous membrane to reach the incisive canal, through which it passes to communicate with its counterpart from the opposite side (Fig. 18-6). It serves the anterior palate as far posteriorly as the cuspid teeth, where it overlaps the distribution of the greater palatine nerve.

Pharyngeal Branch
A pharyngeal branch leaves the posterior aspect of the ganglion to enter the pharyngeal canal. It serves the mucous membrane and the nasopharynx as far as the auditory tube (Fig. 18-6).

Posterior Superior Alveolar Nerve(s)
Arising from the main trunk of the maxillary nerve, while still in the pterygopalatine fossa, is (are) the posterior superior alveolar nerve(s) (Fig. 18-5).

This nerve, which may display more than one terminal, passes down over the tuberosity of the maxilla providing branches to the mucous membrane of the cheek and the adjacent gingiva.
The posterior superior alveolar nerve then enters the same-named foramen to supply the maxillary sinus and the molar teeth, with the exception of the mesial buccal root of the first molar. Sensory innervation to this root is provided by the middle superior alveolar nerve, which is described in the next section.

**Infraorbital Nerve**

After traversing the pterygopalatine fossa, the maxillary nerve enters the floor of the orbit, thus becoming the infraorbital nerve (Fig. 18-5).

On entering the floor of the orbit, the infraorbital nerve sends a **middle superior alveolar nerve** over the lateral wall of the maxillary sinus, which it innervates. Branches of this nerve then enter the mesial buccal root of the first molar and all of the roots of the premolar teeth.

Continuing anteriorly, the infraorbital nerve provides an anterior superior alveolar nerve just before its exit from the infraorbital foramen. The **anterior superior alveolar nerve** supplies the anterior maxillary sinus and the roots of the anterior teeth. Also, small twigs of this nerve enter the nasal cavity to supply its floor, the inferior meatus, and adjacent mucous membrane.

The posterior, middle, and anterior superior alveolar nerves intermingle, forming a dental plexus before innervating the upper teeth.

As the infraorbital nerve exits the skull via the same-named foramen, it provides the following three major groups:

- **Inferior palpebral branches**, ascending to the lower eyelid.
- **External nasal branches**, serving the side of the nose.
- **Superior labial branches**, serving the upper lip.

**Mandibular Nerve V₃**

**Summary Bite.** GSA, SVE, and GP (general proprioception fibers to the muscles of mastication kinesthetic sense) are the modalities carried by the mandibular division of the trigeminal nerve.

The mandibular nerve, the largest division of the trigeminal nerve, is the only division containing both motor and sensory components. The sensory fibers serve the skin about the lower face, cheek and lower lip, ear, external acoustic meatus, temporomandibular joint, and skin about the temporal region. This sensory component also supplies the mucous membranes of the cheek, the mucosa of the anterior two thirds of the tongue, the mandibular teeth, and supporting tissues and gingiva, mastoid air cells, the mandible, and portions of the dura.

The motor component supplies all of the musculature developed within the first pharyngeal arch: the muscles of mastication, including the temporalis, masseter, medial and lateral pterygoid muscles, as well as the tensors tympani and veli palatini, and the anterior belly of the digastric and the mylohyoid muscles (Fig. 18-7 and Tables 18-3 through 18-5).

As described earlier, the motor and sensory roots do not unite before exiting the skull. Rather, both roots pass through the foramen ovale and unite just outside the skull, forming the mandibular trunk. The latter is a mixed nerve that soon divides into a smaller, anterior division that is primarily motor and a larger posterior division that is mostly sensory in function.

Lying just outside the foramen ovale, immediately deep to the mandibular nerve trunk, is the otic ganglion. Although this parasympathetic ganglion (see Table 18-2) is in close association with the mandibular nerve via the nerve to the medial pterygoid muscle that passes through it, the preganglionic parasympathetic fibers synapsing within the ganglion are from the lesser petrosal nerve, a branch of the glossopharyngeal nerve.

Postganglionic fibers from the ganglion are secretomotor to the parotid gland and use the auriculotemporal nerve for distribution. The mandibular nerve possesses several branches: some from the nerve trunk, others from the anterior division, and still others from the posterior division; they are described in that order in the following sections.

**Branches from the Mandibular Trunk**

Two nerves branch from the trunk of the nerve: the recurrent meningeal nerve and the nerve to the medial pterygoid muscle.

The **recurrent meningeal nerve** leaves the mandibular trunk and ascends back into the skull through the foramen spinosum in company with the middle meningeal artery. This nerve supplies the dura, while some fibers supply the mastoid air cells.

The **medial pterygoid nerve** arises from the posterior aspect of the mandibular trunk, passes through the otic ganglion, and then enters the deep surface of the medial pterygoid muscle, supplying it with motor innervation (Fig. 18-7).

Two small branches arise from the medial pterygoid nerve: the **nerve to the tensor tympani muscle**, which penetrates the auditory tube cartilage to supply this muscle with motor innervation, and the **nerve to the tensor veli palatini muscle**, which enters that muscle near its origin, supplying it with motor innervation.
Branches from the Anterior Mandibular Division
The smaller anterior division, through its branches, supplies all of the remaining muscles of mastication with motor innervation (Fig. 18-7).

The buccal nerve is the only branch of the anterior division that is sensory in function. Arising from this division are the deep temporal, lateral pterygoid, masseteric, and buccal nerves.

The deep temporal nerves arise from the anterior division and ascend, usually as anterior and posterior branches, between the two heads of the lateral pterygoid muscle to enter the deep surface of the temporalis muscle, which they supply. Frequently, the anterior branch arises from the buccal nerve, whereas the posterior branch may arise in common with the masseteric nerve.

The lateral pterygoid nerve is very short and almost immediately enters the deep surface of the lateral pterygoid muscle, which it serves. This nerve may originate from the buccal nerve as that nerve passes between the two heads of the lateral pterygoid muscle.

The masseteric nerve passes above the lateral pterygoid muscle on its way to the mandibular notch, which it crosses to enter the masseter muscle in company with the same-named artery; it gives off a sensory twig to the temporomandibular joint before entering the muscle.

The origin of the buccal nerve (clinically sometimes referred to as the long buccal nerve) is not constant. Occasionally, it may arise from the trigeminal ganglion individually, reaching its destination via a separate foramen. Alternatively, it may arise from the inferior alveolar nerve of the posterior division. The description that follows assumes origin from the anterior division. The buccal nerve ascends, passing between the two heads of the lateral pterygoid muscle. Here it may give off branches to the temporalis and/or the lateral pterygoid muscles. It then descends to ramify over the buccinator muscle, supplying sensory innervation to the skin of the cheek in the area. Other branches pierce the muscle to provide sensory fibers to the buccal mucosa and adjacent gingiva. The buccal nerve communicates with the facial nerve, forming a complex over the buccinator muscle, presumably facilitating distribution of both nerves. It should be remembered that the buccal nerve is purely sensory and does not innervate the buccinator muscle (see the VII. Facial Nerve section).

Branches from the Posterior Mandibular Division
The larger posterior division of the mandibular nerve is mainly sensory in function, with the mylohyoid nerve being the only motor nerve of the division. Nerves arising from this division of the mandibular nerve are the lingual, inferior alveolar, and auriculotemporal nerves (Fig. 18-7).

The lingual nerve descends deep to the lateral pterygoid muscle, then courses forward between the medial pterygoid muscle and the mandible, where it is joined by the chorda tympani nerve, a branch of the facial nerve. The lingual nerve then descends over the superior pharyngeal constrictor and styloglossus muscles to reach the lateral aspect of the tongue adjacent to the hyoglossus muscle. Here it lies between that muscle and the submandibular gland.

The nerve proceeds anteriorly to the tip of the tongue, lying alongside the submandibular duct just beneath the mucosa.

Fibers of the lingual nerve, derived from the trigeminal nerve, provide sensory innervation to the mucous membranes of the anterior two thirds of the tongue, the lingual gingiva, and other structures adjacent to the tongue.

Fibers communicated to the lingual nerve from the facial nerve, via the chorda tympani, serve two functions:

- One group provides special sensory fibers for taste to the taste buds of the anterior two thirds of the tongue; these fibers are distributed by the lingual nerve.
- The other group supplies preganglionic parasympathetic fibers destined for the submandibular ganglion (see Table 18-2). The ganglion is suspended from the lingual nerve as that nerve lies between the hyoglossus muscle and the submandibular gland. Preganglionic fibers (contributed by the chorda tympani nerve) leave the lingual nerve to synapse on postganglionic cell bodies within the ganglion.

Postganglionic fibers pass directly to the submandibular gland or reenter the lingual nerve for distribution (as secretomotor fibers) to the sublingual gland and other minor salivary glands in the floor of the mouth.

The inferior alveolar nerve descends along with, but lateral to, the lingual nerve in company with the inferior alveolar artery on its way to the mandibular foramen.

The mylohyoid nerve arises from the inferior alveolar nerve just before the latter enters the mandibular foramen. The mylohyoid nerve descends in the mylohyoid groove on the mandible, then enters the mylohyoid muscle, which it provides with motor innervation. A portion of this nerve continues on the superficial surface of the muscle to the anterior belly of the digastric muscle, supplying it with motor innervation.
Upon entering the mandibular foramen, the inferior alveolar nerve proceeds in the bony mandibular canal, forming a dental plexus that provides sensory innervation to the mandibular teeth and supporting structures.

The nerve divides into two terminals: one, the mental nerve, exits the mental foramen to provide sensation to the skin of the lower lip and chin as well as to the mucous membrane of the lower lip; the other, the incisive nerve, continues to supply the anterior teeth and supporting tissues with sensory innervation.

The auriculotemporal nerve originates usually via two rootlets that arise from the trunk of the posterior division. One rootlet passes deep, whereas the other passes superficial to the middle meningeal artery, forming a loop around it, just prior to the artery entering the foramen spinosum. The two rootlets then unite, forming the auriculotemporal nerve, which courses deep to the lateral pterygoid muscle.

After emerging at the neck of the mandible, the nerve turns superiorly with the superficial temporal artery within the substance of the parotid gland. It continues to ascend between the auricula and temporomandibular joint, exiting the gland to pass over the zygomatic arch to distribute sensory fibers as superficial temporal nerves over the skin of the temporal region.

In its course, the auriculotemporal nerve sends articular branches to the temporomandibular joint, anterior auricular branches to the anterior portion of the external ear, branches to the external acoustic meatus, and branches to the parotid gland. Those branches to the parotid gland are postganglionic parasympathetic fibers whose cell bodies are located in the otic ganglion. These fibers, which supply secretomotor innervation to the gland, are communicated to the rootlets of the auriculotemporal nerve from the otic ganglion for distribution to the parotid gland (see Table 18-2).

Preganglionic parasympathetic fibers to the ganglion are supplied by the lesser petrosal branch of the glossopharyngeal nerve.

Although the auriculotemporal nerve is strictly sensory, it and the facial nerve communicate freely about the parotid gland, each facilitating distribution.

VI. ABDUCENS NERVE

Summary Bite. GSE and GP (general proprioception fibers to an extraocular muscle for kinesthetic sense) are the modalities carried by the abducens nerve.

The abducens nerve arises from the brain between the pons and the medulla. On its course to the orbit, the nerve pierces the dura covering the dorsum sel-
Chapter 18  Cranial Nerves

Clinical Considerations

Abducens Nerve Injury

The abducens nerve provides motor innervation to the lateral rectus muscle. When affected, the muscle on the ipsilateral side will be paralyzed, causing the eyeball to deviate medially, resulting in double vision.

VII. FACIAL NERVE

Summary Bite. SVE, GVE, SVA, GVA, and GSA are the modalities carried by the facial nerve.

The facial nerve exhibits several modalities because its branches serve structures within the temporal bone, deep face, oral cavity, and the superficial face. The modalities carried by the facial nerve include: special visceral efferent, general visceral efferent, special visceral afferent, general visceral afferent, and general somatic afferent (Figs. 18-8 and 18-9 and Tables 18-1, 18-2, and 18-5).

The components of the facial nerve and their functions are as follows (see Fig. 18-8 and Tables 18-1, 18-2, and 18-5):

- **Special Visceral Motor component** serves all of the muscles derived from the second pharyngeal arch, including the muscles of facial expression, the buccinator, platysma, and those of the scalp and external ear, the stapedius, posterior belly of the digastric, and stylohyoid muscles.
- **General sensory component** supplies the external acoustic meatus.
- **Visceral sensory component** supplies the soft palate and some of the pharynx.
- **Special sensory component** is for taste to the anterior two thirds of the tongue.
- **Parasympathetic component** effecting secretomotor function is supplied to the lacrimal, nasal, palatine, submandibular, and sublingual glands (see Table 18-2).

The nerve possesses two roots, a large motor root and a smaller root, termed the *nervus intermedius*, containing the special sensory fibers for taste, parasympathetic fibers, and general sensory fibers. The two roots emerge from the brain between the pons and the inferior cerebellar peduncle.

These roots enter the internal acoustic meatus along with the vestibulocochlear nerve, but separate from it as the two roots enter the petrous portion of the temporal bone in a chamber of its own, the *facial canal* (Fig. 18-9).

Near the tympanic cavity, the facial nerve takes an abrupt turn inferiorly to exit the skull through the stylomastoid foramen. Located at this turn where the two roots fuse is the *geniculate ganglion*, the sensory ganglion of the facial nerve (Fig. 18-8 and Table 18-1).

Several branches arise from the nerve as it courses through the temporal bone, including the greater petrosal nerve from the geniculate ganglion, the nerve to the stapedius muscle, and the chorda tympani nerve.

Greater Petrosal Nerve

Arising from the geniculate ganglion is the greater petrosal nerve, which carries preganglionic parasympathetic fibers destined for the pterygopalatine ganglion along with sensory fibers for the soft palate and pharynx (Tables 18-1 and 18-2). The facial nerve leaves the petrous portion of the temporal bone via the *hiatus of the facial canal* near the foramen lacerum and then enters the pterygoid canal (vidian canal) of the sphenoid bone. Here it is joined by the *deep petrosal nerve*, a postganglionic sympathetic nerve arising from the carotid plexus whose cell bodies are located in the superior cervical ganglion. The combined nerve, known as the *nerve of the pterygoid canal (vidian nerve)*, passes through the same-named canal in the sphenoid bone to gain access to the
pterygopalatine fossa, where it joins the pterygopalatine ganglion.

Preganglionic parasympathetic fibers synapse on postganglionic parasympathetic cell bodies housed within the pterygopalatine ganglion.

Fibers of these postganglionic parasympathetic neurons are communicated to nerves branching from the maxillary division of the trigeminal nerve for distribution to the lacrimal gland, as well as to small glands of the nasal cavity, pharynx, and palate.

The sympathetic component of the vidian nerve does not synapse in the pterygopalatine ganglion; instead, these postganglionic fibers are distributed in the same fashion as the postganglionic parasympathetic fibers.

The parasympathetic fibers are secretomotor in function, whereas the sympathetic fibers function mainly in vasoconstriction.

Some visceral sensory fibers from the geniculate ganglion travel along with the greater petrosal nerve to be distributed ultimately by branches of the maxillary division of the trigeminal nerve to the area of the soft palate via the lesser palatine nerve.

Nerve to the Stapedius Muscle

The nerve to the stapedius muscle, arising from the facial nerve as it descends across the tympanum, provides motor fibers to that muscle.

Chorda Tympani Nerve

The chorda tympani nerve arises from the facial nerve trunk just before the trunk’s exit from the stylomastoid foramen. The chorda tympani courses cranialward in a canal of its own, diverging away from
Chapter 18  Cranial Nerves

the main nerve, bending to pass over the tympanic membrane and across the manubrium of the malleus. It leaves the tympanic cavity to enter a canal in the petrotympanic fissure, then exits the skull at the spine of the sphenoid bone. The chorda tympani nerve, which may receive a communication from the otic ganglion, joins the lingual branch of the mandibular division of the trigeminal nerve for distribution. It contains special sensory fibers destined for taste buds on the anterior two thirds of the tongue and preganglionic parasympathetic fibers destined for the submandibular ganglion (see Figs. 18-7 and 18-8 and Tables 18-1 and 18-2).

The submandibular ganglion, suspended by short nerve filaments from the lingual nerve as it passes the hyoglossus muscle, receives the preganglionic parasympathetic fibers of the chorda tympani nerve via the parasympathetic root (Fig. 18-7). Postganglionic parasympathetic fibers from the submandibular ganglion pass to the submandibular gland or reenter the lingual nerve to be distributed to the sublingual gland and minor salivary glands in the floor of the mouth, providing them with secretomotor innervation. Sympathetic stimulation of the salivary glands is accomplished by postganglionic sympathetic fibers accompanying the arteries serving the glands. The function of this stimulation is generally to elicit vasoconstriction.

Beyond the origin of the chorda tympani nerve, the facial nerve exits the skull through the stylomastoid foramen. There, it gives rise to the posterior auricular nerve and the nerves to the posterior digastric and stylohyoid muscles. It then passes into the retro-mandibular fossa to enter the substance of the parotid gland to form the parotid plexus.

Posterior Auricular Nerve

As the facial nerve exits the stylomastoid foramen, the posterior auricular nerve arises from it to pass superiorly between the auricle and the mastoid process. It divides into occipital and auricular branches after communicating with the auricular branch of the vagus nerve and great auricular and lesser occipital nerves of the cervical plexus. The auricular branch supplies motor innervation to the posterior auricular muscle of the ear and to some of its intrinsic muscles. The occipital branch courses posteriorly to supply the occipitalis muscle with motor innervation (Fig. 18-8).
**Nerve to the Posterior Belly of the Digastric Muscle**

The nerve to the posterior belly of the digastric muscle arises from the trunk of the facial nerve near the stylomastoid foramen and enters the muscle near its midbelly, providing it with motor innervation (Fig. 18-8).

**Nerve to Stylohyoid Muscle**

The nerve to the stylohyoid muscle arises from the facial nerve in a similar fashion to or in common with the nerve to the posterior digastric. The nerve to the stylohyoid muscle then enters the muscle at midbelly, providing it with motor innervation (Fig. 18-8).

**Parotid Plexus**

After entering the parotid gland, the facial nerve divides into *temporofacial* and *cervicofacial* divisions, which form the parotid plexus. From there emerge the branches supplying motor innervation to the muscles of facial expression. These terminal branches are named for the regions they supply, usually dividing into five major branches from the plexus: *temporal, zygomatic, buccal, mandibular,* and *cervical branches* (Fig. 18-8). Space does not permit a repeat of the complete descriptions of each branch's distribution or of the muscles served by each branch, other than to state that, generally, the branch serves facial muscles originating in the area of the nerve branch. The interested reader is referred back to Chapter 8 for a discussion of the distribution of the branches of the parotid plexus.

**VIII. VESTIBULOCOCHLEAR NERVE**

**Summary Bite.** SSA and SP (special proprioception within the vestibular mechanism for body balance) are the modalities carried in the vestibulocochlear nerve.

The nerve of hearing and balance, the vestibulocochlear nerve, is composed of two separate sets of fibers. The *vestibular nerve* for balance and the *cochlear nerve* for hearing are joined as a common nerve entering the internal acoustic meatus with the facial nerve (Fig. 18-9).

These two cranial nerves separate after entering the meatus as the vestibulocochlear nerve approaches the area of its destination within the inner ear. The vestibulocochlear nerve divides, sending the cochlear nerve into the laterally oriented cochlear apparatus and the vestibular nerve medially into the vestibular apparatus.

**Cochlear Nerve**

The cochlear nerve has its peripheral processes in the *organ of Corti*, located in the membranous labyrinth,

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**Clinical Considerations**

**Bell Palsy**

Damage to the facial nerve (or its accidental analgesia during dental procedures) results in paralysis of the muscles of the affected side. Damage may occur during surgical involvement of the parotid gland, infection of the middle ear, knife wounds, or at birth during forceps delivery. Paralysis of the facial muscles results in ptosis of the eye (upper eyelid drooping); depression of the corner of the mouth with accompanying oozing of saliva; speech disorder (especially involving labial sounds); lack of muscle tone; and a sagging, distorted face. Bell palsy affects all of the ipsilateral muscles about the face as well as other muscles that developed from the second pharyngeal arch. Because of this fact, patients affected with Bell palsy have hyperacusis (loss of corneal blink) as well as loss of taste from the ipsilateral side of the anterior tongue.
and its cell bodies are located in the spiral ganglion of the cochlea, which is housed in the modiolus of the cochlea (Fig. 18-9 and Tables 18-1 and 18-5). Central processes of the spiral ganglion become the cochlear division of the nerve responsible for the sense of hearing.

**Vestibular Nerve**

The vestibular nerve cell bodies are located in the vestibular ganglion within the internal auditory meatus of the temporal bone. Peripheral processes of these neurons divide to enter the vestibular mechanism, including the three semicircular canals.

Central processes of these neurons become the vestibular division of the vestibulocochlear nerve responsible for the sense of balance (Fig. 18-9 and Tables 18-1 and 18-5).

### Clinical Considerations

**Conductive Hearing Loss**

Conductive hearing loss results from a defect in the conduction of sound waves from the tympanic membrane through the bony ossicles to the oval window of the cochlea. Conditions that may contribute to conduction deafness include buildup of cerumen (ear wax), perforation of the tympanic membrane, otitis media (middle ear cavity infection), and otosclerosis, excessive growth of bone around the oval window causing impaired movement of the stapes.

**Nerve Deafness**

Nerve deafness results from a lesion within the nerves transmitting impulses to the brain from the spiral organ of Corti. Other causes include certain diseases, drug abuse, and prolonged exposure to loud noises.

**Ménière Disease**

Ménière disease is related to excess fluid in the endolymphatic duct affecting the vestibular mechanism of the vestibulocochlear nerve. This disease is characterized by hearing loss, vertigo, nausea, tinnitus, and vomiting. Drugs can be used for treatment, but in severe cases surgery is required.

**Otitis Media**

The auditory tube permits the spread of infection from the nasal cavity into the middle ear cavity. This condition (otitis media), resulting from acute infection, may result in the rupture of the eardrum and/or the infection may pass into the mastoid air cells. Antibiotics are used to treat this condition. Auditory tube obstructions often lead to middle-ear infections, especially in children.

**Otosclerosis**

Occasionally, the stapes becomes immobilized as a result of bony deposits around the oval window. This condition, known as otosclerosis, is a major cause of hearing loss, especially in older adults. It is usually correctable by surgical procedures. Both otitis media and otosclerosis, if left untreated, will result in deafness.

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**IX. GLOSSOPHARYNGEAL NERVE**

**Summary Bite.** SVA, GVA, GVE, GSA, and SVE are the modalities carried in the glossopharyngeal nerve.

The modalities within the glossopharyngeal nerve include: special visceral efferent, general visceral efferent, special visceral afferent, general visceral afferent, and general somatic afferent (see Fig. 18-10 and Tables 18-1, 18-2, and 18-5).

**Special visceral efferent.** Because the glossopharyngeal nerve is the nerve of the third pharyngeal arch, it serves the only muscle derived from this arch, the styloglossus muscle.
General visceral efferents (parasympathetic) supply the parotid gland and other minor salivary glands in the mucous membrane in and about the posterior tongue and adjacent pharynx.

Special visceral afferents are distributed to the taste buds located on the posterior one third of the tongue, as well as to those located in the circumvallate papillae.

General visceral afferents supply the posterior one third of the tongue, the fauces, the palatine tonsils, and the pharynx. Other general visceral sensory fibers supply the carotid sinus with blood pressure receptors as well as to chemoreceptors located within the carotid body. The latter is a sensory function performed in conjunction with the vagus nerve.

General somatic afferents supply cutaneous sensation about the ear.

The glossopharyngeal nerve leaves the brain as three or four rootlets adjacent to the vagus nerve along the medulla between the olive and the inferior cerebellar peduncle. The rootlets unite to exit the skull through the jugular foramen in company with the vagus and accessory nerves. Housed in the groove within the jugular foramen are the superior and inferior ganglia of the glossopharyngeal nerve, containing the cell bodies of the sensory fibers.

While passing through the jugular foramen, this nerve communicates with the facial nerve, the auricular branch and superior ganglion of the vagus nerve, and the superior cervical sympathetic ganglion.

**Tympanic Nerve**

The tympanic nerve arises from the inferior ganglion of the glossopharyngeal nerve (Fig. 18-10) and enters the petrous portion of the temporal bone, traveling to the tympanic cavity. Here it forms the tympanic plexus with fibers from the carotid plexus and the greater petrosal nerve. Branches from the tympanic plexus serve sensory functions to the mucous membranes of the eardrum, oval and round windows, mastoid air cells, and auditory tube.

The tympanic nerve emerges from the tympanic plexus as the lesser petrosal nerve, providing preganglionic parasympathetic fibers to the otic ganglion (see Tables 18-1 and 18-2), which it reaches by leaving the skull at the fissure between the petrous portion of the temporal bone and the greater wing of the sphenoid bone.

The otic ganglion, described in the section on the mandibular division of the trigeminal nerve, lies just outside the foramen ovale, immediately behind the mandibular nerve. This ganglion receives preganglionic parasympathetic fibers from the lesser petrosal...
nerve and possibly some fibers from the greater petrosal nerve communicated through the tympanic plexus. Postganglionic parasympathetic fibers leave the otic ganglion and are communicated to the auriculotemporal nerve for distribution to the parotid gland, providing it with secretomotor innervation.

Carotid Sinus Nerve

The nerve to the carotid sinus arises as a small filament from the glossopharyngeal nerve subsequent to nerve communications at the jugular foramen. This branch descends along the internal carotid artery, ending in the bifurcation of the common carotid artery (Fig. 18-10). This nerve functions as a baroreceptor within the carotid sinus. On its way to the carotid sinus, the nerve communicates with pharyngeal branch(es) of the vagus and branches from the superior cervical ganglion (postganglionic sympathetic fibers). Glossopharyngeal and vagus nerves transmit afferent fibers from the chemoreceptors within the carotid body.

Nerve to the Stylopharyngeus Muscle

As the glossopharyngeal nerve courses to the posterior pharyngeal wall, a nerve to the stylopharyngeus muscle arises to supply that muscle (Fig. 18-10).

Pharyngeal Branches

The main trunk of the glossopharyngeal nerve terminates as several pharyngeal branches to enter the posterior pharyngeal wall (Fig. 18-10). Some of these branches continue to the tongue as lingual branches, providing general sensation to the posterior one third of the tongue and special sensory fibers to the taste buds on that portion of the tongue as well as to those of the circumvallate papillae. Other branches penetrate the pharyngeal wall as tonsillar branches, communicating with the lesser palatine nerve of the maxillary division of the trigeminal nerve, to supply the soft palate, pharynx, and fauces with general sensation.

Pharyngeal Plexus

Other fibers of the glossopharyngeal nerve join with pharyngeal branches of the vagus nerve and branches from the superior cervical ganglion to form the pharyngeal plexus, located on the wall of the middle pharyngeal constrictor muscle (Fig 18-10). Branches from this plexus penetrate the wall of the pharynx and supply all of the muscles of the pharynx (except the stylopharyngeus) and soft palate (except the tensor veli palatini) with motor innervation and adjacent mucous membranes with sensory innervation. Although the following information was presented in Chapter 16, it is appropriate to present it again because there is confusion related to the function of the individual nerves making up the pharyngeal plexus. Glossopharyngeal contributions to the pharyngeal plexus are sensory, whereas the vagal branches are motor. However, these motor branches are believed to consist mainly of fibers from the cranial portion of the accessory nerve (cranial nerve XI), which are contributed to the vagus nerve before it exits the skull. Postganglionic sympathetic fibers contributed from the superior cervical ganglion to the pharyngeal plexus are vasomotor in function.

X. VAGUS NERVE

Summary Bite. GVE, SVE, GVA, and GSA are the modalities carried in the vagus nerve.

The cranial nerve having the most extensive distribution is the vagus nerve. In addition to its destinations within the head and neck, the vagus nerve also enters the thorax to serve the heart and lungs, and continues
into the abdomen to supply most of the abdominal viscera (Figs. 18-10 and 18-11 and Tables 18-1 and 18-5).

The vagus nerve possesses five modalities, namely, special visceral efferent general somatic afferent, general visceral afferent, special visceral afferent, general visceral efferent, and special visceral efferent.

**Special visceral efferent.** The vagus is the nerve of the fourth pharyngeal arch, and its recurrent laryngeal branch is the nerve of the sixth pharyngeal arch. Consequently, the vagus nerve supplies muscles developed from those arches. Muscles developing from the fourth arch include the pharyngeal constrictors and the cricothyroid muscles. Muscles developed from the sixth arch include the intrinsic muscles of the larynx.

- **General somatic afferent** fibers are provided to the skin about the ear and external acoustic meatus.
- **General visceral afferent** supplies the mucous membranes of the pharynx, larynx, esophagus, bronchi, lungs, heart, and much of the abdominal viscera.
- **General visceral efferent** supplies the smooth muscles and glands of the digestive tract from the esophagus to (and including) most of the intestines, plus the bronchi and trachea.
- **Special visceral afferent** is supplied to the base of the tongue, aryepiglottic fold, and larynx.

The vagus nerve exits the brain at the medulla, between the olive and the inferior cerebellar peduncle just posterior to the glossopharyngeal nerve, via a cluster of 8 to 10 rootlets that unite to exit the skull.

![Figure 18-11. X. Vagus nerve. Only those branches arising in the head and neck are illustrated.](image-url)
through the jugular foramen along with the glos-
sopharyngeal and accessory nerves.

This nerve possesses two sensory ganglia: the super-
ior ganglion, housed in the jugular fossa, and the in-
ferior (nodose) ganglion, appearing as a swelling on
the nerve just after it exits the jugular foramen (Figs.
18-10 and 18-11).

Peripheral processes of the neurons in these gan-
glia are distributed with the vagus nerve as the sen-
sory component. These ganglia receive communica-
tions from the glossopharyngeal, facial, accessory,
and hypoglossal nerves. The sympathetic nervous
system communicates via a filament from the supe-
rior cervical ganglion, and a communication also ex-
ists between the vagal ganglia and the first and
second cervical nerves.

The cranial root of the accessory nerve joins the
vagus nerve just proximal to the inferior ganglion.
Thus, the motor component to the muscles arising
from the fourth and fifth pharyngeal arches, gener-
ally described as arising from the vagus nerve, are ac-
tually from this contribution to the vagus nerve by
the accessory nerve. However, autonomic motor in-
nervation to the esophagus and the structures within
the thorax and abdomen attributed to the vagus arise
from the dorsal motor nucleus of the vagus nerve.

Before its exit from the jugular fossa the vagus
nerve gives off two branches: the meningeal and au-
ricular branches.

**Meningeal Branch**

The meningeal branch of the vagus nerve returns to
the cranial vault to supply the dura in the posterior
cranial fossa (Fig. 18-11).

**Auricular Branch**

An auricular branch arises from the superior vagal
ganglion, communicates with the glossopharyngeal
nerve, and then enters the mastoid canal coursing to
the facial canal. Here it communicates with the facial
nerve, then exits through the tympanomastoid suture
to communicate with the posterior auricular nerve
before distributing to the skin of the posterior aspect
of the ear and the external acoustic meatus.

**Vagal Branches in the Neck**

The following sections describe the branches and dis-
butions of the vagus nerve as it courses through the
neck. Branches arising from the vagus in the neck
include the pharyngeal, superior laryngeal, and supe-
rior cardiac nerves. Also located in the neck is the
recurrent laryngeal nerve that arises from the vagus
nerve at the thoracic inlet to recur back into the neck.

**Pharyngeal Branches**

Pharyngeal branches of the vagus arise from the in-
ferior vagal ganglion and pass over the internal carotid
artery to the pharyngeal constrictor muscles, providing
input to the pharyngeal plexus (Fig. 18-11). From
this plexus, motor innervation is supplied to the pha-
ryngeal but not the stylopharyngeus, as well as to all
muscles of the soft palate except the tensor veli palat-
tini. Mucous membranes of the pharynx are also sup-
plied by the pharyngeal plexus.

Usually, the nerve to the carotid body originates
from the pharyngeal branches. This nerve descends
along the internal carotid artery to terminate in the
carotid body housed in the bifurcation of the common
carotid artery (Fig. 18-11). Chemoreceptors detect
changes in oxygen and carbon dioxide tension as well
as hydrogen ion concentration in the blood at this site.

As previously described, sensory fibers from the
carotid body are also transmitted in the glossopharyn-
geal nerve.

**Superior Laryngeal Nerve**

The superior laryngeal nerve arises from the vagus at
the inferior end of the inferior ganglion and passes
deep to the internal carotid artery, descending to the
thyroid cartilage, where it divides into external and
internal branches (Fig. 18-11).

The smaller external branch continues to de-
scend beneath the sternothyroid muscle to enter the
cricothyroid and inferior pharyngeal constrictor mus-
cles, which it supplies with motor innervation.

The larger internal branch courses over and
pierces the thyrohyoid membrane. This branch sup-
plies sensory innervation to the mucous membranes
superiorly, to the base of the tongue, and to the
epiglottis and the larynx as far inferiorly as the vocal
folds. It is with this branch that the sensation of taste
is transmitted to the brain from the base of the
tongue, epiglottis, and larynx.

The internal laryngeal branch also contains
parasympathetic fibers to the glands associated with
the mucous membranes of the regions just described.
Preganglionic fibers synapse on ganglionic plexuses
within the walls of the viscera served, and from there
the postganglionic fibers distribute secretomotor
fibers to the glands.

**Superior Cardiac Branches**

As the trunk of the vagus nerve descends in the neck
within the carotid sheath, between and posterior to the
internal jugular vein and the internal carotid artery,
superior cardiac branches are given off and descend
into the thorax (Fig. 18-11). Their function is not described here because it is outside the realm of this text.

Recurrent Laryngeal Nerve
At the root of the neck, the recurrent laryngeal nerve arises from the vagus and ascends back into the neck. On the right side, the nerve recurs around the subclavian artery, whereas on the left side the nerve recurs around the arch of the aorta (Fig. 18-11).

Upon reentering the neck, each recurrent laryngeal nerve follows a similar course deep to the carotid artery, along a groove between the trachea and the esophagus, to enter the larynx as inferior laryngeal nerves, piercing the cricothyroid membrane to supply all of the intrinsic muscles of the larynx, except the cricothyroid muscle, with motor innervation.

In the recurrent laryngeal nerve’s path to the larynx, branches to the trachea and the esophagus supply those structures with sensory and parasympathetic innervation in much the same manner as the fibers of the internal branch of the superior laryngeal nerve but more distally. In addition, pharyngeal branches are supplied to the inferior pharyngeal constrictor muscle. Although they serve a minor role, sensory branches of the inferior laryngeal nerve provide sensory fibers to the larynx and overlap sensory fibers of the external laryngeal nerve.

The remaining branches and distributions of the vagus nerve within the thorax and abdomen are not described here. Those interested in this subject are referred to general textbooks in gross anatomy and neuroanatomy, as suggested in the Selected Readings.

XI. ACCESSORY NERVE

Summary Bite. SVE (communicated to the vagus nerve for the muscles of the pharynx and larynx) and SVE (assuming branchomeric origins for the sternocleidomastoid and trapezius muscles) are the modalities carried by the accessory nerve.

The accessory nerve arises from two sources: the brain and the spinal cord. This nerve is described as a motor nerve, serving the sternocleidomastoid and trapezius muscles, and its cranial root is regarded as the motor portion of the vagus nerve within the head and neck, including the contribution that the vagus nerve makes to the pharyngeal plexus.

The spinal portion arises from motor neurons in the first five (or more) spinal cord segments. This portion of the nerve emerges on the surface of the
spinal cord to ascend into the skull via the foramen magnum to join or communicate with the cranial portion of the nerve before exiting the jugular foramen along with the vagus and glossopharyngeal nerves (Figs. 18-10 and 18-12 and Tables 18-1 and 18-5). The cranial portion leaves the brain very close to the vagus nerve and travels along with it to the jugular foramen. After communicating with the spinal portion, the cranial portion joins the vagus, and the spinal portion continues on to descend through the foramen.

The spinal portion descends posterior to the stylohyoid and digastric muscles to enter the sternocleidomastoid muscle, which it pierces and serves before passing obliquely over the posterior triangle to terminate in and supply the trapezius muscle. Along its way, the nerve communicates with the second, third, and fourth cervical nerves.

**XII. HYPOGLOSSAL NERVE**

| Summary Bite. | GSE is the modality carried by the hypoglossal nerve. |

**Clinical Considerations**

**Accessory Nerve Injury**

The accessory nerve, as it progresses subcutaneously through the neck, is subject to injury, (e.g., during lymph node biopsy, carotid artery and/or internal jugular vein surgical procedures). Injury produces weakness in the sternocleidomastoid and trapezius muscles, impairing neck movement and resulting in a drooping of the shoulder.
The most caudal and the last of the cranial nerves is the hypoglossal nerve. This nerve is the motor nerve of the tongue.

It arises as several rootlets from the medulla between the olive and the pyramid and, passing through the hypoglossal canal, the rootlets unite to form a single nerve. It descends deep to the internal jugular vein and internal carotid artery, and then becomes superficial to them as it crosses them at the mandible.

The hypoglossal nerve then courses over the external carotid and lingual arteries deep to the digastric and stylohyoid muscles. It enters the muscles of the tongue, which it supplies, proceeding to the ventral tip of the tongue.

With the exception of the palatoglossus (innervated by the vagus via the pharyngeal plexus), the hypoglossal nerve innervates the hyoglossus, styloglossus, genioglossus, and intrinsic muscles of the tongue (Fig. 18-13 and Tables 18-1 and 18-5).

The hypoglossal nerve communicates with several nerves in its route, including the pharyngeal plexus, the lingual, and the first and second cervical spinal nerves. Branches from the first and second ventral cervical spinal nerves join the hypoglossal later to exit, forming the descending loop (superior root) of the ansa cervicalis, which innervates the infrahyoid muscles.

Some of the fibers from the first cervical nerve continue on to exit from the hypoglossal nerve near the posterior border of the hyoglossus muscle and enter the thyrohyoid and geniohyoid muscles, supplying them with motor innervation.

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**Clinical Considerations**

**Hypoglossal Nerve Injury**

Difficult third molar extractions and/or fractures of the mandible may damage the hypoglossal nerve (cranial nerve XII), causing paralysis of the tongue on the affected side. When the mouth is opened and the tongue is protruded, the genioglossus of the unaffected side will cause the tongue to deviate to the affected side. If the damage is prolonged, the tongue muscles will atrophy.