4th Edition

CURRENT Diagnosis & Treatment

Otolaryngology
Head and Neck Surgery

ANIL K. LALWANI

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CURRENT Diagnosis & Treatment Otolaryngology—Head and Neck Surgery

FOURTH EDITION

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To my parents, Madan and Gulab, for giving me life;
To my in-laws, Rikhab and Ratan, for adding to my life;
To my wife, Renu, who is my life, and, to my children,
Nikita and Sahil, who show me how to enjoy life.

This book is specially dedicated to the faculty, staff, and leadership of the Columbia University Vagelos College of Physicians and Surgeons, and the NewYork–Presbyterian Hospital—who everyday demonstrate their commitment and passion to the highest level of patient care, research, and education.

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Preface

Otolaryngology—Head and Neck Surgery is a unique subspecialty in medicine that deals with medical and surgical management of disorders affecting the ear, nose, throat, and the neck; the care of the senses including smell, taste, balance, and hearing falls under its domain. As a specialty, it interfaces with other medical and surgical subspecialties including allergy and immunology, endocrinology, gastroenterology, gerontology, hematology, neurology, neurosurgery, oncology, ophthalmology, pediatrics, plastic and reconstructive surgery, pulmonology, radiation oncology, rehabilitation medicine, rheumatology, and thoracic surgery among others. Further, the specialty encompasses the care of the young and the old, man and woman, as well as benign and malignant diseases.

Symptoms and diseases affecting the ear, nose, throat, and neck are common and commonly lead to patients seeking medical care. These include sinusitis, upper respiratory tract infections, hoarseness, balance disturbance, hearing loss, dysphagia, snoring, tonsillitis, ear infections, thyroid disorders, head and neck cancer, and ear wax. In this updated fourth edition of *Current Diagnosis & Treatment Otolaryngology—Head and Neck Surgery*, these and many other diseases are covered in a crisp and concise manner. Striking just the right balance between comprehensiveness and convenience, it emphasizes the practical features of clinical diagnosis and patient management while providing a comprehensive discussion of pathophysiology and relevant basic and clinical science. With its consistent formatting chapter-by-chapter, this text makes it simple to locate the practical information you need on diagnosis, testing, disease processes, and up-to-date treatment and management strategies. The book will be of interest to both otolaryngologists and all of the medical and surgical specialties and related disciplines that treat patients with head and neck disorders.

OUTSTANDING FEATURES

- Comprehensive review of basic sciences relevant to otolaryngology
- Concise, complete, and accessible clinical information that is up-to-date
- Discussion of both medical and surgical management of otolaryngologic disorders
- Inclusion of the usual and the unusual diseases of the head and neck
- More than 1000 figures to better illustrate and communicate essential points
- Organization by anatomic region to facilitate quick identification of relevant material

INTENDED AUDIENCE

With its comprehensive review of the sciences and the clinical practice of otolaryngology—head and neck surgery, this fourth edition will be invaluable for medical students, housestaff, physicians of all specialties, nurses, physician assistants, and ancillary health care personnel. The book has been designed to meet the clinician's need for an immediate refresher in the clinic as well as to serve as an accessible text for thorough review of the specialty for the boards. The concise presentation is ideally suited for rapid acquisition of information by the busy practitioner.

Anil K. Lalwani, MD

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Anatomy

1

Nripendra Dhillon, MBBS, MS

The anatomy of the head and neck is rich in complexity as it is populated with motor and sensory organs, cranial nerves, and major arterial and venous structures in a compact three-dimensional space. This chapter provides a broad and concise overview to familiarize the novice and yet is detailed enough to serve as a reference for the more knowledgeable clinician.

FACE

Muscles

The muscles of facial expression develop from the second branchial arch and lie within the skin of the scalp, face, and neck (Figure 1–1).

A. Occipitofrontalis Muscle

The occipitofrontalis muscle, which lies in the scalp, extends from the superior nuchal line in the back to the skin of the eyebrows in the front. It allows for the movement of the scalp against the periosteum of the skull and also serves to raise the eyebrows.

B. Orbicularis Oculi Muscle

The orbicularis oculi muscle lies in the eyelids and also encircles the eyes. It helps to close the eye in the gentle movements of blinking or in more forceful movements, such as squinting. These movements help express tears and move them across the conjunctival sac to keep the cornea moist.

C. Orbicularis Oris Muscle

The orbicularis oris muscle encircles the opening of the mouth and helps to bring the lips together to keep the mouth closed.

D. Buccinator Muscle

The buccinator muscle arises from the pterygomandibular raphe in the back and courses forward in the cheek to blend into the orbicularis oris muscle in the lips. It helps to compress the cheek against the teeth and thus empties food from the vestibule of the mouth during chewing. In addition, it is used while playing musical instruments and performing other actions that require the controlled expression of air from the mouth.

E. Platysma Muscle

The platysma muscle extends from the skin over the mandible through the superficial fascia of the neck into the skin of the upper chest, helping to tighten this skin and also to depress the angles of the mouth. Although lying primarily in the neck, it is grouped with the muscles of facial expression.

Arteries

The blood supply of the face is through branches of the facial artery (Figure 1–2). After arising from the external carotid artery in the neck, the facial artery passes deep to the submandibular gland and crosses the mandible in front of the attachment of the masseter muscle. It takes a tortuous course across the face and travels up to the medial angle of the eye, where it anastomoses with branches of the ophthalmic artery. It gives labial branches to the lips, of which the superior labial artery enters the nostril to supply the vestibule of the nose.

The occipital, posterior auricular, and superficial temporal arteries supply blood to the scalp. They all arise from the external carotid artery. The superficial temporal artery gives a branch, the transverse facial artery, which courses through the face parallel to the parotid duct.

Veins

The superficial temporal and maxillary veins join within the substance of the parotid gland to form the retromandibular

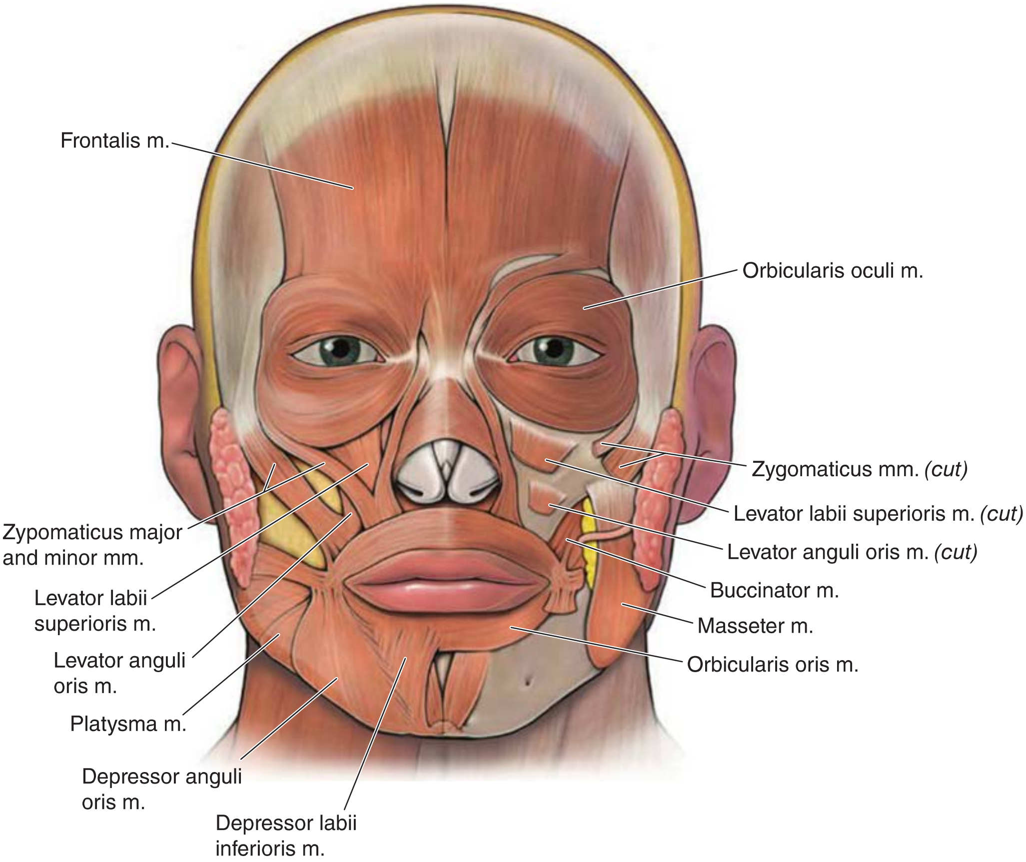


Figure 1–1. Muscles of the face.

vein (Figure 1–3). The facial vein joins the anterior division of the retromandibular vein to drain into the internal jugular vein. Additional details about the venous drainage pattern of the scalp and face are provided in the discussion of the veins of the neck. The facial vein communicates with both the pterygoid venous plexus and the veins in the orbit. Each of these has connections to the cavernous sinus, thus allowing infections to spread from the face into the cranium.

Innervation

A. Sensory Innervation

The sensory innervation of the face is through terminal branches of the trigeminal nerve (V) (Figure 1–4). Two imaginary lines that split the eyelids and the lips help to approximately demarcate the sensory distribution of the three divisions of the trigeminal nerve.

In addition to the skin of the face, branches of the trigeminal nerve (V) are also responsible for carrying sensation from deeper structures of the head, including the eye, the paranasal sinuses, the nose, and the mouth. The details of this distribution are discussed with the orbit and the pterygopalatine and infratemporal fossae.

1. Ophthalmic division of the trigeminal nerve—The ophthalmic division of the trigeminal nerve (V1) carries sensation from the upper eyelid, the skin of the forehead, and the skin of the nose. Its cutaneous branches, from lateral to medial, are the lacrimal, supraorbital, supratrochlear, and nasal nerves.

2. Maxillary division of the trigeminal nerve—The maxillary division of the trigeminal nerve (V2) carries sensation from the lower eyelid, the upper lip, and the face up to the zygomatic prominence of the cheek. Its cutaneous branches are the infraorbital, zygomaticofacial, and zygomaticotemporal nerves.

3. Mandibular division of the trigeminal nerve—The mandibular division of the trigeminal nerve (V3) carries

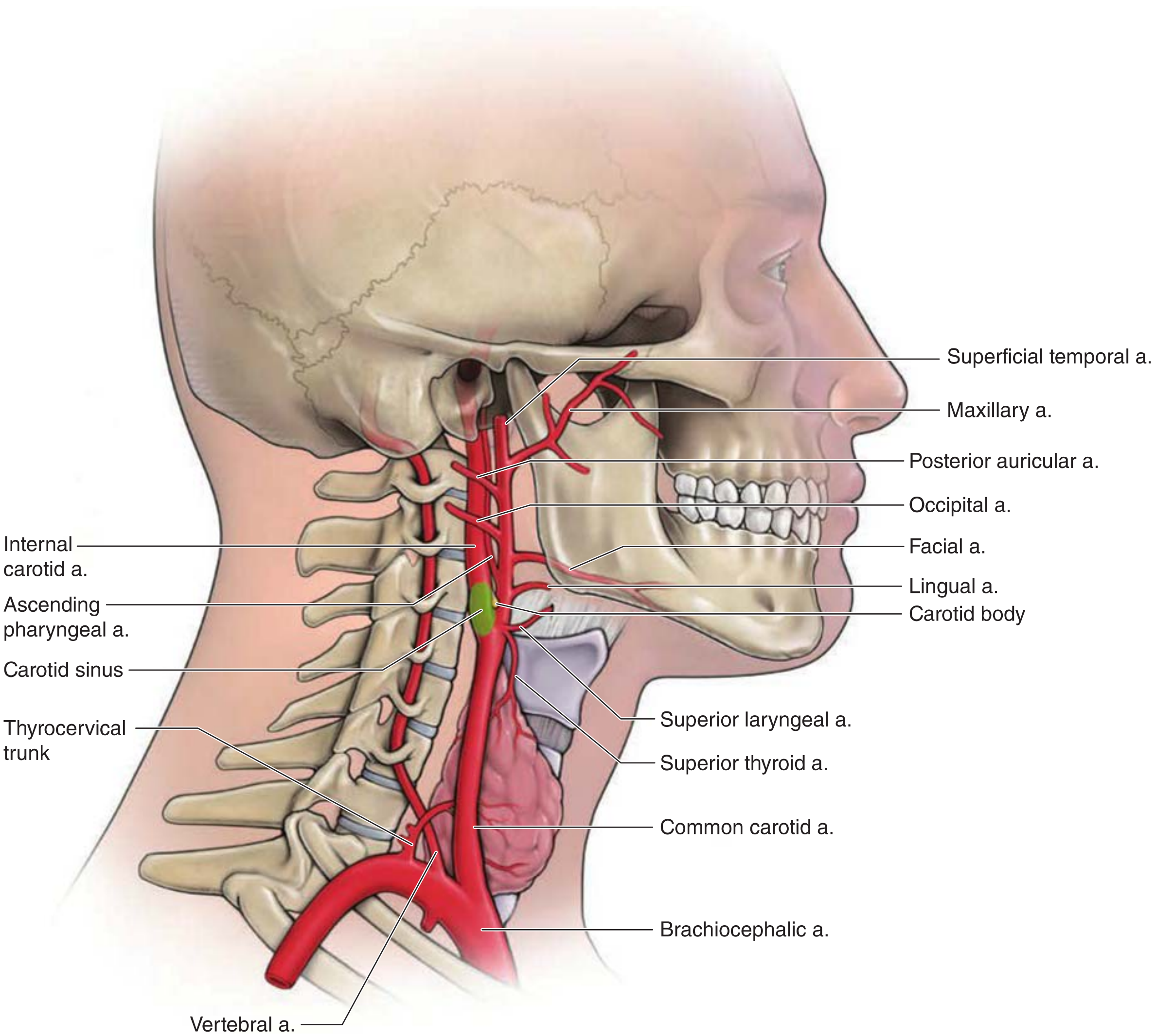
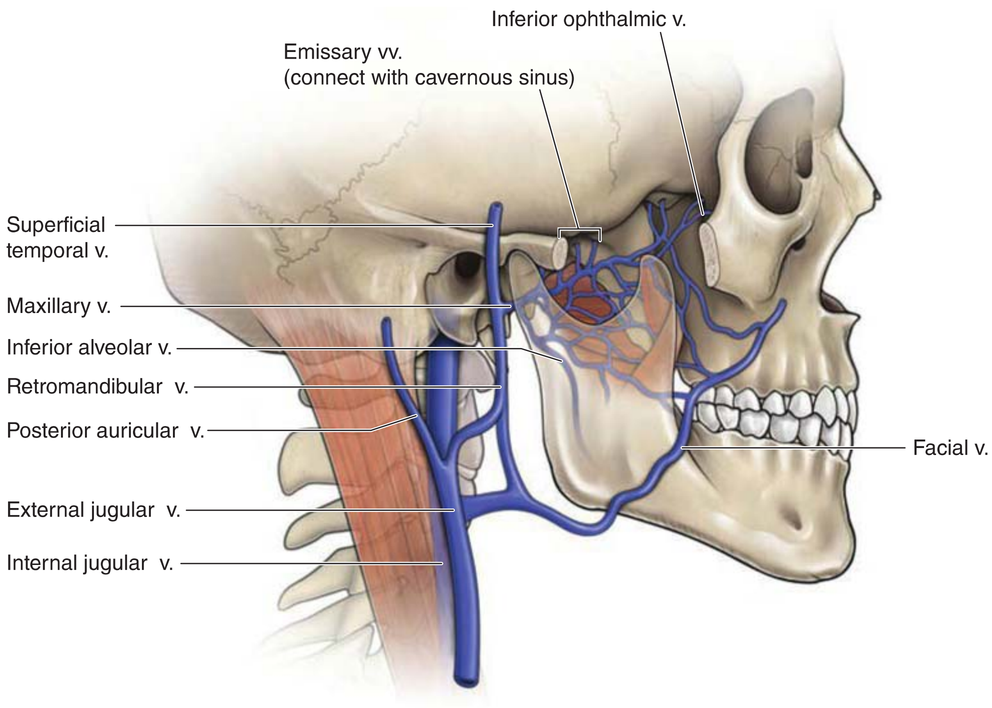


Figure 1–2. Arteries of the neck and face. (Reproduced, with permission, from White JS. USMLS Road Map: Gross Anatomy, 2nd edition, McGraw-Hill, 2003.)

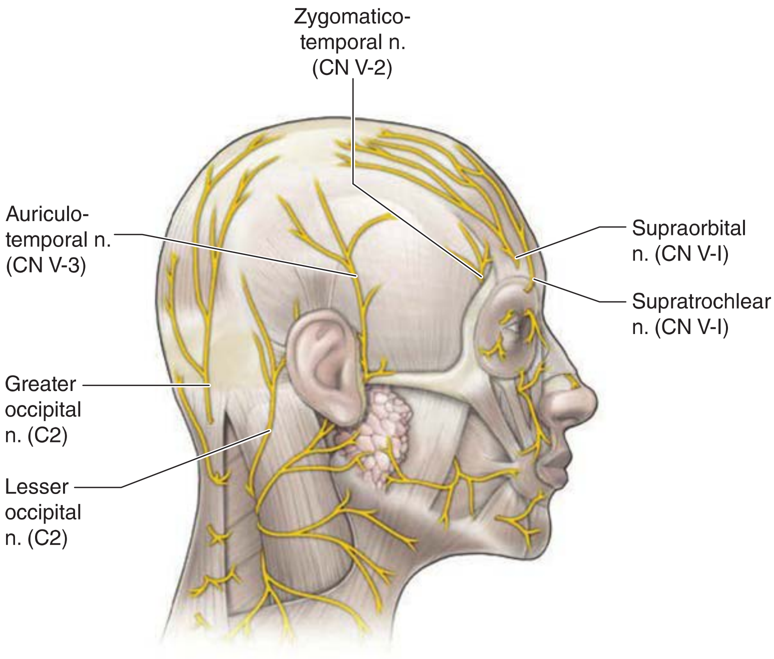
sensation from the lower lip, the lower part of the face, the auricle, and the scalp in front of and above the auricle. Its cutaneous branches are the mental, buccal, and auriculotemporal nerves.

B. Motor Innervation

The muscles of facial expression are innervated by branches of the facial nerve (VII). After emerging from the stylomastoid foramen, the facial nerve lies within the substance of the parotid gland. Here, it gives off its five terminal branches: (1) The temporal branch courses up to the scalp to innervate the occipitofrontalis and orbicularis oculi muscles. (2) The zygomatic branch courses across the cheek to innervate the orbicularis oculi muscle. (3) The buccal branch travels with the parotid duct and innervates the buccinator and orbicularis oris muscles, and also muscles that act on the nose and upper lip. (4) The mandibular branch innervates the orbicularis oris muscle and other muscles that act on the lower lip. (5) The cervical branch courses down to the neck and innervates the platysma muscle.



▲ **Figure 1–3.** Veins of the face.



▲ **Figure 1–4.** Sensory innervation of the head.

NOSE AND SINUSES

THE NASAL CAVITY

The nose is bounded from above by the cribriform plate of the ethmoid bone and from below by the hard palate. It extends back to the choanae, which allow it to communicate with the nasopharynx. The nasal septum is formed by the perpendicular plate of the ethmoid and the vomer bones. The lateral wall of the nose has three bony projections, the conchae, which increase the surface area of the nasal mucosa and help to create turbulence in the air flowing through the nose. This allows the nose to humidify and clean the inhaled air and also to change the air to body temperature. The spaces between the conchae and the lateral wall of the nose are called the meatuses. The middle meatus typically has a bulge in its lateral nasal wall, the bulla ethmoidalis, which is created by the presence of ethmoidal air cells. This bulge is bounded from below by a groove, the hiatus semilunaris. The mucous membrane of the nasal cavity is primarily ciliated columnar epithelium and is specialized for olfaction in the roof of the nose and on the upper surface of the superior concha.

THE PARANASAL SINUSES

Several bones that surround the nose are hollow, and the spaces contained within, the paranasal sinuses, are named for the skull bones in which they lie. They are lined by a mucous membrane that is continuous with the nasal mucosa through openings with which the paranasal sinuses communicate with the nose. The presence of the sinuses decreases the weight of the skull and provides resonant chambers for voice. The secretions of the sinuses are carried into the nose through ciliary action.

The frontal sinus drains into the anterior part of the hiatus semilunaris via the infundibulum. The maxillary sinus also drains into the hiatus semilunaris, as do the anterior and middle ethmoidal sinuses. The posterior ethmoidal sinuses drain into the superior meatus. The sphenoid sinus drains into the space above the superior concha called the sphenoethmoidal recess. The inferior end of the nasolacrimal duct opens in the inferior meatus, allowing tears from the conjunctival sac to be carried into the nose. The maxillary sinus lies between the orbit above and the mouth below. The roots of the upper premolar and molar teeth project into the maxillary sinus, often separated from the contents of the sinus only by the mucous membrane that lines the sinus cavity.

Sensory Innervation

The olfactory nerves (I) pass through the cribriform plate of the ethmoid bone into the olfactory bulb lying in the anterior cranial fossa, carrying the sensations of smell from the olfactory mucosa in the roof of the nose (Figure 1–5). General sensory fibers to the nose are provided by the ophthalmic (V1) and maxillary (V2) divisions of the trigeminal nerve. Specifically, the sensory innervation of the mucosa lining the anterior part of the nasal cavity, as well as that surrounding the olfactory mucosa in the roof of the nose, is by the ethmoidal branches of the ophthalmic division of the trigeminal nerve. Sensation from the lateral wall of the nose is carried by the lateral nasal branches of the maxillary division of the trigeminal nerve. Sensation from the nasal septum is carried by the nasopalatine branch of the maxillary division of the trigeminal nerve.

The sensory innervation of the lining of the frontal sinus is by the supraorbital branch of the ophthalmic division of the trigeminal nerve (V1). Sensory innervation of the sphenoid and ethmoid sinuses is by the ethmoidal branches of the ophthalmic division of the trigeminal nerve. Sensory innervation of the maxillary sinus is by the infraorbital branch of the maxillary division of the trigeminal nerve (V2).

Arteries

The rich blood supply of the nasal cavity is primarily from the sphenopalatine branch of the maxillary artery that enters the nose from the pterygopalatine fossa (Figure 1–6). The superior labial branch of the facial artery supplies the vestibule of the nose. In addition, the ophthalmic branch of the internal carotid artery supplies the roof of the nose. All of these vessels anastomose with one another.

SALIVARY GLANDS

PAROTID GLAND

The parotid gland is wedged into the space between the mandible in front and the temporal bone above and behind. It lies in front of the external auditory meatus. It extends as deep as the pharyngeal wall and is enclosed within a sheath formed by the investing fascia of the neck, which is attached to the zygomatic arch above. The parotid duct passes forward over the masseter muscle and can be palpated just in front of the clenched muscle, about half an inch below the zygomatic arch. It passes into the oral cavity by piercing the buccinator muscle and opens in the buccal mucosa opposite the upper second molar tooth.

Several important structures lie within the capsule of the parotid gland (Figure 1–7). The facial nerve (VII) enters the gland after emerging from the stylomastoid foramen and gives off its terminal branches within the substance of the gland. The external carotid artery ascends the neck, into the gland, and gives off its two terminal branches—the maxillary and superficial temporal arteries—within the gland. The superficial

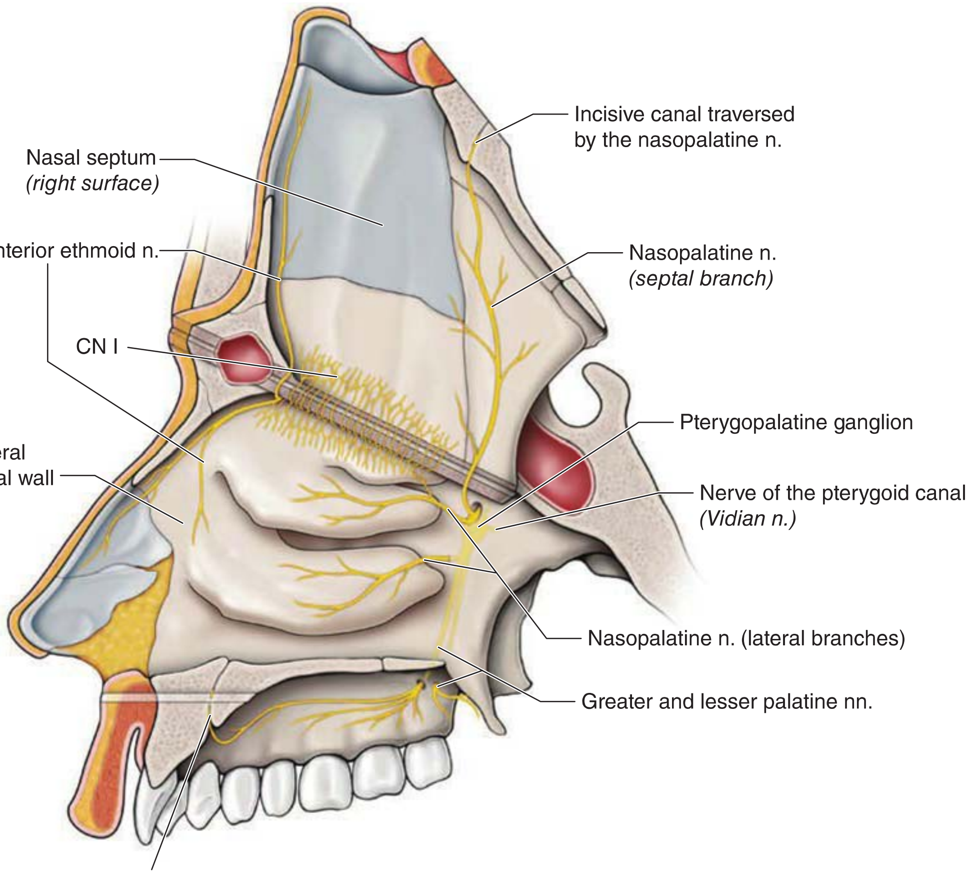


Figure 1–5. Nerves of the nasal cavity.

temporal and maxillary veins come together in the substance of the gland to form the retromandibular vein, which divides into its anterior and posterior portions as it emerges from the gland.

SUBMANDIBULAR GLAND

The submandibular gland lies in the digastric triangle of the neck, below the mylohyoid muscle. Like the parotid gland, it is enclosed within a sheath formed by the investing fascia of the neck that is attached to the mandible above. A part of the gland extends around the posterior, free edge of the mylohyoid muscle to lie above the muscle in the floor of the mouth. The submandibular duct arises from this deep portion of the gland and extends forward, alongside the tongue, to open at the base of the frenulum of the tongue on the submandibular caruncle.

SUBLINGUAL GLAND

The sublingual gland lies below the tongue in the floor of the mouth. It creates a fold of mucous membrane, the sublingual fold, which lies along the base of the tongue, above the mylohyoid muscle. The gland has multiple ducts that open along the sublingual fold.

Innervation

A. Secretomotor Innervation

Although the facial nerve (VII) is responsible for almost all the parasympathetic secretomotor innervation of the head, it is interesting to note that the one gland to which it does not provide secretomotor innervation is the very gland in which it is buried. The secretomotor innervation of the parotid gland is by fibers carried

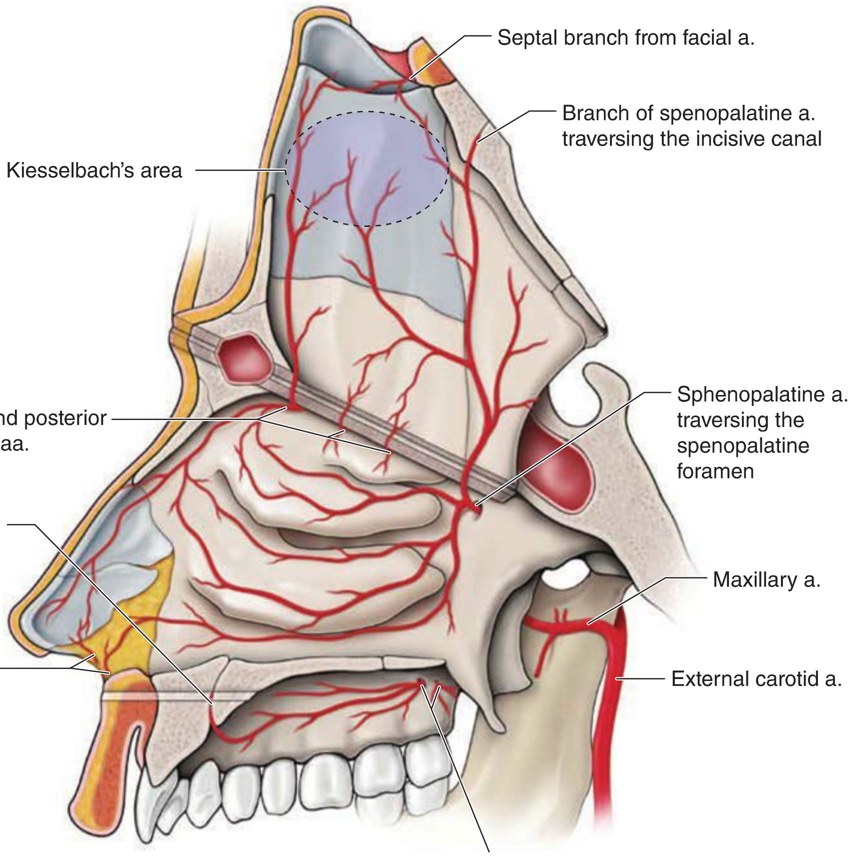


Figure 1–6. Arteries of the nasal cavity.

on the glossopharyngeal nerve (IX). The preganglionic parasympathetic fibers originate in the inferior salivary nucleus and join the glossopharyngeal nerve (Figure 1–8). They course through the lesser superficial petrosal nerve and the foramen ovale to synapse at the otic ganglion. The postganglionic fibers now join the auriculotemporal branch of the mandibular division of the trigeminal nerve to reach the parotid gland.

The secretomotor innervation of the submandibular and sublingual glands is by fibers carried on the facial nerve (VII). The preganglionic parasympathetic fibers originate in the superior salivary nucleus and join the facial nerve (Figure 1–9). They course through the chorda tympani nerve and the petrotympanic fissure to join the lingual branch of the mandibular division of the trigeminal nerve (V3) in the infratemporal fossa, and they synapse at the submandibular ganglion. Postganglionic fibers coursing to the submandibular gland usually reach the gland directly from this ganglion. Postganglionic fibers coursing to the sublingual gland reach the gland on branches of the lingual nerve.

B. Sympathetic Innervation

The sympathetic innervation to the salivary glands controls the viscosity of the glandular secretions. The preganglionic neurons originate in the thoracic spinal cord and ascend in the sympathetic trunk to synapse in the superior cervical ganglion in the neck. From here, postganglionic sympathetic fibers travel as plexuses on the external carotid artery and its branches to reach the salivary glands.

ORAL CAVITY

The mouth is bounded by the palate above, the mylohyoid muscle below, the buccinator muscles in the cheek on each side, and the palatoglossal arches behind. In addition to the oral cavity proper, the mouth includes the vestibule, which is the space between the cheek and the teeth.

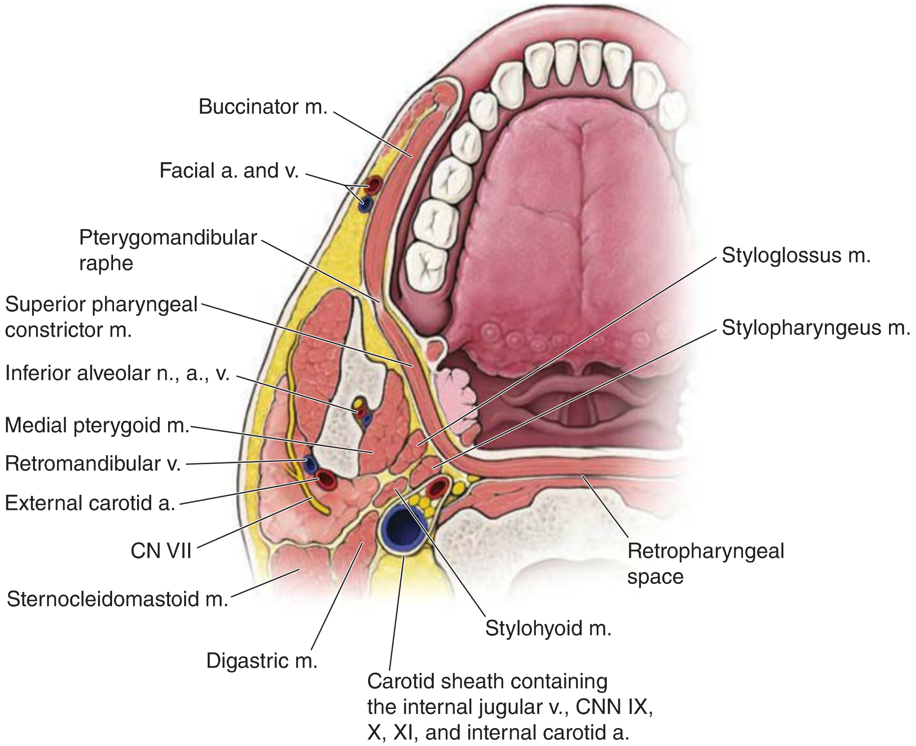


Figure 1–7. Relationships of the parotid gland. (Cross section at C2)

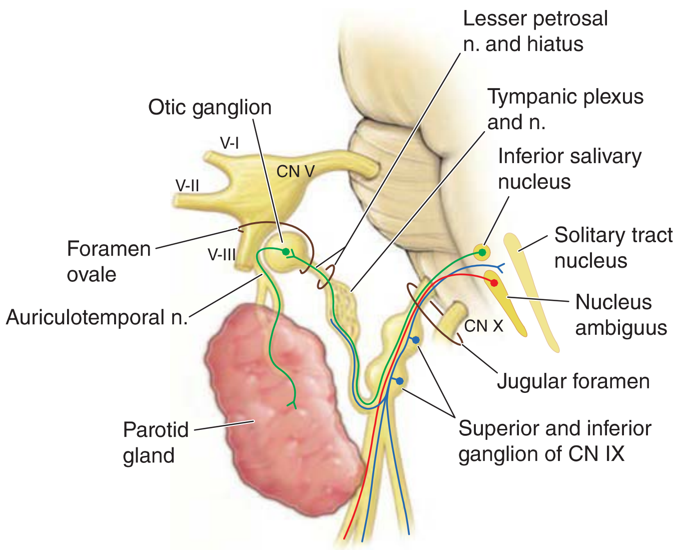
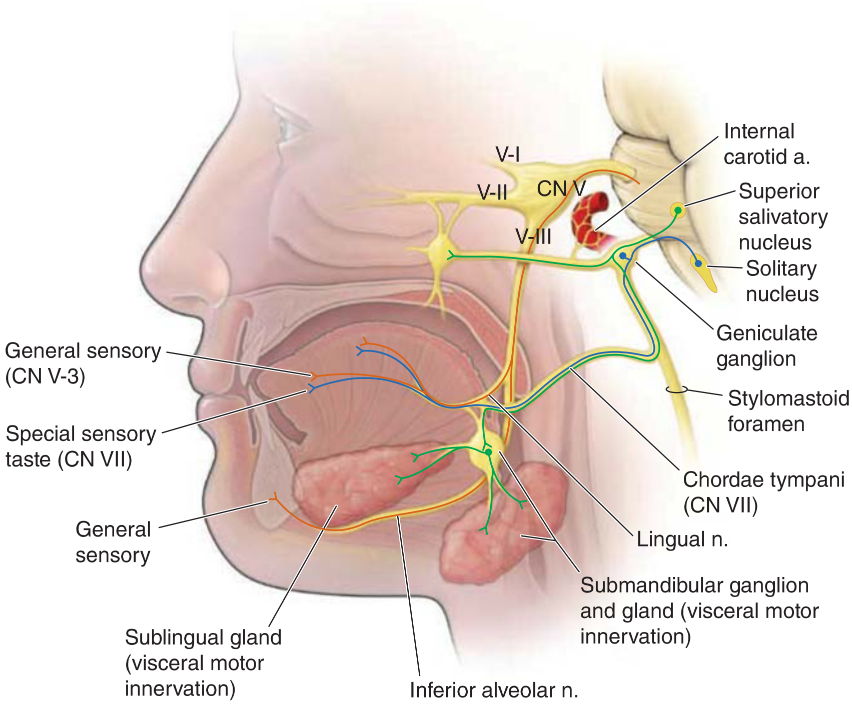


Figure 1–8. Schematic of the innervation of the parotid gland by the glossopharyngeal nerve (IX) (*green lines*).



▲ **Figure 1–9.** Schematic of the innervation of the submandibular and sublingual glands by the facial nerve (VII) (*green lines*).

PALATE

The hard palate is formed by the palatal process of the maxilla and the horizontal process of the palatine bone, which are covered by a mucous membrane. The soft palate is formed by contributions from a number of muscles.

Muscles of the Soft Palate

A. Tensor Veli Palatini Muscle

The tensor veli palatini arises from the scaphoid fossa of the sphenoid bone and descends in the lateral wall of the nose, narrowing to a tendon that turns medially around the pterygoid hamulus. It then fans out to become the palatine aponeurosis and attaches to the muscle of the opposite side. Together, the two muscles tense the soft palate for other muscles to act upon it.

B. Levator Veli Palatini Muscle

The levator veli palatini arises from the petrous part of the temporal bone near the base of the styloid process and from the cartilage of the eustachian tube. It passes between the lowest fibers of the superior pharyngeal constrictor muscle and the highest fibers of the middle pharyngeal constrictor muscle, attaching to the upper surface of the palatine aponeurosis. It helps to elevate the soft palate and, together with the palatopharyngeus and superior pharyngeal constrictor muscles, it closes off the nose from the oropharynx during swallowing.

C. Palatoglossus Muscle

The palatoglossus muscle arises from the lower surface of the palatine aponeurosis and passes down, in front of the palatine tonsil, to attach to the side of the tongue. It pulls the back of the tongue upward and approximates the soft palate to the tongue, closing off the mouth from the pharynx.

D. Palatopharyngeus Muscle

The palatopharyngeus muscle also arises from the lower surface of the palatine aponeurosis and passes down, behind the palatine tonsil, to blend into the longitudinal muscle layer of the pharynx. It helps to pull the pharyngeal wall upward during swallowing, and together with the levator veli palatini and superior pharyngeal constrictor muscles, it closes off the nose from the oropharynx.

E. Musculus Uvulae

The musculus uvulae is a small muscle that helps to elevate the uvula.

Arteries

The blood supply of the palate is from the ascending palatine branches of the facial artery as well as from the palatine branch of the maxillary artery, both of which drop down to the palate from the pterygopalatine fossa by passing through the palatine canal.

TONGUE

The anterior two-thirds of the tongue develop separately from the posterior third, and the two parts come together at the sulcus terminalis. The surface of the anterior two-thirds of the tongue is covered by filiform, fungiform, and vallate papillae. The posterior third of the tongue contains collections of lymphoid tissue, the lingual tonsils.

Muscles

The mass of the tongue is made up of intrinsic muscles that are directed longitudinally, vertically, and transversely; these intrinsic muscles help to change the shape of the tongue. Several extrinsic muscles help to move the tongue (Figure 1–10).

A. Genioglossus Muscle

The genioglossus arises from the genial tubercle on the inside surface of the front of the mandible and passes upward and backward into the tongue. It acts to protrude and depress the tongue.

B. Hyoglossus Muscle

The hyoglossus arises from the hyoid bone and passes upward to attach to the side of the posterior part of the tongue. It acts to depress and retract the back of the tongue.

C. Styloglossus Muscle

The styloglossus arises from the styloid process and passes downward and forward through the middle pharyngeal constrictor muscle to attach to the side of the tongue. It acts to elevate and retract the tongue.

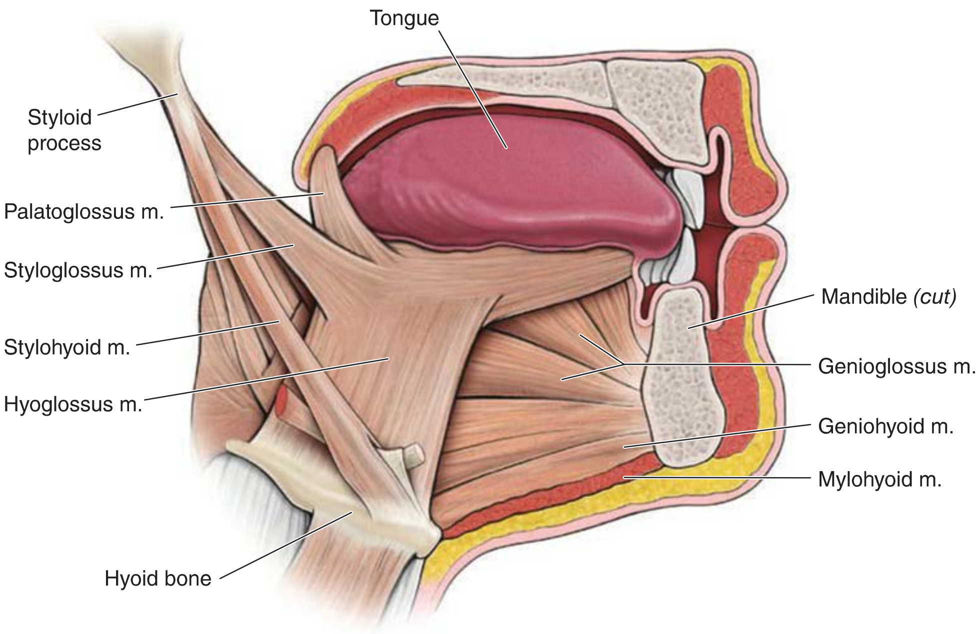


Figure 1–10. Muscles of the tongue and pharynx. (Reproduced, with permission, from Lindner HH. Clinical Anatomy, McGraw-Hill, 1989.)

D. Palatoglossus Muscle

The palatoglossus muscle (described previously) acts on the tongue but is considered a muscle of the palate.

Arteries

The blood supply of the tongue is from the lingual branch of the external carotid artery. The lingual artery reaches the tongue by passing behind the posterior edge of the hyoglossus muscle and turning forward into the substance of the tongue, thus coursing medial to the hyoglossus. In contrast, all the other nerves and vessels of the tongue pass forward lateral to the hyoglossus before entering the tongue.

FLOOR OF THE MOUTH

The floor of the mouth is formed by the mylohyoid muscle upon which lie the geniohyoid muscles (Figure 1–11). The digastric muscle lies immediately below the mylohyoid muscle. Both the geniohyoid and the digastric muscles are discussed with the suprahyoid muscles of the neck. The mylohyoid arises from the similarly named line on the inside surface of the mandible and attaches to the front of the hyoid bone. It is the main support of the structures in the mouth. It helps to elevate the hyoid bone during movements of swallowing and speech. Also, with the infrahyoid muscles holding the hyoid bone in place, the mylohyoid and digastric muscles help to depress the mandible and open the mouth.

The deep part of the submandibular gland and the duct that emerges from it lie above the mylohyoid muscle. The sublingual gland also lies above the mylohyoid. The hypoglossal nerve (XII) enters the mouth from the neck by passing lateral to the hyoglossus muscle and above the free posterior edge of the mylohyoid muscle. It continues in the mouth, inferior to the submandibular duct, and enters the substance of the tongue at its side. The lingual branch of the mandibular division of the trigeminal nerve (V3) enters the mouth from the infratemporal fossa by passing medial to the lower third molar. It initially lies above and lateral to the submandibular duct and then spirals under the duct as it comes to lie above and medial to the duct, where it gives off its terminal branches to the tongue and the floor of the mouth. The glossopharyngeal nerve (IX) passes from the pharynx to the mouth, lies lateral to the bed of the palatine tonsil, and courses into the posterior third of the tongue.

Innervation

A. Sensory Innervation

Sensation from the palate is carried by branches of the maxillary division of the trigeminal nerve (Figure 1–12). From the front of the hard palate, just behind the incisors, sensation is carried by the incisive branch of the nasopalatine nerve. From the rest of the hard palate and the mucosa lining the palatal aspect of the upper alveolar margins, sensation is carried by the greater palatine nerve. From the soft palate, sensation is carried by the lesser palatine nerve.

Sensation from the tongue is carried by nerves predicated upon the development of the tongue. General sensory fibers carry sensations of touch, pressure, and temperature. In addition, special sensory fibers carry the sensation of taste.

General sensation from the anterior two-thirds of the tongue is carried by the lingual branch of the mandibular division of the trigeminal nerve (V3). General sensation from the posterior third of the tongue is carried by the glossopharyngeal nerve (IX). Taste sensation from the anterior two-thirds of the tongue is carried by the chorda tympani branch of the facial nerve (VII). Taste sensation from the posterior third of the tongue is carried by the glossopharyngeal nerve (IX).

Sensation from the floor of the mouth and the mucosa lining the lingual aspect of the lower alveolar margins is carried by the lingual branch of the mandibular division of the trigeminal nerve (V3). Sensation from the buccal mucosa and the mucosa lining the buccal aspect of the upper and lower alveolar margins is carried by the buccal branch of the mandibular division of the trigeminal nerve (V3). Sensation from the mucosa lining the anterior part of the vestibule, inside the upper lip, and the adjacent mucosa lining the labial aspect of the upper alveolar margins is carried by the infraorbital branch of the maxillary division of the trigeminal nerve (V2). Sensation from the mucosa lining the anterior part of the vestibule, inside the lower lip, and the adjacent mucosa lining the labial aspect of the lower alveolar margins is carried by the mental branch of the inferior alveolar branch of the mandibular division of the trigeminal nerve (V3).

B. Motor Innervation

All the muscles of the palate are innervated by branches of the vagus nerve (X) except the tensor veli palatini, which is innervated by the mandibular division of the trigeminal nerve (V3). All the muscles of the tongue, extrinsic and intrinsic, are innervated by the hypoglossal nerve (XII) except the palatoglossus muscle, which is considered a muscle of the palate and is therefore innervated by the vagus nerve (X). The mylohyoid muscle and anterior belly of the digastric muscle are innervated by the nerve to the mylohyoid muscle, a branch of the mandibular division of the trigeminal nerve (V3). The posterior belly of the digastric and the stylohyoid muscle are innervated by the facial nerve (VII). The geniohyoid muscle is innervated by fibers from the cervical spinal cord (C1), which are carried to it by the hypoglossal nerve (XII).

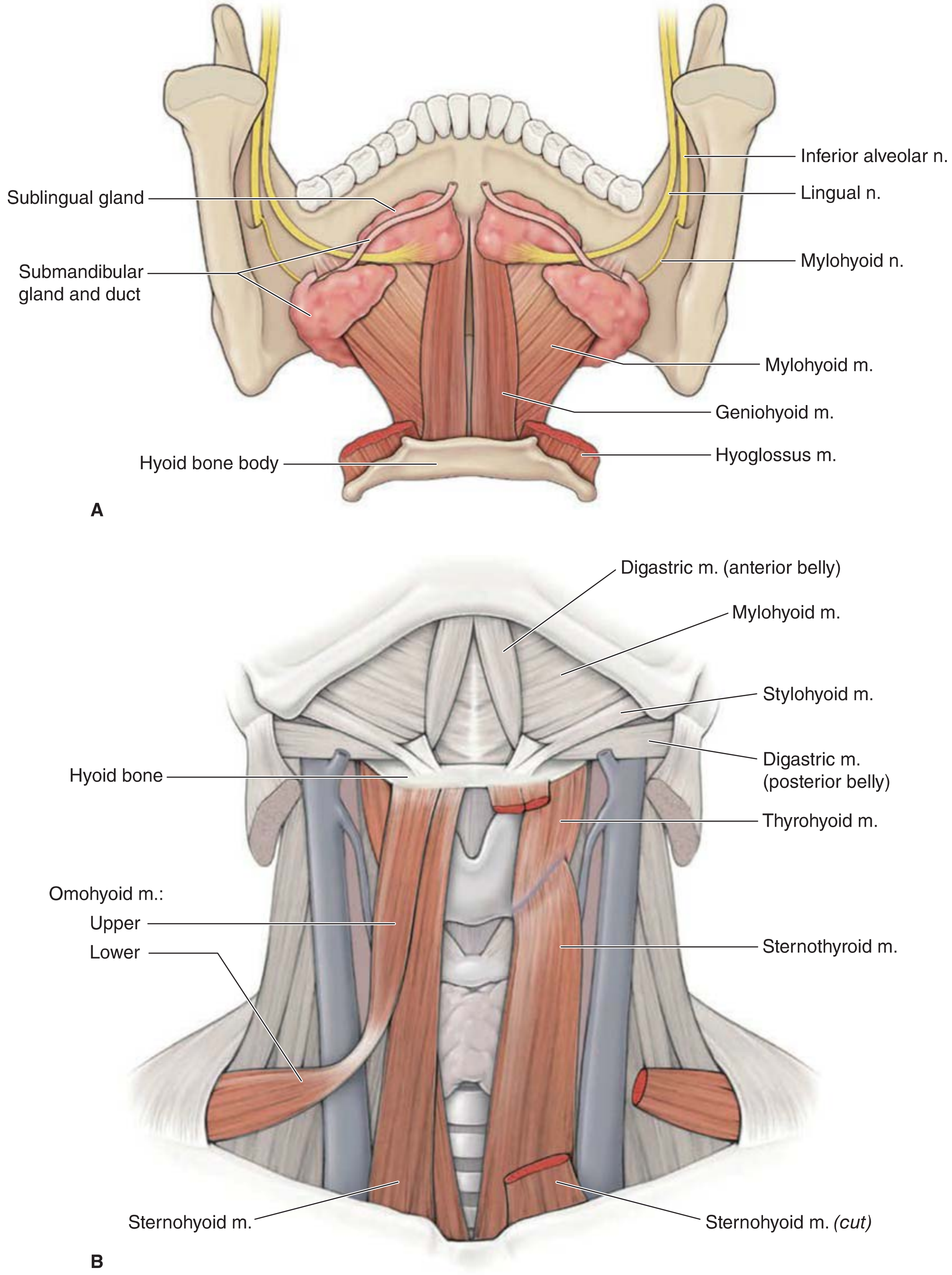


Figure 1–11. Floor of the mouth. **(A)** Superior view. **(B)** Inferior view.

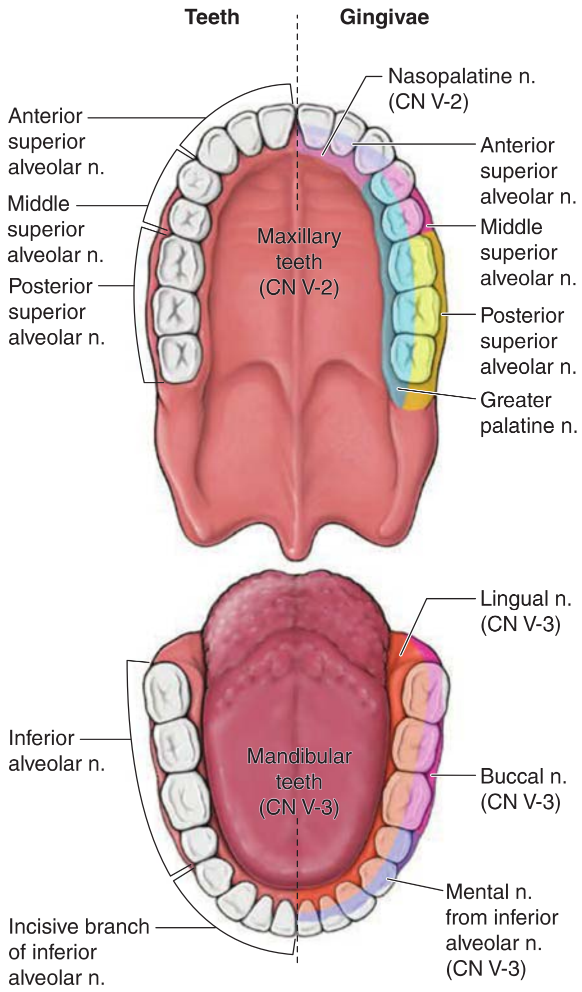


Figure 1–12. Sensory innervation of the oral cavity.

PHARYNX

The pharynx is a muscular tube that both lies behind and communicates with the nasal, oral, and laryngeal cavities (Figure 1–13). It lies in front of the prevertebral fascia of the neck and is continuous with the esophagus at the level of the cricoid cartilage. From within, it is made of mucosa, pharyngobasilar fascia, pharyngeal muscles, and buccopharyngeal fascia.

The mucosa is lined by ciliated columnar epithelium in the area behind the nasal cavity and by stratified squamous epithelium in the remaining areas. The pharyngobasilar fascia, a fibrous layer, is attached above to the pharyngeal tubercle on the base of the skull. The muscles of the pharynx consist of the circular fibers of the constrictor muscles that surround the longitudinally running fibers of the stylopharyngeus, salpingopharyngeus, and palatopharyngeus muscles.

The buccopharyngeal fascia is a layer of loose connective tissue that separates the pharynx from the prevertebral fascia and allows for the free movement of the pharynx against vertebral structures. This layer is continuous around the lower border of the mandible with the loose connective tissue layer that separates the buccinator muscle from the skin overlying it.

Muscles

The muscular layer of the pharynx is made of inner longitudinal and outer circular layers (Figure 1–14). The longitudinally running muscles help to shorten the height of the pharynx. As the pharyngobasilar fascia is attached to the skull, this shortening results in an elevation of the pharynx and larynx during swallowing. The salpingopharyngeus, stylopharyngeus, and palatopharyngeus muscles contribute to this layer.

The circularly running muscles help to constrict the pharynx, and their sequential contractions propel food downward into the esophagus. The superior pharyngeal constrictor muscle arises from the pterygomandibular raphe, the middle pharyngeal constrictor muscle from the hyoid bone, and the inferior pharyngeal constrictor muscle from the thyroid and cricoid cartilages. From these narrow anterior origins, the fibers of the constrictor muscles fan out as they travel back around the pharynx and attach to the corresponding muscles of the opposite side at the midline pharyngeal raphe. The pharyngeal raphe is attached along its length to the pharyngobasilar fascia and is thus anchored to the pharyngeal tubercle on the base of the skull. The orientation of the constrictor muscle fibers is such that the inferior fibers of one muscle are overlapped on the outside by the superior fibers of the next muscle down, producing a "funnel-inside-a-funnel" arrangement that directs food down in an appropriate fashion.

The narrow anterior attachments of the constrictor muscles, compared with their broad posterior insertion, create gaps in the circular muscle coat that surrounds the pharynx. Structures from without can pass into the pharynx through these gaps.

The gap between the base of the skull and the upper fibers of the superior inferior constrictor muscle allows the eustachian tube and the levator veli palatini muscle into the nasopharynx.

The gap between the lower fibers of the superior pharyngeal constrictor muscle and the upper fibers of the middle pharyngeal constrictor muscle allows the stylopharyngeus muscle and the glossopharyngeal nerve (IX) into the oropharynx.

The gap between the lower fibers of the middle pharyngeal constrictor muscle and the upper fibers of the inferior pharyngeal constrictor muscle allows both the internal laryngeal branch of the vagus nerve (X) and the superior laryngeal branch of the superior thyroid artery into the laryngopharynx and the larynx.

The gap between the lower fibers of the inferior pharyngeal constrictor muscle and the upper fibers of the circular muscle of the esophagus allows both the recurrent laryngeal branch of the vagus nerve (X) and the inferior laryngeal branch of the inferior thyroid artery into the larynx.

Innervation

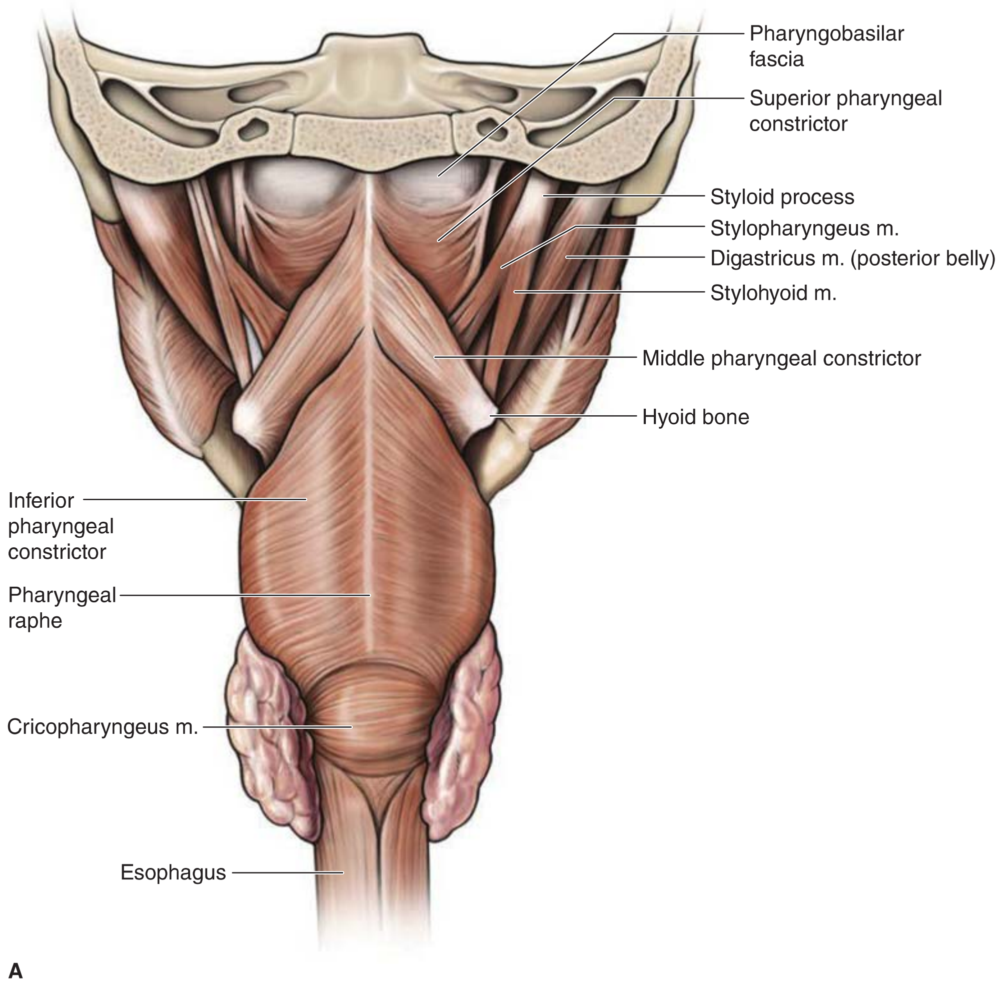
The innervation of the pharynx is by a group of nerves whose branches form a meshwork of neurons, the pharyngeal plexus, which lies in the wall of the pharynx. The glossopharyngeal nerve (IX), the vagus nerve (X), the maxillary division of the trigeminal nerve (V2), and postganglionic fibers from the sympathetic trunk all contribute to the formation of the pharyngeal plexus.

A. Sensory Innervation

The sensory innervation of the upper part of the nasopharynx is carried by branches of the maxillary division of the trigeminal nerve (V2). The sensory innervation of the lower part of the nasopharynx, the oropharynx, and the laryngopharynx is carried by the glossopharyngeal nerve (IX). The internal laryngeal branch of the vagus nerve (X) carries sensation from the piriform recesses of the laryngopharynx.

B. Motor Innervation

Motor innervation of all the muscles of the pharynx, circular and longitudinal, except the stylopharyngeus, is by the



▲ **Figure 1–13.** Exterior of the pharynx. **(A)** Muscles. **(B)** Related structures. (Reproduced, with permission, from Lindner HH. Clinical Anatomy, McGraw-Hill, 1989.)

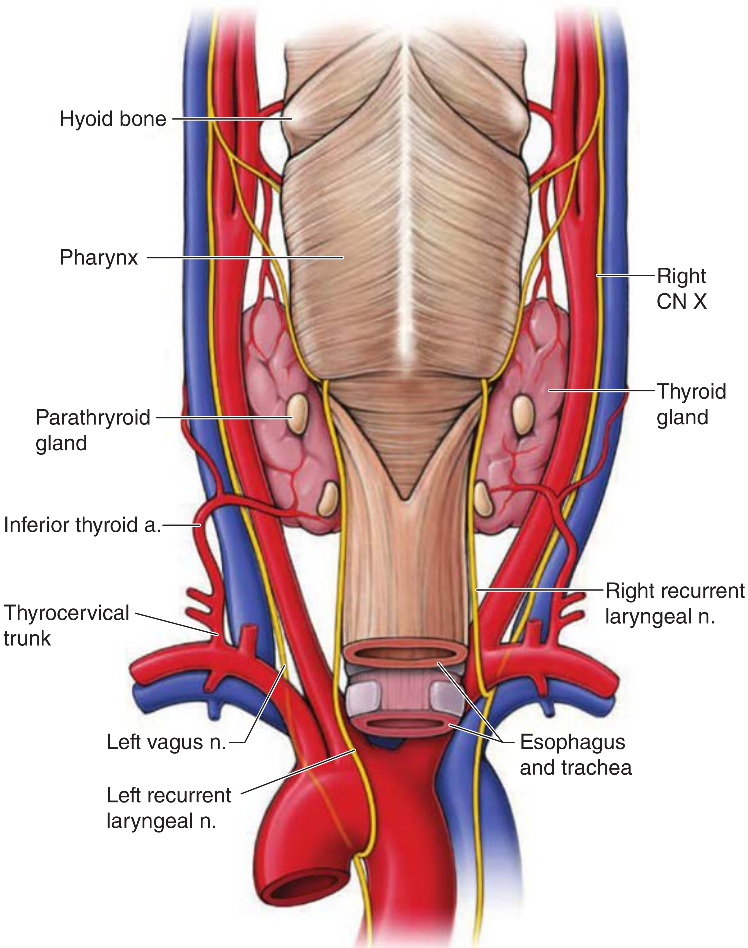


Figure 1–13. (*continued*)

pharyngeal branch of the vagus nerve (X), which carries motor fibers that originated in the cranial component of the accessory nerve (XI). The stylopharyngeus muscle is innervated by the glossopharyngeal nerve (IX).

NASOPHARYNX

The nasopharynx extends from the base of the skull to the level of the soft palate (Figures 1–15 and 1–16). It is continuous with the nasal cavity through the choanae. In its lateral wall, the cartilage of the eustachian tube creates a bulge, the torus tubarius, below which is the opening of the tube. Above and behind this bulge lies a depression called the pharyngeal recess. A collection of lymphoid tissue, the pharyngeal tonsil, lies in the posterior wall and the roof of the nasopharynx. Additional lymphoid tissue, the tubal tonsil, is found around the opening of the eustachian tube. A fold of mucous membrane created by the salpingopharyngeus muscle extends down from the torus tubarius. The nasopharynx is continuous with the oropharynx below.

OROPHARYNX

The oropharynx extends from the soft palate to the epiglottis (Figures 1–15 and 1–16). It is continuous with the mouth through the oropharyngeal isthmus formed by the palatoglossal muscles on each side. The anterior wall of the oropharynx is formed by the posterior third of the tongue. The mucous membrane of the tongue is continuous onto the epiglottis and creates three glossoepiglottic folds—one in the midline and two placed laterally. The space on either side of the median glossoepiglottic fold is the vallecula.

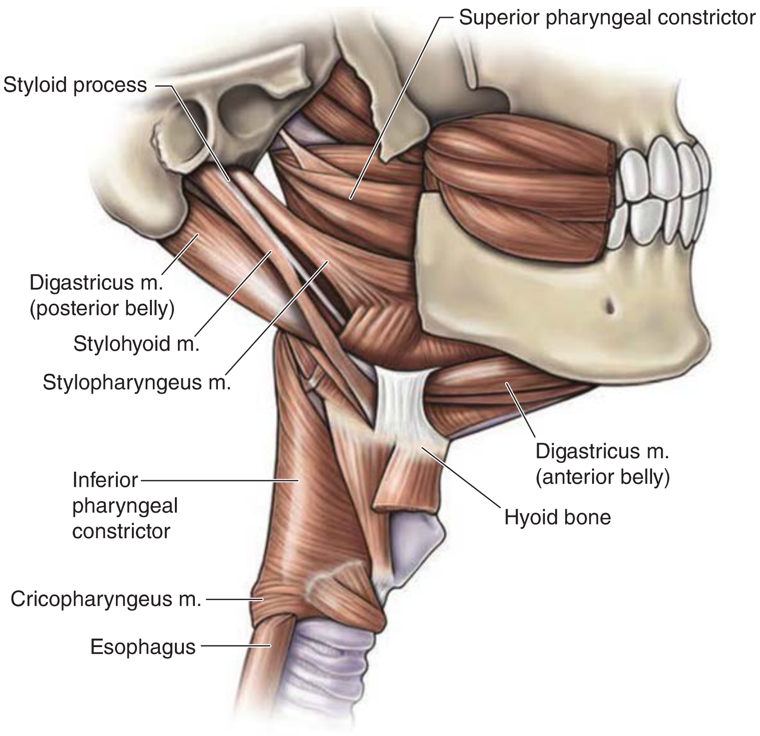


Figure 1–14. Lateral view of the pharynx.

The lateral wall of the oropharynx has two folds of mucous membrane, the palatoglossal and palatopharyngeal, created by the muscles of the same name, which are described with the muscles of the palate. An encapsulated collection of lymphoid tissue, the palatine tonsil, lies in the triangular recess between these two folds. The blood supply of the palatine tonsil is by a branch of the facial artery. Additional lymphoid tissue, the lingual tonsil, is located under the mucous membrane of the posterior third of the tongue. Together, the tonsillar tissues of the nasopharynx and oropharynx form a ring of lymphoid tissue—Waldeyer's ring—that surrounds the entrances into the pharynx from the nose and the mouth. The oropharynx is continuous with the laryngopharynx below.

LARYNGOPHARYNX

The laryngopharynx extends from the epiglottis to the cricoid cartilage (Figures 1–15 and 1–16). It is continuous with the larynx through the laryngeal aditus, which is formed by the epiglottis and the aryepiglottic folds. On either side of these folds and medial to the thyroid cartilage are two pyramidal spaces, the piriform recesses of the laryngopharynx, through which swallowed food passes into the esophagus. The piriform recesses are related to the cricothyroid muscle laterally and the lateral cricoarytenoid muscle medially. The laryngopharynx is continuous with the esophagus below.

NECK

Triangles of the Neck

Bounded by the mandible above and the clavicle below, the neck is subdivided by the sternocleidomastoid muscle into an anterior and a posterior triangular region, each of which is further divided into smaller triangles by the omohyoid and digastric muscles (Figure 1–17). The surface markings of these muscles help to visibly define the borders of the triangles of the neck.

A. Posterior Triangle

The posterior triangle is bounded by the sternocleidomastoid muscle in front, the trapezius muscle behind, and the clavicle below. It is divided by the omohyoid muscle into an occipital triangle and a supraclavicular triangle.

1. Occipital triangle—The occipital triangle has a muscular floor formed from above, downward by the semispinalis capitis, splenius capitis, levator scapulae, and scalenus

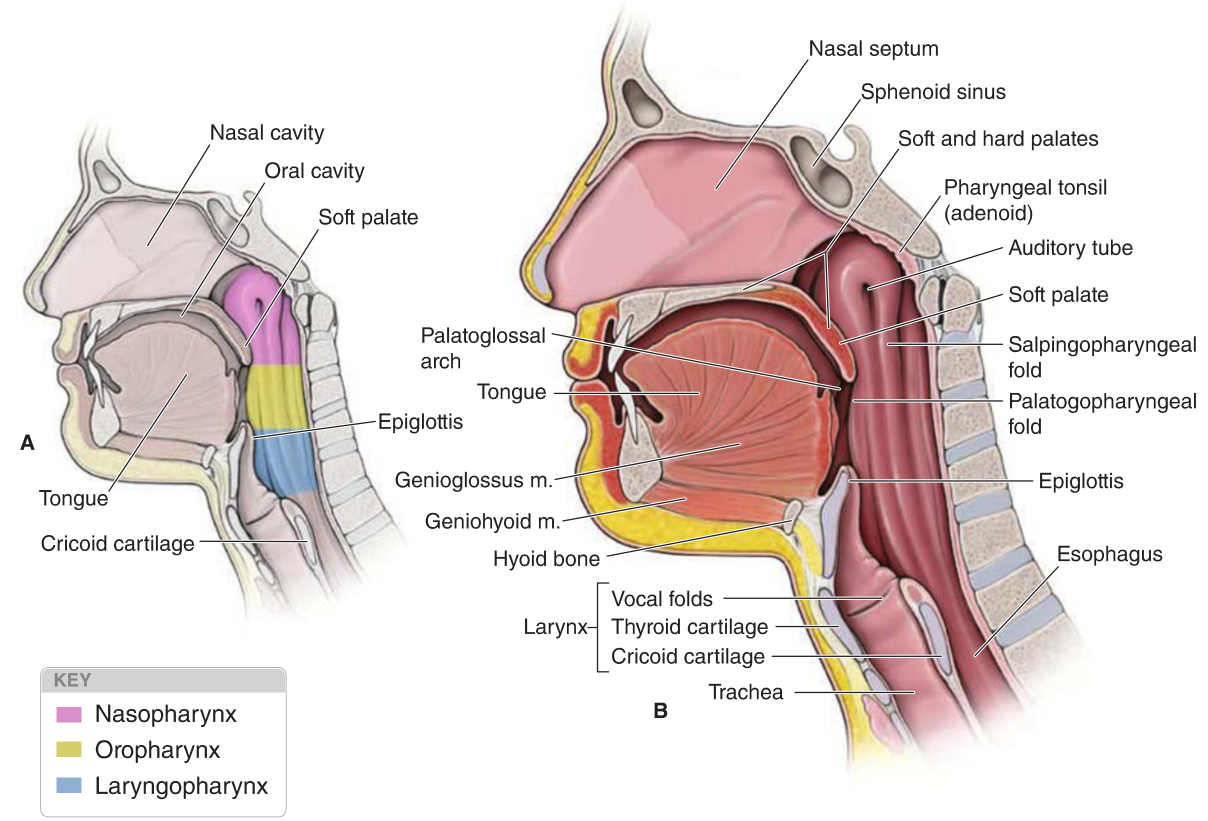


Figure 1–15. Median section of the pharynx.

medius muscles. After emerging from behind the sternocleidomastoid muscle, the spinal accessory nerve (XI) courses across the muscular floor of the posterior triangle to pass deep to the trapezius muscle. In addition, the cutaneous nerves of the neck, discussed below, course through the deep fascia of the neck that covers the posterior triangle.

2. Supraclavicular triangle—The supraclavicular triangle lies above the middle of the clavicle. It contains the terminal portion of the subclavian artery, roots, trunks, and divisions of the brachial plexus, branches of the thyrocervical trunk, and cutaneous tributaries of the external jugular vein. The cupola of the pleural cavity extends above the level of the clavicle and is found deep to the contents of the supraclavicular triangle.

B. Anterior Triangle

The anterior triangle is bounded by the sternocleidomastoid muscle behind, the midline of the neck in front, and the mandible above. It is subdivided into submental, digastric, carotid, and muscular triangles.

1. Submental triangle—The submental triangle is bounded by the anterior belly of the digastric muscle, the midline of the neck, and the hyoid bone. The mylohyoid muscle forms its floor.

2. Digastric triangle—The digastric triangle is bounded by the mandible above and the two bellies of the digastric muscle. In addition, the stylohyoid muscle lies with the posterior belly of the digastric muscle. The mylohyoid and hyoglossus muscles form the floor of this triangle. The submandibular salivary gland is a prominent feature of this area, which is also referred to as the submandibular triangle. The hypoglossal nerve (XII) runs along with the stylohyoid muscle and posterior belly of the digastric muscle, between the hyoglossus muscle and the submandibular gland, on its course into the tongue. The facial vessels course across the triangle, with the facial artery passing deep to the submandibular gland while the facial vein passes superficial to it.

3. Carotid triangle—The carotid triangle is bounded by the sternocleidomastoid muscle behind, the posterior belly of the digastric muscle above, and the omohyoid muscle below.

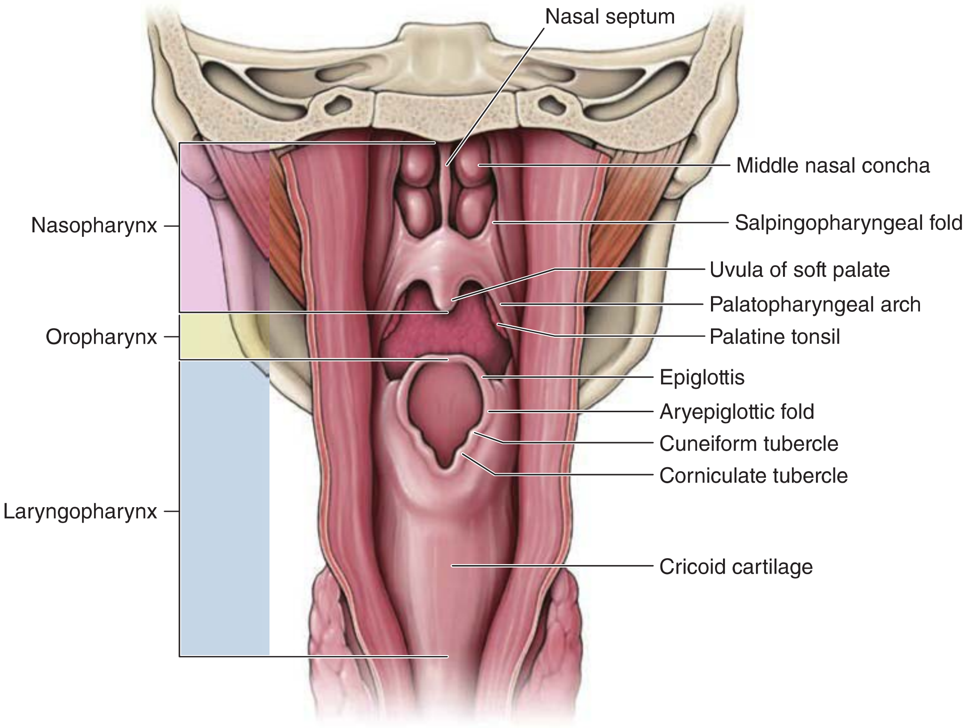


Figure 1–16. Posterior view of the opened pharynx.

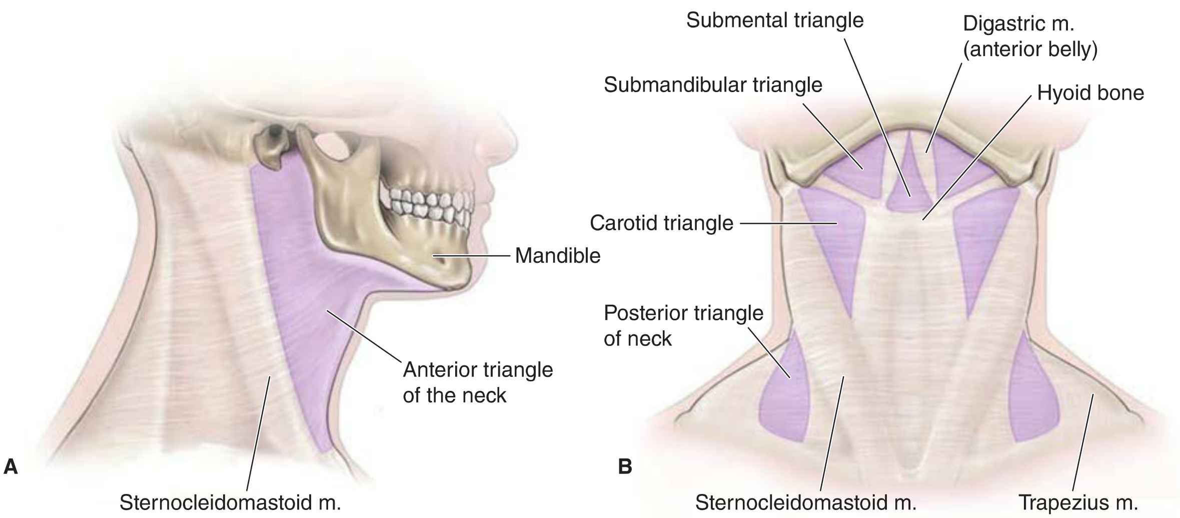


Figure 1–17. Muscles and triangles of the neck. **(A)** Lateral view. **(B)** Anterior view. **(C)** Related structures.

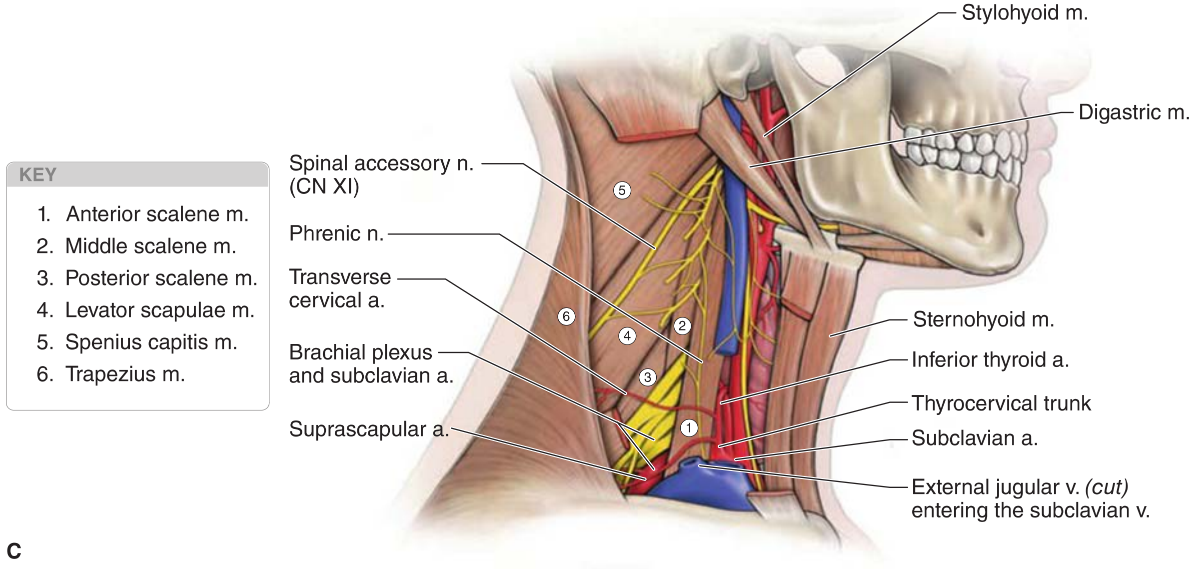


Figure 1–17. (*continued*)

Its floor is formed by the constrictor muscles of the pharynx. It contains the structures of the carotid sheath—namely, the common carotid artery as it divides into its external and internal carotid branches, the internal jugular vein and its tributaries, and the vagus nerve (X) with its branches.

4. Muscular triangle—The muscular triangle is bounded by the omohyoid muscle above, the sternocleidomastoid muscle below, and the midline of the neck in front. It contains the infrahyoid muscles in its floor. Deep to these muscles are the thyroid and parathyroid glands, the larynx, which leads to the trachea, and the esophagus. The hyoid bone forms the superior attachment for the infrahyoid muscles, and the prominent thyroid cartilage and cricoid cartilage are also contained in this region.

Muscles

A. Sternocleidomastoid Muscles

The sternocleidomastoid muscles act together to flex the cervical spine while extending the head at the atlantooccipital joint. Acting independently, each muscle turns the head to face upward and to the contralateral side. By virtue of their attachment to the sternum, the sternocleidomastoids also serve as accessory muscles of respiration.

B. Trapezius Muscles

The trapezius muscles have fibers running in several directions. The uppermost fibers pass downward from the skull to the lateral end of the clavicle and help to elevate the shoulder. The middle fibers pass laterally from the cervical spine to the acromion process of the scapula and help to retract the shoulder. The lowest fibers pass upward from the thoracic spine to the spine of the scapula and help to laterally rotate the scapula, making the glenoid fossa turn upward. This action assists the serratus anterior muscle in rotating the scapula when the arm is abducted overhead.

C. Scalene Muscles

The scalene muscles attach to the cervical spine and pass downward to insert on the first rib. They are contained within the prevertebral layer of deep fascia and help to laterally bend the cervical spine. The roots of the brachial plexus and the subclavian artery pass between the anterior and middle scalene muscles on their course to the axilla. In contrast, the subclavian vein passes anterior to the anterior scalene muscle as it leaves the neck to pass behind the clavicle and reach the axilla. Also, the phrenic nerve lies immediately anterior to the anterior scalene muscle as it runs down the neck into the thorax.

D. Infrahyoid Muscles

The infrahyoid muscles, the omohyoid, sternohyoid, sternothyroid, and thyrohyoid, are named for their attachments. Together, they act to depress the hyoid bone and the thyroid cartilage during movements of swallowing and speech.

E. Suprahyoid Muscles

The suprahyoid muscles, the mylohyoid, stylohyoid, geniohyoid, and digastric, act together to elevate the hyoid bone during movements of swallowing or speech. In addition, with the infrahyoid muscles holding the hyoid bone in place, the suprahyoid muscles help to depress the mandible and open the mouth.

Arteries

The arch of the aorta has three branches: (1) the brachiocephalic artery, (2) the left common carotid artery, and (3) the left subclavian artery. The brachiocephalic artery branches into the right subclavian and right common carotid arteries.

A. Subclavian Artery

The subclavian artery gives off the vertebral artery, the internal thoracic artery, the thyrocervical trunk, and the costocervical trunk (see Figure 1–2).

1. Vertebral artery—The vertebral artery courses up through the transverse foramina of the upper six cervical vertebrae. It enters the vertebral canal, passes through the foramen magnum, and goes on to supply blood to the hindbrain, the midbrain, and the occipital lobe of the forebrain.

2. Internal thoracic artery—The internal thoracic artery leaves the root of the neck and passes into the thorax, where it supplies blood to the anterior chest wall and eventually to the upper part of the anterior abdominal wall through its superior epigastric branch.

3. Thyrocervical trunk—The thyrocervical trunk gives off the following branches: (1) the inferior thyroid artery, which supplies blood to the thyroid gland; (2) the transverse cervical artery, which passes backward across the neck to supply blood to the trapezius and rhomboid muscles; and (3) the suprascapular artery, which courses laterally across the neck toward the suprascapular notch and participates in the elaborate anastomosis of vessels that surround the scapula. The inferior thyroid artery has a branch, the inferior laryngeal artery, which enters the larynx by passing between the lowest fibers of the inferior pharyngeal constrictor muscle and the upper fibers of the circular muscle of the esophagus. The inferior thyroid artery anastomoses with the superior thyroid artery, a branch of the external carotid artery.

4. Costocervical trunk—The costocervical trunk gives off branches that supply blood to the first two intercostal spaces and the postvertebral muscles of the neck.

B. Common Carotid Artery

The common carotid artery courses up into the neck and terminates at the level of the thyroid cartilage by dividing into the internal and external carotid arteries. It has no branches.

1. Internal carotid artery—The internal carotid artery also has no branches in the neck. It travels up to the base of the skull, where it enters the carotid canal and passes through the petrous part of the temporal bone and the cavernous sinus before turning sharply upward and backward at the carotid siphon to pierce the dura mater. It supplies blood to the frontal, parietal, and temporal lobes of the forebrain. Its main branch to the head is the ophthalmic artery, which supplies blood to the orbit and the upper part of the nasal cavity.

2. External carotid artery—The external carotid artery is the main source of blood supply to the head and neck (see Figure 1–2). In the neck, it has a number of branches.

a. Superior thyroid artery—The superior thyroid artery passes downward to supply blood to the upper part of the thyroid gland. It has a branch, the superior laryngeal artery, which pierces the thyrohyoid membrane to pass into the larynx. The superior thyroid artery anastomoses with the inferior thyroid artery, a branch of the thyrocervical trunk of the subclavian artery.

b. Ascending pharyngeal artery—The ascending pharyngeal artery supplies blood to the pharynx.

c. Posterior auricular artery—The posterior auricular artery passes upward, behind the auricle, and supplies blood to the scalp.

d. Occipital artery—The occipital artery passes upward and backward to supply blood to the scalp on the back of the head.

e. Facial artery—The facial artery passes upward and forward, deep to the submandibular salivary gland. It then crosses the mandible, where its pulsations can be palpated just in front of the masseter muscle, to supply blood to the face.

f. Lingual artery—The lingual artery passes upward and forward, behind the posterior edge of the hyoglossus muscle, and into the substance of the tongue, to which it supplies blood.

g. Terminal branches—The external carotid artery then ascends into the substance of the parotid gland, where it gives off two terminal branches.

*(1) Superficial temporal artery—*The superficial temporal artery crosses the zygomatic arch just in front of the auricle, where its pulsations can be palpated. It then goes on to supply blood to the scalp.

*(2) Maxillary artery—*The maxillary artery passes medially into the infratemporal fossa and is responsible for the blood supply to the deep structures of the face and the nose.

Veins

The venous drainage of the head and neck is best understood by comparing it with the arterial distribution described above. Many variations exist in the pattern of venous drainage, but each of the arteries has a vein that corresponds to it (see Figure 1–3).

A. Retromandibular Vein

The veins that correspond to the two terminal branches of the external carotid artery, the superficial temporal and maxillary veins, come together within the substance of the parotid gland to form the retromandibular vein. At the angle of the mandible, the retromandibular vein divides into an anterior and a posterior division.

B. External Jugular Vein

The two veins that correspond to the arteries that pass backward from the external carotid artery, the posterior auricular and occipital veins, join the posterior division of the retromandibular vein and become the external jugular vein. In addition, the suprascapular and transverse cervical veins drain into the external jugular vein.

C. Internal Jugular Vein

The two veins that correspond to the arteries that pass forward from the external carotid artery, the facial and lingual veins, join the anterior division of the retromandibular vein and drain into the internal jugular vein. The internal jugular vein drains blood from the areas to which the internal carotid artery supplies blood. In addition, the superior and middle thyroid veins drain into the internal jugular vein.

D. Inferior Thyroid Veins

The inferior thyroid veins lie in front of the trachea and drain blood from the isthmus of the thyroid gland into the left brachiocephalic vein as it lies behind the manubrium of the sternum.

E. Brachiocephalic Vein

The external jugular vein drains into the subclavian vein, which joins the internal jugular vein at the root of the neck to become the brachiocephalic vein. The two brachiocephalic veins come together to form the superior vena cava.

Lymphatics

The superficial lymph nodes of the head and neck are named for their regional location (Figure 1–18). The occipital, retroauricular, and parotid nodes drain lymph from the scalp, auricle, and middle ear. The submandibular nodes receive lymph from the face, sinuses, mouth, and tongue. The retropharyngeal nodes, although not truly superficially located, receive lymph from deeper structures of the head, including the upper parts of the pharynx. All of these regional nodes drain their lymphatic efferents into the deep cervical nodes, which lie along the internal jugular vein. Two of these deep nodes are commonly referred to as the jugulodigastric and the juguloomohyoid nodes. They lie at locations at which the internal jugular vein is crossed by the digastric and omohyoid muscles, respectively. The jugulodigastric node is concerned with the lymphatic drainage of the palatine tonsil; the juguloomohyoid node is concerned primarily with the lymphatic drainage of the tongue. The deep cervical nodes drain their lymph into either the thoracic duct or the right lymphatic duct. The thoracic duct empties into the junction of the left internal jugular vein and the left subclavian vein. The right lymphatic duct drains into a similar location on the right side of the root of the neck.

Innervation

A. Sensory Innervation

The cutaneous innervation of the anterior skin of the neck is by the ventral rami of cervical spinal nerves that form the cervical plexus (C2–4), whereas the posterior skin of the neck is innervated by the dorsal rami of cervical spinal nerves (C2–5) (see Figure 1–4). The cutaneous branches of the cervical plexus emerge from just behind the sternocleidomastoid muscle, at a point about halfway between its attachments to the sternum and the mastoid process. They are named for the areas of skin from which they carry sensation.

1. Transverse cervical nerve—The transverse cervical nerve turns forward and courses across the neck, with its branches carrying sensation from the anterior neck.

2. Supraclavicular nerves—The supraclavicular nerves course down toward the clavicle and carry sensation from the skin of the lower neck, extending from the clavicle in front to the spine of the scapula behind.

3. Greater auricular nerve—The greater auricular nerve courses up toward the auricle, with its branches carrying sensation from the skin of the upper neck, the skin overlying the parotid gland, and the auricle itself.

4. Lesser occipital nerve—The lesser occipital nerve courses upward to carry sensation from the skin of the scalp that lies just behind the auricle.

B. Motor Innervation

The infrahyoid muscles are innervated by branches of the ansa cervicalis, which is formed by the descending cervical nerve and the descending hypoglossal nerve. The descending cervical nerve (C2 and 3) arises from the cervical plexus. The descending hypoglossal nerve contains fibers from the first cervical spinal nerve, some of which initially joined the hypoglossal nerve (XII) before dropping from that nerve to form the ansa cervicalis (Figure 1–19). Other fibers from the first cervical spinal nerve continue on the hypoglossal nerve and later branch off to supply the thyrohyoid muscle.

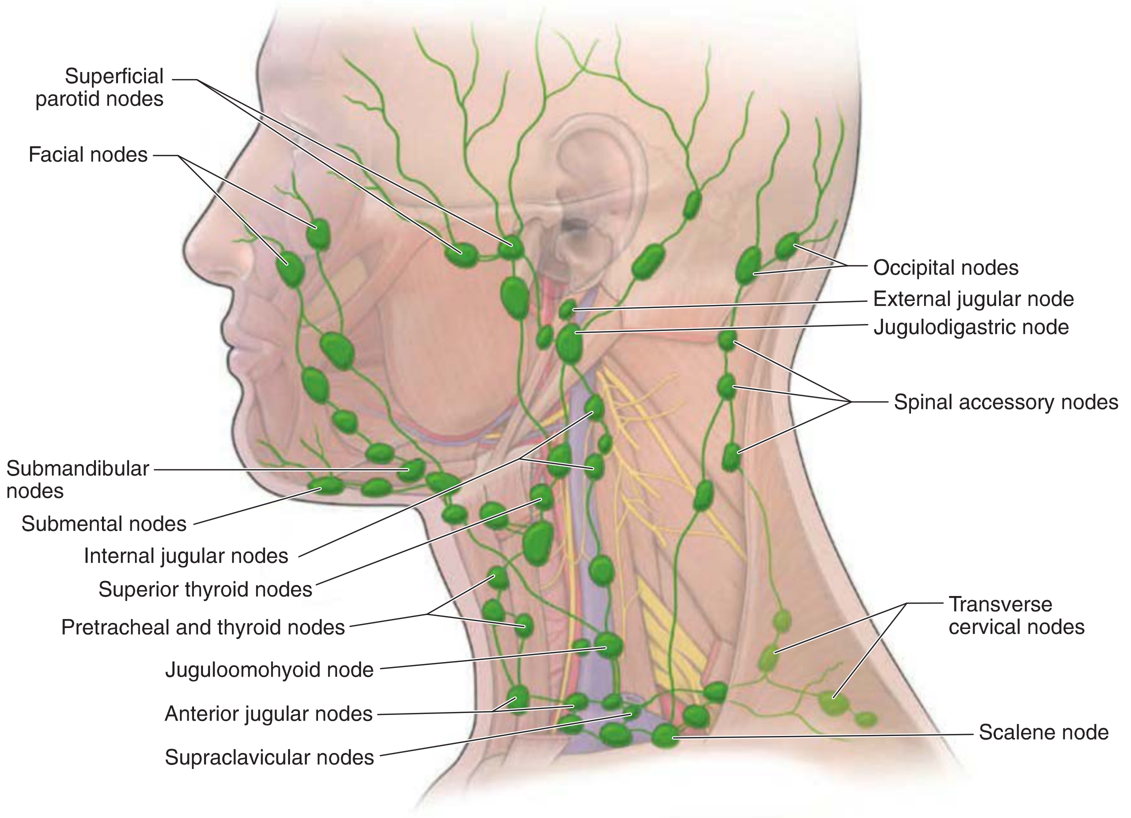


Figure 1–18. Head and neck lymphatics.

Of the suprahyoid muscles, the mylohyoid muscle and the anterior belly of the digastric muscle are innervated by the nerve to the mylohyoid muscle, which is a branch of the inferior alveolar nerve from the mandibular division of the trigeminal nerve (V3). The stylohyoid muscle and the posterior belly of the digastric muscle are innervated by the facial nerve (VII). The geniohyoid muscle is innervated by C1 fibers carried by the hypoglossal nerve (XII).

The prevertebral musculature and the scalene muscles receive motor innervation from direct branches of the cervical plexus. The sternocleidomastoid muscles and the trapezius muscles are innervated by the spinal accessory nerve (XI).

Vagus Nerve

The vagus nerve (X) travels in the carotid sheath with the internal jugular vein and the carotid artery (Figures 1–20 and 1–21). In the neck, it has branches to the larynx, the pharynx, and the heart. The laryngeal and pharyngeal branches of the vagus nerve carry motor fibers that originate in the cranial component of the accessory nerve (XI).

A. Superior Laryngeal Nerve

The superior laryngeal nerve gives off two branches, the external and the internal laryngeal nerves. The external laryngeal nerve provides motor innervation to the cricothyroid muscle. The internal laryngeal nerve pierces the thyrohyoid membrane to enter the larynx. It carries sensation from the part of the larynx that lies above the vocal folds and also carries sensation from the piriform recess of the laryngopharynx.

B. Recurrent (Inferior) Laryngeal Nerve

The recurrent (inferior) laryngeal nerve provides motor innervation to all the muscles of the larynx, with the exception of the cricothyroid muscle, as previously described. In addition, it carries sensation from the part of the larynx that lies below the vocal folds and from the upper part of the trachea. It courses up the neck in the groove between the trachea and the esophagus. As a result of the differing development of the aortic arches on the right and left sides of the body, the right recurrent laryngeal nerve passes in front of the right subclavian artery and turns up and back around this vessel to course toward the larynx. In contrast, the left recurrent laryngeal nerve passes into the thorax and lies in front of the arch of the aorta before turning up and back around the aorta, behind the ligamentum arteriosum, to reach the larynx.

C. Pharyngeal Branches

The pharyngeal branches provide motor innervation to all the muscles of the pharynx, with the exception of the stylopharyngeus muscle, and to all the muscles of the palate, with the exception of the tensor veli palatini muscle.

D. Thoracic Branches

The cardiac branches descend into the mediastinum and provide parasympathetic innervation to the heart. Additional branches arise in the chest to provide parasympathetic innervation to the lungs.

E. Sensory Branches

The vagus has sensory branches that serve the meninges and the external ear.

Phrenic Nerve

The phrenic nerve arises from the ventral rami of cervical spinal nerves C3–5 and courses down in the prevertebral fascia, in front of the anterior scalene muscle, into the thorax between the subclavian artery and vein. It provides motor innervation to the diaphragm. In addition, it carries sensation from the mediastinal and diaphragmatic parietal pleura, the pericardium, and the parietal peritoneum under the diaphragm.

Sympathetic Trunk

The sympathetic trunk in the neck is an upward continuation of the thoracic part of the trunk and reaches the base of the skull, lying medial to the carotid sheath in the prevertebral fascia. Unlike the thoracic part of the trunk, which has a sympathetic ganglion associated with each spinal nerve, the cervical part of the trunk has only three ganglia. The inferior cervical ganglion lies near the first rib and is frequently fused with the first thoracic ganglion to form the stellate ganglion. The middle cervical ganglion lies at the level of the cricoid cartilage. The superior cervical ganglion lies at the base of the skull, just below the inferior opening of the carotid canal. The cervical sympathetic ganglia get preganglionic input

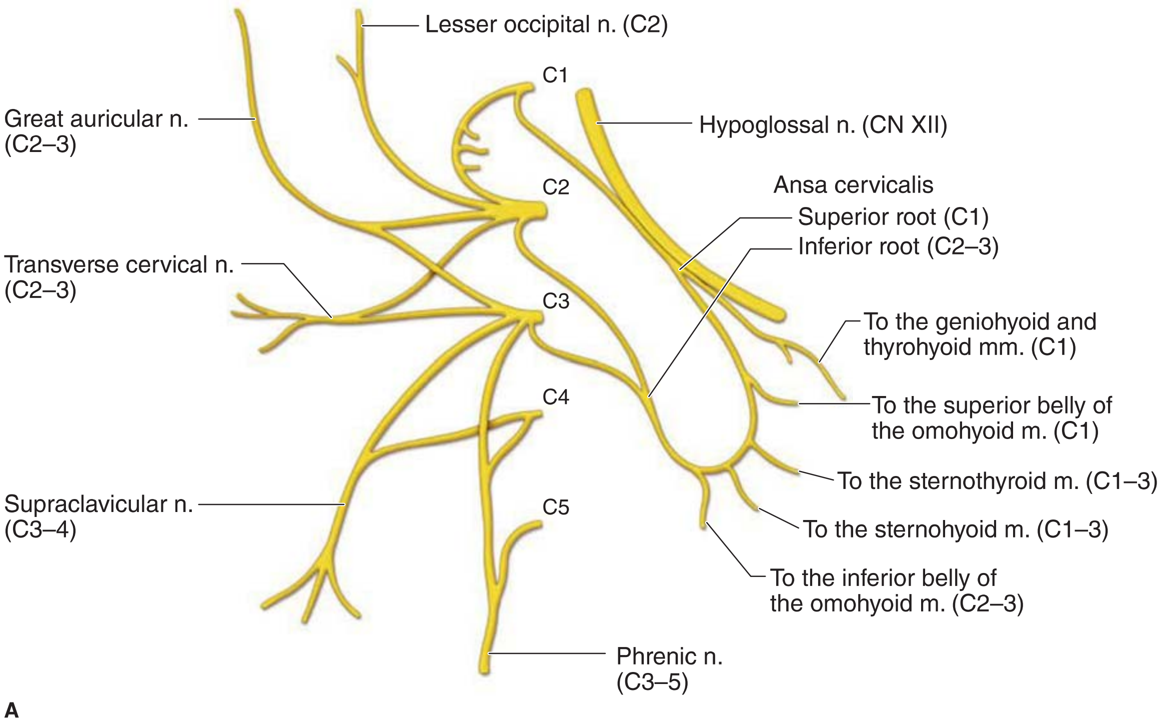


Figure 1–19. Cervical plexus. Motor and sensory innervation of the neck. **(A)** Schematic. **(B)** In situ. (Reproduced, with permission, from Lindner HH. Clinical Anatomy, McGraw-Hill, 1989.)

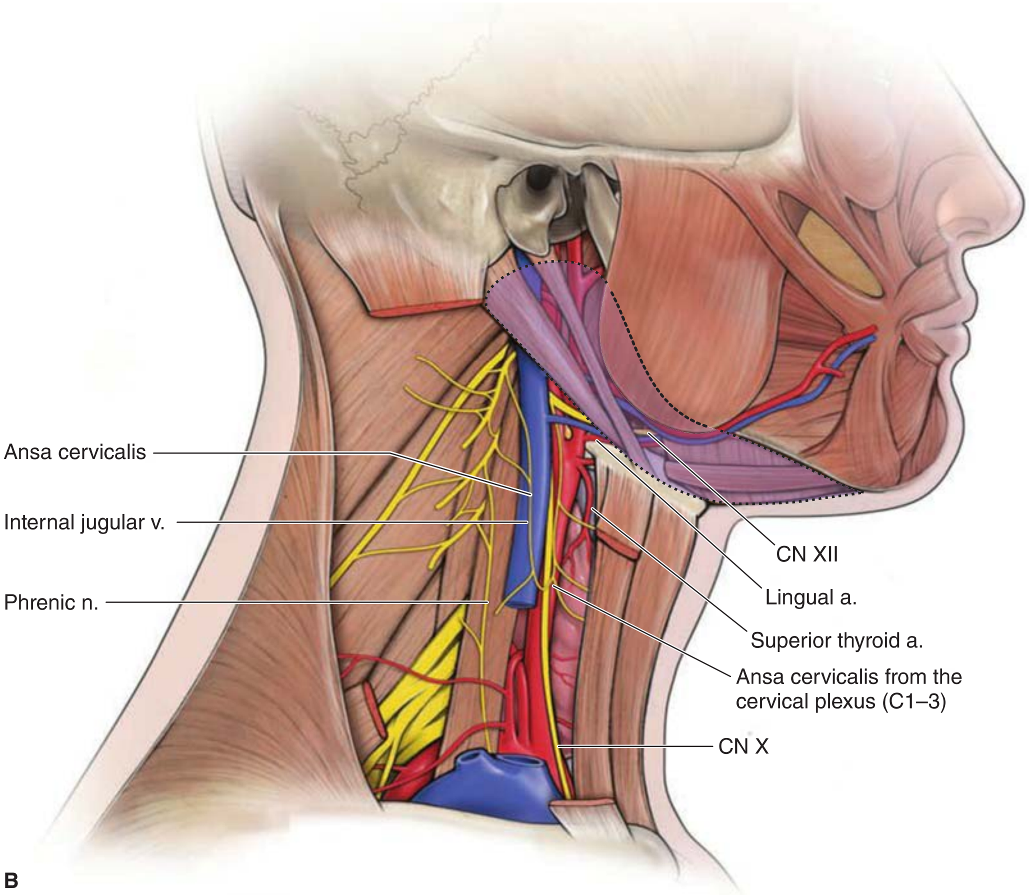


Figure 1–19. (*continued*)

from fibers that originate in the upper thoracic spinal cord and ascend in the sympathetic trunk to reach the neck. Postganglionic outflow from these ganglia passes to the cervical spinal nerves, the cardiac plexus, the thyroid gland, the pharyngeal plexus, and the neurons that form plexuses around the internal and external carotid arteries as those vessels course up to the head.

Fascial Planes

The deep fascia of the neck is thickened into several well-defined layers that are of clinical significance (Figure 1–22).

A. Investing Fascia

The investing fascia surrounds the neck, attached below to the sternum and the clavicle, and above to the lower border of the mandible, the zygomatic arch, the mastoid process, and the superior nuchal line of the occipital bone. The fascia splits to enclose the sternocleidomastoid and trapezius muscles and the submandibular and parotid salivary glands.

B. Prevertebral Fascia

The prevertebral fascia surrounds the prevertebral and postvertebral muscles, and is attached to the ligamentum nuchae in the back. It is attached to the base of the skull above and extends down into the mediastinum below. There is a potential space, the retropharyngeal space, between this fascial layer and the pharynx and esophagus, allowing for the free movement of these structures against the vertebral column. However, this arrangement also provides a communicating space that extends from the base of the skull down into the mediastinum, allowing for infections to easily track in either direction.

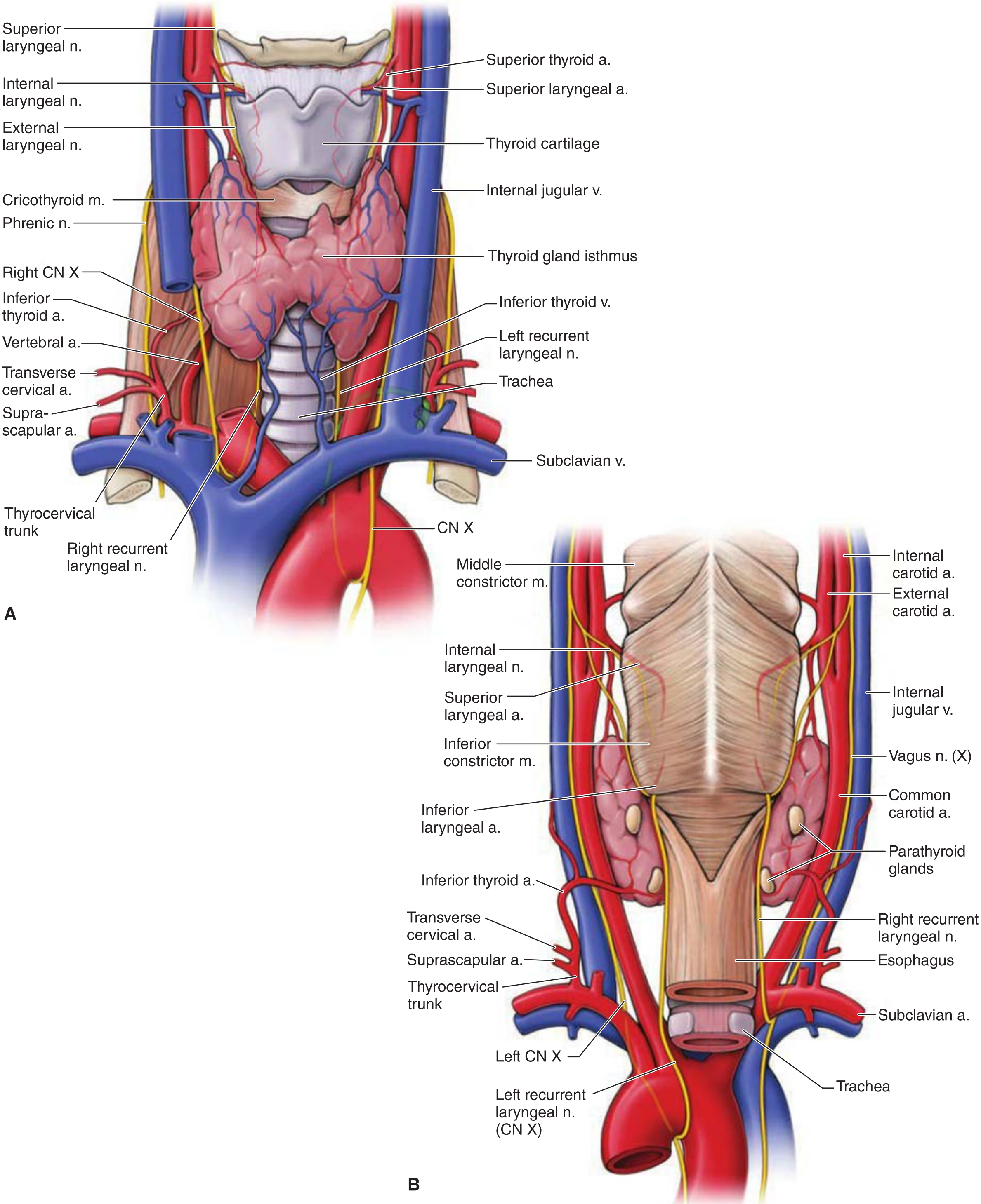


Figure 1–20. Structures related to the carotid sheath and the thyroid gland. **(A)** Anterior view. **(B)** Posterior view.

C. Carotid Sheath

The carotid sheath surrounds the carotid arteries, the internal jugular vein, the vagus nerve (X), and the deep cervical lymph nodes.

D. Visceral Fascia

The visceral fascia surrounds the thyroid and parathyroid glands and the infrahyoid muscles. It extends from its attachment to the thyroid cartilage above to the pericardium below and is fused with the carotid sheath and the investing fascia.

LARYNX

The larynx extends from the epiglottis and the aryepiglottic folds to the cricoid cartilage (Figure 1–23). It communicates with the laryngopharynx above—through the laryngeal aditus—and with the trachea below. Its lateral walls have two infoldings of mucous membrane: the vestibular folds above and the vocal folds below. The space between the two vestibular folds is called the rima vestibuli, and the space between the two vocal folds is called the rima glottidis. The part of the larynx that extends from the aditus to the rima vestibuli is called the vestibule of the larynx, and the part that

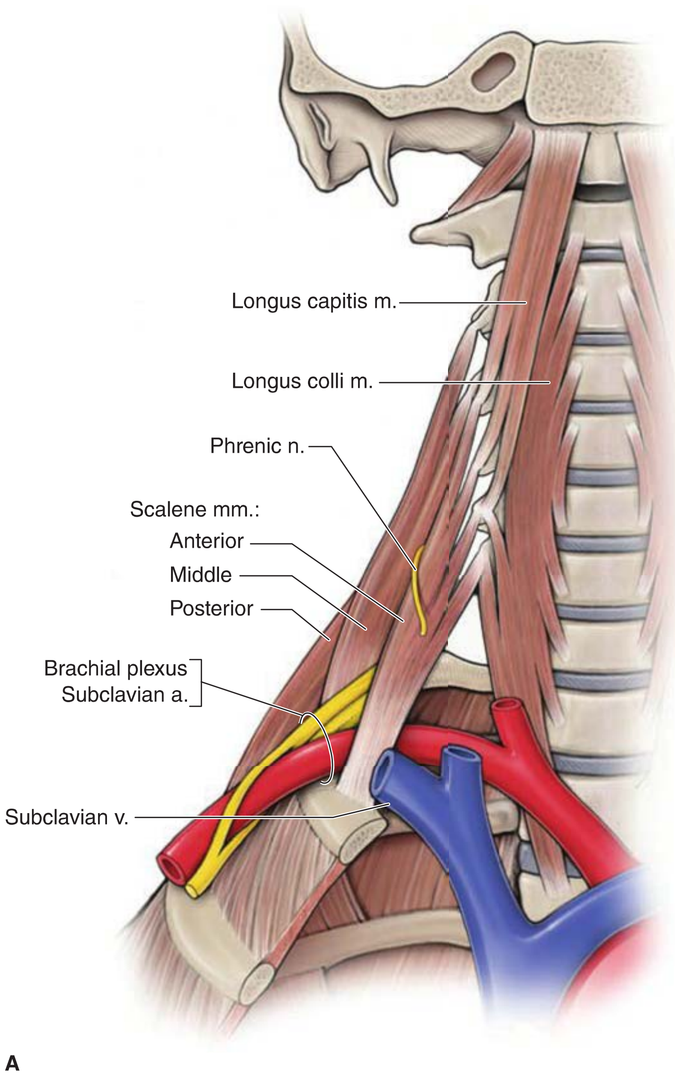


Figure 1–21. Root of the neck.

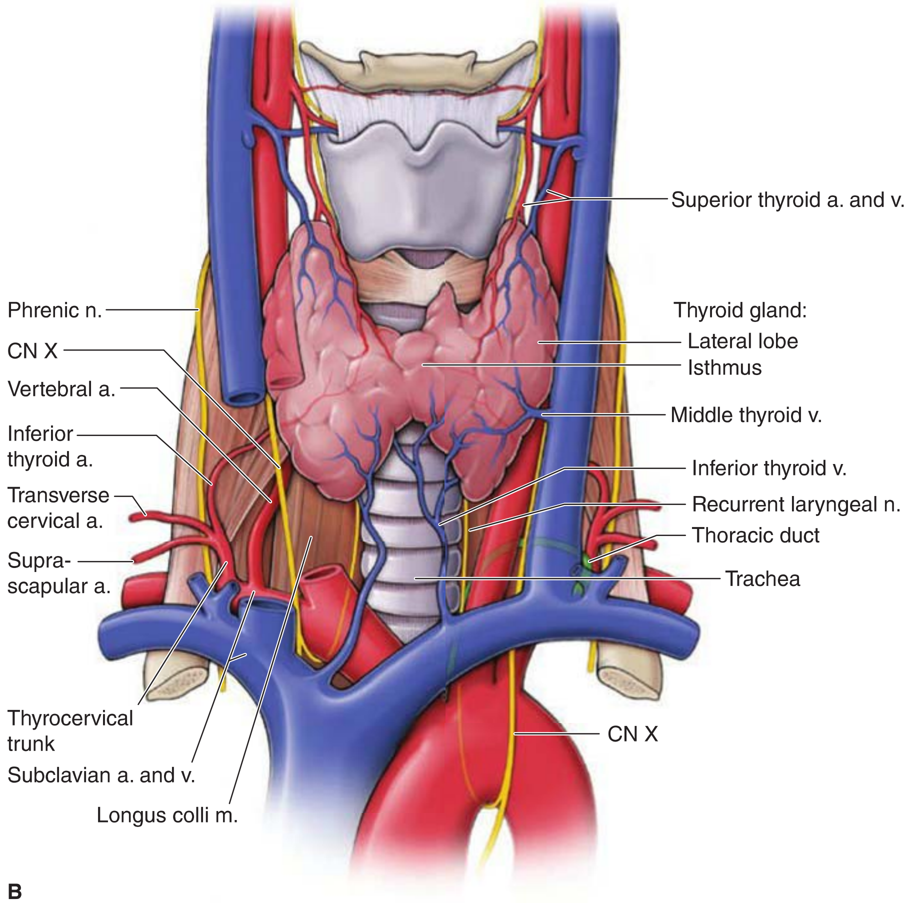


Figure 1–21. (*continued*)

lies between the rima vestibuli and the rima glottidis is called the ventricle of the larynx. The ventricle has a lateral extension, the saccule, between the vestibular fold and the thyroid cartilage. The mucous membrane of the larynx is primarily ciliated columnar epithelium. The larynx is made of cartilages and ligaments that are essential to its role in phonation.

Cartilages

A. Thyroid Cartilage

The thyroid cartilage (Adam's apple) makes up the bulk of the larynx but is deficient posteriorly. It articulates with the cricoid cartilage below, which is narrow in front but taller in the back.

B. Arytenoid Cartilages

Articulating with the posterior lamina of the cricoid cartilage and lying directly behind the thyroid cartilage are the paired arytenoid cartilages. These cartilages have laterally extending muscular processes that allow for the attachment of several muscles of vocalization, and anteriorly extending vocal processes that allow for the attachment of the vocal ligaments.

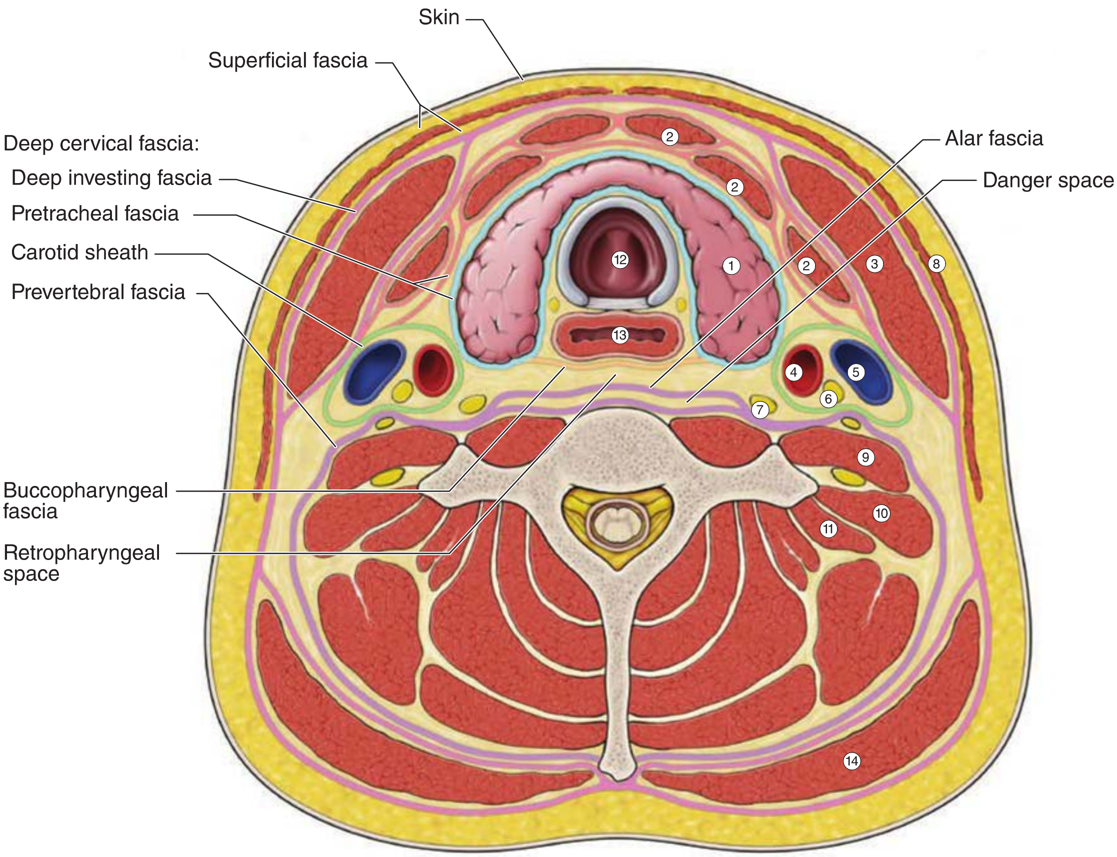
C. Corniculate and Cuneiform Cartilages

The epiglottis forms the roof of the larynx. The aryepiglottic folds contain two additional pairs of cartilages, the corniculate and cuneiform, which add support to the folds.

Ligaments

A. Thyrohyoid Ligament

The thyrohyoid ligament extends from the upper border of the thyroid cartilage to the hyoid bone above, anchoring the larynx to the hyoid bone and its associated muscles.



KEY

1. Thyroid gland
2. Infrahyoid m.
3. Sternocleidomastoid m.
4. Common carotid a.
5. Internal jugular v.
6. Vagus n.
7. Sympathetic trunk
8. Platysma m.
9. Ant. scalene m.
10. Mid. scalene m.
11. Post. scalene m.
12. Trachea
13. Esophagus
14. Trapezius m.

Figure 1–22. Fascial planes of the neck. (Cross section at C7)

B. Quadrangular Ligament

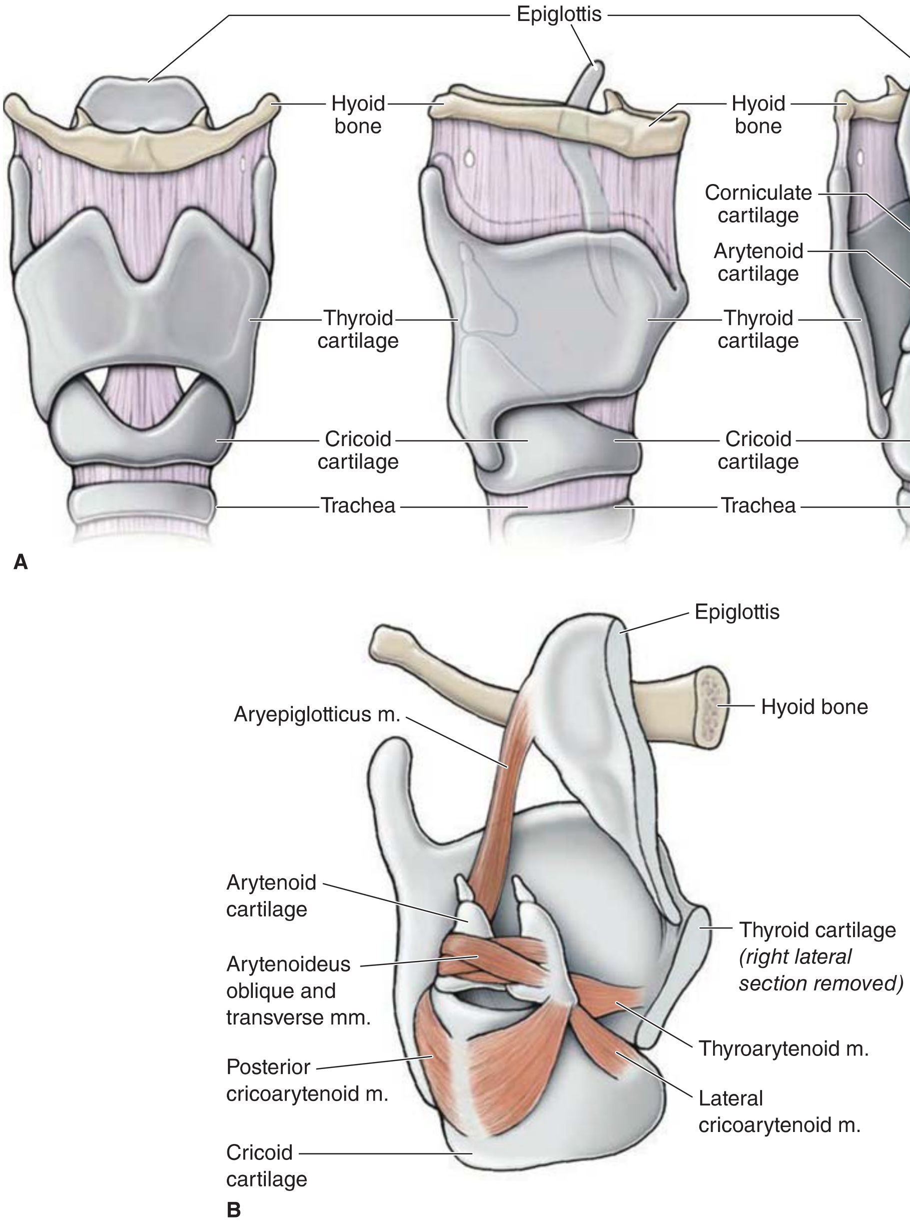
The quadrangular ligament lies within the aryepiglottic folds, and its lower edge extends into the vestibular folds of the larynx.

C. Cricothyroid Ligament

The cricothyroid ligament (triangular ligament) extends upward from the upper border of the cricoid cartilage. However, it is not attached to the lower border of the thyroid cartilage. Instead, it ascends medial to the thyroid cartilage and is compressed sagittally, with its top edges forming the vocal ligaments that are attached to the inside of the thyroid cartilage in front and the vocal processes of the arytenoid cartilage behind.

Muscles

The muscles of the larynx change the spatial relationships of the laryngeal cartilages during speech and swallowing.



▲ **Figure 1–23.** Muscles and cartilages of the larynx. **(A)** Anterior, lateral, and posterior views (*left to right*). **(B)** Muscles with a part of thyroid cartilage removed.

A. Posterior Cricoarytenoid Muscle

The posterior cricoarytenoid muscle arises from the posterior aspect of the cricoid cartilage and courses upward and laterally to attach to the muscular process of the arytenoid cartilage. Its contraction pulls the muscular process backward and rotates the arytenoid cartilage around a vertical axis so that the two vocal processes are abducted and the size of the rima glottidis is increased. In addition, the two arytenoid cartilages are approximated, an action that is similar to that of the transverse arytenoid muscle.

B. Lateral Cricoarytenoid Muscle

The lateral cricoarytenoid muscle arises from the front of the arch of the cricoid cartilage and courses upward and backward to attach to the muscular process of the arytenoid cartilage. Its contraction pulls the muscular processes forward and rotates the arytenoid cartilage around a vertical axis, in a direction opposite to the movement created by the contraction of the posterior cricoarytenoid muscle so that the vocal processes are adducted and the rima glottidis is closed. Additional contraction of the lateral cricoarytenoid muscle from this adducted position of the vocal ligaments, coupled with a relaxation of the transverse arytenoid muscle, pulls the two arytenoid cartilages away from each other, positioning the vocal folds for whispering, with approximated vocal ligaments but an open posterior rima glottidis.

C. Transverse Arytenoid Muscle

The transverse arytenoid muscle extends between the bodies of the two arytenoid cartilages, bringing them together by its contraction.

D. Thyroarytenoid Muscle

The thyroarytenoid muscle has fibers that run parallel with the vocal ligaments, attaching to the deep surface of the thyroid cartilage in front and the muscular process of the arytenoid cartilage behind. Its contraction brings the arytenoid and thyroid cartilages closer, decreases the length and tension of the vocal ligaments, and lowers the pitch of the voice. A part of the thyroarytenoid muscle that lies adjacent to the vocal ligament is called the vocalis muscle. Because its fibers attach to the vocal ligaments, this muscle can provide fine control of the tension in the vocal ligaments, allowing for rapid alterations in the pitch of the voice. When the vocalis muscle contracts by itself, without an accompanying contraction of the thyroarytenoid muscle, it can pull on the vocal ligaments, increase the tension in them, and raise the pitch of the voice.

E. Cricothyroid Muscle

The cricothyroid muscle arises from the front and side of the cricoid cartilage and courses upward and backward to attach to the inferior border of the posterior part of the thyroid cartilage. Its contraction produces a rocking movement at the joints between the thyroid and cricoid cartilages, so that the front of the cricoid is pulled upward and the cricoid cartilage is tilted backward. This moves the arytenoid cartilages farther from the thyroid cartilage and increases the tension in the vocal ligaments, raising the pitch of the voice.

F. Aryepiglottic Muscle

The aryepiglottic muscle arises from the muscular process of the arytenoid cartilage and extends into the epiglottis within the opposite aryepiglottic fold. Its contraction decreases the size of the laryngeal aditus and, combined with an elevation of the larynx by the suprahyoid muscles and longitudinal muscles of the pharynx as well as the push of the tongue on the epiglottis from above, prevents food from entering the larynx.

Innervation and Blood Supply

The vagus nerve (X) provides sensory and motor innervation to the larynx. These details are discussed with the vagus nerve in the neck. Briefly, sensation from the vestibule and ventricle of the larynx, above the vocal folds, is carried by the internal laryngeal branch of the vagus nerve, and sensation from below the vocal folds is carried by the recurrent laryngeal branch of the vagus nerve. Motor innervation of all the muscles of the larynx is by the recurrent laryngeal branch of the vagus nerve, except the cricothyroid muscle, which is innervated by the external laryngeal branch of the vagus nerve.

The superior laryngeal branch of the superior thyroid artery, a branch of the external carotid artery, supplies blood to the upper half of the larynx. The inferior laryngeal branch of the inferior thyroid artery, a branch of the thyrocervical trunk from the subclavian artery, supplies blood to the lower half of the larynx.

ORBIT

The orbit lies between the frontal bone with the anterior cranial fossa above and the maxilla and maxillary sinus below. The sphenoid bone lies behind and separates the orbit from the middle cranial fossa. The zygomatic and sphenoid bones lie lateral to the orbit, and the ethmoid and sphenoid bones lie medial to it. The orbit communicates with the infratemporal fossa through the lateral end of the inferior orbital fissure and with the pterygopalatine fossa through the medial end of this fissure. In addition, the orbit communicates with the middle cranial fossa through the superior orbital fissure and the optic canal, and with the nose through the nasolacrimal canal. The structures in the orbit receive their blood supply from the ophthalmic branch of the internal carotid artery. The corresponding veins form the ophthalmic venous plexus, which communicates in front with the facial vein, behind with the cavernous sinus through the superior orbital fissure, and below with the pterygoid venous plexus through the inferior orbital fissure. The orbit contains the eye surrounded by orbital fat, the lacrimal gland, which lies above and lateral to the eye, the muscles that help move the eye, and the nerves and vessels related to these structures.

Muscles

All of the muscles of the orbit, with the exception of the inferior oblique, arise from the sphenoid bone at or near the opening of the optic canal behind the eye (Figure 1–24). They pass forward to attach to the sclera of the eye, except for the levator palpebrae superioris muscle, which inserts on the upper eyelid. The inferior oblique arises from the anterior and medial part of the floor of the orbit.

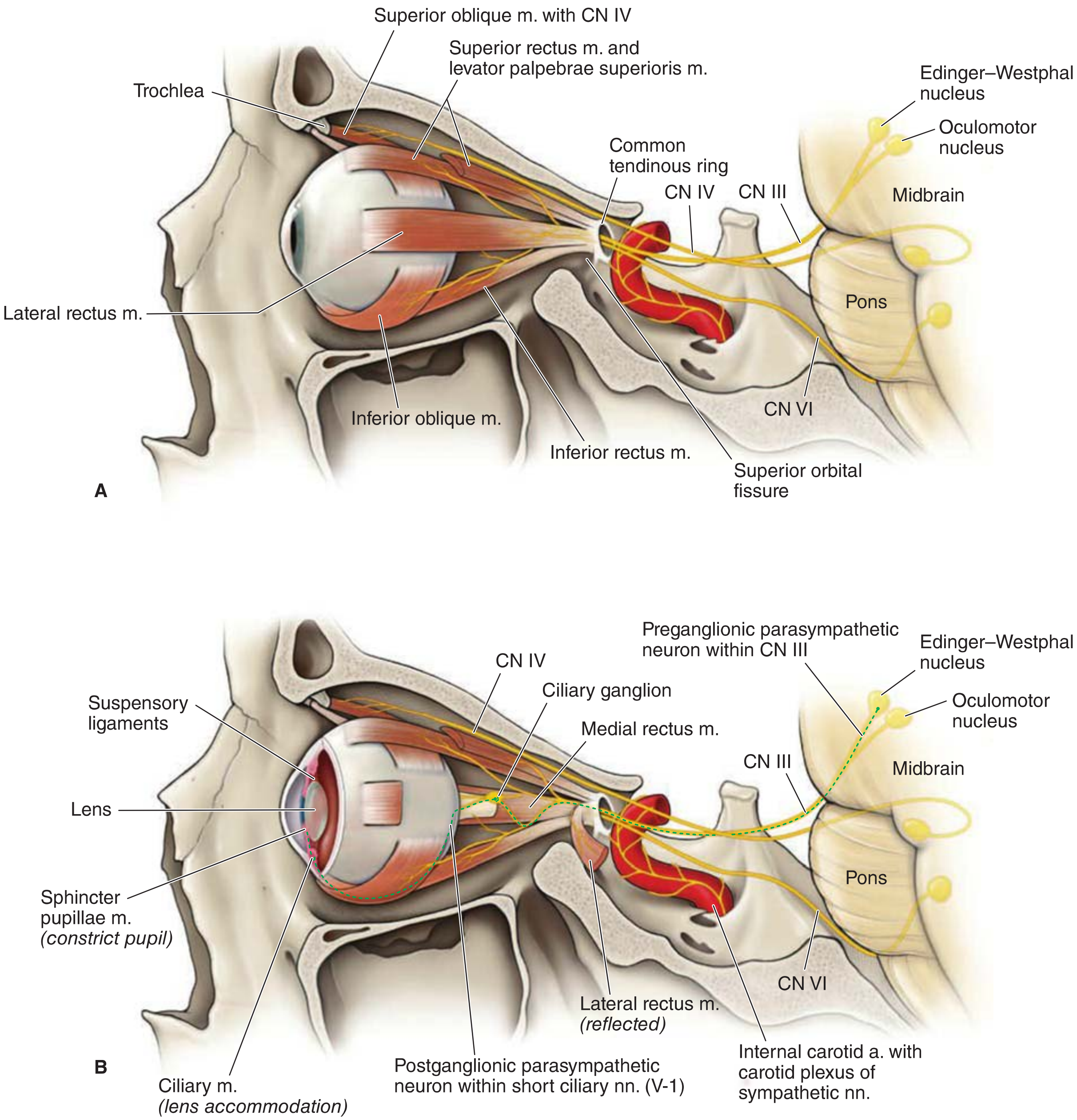


Figure 1–24. Muscles and nerves of the orbit. **(A)** Lateral wall of orbit removed. **(B)** Lateral rectus muscle removed.

A. Levator Palpebrae Superioris Muscle

The levator palpebrae superioris passes over the eye and attaches to the tarsal plate of the upper eyelid. It helps to elevate the eyelid and keep the eye open. A part of this muscle is made of smooth muscle fibers that get sympathetic innervation.

B. Superior Rectus Muscle

The superior rectus muscle passes over the eye and helps to turn the eye upward. It is assisted in this action by the inferior oblique muscle.