About the Author

Neil S. Norton, PhD, joined Creighton University, Omaha, Nebraska in 1996 and is currently Associate Professor of Oral Biology in the School of Dentistry. He also holds a secondary appointment in the Department of Pharmacology in the School of Medicine. After graduating Phi Beta Kappa from Randolph-Macon College in Ashland, Virginia with a BA in Biology he went on to receive his PhD training in Anatomy from the University of Nebraska Medical Center. Dr. Norton has been the recipient of numerous teaching awards including eight Outstanding Instructor of the Year Awards from the freshman classes and five Dr. Theodore J. Urban Pre-Clinical Awards, presented by graduating senior classes for dedication and outstanding Basic Science instruction. Dr. Norton is the third professor in the history of the School of Dentistry to receive the prestigious Robert F. Kennedy Memorial Award for Teaching Achievement, the highest teaching recognition offered by the University. Dr. Norton is an active member of the School of Dentistry faculty. He is a member of Omicron Kappa Upsilon, the Honor Dental Society. His teaching responsibilities include Head and Neck Anatomy, General Anatomy, Neuroscience, and Pain Control. Dr. Norton continues to actively publish on a variety of anatomic topics in addition to his administrative duties. Currently, Dr. Norton serves as the President of the University Faculty at Creighton University.

Preface

Netter's Head and Neck Anatomy for Dentistry is a text/atlas written to help dental students and professionals learn and review head and neck anatomy. Designed for first-year dental students, it also serves to teach anatomy to students of dental hygiene, and as a review for the practicing clinician. The head and neck comprise the foundation for the study of dental anatomy. The many small, interrelated structures are not easily observable, which makes head and neck anatomy one of the most difficult disciplines for students to master.

To understand the clinical significance of an anatomic concept is to understand the anatomy. Accordingly, a series of clinical correlates that relate to dentistry are provided at the end of every chapter. Many anatomic topics covered in head and neck courses have been expanded especially for this text. A chapter has been dedicated to the temporomandibular joint. In the chapter on the oral cavity, more information has been provided for the reader on such topics as dentition. Chapters on the development of the head and neck and basic neuroscience are included to help connect with other related anatomic areas. A chapter on intraoral injections is included to help teach and reinforce an area often overlooked. These chapters provide the reader with a brief overview of important concepts related to head and neck anatomy.

A superb team of medical illustrators created new art to complement the anatomic illustrations of Dr. Frank H. Netter, which resulted in a more complete learning tool. Essential information is presented in tables and brief text that are integrated with the Netter art to help bridge gaps and augment the reader's knowledge of head and neck anatomy.

Netter's Head and Neck Anatomy for Dentistry is for those in all stages of the dental profession. My hope is that this book will provide an essential resource to readers in helping them to learn and appreciate the complex anatomy of the head and neck.

Neil S. Norton, PhD

Acknowledgments

This book is the culmination of many hours of hard but very satisfying work. Like any project of considerable magnitude, it would not have been possible without the help of many talented and dedicated people, to whom I am deeply indebted.

I started at Creighton University School of Dentistry in 1996 and was overwhelmed by the camaraderie that existed at both the School and the University levels. I am grateful every day to be part of such a fine institution that is committed to the education of students. The support and assistance that my fellow colleagues provided have been immeasurable. I would especially like to thank the following persons for their review of chapters, suggestions, and willingness to provide materials: Drs. W. Thomas Cavel, Paul Edwards, Terry Lanphier, Cyndi Russell, Tarjit Saini, John McCabe, Timothy McVaney, and Nici Kimmes.

I am grateful to Dr. Laura Barritt, who was instrumental in the creation of the Development chapter of the book, and also provided various suggestions in many other chapters. Another special thanks goes to my chair, Dr. Margaret Jergenson. Since 1996, Dr. Jergenson and I have taught general anatomy and head and neck anatomy to freshman dental students. Her clinical background as a dentist has been invaluable in helping me appreciate head and neck anatomy from a dental perspective. I could not ask for a better colleague with whom to teach anatomy.

Thank you to the reviewers who examined the chapters and provided excellent feedback to ensure accuracy: Robert Spears, PhD, Assistant Professor, Baylor College of Dentistry–Texas A&M; Kathleen M. Klueber, PhD, Associate Professor, University of Louisville; Brian R. MacPherson, PhD, Vice-Chair and Holsinger Endowed Professor of Anatomy, The University of Kentucky; and Cindy Evans, MEd, RDH, CDA, Assistant Professor, Columbus State Community College. My sincere appreciation goes to friend and colleague Dr. Thomas Quinn who offered helpful comments and words of encouragement throughout the textual writing and development of the art.

I enlisted the help of my dental students to make *Netter's Head and Neck Anatomy for Dentistry* more student friendly. Special thanks go to Joseph Opack for providing excellent critiques on each chapter and Dr. Ryan Dobbs for his assistance in keeping many of my chapters well organized and developed. Additional thanks go to Drs. Steve Midstokke and Paul Mendes for helping in the creation of some of the new pieces of art.

This book would not be possible if not for the beautiful new artwork created by five incredible medical illustrators. Their hard work not only supplemented the illustrations of Dr. Frank Netter, John Craig, MD, Carlos Machado, MD, and James Perkins, MS, MFA seamlessly but also added to the vast Netter collection of anatomic pieces. Thus, a very special thanks to Kip Carter, William Winn, and Andrew Swift for helping put my vision into art. Their artistic interpretations are simply magnificent. Additionally, I would like to thank Dr. Machado for taking time out of his busy schedule to create additional pieces for this book.

The Elsevier Saunders team deserves a special thanks for making this project happen. Jennifer Surich and Marybeth Thiel, had the unenviable task of keeping me on schedule. They always went the extra step, and for that I will always be grateful. The hard work of

Carolyn Kruse, was second to none. And Jonathan Dimes, managed four medical illustrators and also used his excellent talents as a medical illustrator by helping update numerous plates for this text. The art would not have been possible if not for his hard work.

Additional thanks goes to Elyse O'Grady who helped put the finishing touches on this project. Special thanks to Project Manager Frank Morales who carefully placed all of the text and images on the pages that you are reading. I would also like to offer my sincere thanks to Megan Poles, Louis Forgione, Linda Van Pelt, Elizabeth Galbraith, and all of the other people at Elsevier Saunders that have helped in the production of this book.

A very special thanks goes to Paul Kelly. I have had the great honor and privilege of knowing Paul for the past 10 years. I remember many conversations with Paul over the years in which he encouraged me to put together an anatomic project for dentistry. I presented him with the rough outline and prospectus for a text/atlas that evolved into this book.

Last, I thank all of the students whom I have instructed over my career. You have always served as a great inspiration to me. It has been an honor and a privilege to be a part of your education. *Netter's Head and Neck Anatomy for Dentistry* is for you.

Neil S. Norton

Frank H. Netter, MD

Frank H. Netter was born in 1906 in New York City. He studied art at the Art Student's League and the National Academy of Design before entering medical school at New York University, where he received his MD degree in 1931. During his student years, Dr. Netter's notebook sketches attracted the attention of the medical faculty and other physicians, allowing him to augment his income by illustrating articles and textbooks. He continued illustrating as a sideline after establishing a surgical practice in 1933, but he ultimately opted to give up his practice in favor of a full-time commitment to art. After service in the United States Army during World War II, Dr. Netter began his long collaboration with the CIBA Pharmaceutical Company (now Novartis Pharmaceuticals). This 45-year partnership resulted in the production of the extraordinary collection of medical art so familiar to physicians and other medical professionals worldwide.

Icon Learning Systems acquired the Netter Collection in July 2000 and continued to update Dr. Netter's original paintings and to add newly commissioned paintings by artists trained in the style of Dr. Netter. In 2005, Elsevier, Inc. purchased the Netter Collection and all publications from Icon Learning Systems. There are now over 50 publications featuring the art of Dr. Netter available through Elsevier.

Dr. Netter's works are among the finest examples of the use of illustration in the teaching of medical concepts. The 13-book *Netter Collection of Medical Illustrations*, which includes the greater part of the more than 20,000 paintings created by Dr. Netter, remains one of the most famous medical works ever published. *The Netter Atlas of Human Anatomy*, first published in 1989, presents the anatomic paintings from the Netter Collection. Now translated into 16 languages, it is the anatomy atlas of choice among medical and health professions students the world over.

The Netter illustrations are appreciated not only for their aesthetic qualities but, more important, for their intellectual content. As Dr. Netter wrote in 1949, ". . . clarification of a subject is the aim and goal of illustration. No matter how beautifully painted, how delicately and subtly rendered a subject may be, it is of little value as a *medical illustration* if it does not serve to make clear some medical point." Dr. Netter's planning, conception, point of view, and approach are what inform his paintings and what make them so intellectually valuable.

Frank H. Netter, MD, physician and artist, died in 1991.

CHAPTER 1

DEVELOPMENT OF THE HEAD AND NECK

1 Overview

GENERAL INFORMATION

3 major germ layers form the initial developing embryo:
- Ectoderm
- Mesoderm
- Endoderm

Mesoderm differentiates into:
- Paraxial mesoderm
- Intermediate mesoderm
- Lateral plate mesoderm

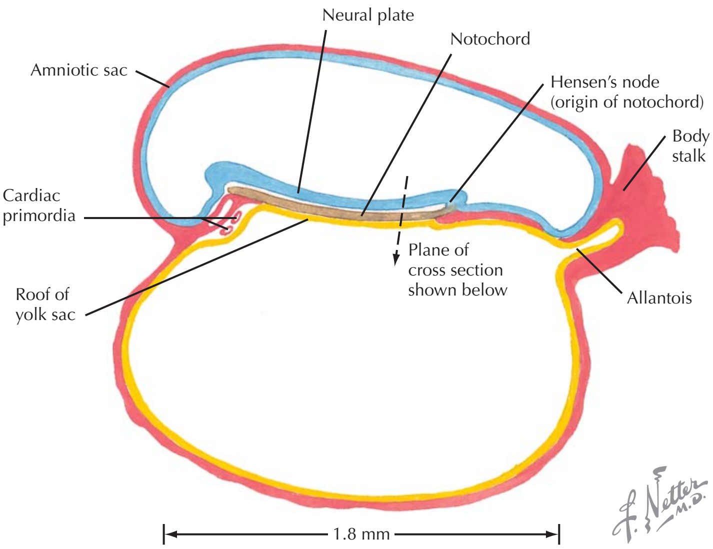
Ectoderm gives rise to 2 layers:
- Neuroectoderm
- Neural crest

The head and neck are formed by:
- Paraxial mesoderm
- Lateral plate mesoderm
- Neural crest
- Ectodermal placodes

Most of the head and neck is formed from the pharyngeal arches

Human Embryo at 16 Days

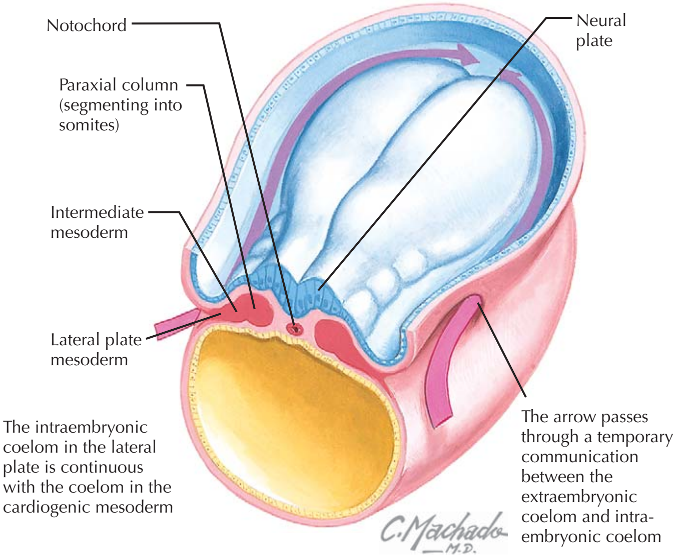
A. Midsagittal section



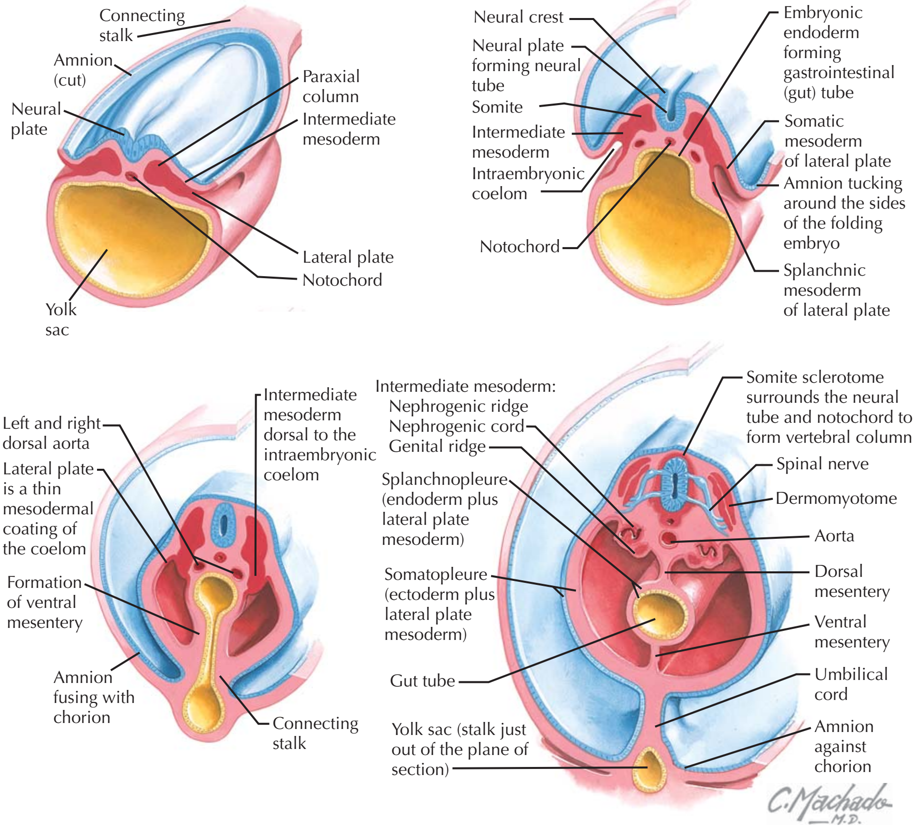
Overview

GENERAL INFORMATION *CONTINUED*

Cross section of embryo



Vertebrate Body Plan after 4 Weeks



1

Pharyngeal Arches

GENERAL INFORMATION

Start forming in the 4th week of development

Develop as blocks separated by pharyngeal clefts

Initially, 6 arches develop, but the 5th regresses

Arising from the endoderm are compartments called pharyngeal pouches that extend toward the pharyngeal clefts

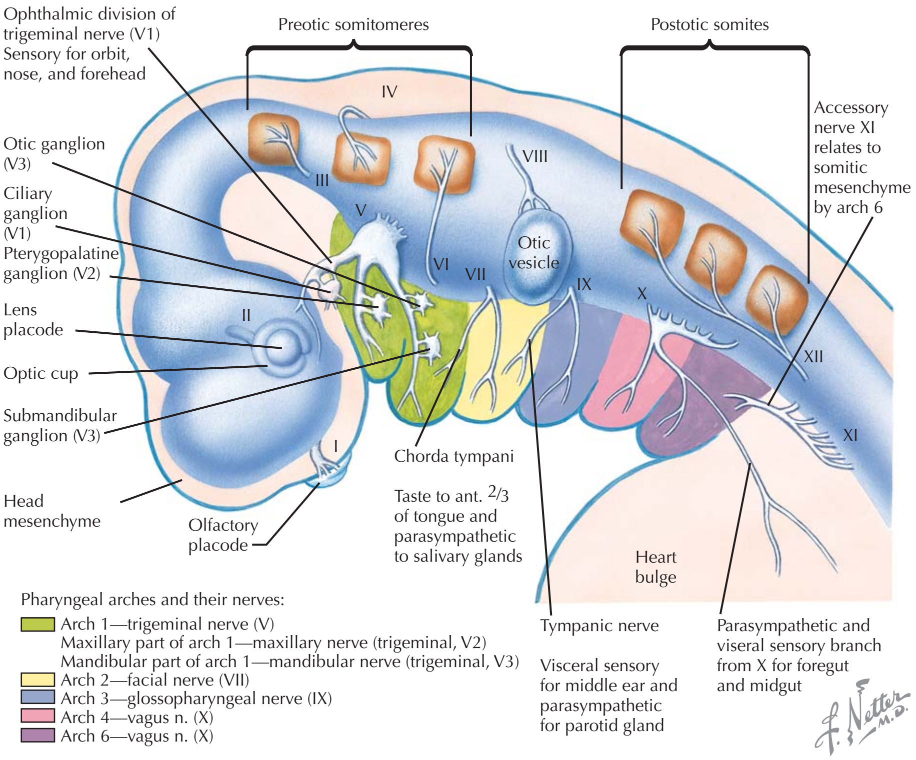
Help form 4 of the 5 swellings of the face:
- 2 mandibular processes (pharyngeal arch)
- 2 maxillary processes (pharyngeal arch)
- 1 frontonasal prominence

Composed of:
- External surface—ectoderm
- Internal surface—endoderm
- Central part—lateral plate mesoderm, paraxial mesoderm, neural crest

Skeletal components develop from the neural crest tissue

Muscular structures develop collectively from the mesoderm

Each arch is innervated by a cranial nerve that migrates with the muscles

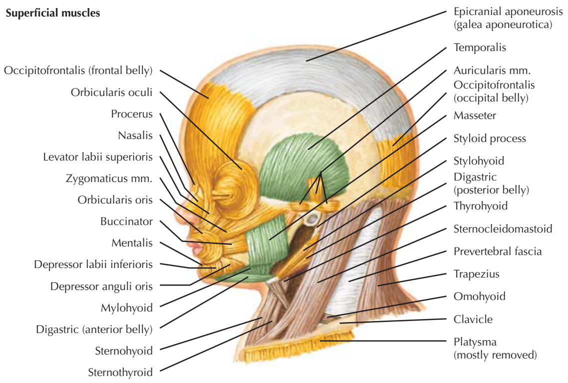


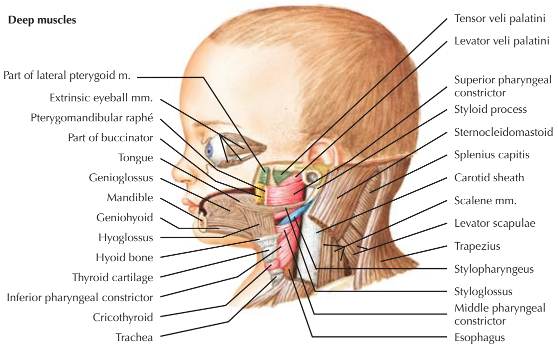
Pharyngeal Arches

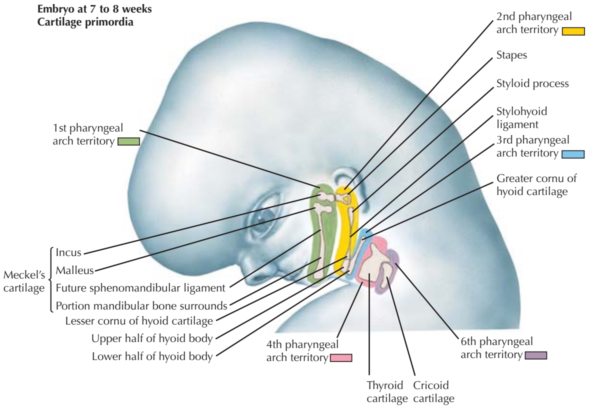
DERIVATIVES OF THE PHARYNGEAL ARCHES

Arch	Muscles from Mesoderm	Skeletal Structures from Neural Crest	Cartilage Structures	Connective Tissue Structures	Nerve
1 Develops into: • Maxillary process • Mandibular process	Masseter Temporalis Lateral pterygoid Medial pterygoid Mylohyoid Anterior digastric Tensor tympani Tensor veli palatini	Maxilla Temporal (squamous portion) Zygoma Mandible Malleus Incus	Meckel's cartilage (degenerates in adulthood)	Sphenomandibular ligament Anterior ligament of the malleus	Trigeminal
2	Muscles of facial expression Posterior digastric Stylohyoid Stapedius	Lesser cornu of the hyoid Superior part of the hyoid body Styloid process Stapes	Reichert's cartilage	Stylohyoid ligament Connective tissue of the tonsil	Facial
3	Stylopharyngeus	Greater cornu of the hyoid Inferior part of the hyoid body		Connective tissue of the thymus and inferior parathyroid	Glossopharyngeal
4	Musculus uvulae Levator veli palatini Palatopharyngeus Palatoglossus Superior constrictor Middle constrictor Inferior constrictor Salpingopharyngeus Cricothyroid		Thyroid (from lateral plate mesoderm) Epiglottis	Connective tissue of the superior parathyroid and the thyroid	Vagus
5	Thyroarytenoid Vocalis Lateral cricoarytenoid Oblique arytenoids Transverse arytenoids Posterior cricoarytenoid Aryepiglottis Thyroepiglottis		Arytenoid Cricoid Cuneiform Corniculate (from lateral plate mesoderm)		Vagus

DERIVATIVES OF THE PHARYNGEAL ARCHES *CONTINUED*







PHARYNGEAL ARCH BONES AND CARTILAGE

Arch #	Derivatives of Arch Cartilages
1	Malleus, incus, sphenomandibular ligament
2	Stapes, styloid process, stylohyoid ligament, upper half of hyoid
3	Lower half and greater horns of hyoid
4	Thyroid and epiglottic cartilages of larynx
6	Cricoid, arytenoid, and corniculate cartilages of larynx

F. Netter M.D.

Pharyngeal Pouches, Membranes, and Clefts

GENERAL INFORMATION

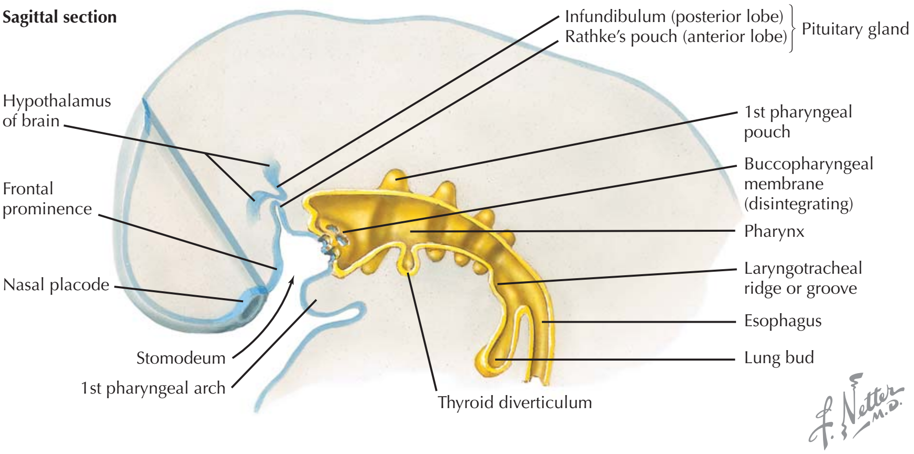
Pharyngeal pouches—4 develop from endoderm

Pharyngeal clefts—each is a groove formed from ectoderm

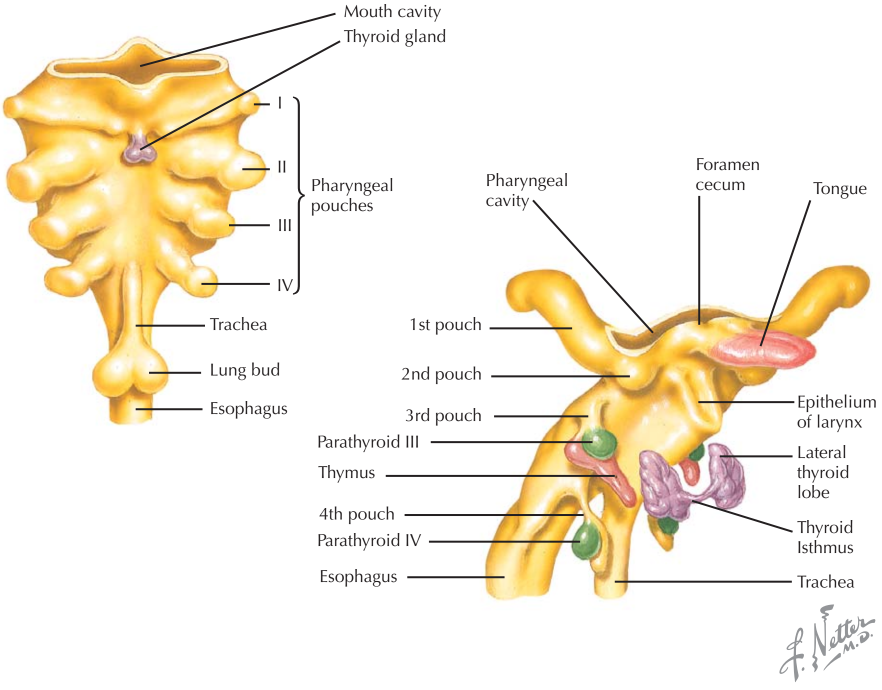
Pharyngeal membranes—each is composed of tissue located between a pharyngeal pouch and a pharyngeal cleft; composed of external ectoderm, mesoderm and neural crest in the core, and an internal endoderm lining

PHARYNGEAL POUCHES

Pouch	Location	Embryonic Structure	Adult Structure
1	Opposite the 1st pharyngeal cleft, separated by the 1st pharyngeal membrane	Tubotympanic recess	Epithelium of the auditory tube and tympanic cavity
2	Opposite the 2nd pharyngeal cleft, separated by the 2nd pharyngeal membrane	Primitive palatine tonsils	Tonsilar fossa Epithelium of the palatine tonsil
3	Opposite the 3rd pharyngeal cleft, separated by the 3rd pharyngeal membrane	Divides into a dorsal and a ventral part Dorsal part migrates inferiorly toward the thorax	Inferior parathyroid gland (from the dorsal part) Thymus (from the ventral part)
4	Opposite the 4th pharyngeal cleft, separated by the 4th pharyngeal membrane	Divides into a dorsal and a ventral part Ventral part is invaded by neural crest to form the parafollicular cells	Superior parathyroid gland (from the dorsal part) Ultimobranchial body (from the ventral part)



PHARYNGEAL POUCHES *CONTINUED*



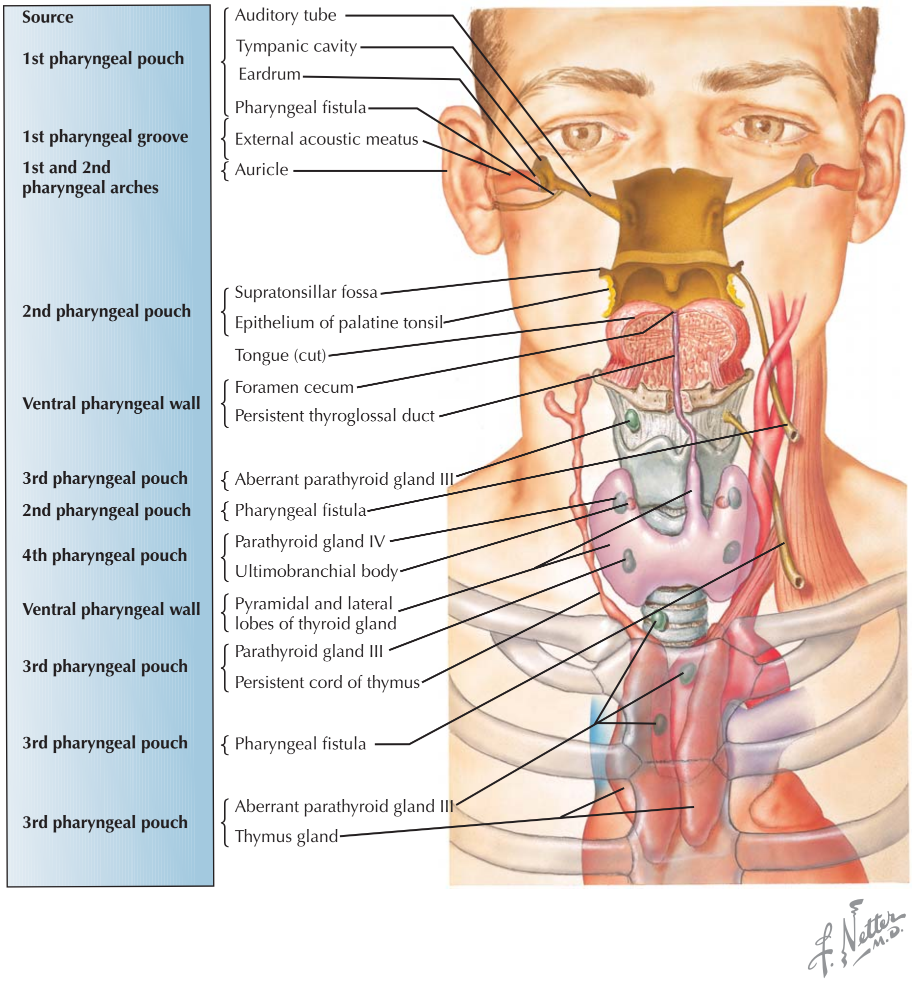
Pharyngeal Pouches, Membranes, and Clefts

PHARYNGEAL MEMBRANES

Membrane	Location	Adult Structure
1	Between the 1st pharyngeal cleft and the 1st pharyngeal pouch	Tympanic membrane
2	Between the 2nd pharyngeal cleft and the 2nd pharyngeal pouch	
3	Between the 3rd pharyngeal cleft and the 3rd pharyngeal pouch	
4	Between the 4th pharyngeal cleft and the 4th pharyngeal pouch	

PHARYNGEAL CLEFTS

Cleft	Location	Adult Structure
1	A groove between the 1st and 2nd pharyngeal arches	External acoustic meatus
2	A groove between the 2nd and 3rd pharyngeal arches	Obliterated cervical sinus by the 2nd pharyngeal arch, which grows over the cleft
3	A groove between the 3rd and 4th pharyngeal arches	
4	A groove between the 4th and 6th pharyngeal arches	



1 Skull

GENERAL INFORMATION

Skull is formed from:

- Lateral plate mesoderm (neck region)
- Paraxial mesoderm
- Neural crest

Bony skull is formed by either of 2 mechanisms:

- Intramembranous ossification
- Endochondral ossification

Skull development is divided into 2 parts:

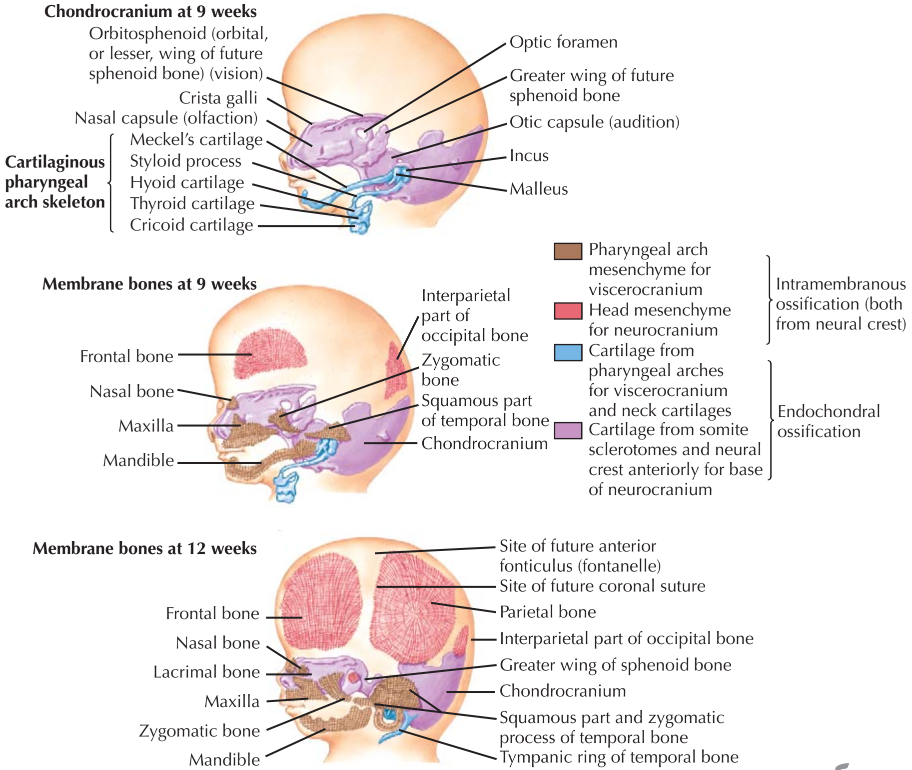
- Viscerocranium—forms the bones of the face
- Neurocranium—forms the bones of the cranial base and cranial vault and can be divided into membranous neurocranium and cartilaginous neurocranium

VISCEROCRANIUM

Germ Layers	Origins	Adult Structure	Ossification
Neural crest	1st pharyngeal arch		
	• *Maxillary process*	Maxilla	Intramembranous
		Temporal bone	
		Zygoma	
		Palatine	
		Lacrimal	
		Vomer	
		Nasal	
		Inferior nasal concha	
	• *Mandibular process*	Mandible	Intramembranous and endochondral
		Sphenomandibular ligament	Not ossified
		Malleus	Endochondral
		Incus	
	2nd pharyngeal arch	Styloid process	Endochondral
		Stapes	
		Hyoid	
		Stylohyoid ligament	Not ossified

Skull

VISCEROCRANIUM *CONTINUED*



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1 Skull

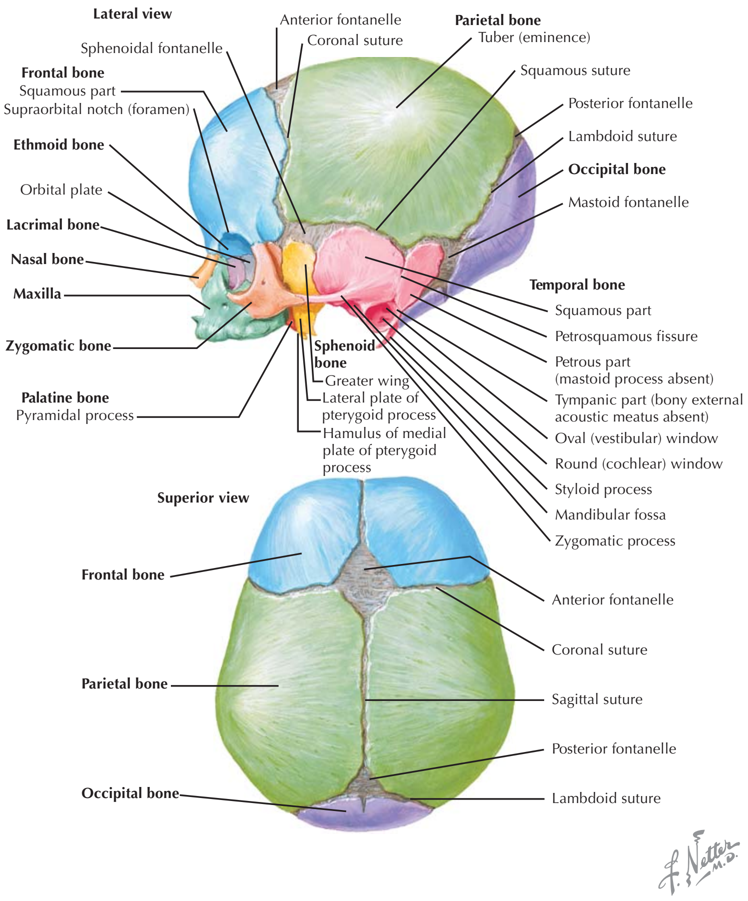
MEMBRANOUS NEUROCRANIUM

Germ Layer	Portions of Neurocranium	Adult Structure	Ossification
Neural crest	Main portion of the roof and lateral sides of the cranial vault	Frontal bone Squamous portion of the temporal bone	Intramembranous
Paraxial mesoderm		Parietal bone Occipital bone (intraparietal portion)	

CARTILAGINOUS NEUROCRANIUM

Germ Layer	Portions of Neurocranium	Adult Structure	Ossification
Neural crest	Prechordal Anterior to the sella turcica	Ethmoid Sphenoid	Endochondral
Paraxial mesoderm	Chordal Posterior to the sella turcica	Petrous portion of the temporal bone Mastoid process of the temporal bone Occipital bone	

Skull of Newborn



Face

GENERAL INFORMATION

The face is formed mainly from neural crest, which makes 3 swellings that surround the stomodeum:

- Frontonasal prominence
- Maxillary prominence (from the 1st pharyngeal arch)
- Mandibular prominence (from the 1st pharyngeal arch)

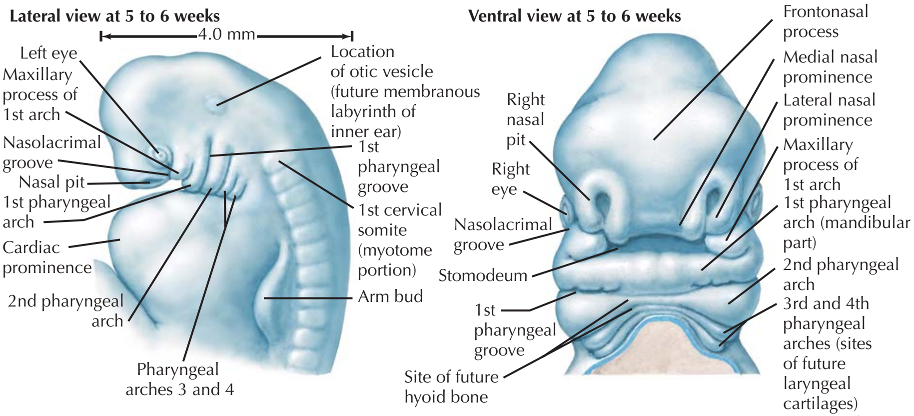
Lateral to the frontonasal prominence, 2 additional areas of ectoderm form the 2 nasal placodes that invaginate in the center to form nasal pits, creating ridges of tissue on either side of the pits:

- Lateral nasal prominence
- Medial nasal prominence

Fusion of the medial nasal prominences at the midline results in formation of the intermaxillary segment

ADULT STRUCTURES OF THE FACE

Structure(s)	Develop(s) from
Upper lip	Maxillary prominence Medial nasal prominence
Lower lip	Mandibular prominence
Lacrimal sac Nasolacrimal duct	A nasolacrimal groove that separates the lateral nasal prominence and the maxillary prominence
Nose	Frontonasal prominence Medial nasal prominence Lateral nasal prominence
Cheeks	Maxillary prominence
Philtrum Primary palate Upper jaw containing the central and lateral incisors	Intermaxillary segment



Lateral view at 5 to 6 weeks

Ventral view at 5 to 6 weeks

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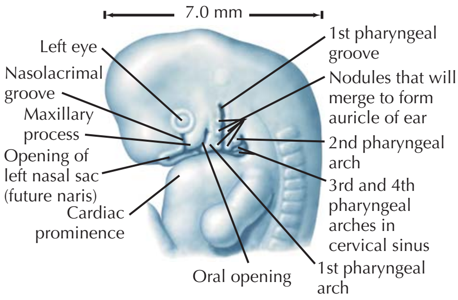
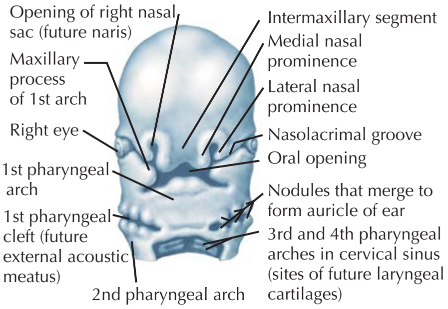
GENERAL INFORMATION *CONTINUED*

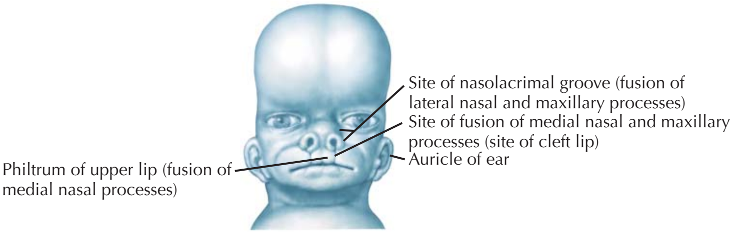
Lateral view at 6 to 7 weeks



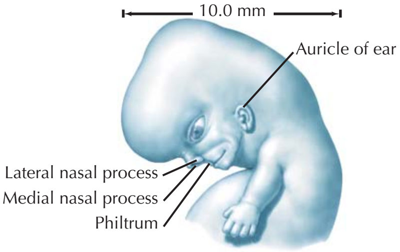
Ventral view at 6 to 7 weeks



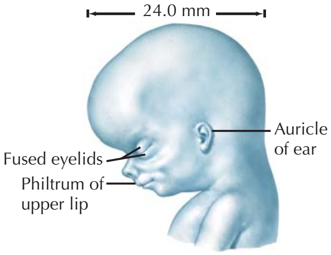
Ventral view at 7 to 8 weeks



Lateral view at 7 to 8 weeks



Lateral view at 8 to 10 weeks



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Palate

GENERAL INFORMATION

Formed by the:

- Primary palate (intermaxillary segment)
- Secondary palate (protrusions from the maxillary prominences)

Intermaxillary segment: the initial portion of the palate in development; contains the central and lateral incisors

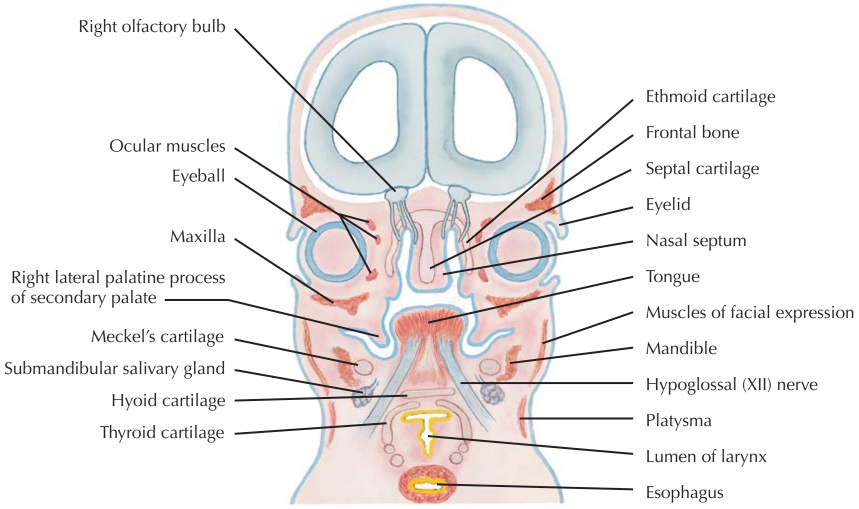
Swellings of the maxillary prominence form shelves that project medially and are separated by the tongue

When the tongue no longer occupies the space between the palatal shelves, these processes fuse together to form the secondary palate

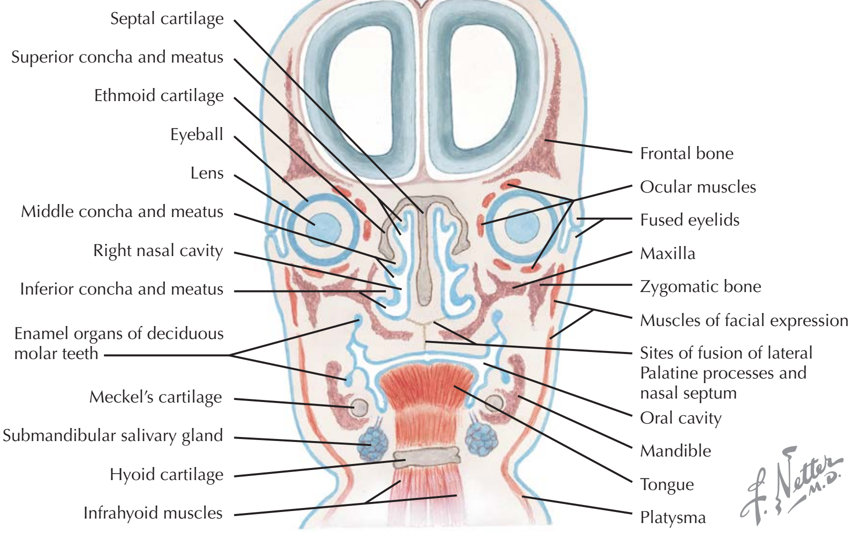
The primary and secondary palatal tissues all meet at the *incisive foramen*

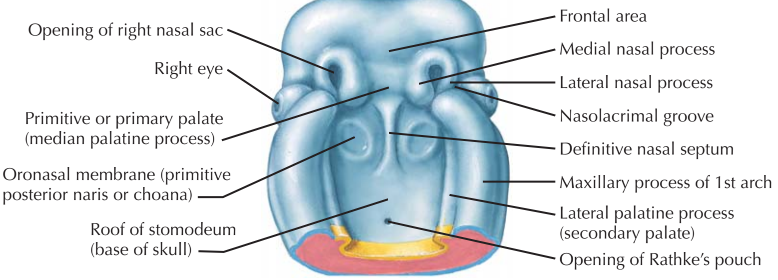
Primary and secondary palates and the nasal septum fuse to form the definitive palate

Frontal (coronal) section at 7 to 8 weeks

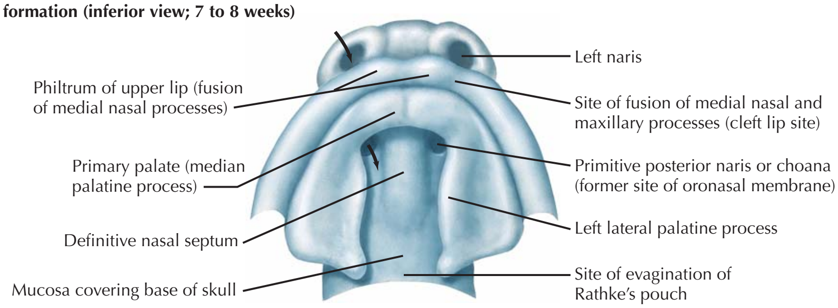


Frontal (coronal) section at 8 to 10 weeks

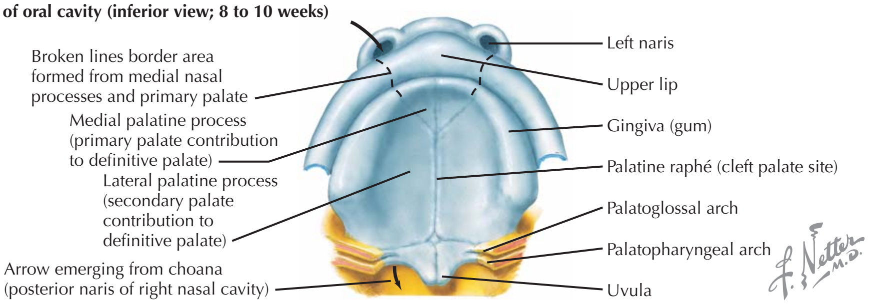




Roof of stomodeum (inferior view; 6 to 7 weeks)



Palate formation (inferior view; 7 to 8 weeks)



Roof of oral cavity (inferior view; 8 to 10 weeks)

Tongue

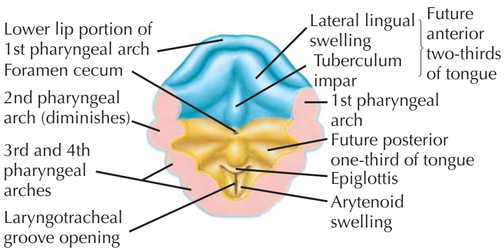
GENERAL INFORMATION

Pharyngeal Arch	Embryonic Structure(s)	Adult Structure	Innervation
1	2 lateral lingual swellings Tuberculum impar	Anterior 2/3 of the tongue	GSA: Lingual branch of the mandibular division of the trigeminal n. SVA: Chorda tympani of the facial n.
2	Is overgrown by the 3rd arch; does not contribute to the adult tongue Very little contributes to the hypobranchial eminence	Does not contribute to the adult tongue	
3	Hypobranchial eminence	Posterior 1/3 of the tongue	GSA: Glossopharyngeal n. SVA: Glossopharyngeal n.
4	Hypobranchial eminence Epiglottic swelling Arytenoid swelling Laryngotracheal groove	Root of the tongue	GSA: Internal laryngeal branch of the vagus n. SVA: Internal laryngeal branch of the vagus n.

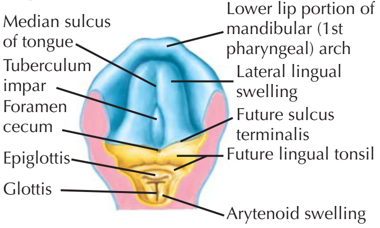
MUSCLES

Mesoderm from the occipital somites migrates anteriorly with the hypoglossal nerve to give rise to the extrinsic and intrinsic muscles of the tongue

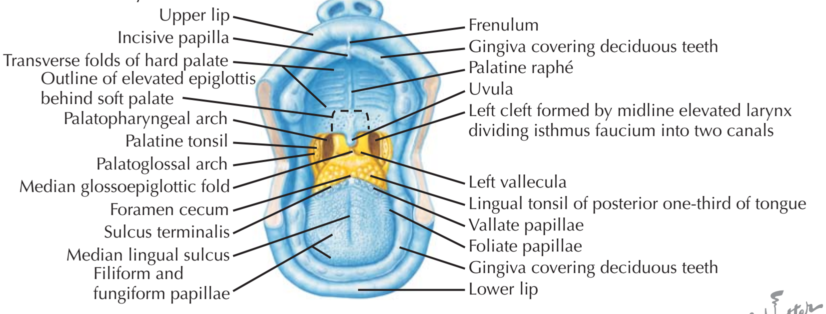
Floor of oral cavity and pharynx (superior view; 5 to 6 weeks)



Floor of oral cavity and pharynx (superior view; 6 to 7 weeks)



Oral cavity and fauces (36 weeks)



1 Thyroid Gland

GENERAL INFORMATION

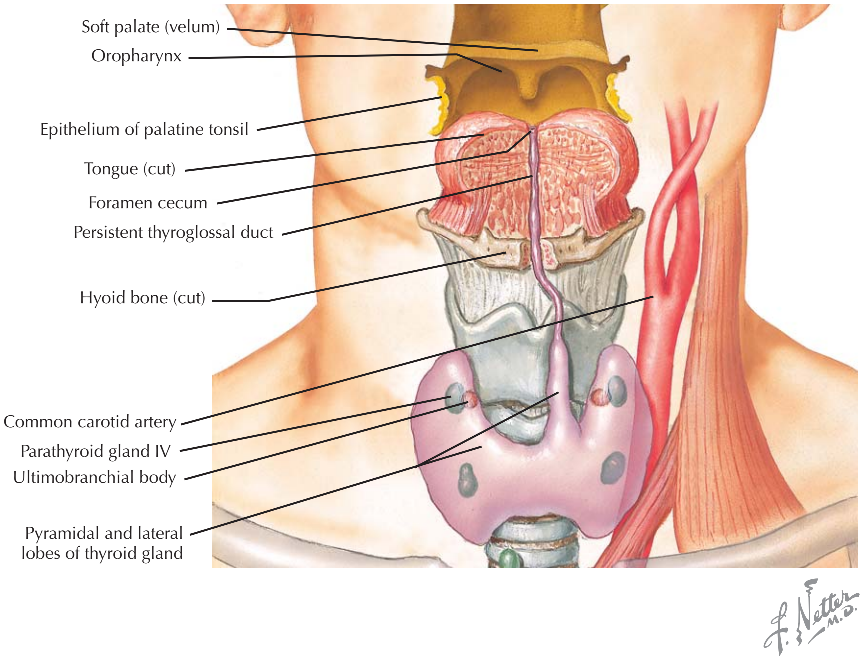
Begins as an invagination at the foramen cecum

Descends inferiorly to its final position alongside the larynx

May be connected to the foramen cecum by the thyroglossal duct

Divided into 2 lateral lobes connected by an isthmus, from which a pyramidal lobe sometimes develops

Follicular cells are derived from the endoderm; parafollicular cells are derived from the ultimobranchial body



Clinical Correlate

PHARYNGEAL POUCH ABNORMALITIES

ECTOPIC THYROID

Thyroid tissue in an aberrant location

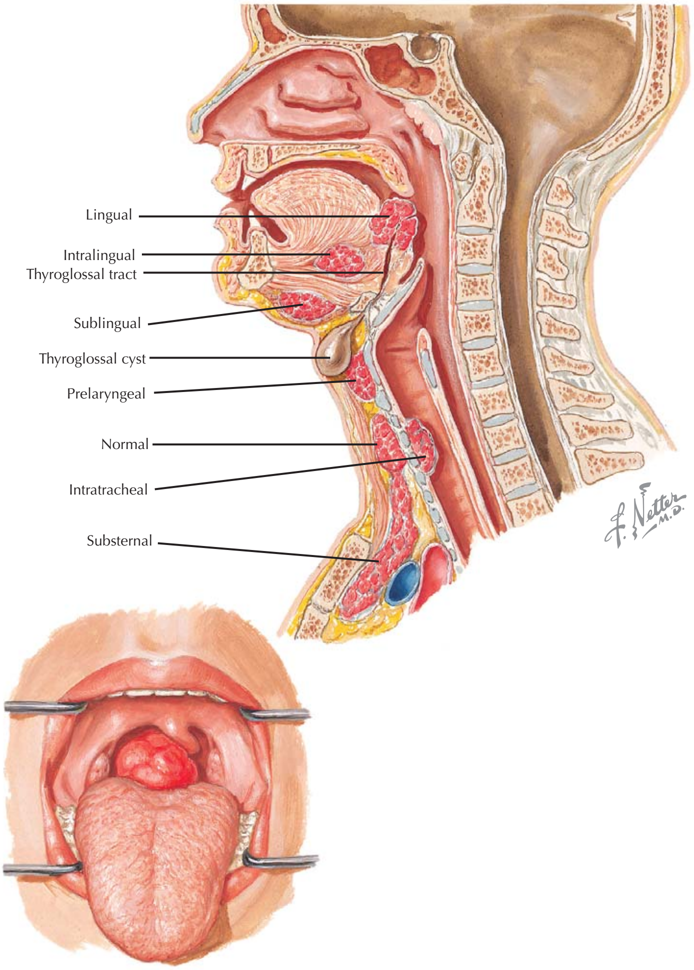
Often the only thyroid tissue in the affected person

Susceptible to thyroid diseases like normal thyroid tissue

May occur anywhere along the migratory pathway of the thyroid gland beginning at the foramen cecum

Usually located at the base of the tongue (lingual thyroid)

Common locations include:
- Lingual thyroid
- Sublingual thyroid
- Thyroglossal duct remnant
- Anterior mediastinum
- Prelaryngeal
- Intralingual
- Intratracheal



1 Clinical Correlate

PHARYNGEAL ARCH ABNORMALITIES

PIERRE ROBIN

First reported as a condition characterized by micrognathia, cleft palate, and glossoptosis

Now includes any condition with a series of anomalies caused by events initiated by a single malformation

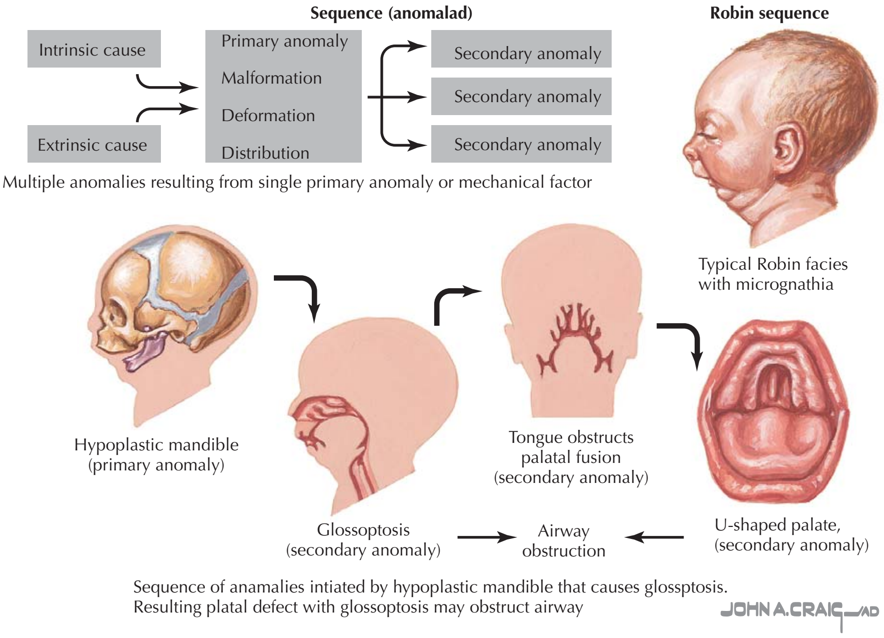
In this micrognathia, the inferior dental arch is posterior to the superior arch

The cleft palate may affect the hard and the soft palate

Glossoptosis (posterior displacement of the tongue) may cause airway obstruction or apnea

The mandible usually grows fairly quickly during childhood

Multiple surgeries typically needed to correct the cleft palate and to aid speech development in children



Multiple anomalies resulting from single primary anomaly or mechanical factor

Sequence of anamalies intiated by hypoplastic mandible that causes glossptosis. Resulting platal defect with glossoptosis may obstruct airway

Clinical Correlate

PHARYNGEAL ARCH ABNORMALITIES *CONTINUED*

TREACHER COLLINS

A hereditary condition affecting the head and neck

Thought to be caused by a defect in the gene or chromosome 5

Children of an affected parent have a 50% risk of having the syndrome

Clinical manifestations include:
- Downslanting eyes
- Notching of the lower eyelids
- Hypoplastic mandible
- Hypoplastic zygomatic bones (zygomas)
- Underdeveloped or malformed ears or “sideburns,” or both, are prominent

Common associated problems include:
- Hearing loss
- Eating/breathing difficulties
- Cleft palate

Treacher Collins Syndrome

Clinical Correlate

PHARYNGEAL ARCH ABNORMALITIES *CONTINUED*

DIGEORGE SYNDROME

A rare condition caused by a deletion on chromosome 22, characterized by a wide array of clinical manifestations

Possible explanation: proper development is dependent on migration of neural crest cells to the area of the pharyngeal pouches

Although researchers described the syndrome as abnormal development of the 3rd and 4th pharyngeal pouches, defects involving the 1st to the 6th pouches have been observed

Possible associated problems include:

- Congenital heart defects (such as tetralogy of Fallot, right infundibular stenosis, truncus arteriosus, aberrant left subclavian artery, and ventricular septal defect)
- Facial defects (such as cleft palate, microstomia, down-slanting eyes, low-set ears, or hypertelorism)
- Increased vulnerability to infections (due to impaired immune system from the loss of T cells associated with absence or hypoplasia of the thymus)

DiGeorge Syndrome

Clinical Correlate

CLEFT LIP AND PALATE

Cleft lip: a gap in the upper lip

Cleft palate: a gap in the palate

Classification of the developmental defect is with reference to the incisive foramen:
- Primary cleft
- Secondary cleft
- Complete cleft

Both cleft lip and cleft palate often cause difficulty with feeding and eventually speech

Surgery is the most common form of treatment for both

PRIMARY

Occurs anterior to the incisive foramen and results from a failure of the mesenchyme in the lateral palatine process to fuse with the intermaxillary segment (primary palate)

Common types of primary cleft:
- Unilateral cleft lip
- Unilateral cleft alveolus
- Unilateral cleft lip and primary palate
- Bilateral cleft lip and primary palate

SECONDARY

Occurs posterior to the incisive foramen; results from failure of the lateral palatine process to fuse together

Common types of secondary cleft:
- Cleft in soft palate
- Unilateral cleft in hard and soft palate
- Bilateral cleft of hard and soft palate

COMPLETE

Extends through the lip, the primary palate, and the lateral palatine process; results from a failure of the lateral palatine process to fuse together with each other, as well as with the nasal septum and primary palate

Common types of complete cleft:
- Unilateral cleft lip and cleft palate
- Bilateral cleft lip and cleft palate

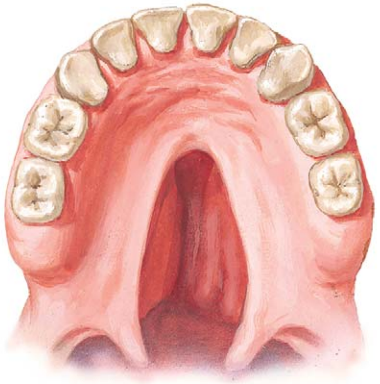
1 Clinical Correlate

CLEFT LIP AND PALATE *CONTINUED*

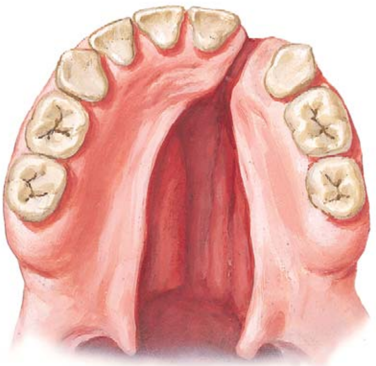
Unilateral cleft lip—partial

Unilateral cleft of primary palate—
complete, involving lip and alveolar ridge

Bilateral cleft lip



Partial cleft of palate



Complete cleft of secondary palate
and unilateral cleft of primary palate

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CHAPTER 2

OSTEOLOGY

2 Overview

GENERAL INFORMATION

Most complicated bony structure in the human body

The complete bony framework of the head; includes the mandible

28 individual bones make up the skull:
- 11 are paired
- 6 are single

Wormian bones, or sutural bones, are irregularly shaped small bones found along sutures that occur naturally

FUNCTIONS

Most important function: to protect the brain

Also protects the 5 organs of special sense:
- Olfaction
- Vision
- Taste
- Vestibular function
- Auditory function

DIVISIONS

Two major ways to divide the bones of the skull:
- Regional
- Developmental

Regionally, the skull is divided into the mandible (lower jaw) and cranium (skull without the mandible)

Cranium is further divided into:
- Cranial vault—upper portion of the skull
- Cranial base—inferior portion of the skull
- Cranial cavity—interior of the skull
- Facial skeleton—bones that make up the face
- Acoustic skeleton—ear ossicles

Developmentally, the skull is divided into:
- Viscerocranium—the portion of the skull related to the digestive and respiratory systems
- Neurocranium—the portion of the skull that protects the brain and the 5 organs of special sense

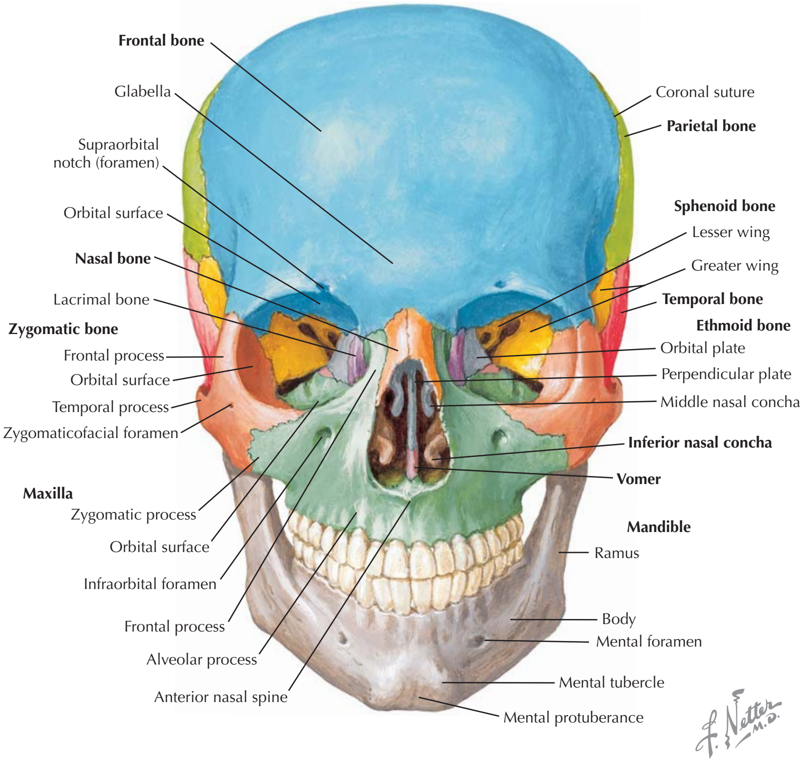
Cranial cavity divisions:
- Anterior cranial fossa—contains the frontal lobe of the brain
- Middle cranial fossa—contains the temporal lobe of the brain
- Posterior cranial fossa—contains the cerebellum

Skull is depicted by observing it from 5 views:
- Norma frontalis—the anterior view
- Norma lateralis—the lateral view
- Norma occipitalis—the posterior view
- Norma basalis—the inferior view
- Norma verticalis—the superior view

Overview

ARTICULATIONS

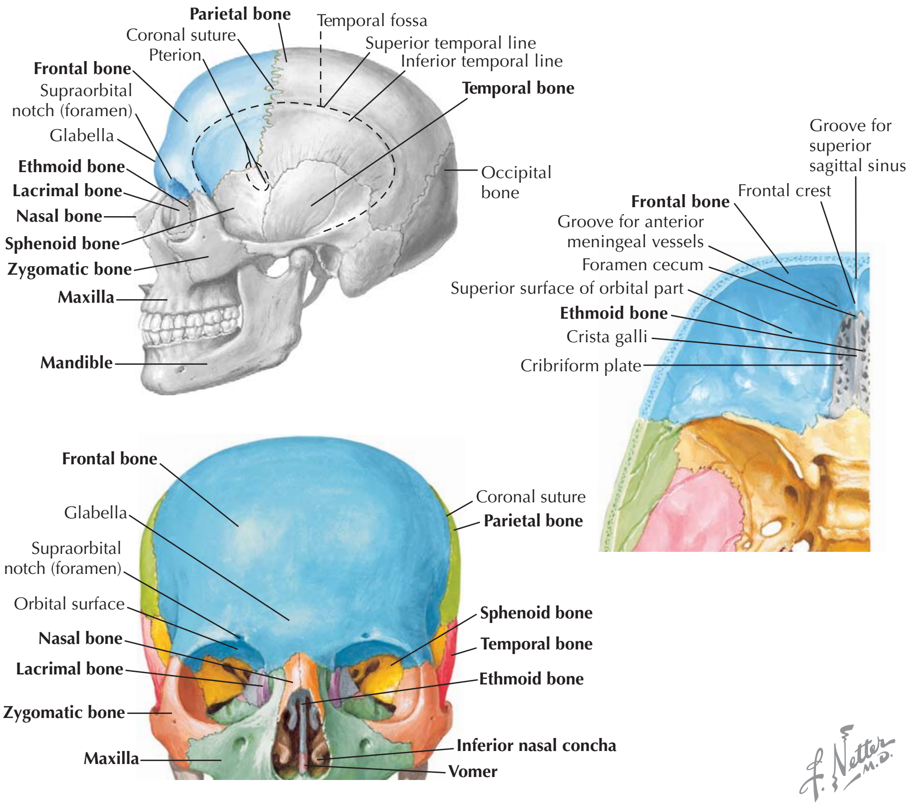
Bone	Single	Paired	Articulates with
Frontal	X		Parietal, sphenoid, zygomatic, maxilla, ethmoid, nasal, lacrimal
Parietal		X	Frontal, parietal, temporal, occipital, sphenoid
Temporal		X	Parietal, occipital, sphenoid, zygomatic, mandible
Occipital	X		Parietal, temporal, sphenoid, and atlas (C1)
Sphenoid	X		Frontal, parietal, temporal, occipital, zygomatic, maxilla, ethmoid, palatine, vomer
Zygomatic		X	Frontal, temporal, maxilla
Maxilla		X	Frontal, sphenoid, zygomatic, maxilla, ethmoid, palatine, vomer, nasal, lacrimal, inferior nasal concha
Ethmoid	X		Frontal, sphenoid, maxilla, palatine, vomer, nasal, lacrimal, inferior nasal concha
Palatine		X	Sphenoid, maxilla, ethmoid, palatine, vomer, inferior nasal concha
Vomer	X		Sphenoid, maxilla, ethmoid, palatine
Nasal		X	Frontal, maxilla, nasal
Lacrimal		X	Frontal, maxilla, ethmoid, inferior nasal concha
Inferior nasal concha		X	Maxilla, ethmoid, palatine, lacrimal
Mandible	X		Temporal



2 Bones of the Skull

FRONTAL BONE

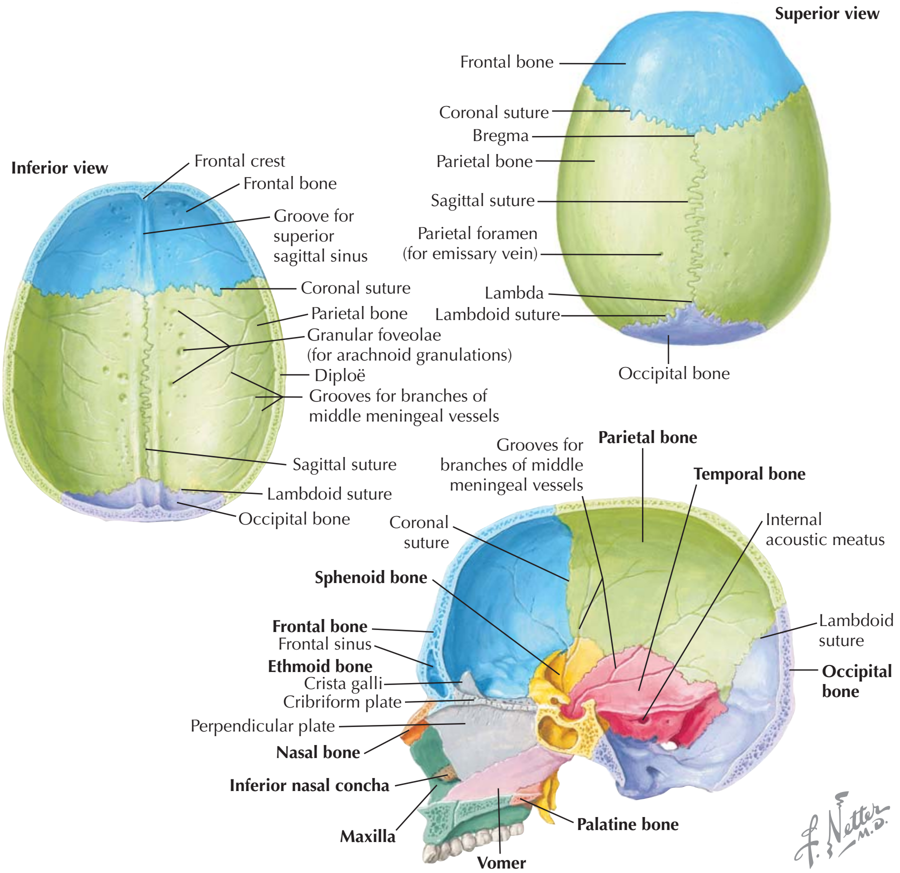
Characteristics	Parts	Ossification	Comments
Contains the frontal paranasal sinuses Has two primary centers that ossify along the frontal suture (metopic) in the 2nd year Helps form the foramen cecum, which allows passage of an emissary vein that connects to the superior sagittal sinus There is 1 frontal bone	Squamous portion	*For all 3 parts:* Intramembranous	The largest part of the frontal bone Forms the majority of the forehead Forms the supraorbital margin and the superciliary arch The zygomatic process of the frontal bone extends from the posterior part of the supraorbital margin *Arachnoid foveae*—depressions caused by arachnoid granulations that push on the dura mater, causing bone resorption on the endocranial surface
	Orbital portion		Forms the roof of the orbit and floor of the anterior cranial fossa
	Nasal portion		The trochlea of the orbit articulates with the orbital portion Articulates with the nasal bones and the frontal process of the maxilla to form the root of the nose



Bones of the Skull

PARIETAL BONE

Characteristics	Parts	Ossification	Comments
Forms the majority of the cranial vault Provides for the attachment of the temporalis muscle The four corners of the parietal are not ossified at birth and give rise to the fontanelles There are 2 parietal bones	Has 4 angles: ● Frontal—located at bregma ● Sphenoid—located at pterion ● Occipital—located at lambda ● Mastoid—located at asterion	Intramembranous	Relatively square, forming the roof and sides of the cranial vault Endocranial surface is filled with grooves made by branches of the middle meningeal a. Sigmoid sulcus is a groove caused by the beginning of the transverse sinus, located at the mastoid angle



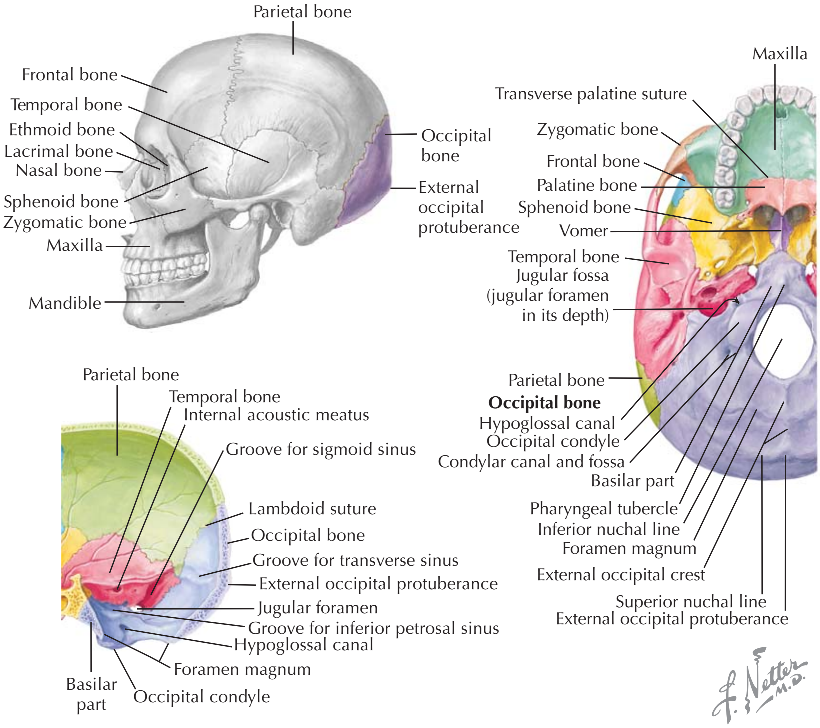
2 Bones of the Skull

OCCIPITAL BONE

Characteristics	Parts	Ossification	Comments
Forms the posterior part of the cranial vault Articulates with the atlas The squamous and lateral portions normally ossify together by year 4 The basilar portion unites to this section at year 6 There is 1 occipital bone	Squamous portion	Intramembranous	Articulates with the temporal and parietal bones The largest portion of the occipital bone Located posterior and superior to the foramen magnum Has the external occipital protuberance (more pronounced in males) Has the superior and the inferior nuchal lines Has grooves on the internal surface for 3 of the sinuses forming the confluence of the sinuses (the superior sagittal and the right and left transverse sinuses) The depression superior to the transverse sinus is for the occipital lobes of the brain The depression inferior to the transverse sinus is for the cerebellum
	Lateral portion	Endochondral	Articulates with the temporal bone Is the portion lateral to the foramen magnum Has the occipital condyles that articulate with the atlas Contains the hypoglossal canal Forms a portion of the jugular foramen
	Basilar portion	Endochondral	Articulates with the petrous part of the temporal and the sphenoid bones Is the portion immediately anterior to the foramen magnum Pharyngeal tubercle is part of the basilar portion that provides attachment for the superior constrictor Internal surface of the basilar portion is called the clivus, and part of the brainstem lies against it

Bones of the Skull

OCCIPITAL BONE *CONTINUED*

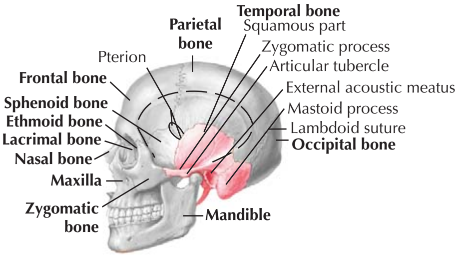


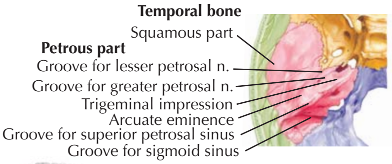
TEMPORAL BONE

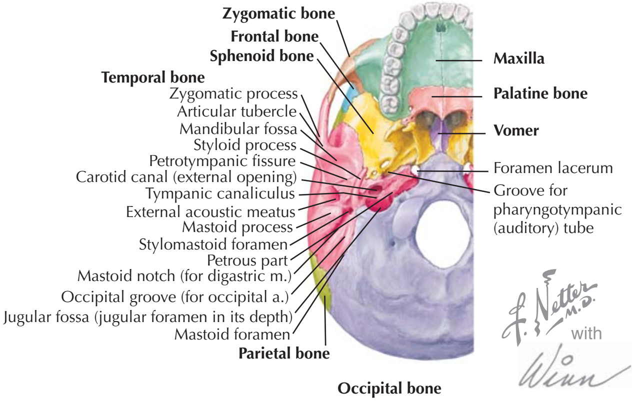
Characteristics	Parts	Ossification	Comments
The paired temporal bones: Help form the base and the lateral walls of the skull House the auditory and vestibular apparatuses Contain mastoid air cells Each bone has 8 centers of ossification that give rise to the 3 major centers observed before birth There are 2 temporal bones	Squamous part	Intramembranous	The largest portion of the bone Three portions to the squamous part: • Temporal • Zygomatic process • Glenoid fossa *Temporal portion* is the thin large area on the squamous part of the temporal On the internal surface of the temporal portion lies a groove for the middle meningeal a. The *zygomatic process* extends laterally and anteriorly from the squamous portion; it articulates with the temporal process of the zygomatic bone to make the zygomatic arch *Glenoid fossa* is inferior and medial to the zygomatic process; it articulates with the mandibular condyle, forming the temporomandibular joint
	Petrous part	Endochondral	Forms the solid portion of bone The auditory and vestibular apparatuses are located within the petrous part Helps separate the temporal and the occipital lobes of the brain It extends anteriorly and medially The medial part articulates with the sphenoid bone to form the foramen lacerum Internal acoustic meatus is observed on the medial side of the petrous part Carotid canal lies on the inferior part of the petrous part Petrotympanic fissure lies between the petrous part of the temporal bone and the tympanic part of the temporal bone On the medial portion of the petrous part lie grooves for the superior and inferior petrosal sinuses On the posterior inferior surface of the petrous part lies the jugular fossa Between the jugular fossa and the carotid canal is the tympanic canaliculus The mastoid process extends posteriorly and has large mastoid air cells
	Tympanic part	Intramembranous	A plate of bone forming the anterior, posterior, and inferior portions of the external acoustic meatus Anterior part forms the posterior portion of the glenoid fossa
	Styloid process	Endochondral	A projection from the temporal bone The stylomastoid foramen lies posterior to this process

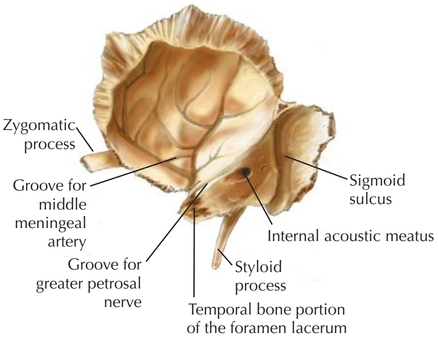
Bones of the Skull

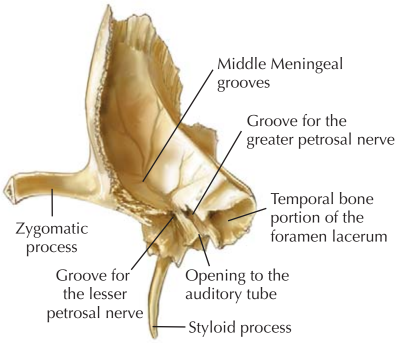
TEMPORAL BONE *CONTINUED*









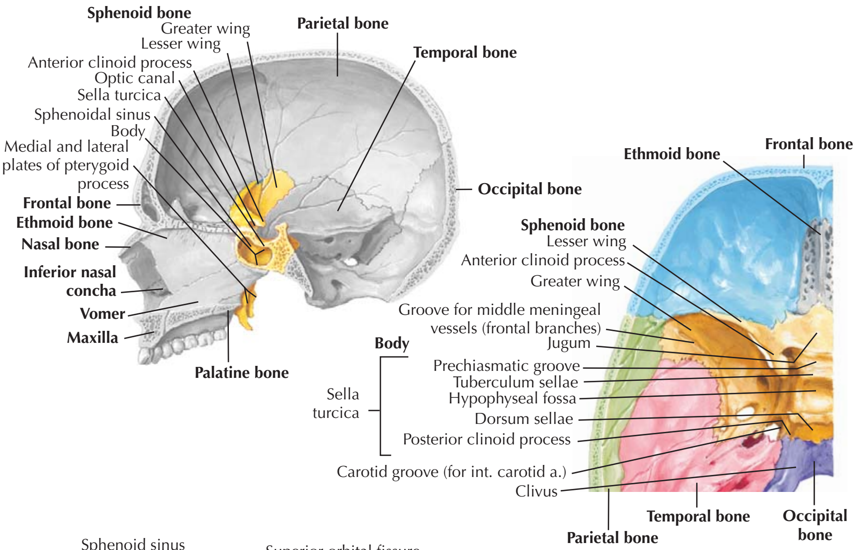


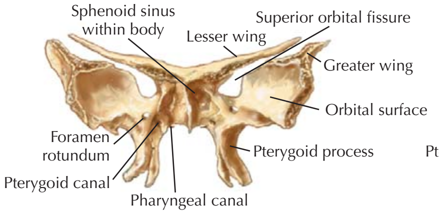
SPHENOID BONE

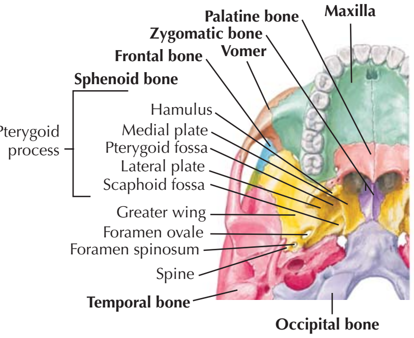
Characteristics	Parts	Ossification	Comments
Forms the majority of the middle portion of the cranial base Forms the majority of the middle cranial fossa Contains the sphenoid paranasal sinus There is 1 sphenoid bone	Body	Endochondral ossification	The center of the sphenoid Anterior portion of the body helps form part of the nasal cavity Superior part of the body, known as the sella turcica, is saddle-shapedand possesses the anterior and posterior clinoid processes Hypophyseal fossa, the deepest part of the sella turcica, houses the pituitary gland Dorsum sellae is a square-shaped part of the bone that lies posterior to the sella turcica Clivus is the portion that slopes posterior to the body Body contains the sphenoid paranasal sinuses Lateral portion of the body is covered by the cavernous sinus Optic canal is found in the body of the sphenoid
	Greater wing	Endochondral and intramembranous ossification	Extends laterally and anteriorly from the posterior portion of the body of the sphenoid Endocranial portion helps form a large part of the middle cranial fossa Lateral portion is the infratemporal surface Anterior portion lies in the orbit Contains 3 foramina: • Foramen spinosum • Foramen rotundum • Foramen ovale
	Lesser wing	Endochondral ossification	Extends laterally and anteriorly from the superior portion of the sphenoid body Separated from the greater wing by the superior orbital fissure
	Pterygoid process	Intramembranous ossification	Arises from the inferior surface of the body There are 2 pterygoid processes Each has a: • Lateral pterygoid plate • Medial pterygoid plate Pterygoid hamulus extends from the medial pterygoid plate Two canals are associated with the pterygoid process: • Pterygoid canal • Pharyngeal canal

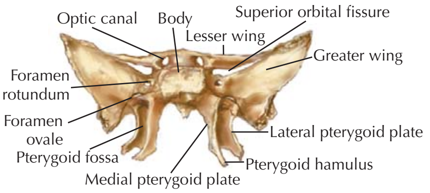
Bones of the Skull

SPHENOID BONE *CONTINUED*









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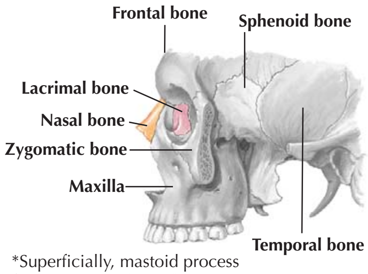
with

LACRIMAL BONE

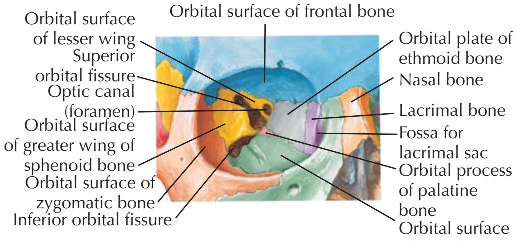
Characteristics	Parts	Ossification	Comments
Lacrimal bone is small and rectangular in shape and very thin and fragile There are 2 lacrimal		Intramembranous	Forms a small portion of the medial wall of the orbit Articulates with the frontal process of the maxilla, orbital plate of the ethmoid bone, the frontal bone, and the inferior nasal concha The region that articulates with the frontal process of the maxilla forms the lacrimal fossa, the location of the lacrimal sac The inferior part of the lacrimal forms a small portion of the lateral wall of the nasal cavity

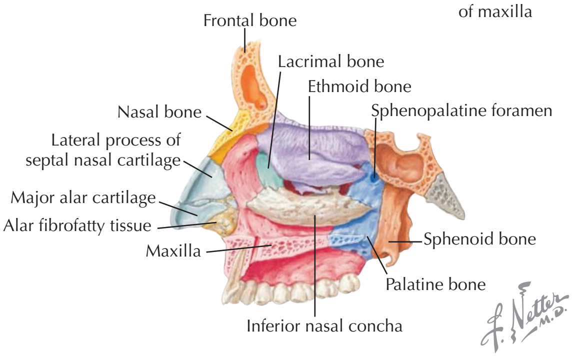
NASAL BONE

Characteristics	Parts	Ossification	Comments
Inferior portion forms the superior margin of the nasal aperture Forms the bridge of the nose There are 2 nasal bones		Intramembranous	Articulates with the nasal bone of the opposite side, the nasal portion of the frontal bone, the frontal process of the maxilla, and the perpendicular plate of the ethmoid Inferior portion of the nasal bones attaches with the lateral nasal cartilages and septal cartilage



*Superficially, mastoid process forms posterior boundary

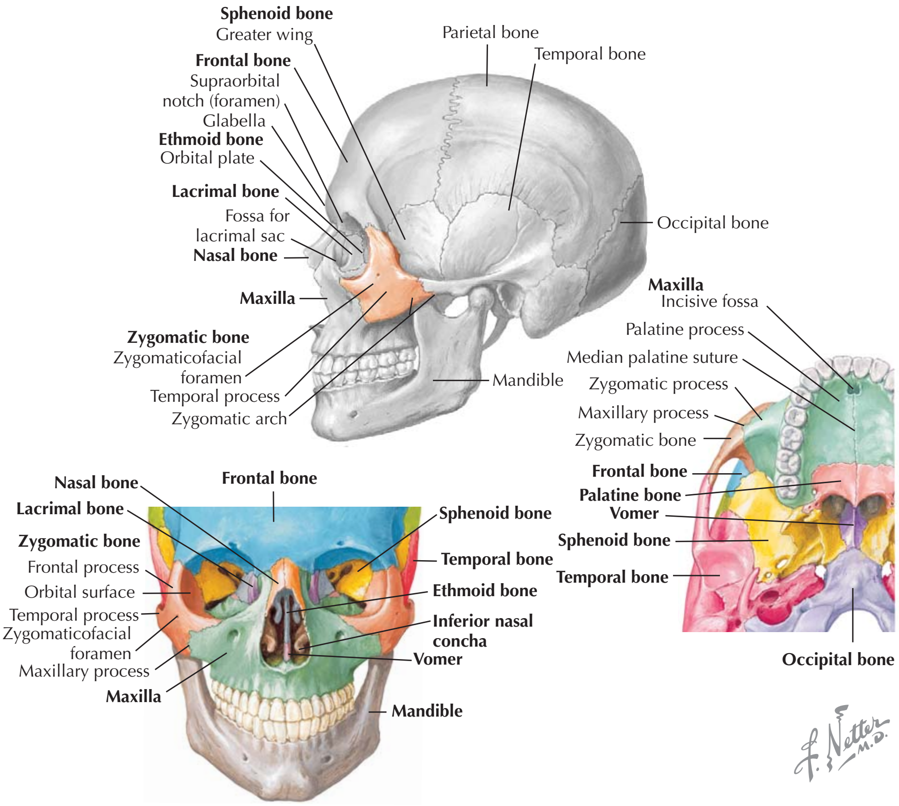




Bones of the Skull

ZYGOMATIC BONE (ZYGOMA)

Characteristics	Part	Ossification	Comments
Forms the majority of the skeleton of the cheek Provides for attachment of the masseter Three foramina in the zygoma: • Zygomatico-orbital foramen • Zygomaticofacial foramen • Zygomaticotemporal foramen There are 2 zygomatic bones	Frontal process Temporal process Maxillary process	Intramembranous	Articulates with the frontal bone to help form the orbit Articulates with the zygomatic process of the temporal bone to form the zygomatic arch Articulates with the zygomatic process of the maxillary bone to help form the orbit



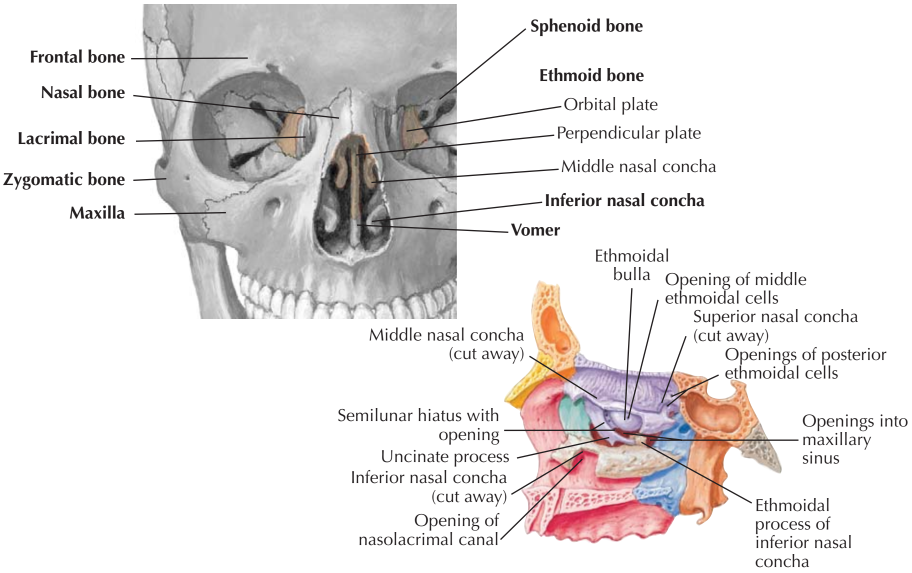
Bones of the Skull

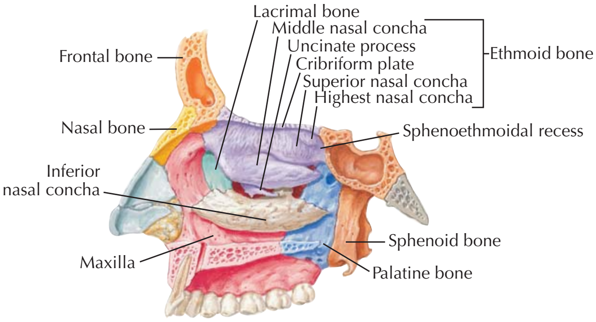
ETHMOID BONE

Characteristics	Part	Ossification	Comments
A porous bone that forms the major portion of the middle part of the face between the orbits Helps form the orbit, nasal cavity, nasal septum, and anterior cranial fossa There is 1 ethmoid bone	Perpendicular plate	Endochondral	A flat plate that descends from the cribriform plate to form part of the nasal septum Articulates with the vomer inferiorly
	Cribriform plate		A horizontal bone that forms the superior surface of the ethmoid Contains numerous foramina for the olfactory n. Crista galli is a vertical plate that extends superiorly from the cribriform plate providing attachment for the falx cerebri of the meninges Associated with a small foramen cecum
	Ethmoid labyrinth		The largest part of the ethmoid bone Descends inferiorly from the cribriform plate Ethmoid paranasal sinuses are located within the ethmoid labyrinth Ethmoid labyrinth forms 2 major structures within the nasal cavity: ● Superior nasal concha ● Middle nasal concha Ethmoid bulla is the large elevation of bone located by the middle ethmoid paranasal sinuses Uncinate process is a curved piece of bone Between the uncinate process and the ethmoid bulla is the hiatus semilunaris

Bones of the Skull

ETHMOID BONE *CONTINUED*





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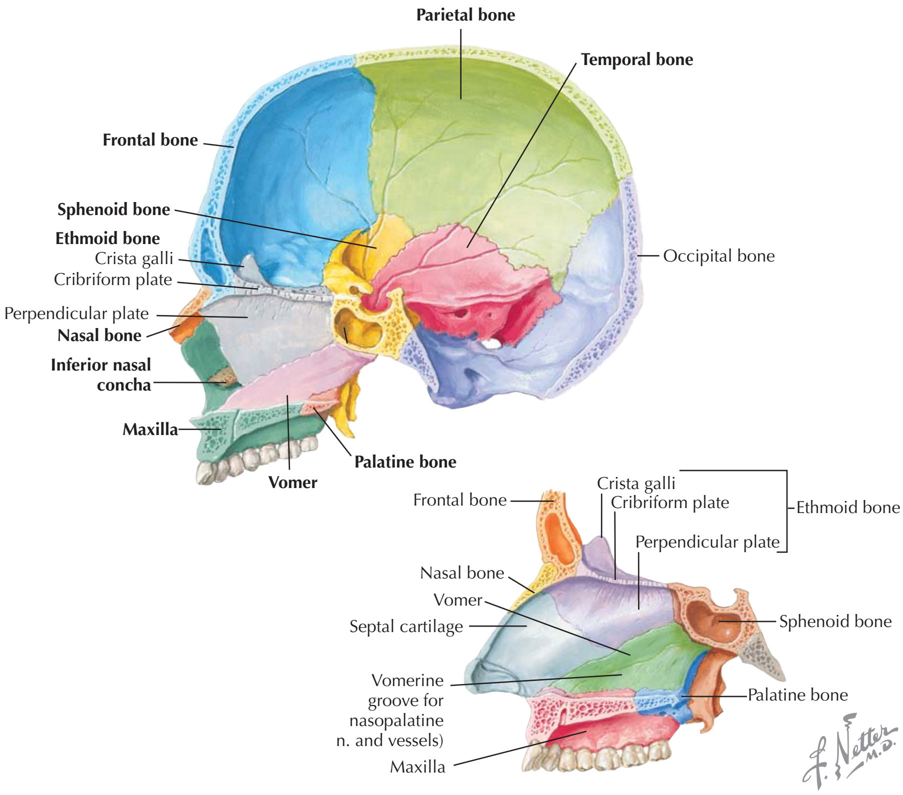
Bones of the Skull

VOMER

Characteristics	Part	Ossification	Comments
Shaped like a "plough" Forms the posterior inferior part of the nasal septum There is 1 vomer bone		Intramembranous	Articulates with the perpendicular plate of the ethmoid, maxilla, palatine, and sphenoid bones and septal cartilage Posterior border does not articulate with any other bone



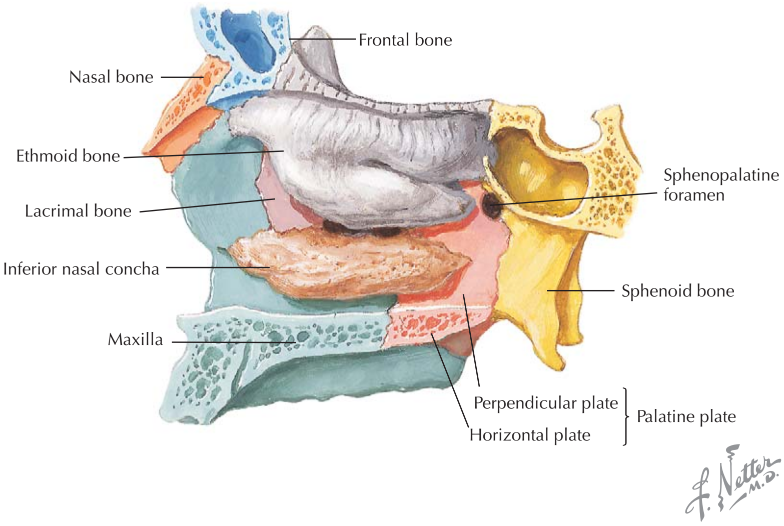
Bones of the Skull

INFERIOR NASAL CONCHA

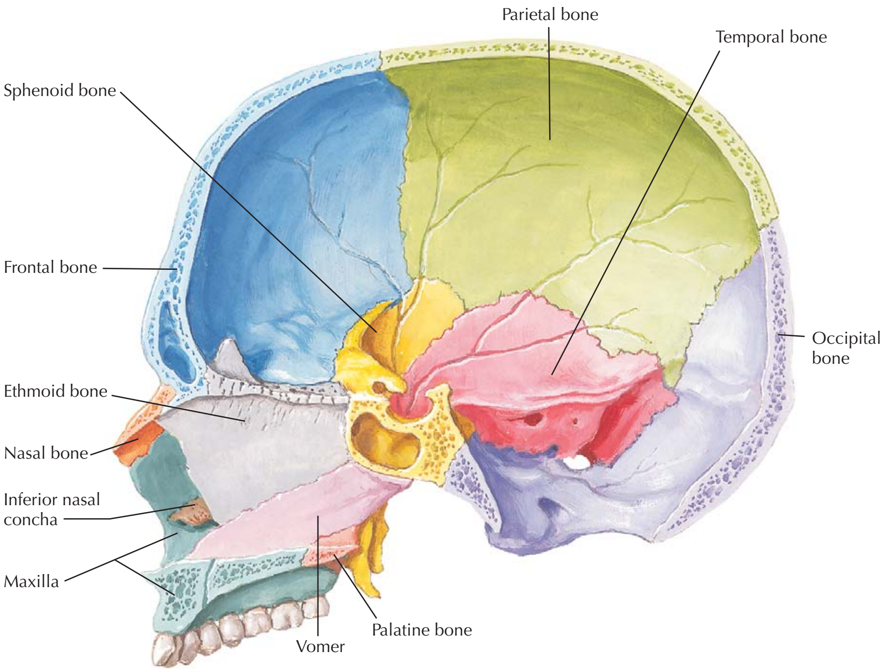
Characteristics	Part	Ossification	Comments
Is described as a curved bone that forms part of the lateral wall of the nasal cavity There are 2 inferior nasal conchae		Endochondral	Lies within a curve in the lateral wall of the nasal cavity Articulates with the maxilla and perpendicular plate of the palatine, lacrimal, and ethmoid bones

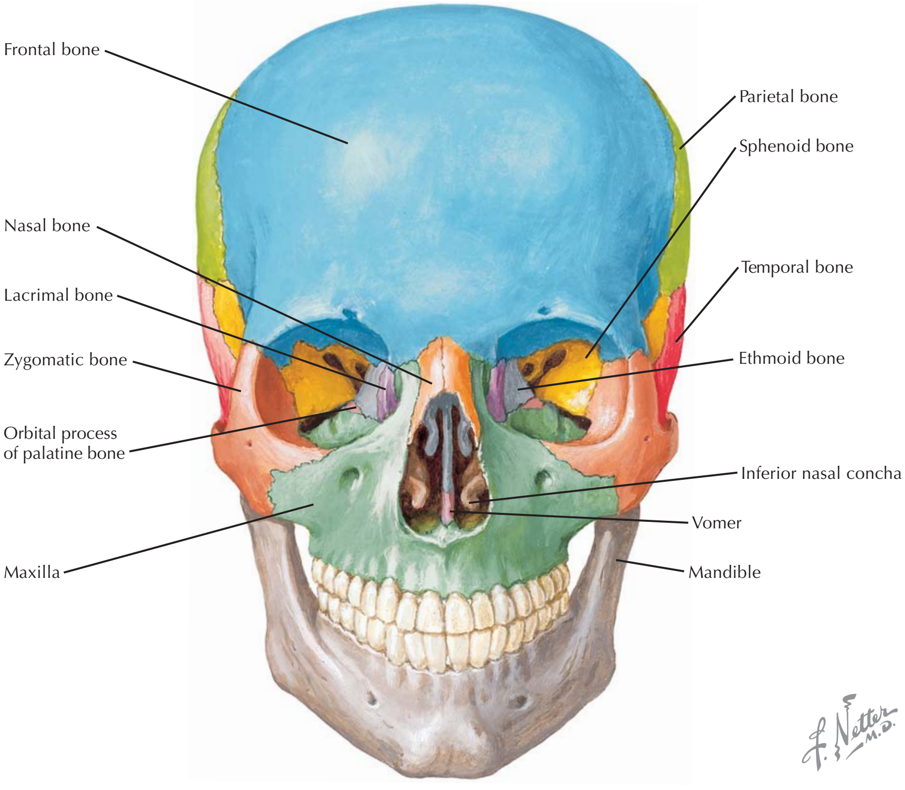
PALATINE BONE

Characteristics	Part	Ossification	Comments
Forms part of the nasal cavity and the hard palate Is L-shaped There are 2 palatine bones	Perpendicular plate	Intramembranous	Is in the shape of a vertical rectangle On the superior border is a notch that articulates with the sphenoid bone, forming the sphenopalatine foramen A small orbital process helps form part of the orbit Forms part of the wall of the pterygopalatine fossa and the lateral wall of the nasal cavity Lateral wall articulates with the maxilla to form the palatine canal
	Horizontal plate		Forms the posterior portion of the hard palate Superior to the horizontal plate is the nasal cavity On the medial part, formed by both of the horizontal plates, is the posterior nasal spine Greater palatine foramen is on this plate
	Pyramidal process		Extends posteriorly and inferiorly from the junction of the perpendicular and horizontal plates of the palatine Lesser palatine foramina are located here



INFERIOR NASAL CONCHA *CONTINUED*



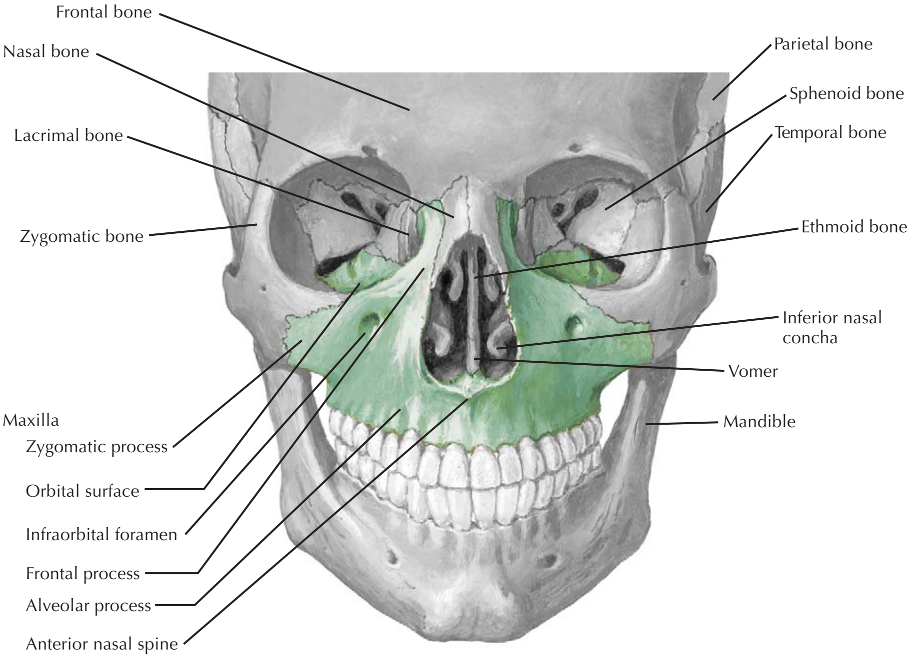


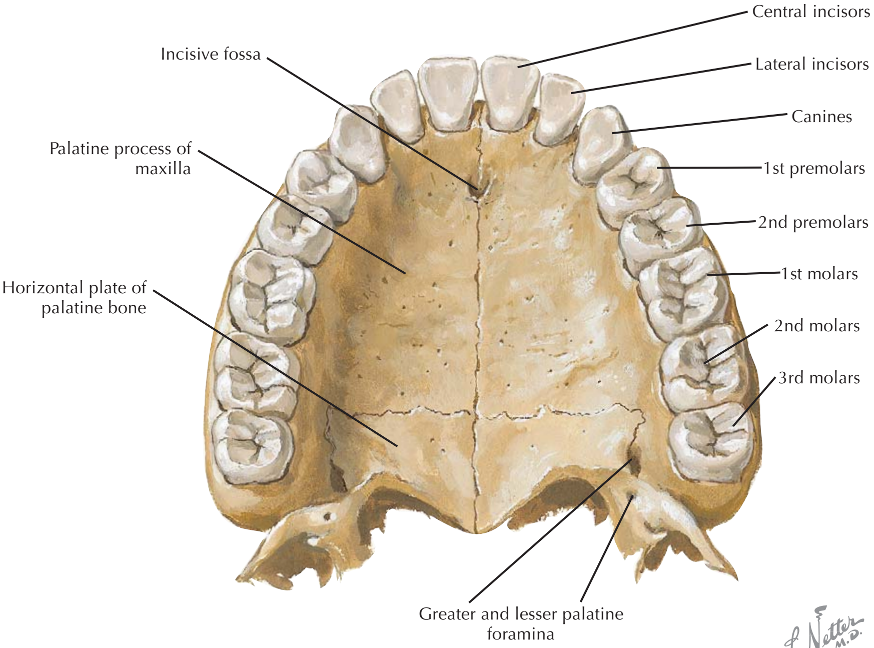
Bones of the Skull

MAXILLA

Characteristics	Part	Ossification	Comments
Forms the majority of the skeleton of the face and the upper jaw Contains the maxillary paranasal sinus Articulates with the opposite maxilla and the frontal, sphenoid, nasal, vomer, and ethmoid bones; inferior nasal concha; palatine, lacrimal, and zygomatic bones; and the septal and nasal cartilages There are 2 maxilla bones (maxillae)	Body	Intramembranous	Major part of the bone Shaped like a pyramid Contains the maxillary paranasal sinus *Gives rise to 4 different regions:* ● Orbit ● Nasal cavity ● Infratemporal fossa ● Face Infraorbital canal and foramen pass from the orbit region to the face region
	Frontal process		Extends superiorly to articulate with the nasal, frontal, ethmoid, and lacrimal bones Forms the posterior boundary of the lacrimal fossa
	Zygomatic process		Extends laterally to articulate with the maxillary process of the zygomatic bone
	Palatine process		Extends medially to form the majority of the hard palate Articulates with the palatine process of the opposite side and the horizontal plate of the palatine bone Incisive foramen is located in the anterior portion
	Alveolar process		The part of the maxilla that supports all of the maxillary teeth Extends inferiorly from the maxilla Each maxilla contains 5 primary and 8 permanent teeth Alveolar bone is resorbed when a tooth is lost

MAXILLA *CONTINUED*

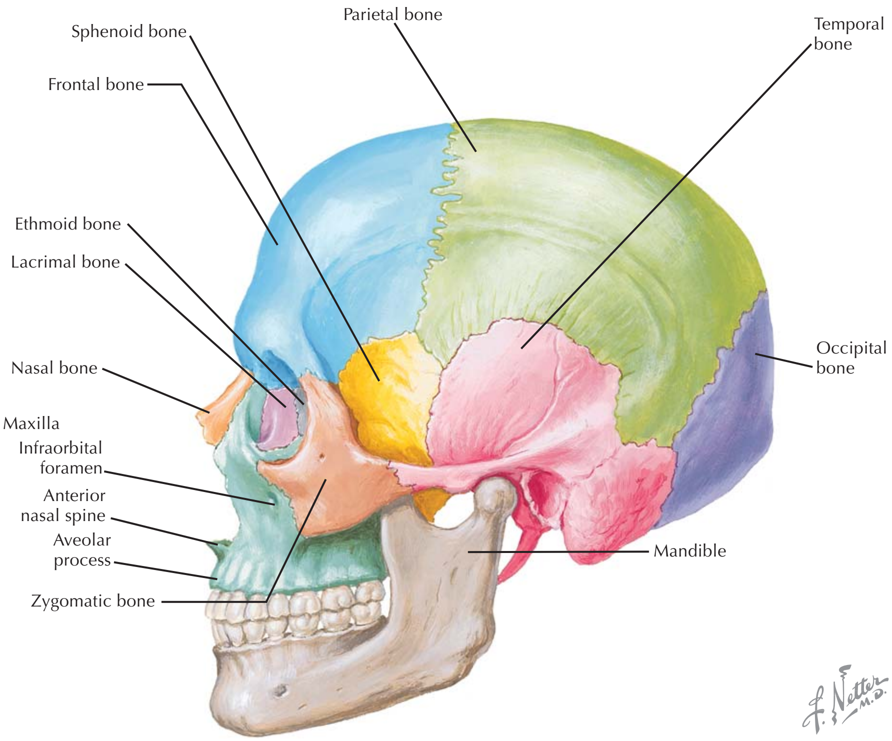




Upper permanent teeth

Bones of the Skull

MAXILLA *CONTINUED*

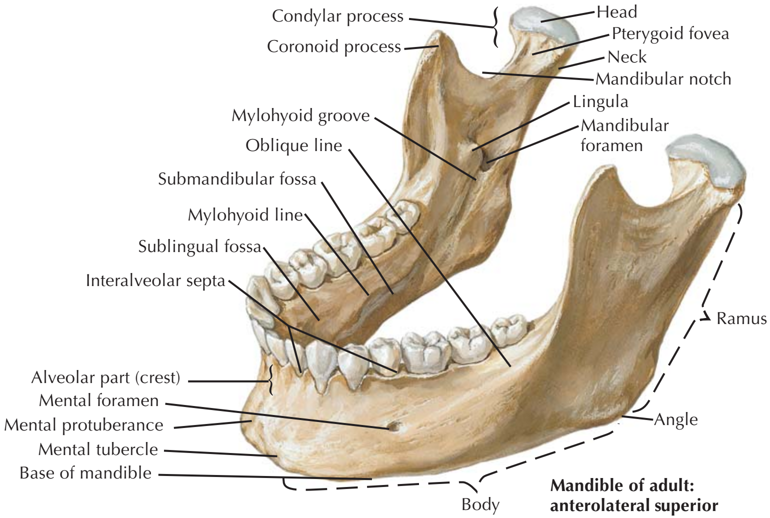


MANDIBLE

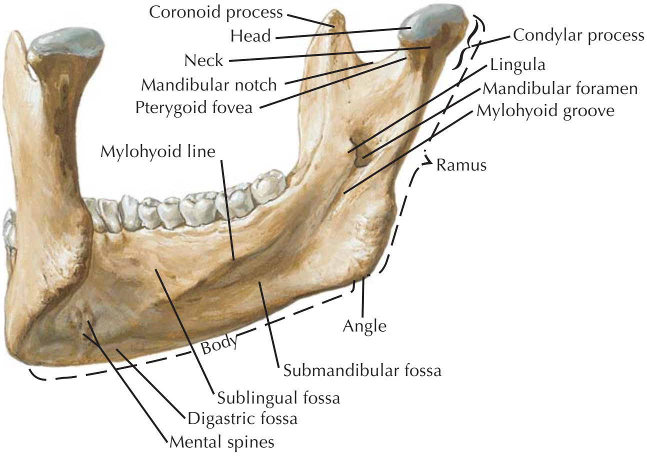
Characteristics	Part	Ossification	Comments
Forms the lower jaw Described as horseshoe shaped All muscles of mastication attach to the mandible There is 1 mandible	Body	Intramembranous (ossifies around Meckel's cartilage)	Mental foramen lies on the anterior part of the lateral surface of the body External oblique line is observed on the lateral side of the mandible On the medial side of the body lies the mylohyoid line Mylohyoid line helps divide a sublingual from a submandibular fossa Posterior border of the mylohyoid line provides for attachment of the pterygomandibular raphe At the midline on the medial side are the superior and inferior genial tubercles, as well as the digastric fossa
	Ramus		Meets the body of the mandible at the angle of the mandible on each side Masseter m. attaches to the lateral side Medial pterygoid m. and sphenomandibular lig. attach to the medial side Mandibular foramen is located on the medial side of the ramus Superior part divides into a coronoid process anteriorly and a condylar process posteriorly, separated by a mandibular notch
	Coronoid process		The anteriormost superior extension of each ramus Temporalis m. attaches to the coronoid process
	Condylar process		Articulates with the temporal bone in the temporomandibular joint Has a neck that forms a condyle superiorly Lateral pterygoid muscle attaches to pterygoid fovea on the neck
	Alveolar process		Extends superiorly from the body Created by a thick buccal and a thin lingual plate of bone The part of the mandible that supports the mandibular teeth Each side of the mandible contains 5 primary and 8 permanent teeth Alveolar bone is resorbed when a tooth is lost

Bones of the Skull

MANDIBLE *CONTINUED*



Mandible of adult: anterolateral superior view



Mandible of adult: left posterior view

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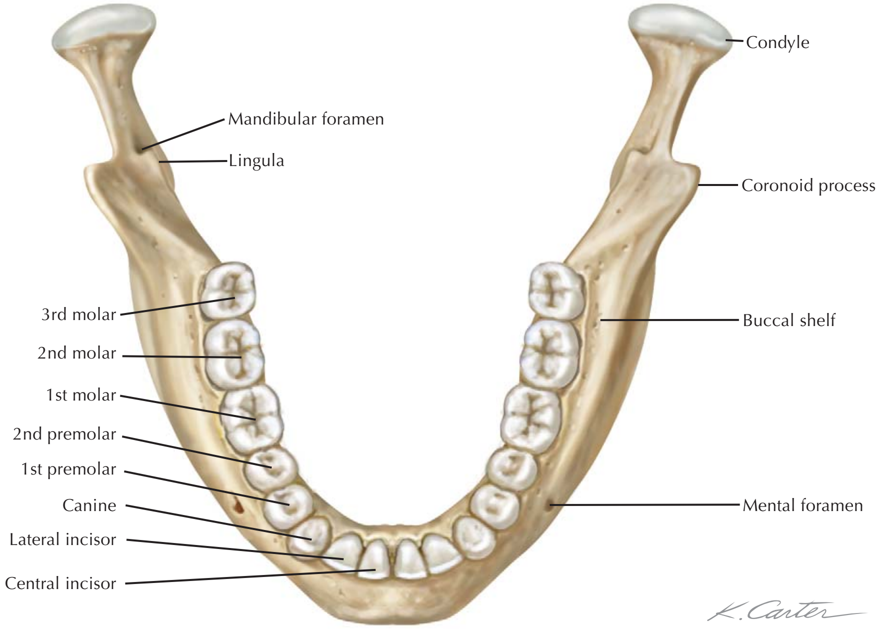
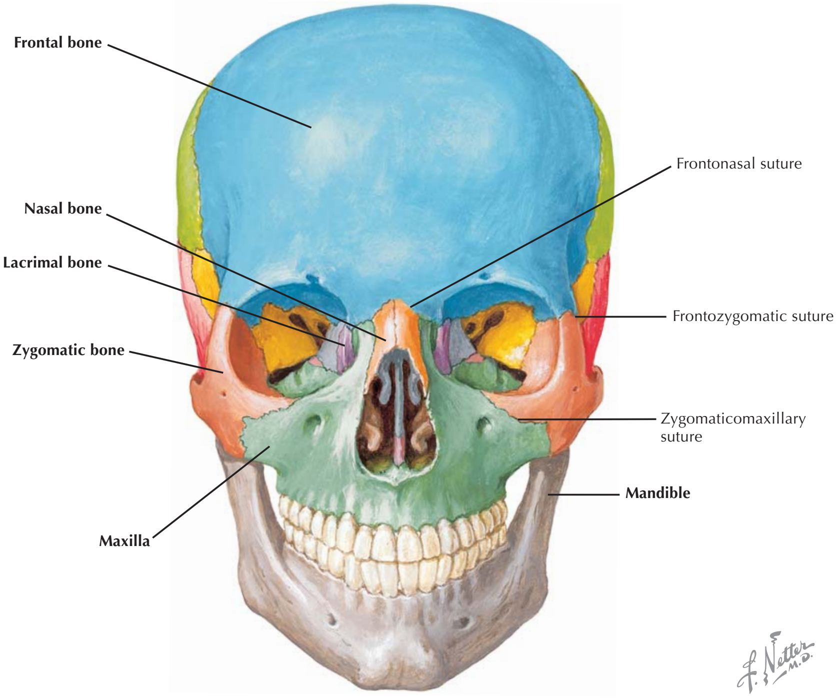
MANDIBLE *CONTINUED*



Views and Sutures

NORMA FRONTALIS

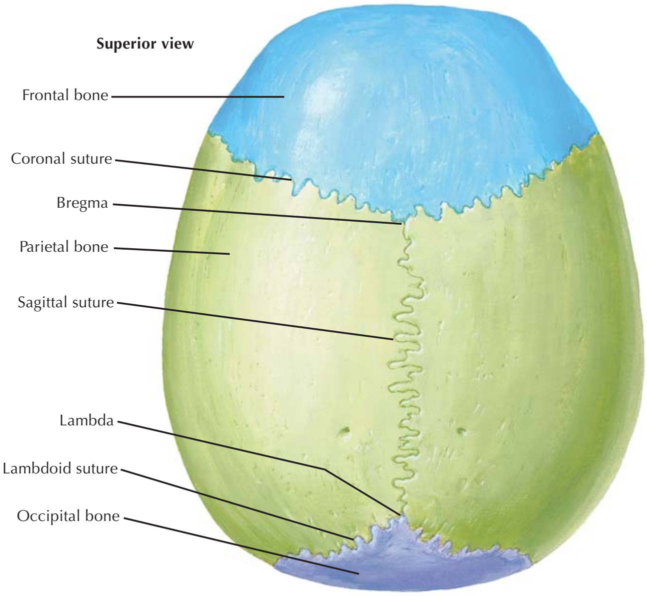
Bones	Frontal Nasal Maxilla Zygomatic Mandible
Sutures	Frontonasal Frontozygomatic Zygomaticomaxillary Metopic

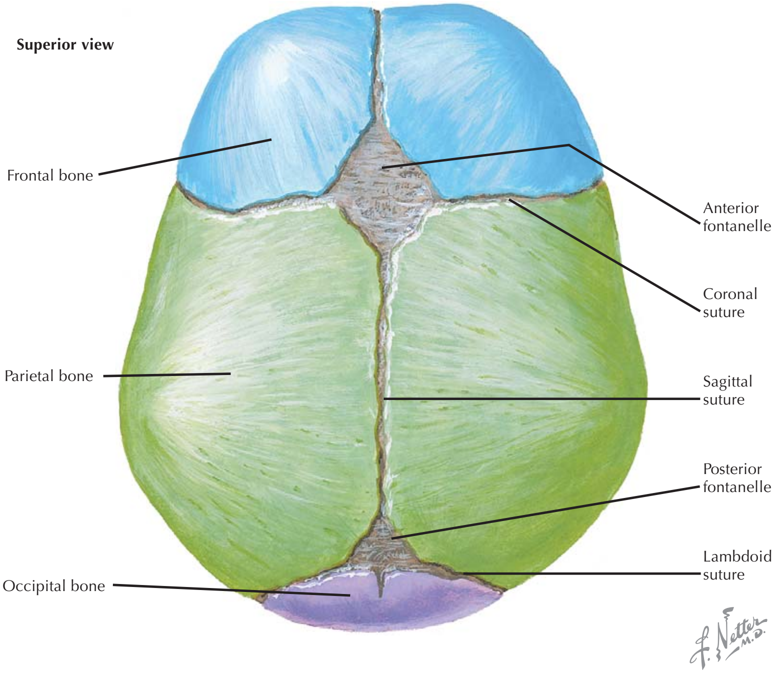


Views and Sutures

NORMA VERTICALIS

Bones	Frontal Parietal Occipital
Sutures	Coronal Sagittal Lambdoidal

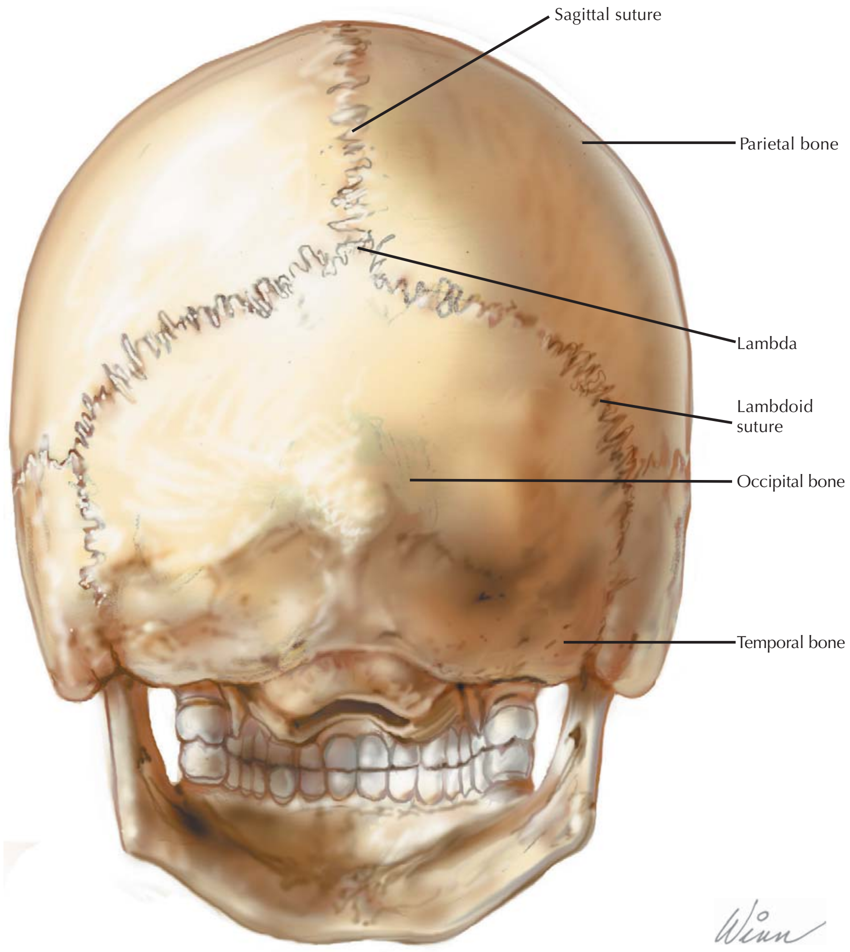




Views and Sutures

NORMA OCCIPITALIS

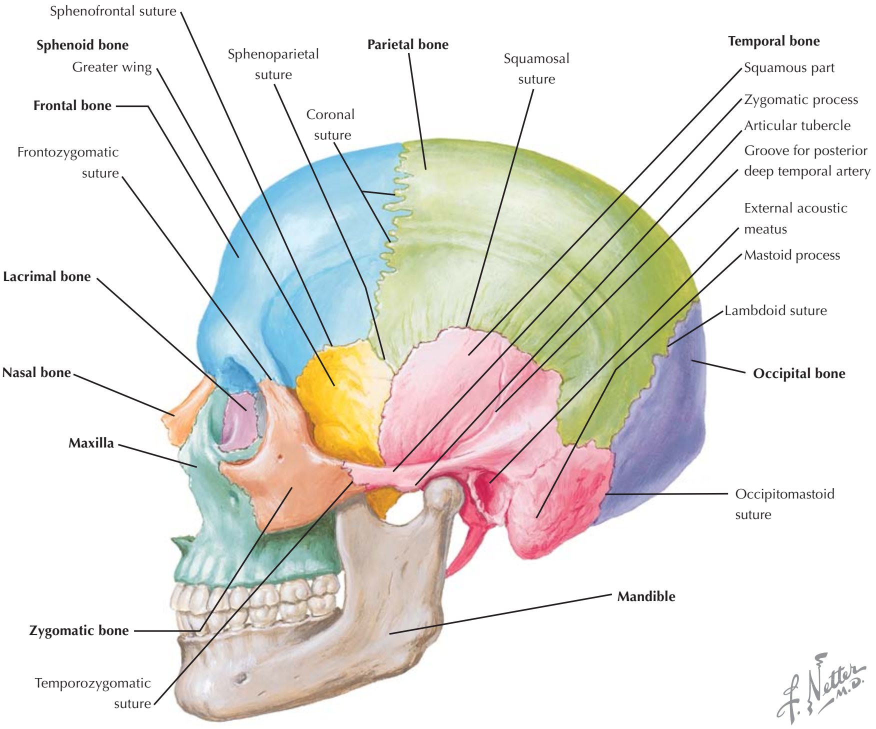
Bones	Parietal Occipital
Sutures	Sagittal Lambdoidal



Views and Sutures

NORMA LATERALIS

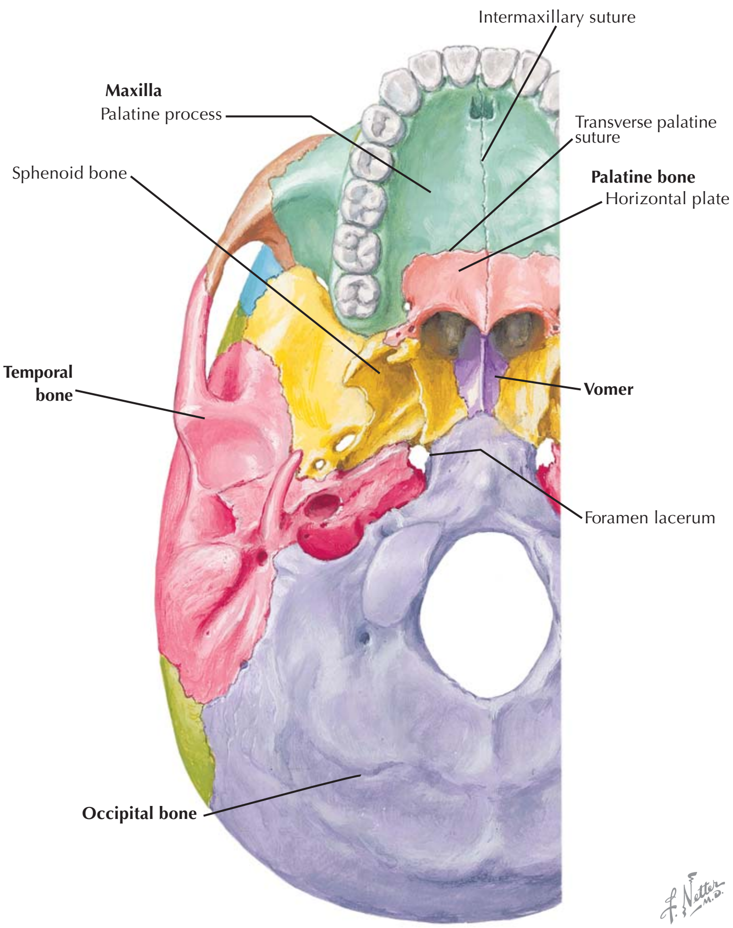
Bones	Frontal Parietal Lacrimal Temporal Zygomatic Maxilla Nasal Occipital Greater wing of the sphenoid Mandible
Sutures	Coronal Squamosal Sphenofrontal Sphenoparietal Lambdoidal Occipitomastoid Temporozygomatic Frontozygomatic



Views and Sutures

NORMA BASALIS

Bones	Palatine process of maxilla Occipital Temporal Horizontal plate of the palatine Greater wing of the sphenoid Vomer Medial pterygoid plate Lateral pterygoid plate
Sutures	Intermaxillary Transverse palatine Petro-occipital Spheno-occipital Petrosquamous Petrotympanic Squamotympanic



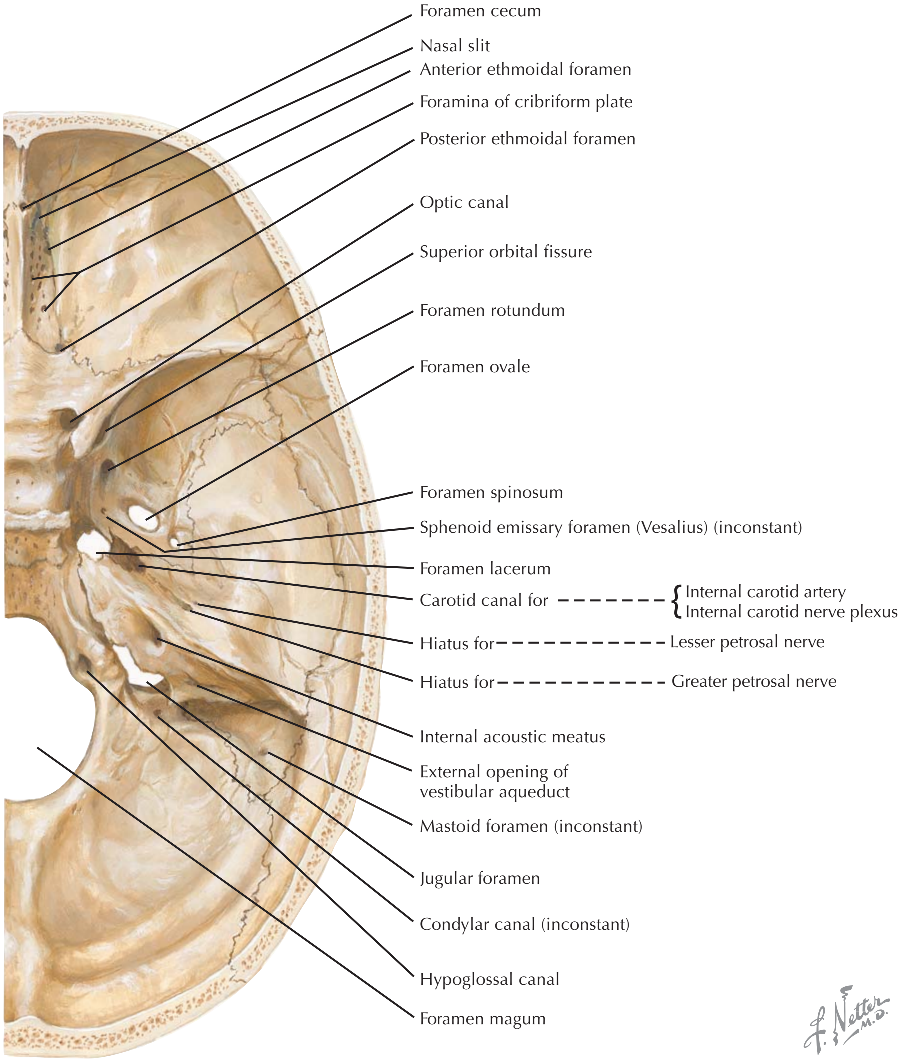
2 Major Foramina and Fissures

SUPERIOR VIEW OF THE CRANIAL BASE

Foramen/Fissure	Located in or Formed by	Structures Passing through
Cribriform plate	Ethmoid	Olfactory nn. from the olfactory bulb
Foramen cecum	Between the frontal and the ethmoid bones	Emissary v. from nasal cavity to the superior sagittal sinus
Anterior ethmoid foramen		Anterior ethmoid n. and vessels
Aosterior ethmoid foramen		Posterior ethmoid n. and vessels
Optic canal	Sphenoid	Optic n., ophthalmic a.
Superior orbital fissure	Between the greater and the lesser wings of the sphenoid	Nasociliary, frontal, and lacrimal branches of the ophthalmic division of the trigeminal n., oculomotor n., trochlear n., abducens n., superior and inferior ophthalmic vv.
Foramen rotundum	Sphenoid	Maxillary division of the trigeminal n.
Foramen ovale		Mandibular division of the trigeminal n., accessory meningeal a., lesser petrosal n., emissary v.
Foramen spinosum		Middle meningeal vessels and meningeal branch of the mandibular division of the trigeminal n.
Sphenoid foramen		Emissary v.
Foramen lacerum	Articulation of the sphenoid (greater wing and body), temporal (petrous portion), and occipital (basilar portion) bones	Nothing passes through it Filled with fibrocartilage during life (although the anterior wall of the foramen has an opening for the pterygoid canal and the posterior wall has an opening for the carotid canal)
Carotid canal	Temporal (petrous portion)	Internal carotid a., internal carotid n. plexus (sympathetics)
Hiatus for the lesser petrosal n.		Lesser petrosal n.
Hiatus for the greater petrosal n.		Greater petrosal n.
Internal acoustic meatus		Facial n., vestibulocochlear n., labyrinthine a.
Opening of the vestibular aqueduct		Endolymphatic duct
Mastoid foramen	Temporal (mastoid portion)	Emissary v. (sometimes branches of the occipital a.)
Jugular foramen	Temporal (petrous portion) and occipital	Glossopharyngeal n., vagus n., spinal accessory n., inferior petrosal sinus, sigmoid sinus, posterior meningeal a.
Condylar canal	Occipital	Emissary v., meningeal branches of ascending pharyngeal a.
Hypoglossal canal		Hypoglossal n.
Foramen magnum		Medulla oblongata, vertebral arteries, spinal roots of the spinal accessory n.

Major Foramina and Fissures

SUPERIOR VIEW OF THE CRANIAL BASE *CONTINUED*



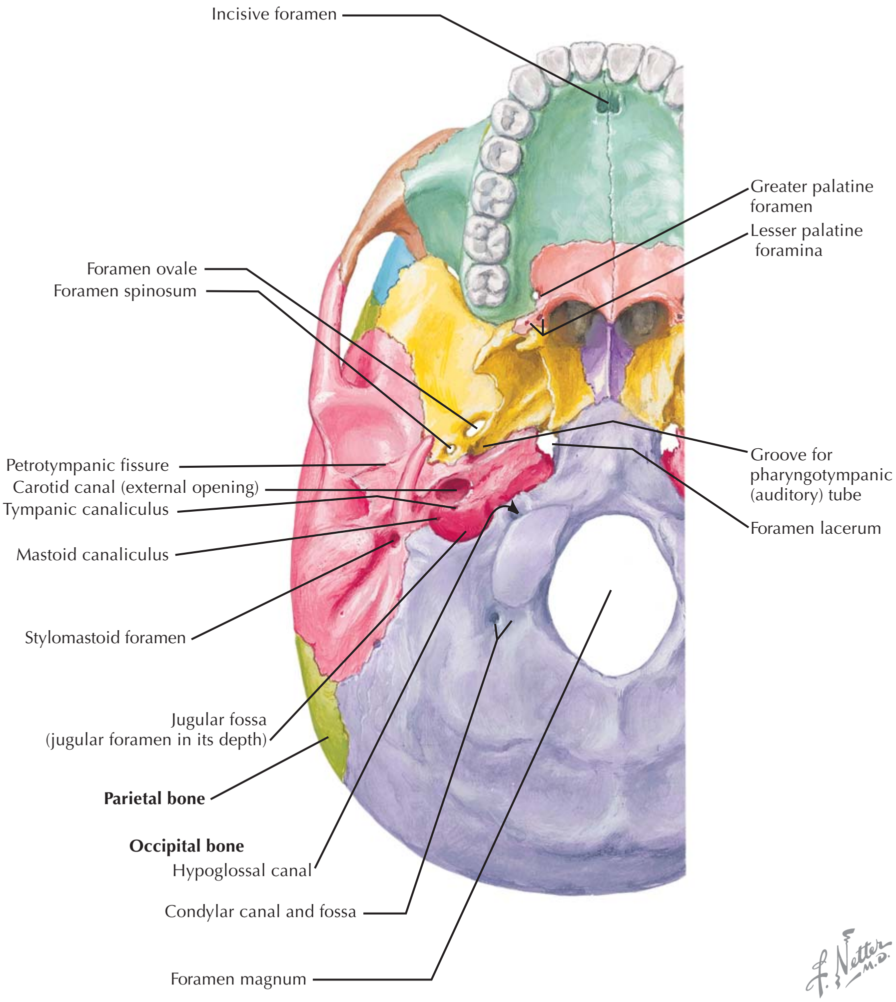
2 Major Foramina and Fissures

INFERIOR VIEW OF THE CRANIAL BASE

Foramen/Fissure	Located in or Formed by	Structures Passing through
Incisive foramen	Maxilla (palatine process)	Nasopalatine n., sphenopalatine a.
Greater palatine foramen	Palatine	Greater palatine n. and vessels
Lesser palatine foramina	Palatine	Lesser palatine n. and vessels
Foramen ovale	Sphenoid	Mandibular division of the trigeminal n., accessory meningeal a., lesser petrosal n., emissary v.
Foramen spinosum	Sphenoid	Middle meningeal vessels and meningeal branch of the mandibular division of the trigeminal n.
Foramen lacerum	Articulation of the sphenoid (greater wing and body), temporal (petrous portion), and occipital (basilar portion) bones	Nothing passes through it Filled with fibrocartilage during life (although the anterior wall of the foramen has an opening for the pterygoid canal and the posterior wall has an opening for the carotid canal)
Opening for auditory tube	Temporal and sphenoid	Cartilaginous portion of the auditory tube
Carotid canal	Temporal (petrous portion)	Internal carotid a., internal carotid n. plexus (sympathetics)
Tympanic canaliculus	Temporal	Tympanic branch of the glossopharyngeal n.
Jugular foramen	Temporal (petrous portion) and occipital	Glossopharyngeal n., vagus n., spinal accessory n., inferior petrosal sinus, sigmoid sinus, posterior meningeal a.
Mastoid canaliculus	Temporal (within the jugular fossa)	Auricular branch of the vagus n.
Petrotympanic fissure	Temporal	Chorda tympani n.
Stylomastoid foramen		Facial n., stylomastoid a.
Tympanomastoid fissure		Auricular branch of the vagus n.
Hypoglossal canal	Occipital	Hypoglossal n.
Condylar canal		Emissary v., meningeal branches of ascending pharyngeal a.
Foramen magnum		Medulla oblongata, vertebral arteries, spinal roots of the spinal accessory n.

Major Foramina and Fissures

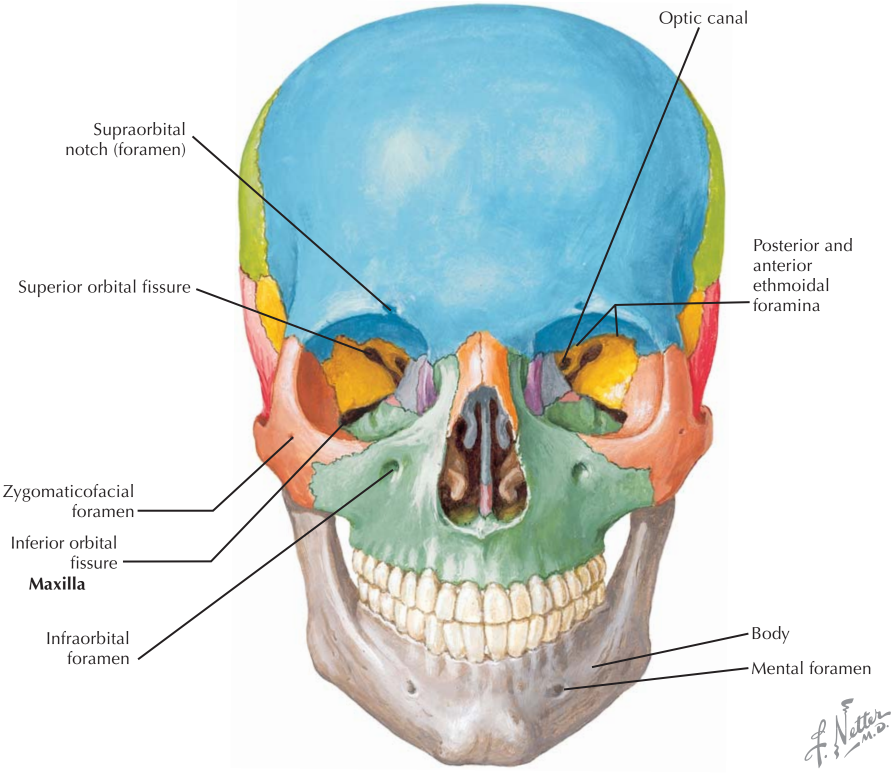
INFERIOR VIEW OF THE CRANIAL BASE *CONTINUED*



2 Major Foramina and Fissures

ANTERIOR VIEW

Foramen/Fissure	Located in or Formed by	Structures Passing through
Supraorbital foramen	Frontal	Supraorbital n. and vessels
Optic canal	Sphenoid	Optic n., ophthalmic a.
Superior orbital fissure	Between the: • Greater wing of the sphenoid and • Lesser wing of the sphenoid	Nasociliary, frontal, and lacrimal branches of the ophthalmic division of the trigeminal n., oculomotor n., trochlear n., abducens n., superior and inferior ophthalmic vv.
Inferior orbital fissure	Between the: • Greater wing of the sphenoid and • Maxilla and orbital portion of the palatine bones	Maxillary division of the trigeminal n., zygomatic n., infraorbital vessels
Anterior ethmoid foramen	Between the: • Frontal and • Ethmoid	Anterior ethmoid n. and vessels
Posterior ethmoid foramen		Posterior ethmoid n. and vessels
Zygomaticofacial foramen	Zygomatic	Zygomaticofacial n. and vessels
Infraorbital foramen	Maxilla	Infraorbital n. and vessels
Mental foramen	Mandible	Mental n. and vessels



Cervical Vertebrae

GENERAL INFORMATION

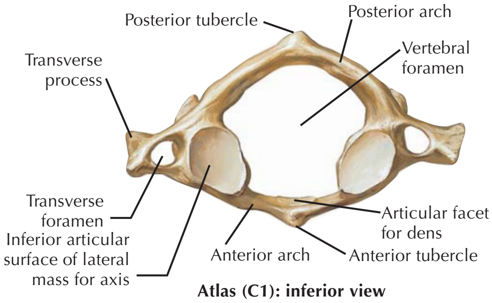
7 cervical vertebrae (C1 to C7)

The smallest vertebrae in the body

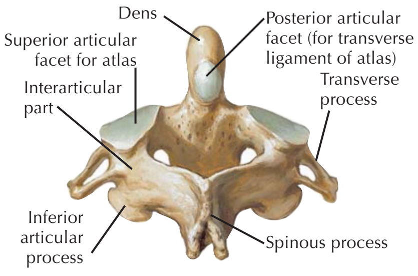
The 1st, 2nd, and 7th cervical vertebrae are unique in their shape; the 3rd to the 6th are similarly shaped

BONES

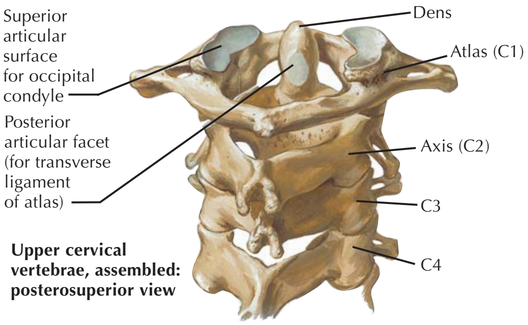
Vertebra	Characteristics
Atlas (C1)	Supports the skull No body No spinous process Has an anterior arch and a posterior arch Large lateral masses support the occipital condyles of the skull superiorly and articulate with the axis inferiorly Foramen transversarium located in the large transverse process
Axis (C2)	Dens (odontoid process) located on the body's superior surface Foramen transversarium located in the small transverse process Spinous process is large and bifid
C3–C6	Cervical vertebrae have small bodies Pedicles project posteriorly and laterally Spinous processes are short and bifid Vertebral foramina are large and triangular Each foramen transversarium is located in the transverse process Vertebral a. enters the foramen transversarium at C6 Transverse processes each have an anterior and a posterior portion called the anterior tubercle and the posterior tubercle
C7	Also called "vertebra prominens" because its long spinous process makes it visible under the skin Long spinous process is not bifid Foramen transversarium located in the large transverse process Normally, the vertebral vessels do not pass through the foramen transversarium of C7 (the veins pass through more frequently than the arteries)



Atlas (C1): inferior view



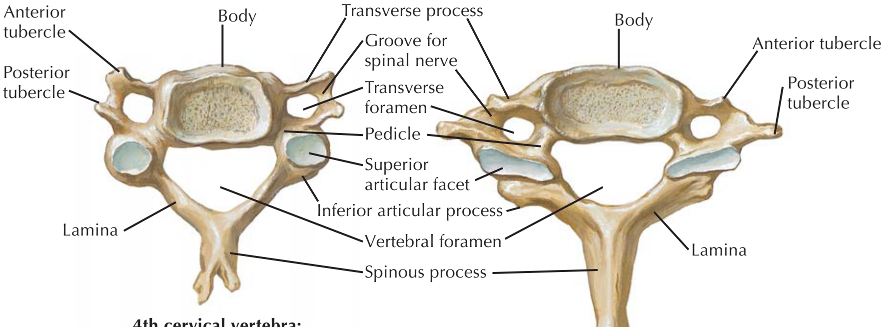
Axis (C2): posterosuperior view



Upper cervical vertebrae, assembled: posterosuperior view

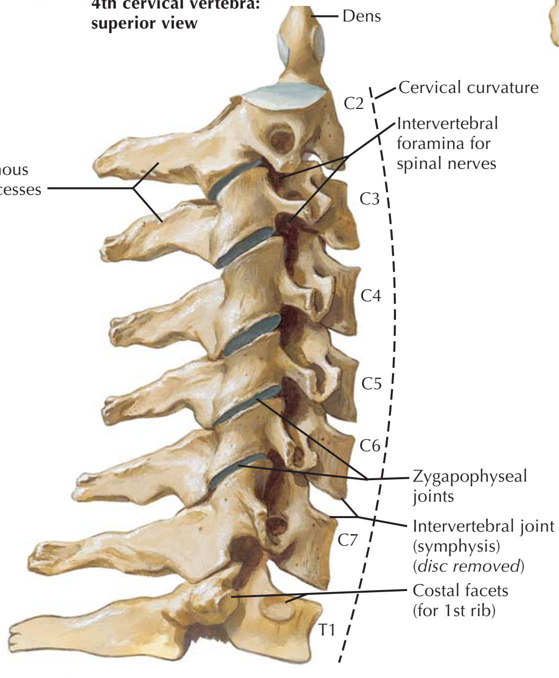
Cervical Vertebrae

GENERAL INFORMATION *CONTINUED*



4th cervical vertebra: superior view

7th cervical vertebra: superior view



2nd cervical to 1st thoracic vertebrae: right lateral view

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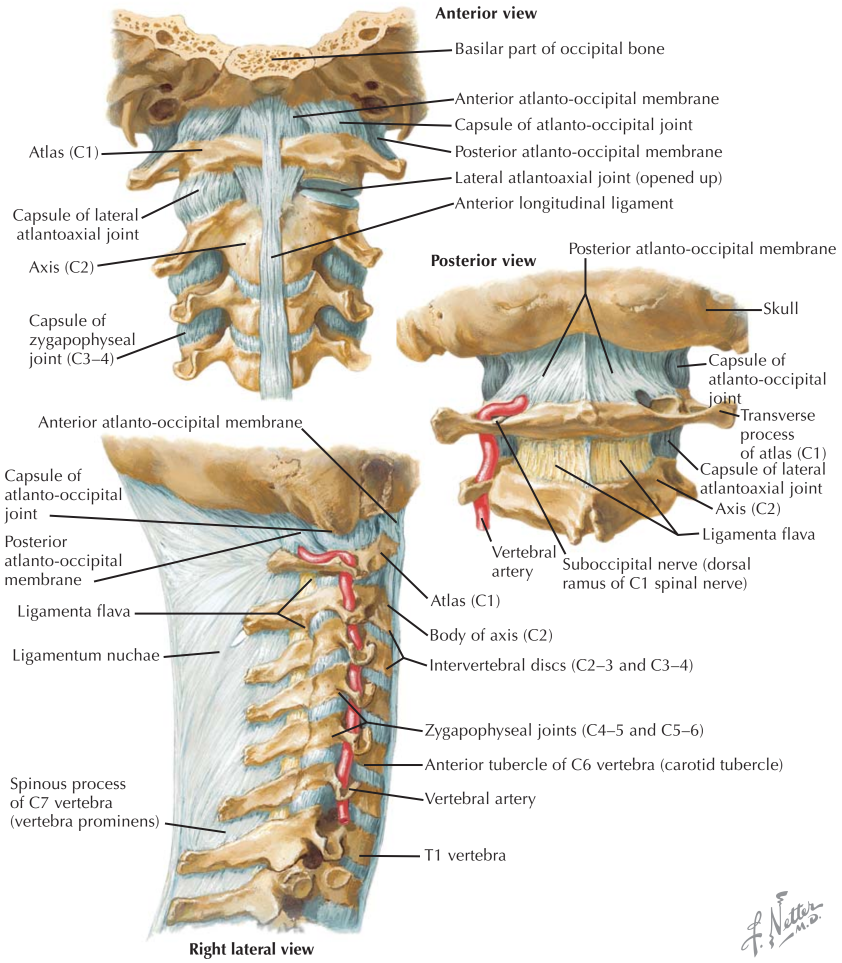
Cervical Vertebrae

MAJOR EXTERNAL LIGAMENTS

Ligament(s)/Membrane(s)	Comments
Anterior longitudinal ligament	Attached to the anterior surfaces of the vertebral bodies, extending from the axis to the sacrum Superior to the axis, it is continuous with the anterior atlantoaxial lig.
Ligamenta flava	Attached to the anterior surfaces of the lamina within the vertebral foramen extending from the axis to the first sacral vertebra
Ligamentum nuchae	Extends from the external occipital protuberance and median nuchal line to the spinous process of C7 Between these attachments, it attaches to the posterior tubercle of the atlas and the spinous processes of the axis and C3–C6
Anterior atlanto-occipital membrane	Extends from the anterior margin of the foramen magnum superiorly and the anterior arch of the atlas inferiorly Continuous with the capsule of the atlanto-occipital joint laterally
Posterior atlanto-occipital membrane	Extends from the posterior margin of the foramen magnum superiorly to the posterior arch of the atlas inferiorly Allows passage of the vertebral a. on the lateral margin

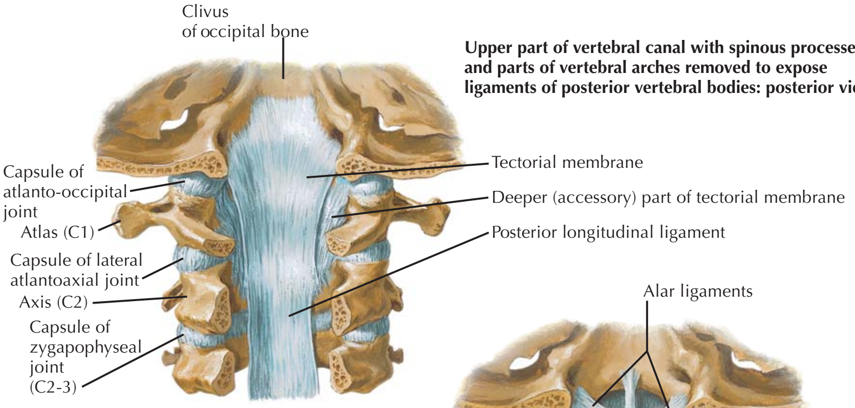


MAJOR INTERNAL LIGAMENTS

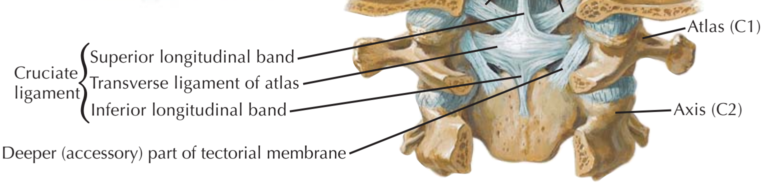
Ligament(s)/Membrane(s)	Comments
Deep Ligaments/Membranes	
Alar ligament	Extends from the dens to the medial portions of the occipital condyles Also known as "check ligaments" because they limit skull rotation
Apical ligament of the dens	Extends from the dens to the anterior margin of the foramen magnum
Cruciate ligament • *Superior longitudinal band*	Part of the transverse lig. of the atlas, which extends superiorly to attach to the basilar portion of the occipital bone
• *Transverse ligament of atlas*	Thick ligament extending from one side of the internal surface of the anterior arch of the atlas to the other side, holding the dens in contact with the anterior arch
• *Inferior longitudinal band*	Part of the transverse lig. of the atlas that extends inferiorly, attaching to the posterior body of the axis
Superficial Ligaments/Membranes	
Tectorial membrane	Extends from the basilar portion of the occipital bone, where it blends with the dura mater, to the posterior portion of the body of the axis Continuous inferiorly with the posterior longitudinal lig.
Posterior longitudinal ligament	Attached to the posterior surfaces of the bodies of the vertebrae extending within the vertebral foramen from the axis to the sacrum Superior to the axis, it is continuous with the tectorial membrane

Cervical Vertebrae

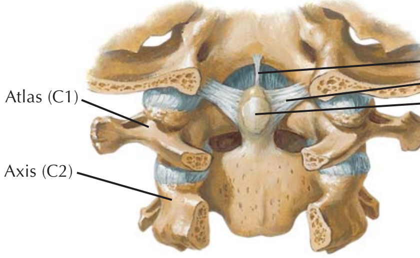
MAJOR INTERNAL LIGAMENTS *CONTINUED*



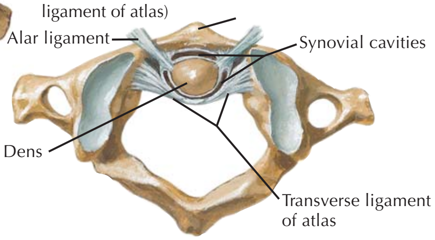
Upper part of vertebral canal with spinous processes and parts of vertebral arches removed to expose ligaments of posterior vertebral bodies: posterior view



Principal part of tectorial membrane removed to expose deeper ligaments: posterior view



Cruciate ligament removed to show deepest ligaments: posterior view



Median atlantoaxial joint: superior view

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Clinical Correlate

ZYGOMATIC FRACTURES

Zygoma is the second most commonly fractured bone of the face after the nasal bone

Susceptible to fracture, usually due to a facial blow from a fist or trauma related to a car accident

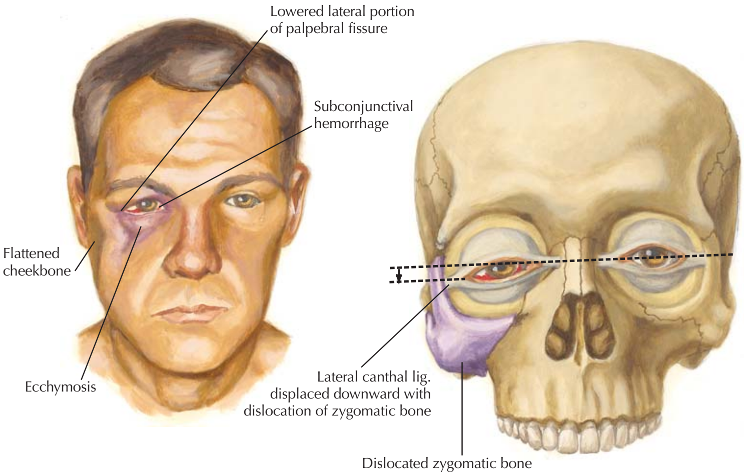
In fractures due to blows from a fist, the left zygomatic bone is more frequently fractured than the right

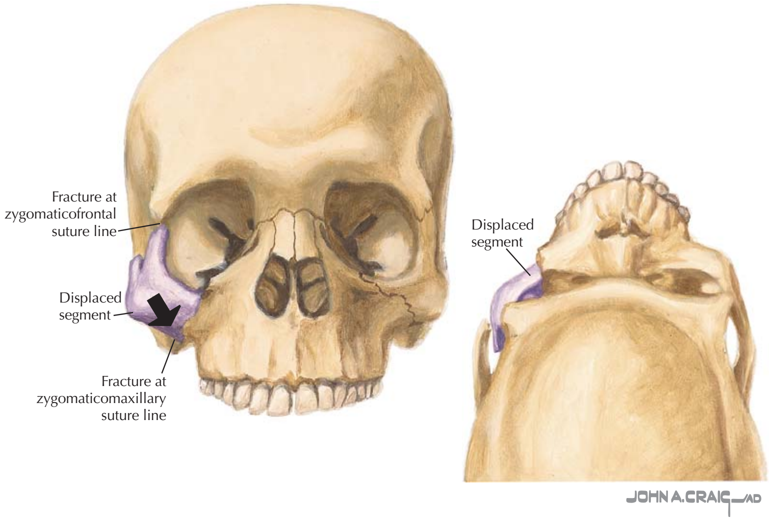
Most fractures are unilateral

May displace the zygomatic bone along the sutures, or more severe displacement in a posterior, medial, and inferior direction may occur

Common clinical manifestations include:

- Pain
- Swelling
- Diplopia
- Paresthesia
- Depressed cheek





Clinical Correlate

LE FORT FRACTURES

Trauma to the midface usually follows 1 of 3 patterns of fracture:

- Le Fort I
- Le Fort II
- Le Fort III

LE FORT I

Horizontal, extending from the lateral margin of the piriform aperture to the pterygoid plates just superior to the apices of the teeth

Gives rise to a detached upper jaw relative to the rest of the maxillofacial skeleton

LE FORT II

Pyramidal in outline, extending from the bridge of the nose at or inferior to the nasofrontal suture or maxilla, then inferiorly and laterally through the inferior orbital floor near the infraorbital foramen, through the anterior wall of the maxillary sinus, to the pterygoid plates

LE FORT III

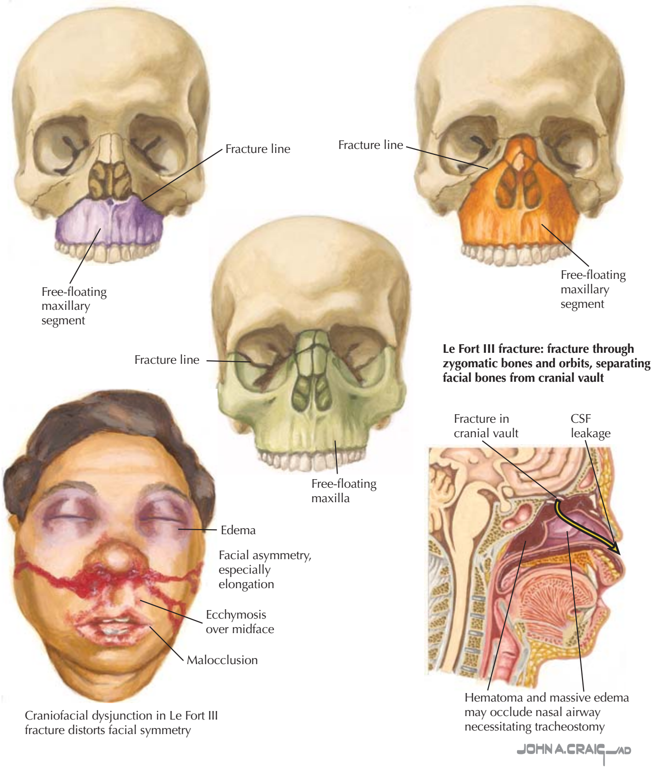
Transverse, extending from the nasofrontal suture and frontomaxillary suture and passing posteriorly along the medial wall of the orbit through the nasolacrimal groove and ethmoid, then following the inferior orbital fissure to the lateral wall of the orbit, and extending through the frontozygomatic suture

Within the nose, the fracture extends along the perpendicular plate, vomer, and pterygoid plates

In a Le Fort III fracture, the facial skeleton is detached from the base of the skull

Le Fort I fracture: horizontal detachment of maxilla at level of nasal floor

Le Fort II fracture: fracture through maxillae, antra, nasal bones, and infraorbital rims



Craniofacial dysjunction in Le Fort III fracture distorts facial symmetry

Hematoma and massive edema may occlude nasal airway necessitating tracheostomy

Clinical Correlate

MANDIBLE FRACTURES

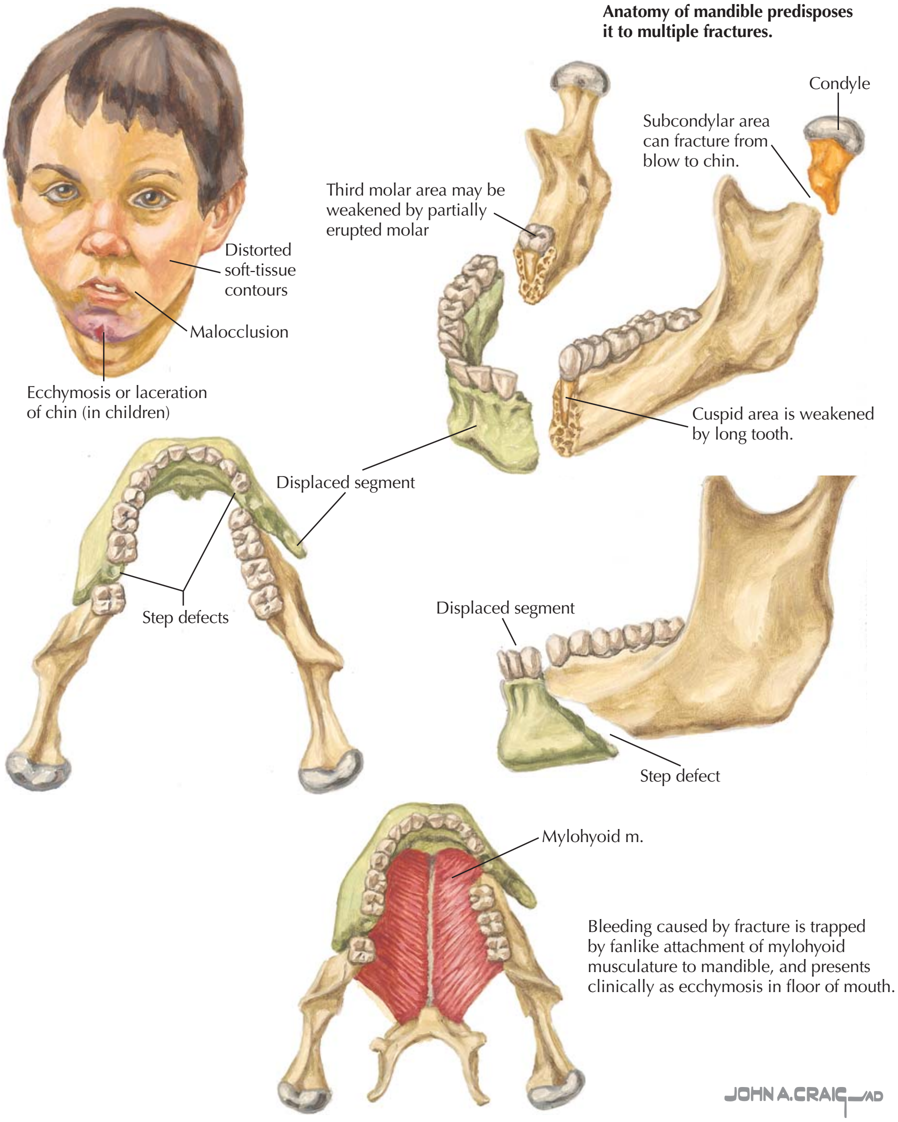
Mandible is a frequently fractured bone

Fractures result from blow from a fist or trauma incurred in motor vehicle accidents

Common sites (in decreasing order of frequency):

- Body
- Angle
- Condyle
- Symphysis
- Ramus
- Alveolus
- Coronoid process

With double mandibular fractures, the second usually is contralateral



Bleeding caused by fracture is trapped by fanlike attachment of mylohyoid musculature to mandible, and presents clinically as ecchymosis in floor of mouth.

Clinical Correlate

CERVICAL FRACTURES

Two common types of cervical fractures:
- Jefferson fracture (at C1)
- Hangman's fracture (at C2)

JEFFERSON FRACTURE

Involves the atlas

Results from skull compression due to axial loading, causing the atlas to burst

Most patients are neurologically intact but have severe neck pain

Vertebral artery can be compromised

Classified as stable or unstable according to whether the transverse ligament of the atlas is intact:
- *Stable fractures* can be treated with an orthosis such as a soft collar
- *Unstable fractures* are more problematic; may require cranial traction applied with use of a halo, as well as cervical fusion

HANGMAN'S FRACTURE

Occurs through the vertebral arch of the axis between the superior and the inferior articulating facets

A traumatic spondylolisthesis often is caused by extension of the neck with axial compression, common in car accidents

The historical hangman's fracture is caused by extension and distraction of the neck

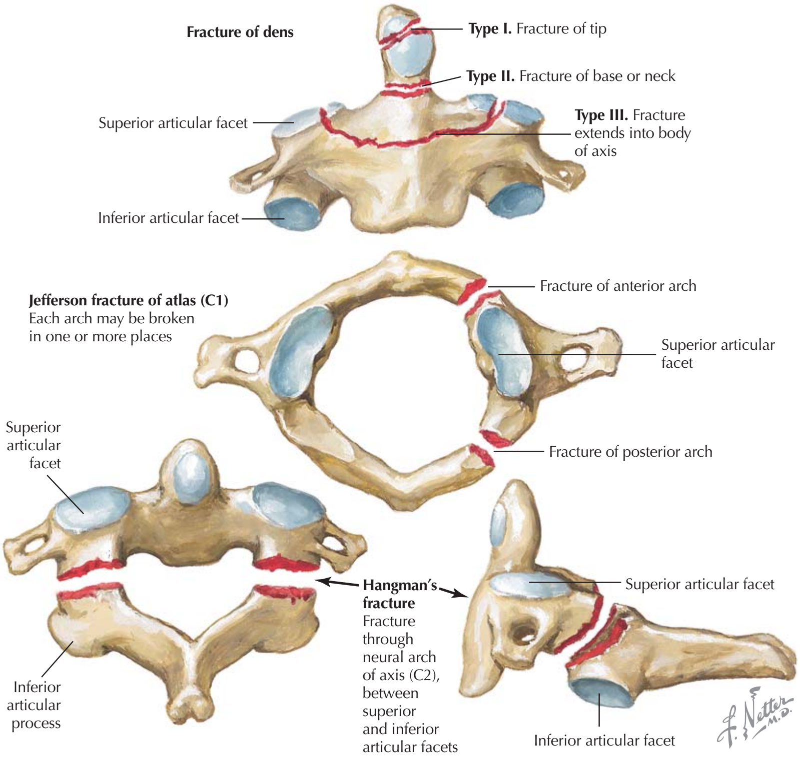
ODONTOID FRACTURE

Involves the axis

Classification into 3 types:
- Type 1—fracture at the tip of the odontoid process
- Type 2—fracture along the base or the neck of the odontoid
- Type 3—fracture that passes through the body of the axis

CERVICAL FRACTURES *CONTINUED*

Fractures of cervical vertebrae



CHAPTER 3

BASIC NEUROANATOMY AND CRANIAL NERVES

3 Nervous Tissue

GENERAL INFORMATION

Nervous tissue is divided into 2 major cell types:
- Neurons
- Neuroglial cells (the neuroglia)

NEURONS

The structural and functional cells in the nervous system

Respond to a nervous stimulus and conduct the stimulus along the length of the cell

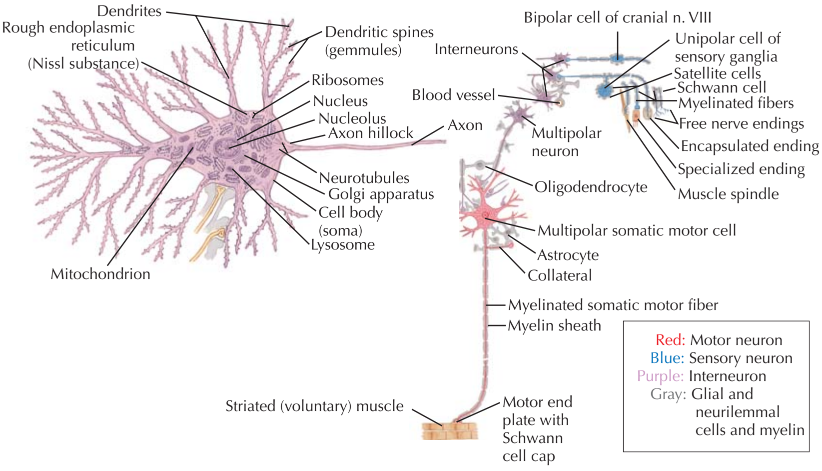
A neuron's cell body is called the perikaryon, or soma

Cell bodies are classified by their location:
- Ganglion—a collection of nerve cell bodies located in the peripheral nervous system (e.g., dorsal root ganglion, trigeminal ganglion, ciliary ganglion)
- Nucleus—a collection of nerve cell bodies located in the central nervous system (e.g., Edinger-Westphal nucleus, chief sensory nucleus of cranial nerve V, motor nucleus of cranial nerve VII)

Neuron's cell bodies contain typical cellular organelles within their cytoplasm:
- Mitochondria
- Nucleus
- Nucleolus
- Ribosomes
- Rough endoplasmic reticulum (Nissl substance)
- Neurotubules
- Golgi apparatus
- Lysosomes

Neurons have 2 types of processes that extend from the nerve cell body:
- Dendrite—process that carries nerve impulses towards the nerve cell body; neurons may have multiple dendrites
- Axon—process that carries nerve impulses away from the nerve cell body; neurons can have *only 1* axon

3 major types of neurons:
- Unipolar—has only 1 process from the cell body (sensory neurons)
- Bipolar—has 2 processes from the cell body: 1 dendrite and 1 axon (sensory neurons; located only in the retina, olfactory epithelium, and the vestibular and cochlear ganglia)
- Multipolar—has 3 or more processes from the cell body: 2 or more dendrites and 1 axon (motor neurons and interneurons)



Nervous Tissue

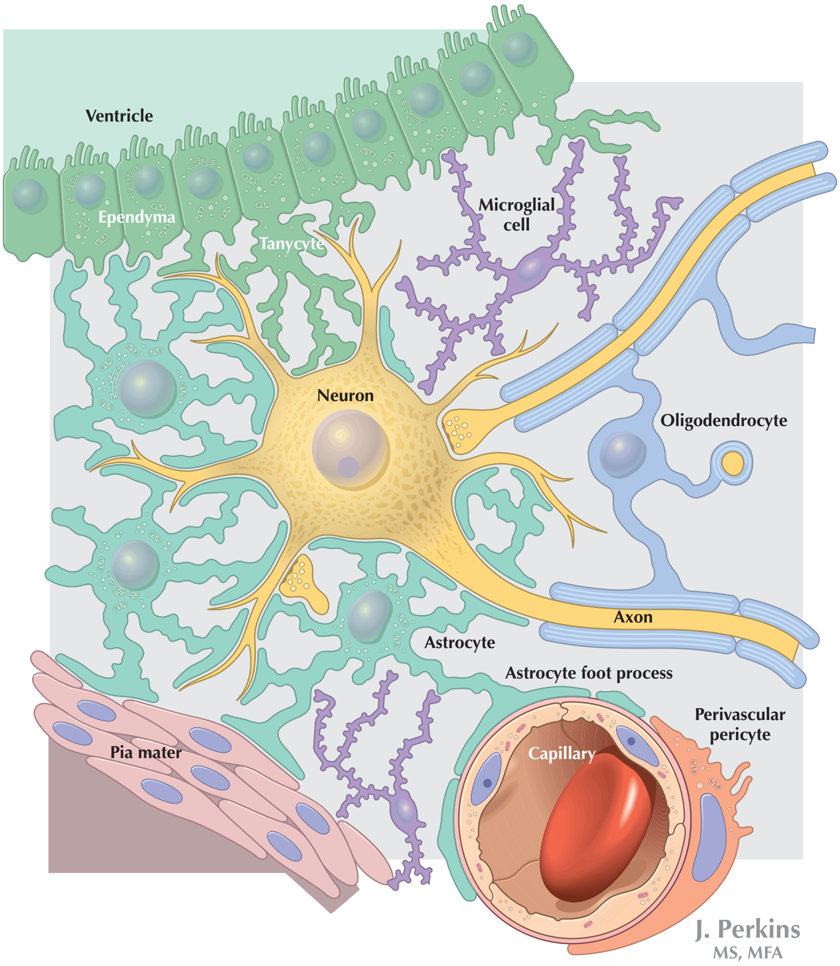
NEUROGLIA

Neuroglia is the supporting nervous tissue for neurons, although neuroglial cells also have assistive roles in neuron function

Neuroglial cells have only 1 type of process

Classification:

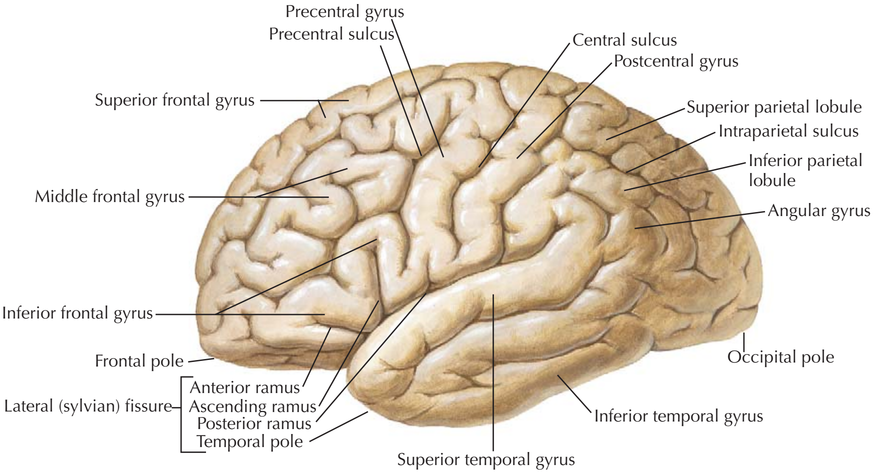
- Astrocytes—located in the central nervous system; help keep neurons in place, provide nutritional support, regulate the extracellular matrix, form part of the blood-brain barrier
- Oligodendrocytes—located in the central nervous system; responsible for axon myelination in the central nervous system
- Microglia—located in the central nervous system; responsible for phagocytosis to remove waste
- Schwann cells—located in the peripheral nervous system; responsible for axon myelination in the peripheral nervous system
- Satellite cells—located in the peripheral nervous system; surround the nerve cell bodies of ganglia

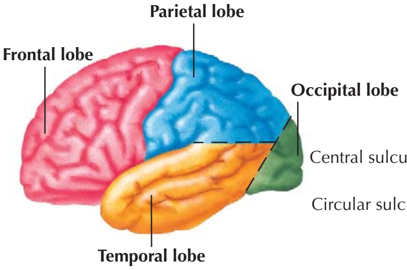


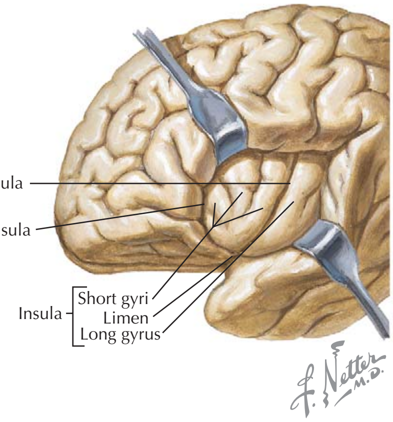
3 Central Nervous System

GENERAL INFORMATION

The *central nervous system* is composed of the:
- Brain
- Spinal cord







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Central Nervous System

BRAIN

CEREBRUM

The surface of the cerebral cortex of the brain is divided by:

- Gyri (singular gyrus)—the elevations of brain tissue on the surface
- Sulci (singular sulcus)—the grooves or fissures located between the gyri

There are 3 large sulci that help divide the cerebral hemispheres into 4 of its lobes:

- Central sulcus (of Rolando)—divides frontal lobe from parietal lobe
- Lateral sulcus (of Sylvius)—divides the frontal and parietal lobes from the temporal lobe
- Parieto-occipital sulcus—divides the parietal lobe from the occipital lobe

The brain is divided into 5 lobes:

- Frontal—motor movement, motor aspect of speech (Broca's area), reasoning, emotions, personality, and problem solving
- Parietal—sensory perceptions related to pain, temperature, touch and pressure, spatial orientation and perception, sensory aspect of language (Wernicke's area)
- Temporal—auditory perceptions, learning, and memory
- Occipital—vision
- Insula—associated with visceral functions including taste

DIENCEPHALON

Composed of 4 parts:

- Thalamus—major relay center of the somatosensory system and parts of the motor system
- Hypothalamus—controls the autonomic nervous system and endocrine system
- Epithalamus—major structure is the pineal gland, which controls circadian rhythms
- Subthalamus—an extrapyramidal nucleus of the motor system

BRAINSTEM

Composed of 3 parts:

- Midbrain
- Pons
- Medulla

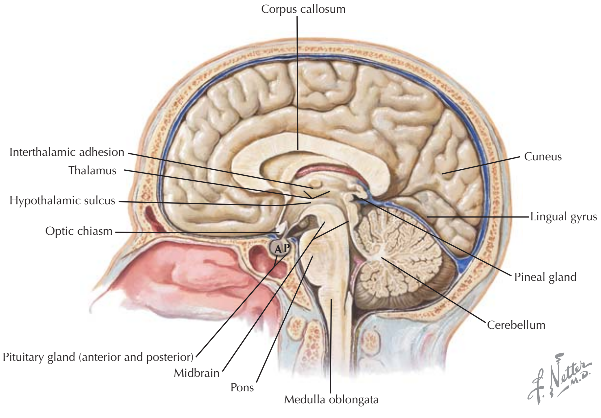
CEREBELLUM

Part of the motor system

Receives sensory input of all forms that use the deep cerebellar nuclei

Associated with:

- Equilibrium
- Posture
- Tone of axial muscles
- Gait



3 Central Nervous System

SPINAL CORD

The caudal continuation of the central nervous system

Begins at the caudal end of the medulla and ends at vertebral level L1–2, tapering into the conus medullaris

Has 2 enlargements associated with the limbs:

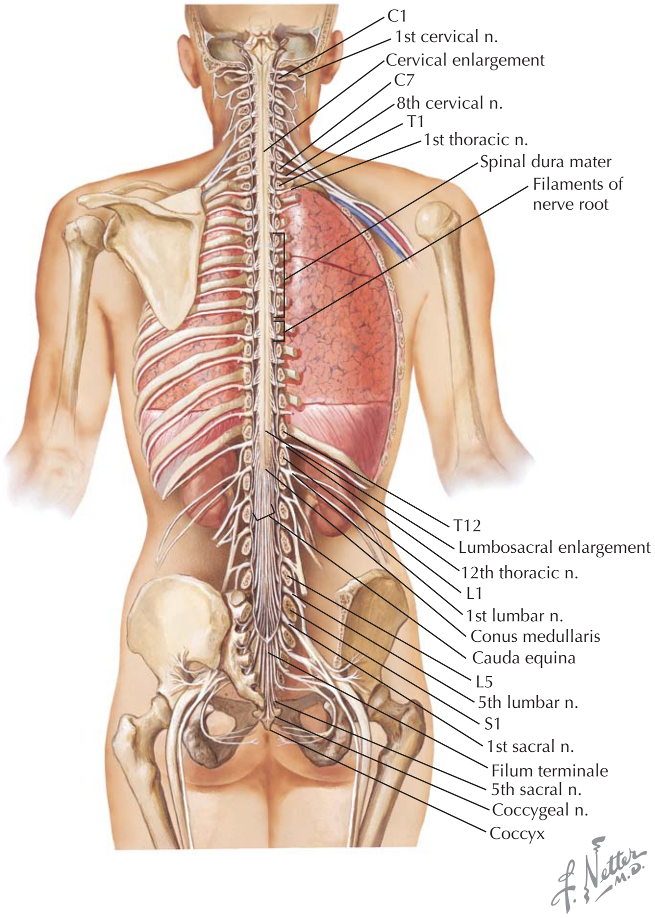
- Cervical—associated with the upper limb and found between the spinal cord at levels C4 to T1
- Lumbosacral—associated with the lower limb and found between the spinal cord at levels L1 to S2

Composed of:

- Gray matter—location of nerve cell bodies and neuroglial cells
- White matter—location of the axons and neuroglial cells

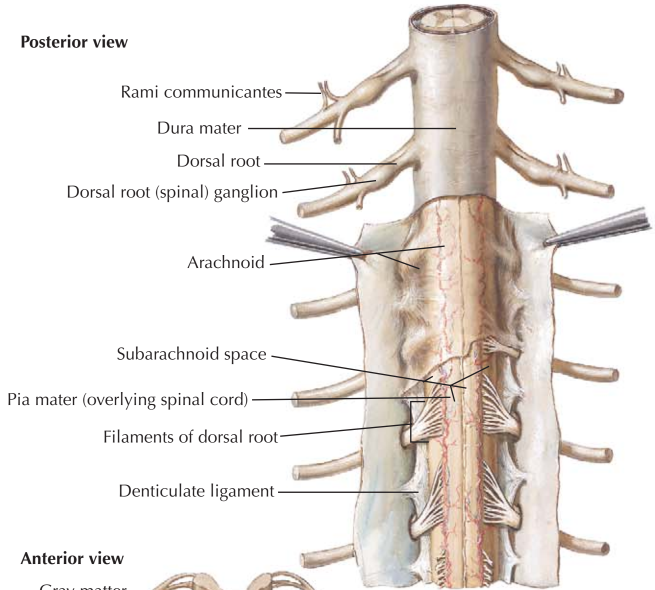
Has 5 levels:

- Cervical—8 spinal nerves
- Thoracic—12 spinal nerves
- Lumbar—5 spinal nerves
- Sacral—5 spinal nerves
- Coccygeal—1 spinal nerve

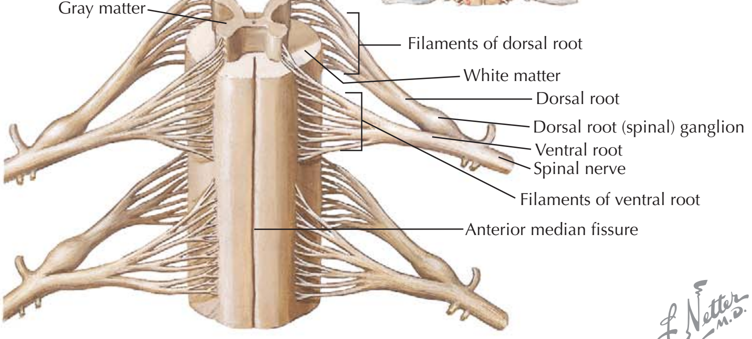


SPINAL CORD *CONTINUED*

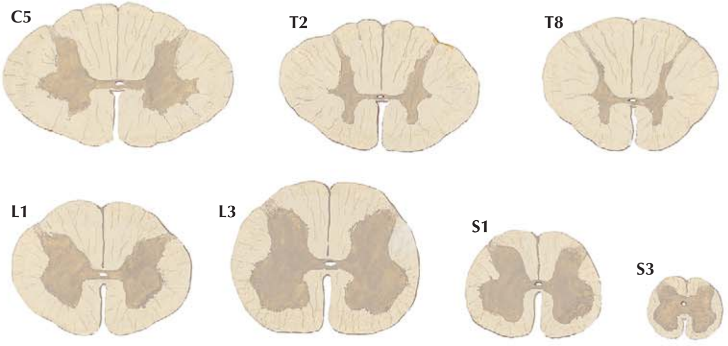
Posterior view



Anterior view



Sections through spinal cord at various levels



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Peripheral Nervous System

GENERAL INFORMATION

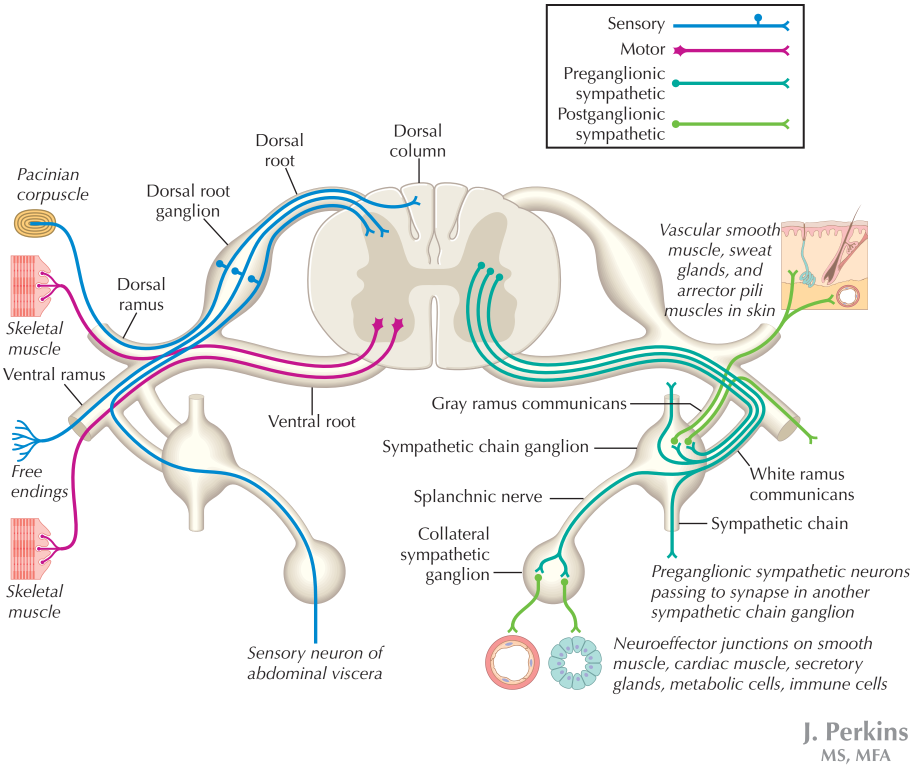
Peripheral nervous system is that portion of the nervous system located external to the central nervous system

Consists of:

- Cranial nerves—12 pairs
- Spinal nerves—31 pairs

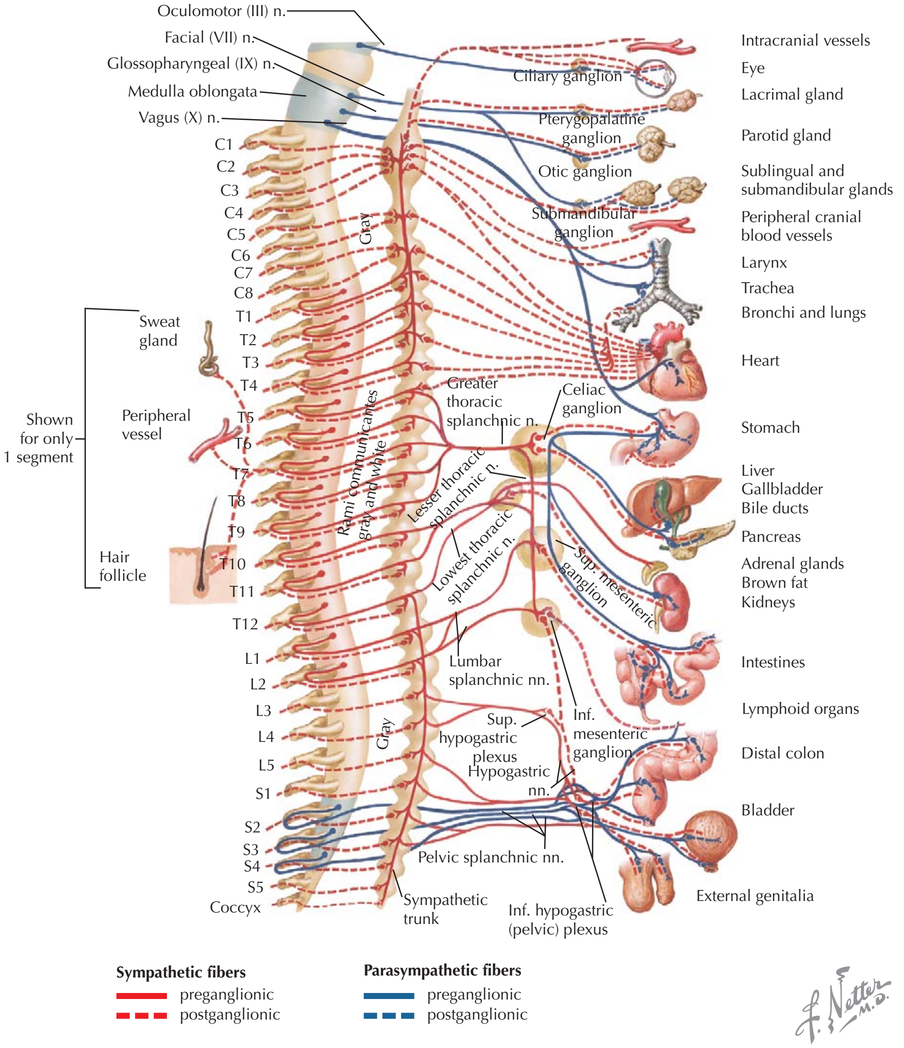
Can be subdivided into:

- Somatic nervous system—voluntary system associated with afferent (sensory) and efferent (motor) fibers
- Autonomic nervous system—involuntary system associated with homeostasis of the body



Peripheral Nervous System

SPINAL NERVES AND CRANIAL NERVES



3 Cranial Nerves

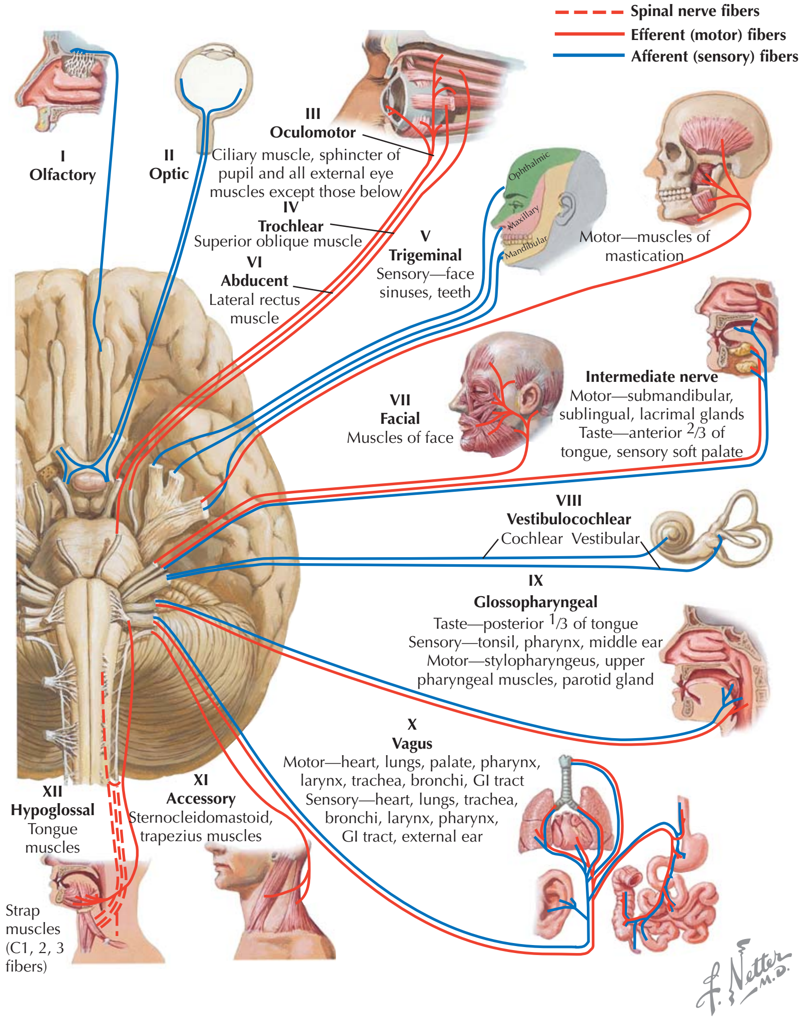
GENERAL INFORMATION

Cranial nerves or *cerebral nerves* are those peripheral nerves that leave the brain or brainstem

The cranial nerves customarily are subdivided into 12 pairs:

I: Olfactory nerve
II: Optic nerve
III: Oculomotor nerve
IV: Trochlear nerve
V: Trigeminal nerve
VI: Abducens nerve
VII: Facial nerve
VIII: Vestibulocochlear nerve
IX: Glossopharyngeal nerve
X: Vagus nerve
XI: Spinal accessory nerve
XII: Hypoglossal nerve

Because of the high degree of differentiation in the brain of humans, cranial nerves are more complex in structure and function than spinal nerves



Cranial Nerves

FUNCTIONAL COLUMNS

7 functional components (or functional columns) of the cranial nerves are recognized

- Concept of *functional columns* comes from studies of spinal nerves—functions associated with different neurologic pathways along spinal column are assigned corresponding "columns"

A given cranial nerve may have 1 to 5 functional columns

The functional columns are classified as *general* or *special*:

- General—these functional columns have the same functions as those for spinal nerves
- Special—these functional columns are specific only to cranial nerves

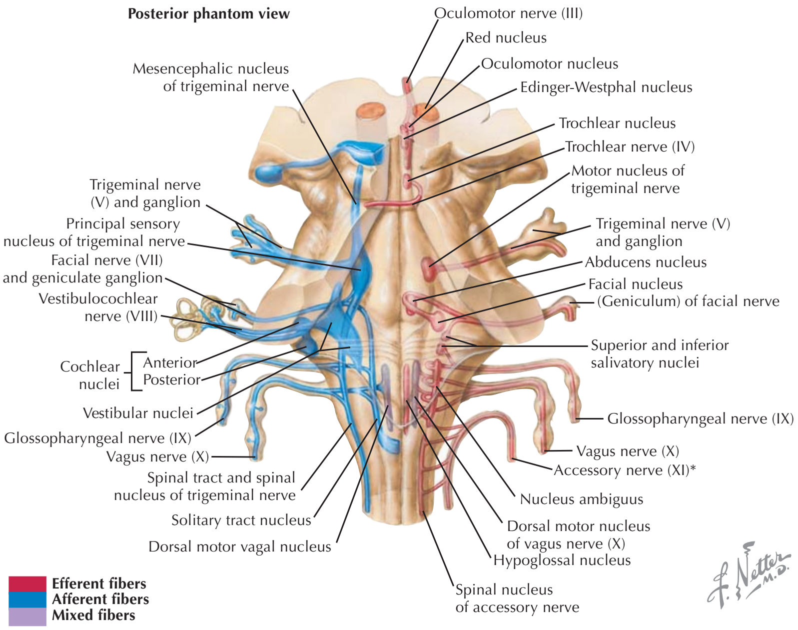
General and special functional columns each are subdivided into 2 additional categories:

- *Afferent* (sensory) and *efferent* (motor)
- *Somatic* (body-related) and *visceral* (organ-related)

SUMMARY OF FUNCTIONS

GSA	Exteroceptors and proprioceptors (e.g., for pain and temperature, or within tendons and joints) These are the same as in spinal nerves
SSA	Special senses in eye and ear (vision; hearing and equilibrium)
GVA	Sensory from viscera (gut) These are the same as in spinal nerves
SVA	Olfaction and taste
GVE	Autonomic nervous system These are the same as in spinal nerves
GSE	Body (somatic) muscle These are the same as in spinal nerves
SVE	Pharyngeal (branchial) arch muscles (homologous to GSE)

**Within each designation:* G or S, general or special; S or V, somatic or visceral; A or E, afferent or efferent.

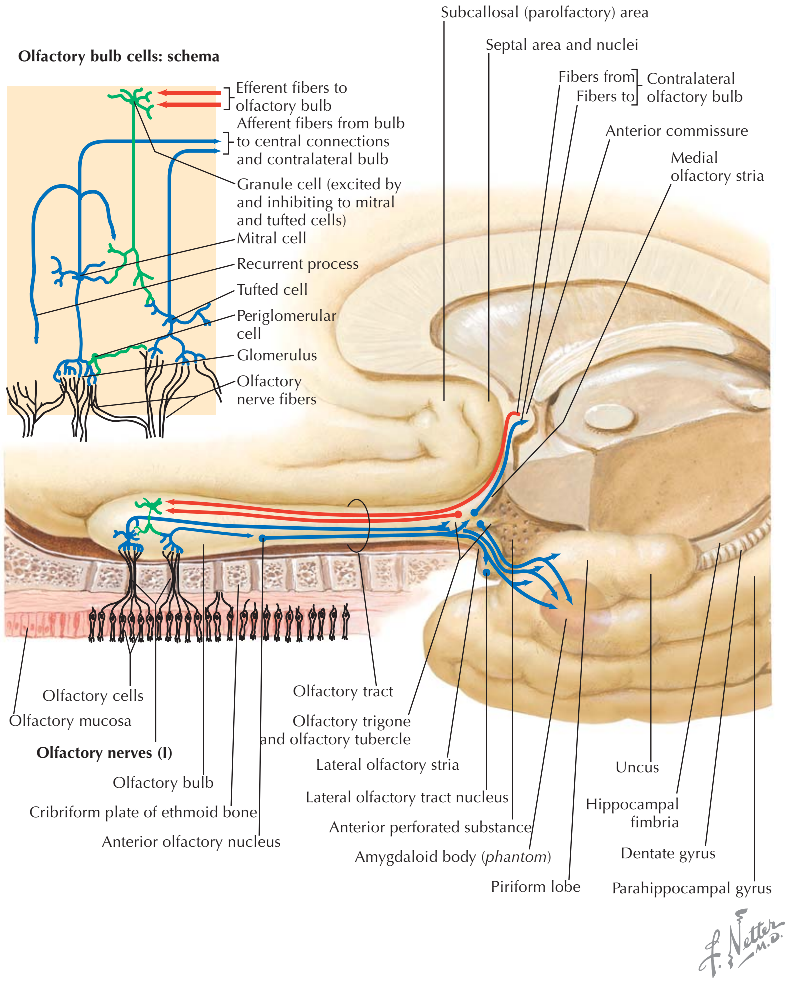


*Recent evidence suggests that the accessory nerve lacks a cranial root and has no connection to the vagus nerve. Verification of this finding awaits further investigation

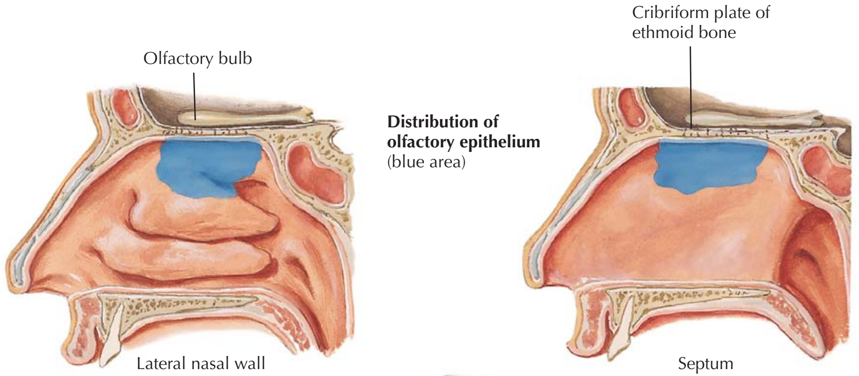
3 Cranial Nerves

CRANIAL NERVE I: OLFACTORY NERVE

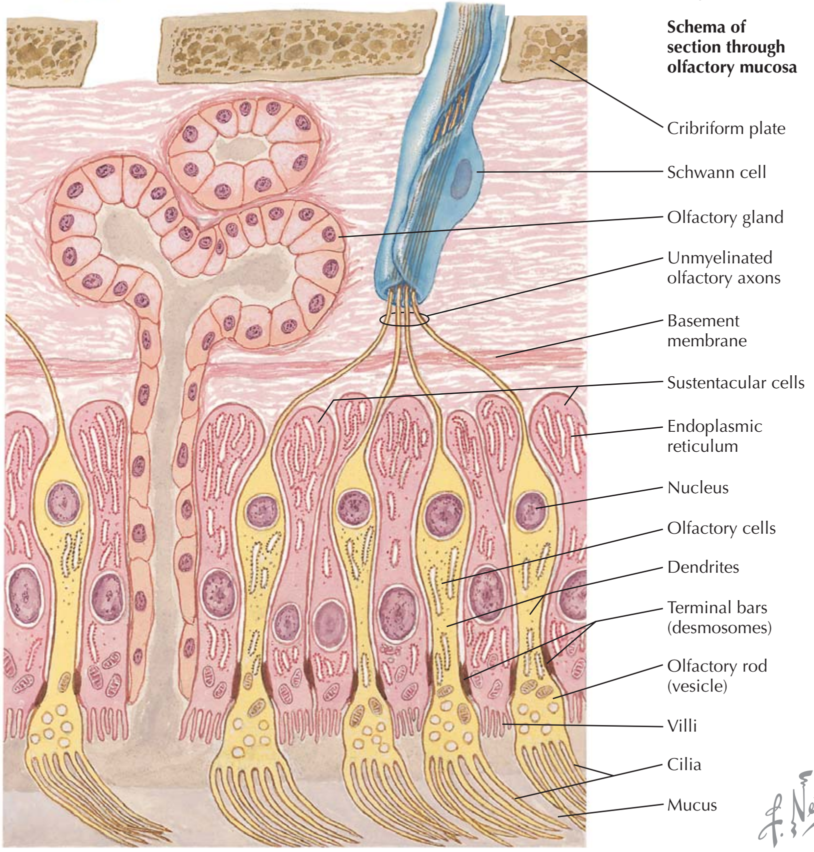
Functional Column	Origin of Fibers	Termination of Fibers	Summary	Comment
SVA	Fibers originate in the neurosensory cells of the olfactory epithelium The primary fibers travel through the cribriform plate to synapse on the secondary fibers within the olfactory bulb These fibers continue posteriorly as the olfactory tract that carries the fibers to the olfactory areas	The secondary fibers continue to synapse in the olfactory areas: • Lateral olfactory area • Anterior olfactory nucleus • Intermediate olfactory area • Medial olfactory area	The SVA fibers are responsible for the sense of smell	Tumors of the olfactory lobe can affect the olfactory system



CRANIAL NERVE I: OLFACTORY NERVE *CONTINUED*



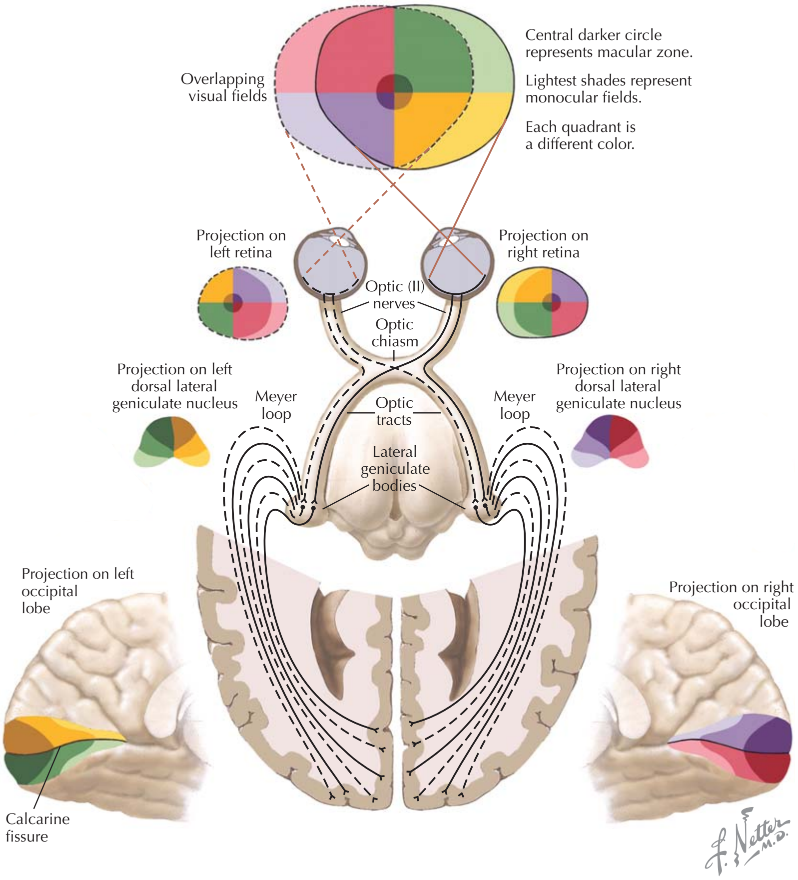
Distribution of olfactory epithelium (blue area)



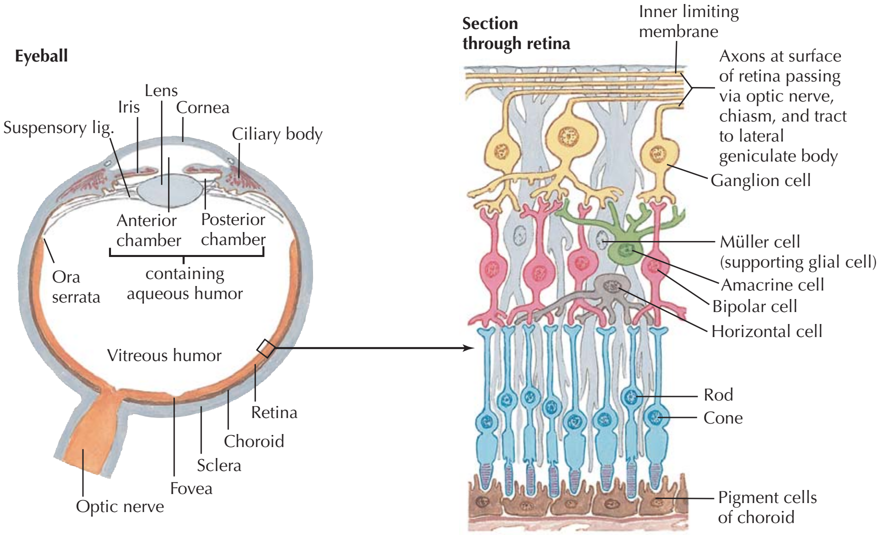
Schema of section through olfactory mucosa

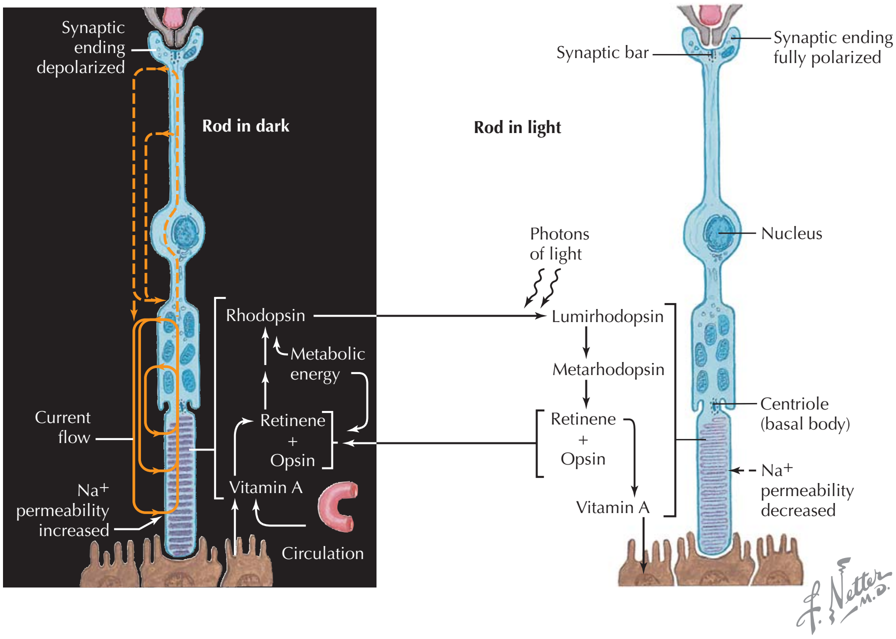
CRANIAL NERVE II: OPTIC NERVE

Functional Column	Origin of Fibers	Termination of Fibers	Summary	Comment
SSA	Begins in the retina with the receptors of rods and cones that synapse on bipolar cells which synapse with ganglion cells	Ganglionic axons form the optic nerve that meets in an incomplete crossing at the optic chiasm where: • Nasal retinal fibers decussate to the opposite side • Temporal retinal fibers remain on the ipsilateral side These form an optic tract that terminates on the lateral geniculate nucleus Fibers from the lateral geniculate travel to synapse in the occipital lobe	The SSA fibers are responsible for vision	Lesions of the optic nerve lead to blindness Lesions of the optic chiasm lead to bitemporal hemianopsia Lesions of the optic tract lead to homonymous hemianopsia



CRANIAL NERVE II: OPTIC NERVE *CONTINUED*



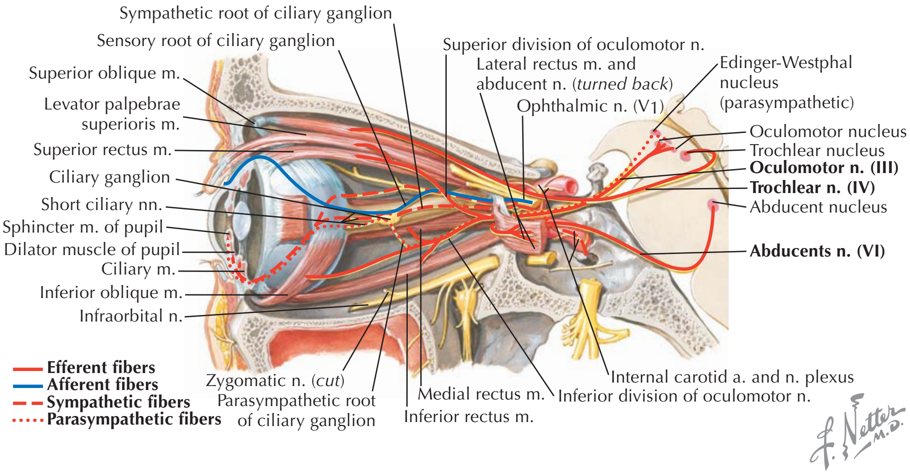


CRANIAL NERVES III, IV, AND VI: OCULOMOTOR, AND TROCHLEAR, ABDUCENS NERVES

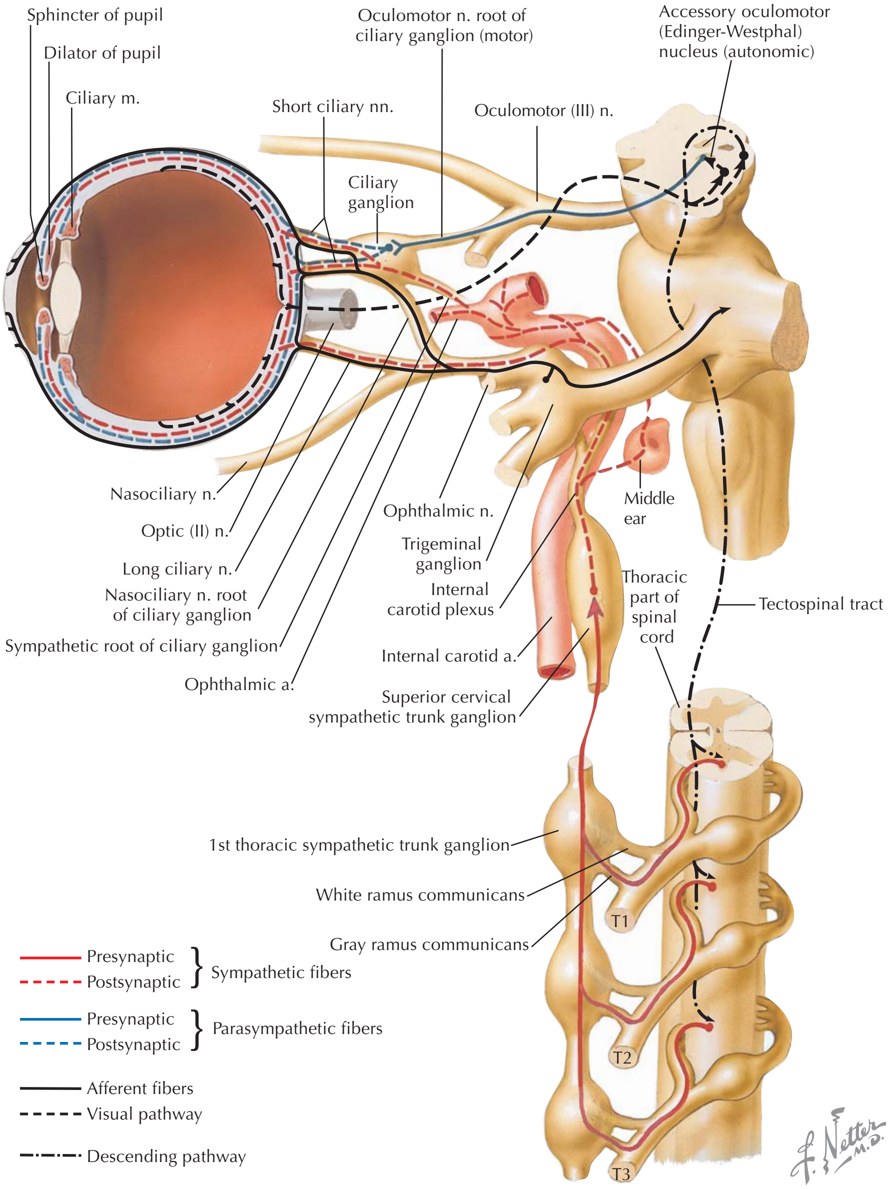
OCULOMOTOR NERVE				
Functional Column	**Origin of Fibers**	**Termination of Fibers**	**Summary**	**Comment**
GSE	Begins in the oculomotor nucleus	Innervates the superior rectus, inferior rectus, medial rectus, inferior oblique, and levator palpebrae superioris mm.	GSE fibers are responsible for innervating the majority of the extraocular eye muscles	Lesions of the oculomotor nerve result in diplopia, lateral strabismus, ptosis, and mydriasis
GVE	Preganglionic parasympathetic fibers begin in the Edinger-Westphal nucleus	Innervates the sphincter pupillae and ciliary mm.	GVE fibers are responsible for providing the parasympathetic innervation to the intrinsic eye muscles	GVE fibers utilize 1 ganglion: ● Ciliary

TROCHLEAR NERVE				
Functional Column	**Origin of Fibers**	**Termination of Fibers**	**Summary**	**Comment**
GSE	Begins in the trochlear nucleus	Innervates the superior oblique m.	GSE fibers are responsible for innervating 1 extraocular muscle of the eye: the superior oblique	The trochlear nerve exits the brainstem dorsally Lesions of the trochlear n. result in diplopia In trochlear n. lesions, the eye is adducted and elevated

ABDUCENS NERVE				
Functional Column	**Origin of Fibers**	**Termination of Fibers**	**Summary**	**Comment**
GSE	Begins in the abducens nucleus	Innervates the lateral rectus m.	GSE fibers are responsible for innervating 1 extraocular muscle of the eye: the lateral rectus	Lesions of the abducens nerve result in diplopia and medial strabismus

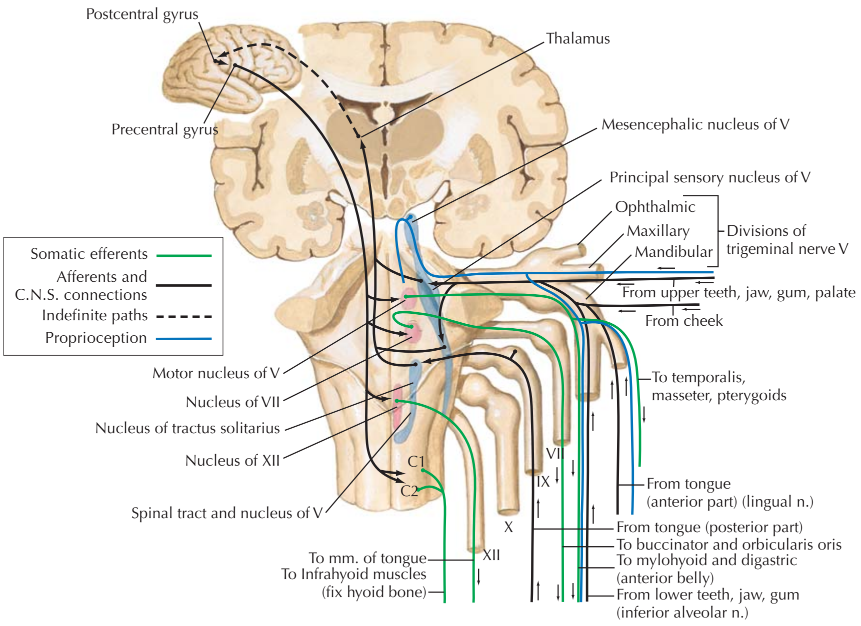


CRANIAL NERVES III, IV, AND VI: OCULOMOTOR, AND TROCHLEAR, ABDUCENS NERVES *CONTINUED*

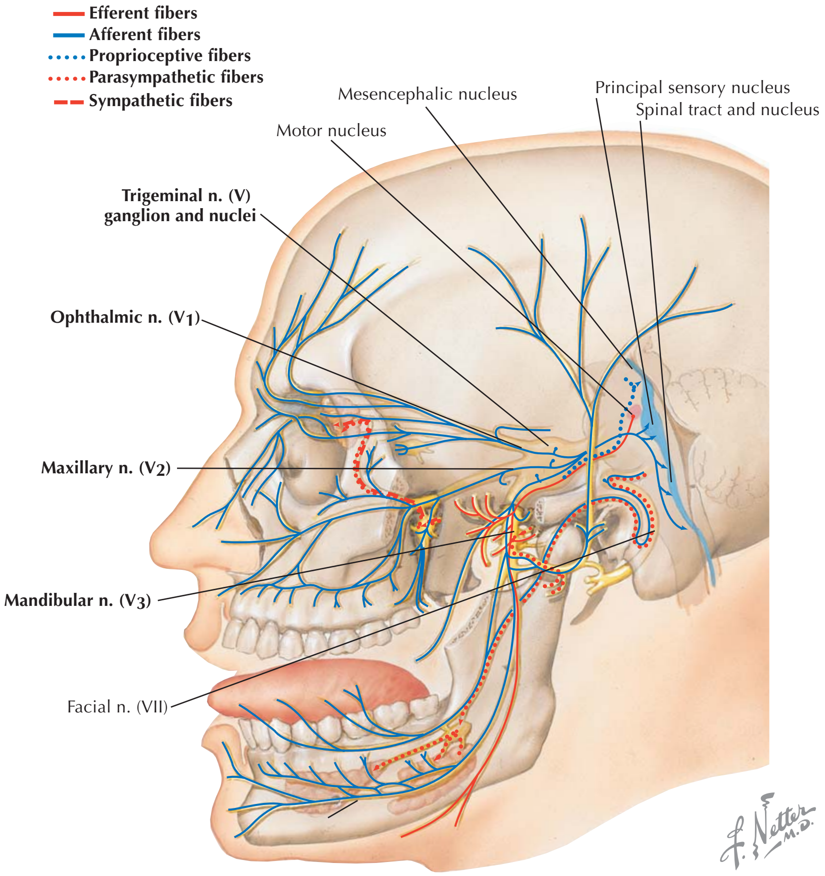


CRANIAL NERVE V: TRIGEMINAL NERVE

Functional Column	Origin of Fibers	Termination of Fibers	Summary	Comment
GSA	Afferent fibers begin in the various receptors (nociceptors, mechanoceptors, proprioceptors) of the skin and deep tissues of the head	Pain and temperature, and light touch fibers terminate in the spinal nucleus of V Discriminative touch fibers terminate in the main sensory nucleus of V Proprioception fibers have their cell bodies in the mesencephalic nucleus of V	GSA fibers are responsible for providing sensory innervation to the major part of the head GSA fibers utilize the trigeminothalamic lemniscus to carry their sensory impulses to consciousness	Provides sensory innervation through 3 main divisions: ● Ophthalmic ● Maxillary ● Mandibular The nerve cell bodies for the primary fibers are located in the trigeminal ganglion
SVE	Begins in the motor nucleus of the trigeminal	Innervates the muscles of mastication: ● Masseter ● Temporalis ● Medial pterygoid ● Lateral pterygoid Also innervates: ● Mylohyoid ● Anterior digastric ● Tensor tympani ● Tensor veli palatini	The SVE fibers are responsible for innervating the muscles of the 1st pharyngeal arch	



CRANIAL NERVE V: TRIGEMINAL NERVE *CONTINUED*



OPHTHALMIC DIVISION OF THE TRIGEMINAL NERVE

The ophthalmic division (V_1), being a branch of the trigeminal n., is sensory in function

Arises from the main nerve in the middle cranial fossa

Passes anterior on the lateral wall of the cavernous sinus immediately inferior to the oculomotor and trochlear nn., but superior to the maxillary division of the trigeminal n.

Immediately before entering the orbit, through the superior orbital fissure, it divides into 3 major branches:

- Lacrimal
- Frontal
- Nasociliary

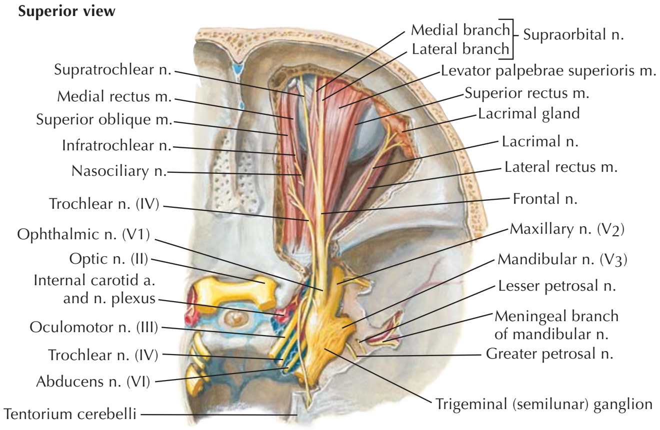
Nerve	Source	Course
Lacrimal	1 of the 3 major branches of the ophthalmic division of the trigeminal n.	Smallest branch of the ophthalmic division of the trigeminal n. Passes anteriorly to enter the orbit through the superior orbital fissure In the orbit it travels on the superior border of the lateral rectus with the lacrimal a. Before reaching the lacrimal gland, it communicates with the zygomatic branch of the maxillary division of the trigeminal n. to receive autonomic nervous fibers Enters the lacrimal gland and supplies it and the conjunctiva before piercing the orbital septum to supply the skin of the upper eyelid

CRANIAL NERVE V: TRIGEMINAL NERVE *CONTINUED*

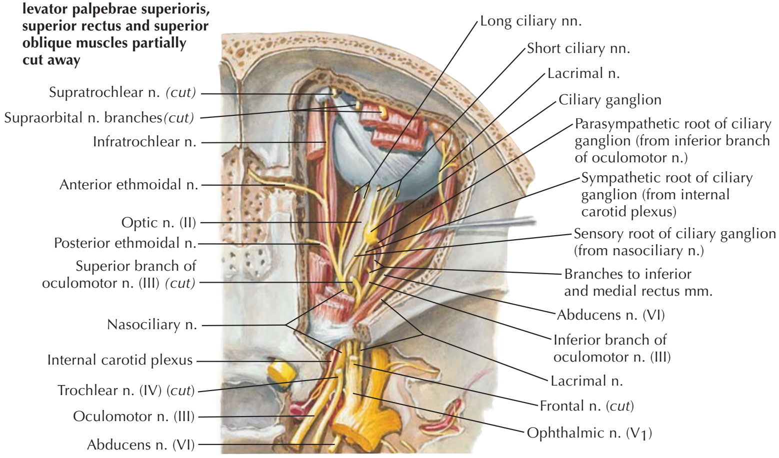
Nerve	Source	Course
Frontal		Largest branch of the ophthalmic division of the trigeminal n. Passes anteriorly to enter the orbit through the superior orbital fissure In the orbit it passes anteriorly between the periosteum of the orbit and the levator palpebrae superioris m. About halfway in the orbit, it divides into its 2 terminal nerves, the supraorbital and supratrochlear nn.
Supraorbital	Frontal n.	1 of the 2 terminal branches of the frontal n. in the orbit Passes between the levator palpebrae superioris m. and periosteum of the orbit Continues anteriorly to the supraorbital foramen (notch) At the level of the supraorbital margin, it sends nerve supply to the frontal sinus and ascends superiorly along the scalp Divides into medial and lateral branches, which travel up to the vertex of the scalp
Supratrochlear		1 of the 2 terminal branches of the frontal n. in the orbit Once the supratrochlear a. joins it within the orbit, it continues to pass anteriorly toward the trochlear n. In the trochlear region, it often supplies the frontal sinus before exiting the orbit Ascends along the scalp, at first deep to the musculature in the region, before piercing these muscles to reach the cutaneous innervation along the scalp
Nasociliary	1 of the 3 major branches of the ophthalmic division of the trigeminal n.	Passes anteriorly to enter the orbit through the superior orbital fissure Enters the orbit lateral to the optic n. Travels across the optic n. anteriorly and medially to lie between the medial rectus m. and the superior oblique m. along the medial wall of the orbit All along its path, it gives rise to other nerves, including the sensory root of the ciliary ganglion and the long ciliary and posterior ethmoid nn., until terminating into the anterior ethmoid and infratrochlear nn. near the anterior ethmoid foramen
Sensory root of the ciliary ganglion	Nasociliary n.	Travels anteriorly on the lateral side of the optic n. to enter the ciliary ganglion Carries general sensory fibers, which are distributed by the short ciliary nn.
Short ciliary	Ciliary ganglion	Arises from the ciliary ganglion to travel to the posterior surface of the eye Supplies the sensory fibers to the eye and helps carry the postganglionic parasympathetic fibers to the sphincter pupillae and the ciliary muscle
Long ciliary	Nasociliary n.	Has 2 to 4 branches that travel anteriorly to enter the posterior part of the sclera of the eye
Posterior ethmoid		Travels deep to the superior oblique m. to pass through the posterior ethmoid foramen Supplies the sphenoid sinus and the posterior ethmoid sinus
Anterior ethmoid		Arises on the medial wall of the orbit Enters the anterior ethmoid foramen and travels through the canal to enter the anterior cranial fossa Supplies the anterior and middle ethmoid sinus before entering and supplying the nasal cavity Terminates as the external nasal n. on the face
External nasal	A terminal branch of the anterior ethmoid n.	Exits between the lateral nasal cartilage and the inferior border of the nasal bone Supplies the skin of the ala and apex of the nose around the nares
Internal nasal		Supplies the skin on the internal surface of the vestibule
Infratrochlear	Nasociliary n.	1 of the terminal branches of the nasociliary branch of the ophthalmic division of the trigeminal n. Passes anteriorly on the superior border of the medial rectus m. Passes inferior to the trochlea toward the medial angle of the eye Supplies the skin of the eyelids and bridge of the nose, the conjunctiva, and all of the lacrimal structures

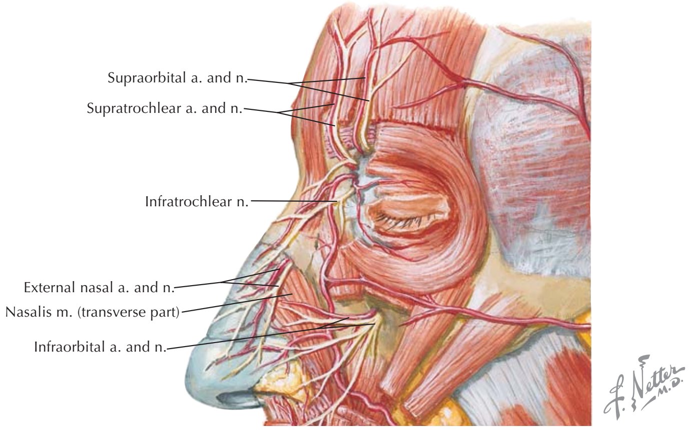
CRANIAL NERVE V: TRIGEMINAL NERVE *CONTINUED*

Superior view



Superior view: levator palpebrae superioris, superior rectus and superior oblique muscles partially cut away





CRANIAL NERVE V: TRIGEMINAL NERVE *CONTINUED*

MAXILLARY DIVISION OF THE TRIGEMINAL NERVE

The maxillary division (V_2), being a branch of the trigeminal n., is sensory in function

Branches from the trigeminal n. and travels along the lateral wall of the cavernous sinus

Passes from the middle cranial fossa into the pterygopalatine fossa via the foramen rotundum

Within the pterygopalatine fossa, it gives rise to 4 branches

1 of those nerves, the infraorbital n., is considered the continuation of the maxillary division of the trigeminal n.

BRANCHES WITHIN THE MIDDLE CRANIAL FOSSA

Nerve	Course
Meningeal	A small meningeal branch is given off within the middle cranial fossa The nerve supplies the meninges

BRANCHES WITHIN THE PTERYGOPALATINE FOSSA

Nerve	Course
Posterior superior alveolar	Passes through the pterygomaxillary fissure to enter the infratemporal fossa In the infratemporal fossa, it passes on the posterior surface of the maxilla along the region of the maxillary tuberosity Gives rise to a gingival branch that innervates the buccal gingiva alongside the maxillary molars Enters the posterior surface of the maxilla and supplies the maxillary sinus and the maxillary molars, with the possible exception of the mesiobuccal root of the 1st maxillary molar, and the gingiva and mucosa alongside the same teeth
Zygomatic	Passes through the inferior orbital fissure to enter the orbit Passes on the lateral wall of the orbit and branches into the zygomaticotemporal and zygomaticofacial branches A communicating branch from it joins the lacrimal n. from the ophthalmic division of the trigeminal n. to carry autonomics to the lacrimal gland
Ganglionic branches	Usually 1 or 2 ganglionic branches that connect the maxillary division of the trigeminal n. to the pterygopalatine ganglion Contain sensory fibers that pass through the pterygopalatine ganglion (without synapsing) to be distributed with the nerves that arise from the pterygopalatine ganglion Also contain postganglionic autonomic fibers to the lacrimal gland that pass through the pterygopalatine ganglion (parasympathetic fibers form a synapse here between the preganglionic fibers from the vidian n. and the postganglionic fibers)
Infraorbital	Considered the continuation of the maxillary division of the trigeminal n. Passes through the inferior orbital fissure to enter the orbit Passes anteriorly through the infraorbital groove and infraorbital canal and exits onto the face via the infraorbital foramen

BRANCHES ASSOCIATED WITH THE PTERYGOPALATINE GANGLION

Nerve	Course
Pharyngeal	Passes through the pharyngeal canal to enter and supply the nasopharynx
Posterior superior nasal	A branch of the maxillary division of the trigeminal n. Arises from the pterygopalatine ganglion in the pterygopalatine fossa Passes through the sphenopalatine foramen to enter the nasal cavity and branches into the: • Posterior medial superior nasal n. • Posterior lateral superior nasal n.
Posterior lateral superior nasal	A branch of the posterior superior nasal n. that supplies the posterosuperior portion of the lateral wall of the nasal cavity in the region of the superior and middle concha
Posterior medial superior nasal	Arises from the posterior superior nasal n. from the maxillary division of the trigeminal n. This nerve supplies the posterior portion of the nasal septum
Greater palatine	Passes through the palatine canal to enter the hard palate via the greater palatine foramen Supplies the palatal gingiva and mucosa from the area in the premolar region to the posterior border of the hard palate to the midline

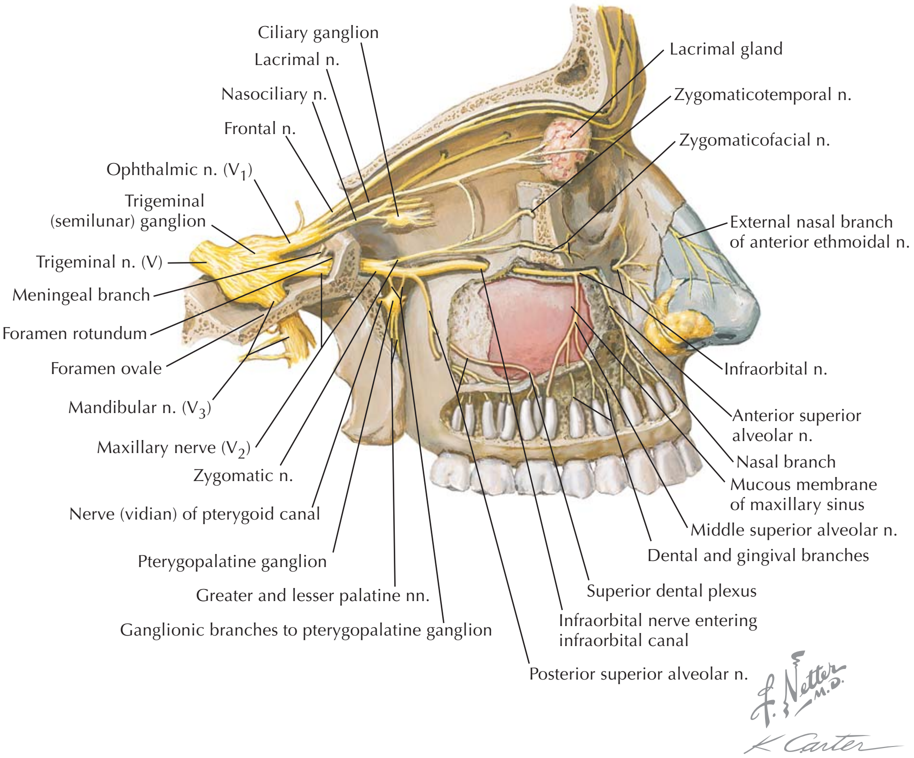
CRANIAL NERVE V: TRIGEMINAL NERVE *CONTINUED*

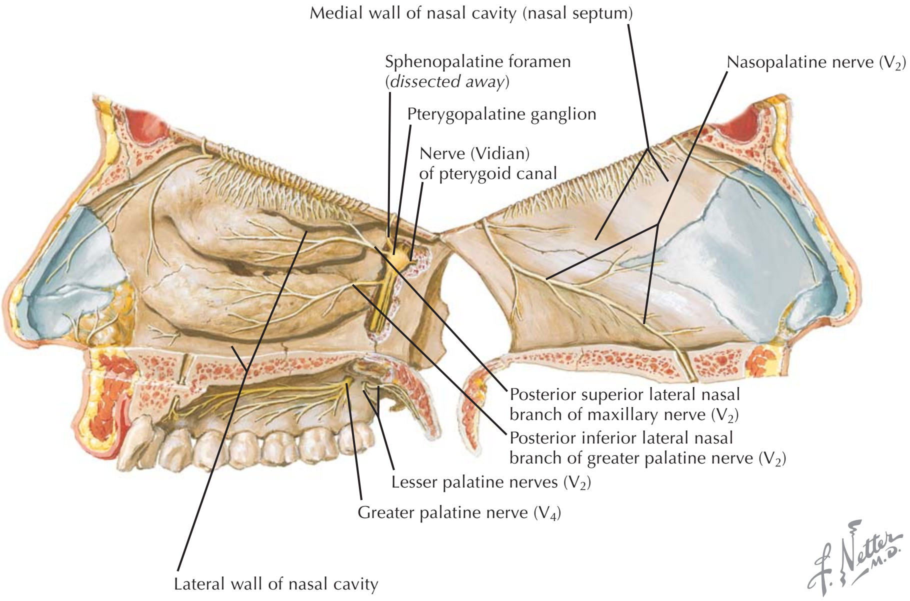
BRANCHES ASSOCIATED WITH THE PTERYGOPALATINE GANGLION	
Nerve	**Course**
Posterior inferior nasal branch of the greater palatine	While descending in the palatine canal, the greater palatine n. gives rise to a posterior inferior nasal branch Supplies the posterior part of the lateral wall of the nasal cavity in the region of the middle meatus
Lesser palatine	Passes through the palatine canal to enter and supply the soft palate via the lesser palatine foramen
Nasopalatine	Branches from the pterygopalatine ganglion in the pterygopalatine fossa Passes through the sphenopalatine foramen to enter the nasal cavity Passes along the superior portion of the nasal cavity to the nasal septum, where it travels anteroinferiorly to the incisive canal, supplying the septum Passes through the incisive canal to supply the gingiva and mucosa of the hard palate from central incisor to canine

BRANCHES WITHIN THE INFRAORBITAL CANAL	
Nerve	**Course**
Middle superior alveolar	A variable nerve When present, it branches off the infraorbital n. as it travels in the infraorbital canal As the nerve descends to form the superior dental plexus, it innervates part of the maxillary sinus; the premolars and possibly the mesiobuccal root of the 1st molar; and the gingiva and mucosa alongside the same teeth
Anterior superior alveolar	While in the infraorbital canal, it gives rise to the anterior superior alveolar n., which has a small branch that supplies the nasal cavity in the region of the inferior meatus and inferior corresponding portion of the nasal septum, the maxillary sinus As the nerve descends to form the superior dental plexus, it innervates part of the maxillary sinus; maxillary central incisor, lateral incisor, and canine teeth; and the gingiva and mucosa alongside the same teeth

BRANCHES AFTER INFRAORBITAL NERVE EMERGES FROM THE INFRAORBITAL FORAMEN	
Nerve	**Course**
Superior labial branch of the infraorbital	Supplies the skin of the upper lip
Nasal branch of the infraorbital	Supplies the ala of the nose
Inferior palpebral branch of the infraorbital	Supplies the skin of the lower eyelid

CRANIAL NERVE V: TRIGEMINAL NERVE *CONTINUED*





CRANIAL NERVE V: TRIGEMINAL NERVE *CONTINUED*

MANDIBULAR DIVISION OF THE TRIGEMINAL NERVE

			Divisions	
Description	**Source**	**Course**	**Anterior**	**Posterior**
Mandibular division (V_3) is the largest of the 3 divisions of the trigeminal n. Has motor *and* sensory functions	Created by a large sensory root and a small motor root that unite just after passing through the foramen ovale to enter the infratemporal fossa	Immediately gives rise to a meningeal branch and then divides into anterior and posterior divisions	Smaller; mainly motor, with 1 sensory branch (buccal): • Masseteric • Anterior and posterior deep temporal • Medial pterygoid • Lateral pterygoid • Buccal	Larger; mainly sensory, with 1 motor branch (nerve to the mylohyoid): • Auriculotemporal • Lingual • Inferior alveolar • Mylohyoid nerve

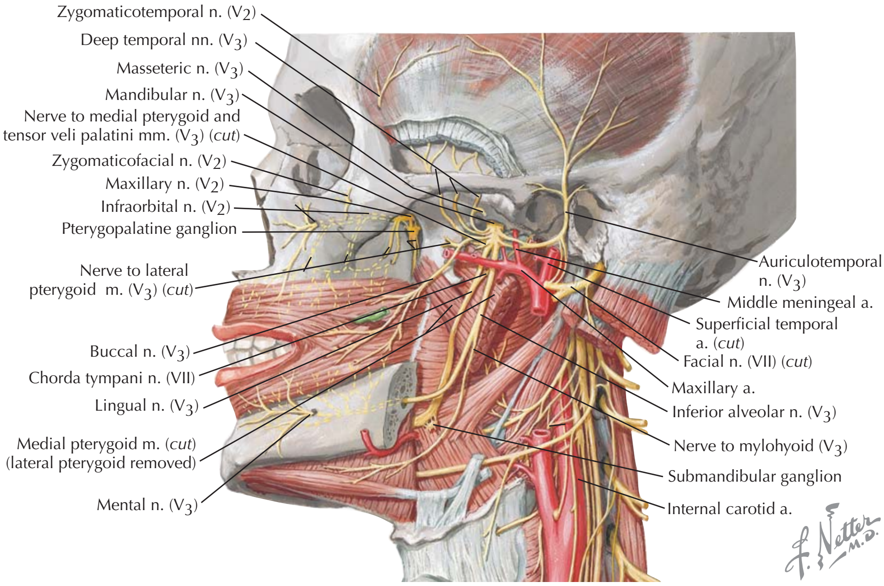
ANTERIOR DIVISION OF THE MANDIBULAR NERVE

Branch	Course
Masseteric	Passes laterally superior to the lateral pterygoid m. Lies anterior to the temporomandibular joint and posterior to the tendon of the temporalis m. Crosses the mandibular notch with the masseteric a. to innervate the masseter m. Also provides a small branch to the temporomandibular joint
Anterior and posterior deep temporal	Pass superior to the lateral pterygoid m. between the skull and the temporalis m. while passing deep to the muscle to innervate it
Medial pterygoid	Enters the deep surface of the muscle
Lateral pterygoid	Passes into the deep surface of the muscle Often arises from the buccal n.
Buccal	Passes anteriorly between the 2 heads of the lateral pterygoid m. Descends inferiorly along the lower part of the temporalis m. to appear from deep to the anterior border of the masseter m. Supplies the skin over the buccinator m. before passing through it to supply the mucous membrane lining its inner surface and the gingiva along the mandibular molars

POSTERIOR DIVISION OF THE MANDIBULAR NERVE

Branch	Course
Auriculotemporal	Normally arises by 2 roots, between which the middle meningeal a. passes Runs posteriorly just inferior to the lateral pterygoid and continues to the medial side of the neck of the mandible Then it turns superiorly with the superficial temporal vessels between the auricle and condyle of the mandible deep to the parotid gland On exiting the parotid gland, it ascends over the zygomatic arch and divides into superficial temporal branches
Lingual	Lies inferior to the lateral pterygoid and medial and anterior to the inferior alveolar n. The chorda tympani n. also joins the posterior part The lingual n. passes between the medial pterygoid and the ramus of the mandible to pass obliquely to enter the oral cavity bounded by the superior pharyngeal constrictor m., medial pterygoid, and the mandible Supplies the mucous membrane of the anterior 2/3 of the tongue and gingiva on the lingual side of the mandibular teeth
Inferior alveolar	The largest branch of the mandibular division Descends following the inferior alveolar a. inferior to the lateral pterygoid and finally between the sphenomandibular lig. and the ramus of the mandible until it enters the mandibular foramen Innervates all mandibular teeth and the gingiva from the premolars anteriorly to the midline via the mental branch
Mylohyoid	Branches from the inferior alveolar n. immediately before it enters the mandibular foramen Descends in a groove on the deep side of the ramus of the mandible until it reaches the superficial surface of the mylohyoid Supplies the mylohyoid and the anterior belly of the digastric m.

CRANIAL NERVE V: TRIGEMINAL NERVE *CONTINUED*



TRIGEMINAL NERVE PATHWAYS

Responsible for carrying to conscious level:
- Pain and temperature
- Light touch
- Discriminative touch
- Pressure

Utilizes a 3-neuron sensory system:
- Primary neuron
- Secondary neuron
- Tertiary neuron

Utilizes the contralateral ventral trigeminothalamic tract

Some discriminative touch and pressure fibers utilize the ipsilateral dorsal trigeminothalamic tract, but this contribution is very minor

Proprioception fibers are unique in that the cell body for the sensory nerve fiber is located in the central nervous system (mesencephalic nuceus)

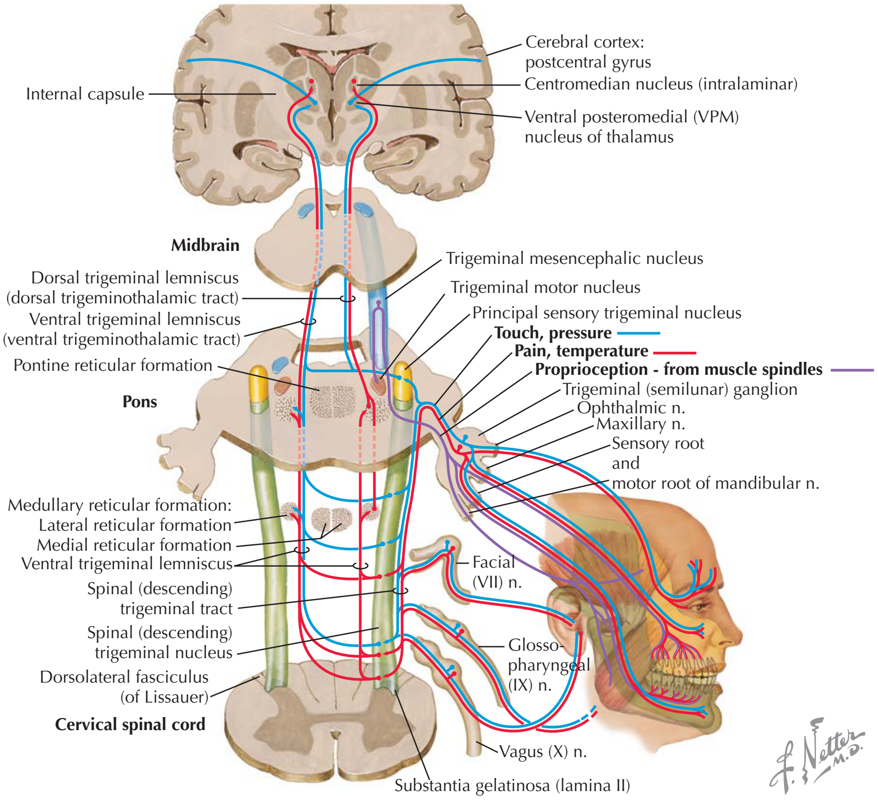
Types of Fibers	Trigeminal Sensory Nucleus	Ascending Pathway
Pain and temperature Light touch	Spinal (descending) nucleus	Ventral trigeminothalamic tract
Discriminative touch Pressure	Principal (main) sensory nucleus	Ventral trigeminothalamic tract (Dorsal trigeminothalamic tract subserves discriminative touch and pressure)
Proprioception	Mesencephalic nucleus	Projects to motor nucleus of V to control the jaw jerk reflex and force of bite

CRANIAL NERVE V: TRIGEMINAL NERVE *CONTINUED*

MAJOR ASCENDING PATHWAYS OF THE TRIGEMINAL NERVE			
Types of Neurons	**Path of Pain and Temperature**	**Path of Light Touch**	**Path of Discriminative Touch and Pressure**
Primary neuron	Fibers travel from the receptor from the ophthalmic, maxillary, and mandibular divisions of the trigeminal n. The nerve cell body of the primary neuron is located in the trigeminal ganglion Fibers enter the pons Fibers descend in the spinal (descending) tract located from the pons to the upper cervical spinal cord Fibers synapse on the nerve cell body of the secondary neuron	Fibers travel from the receptor from the ophthalmic, maxillary, and mandibular divisions of the trigeminal n. The nerve cell body of the primary neuron is located in the trigeminal ganglion Fibers enter the pons Fibers may have either of 2 courses: • May descend in the spinal (descending) tract located from the pons to the upper cervical spinal cord • May ascend to synapse on the nerve cell body of the secondary neuron Fibers synapse on the nerve cell body of the secondary neuron	Fibers travel from the receptor from the ophthalmic, maxillary, and mandibular divisions of the trigeminal n. The nerve cell body of the primary neuron is located in the trigeminal ganglion Fibers enter the pons Fibers ascend to synapse on the nerve cell body of the secondary neuron
Secondary neuron	Secondary nerve cell bodies begin in the spinal (descending) nucleus located from the pons to the upper cervical spinal cord Fibers decussate and ascend in the ventral trigeminothalamic tract (lemniscus) to the thalamus Fibers synapse on the nerve cell body of the tertiary neuron	Secondary nerve cell bodies may reach the thalamus along either of 2 courses: • May begin in the spinal (descending) nucleus and decussate and ascend in the ventral trigeminothalamic tract (lemniscus) to the thalamus • May begin in the principal (main) sensory nucleus and decussate and ascend in the ventral trigeminothalamic tract (lemniscus) to the thalamus (NOTE: some fibers ascend in the ipsilateral dorsal trigeminothalamic tract) Fibers synapse on the nerve cell body of the tertiary neuron	Secondary nerve cell bodies begin in the principal (main) sensory nucleus located in the pons Fibers decussate and ascend in the ventral trigeminothalamic tract (lemniscus) to the thalamus (NOTE: some fibers ascend in the ipsilateral dorsal trigeminothalamic tract) Fibers synapse on the nerve cell body of the tertiary neuron
Tertiary neuron	Tertiary nerve cell bodies begin in the ventral posteromedial nucleus of the thalamus (VPM) Fibers ascend through the posterior limb of the internal capsule to terminate in the postcentral gyrus	Tertiary nerve cell bodies begin in the VPM Fibers ascend through the posterior limb of the internal capsule to terminate in the postcentral gyrus	Tertiary nerve cell bodies begin in the VPM Fibers ascend through the posterior limb of the internal capsule to terminate in the postcentral gyrus

PROPRIOCEPTION OF THE TRIGEMINAL NERVE
Sensory fibers carry input from the neuromuscular spindles along the mandibular division of the trigeminal n. The nerve cell bodies of these sensory neurons are located in the mesencephalic nucleus of the midbrain These fibers project to the motor nucleus of the trigeminal n. innervate the muscles of mastication, to control the jaw jerk reflex and force of bite

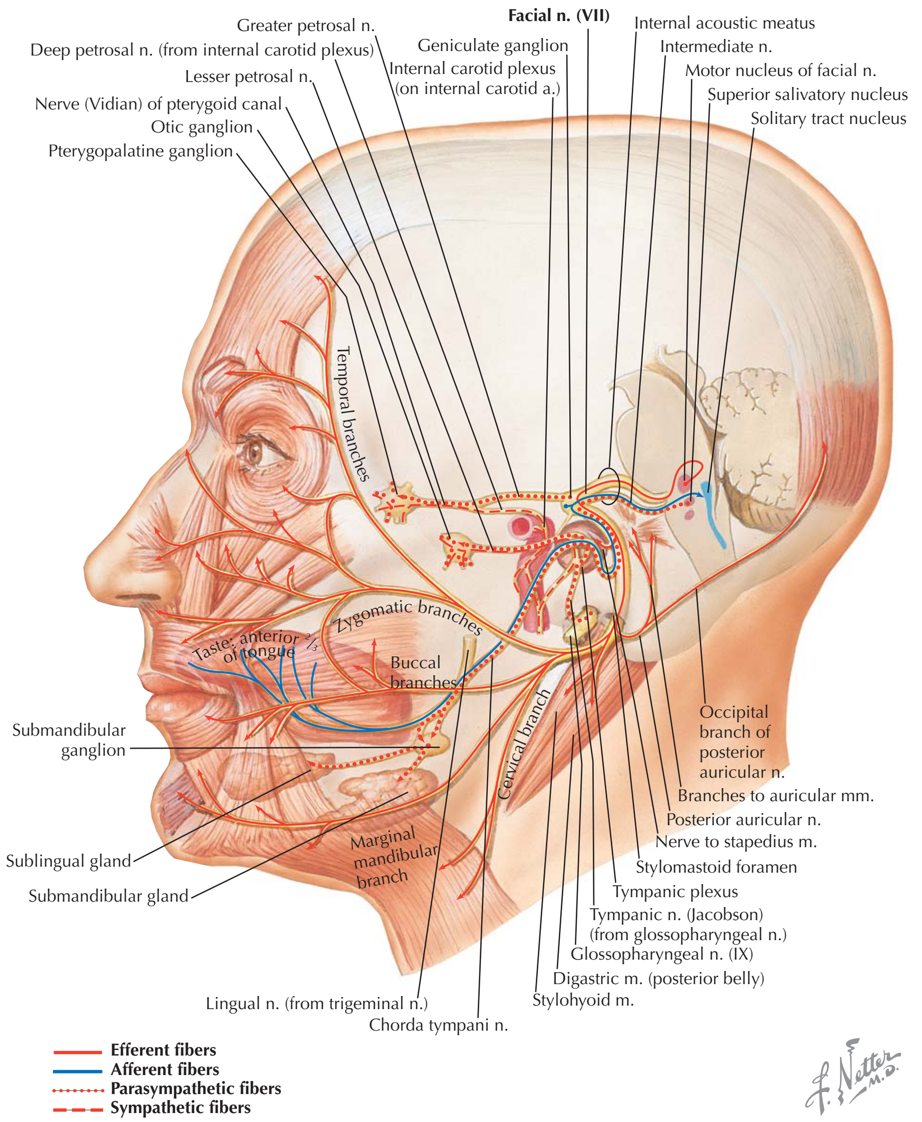
CRANIAL NERVE V: TRIGEMINAL NERVE *CONTINUED*



CRANIAL NERVE VII: FACIAL NERVE

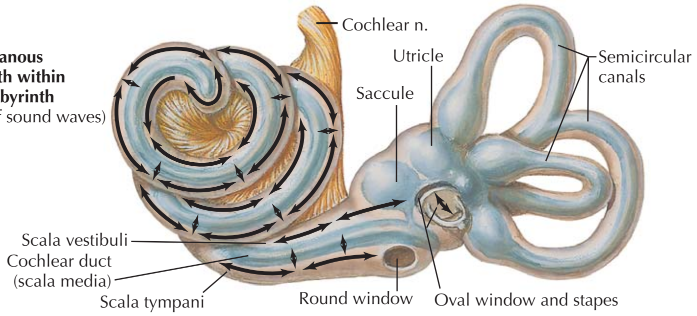
Functional Column	Origin of Fibers	Termination of Fibers	Summary	Comment
GSA	Afferent fibers begin in the various receptors (nociceptors, mechanoceptors, proprioceptors) of the skin of the external ear and tympanic membrane	Pain and temperature fibers terminate in the spinal nucleus of V	GSA fibers are carried in the nervus intermedius portion of the facial n. GSA fibers are responsible for providing sensory innervation to a portion of the external ear and tympanic membrane GSA fibers of the facial n. utilize the trigeminothalamic lemniscus to carry their sensory impulses to consciousness	Facial nerve provides a very small area of GSA distribution Nerve cell bodies for the primary fibers are located in the geniculate ganglion
SVA	Afferent fibers begin in the taste receptors of the anterior 2/3 of the tongue	Primary afferent fibers travel in the tractus solitarius and terminate in the nucleus solitarius	SVA fibers are carried in the nervus intermedius portion of the facial n. SVA fibers are responsible for carrying the taste fibers from the taste buds on the anterior 2/3 of the tongue	Nerve cell bodies for the primary fibers are located in the geniculate ganglion
GVA	Afferent fibers begin in the various receptors (such as nociceptors) of the mucous membranes of the nasopharynx	Primary afferent fibers travel in the tractus solitarius and terminate in the nucleus solitarius	GVA fibers are carried in the nervus intermedius portion of the facial n. GVA fibers utilize the same pathway as for the SVA fibers	Nerve cell bodies for the primary fibers are located in the geniculate ganglion
GVE	Preganglionic parasympathetic fibers begin in the superior salivatory nucleus	Postganglionic parasympathetic fibers innervate the lacrimal, nasal, submandibular, and sublingual glands	GVE fibers are carried in the nervus intermedius portion of the facial n.	GVE fibers utilize 2 ganglia: • Pterygopalatine • Submandibular
SVE	Begins in the motor nucleus of the facial n.	Innervates the muscles of facial expression, stylohyoid, posterior digastric, and stapedius mm.	SVE fibers are carried in the motor root of the facial n. SVE fibers are responsible for innervating the muscles of the 2nd pharyngeal arch	In Bell's palsy, the easiest symptom to observe is that the muscles innervated by the SVE fibers are paralyzed

CRANIAL NERVE VII: FACIAL NERVE *CONTINUED*

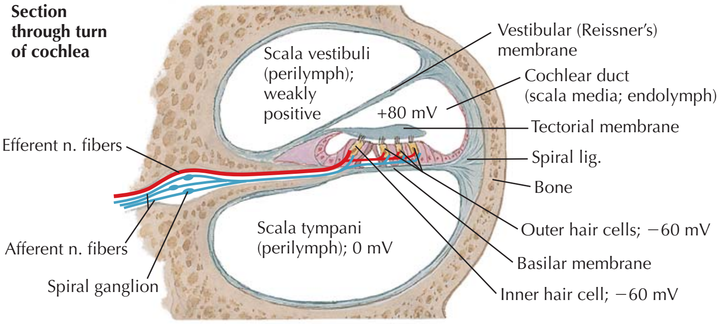


CRANIAL NERVE VIII: VESTIBULOCOCHLEAR NERVE

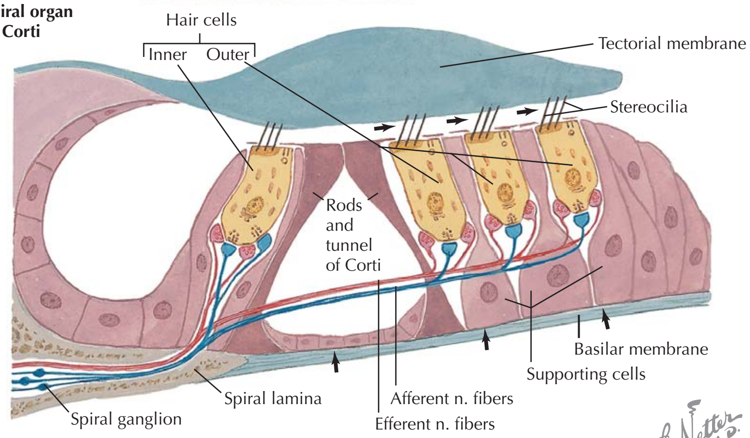
Functional Column	Origin of Fibers	Termination of Fibers	Summary	Comment
SSA	Organ of Corti Cristae of semicircular canals Maculae of utricle and saccule	Cochlear and vestibular nuclei	SSA fibers travel from the various vestibulocochlear receptors to their respective nuclei in the brainstem	Vestibulocochlear and facial nn. both enter the internal acoustic meatus and can be affected by tumors in the region



Membranous labyrinth within bony labyrinth
(path of sound waves)



Section through turn of cochlea



Spiral organ of Corti

As basilar membrane moves up, hairs are deflected outward, causing depolarization of hair cells and increased firing of afferent nerve fibers

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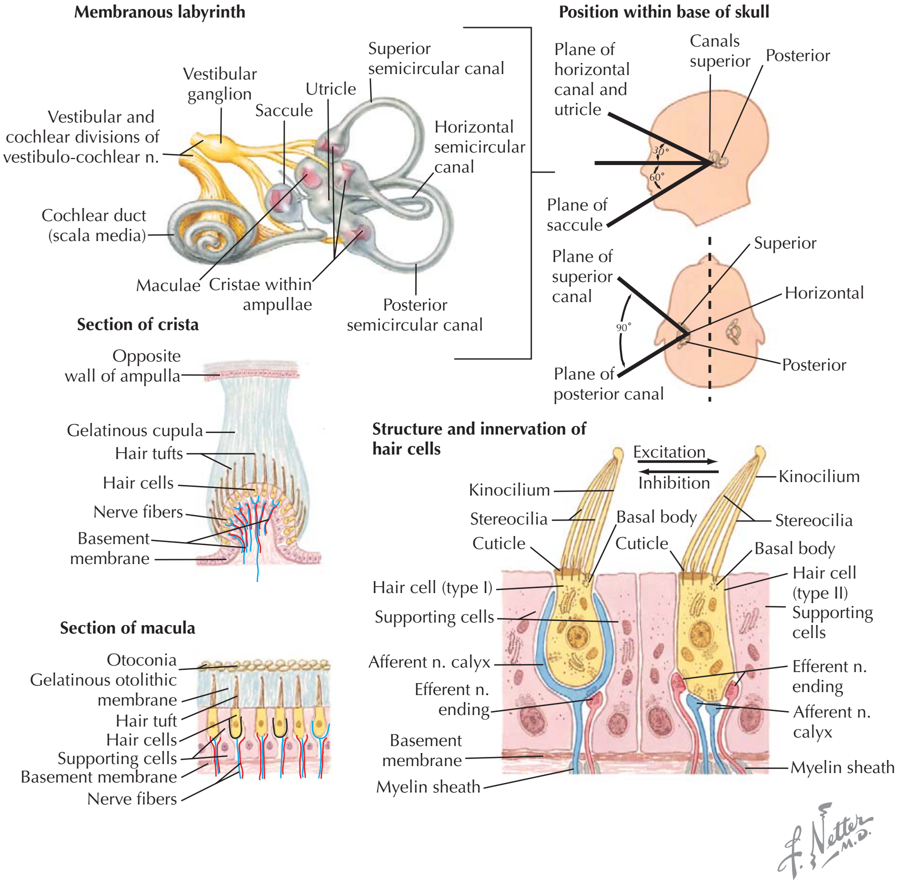
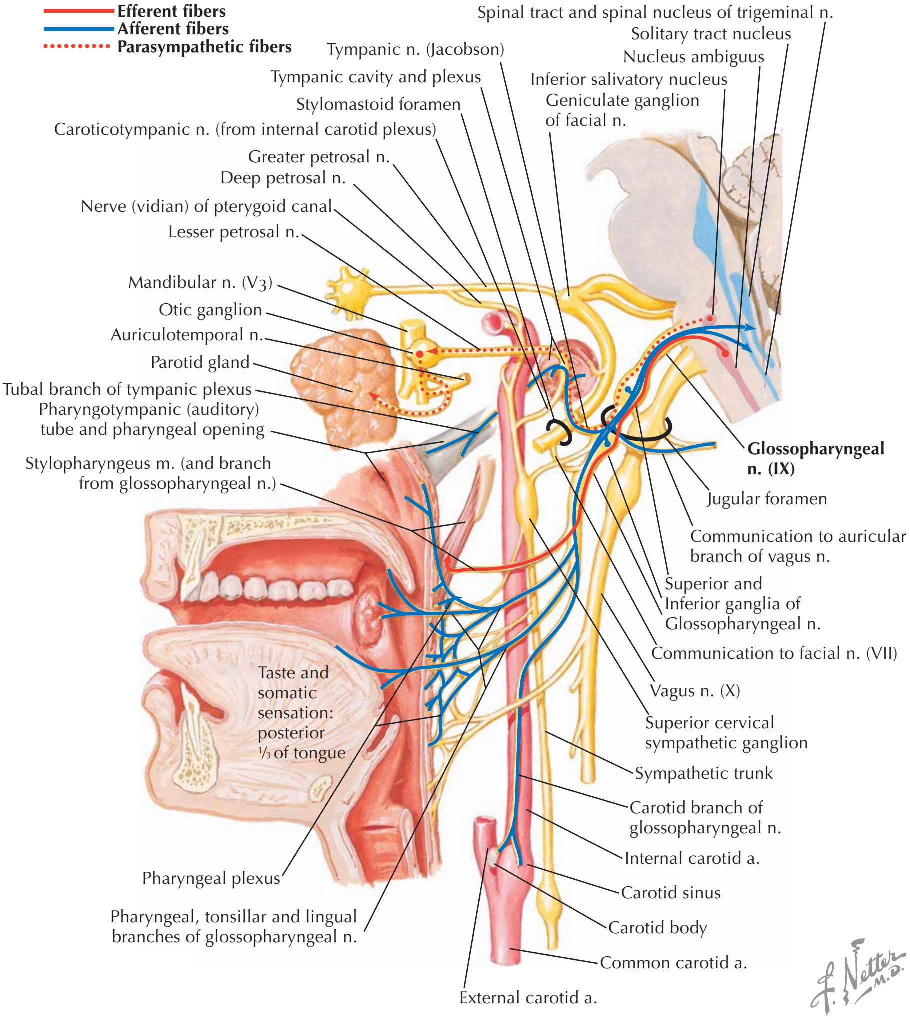
CRANIAL NERVE VIII: VESTIBULOCOCHLEAR NERVE *CONTINUED*



CRANIAL NERVE IX: GLOSSOPHARYNGEAL NERVE

Functional Column	Origin of Fibers	Termination of Fibers	Summary	Comment
GSA	Afferent fibers begin in the various receptors of the skin of the external ear and the posterior 1/3 of the tongue	Pain and temperature fibers terminate in the spinal nucleus of V	GSA fibers are responsible for providing sensory innervation to a small portion of the external ear and posterior 1/3 of the tongue GSA fibers of the glossopharyngeal n. utilize the trigeminothalamic lemniscus to carry their sensory impulses to consciousness	Nerve cell bodies for the primary fibers are located in the superior ganglion of IX
SVA	Afferent fibers begin in the taste receptors of the posterior 1/3 of the tongue	Primary afferent fibers travel in the tractus solitarius and terminate in the nucleus solitarius	SVA fibers are responsible for carrying the taste fibers from the circumvallate papillae and the taste buds on the posterior 1/3 of the tongue	Nerve cell bodies for the primary fibers are located in the inferior ganglion of IX
GVA	Afferent fibers begin in the various receptors of the mucous membranes of the nasopharynx. oropharynx, middle ear, carotid body, and carotid sinus	Primary afferent fibers travel in the tractus solitarius and terminate in the nucleus solitarius	GVA fibers utilize the same pathway as for the SVA fibers	The nerve cell bodies for the primary fibers are located in the inferior ganglion of IX GVA fibers are predominantly the sensory portion of the pharyngeal plexus
GVE	Preganglionic parasympathetic fibers begin in the inferior salivatory nucleus	Postganglionic parasympathetic fibers innervate parotid gland	The GVE fibers are responsible for providing the parasympathetic innervation to the parotid gland	GVE fibers utilize 1 ganglion: • Otic
SVE	Begins in the nucleus ambiguus	Innervates the stylopharyngeus m.	SVE fibers are responsible for innervating the muscles of the 3rd pharyngeal arch	Stylopharyngeus is the only muscle innervated by the glossopharyngeal n.

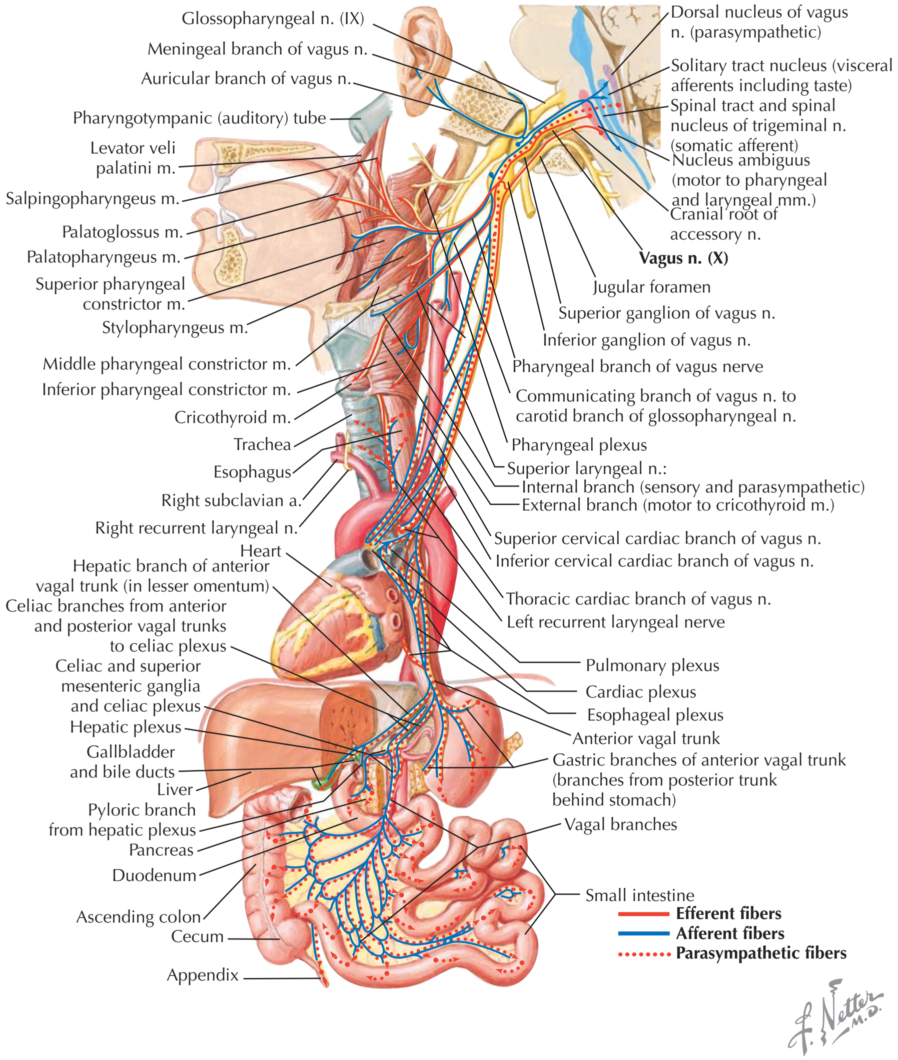
CRANIAL NERVE IX: GLOSSOPHARYNGEAL NERVE *CONTINUED*



CRANIAL NERVE X: VAGUS NERVE

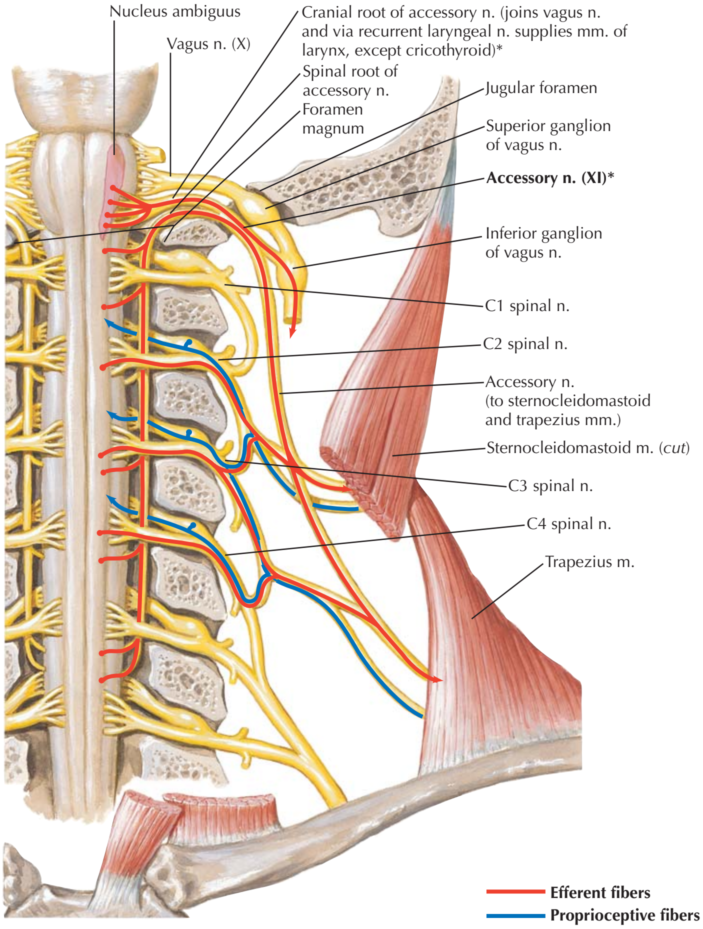
Functional Column	Origin of Fibers	Termination of Fibers	Summary	Comment
GSA	Afferent fibers begin in the various receptors on a small part of the skin of the external ear	Pain and temperature fibers terminate in the spinal nucleus of V	The GSA fibers are responsible for providing sensory innervation to a very small portion of the external ear The GSA fibers of the glossopharyngeal n. utilize the trigeminothalamic lemniscus to carry their sensory impulses to consciousness	The nerve cell bodies for the primary fibers are located in the superior ganglion of X
SVA	Afferent fibers begin in the taste receptors of the epiglottic region and are scattered on the palate	Primary afferent fibers travel in the tractus solitarius and terminate in the nucleus solitarius	The SVA fibers are responsible for carrying the taste fibers from the epiglottic region and are scattered on the palate	The nerve cell bodies for the primary fibers are located in the inferior ganglion of X
GVA	Afferent fibers begin in the various receptors of the mucous membranes of the laryngopharynx, larynx, thorax, and abdomen	Primary afferent fibers travel in the tractus solitarius and terminate in the nucleus solitarius	The GVA fibers utilize the same pathway as for the SVA fibers	The nerve cell bodies for the primary fibers are located in the inferior ganglion of X
GVE	Preganglionic parasympathetic fibers begin in the dorsal motor nucleus of the vagus n.	Postganglionic parasympathetic fibers innervate thoracic and abdominal viscera	The GVE fibers are responsible for providing the parasympathetic innervation to the thoracic and abdominal viscera	The GVE fibers utilize: • Intramural ganglia
SVE	Begins in the nucleus ambiguus	Innervates the muscles of the pharynx (via the pharyngeal plexus) and the larynx	The SVE fibers are responsible for innervating the muscles of the 4th pharyngeal arch	The SVE fibers are the motor component to the pharyngeal plexus (muscles of pharynx) Lesions of the vagus paralyze the muscles of the larynx on the affected side

CRANIAL NERVE X: VAGUS NERVE *CONTINUED*



CRANIAL NERVE XI: SPINAL ACCESSORY NERVE

Functional Column	Origin of Fibers	Termination of Fibers	Summary	Comment
SVE	Cranial part: Begins in the nucleus ambiguus Spinal part: Begins in the upper cervical levels of the spinal cord	Cranial part: Innervates the muscles of the pharynx (via the pharyngeal plexus) Spinal part: Innervates the trapezius and sternocleidomastoid mm.	These SVE fibers of the cranial part travel with the vagus n. and arise from the same nucleus (nucleus ambiguus) and often are considered to be the same	The cranial and spinal parts separate so the cranial part can join the pharyngeal plexus and the spinal part can innervate the sternocleidomastoid m. and pass through the posterior triangle until reaching the trapezius m.



*Recent evidence suggests that the accessory nerve lacks a cranial root and has no connection to the vagus nerve. Verification of this finding awaits further investigation.

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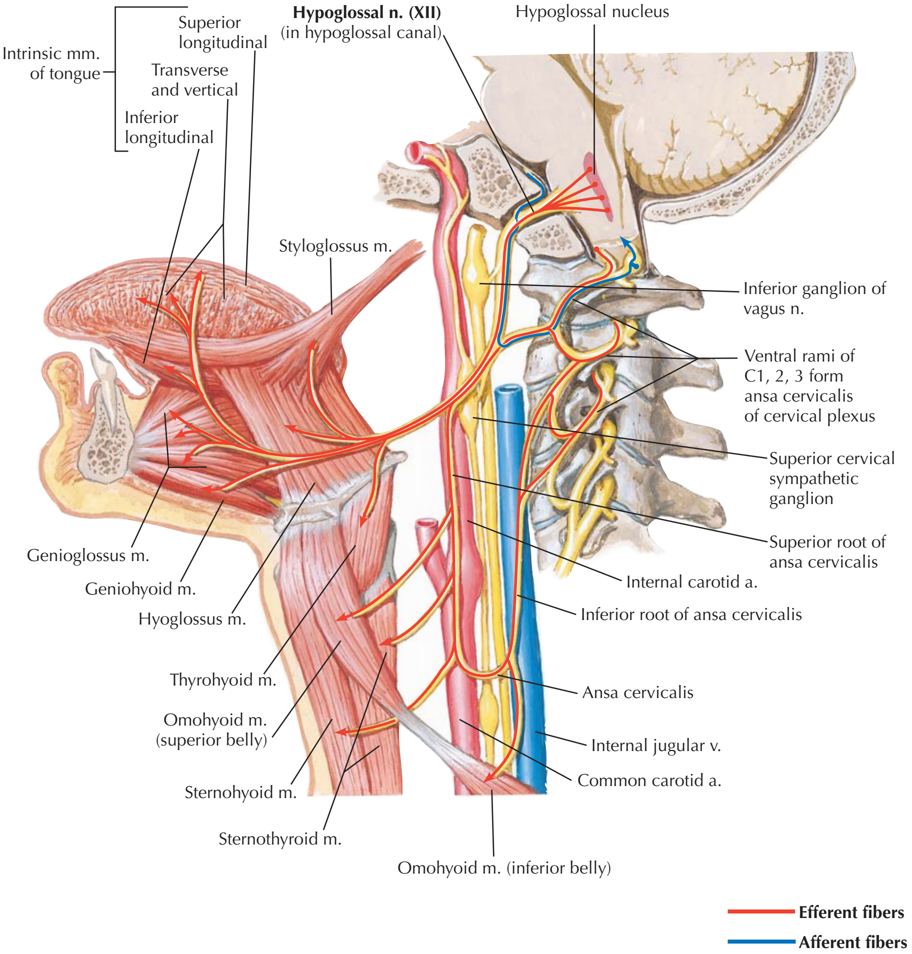
CRANIAL NERVE XII: HYPOGLOSSAL NERVE

Functional Column	Origin of Fibers	Termination of Fibers	Summary	Comment
GSE	Begins in the hypoglossal nucleus	Innervates the genioglossus, hyoglossus, and styloglossus mm. and the intrinsic mm. of the tongue	The GSE fibers are responsible for innervating the major portion of the tongue musculature	Lesions of the hypoglossal n. cause the tongue to deviate to the side of the lesion on protrusion



Clinical Correlate

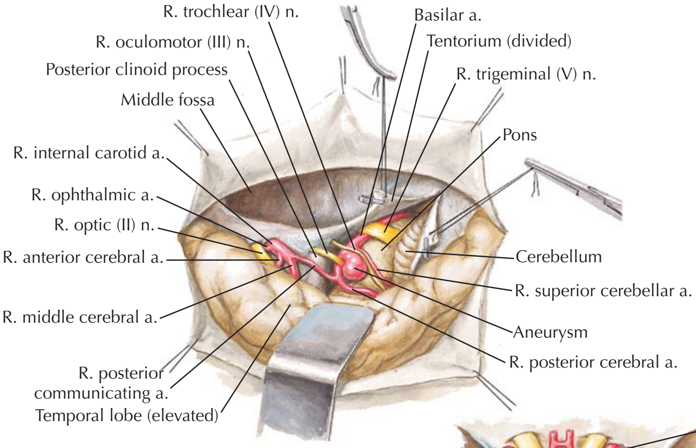
CEREBRAL ANEURYSMS CAUSING OPHTHALMOPLEGIA

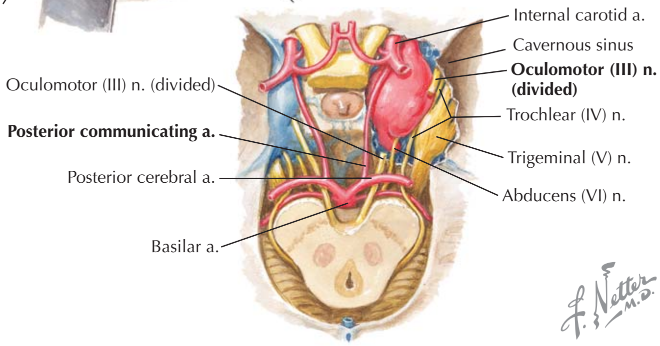
Because of the close proximity of the oculomotor, trochlear, and abducens nerves to blood vessels supplying the brain, aneurysms along these vessels may lead to a paralysis of the muscles that they innervate

Commonly affected vessels include the basilar, posterior cerebral, and posterior communicating arteries

Neuromuscular disorders
Abducens palsy: Affected eye turns medially. May be first manifestation of intracavernous carotid aneurysm. Pain above eye or on side of face may be secondary to trigeminal (V) nerve involvement.

Oculomotor palsy: Ptosis, eye turns laterally and inferiorly, pupil dilated; common finding with cerebral aneurysms, especially carotid-posterior communicating aneurysms





Clinical Correlate

LESIONS AFFECTING THE VOICE

The vagus nerve provides all of the motor and sensory innervation to the larynx

The superior laryngeal nerve divides into the internal laryngeal (sensory) and external laryngeal (motor to the cricothyroid)

The recurrent laryngeal provides sensory and motor innervation to the remainder of the muscles of the larynx

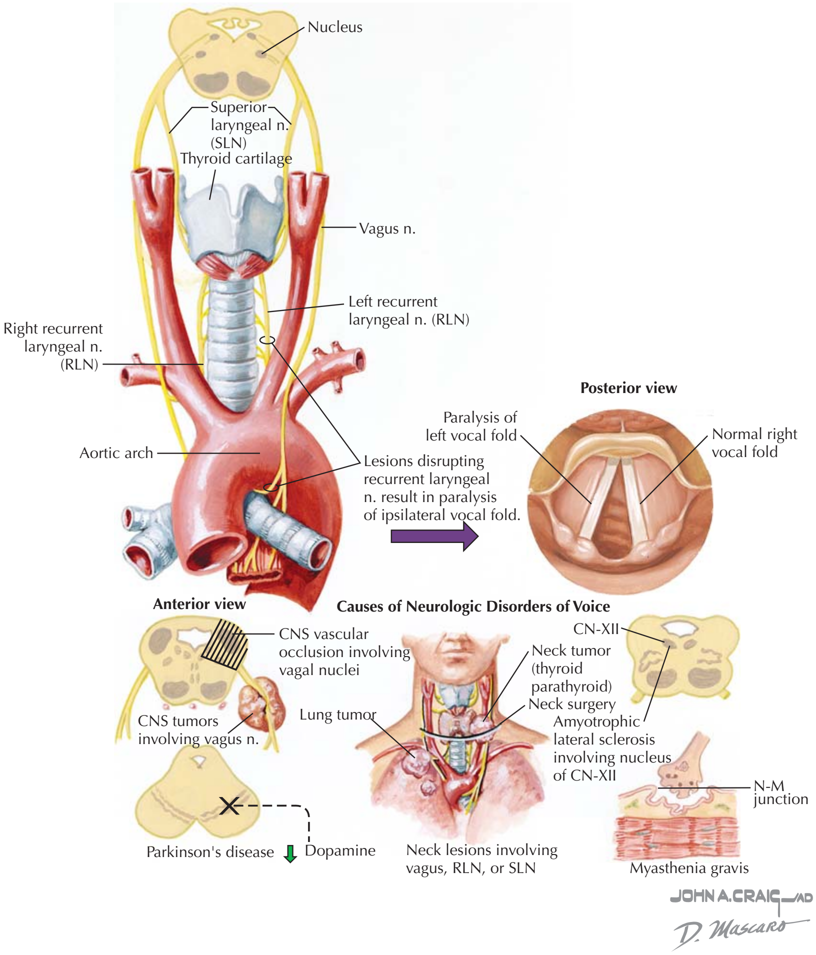
Lesions of the recurrent laryngeal nerve result in a paralysis of the ipsilateral vocal fold

This problem usually manifests clinically as hoarseness with an ineffective cough

Common causes include:

- Thyroid tumors
- Neck tumors
- Cerebrovascular accidents
- Lung tumors
- Surgery
- Thyroiditis

The voice also may be affected in Parkinson's disease and myasthenia gravis



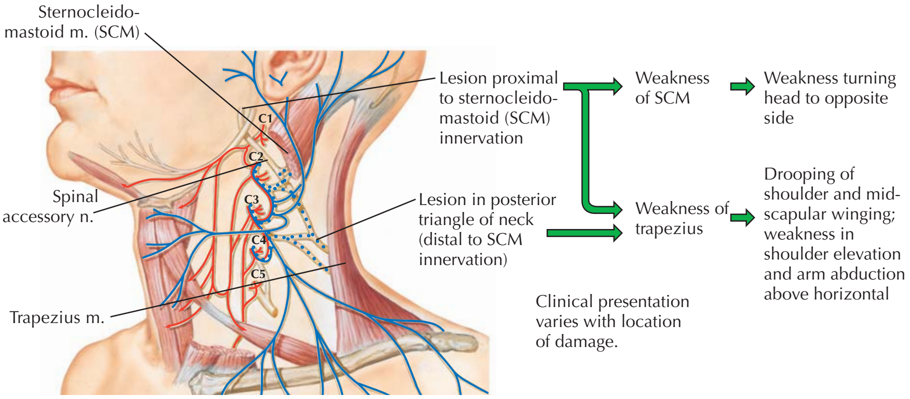
Clinical Correlate

LESIONS AFFECTING THE SPINAL ACCESSORY NERVE

The spinal accessory nerve provides motor innervation to the sternocleidomastoid and trapezius muscles

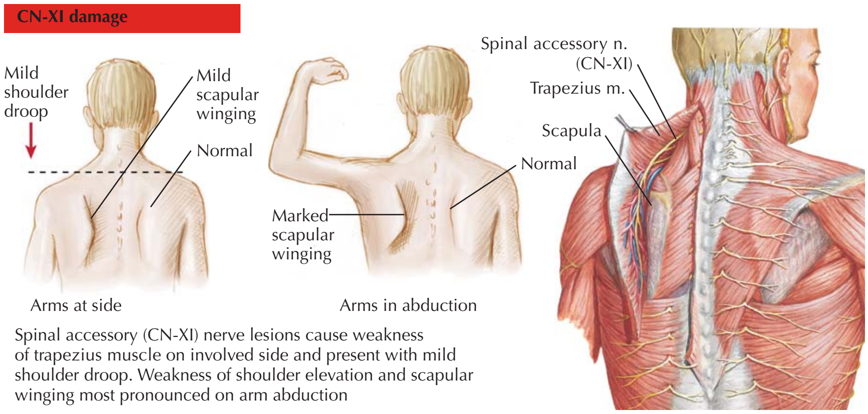
The spinal accessory nerve courses close to the superficial cervical lymph nodes
- This course makes it vulnerable to damage during biopsy or radical neck dissection in the posterior triangle
- Damage to the spinal accessory nerve also may result from a carotid endarterectomy

In lesions located in the posterior triangle, the sternocleidomastoid muscle is unaffected, but the trapezius muscle is deinnervated
- The shoulder droops, with mild winging of the scapula
- Abduction of the arm also is affected when patient attempts to raise it above the horizontal plane



Clinical presentation varies with location of damage.

Comparison of clinical findings in CN-XI and long thoracic nerve damage



Spinal accessory (CN-XI) nerve lesions cause weakness of trapezius muscle on involved side and present with mild shoulder droop. Weakness of shoulder elevation and scapular winging most pronounced on arm abduction

Clinical Correlate

LESIONS AFFECTING THE HYPOGLOSSAL NERVE

The hypoglossal nerve provides motor innervation to a majority of the muscles of the tongue, including:

- Genioglossus
- Hyoglossus
- Styloglossus

Protrusion of the tongue is accomplished by the bilateral actions of the genioglossus muscles

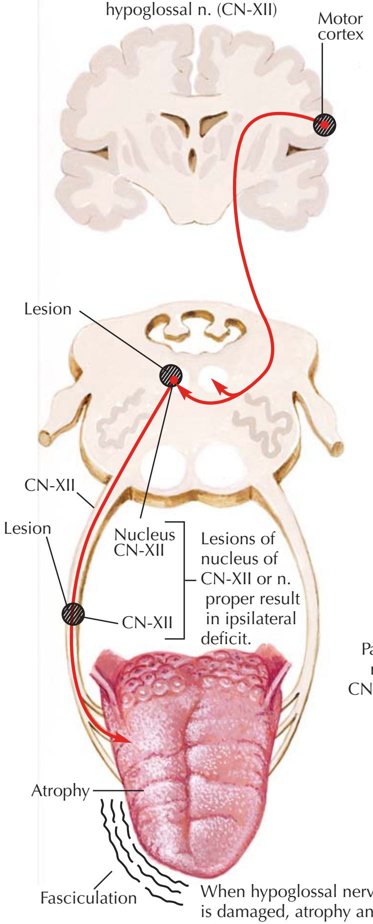
Paralysis of a genioglossus muscle causes the protruded tongue to deviate to the paralyzed side

Paralysis of the hypoglossal nerve can be caused by:

- Tumors
- Neck trauma
- Radiation therapy

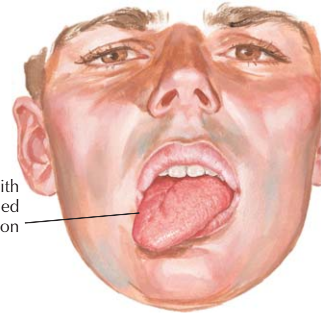
A similar paralysis can be caused by a stroke affecting the upper motor neurons on the side contralateral to the paralyzed muscles, owing to the crossing fibers of the upper motor neurons

Sites of lesions affecting hypoglossal n. (CN-XII)



When hypoglossal nerve or its nucleus is damaged, atrophy and fasciculation of the tongue are noted on evaluation.

Subtle weakness of tongue may be tested by asking patient to press tongue against cheek (shown) or against a tongue depressor.



If hypoglossal nerve is affected on one side, the tongue often deviates toward the side of the lesion on protrusion (due to imbalance of genioglossus contraction).

F. Netter M.D.
JOHN A.CRAIG AD
with
E. Hatton

CHAPTER 4

THE NECK

4 Overview and Topographic Anatomy

GENERAL INFORMATION

The *neck* is the area between the base of the skull and inferior border of the mandible and the superior thoracic aperture

The anterior portion of the neck contains the major visceral structures between the head and the thorax:

- Pharynx
- Larynx
- Trachea
- Esophagus
- Thyroid and parathyroid glands

For descriptive purposes, the neck is divided into 2 triangles:

- Anterior triangle
- Posterior triangle

Skin is the most superficial structure covering the neck

FASCIA

The neck is surrounded by 2 main layers of cervical fascia that can be further subdivided:

- Superficial fascia
- Deep fascia
- Superficial layer of deep cervical fascia (investing)
- Middle layer of deep fascia (includes muscular and visceral parts such as the pretracheal)
- Deep layer of deep fascia (includes prevertebral and alar)
- Carotid sheath

Superficial fascia is deep to the skin and surrounds the platysma muscle

Sensory branches to the neck are located in the superficial fascia

Deep to the superficial fascia is the investing layer of deep cervical fascia

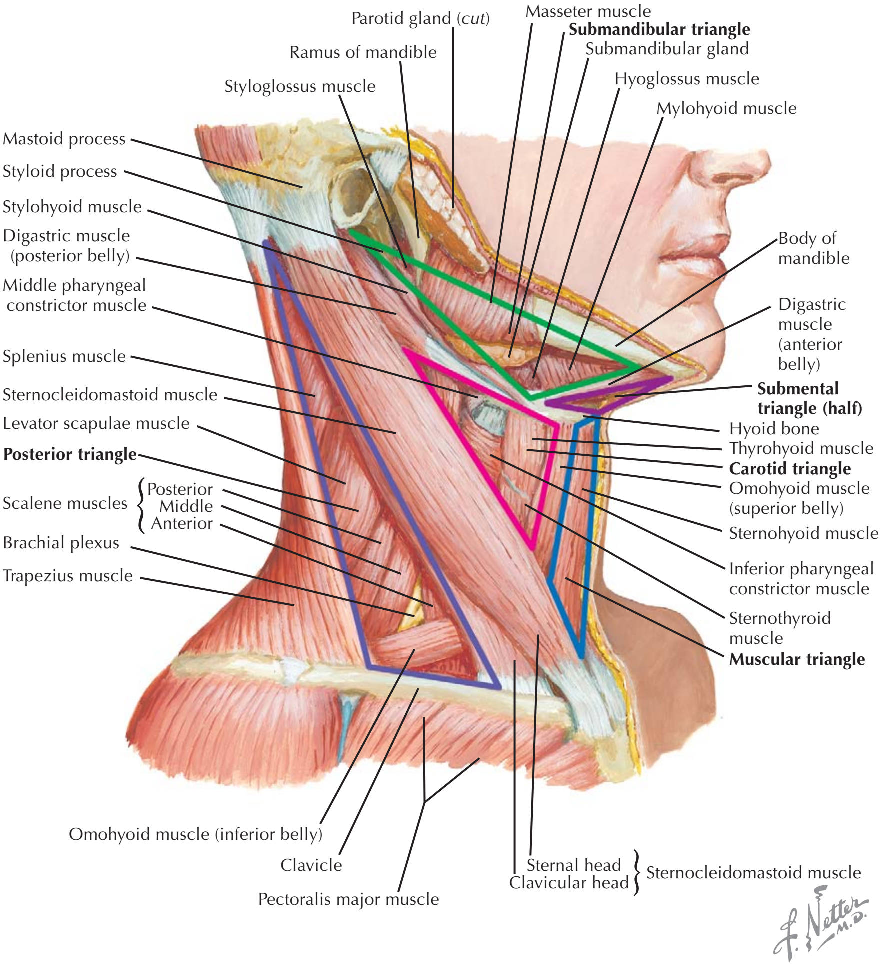
The superficial (or investing) layer of deep cervical fascia attaches posteriorly along the midline and passes anteriorly to surround the entire neck

The superficial (or investing) layer of deep cervical fascia surrounds these muscles:

- Trapezius
- Sternocleidomastoid

Overview and Topographic Anatomy

GENERAL INFORMATION *CONTINUED*



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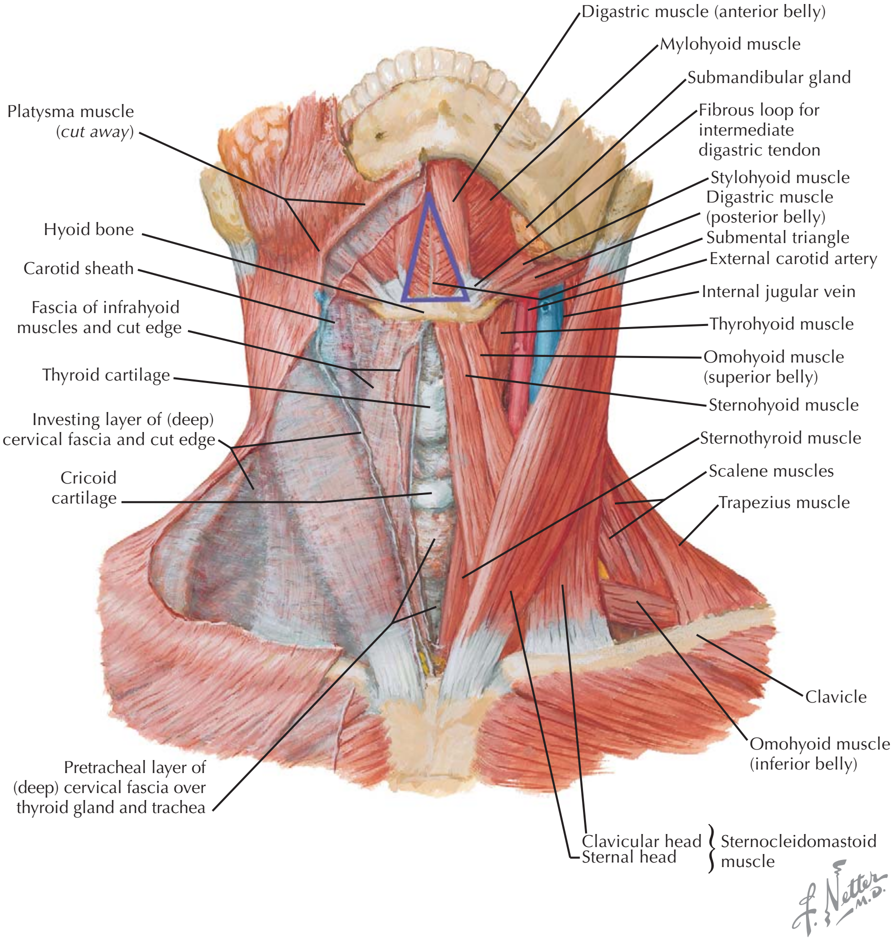

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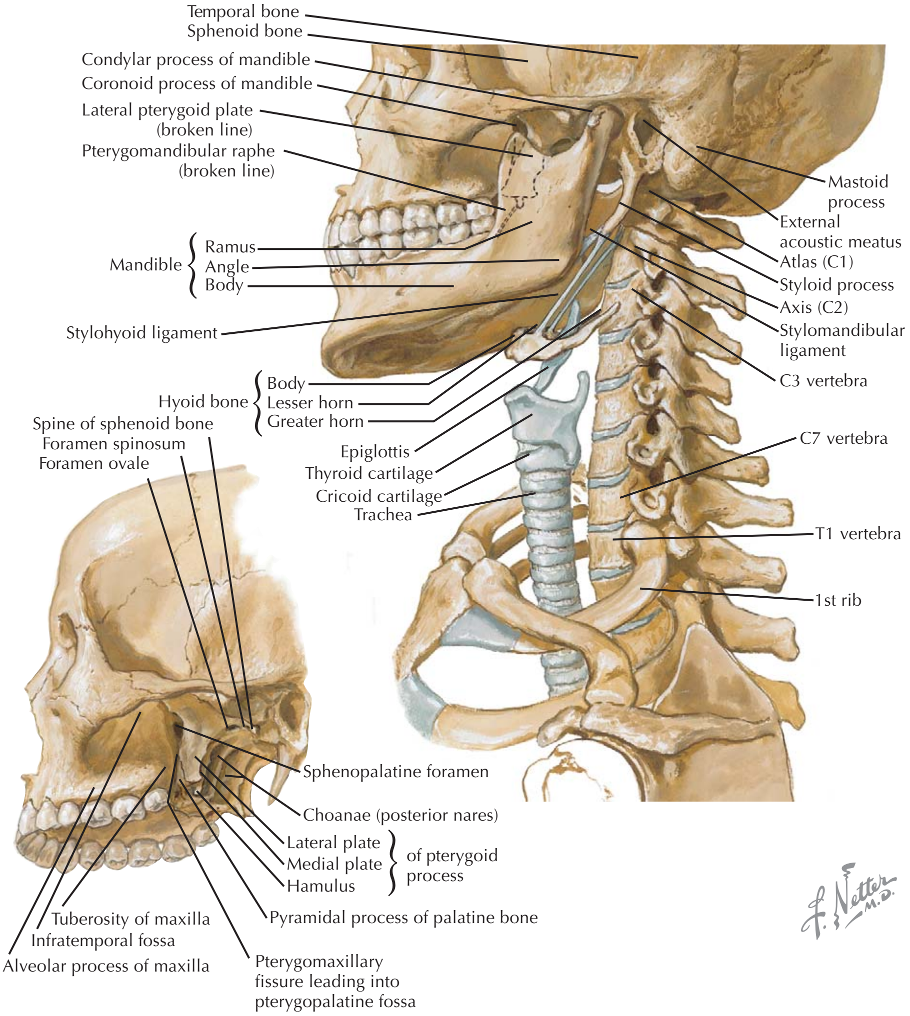


Triangles of the Neck

ANTERIOR TRIANGLE

Borders of the anterior triangle:

- Anterior border of the sternocleidomastoid
- Inferior border of the mandible
- Midline of the neck

Using the hyoid as a keystone, the omohyoid and digastric muscles subdivide the anterior triangle into:

- Submandibular triangle
- Carotid triangle
- Muscular triangle
- Submental triangle

All of the triangles within the anterior triangle are paired except for the submental triangle, which spans the right and the left sides of the neck

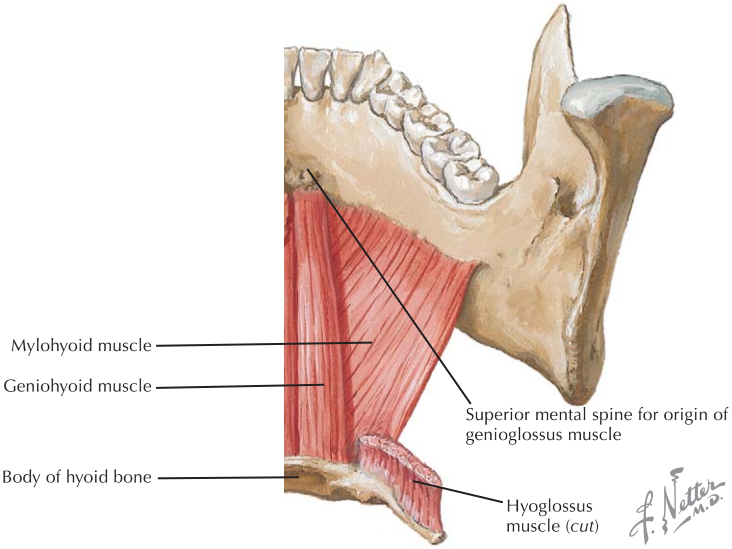
Hyoid bone divides the anterior triangle into 2 areas: suprahyoid and infrahyoid regions

The suprahyoid region contains 4 muscles:

- Mylohyoid
- Digastric
- Stylohyoid
- Geniohyoid

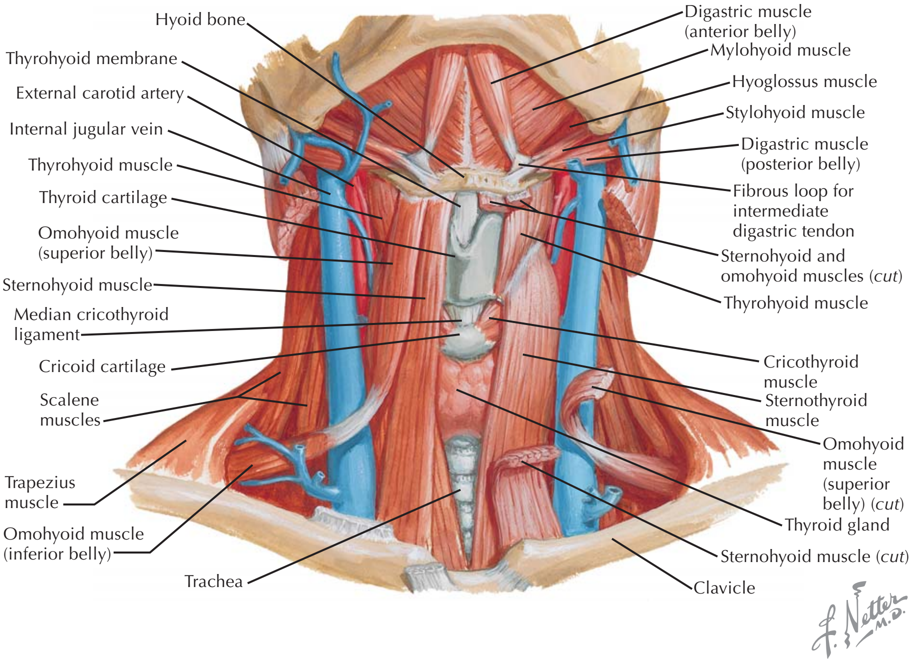
The infrahyoid region contains 4 muscles commonly called strap muscles:

- Omohyoid
- Sternohyoid
- Sternothyroid
- Thyrohyoid



Triangles of the Neck

ANTERIOR TRIANGLE *CONTINUED*



Anterior Triangle

SUBMANDIBULAR TRIANGLE

Often called the digastric triangle

Borders of the submandibular triangle:
- Inferior border of the mandible
- Posterior digastric
- Anterior digastric

Floor of the triangle is composed of the:
- Hyoglossus
- Mylohyoid
- Middle constrictor

Roof is made of the:

- Skin
- Superficial fascia with platysma
- Deep cervical fascia

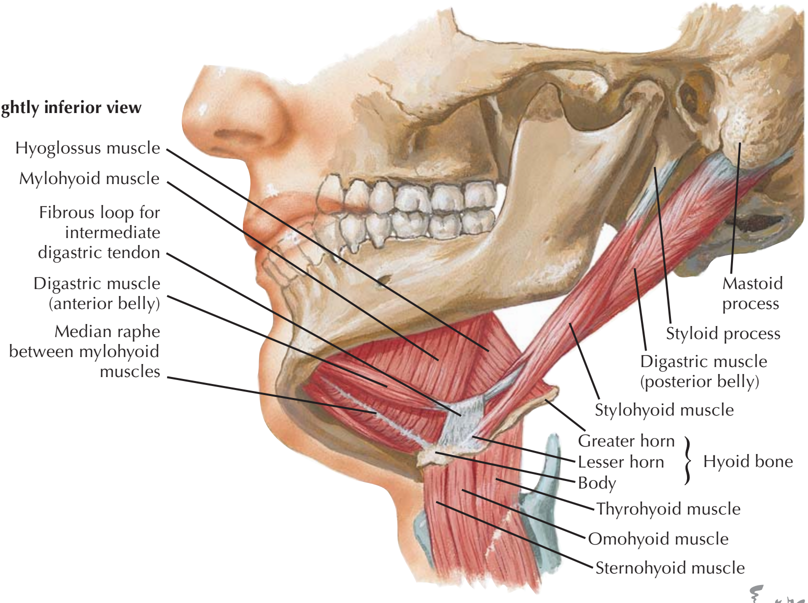
Submandibular triangle is paired

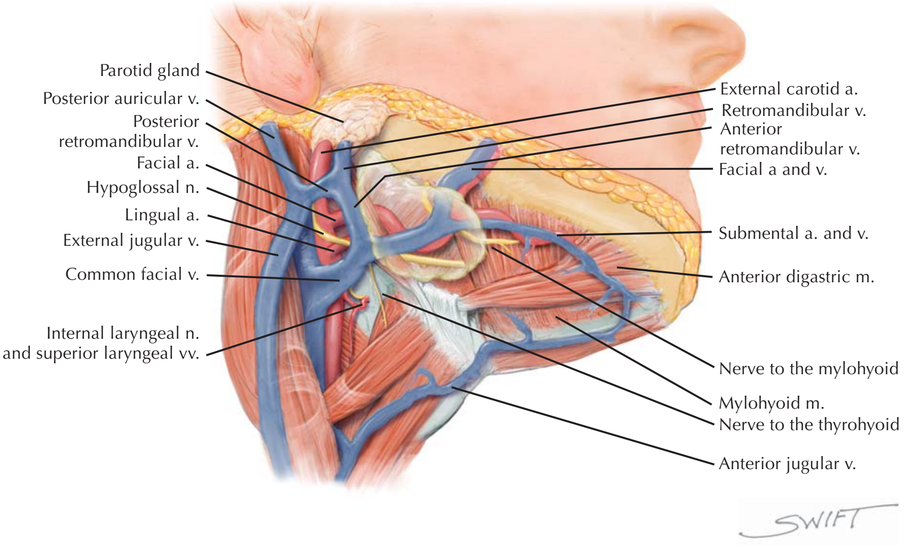
CONTENTS OF THE SUBMANDIBULAR TRIANGLE			
Arteries	**Veins**	**Nerves**	**Structures**
Facial Submental	Facial Submental	Mylohyoid Hypoglossal	Submandibular gland Submandibular lymph nodes Inferior portion of the parotid gland

Anterior Triangle

SUBMANDIBULAR TRIANGLE *CONTINUED*

Lateral, slightly inferior view





CAROTID TRIANGLE

Borders of the carotid triangle:
- Anterior border of the sternocleidomastoid
- Posterior digastric
- Superior omohyoid

Floor of the triangle is composed of the:
- Hyoglossus
- Thyrohyoid
- Middle constrictor
- Inferior constrictor

Roof is made of the:
- Skin
- Superficial fascia with platysma
- Deep cervical fascia

Carotid triangle is paired

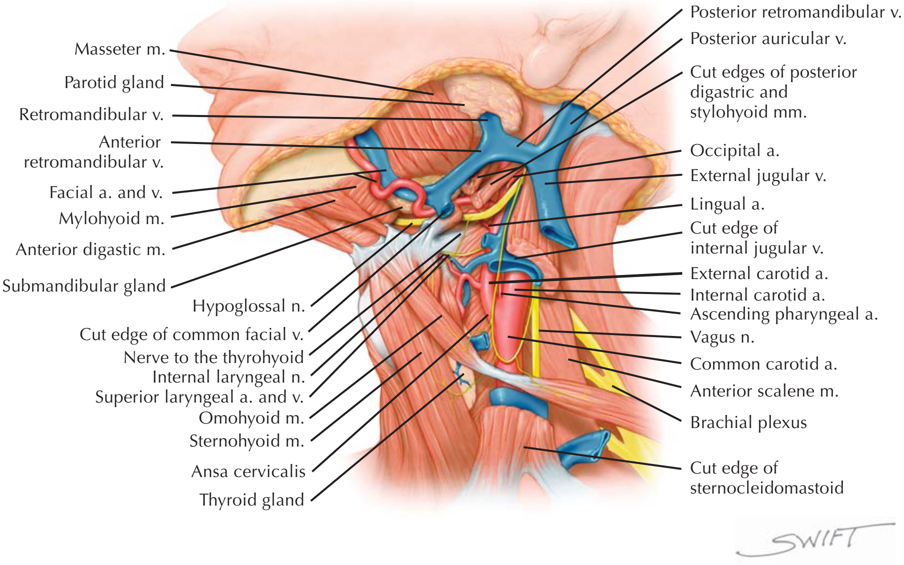
CONTENTS OF THE CAROTID TRIANGLE

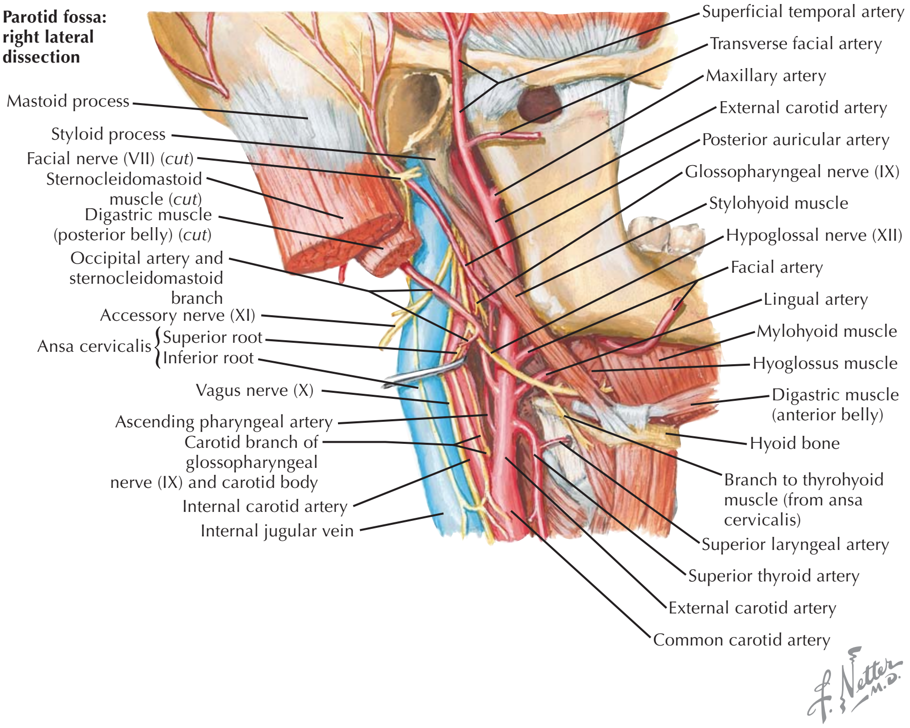
Arteries	Veins	Nerves	Structures

Common carotid (with carotid body)
• Internal carotid (with carotid sinus)
• External carotid
  • Superior thyroid (with superior laryngeal branch)
  • Lingual
  • Facial
  • Ascending pharyngeal
  • Occipital
	Internal jugular
	Common facial
	Lingual
	Superior thyroid
	Middle thyroid
		Vagus
		• External laryngeal
		• Internal laryngeal
		Spinal accessory (small portion)
		Hypoglossal
		Ansa cervicalis (superior limb)
			Larynx (small portion)
			Thyroid (small portion)

Anterior Triangle

CAROTID TRIANGLE *CONTINUED*





Anterior Triangle

MUSCULAR TRIANGLE

Borders of the muscular triangle:

- Anterior border of the sternocleidomastoid
- Superior omohyoid
- Midline

Floor of the triangle is composed of the:

- Sternohyoid
- Sternothyroid

Roof is made of the:

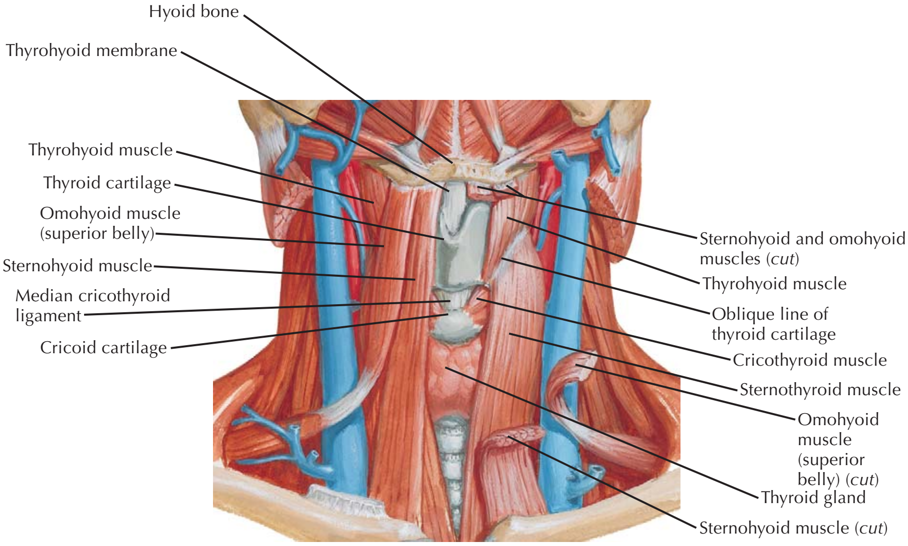
- Skin
- Superficial fascia with platysma
- Deep cervical fascia

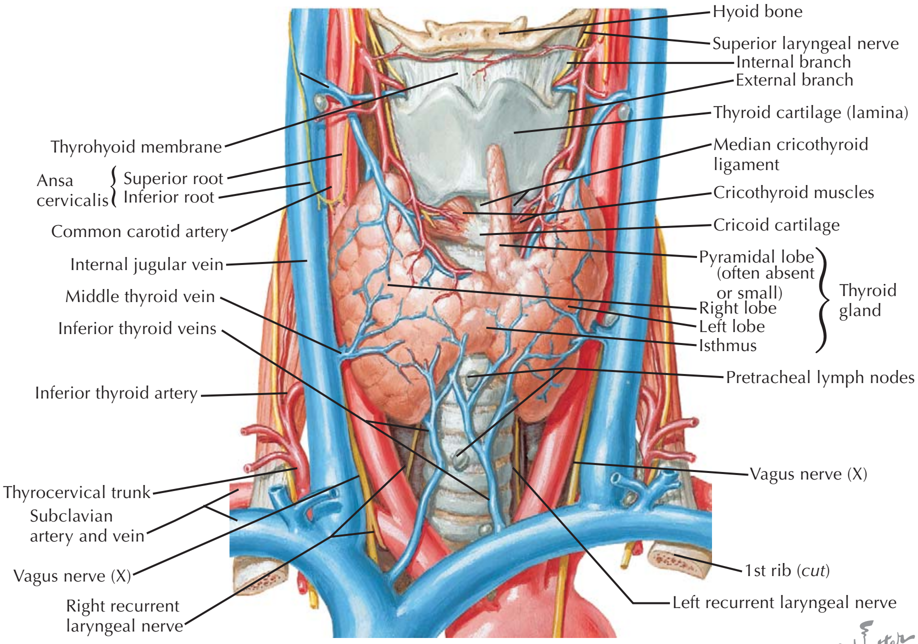
Muscular triangle is paired

CONTENTS OF THE MUSCULAR TRIANGLE			
Artery	**Veins**	**Nerve**	**Structures**
Superior thyroid	Inferior thyroid Anterior jugular	Ansa cervicalis	Strap muscles: • Sternohyoid • Sternothyroid • Thyrohyoid Thyroid gland Parathyroid gland Larynx Trachea Esophagus

Anterior Triangle

MUSCULAR TRIANGLE *CONTINUED*





F. Netter M.D.

Anterior Triangle

SUBMENTAL TRIANGLE

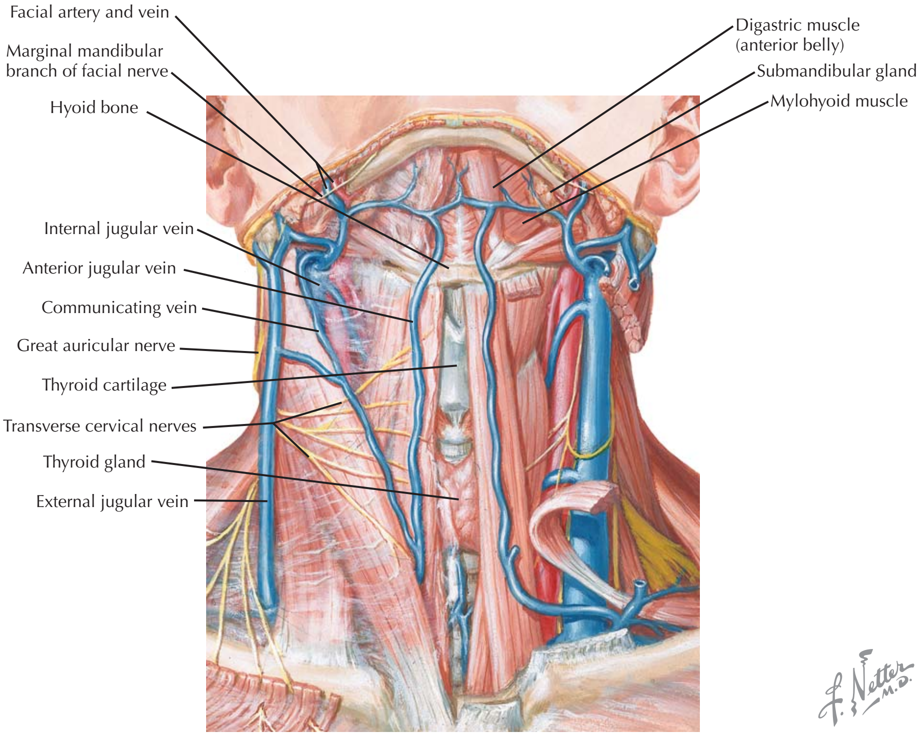
Borders of the submental triangle:
- Body of hyoid
- Anterior digastric on right
- Anterior digastric on left

Floor of the triangle is composed of the:
- Mylohyoid

Roof is made of the:
- Skin
- Superficial fascia with platysma
- Deep cervical fascia

Submental triangle is unpaired

CONTENTS OF THE SUBMENTAL TRIANGLE			
Artery	**Vein**	**Nerve**	**Structures**
	Anterior jugular		Submental lymph nodes



Posterior Triangle

GENERAL INFORMATION

Borders of the posterior triangle:
- Posterior border of the sternocleidomastoid
- Middle third of the clavicle
- Anterior border of the trapezius

Located on the lateral side of the neck and spirals around the neck

Is subdivided into 2 triangles by the omohyoid:
- Omoclavicular (also called the supraclavicular triangle)
- Occipital

Roof of the posterior triangle includes:
- Skin
- Superficial fascia
- Superficial (investing) layer of deep cervical fascia

Floor of the posterior triangle includes*:
- Semispinalis capitis
- Splenius capitis
- Levator scapulae
- Posterior scalene
- Middle scalene
- Anterior scalene

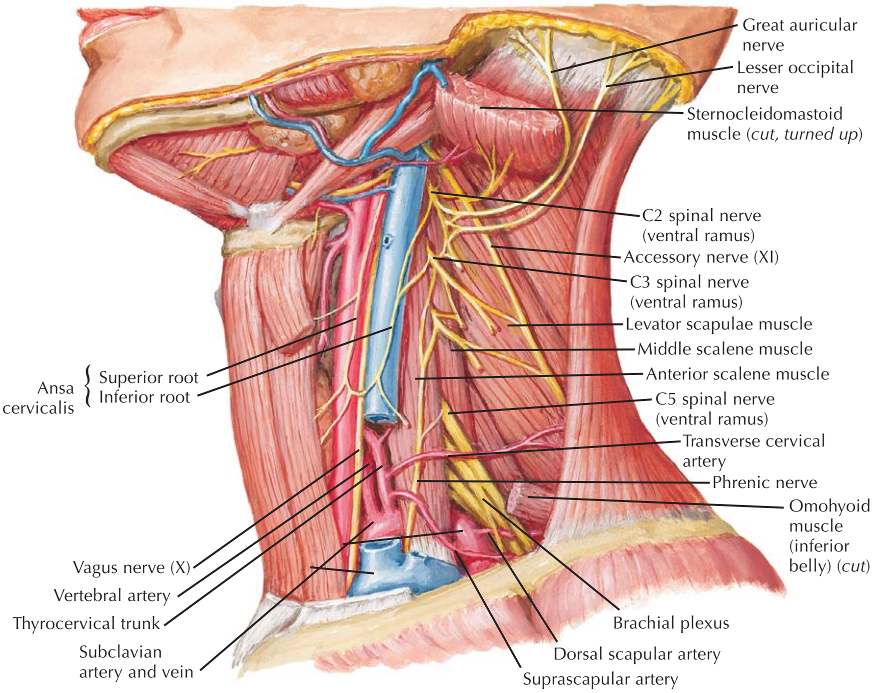
Posterior triangle is paired

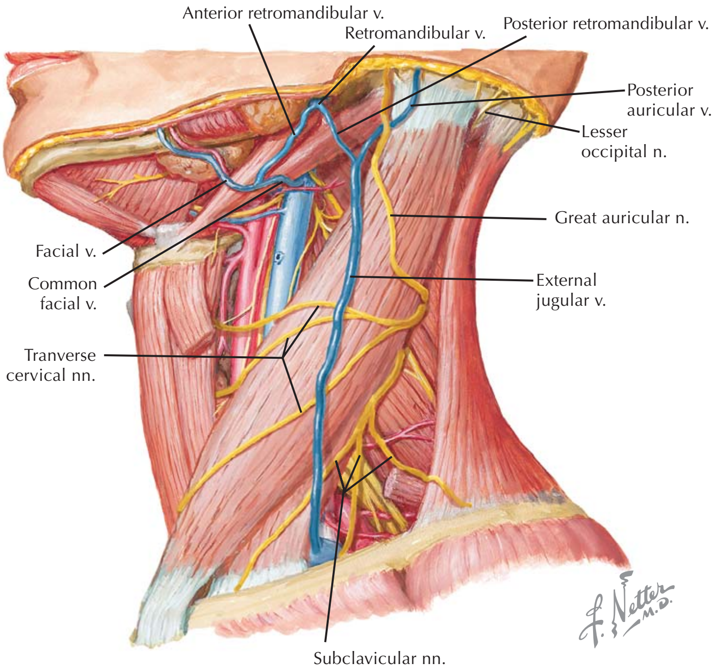
CONTENTS OF THE POSTERIOR TRIANGLE		
Arteries	**Veins**	**Nerves**
3rd part of the subclavian Occipital Suprascapular Transverse cervical Dorsal scapular (usually)	External jugular Occipital Suprascapular Transverse cervical	Cervical plexus (sensory branches): • Lesser occipital • Transverse cervical • Great auricular • Supraclavicular Spinal accessory Dorsal scapular Long thoracic Suprascapular Rami and trunks of brachial plexus

*These muscles are covered by the prevertebral layer of deep cervical fascia.

Posterior Triangle

GENERAL INFORMATION *CONTINUED*





Suboccipital Triangle

GENERAL INFORMATION

Borders of the suboccipital triangle:
- Obliquus capitis superior
- Obliquus capitis inferior
- Rectus capitis posterior major

Roof of the suboccipital triangle includes:
- Dense connective tissue

Floor of the suboccipital triangle includes:
- Posterior atlanto-occipital membrane
- Posterior arch of the atlas

Suboccipital triangle is paired

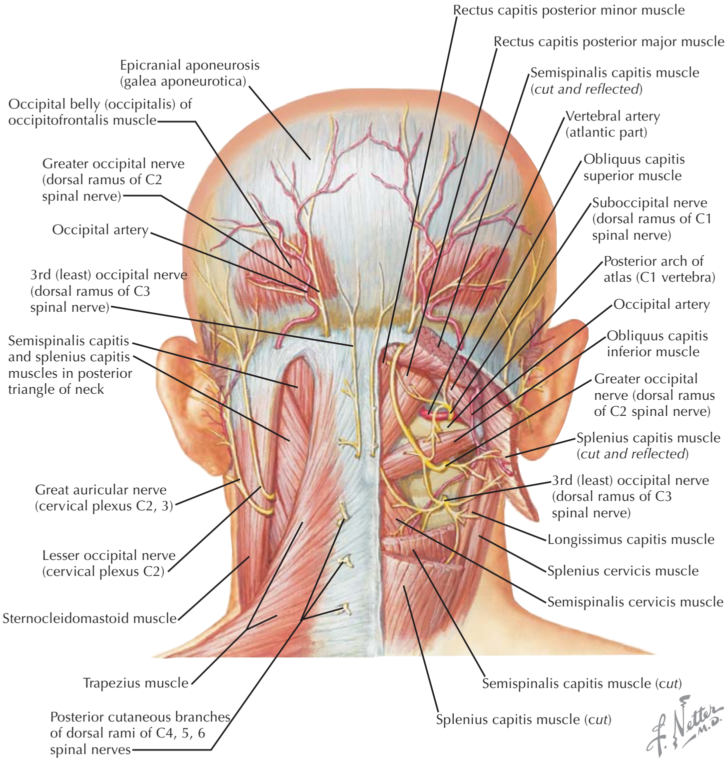
VERTEBRAL ARTERIES

These vessels enter the foramen transversarium of the 6th cervical vertebra, emerging above the 1st cervical vertebra to enter the suboccipital triangle

They curve medially to lie in a groove on the posterior arch of the atlas

Pass through the posterior atlanto-occipital membrane to enter the vertebral canal

CONTENTS OF THE SUBOCCIPITAL TRIANGLE			
Artery	**Vein**	**Nerves**	**Structures**
Vertebral	Vertebral	Greater occipital Suboccipital	Muscles: • Rectus capitis posterior major • Rectus capitis posterior minor • Obliquus capitis superior • Obliquus capitis inferior



4 Visceral Contents

THYROID GLAND

Highly vascular organ located on the anterior and lateral surfaces of the neck

Formed by a right and a left lobe connected in the midline by an isthmus

Lies roughly at a level between the 5th cervical and the 1st thoracic vertebrae

The isthmus crosses at the 2nd and 3rd tracheal rings

A pyramidal lobe often arises from the isthmus and extends superiorly

Arterial supply arises from the superior and inferior thyroid arteries, with the major portion from the inferior thyroid artery

A thyroidea ima vessel may supply the thyroid gland and arises from the brachiocephalic artery or as a direct branch from the aorta

Venous drainage forms from a plexus on the surface of the thyroid gland that drains into the superior, middle, and inferior thyroid veins

Microscopically, the thyroid is made of thyroid epithelial cells, which secrete thyroid hormones (thyroxine and triiodothyronine), and parafollicular (C cells), which secrete calcitonin

PARATHYROID GLANDS

Parathyroid glands normally are 4 glands located on the posterior surface of the thyroid lobes

The superior parathyroids are supplied by the superior thyroid artery and the inferior parathyroids are supplied by the inferior thyroid artery

Microscopically, their cells are organized in cords and secrete parathyroid hormone

LARYNX

Connection between the pharynx and the trachea

Prevents foreign bodies from entering the airways

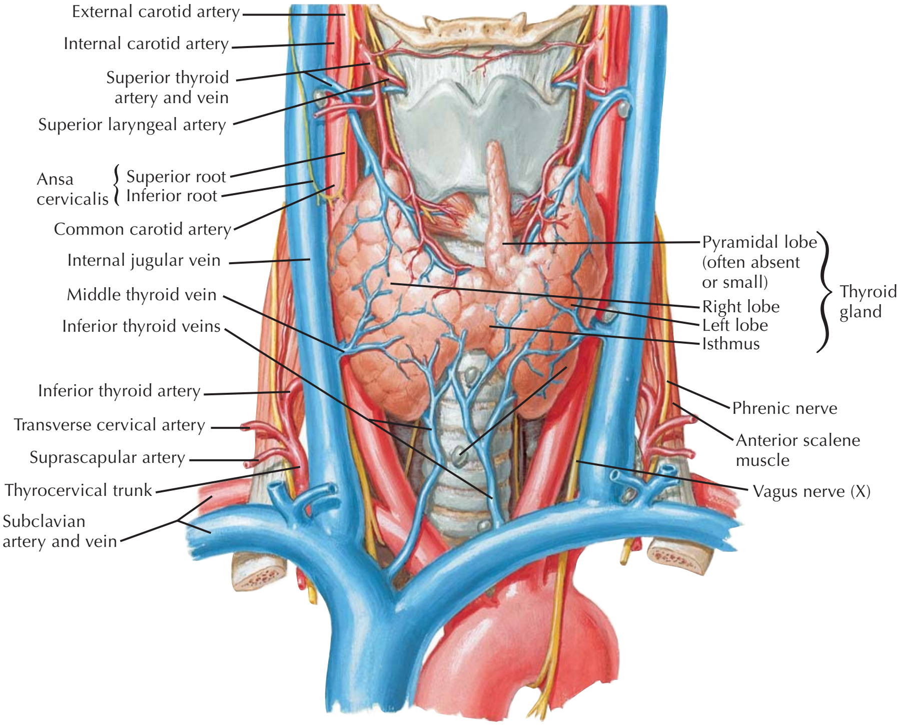
Designed for the production of sound (phonation)

Shorter in women and children

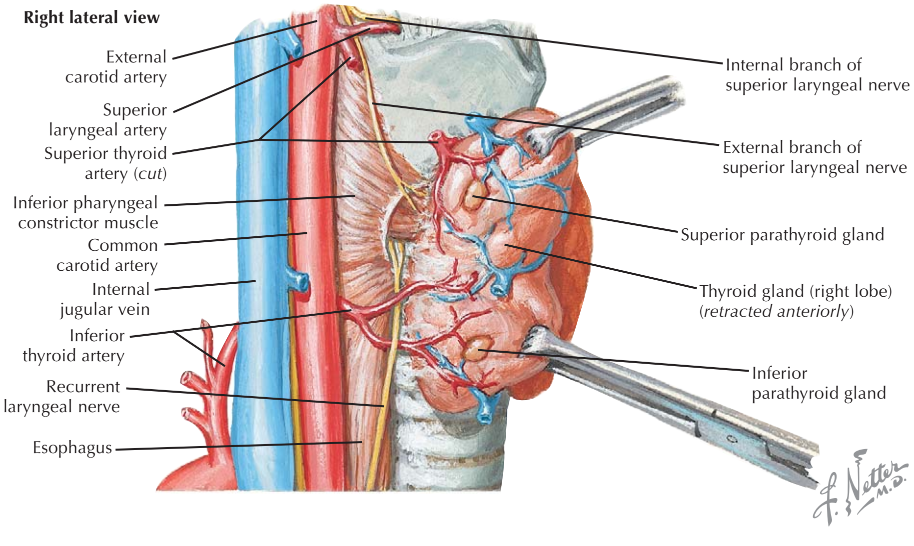
Formed by 9 cartilages: 3 paired and 3 unpaired

Located in the midline opposite the 3rd to 6th cervical vertebrae

THYROID GLAND, PARATHYROID GLANDS, LARYNX *CONTINUED*



Right lateral view



4 Root of the Neck

GENERAL INFORMATION

Root of the neck connects the structures of the neck with the thoracic cavity

The superior thoracic aperture is bounded by:
- Manubrium
- 1st rib and cartilage
- 1st thoracic vertebra

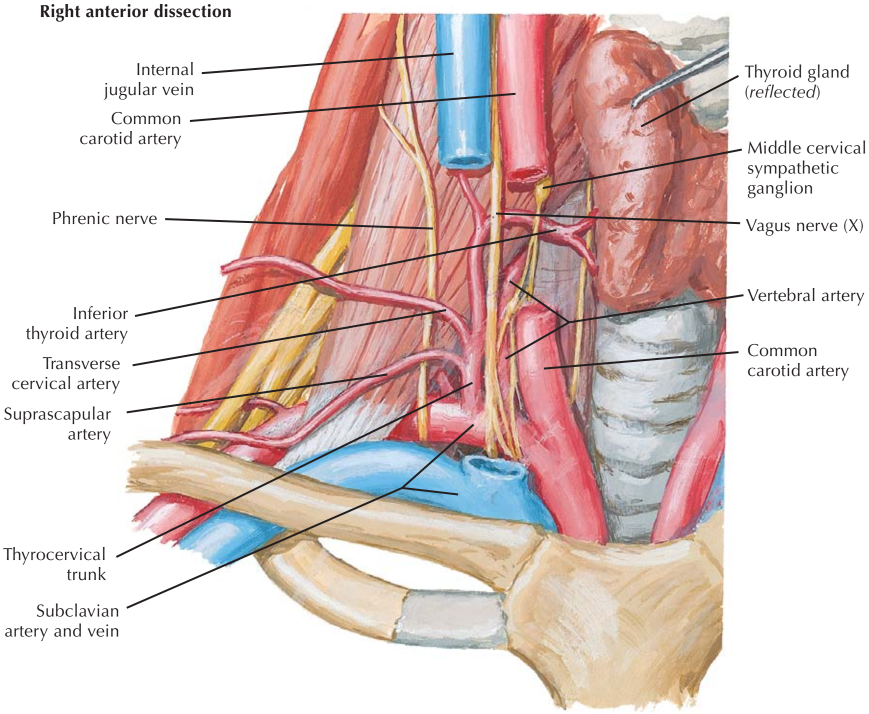
The apex of each lung extends into the root of the neck on the lateral side of the superior thoracic aperture

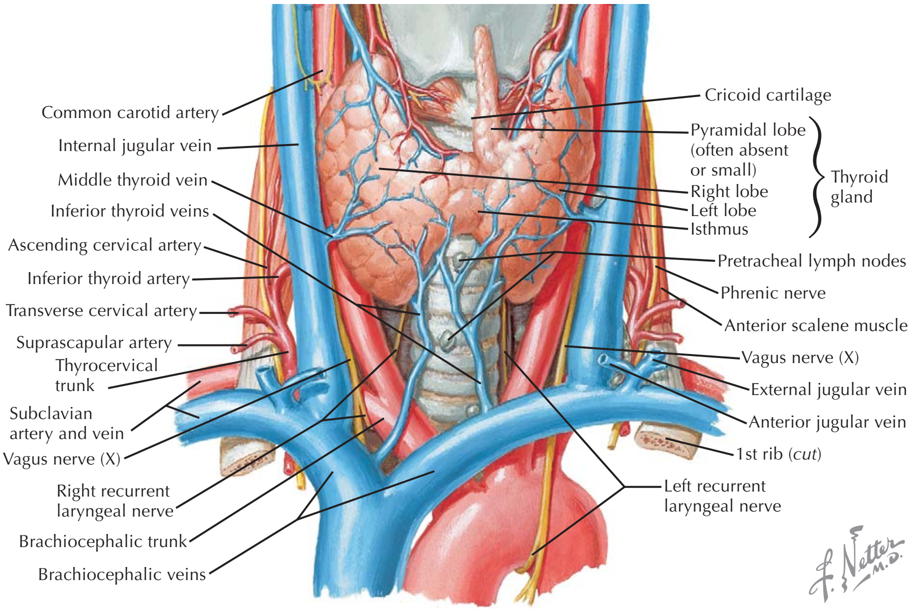
CONTENTS OF THE ROOT OF THE NECK			
Arteries	**Veins**	**Nerves**	**Structures**
Common carotid Subclavian Vertebral Transverse cervical	Internal jugular Subclavian Brachiocephalic Inferior thyroid Vertebral	Vagus Recurrent laryngeal Phrenic Sympathetic trunk Brachial plexus	Trachea Esophagus Thoracic duct Right lymphatic duct

Root of the Neck

GENERAL INFORMATION *CONTINUED*

Right anterior dissection



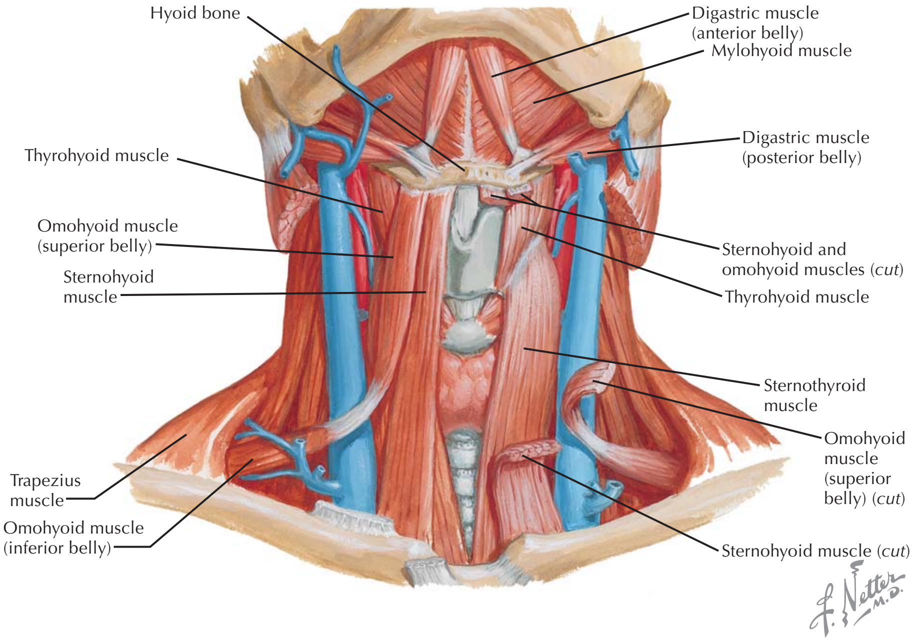


MAJOR BORDERS OF THE TRIANGLES

Muscle	Origin	Insertion	Actions	Nerve Supply
Trapezius	External occipital protuberance Superior nuchal line Ligamentum nuchae Spinous process of C7 Spinous processes of T1 to T12	Spine of the scapula Acromion Lateral 1/3 of the clavicle	Elevate the scapula Retract the scapula Depress the scapula	Spinal accessory n. also receives some branches from C3 and C4, thought to be proprioceptive
Sternocleido-mastoid	Manubrium Medial 1/3 of the clavicle	Mastoid process of the temporal bone Superior nuchal line	Unilaterally: ● Face turns to contralateral side ● Head tilts to ipsilateral side Bilaterally: ● Head is flexed	Spinal accessory n.

MUSCLES THAT SUBDIVIDE THE TRIANGLES

Muscle	Origin	Insertion	Actions	Nerve Supply
Digastric (posterior and anterior bellies connected by a tendon attached to the hyoid)	Mastoid process	Digastric fossa of the mandible	Elevates hyoid Helps depress and retract the mandible	Facial n. (posterior belly) Trigeminal n. (anterior belly)
Omohyoid (superior and inferior bellies connected by a tendon)	Superior border of the scapula	Body of the hyoid	Depresses the hyoid Helps depress the larynx	Ansa cervicalis



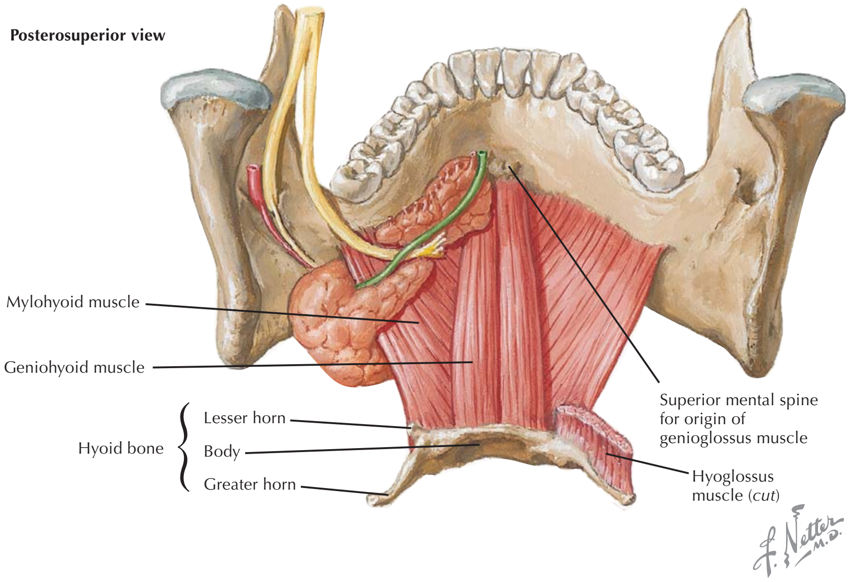
Muscles

SUPRAHYOID MUSCLES

Muscle	Origin	Insertion	Actions	Nerve Supply
Stylohyoid	Styloid process	Body of the hyoid	Elevates the hyoid Retracts the hyoid	Facial n.
Mylohyoid	Mylohyoid line of the mandible	Mylohyoid of opposite side at the raphe Body of the hyoid	Elevates the hyoid Elevates the floor of the oral cavity	Trigeminal n. (mandibular division)
Digastric (posterior and anterior bellies connected by a tendon attached to the hyoid)	Mastoid process	Digastric fossa of the mandible	Elevates hyoid Helps depress and retract the mandible	Facial n. (posterior belly) Trigeminal n. (anterior belly—mandibular division)
Geniohyoid	Inferior genial tubercle	Body of the hyoid	Helps move the hyoid and tongue anteriorly	C1 (ventral ramus, which follows the hypoglossal n.)

INFRAHYOID MUSCLES

Muscle	Origin	Insertion	Actions	Nerve Supply
Omohyoid (superior and inferior bellies connected by a tendon)	Superior border of the scapula	Body of the hyoid	Depresses the hyoid	Ansa cervicalis
Sternohyoid	Manubrium	Body of the hyoid	Depresses the hyoid	Ansa cervicalis
Sternothyroid	Manubrium	Oblique line of the thyroid cartilage	Depresses the larynx	Ansa cervicalis
Thyrohyoid	Oblique line of the thyroid cartilage	Greater cornu (horn) of the hyoid	Depresses the hyoid	C1 (ventral ramus, which follows the hypoglossal n.)

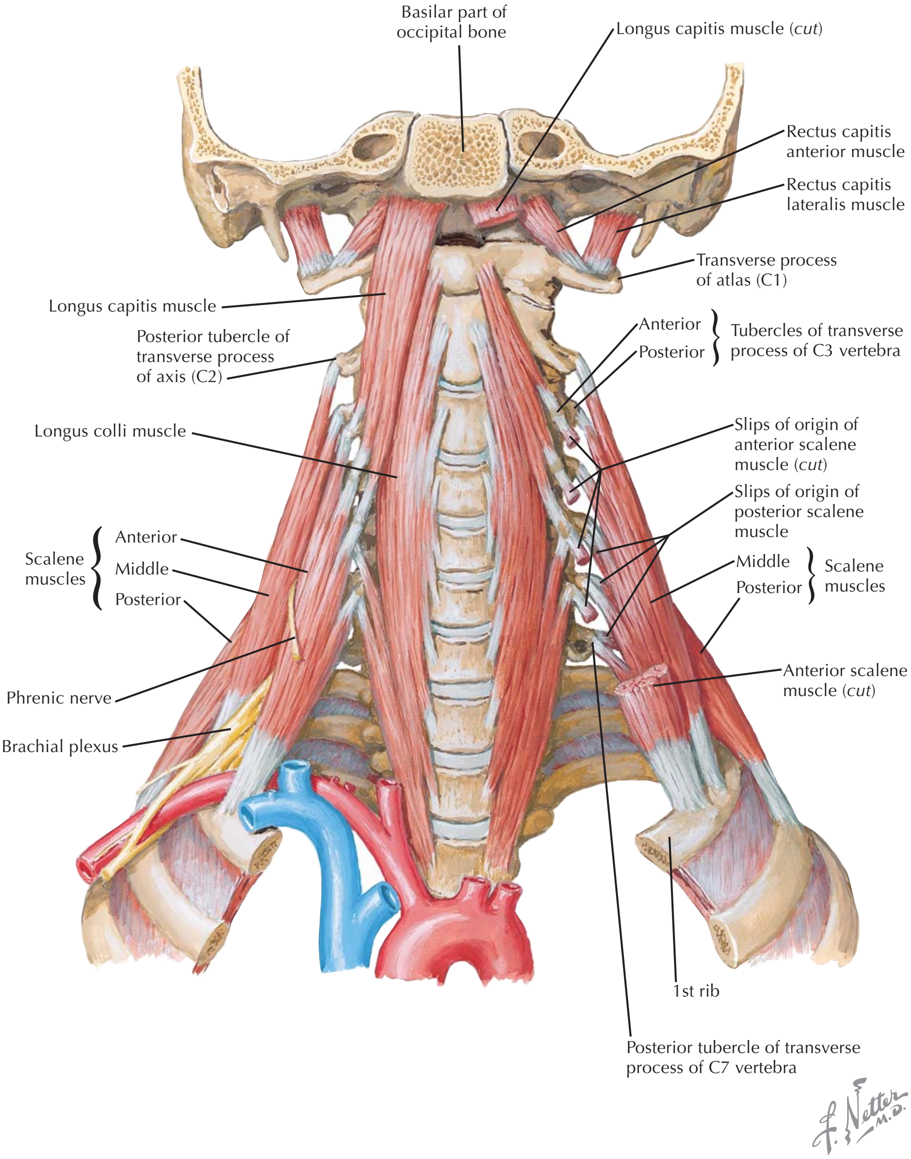


PREVERTEBRAL MUSCLES

Muscle	Origin	Insertion	Actions	Nerve Supply
Longus colli			Flexion of the neck Helps rotate the neck	Ventral rami of C2 to C8
Superior oblique	Transverse processes of C3 to C5	Anterior arch of atlas		
Inferior oblique	Vertebral bodies of T1 to T3	Transverse process of C5 to C6		
Vertical	Vertebral bodies of C5 to C7 and T1 to T3	Vertebral bodies of C2 to C4		
Longus capitis	Transverse processes of C3 to C6	Basilar portion of the occipital bone	Flexion of the head	Ventral rami of C1 to C3
Rectus capitis anterior	Transverse process of the atlas			Ventral rami of C1 and C2
Rectus capitis lateralis		Jugular portion of the occipital bone	Lateral flexion of the head	
Anterior scalene	Transverse processes of C3 to C6	Scalene tubercle on the 1st rib	Elevates 1st rib Lateral flexion of the neck	Ventral rami of C4 to C6
Middle scalene	Transverse processes of C2 to C7	1st rib	Lateral flexion of the neck	Ventral rami of C5 to C8
Posterior scalene	Transverse processes of C5 to C7	2nd rib		Ventral rami of C6 to C8

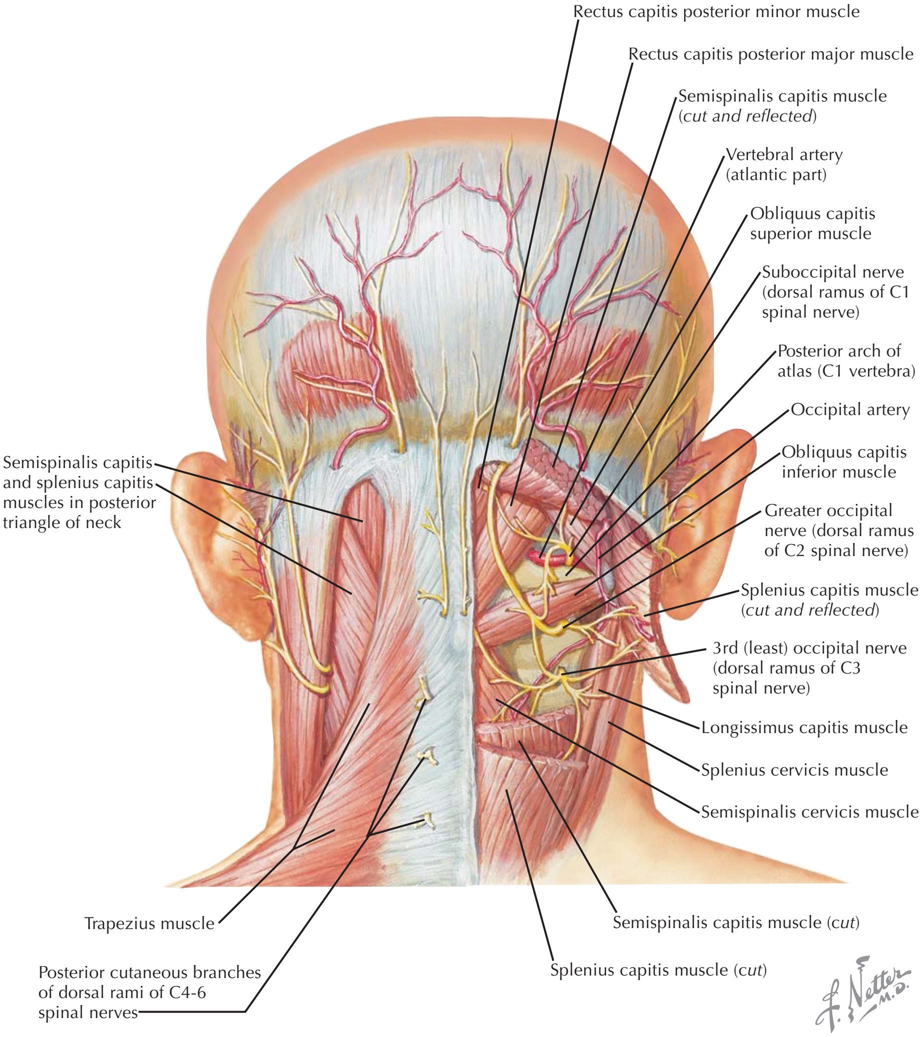
Muscles

PREVERTEBRAL MUSCLES *CONTINUED*



SUBOCCIPITAL TRIANGLE MUSCLES

Muscle	Origin	Insertion	Actions	Nerve Supply
Obliquus capitis superior	Transverse process of the atlas	Occipital bone	Extends head Lateral flexion of head	Suboccipital n. (dorsal rami of C1)
Obliquus capitis inferior	Spinous process of the axis	Transverse process of the atlas	Rotates head to ipsilateral side	Suboccipital n. (dorsal rami of C1)
Rectus capitis posterior major		Inferior nuchal line (lateral portion) of the occipital bone	Extends head Rotates head to ipsilateral side	Suboccipital n. (dorsal rami of C1)
Rectus capitis posterior minor	Posterior arch of the atlas	Inferior nuchal line (medial portion) of the occipital bone	Extends head	Suboccipital n. (dorsal rami of C1)



Vascular Supply of the Neck

ARTERIAL SUPPLY

The major arteries of the neck are the common carotid and the subclavian arteries

SUBCLAVIAN

- Thyrocervical
- Costocervical
- Vertebral
- Dorsal scapular (usually)

(Internal thoracic artery is located in the thorax)

COMMON CAROTID

- Internal carotid
- External carotid
  - Superior thyroid
  - Lingual
  - Facial
  - Ascending pharyngeal
  - Occipital

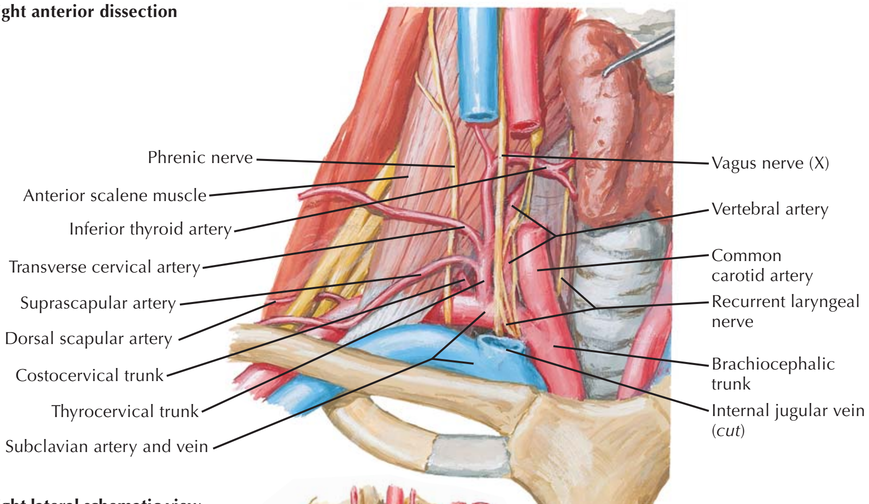
(Posterior auricular, maxillary, and superficial temporal arteries are located in the head)

SUBCLAVIAN VASCULAR SUPPLY OF THE NECK

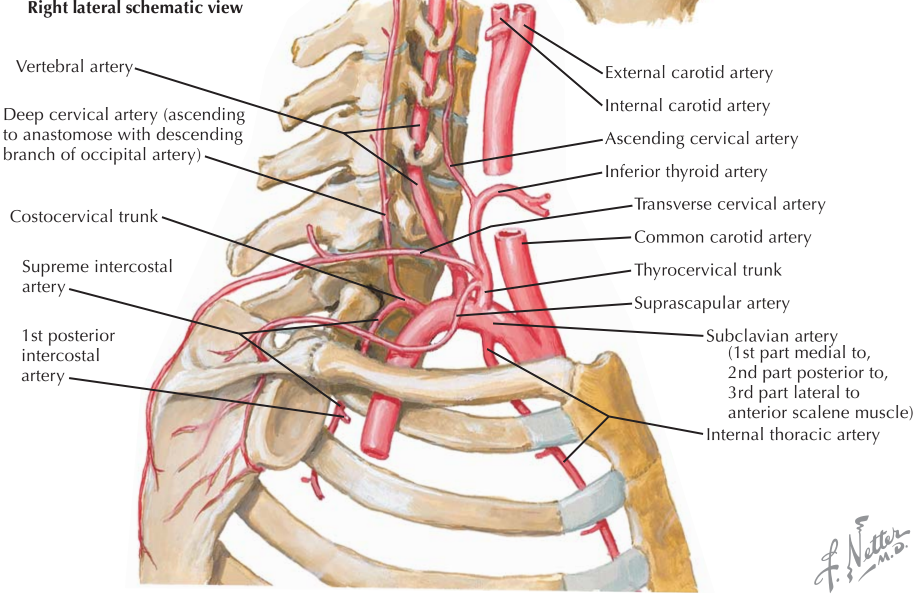
Artery	Source	Comments
Subclavian	Right subclavian a. is a branch of the brachiocephalic a.; left subclavian a. is a direct branch of the aorta	Both subclavian aa. travel lateral to the trachea into the root of the neck, passing between the anterior and middle scalene aa. Divided into 3 parts based on its relationship to the anterior scalene m.: • 1st part—extends from the beginning of the subclavian to the medial border of the anterior scalene, and all of the branches of the subclavian a. arise from the 1st part, except the left costocervical trunk, which often is a branch of the 2nd part • 2nd part—located posterior to the anterior scalene • 3rd part—located from the lateral margin of the anterior scalene to the lateral border of the 1st rib, where it becomes the axillary a.
Thyrocervical	A branch of the 1st part of the subclavian along the medial aspect of the anterior scalene m.	Immediately divides into 3 branches: • Inferior thyroid—travels along the medial border of the anterior scalene posterior to the carotid sheath and anterior to the vertebral a. to the thyroid gland while accompanied by the recurrent laryngeal n.; it gives rise to the inferior laryngeal a. to the larynx and the ascending cervical, which helps supply the muscles in the area and sends branches to the vertebral a. • Suprascapular—travels inferior to and laterally across the anterior scalene m. and phrenic n. deep to the sternocleidomastoid m. and crosses the posterior triangle of the neck to reach the scapula, where it passes superior to the transverse lig. of the scapula • Transverse cervical—travels across the posterior triangle of the neck to reach the anterior border of the trapezius m.
Costocervical	A branch of the 1st part of the right subclavian a. and the 2nd part of the left subclavian a.	Divides into 2 branches: • Deep cervical—travels superiorly along the posterior part of the neck mainly to help supply the muscles • Supreme intercostal—travels to supply the 1st and 2nd intercostal spaces
Vertebral	1st part of the subclavian a.	Ascends to enter the foramen transversarium of C6 Passes around the atlas and then through the foramen magnum to enter the skull, where it unites with the opposite vertebral to form the basilar a. along the ventral surface of the pons
Dorsal scapular	2nd or 3rd part of the subclavian a.	Arises from the subclavian a. in about 70% to 75% of people and the transverse cervical a. in the other 25% to 30% When arising from the subclavian a., it passes posteriorly between the trunks of the brachial plexus to travel across the posterior triangle of the neck to reach the anterior border of the trapezius m.

ARTERIAL SUPPLY *CONTINUED*

Right anterior dissection



Right lateral schematic view



Vascular Supply of the Neck

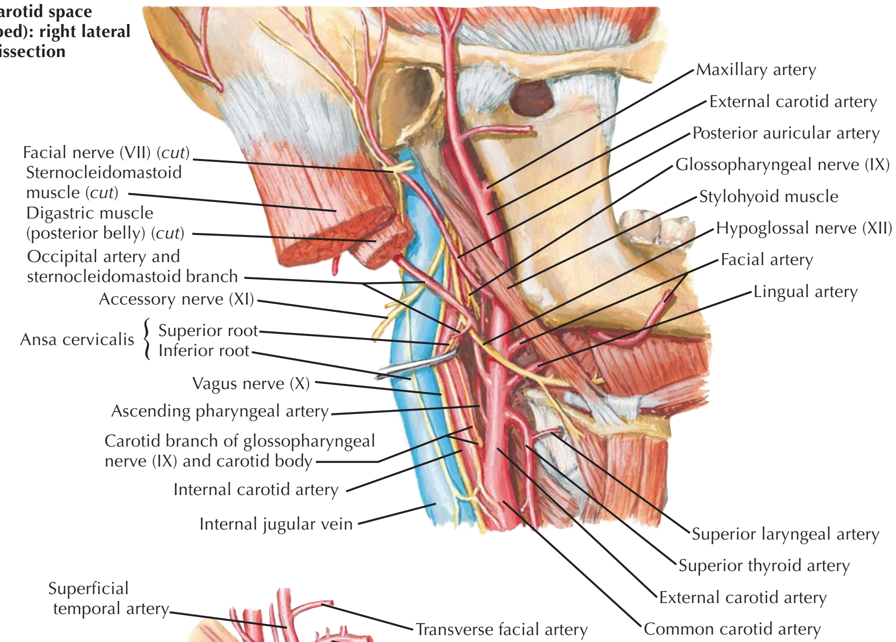
ARTERIAL SUPPLY *CONTINUED*

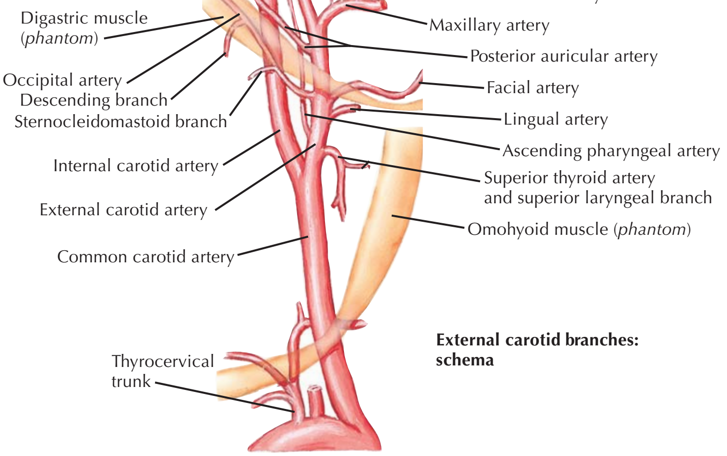
CAROTID VASCULAR SUPPLY OF THE NECK

Artery	Source	Comments
Common carotid	Right common carotid a. is a branch of the brachiocephalic a.; left common carotid a. is a direct branch of the aorta	Both common carotids ascend posterior to the sternoclavicular joint into the neck and bifurcate at the superior border of the thyroid cartilage at C3 into the: ● External carotid a. ● Internal carotid a. There are no branches of the common carotid a. in the neck Carotid body: A chemoreceptor located along the common carotid a. Usually receives its sensory innervation from the carotid branch of the glossopharyngeal n.
Internal carotid	The 2 branches of the common carotid a.; arise at the superior border of the thyroid cartilage at C3	There are no branches of the internal carotid a. in the neck Passes superiorly in the neck within the carotid sheath along with the internal jugular v. and the vagus n. anterior to the transverse processes of the upper cervical vertebrae Carotid sinus: A baroreceptor located as a dilation at the beginning of the internal carotid a. Usually receives its sensory innervation from the carotid branch of the glossopharyngeal n.
External carotid		Gives rise to a majority of the branches to the neck Located external to the carotid sheath and travels anteriorly and superiorly in the neck posterior to the mandible and deep to the posterior belly of the digastric and stylohyoid mm. to enter the parotid gland
Superior thyroid	The first branch of the external carotid a.; arises in the carotid triangle	Passes inferiorly along the inferior constrictor m. on its path to the thyroid gland The superior laryngeal a. arises from the superior thyroid a. and passes through the thyrohyoid membrane to supply the larynx
Lingual	External carotid a.; arises within the carotid triangle	Passes superiorly and medially toward the greater cornu of the hyoid bone in an oblique fashion and makes a loop by passing anteriorly and inferiorly while traveling superficial to the middle constrictor m. While forming a loop, the artery is crossed superficially by the hypoglossal n. The lingual a. passes deep to the posterior belly of the digastric and stylohyoid mm. as it travels anteriorly At this region, it gives rise to a hyoid branch that travels on the superior surface of the hyoid bone supplying the muscles in the area Passes deep to the hyoglossus m. and travels anteriorly between the hyoglossus and genioglossus mm. to supply the tongue
Facial	External carotid a. in the carotid triangle of the neck	Passes superiorly immediately deep to the posterior belly of the digastric and stylohyoid mm. Passes along the submandibular gland giving rise to the submental a., which helps supply the gland Passes superiorly over the body of the mandible at the masseter m. in a tortuous pattern to supply the face
Ascending pharyngeal	Posterior portion of the external carotid a. near the bifurcation of the common carotid a.	The smallest branch of the external carotid Ascends superiorly between the lateral side of the pharynx and the internal carotid a. Has a series of branches: 3 to 4 pharyngeal branches supply the superior and middle constrictor mm. The most superior branch passes through the gap superior to the superior constrictor m.
Occipital	External carotid a. in the carotid triangle of the neck	Branches along the inferior margin of the posterior belly of the digastric and stylohyoid mm. The hypoglossal n. wraps around the occipital a. from the posterior part of the vessel, traveling anteriorly Passes posteriorly along the mastoid process, making a groove on the bone Pierces the fascia that connects the attachment of the trapezius with the sternocleidomastoid m. Ascends in the connective tissue layer of the scalp, dividing into many branches Anastomoses with the posterior auricular and superficial temporal aa. The terminal part of the artery is accompanied by the greater occipital n.

ARTERIAL SUPPLY *CONTINUED*

Parotid space (bed): right lateral dissection





External carotid branches: schema

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Vascular Supply of the Neck

VENOUS DRAINAGE

Highly variable with inconsistent drainage

VEINS OF THE NECK

Internal jugular
- Occipital
- Facial
- Lingual
- Pharyngeal
- Superior thyroid
- Middle thyroid

External jugular

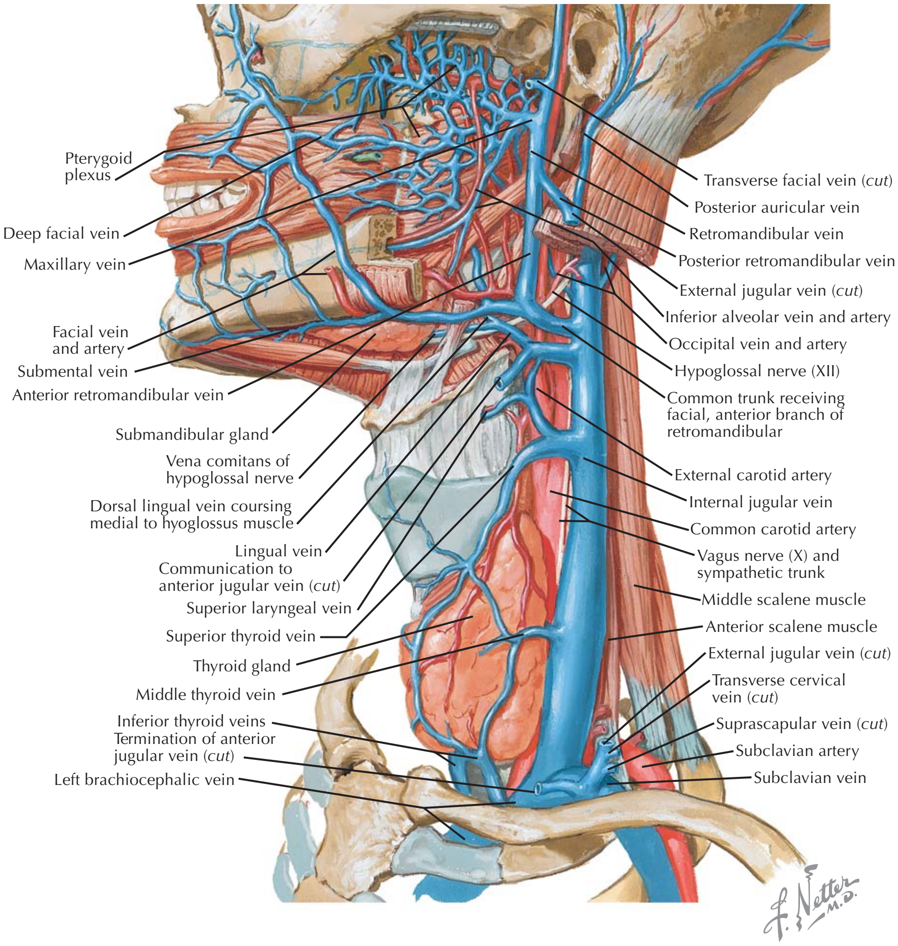
Anterior jugular

Subclavian
- Vertebral

JUGULAR VASCULAR SUPPLY OF THE NECK

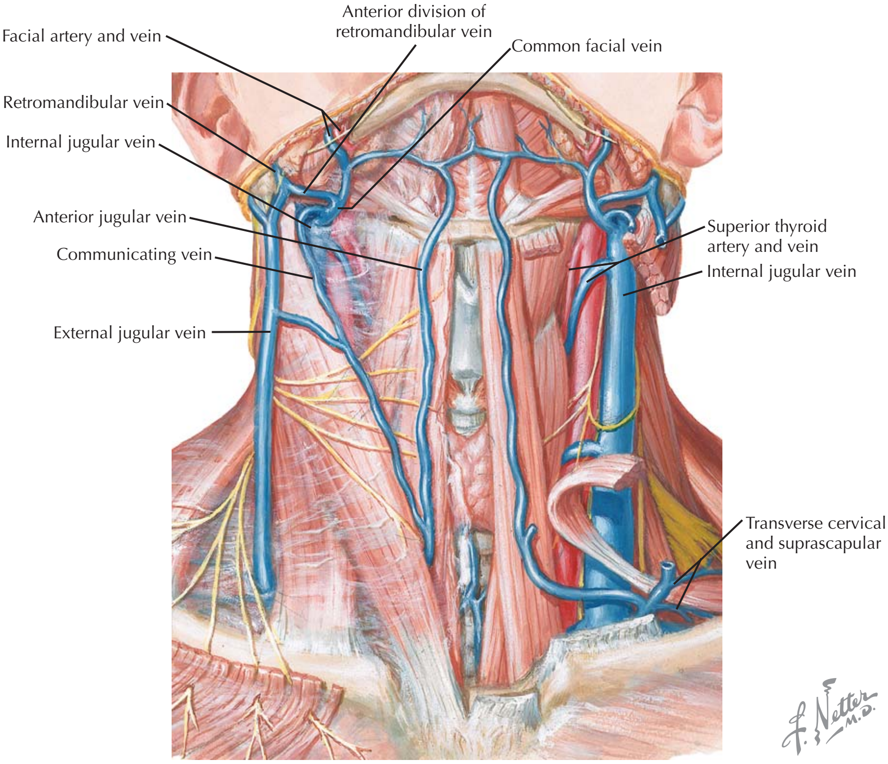
Vein	Comments
Internal jugular	Continuous with the sigmoid sinus within the cranial cavity Begins at the base of the skull at a dilation called the superior bulb Lies posterior to the internal carotid a. and the glossopharyngeal, vagus, and spinal accessory nn. as it initially descends Travels lateral to the internal carotid a. within the carotid sheath with the vagus n. posterior to the vessels Unites with the subclavian v. to form the brachiocephalic v. at the root of the neck Receives a series of branches
Occipital	Begins on the posterior portion of the scalp at the vertex Passes from superficial to deep by passing through the attachment of the sternocleidomastoid m. Has a mastoid emissary v. that connects it to the transverse sinus The veins termination is variable, but it usually passes inferiorly to join the internal jugular v.
Facial	Has no valves to allow blood to backflow Begins as the angular v. Passes inferiorly along the side of the nose, receiving the lateral nasal v. Continues in a posterior and inferior path across the angle of the mouth to the cheek, receiving the superior and inferior labial vv. While passing toward the mandible, the deep facial v. connects the facial v. to the pterygoid plexus In the submandibular triangle, the facial v. joins the anterior branch of the retromandibular to form the common facial v. Common facial v. drains into the internal jugular v.
Lingual	Passes with the lingual a., deep to the hyoglossus m., and ends in the internal jugular v. The vena comitans nervi hypoglossi, or accompanying v. of the hypoglossal n., begins at the apex of the tongue and either joins the lingual v. or accompanies the hypoglossal n. and enters the common facial v., draining into the internal jugular v.
Pharyngeal	Pharyngeal vv. pass from the pharyngeal plexus of vv. along the posterior portion of the pharynx Drain into the internal jugular v.
Superior thyroid	Forms a venous plexus on the thyroid gland with the middle and inferior thyroid vv. before draining into the internal jugular v.
Middle thyroid	Forms a venous plexus on the thyroid gland with the superior and inferior thyroid vv. before draining into the internal jugular v.
External jugular	Formed by the combination of the posterior branch of the retromandibular and posterior auricular vv. in the parotid gland Lies deep to the platysma m. but superficial to the sternocleidomastoid m. as it descends vertically Passes into the posterior triangle of the neck, where it drains into the subclavian v. immediately lateral to the anterior scalene m.
Transverse cervical	Passes from the anterior border of the trapezius m. through the posterior triangle to drain into the external jugular v.
Suprascapular	Arises from the scapula above the transverse scapular lig. to pass through the posterior triangle of the neck to drain into the external jugular v.
Anterior jugular	Arises by the joining of a series of superficial veins in the submental region Descends anterior to the sternocleidomastoid m. and passes deep to the muscle before draining into the external jugular or the subclavian
Subclavian	The continuation of the axillary v. Located along the lateral border of the 1st rib until it unites with the internal jugular v. Passes anterior to the anterior scalene m.
Vertebral	Begins as a plexus in the suboccipital triangle and descends through the foramen transversarium of all of the cervical vertebrae before draining into the subclavian or, more commonly, the brachiocephalic v.

VENOUS DRAINAGE *CONTINUED*



Vascular Supply of the Neck

VENOUS DRAINAGE *CONTINUED*



4 Nerve Supply of the Neck

GENERAL INFORMATION

The nerve supply to the neck is extensive; it is made up of:

- Cranial nerves
  - Glossopharyngeal
  - Vagus
  - Spinal accessory
  - Hypoglossal
- Cervical plexus
- Brachial plexus
  - Dorsal scapular
  - Long thoracic
  - Suprascapular
- Phrenic
- Other cervical ventral rami

CRANIAL NERVES OF THE NECK

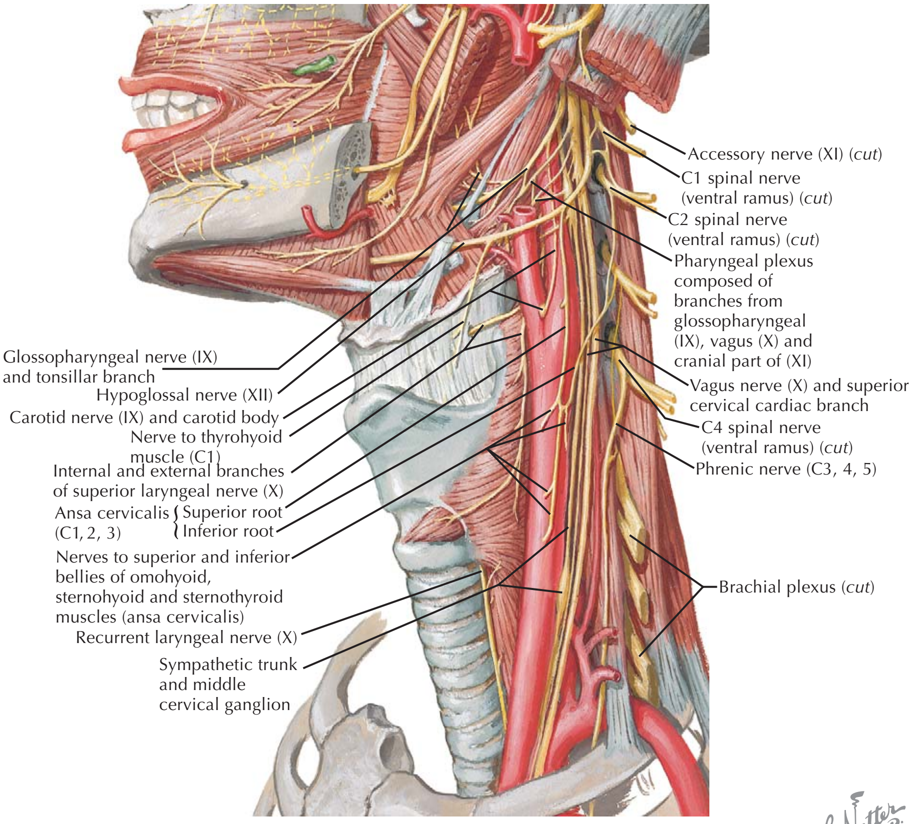
GLOSSOPHARYNGEAL NERVE
Also known as cranial nerve IX
Branches from the medulla oblongata and passes through the jugular foramen with the vagus and spinal accessory nn.
Immediately after passing through the jugular foramen, it gives off the tympanic branch
As the glossopharyngeal passes through the foramen, it passes between the internal carotid a. and internal jugular v. in an inferior direction
Gives rise to the carotid branch that passes between the internal and external carotid aa. to the carotid body and carotid sinus
The main glossopharyngeal n. continues to pass inferiorly, giving rise to the pharyngeal branch, which is the sensory nerve to the pharyngeal plexus that perforates the muscles of the pharynx and supplies the mucous membranes (mainly oropharynx region)
Continues to pass inferiorly; travels posterior to the stylopharyngeus m. and innervates it
Passes anteriorly with the stylopharyngeus and travels between the superior and middle constrictor mm. to be located by the palatine tonsils
Small lingual branches arise from the it and distribute general somatic afferent (GSA) fibers to the mucous membrane of the posterior 1/3 of the tongue, in addition to the fauces, and special visceral afferent (SVA) fibers to the taste buds
VAGUS NERVE
Also known as cranial nerve X
Branches from the medulla oblongata and passes through the jugular foramen with the glossopharyngeal and spinal accessory nn.
As the vagus n. passes through the foramen, it passes between the internal carotid a. and internal jugular v.
A series of nerves branch from the vagus n. as it passes from the base of the skull through the neck: auricular, pharyngeal, superior laryngeal, recurrent laryngeal, and cardiac vagal branches
Auricular Branch
Arises from the superior ganglion, travels posterior to the internal jugular v., and passes along the temporal bone to enter the mastoid canaliculus and give branches that innervate the skin of the back of the auricle and the posterior portion of the external acoustic meatus
Pharyngeal Branch
Arises from the upper part of the inferior ganglion of the vagus n., contains filaments from the cranial portion of the spinal accessory n., and serves as the motor component to the pharyngeal plexus
Superior Laryngeal n.
Travels inferiorly posterior to the internal carotid and on the side of the pharynx, and divides into the: • Internal laryngeal n.—passes inferiorly to the larynx through the thyrohyoid membrane along with the superior laryngeal vessels to distribute the GSA fibers to the base of the tongue at the epiglottic region, and to the mucous membranes of the larynx as far inferiorly as the false vocal folds; and SVA fibers to the taste buds in the area • External laryngeal n.—travels inferiorly along the inferior constrictor to supply the cricothyroid muscle and the inferior portion of the inferior constrictor

Nerve Supply of the Neck

CRANIAL NERVES OF THE NECK *CONTINUED*

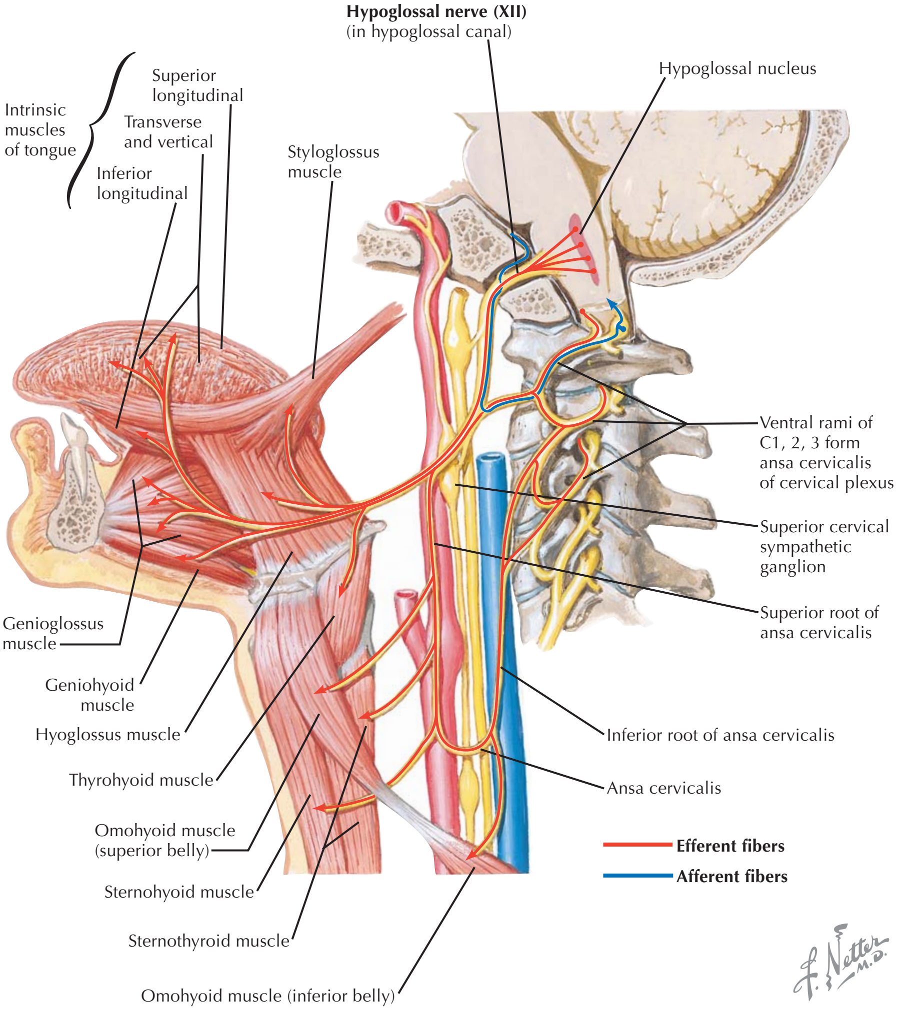
Recurrent Laryngeal n.
Arises from the vagus n. differently, depending on the side of the body The right recurrent laryngeal n. loops under the right subclavian, whereas the left recurrent laryngeal n. loops under the ligamentum arteriosum posterior to the aorta Ascends on the lateral side of the trachea until reaching the pharynx where it passes deep to the inferior constrictor m. to reach the larynx, innervating the mucous membranes below the false vocal folds and all of the intrinsic muscles of the larynx except the cricothyroid
Cardiac Vagal Branches
Descend to form the parasympathetic portion of the cardiac plexus
SPINAL ACCESSORY NERVE
Also known as cranial nerve XI Described as being formed from 2 parts: cranial and spinal
Cranial Part
Begins in the nucleus ambiguus from the medulla as 4 to 5 branches just inferior to the roots of the vagus n. and passes laterally to the jugular foramen, where it merges with the fibers of the spinal part of the spinal accessory n. While united for a short distance, it also is connected by 1 or 2 branches with the inferior ganglion of the vagus n. Exits through the jugular foramen, separates from the spinal part, and continues over the surface of the inferior ganglion of the vagus n. to be distributed mainly to the pharyngeal branches of the vagus to form the motor portion of the pharyngeal plexus, which innervates the muscles in the pharynx, soft palate, and 1 tongue muscle
Spinal Part
Begins in the upper cervical levels of the spinal cord and after separating from the cranial part provides innervation to the sternocleidomastoid m. and passes obliquely through the posterior triangle of the neck to innervate the trapezius m.
HYPOGLOSSAL NERVE
Also known as cranial nerve XII Arises as a series of rootlets from the medulla oblongata and passes through the hypoglossal canal Travels inferiorly, located between the internal carotid a. and the internal jugular v. Passes anteriorly as it wraps around the occipital a. inferior to the posterior belly of the digastric m. Passes superficial to the external carotid a. and the loop of the lingual a. in its anterior path Passes deep to the posterior belly of the digastric and stylohyoid mm. and lies superficial to the hyoglossus m. with the accompanying v. of the hypoglossal n. It passes deep to the mylohyoid m. and continues anterior in the genioglossus m. Gives rise to muscular branches that supply all the intrinsic tongue muscles and the hyoglossus, genioglossus, and styloglossus mm.

CRANIAL NERVES OF THE NECK *CONTINUED*



Nerve Supply of the Neck

CRANIAL NERVES OF THE NECK *CONTINUED*



4 Nerve Supply of the Neck

SENSORY INNERVATION OF THE NECK

Skin of the neck receives sensory innervation from both dorsal and ventral rami

Dorsal ramus of C1 lacks sensory fibers and does not contribute to the sensory distribution to the neck

Dorsal rami of C6 to C8 lack sensory fibers and do not contribute to the sensory distribution to the neck

Ventral rami provide most of the sensory innervation to the neck through the sensory branches of the cervical plexus

CERVICAL PLEXUS

Formed by C1 to C4 ventral rami

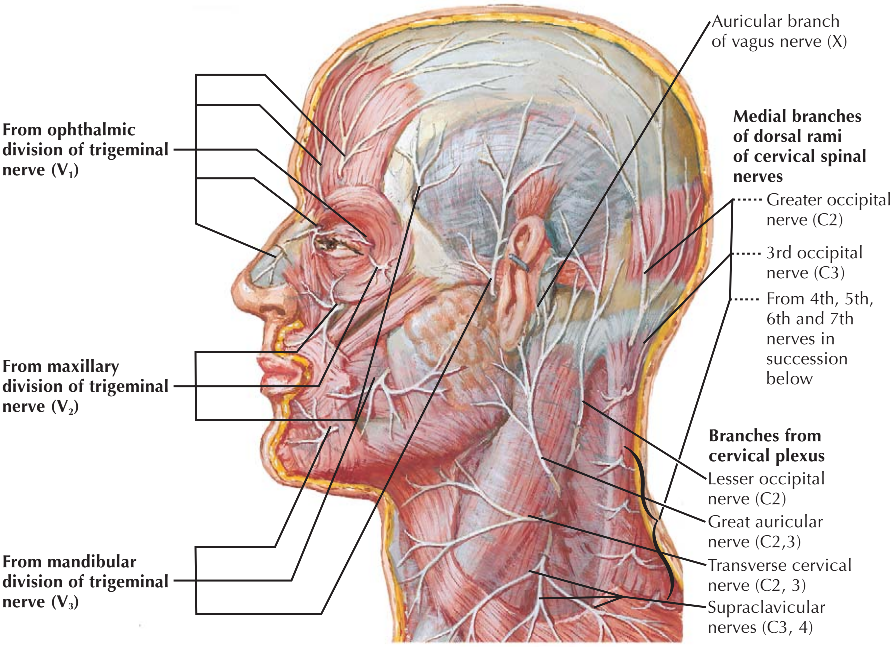
Originates deep to the sternocleidomastoid

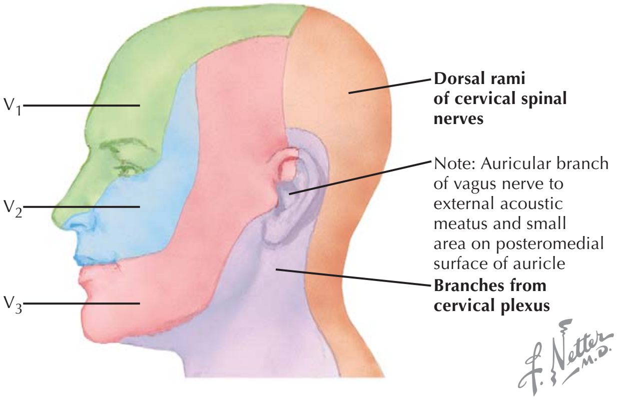
Sensory branches pass along the posterior border of the muscle at Erb's point to travel to their destinations

VENTRAL RAMI		
Nerve	**Source**	**Comments**
Lesser occipital	Cervical plexus by contributions from the ventral ramus of C2	Passes posterior to the sternocleidomastoid m. at Erb's point Ascends posterior to the sternocleidomastoid along the posterior portion of the head Continues on the head posterior to the auricle supplying the skin in the region
Great auricular	Cervical plexus formed by contributions of ventral rami C2 and C3	Passes posterior to the sternocleidomastoid m. at Erb's point Ascends along the sternocleidomastoid, dividing into anterior and posterior branches: Anterior branch innervates the skin of the face over the parotid gland Posterior branch innervates the skin over the mastoid process, the posterior portion of the auricle, and the concha and lobule
Transverse cervical		Passes posterior to the sternocleidomastoid m. at Erb's point Crosses anteriorly along the sternocleidomastoid, dividing into ascending and descending branches Ascending and descending branches pass through the platysma m. to supply the skin of the neck from the region between the mandible and the manubrium
Supraclavicular	Cervical plexus formed by contributions of ventral rami C3 and C4	Passes posterior to the sternocleidomastoid m. at Erb's point Travels inferiorly in an oblique direction through the posterior triangle of the neck *Divides into 3 major branches:* ● Medial supraclavicular—supplies the skin up to the midline ● Middle supraclavicular—supplies the skin over the pectoralis major and deltoid m. region ● Lateral supraclavicular—supplies the skin along the deltoid and anterior trapezius mm.
DORSAL RAMI		
Nerve	**Source**	**Comments**
Greater occipital	Dorsal ramus of C2	Ascends after emerging from the suboccipital triangle obliquely between the inferior oblique and semispinalis capitis mm. Passes through the trapezius m. and ascends to innervate the skin along the posterior part of the scalp to the vertex
3rd occipital	Branch of the dorsal ramus of C3 deep to the trapezius m.	Passes through the trapezius m. and ascends along in the skin of the inferior portion of the posterior surface of the head near the midline
Dorsal ramus of C4	Dorsal ramus of C4 deep to the trapezius m.	Passes through the trapezius m. and ascends along in the skin of the inferior portion of the posterior surface of the head near the midline
Dorsal ramus of C5	Dorsal ramus of C5 deep to the trapezius m.	Passes through the trapezius m. and ascends along in the skin of the inferior portion of the posterior surface of the head near the midline

Nerve Supply of the Neck

SENSORY INNERVATION OF THE NECK *CONTINUED*





4 Nerve Supply of the Neck

CERVICAL PLEXUS OF THE NECK

Arises from the ventral rami of C1 to C4

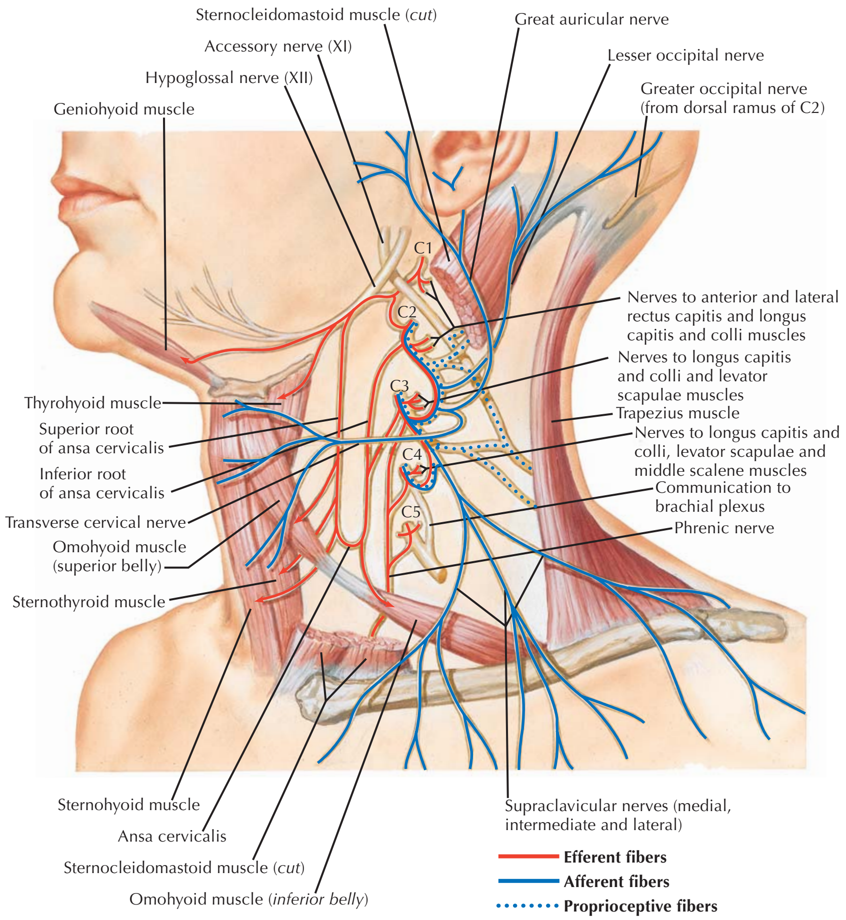
Divided into 2 parts:
- Ansa cervicalis (motor component)
- Cutaneous branches (sensory component):
  - Lesser occipital
  - Transverse cervical
  - Great auricular
  - Supraclavicular

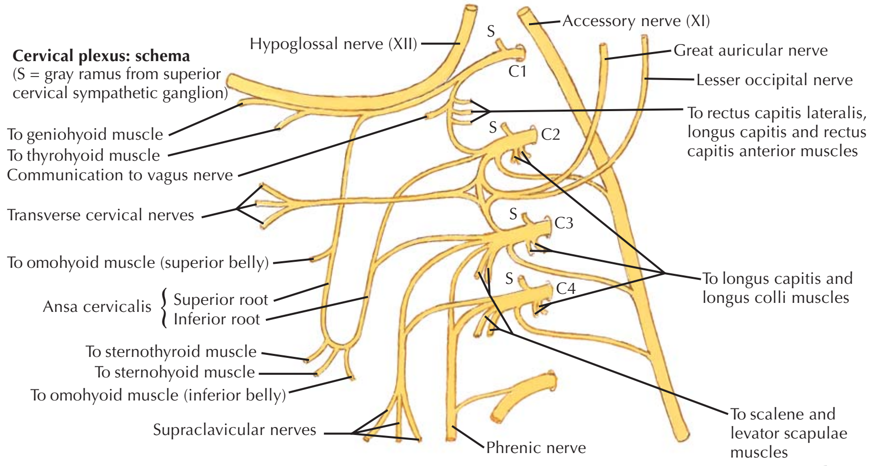
ANSA CERVICALIS	
Source	**Comments**
Ventral rami of C1 to C3	The motor component of the cervical plexus Innervates the: • Omohyoid • Sternohyoid • Sternothyroid **Divisions:** Superior root (descendens hypoglossi) Arises from the ventral ramus of C1, which passes anteriorly and joins the hypoglossal n., and the fibers travel together without mixing As the hypoglossal n. passes anteriorly toward the tongue, some of the fibers of C1 branch inferiorly to form the superior root of the ansa cervicalis Superior root joins the inferior root along the lateral border of the carotid sheath Some of the fibers from C1 continue to follow the hypoglossal n. to innervate the geniohyoid and thyrohyoid mm. Inferior root (descendens cervicalis) Arises from the ventral rami of C2 and C3 These branches unite to form the inferior root that unites with the superior root along the lateral border of the carotid sheath

CUTANEOUS BRANCHES		
Nerve	**Source**	**Comments**
Lesser occipital	Cervical plexus by contributions from the ventral ramus of C2	Passes posterior to the sternocleidomastoid m. at Erb's point Ascends posterior to the sternocleidomastoid along the posterior portion of the head Continues on the head posterior to the auricle supplying the skin in the region
Great auricular	Cervical plexus formed by contributions of ventral rami C2 and C3	Passes posterior to the sternocleidomastoid m. at Erb's point Ascends along the sternocleidomastoid dividing into anterior and posterior branches: Anterior branch innervates the skin of the face over the parotid gland Posterior branch innervates the skin over the mastoid process, the posterior portion of the auricle, and the concha and lobule
Transverse cervical		Passes posterior to the sternocleidomastoid m. at Erb's point Crosses anteriorly along the sternocleidomastoid dividing into ascending and descending branches Ascending and descending branches pass through the platysma to supply the skin of the neck from the region between the mandible and the manubrium
Supraclavicular	Cervical plexus formed by contributions of ventral rami C3 and C4	Passes posterior to the sternocleidomastoid m. at Erb's point Travels inferiorly in an oblique direction through the posterior triangle of the neck *Divides into 3 major branches:* • Medial supraclavicular—supplies the skin up to the midline • Middle supraclavicular—supplies the skin over the pectoralis major and deltoid m. region • Lateral supraclavicular—supplies the skin along the deltoid and anterior trapezius mm.

Nerve Supply of the Neck

CERVICAL PLEXUS OF THE NECK *CONTINUED*





Cervical plexus: schema
(S = gray ramus from superior cervical sympathetic ganglion)

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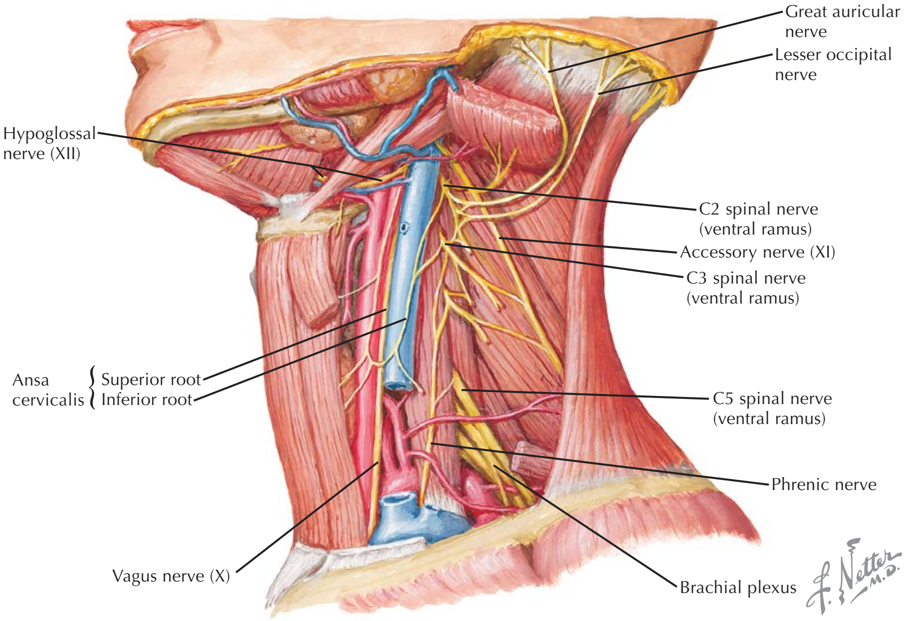
Nerve Supply of the Neck

VENTRAL RAMI NERVES OF THE NECK

Nerve	Source	Comments
Phrenic	Arises from the ventral rami of C3 to C5	Passes inferiorly along the anterior surface of the anterior scalene m. Eventually passes through the thorax to innervate the diaphragm
Brachial plexus	Ventral rami of C5 to C8 and T1 form the brachial plexus, which provides motor and sensory function to the upper limb	These rami pass between the anterior and the middle scalene mm. Ventral rami of C5 and C6 unite to form the upper trunk Ventral ramus of C7 continues as the middle trunk Ventral ramus of C8 to T1 form the inferior trunk These trunks continue to form the divisions of the brachial plexus that enter the axilla 3 branches of the brachial plexus are contained in the posterior triangle of the neck: • Dorsal scapular—arises from C5 and passes through the middle scalene before passing obliquely to the levator scapulae, which it innervates (along with the rhomboid major and minor mm.) • Long thoracic—arises from the ventral rami C5 to C7 to pass through the middle scalene before passing inferiorly to the serratus anterior, which it innervates • Suprascapular—arises from the upper trunk to pass through the posterior triangle of the neck to reach the supraspinatus and infraspinatus mm. by passing below the transverse scapular lig.



Nerve Supply of the Neck

SYMPATHETICS IN THE NECK

Sympathetic trunk extends into the neck from the thorax
In the neck, the sympathetic trunk typically has 3 ganglia:

- Superior cervical ganglion—located at the base of the skull
- Middle cervical ganglion—located at C6
- Inferior cervical ganglion—located immediately posterior to the vertebral artery near the vessel's origin

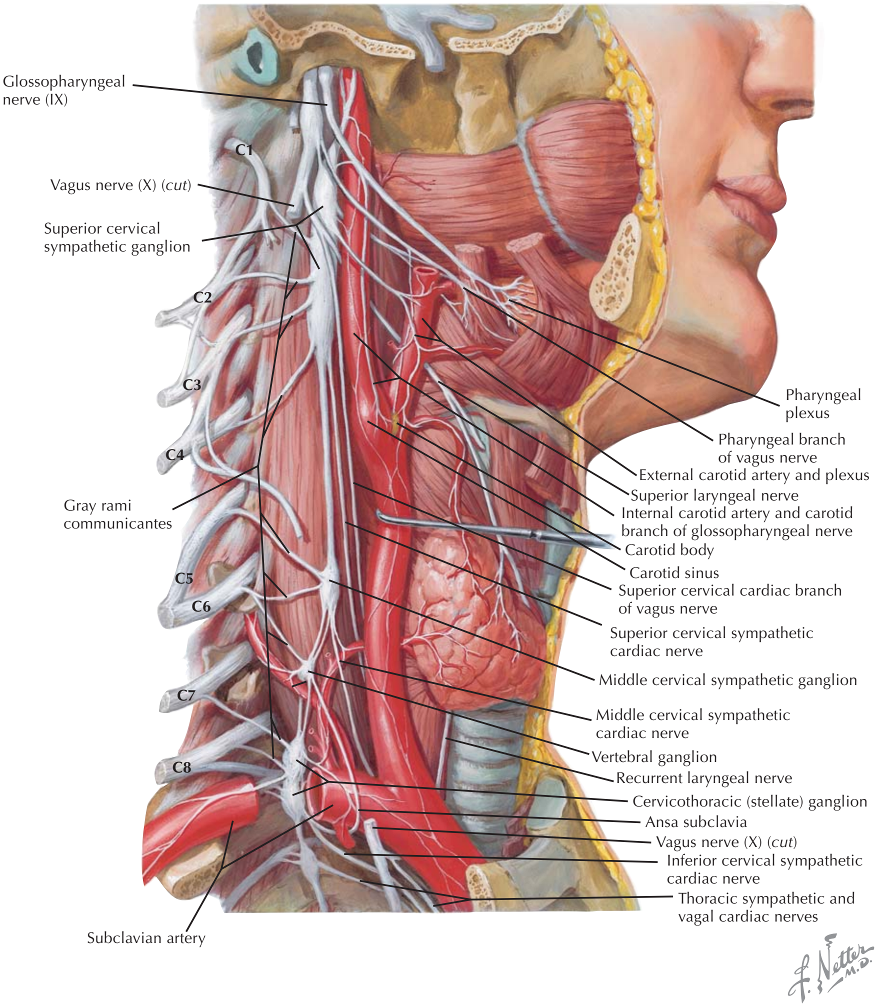
Often the inferior cervical ganglion unites with the 1st thoracic ganglion to create the stellate ganglion

Sympathetics for the head and neck arise in the intermediolateral horn column of the spinal cord from T1 to T4

These preganglionic fibers ascend through the sympathetic trunk to reach the cervical ganglia and synapse with the postganglionic neurons

Postganglionic neurons follow either of 2 paths:

- May travel to the spinal nerves via the gray ramus
- May follow the arterial supply to the effector organs of the head



4 Clinical Correlate

TORTICOLLIS

Torticollis, also known as "wryneck," is a disorder in which the muscles of the neck are flexed, extended, or twisted in an abnormal position

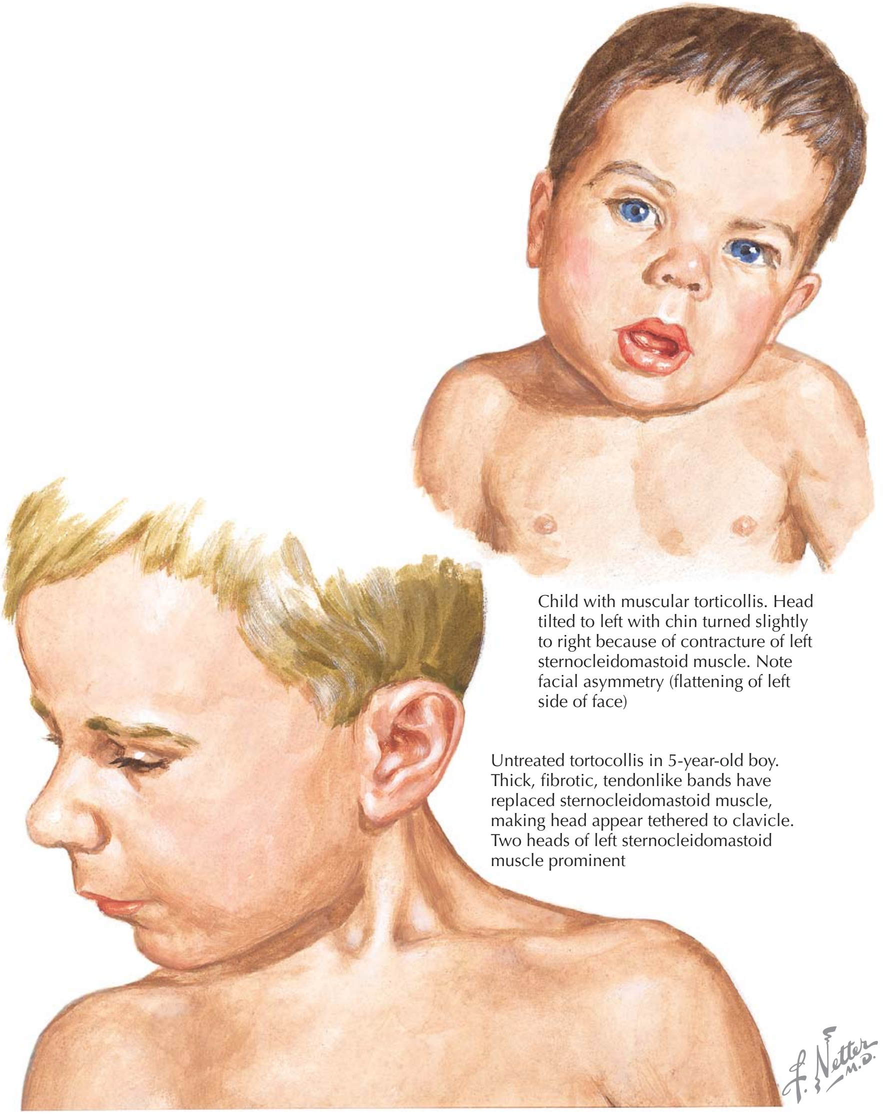
The sternocleidomastoid is the most commonly affected muscle

The neck typically twists to one side, leading to abnormal movements and postures of the head

In congenital muscular torticollis, the bent neck is caused by a tight sternocleidomastoid on one side of the body

Early treatment is important in preventing permanent deformities

Certain drugs, such as neuroleptic agents, can cause *dystonia*, a condition in which involuntary muscle contraction occurs in the neck, back, and trunk



Child with muscular torticollis. Head tilted to left with chin turned slightly to right because of contracture of left sternocleidomastoid muscle. Note facial asymmetry (flattening of left side of face)

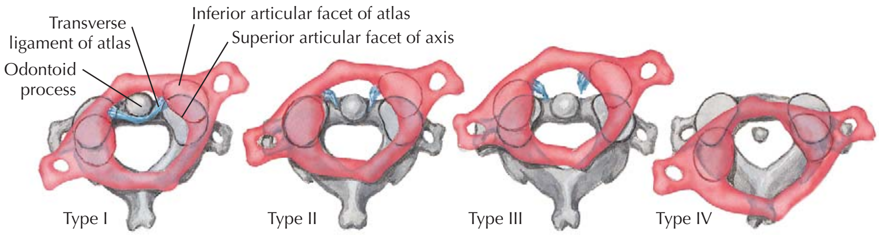
Untreated tortocollis in 5-year-old boy. Thick, fibrotic, tendonlike bands have replaced sternocleidomastoid muscle, making head appear tethered to clavicle. Two heads of left sternocleidomastoid muscle prominent

Clinical Correlate

TORTICOLLIS *CONTINUED*

Nonmuscular Causes of Torticollis

Atlantoaxial rotatory subluxation and fixation (after Fielding and Hawkins)



Type I

Rotatory subluxation of atlas about dens but transverse ligament intact. No anterior displacement

Type II

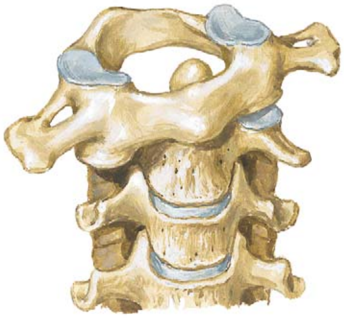
One articular facet subluxated, other acts as pivot; transverse ligament defective. Anterior displacement of 3–5 mm

Type III

Both articular facets subluxated, transverse ligament defective. Anterior displacement of >5 mm

Type IV

Posterior rotatory subluxation (rare). Os odontoideum or absent or defective dens



Type I rotatory subluxation

Clinical Correlate

HYPOTHYROIDISM

Hypothyroidism: a condition in which the thyroid gland does not produce enough thyroid hormones

The pituitary gland regulates the thyroid's normal production of the hormones thyroxine and triiodothyronine

The lack of hormones leads to an overall slowing of mental and physical activities

Congenital hypothyroidism is known as cretinism

CAUSES

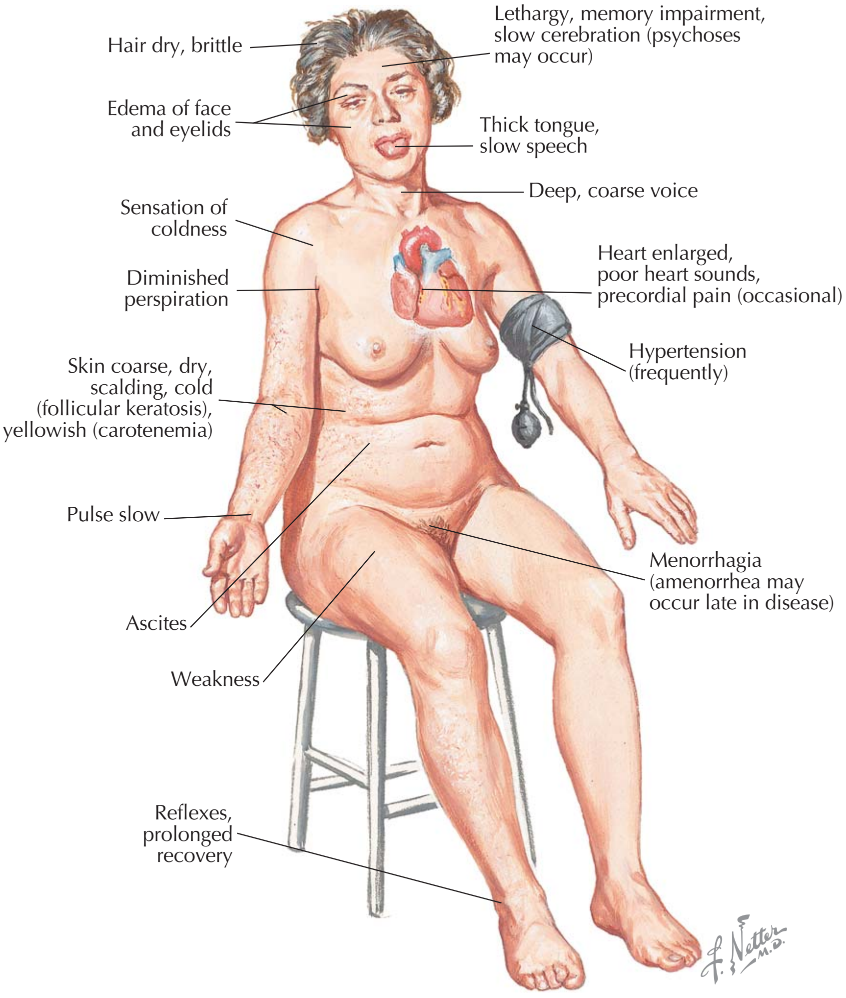
- Hashimoto's thyroiditis—immune system of the body attacks the gland
- Irradiation of the gland
- Surgical removal of the gland
- Congenital defects

RISK FACTORS

- Obesity
- Age older than 50 years
- Female gender

CLINICAL MANIFESTATIONS

- Fatigue
- Weakness
- Slow pulse
- Edema of face
- Cold sensations
- Dry and coarse skin
- Coarse voice



Clinical Correlate

HYPERTHYROIDISM

Hyperthyroidism: a condition characterized by hypermetabolism and elevated levels of thyroid hormones

Can lead to *thyrotoxicosis,* a toxic condition caused by excess thyroid hormones regardless of the cause

CAUSES

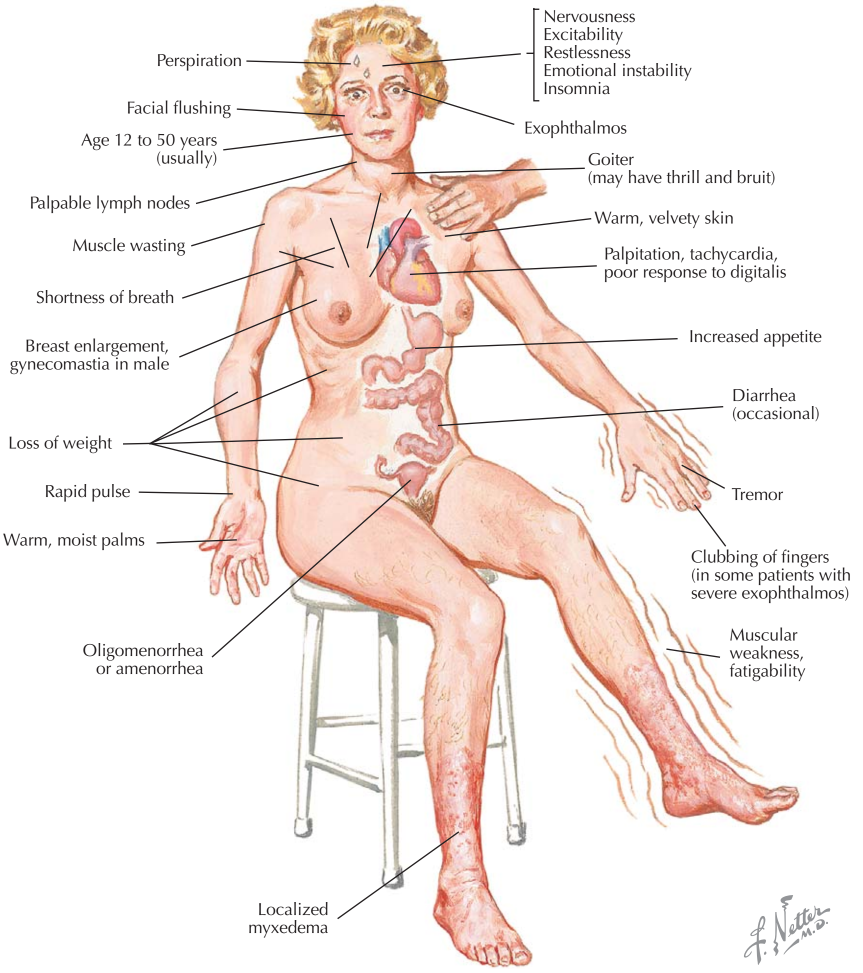
- Graves' disease—most common cause (in greater than 80% of all cases of hyperthyroidism), in which the body produces antibodies that stimulate the thyroid to synthesize excess thyroid hormones
- Benign growths of the thyroid or pituitary gland
- Thyroiditis
- Ingestion of excess thyroid hormones or iodine
- Gonadal tumors

CLINICAL MANIFESTATIONS

- Loss of weight
- Restlessness
- Nervousness
- Increased appetite
- Fatigue
- Goiter

TREATMENT

- Radioactive iodine—but too much can lead to hypothyroidism
- Surgery
- Antithyroid agents



CHAPTER 5

SCALP AND MUSCLES OF FACIAL EXPRESSION

5 Overview and Topographic Anatomy

GENERAL INFORMATION

SCALP

The area bordered by the forehead, superior part of the cranium, and occipital area immediately superior to the superior nuchal line

The lateral portion of the scalp blends with the temporal area because it extends inferiorly to the zygomatic arch

Anatomy of the scalp is important because of frequent trauma in this region

FACE

The area bordered within the hairline, anterior border of the auricles, and the chin

Major contents: eyes, nose, mouth, muscles of facial expression, muscles of mastication, parotid gland, trigeminal nerve, and facial nerve

BONES

Bones of the facial skeleton:

- Frontal bone
- Zygomatic bone (zygoma)
- Maxilla
- Palatine bone
- Nasal bone
- Mandible

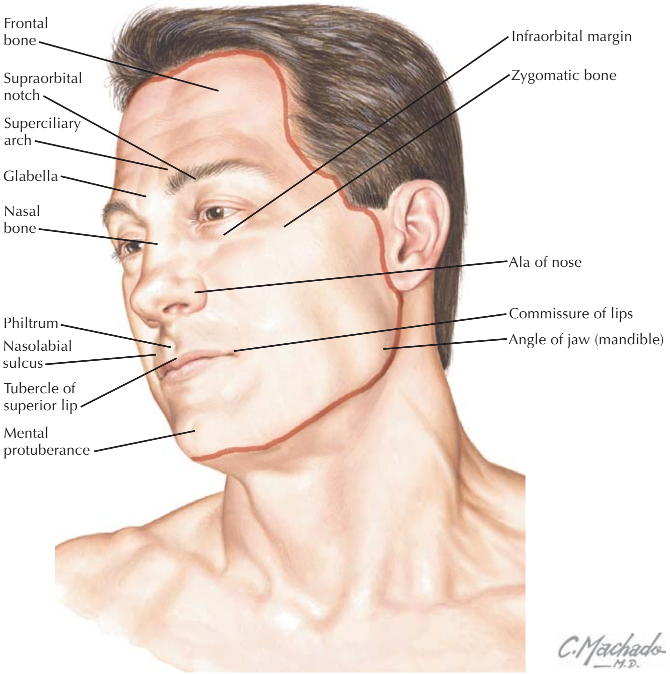
Besides the nasal bone, the most commonly fractured bone of the facial skeleton is the zygomatic bone

MUSCLES OF FACIAL EXPRESSION

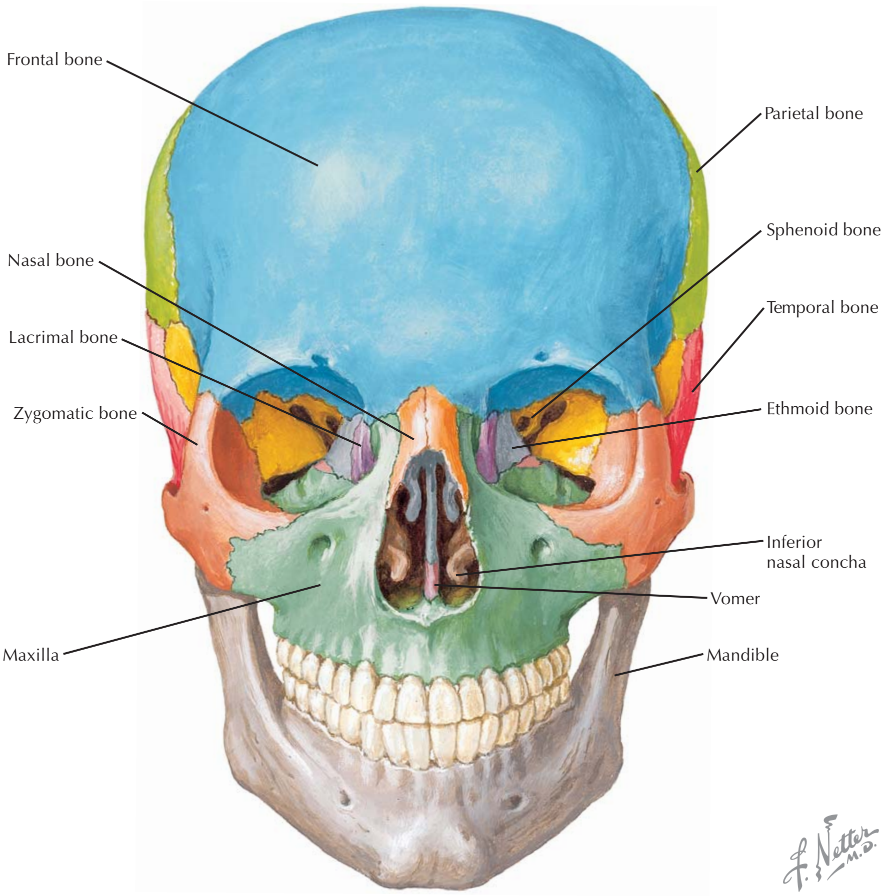
Innervated by the facial nerve

Derivatives of the 2nd pharyngeal arch

Originate from either bone or fascia and insert on the skin



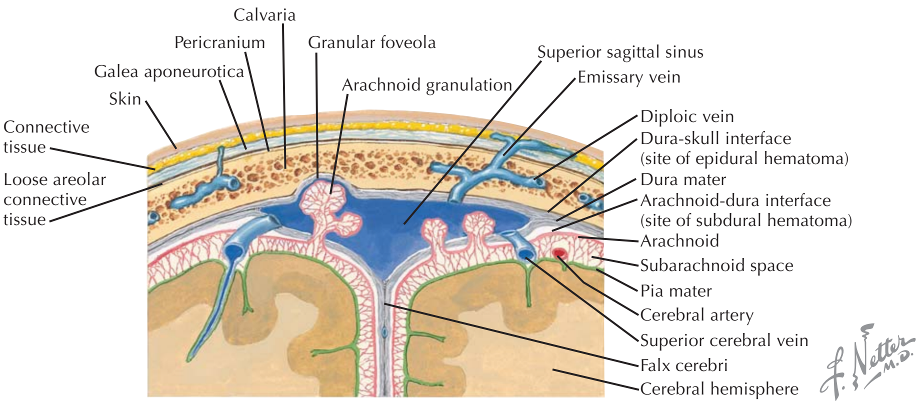
GENERAL INFORMATION *CONTINUED*



5 Overview of the Scalp

GENERAL INFORMATION

Layer	Description
Skin	Thickest layer of the scalp Contains the hair follicles
Connective tissue	Heavily vascularized Arteries, veins, and nerves of the scalp are located here Emissary veins connect this layer to the dural venous sinuses, providing channel for infections to spread Head wounds that pierce the skin and connective tissue layers bleed profusely
Aponeurosis	Also called galea aponeurosis Continuous with the occipitofrontalis m.: anteriorly with the frontalis, posteriorly with the occipitalis Blends laterally with the temporal fascia Its surgical manipulation is important in cosmetic surgery Head wounds that pierce the skin, connective tissue, and aponeurosis layers bleed and gape open from the pull of the 2 bellies of the occipitofrontalis Skin, connective tissue, and aponeurosis layers are adherent and often called "scalp proper"
Loose areolar connective tissue	Thin and mobile Helps form a subaponeurotic layer that extends from the eyebrows to the superior nuchal line and external occipital protuberance Allows substances such as bacteria and blood to pass freely Separates with scalp avulsion
Pericranium	Covers the outer surface of the cranium



Vascular Supply of the Scalp

GENERAL INFORMATION

Highly vascularized; the vessels anastomose freely on the scalp

Arteries are derived from the external and the internal carotid arteries

The neurovascular supply arises from the anterior, lateral, and posterior scalp regions

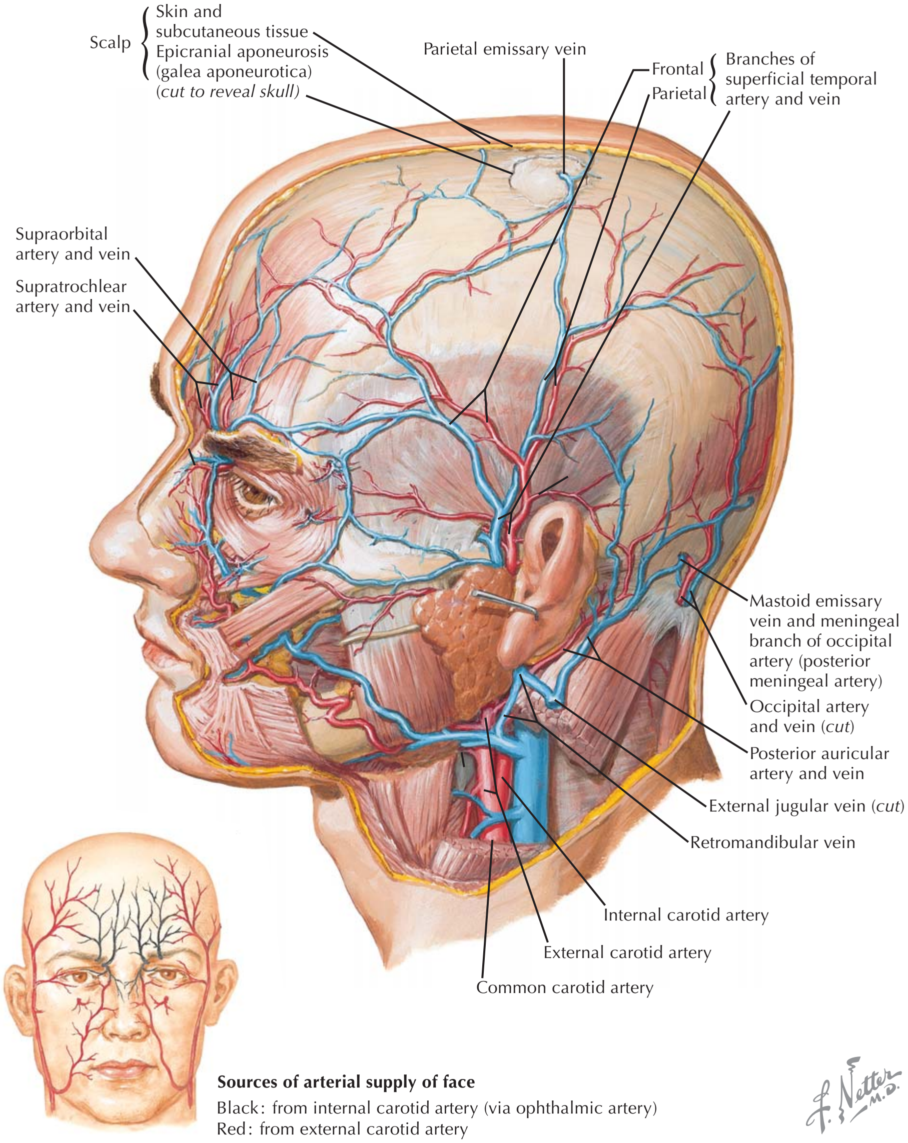
ARTERIAL SUPPLY		
Artery	**Source**	**Course**
Supratrochlear	Ophthalmic a. from the internal carotid a.	Exits the orbit at the medial angle accompanied by supratrochlear n. Ascends on the scalp Anastomoses with the contralateral supraorbital and supratrochlear aa.
Supraorbital		Branches from the ophthalmic a. as the artery passes the optic n. Passes medially to the levator palpebrae superioris and superior rectus mm. to join the supraorbital n. Passes through the supraorbital foramen (notch) and ascends superiorly along the scalp Anastomoses with the supratrochlear and superficial temporal aa.
Superficial temporal	1 of 2 external carotid a. terminal branches	Begins posterior to the neck of the mandible and travels superiorly as a continuation of the external carotid a. Joined by the auriculotemporal n. Anastomoses with a majority of other branches supplying the scalp
Posterior auricular	External carotid a.	Arises within the parotid gland Passes superiorly between the mastoid process and the cartilage of the ear Anastomoses with the superficial temporal and occipital aa.
Occipital		Branches along the inferior margin of the posterior belly of the digastric and stylohyoid mm. Hypoglossal n. wraps around it from the posterior part of the vessel, traveling anteriorly Passes posteriorly along the mastoid process, making a groove on the bone Pierces the fascia that connects the attachment of the trapezius with the sternocleidomastoid m. Ascends in the connective tissue layer of the scalp, dividing into many branches The terminal part is accompanied by the greater occipital n. Anastomoses with the posterior auricular and superficial temporal aa.

VENOUS DRAINAGE

Vein	Course
Supratrochlear	Begins on the forehead, where it communicates with the superficial temporal v. Passes inferiorly along the forehead parallel with the vein of the opposite side At the medial angle of the orbit, it joins the supraorbital and the angular v.
Supraorbital	Begins on the forehead, where it communicates with the superficial temporal v. Passes inferiorly superficial to the frontalis m. and joins the supratrochlear v. at the medial angle of the orbit and the angular v.
Superficial temporal	Descends posterior to the zygomatic root of the temporal bone alongside the auriculotemporal n. to enter the substance of the parotid gland Unites with the maxillary v. to form the retromandibular v.
Posterior auricular	Begins on the side of the scalp, posterior to the auricle Passes inferiorly and joins the posterior division of the retromandibular v. to form the external jugular v.
Occipital	Begins on the posterior portion of the scalp at the vertex Passes from superficial to deep by passing through the attachment of the sternocleidomastoid m. to the skull Has a mastoid emissary v. that connects it to the transverse sinus The vein's termination is variable, but it usually passes inferiorly to join the internal jugular v.

Vascular Supply of the Scalp

VENOUS DRAINAGE *CONTINUED*



Sources of arterial supply of face

Black: from internal carotid artery (via ophthalmic artery)
Red: from external carotid artery

Nerve Supply of the Scalp

SENSORY DISTRIBUTION

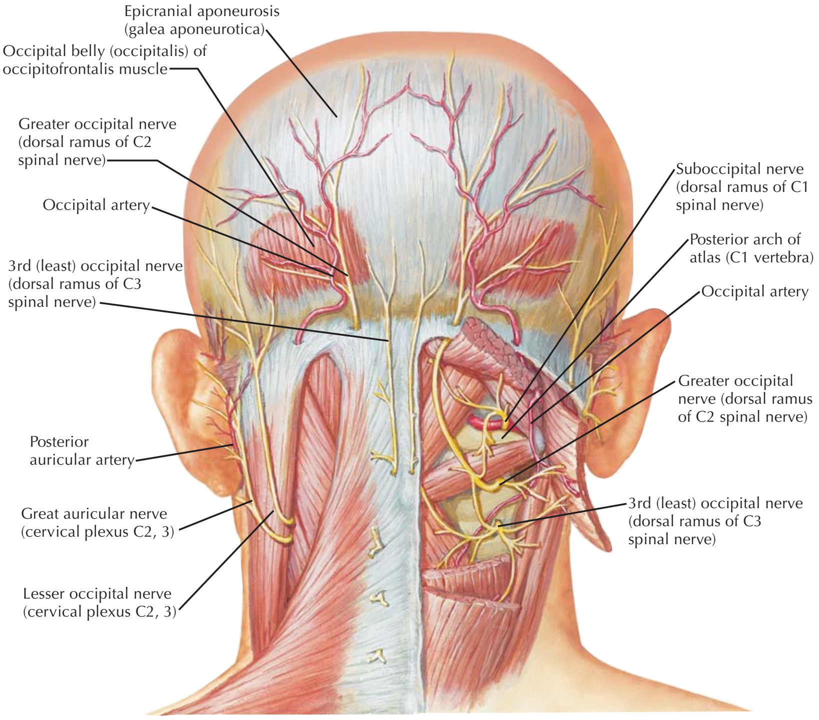
Sensory supply is derived from all 3 divisions of the trigeminal nerve, branches of the cervical plexus, and upper cervical dorsal rami

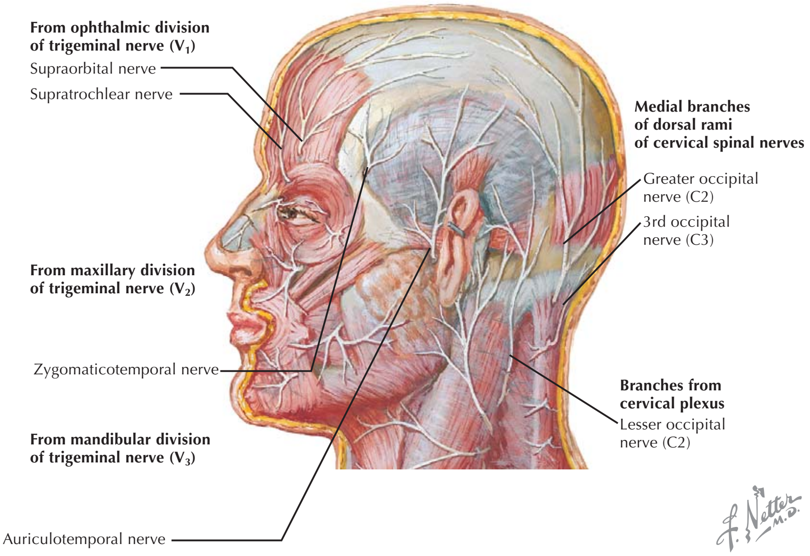
These nerves travel in the scalp's connective tissue layer

SENSORY NERVES OF THE SCALP		
Nerve	**Source**	**Course**
Supratrochlear	Arises from the ophthalmic division of the trigeminal n.; 1 of the 2 terminal branches of the frontal n. in the orbit	Continues to pass anteriorly toward the trochlea once the supratrochlear a. joins it within the orbit In the trochlear region, it often supplies the frontal sinus before exiting the orbit Ascends along the scalp, at first deep to the musculature in the region, before piercing them to reach the cutaneous innervation along the scalp
Supraorbital		Passes between the levator palpebrae superioris m. and periosteum of the orbit Continues anteriorly to the supraorbital foramen (notch) At the level of the supraorbital margin, the supraorbital n. supplies the frontal sinus and ascends superiorly along the scalp Divides into medial and lateral branches that travel to the vertex of the scalp
Zygomaticotemporal	Maxillary division of the trigeminal n.	Arises from the zygomatic n. in the pterygopalatine fossa, and passes through the inferior orbital fissure to enter the lateral wall of the orbit and branches into the zygomaticotemporal and zygomaticofacial branches Passes on the lateral wall of the orbit in a groove in the zygomatic bone, then through a foramen in the zygomatic bone to enter the temporal fossa region Within the temporal fossa, it passes superiorly between the bone and the temporalis m. to pierce the temporal fascia superior to the zygomatic arch Passes along the skin of the side of the scalp
Auriculotemporal	Mandibular division of the trigeminal n.	Normally arises as 2 roots, between which the middle meningeal a. passes Runs posteriorly just inferior to the lateral pterygoid and continues to the medial aspect of the neck of the mandible Turns superiorly with the superficial temporal vessels between the auricle and the condyle of the mandible deep to the parotid gland On exiting the parotid gland, ascends over the zygomatic arch and divides into branches along the scalp
Lesser occipital	Arises from the cervical plexus from the ventral ramus of C2	Wraps around and travels superiorly along the posterior border of the sternocleidomastoid At the skull, it passes through the investing layer of deep cervical fascia and continues superiorly posterior to the auricle to supply the skin in the area
Greater occipital	Dorsal ramus of C2	Ascends between the obliquus capitis inferior and semispinalis capitis mm. in the suboccipital triangle Passes through the semispinalis capitis and trapezius mm. near their bony attachments Ascends on the back of the head with the occipital a. to supply the skin as far anterior as the vertex
3rd occipital	Dorsal ramus of C3	Arises deep to the trapezius m., passes through it, and ascends in the skin of the inferior portion of the posterior surface of the head near the midline

Nerve Supply of the Scalp

SENSORY DISTRIBUTION *CONTINUED*





F. Netter M.D.

Overview of Muscles of Facial Expression

GENERAL INFORMATION

Innervated by the facial nerve

Derivatives of the 2nd pharyngeal arch

Insert into the skin to provide movement

Most muscles of facial expression are localized around the facial orifices

There is no deep fascia along the face

ORAL GROUP

Muscle	Origin	Insertion	Actions	Nerve	Comments
Orbicularis oris	*Bone*: anterior midline of the maxilla and mandible *Muscular*: angle of the mouth where fibers blend with levator anguli oris, depressor anguli oris, zygomaticus major, and risorius mm.	Skin along the mouth	Closes mouth Protrusion of lips Pursing of lips	Facial (buccal and mandibular branches)	Sphincter of the mouth Muscle fibers encircle the mouth
Depressor anguli oris	Mandible along area near the external oblique line	Angle of the mouth Some fibers blend and provide origin for the orbicularis oris m. Fibers overlap those of the depressor labii inferioris m.	Depresses the corners of the mouth Antagonizes the levator anguli oris m.		Antagonizes levator anguli oris m.
Levator anguli oris	Canine fossa of the maxilla (inferior to the infraorbital foramen)	Angle of the mouth Some fibers blend and provide origin for the orbicularis oris m.	Elevates the angle of the mouth	Facial (zygomatic and buccal branches)	In an infraorbital injection, the needle lies between the levator anguli oris and levator labii superioris mm.
Zygomaticus major	Zygomatic bone (anterior to the zygomaticotemporal suture)		Moves the angle of the mouth superiorly and laterally		Commonly called the "laughing muscle" owing to its action
Zygomaticus minor	Zygomatic bone (anterior to the zygomaticus major)	Lateral upper lip	Helps elevate the upper lip		Inserts between the levator labii superioris and zygomaticus major mm.

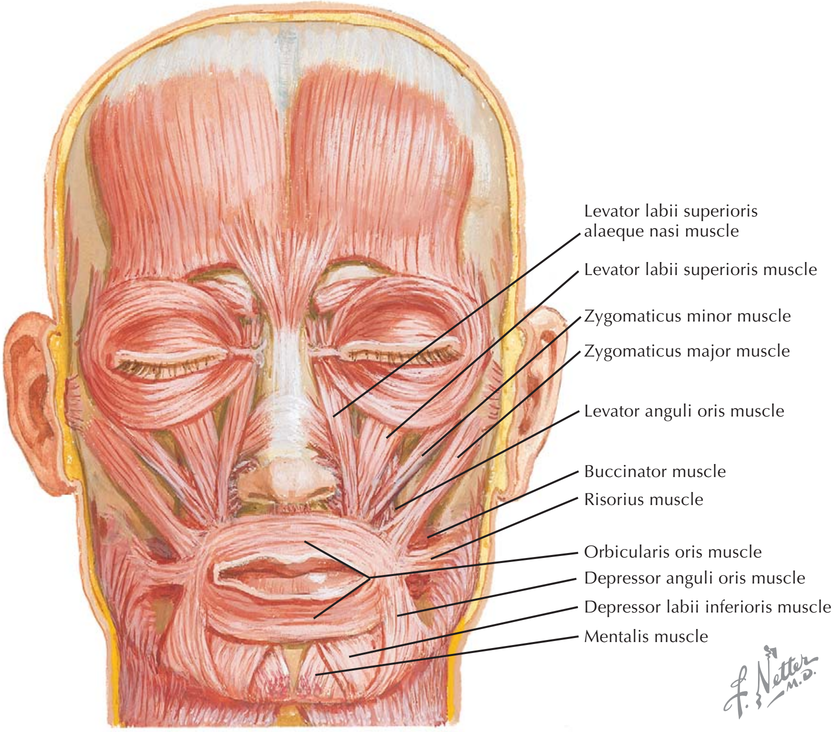
5 Overview of Muscles of Facial Expression

ORAL GROUP *CONTINUED*

Muscle	Origin	Insertion	Actions	Nerve	Comments
Levator labii superioris	Maxilla (superior to the infraorbital foramen along the inferior margin of the orbit)	Lateral upper lip Some fibers blend and provide origin for the orbicularis oris m.	Elevates the upper lip		In an infraorbital injection, the needle lies between the levator anguli oris and levator labii superioris mm.
Levator labii superioris alaeque nasi	Maxilla (near the bridge of the nose)	Cartilage of the nose Lateral upper lip	Elevates the upper lip Dilates the nostril		Also called the angular part of the levator labii superioris m.
Risorius	Fascia overlying the parotid gland	Angle of the mouth	Moves the angle of the mouth laterally		Commonly called the “grinning muscle”
Depressor labii inferioris	Mandible (inferior to the mental foramen)	Fibers blend and provide origin for the orbicularis oris m.	Depresses the lower lip	Facial (mandibular branch)	Fibers of the depressor anguli oris m. overlap the fibers of the depressor labii inferioris m.
Mentalis	Incisive fossa of the mandible	Skin of the lower lip	Protrudes the lower lip		Used in “pouting”
Buccinator	Pterygomandibular raphe Alveolar margins of the maxilla and mandible	Some fibers blend and provide origin for the orbicularis oris Some fibers blend into the upper and lower lips	Aids in mastication keeping the bolus between cheek and teeth Helps forcibly expel air or create a sucking action	Facial (buccal branch)	Creates the framework of the cheek

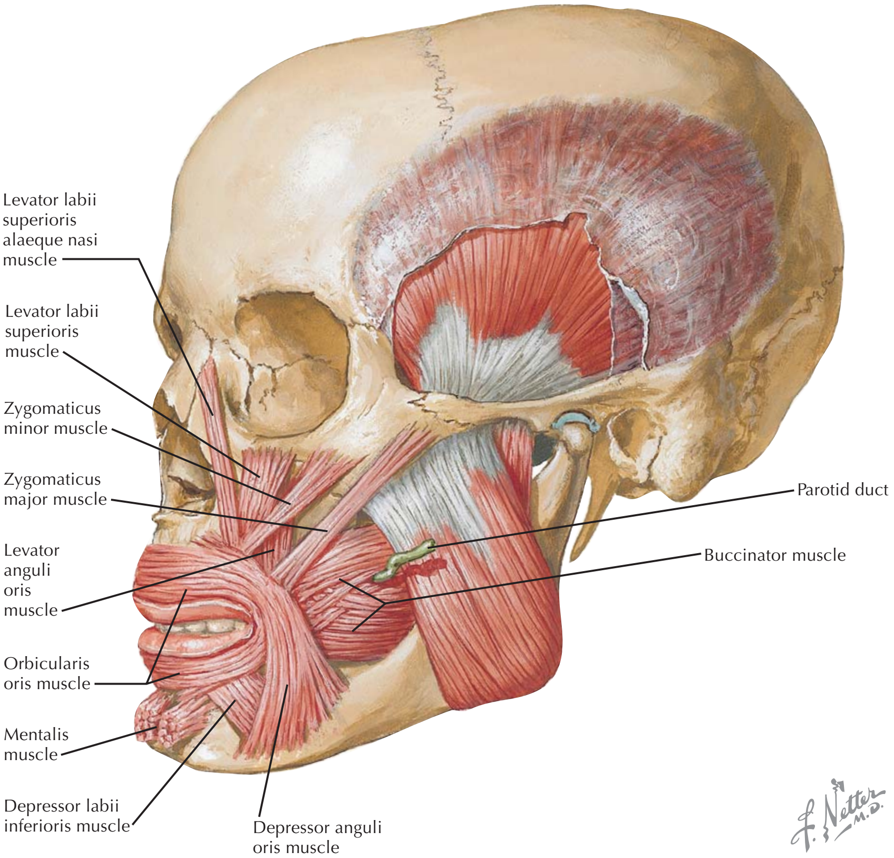
Overview of Muscles of Facial Expression

ORAL GROUP *CONTINUED*



Overview of Muscles of Facial Expression

ORAL GROUP *CONTINUED*



Overview of Muscles of Facial Expression

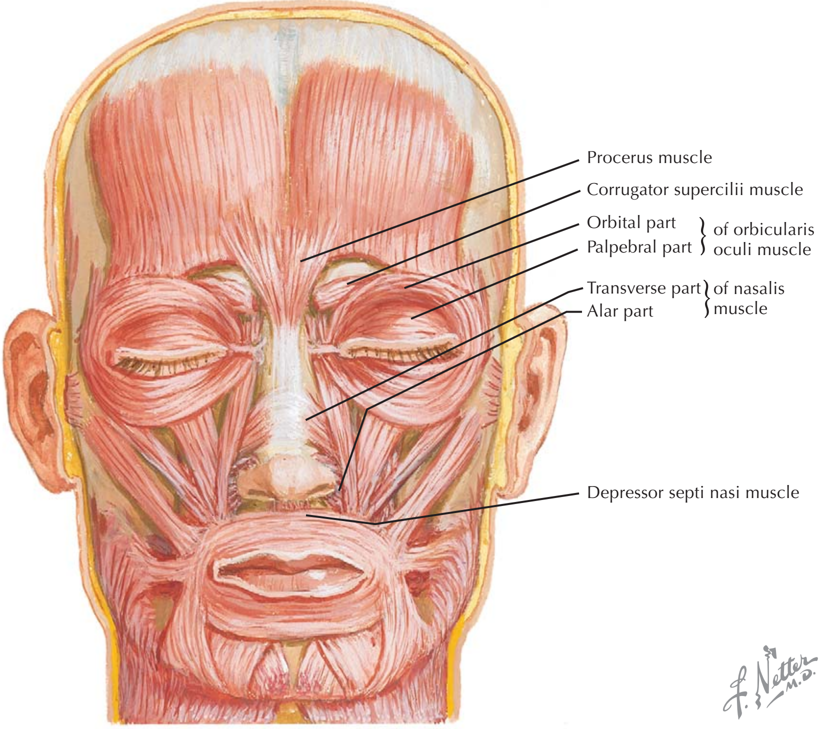
NASAL GROUP

Muscle		Origin	Insertion	Actions	Nerve	Comment
Nasalis	Compressor naris	Maxilla	Compressor naris m. of opposite side	Compresses the nostril	Facial n.: buccal branch	Variable and occasionally absent
	Dilator naris		Nasal cartilage	Dilates the nostril		
Depressor septi			Nasal septum	Draws nasal septum anteriorly to constrict the nostril		Antagonistic to the dilator naris m.
Procerus		Nasal bone Lateral nasal cartilage	Skin of the bridge of the nose	Brings skin together producing transverse wrinkles on the bridge of the nose	Facial n.: temporal and zygomatic branches	Partially excised in some facelift procedures (rhytidectomy)

ORBITAL GROUP

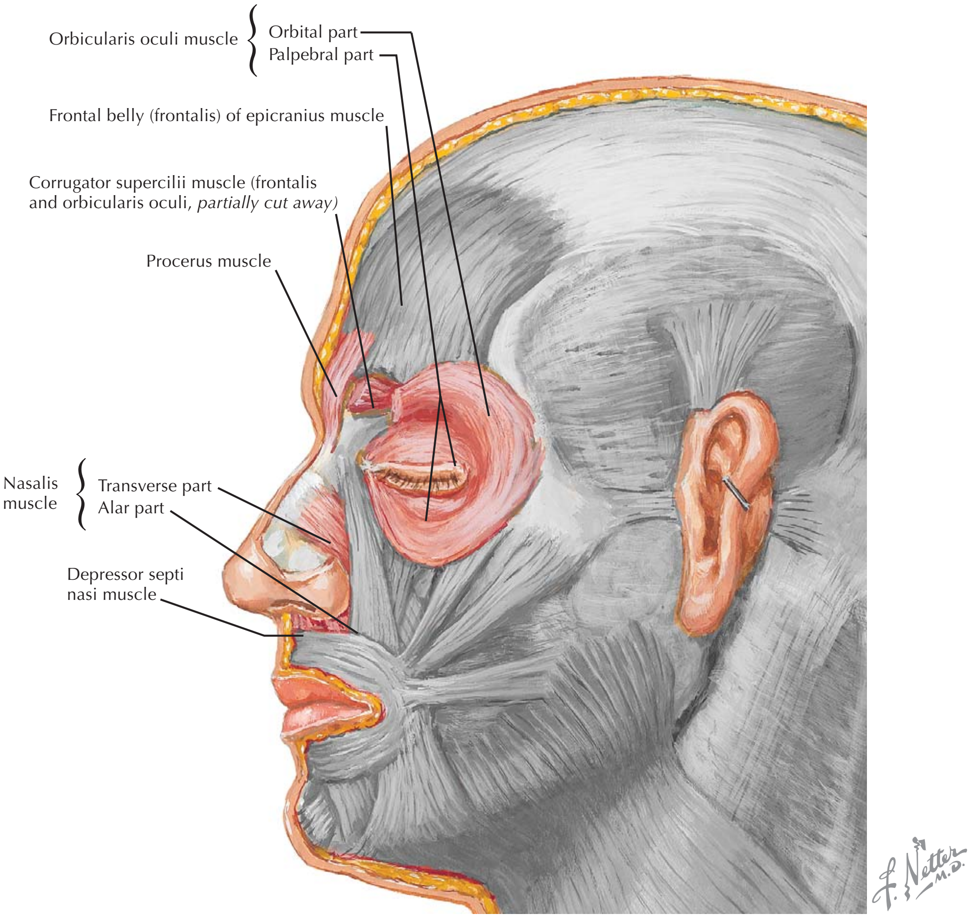
Muscle		Origin	Insertion	Actions	Nerve	Comment
Orbicularis oculi	Orbital	Frontal process of maxilla Nasal portion of frontal bone Medial palpebral ligament	Around the orbit	Forcible closure of the eye	Facial n.: temporal and zygomatic branches	Fat that accumulates around the eye from aging may be removed surgically (blepharoplasty)
	Lacrimal	Lacrimal bone	Lacrimal fascia around the lacrimal canaliculi	Aids the flow of tears		Because the orbicularis oculi m. moves the skin around the eye, its attachment is extremely important
	Palpebral	Medial palpebral ligament	Lateral palpebral raphe	Closure of eyelids gently (blinking)		
Corrugator supercilii		Frontal bone (supraorbital ridge)	Middle of the eyebrow	Draws the eyebrows medially and inferiorly	Facial n.: temporal branch	Fibers lie deep to the orbicularis oculi m.

NASAL GROUP *CONTINUED*



Overview of Muscles of Facial Expression

NASAL GROUP *CONTINUED*



Overview of Muscles of Facial Expression

AURICULAR GROUP

Muscle		Origin	Insertion	Actions	Nerve	Comment
Auricular	Posterior	Galea aponeurosis	Helix	Draws auricle anteriorly	Facial n.: temporal branch	These muscles usually provide little movement and tend to not always be voluntary
	Anterior		Superior part of the auricle	Draws auricle superiorly		
	Superior	Mastoid process	Posterior part of the auricle	Draws auricle posteriorly	Facial n.: posterior auricular branch	

SCALP GROUP (OCCIPITOFRONTALIS)

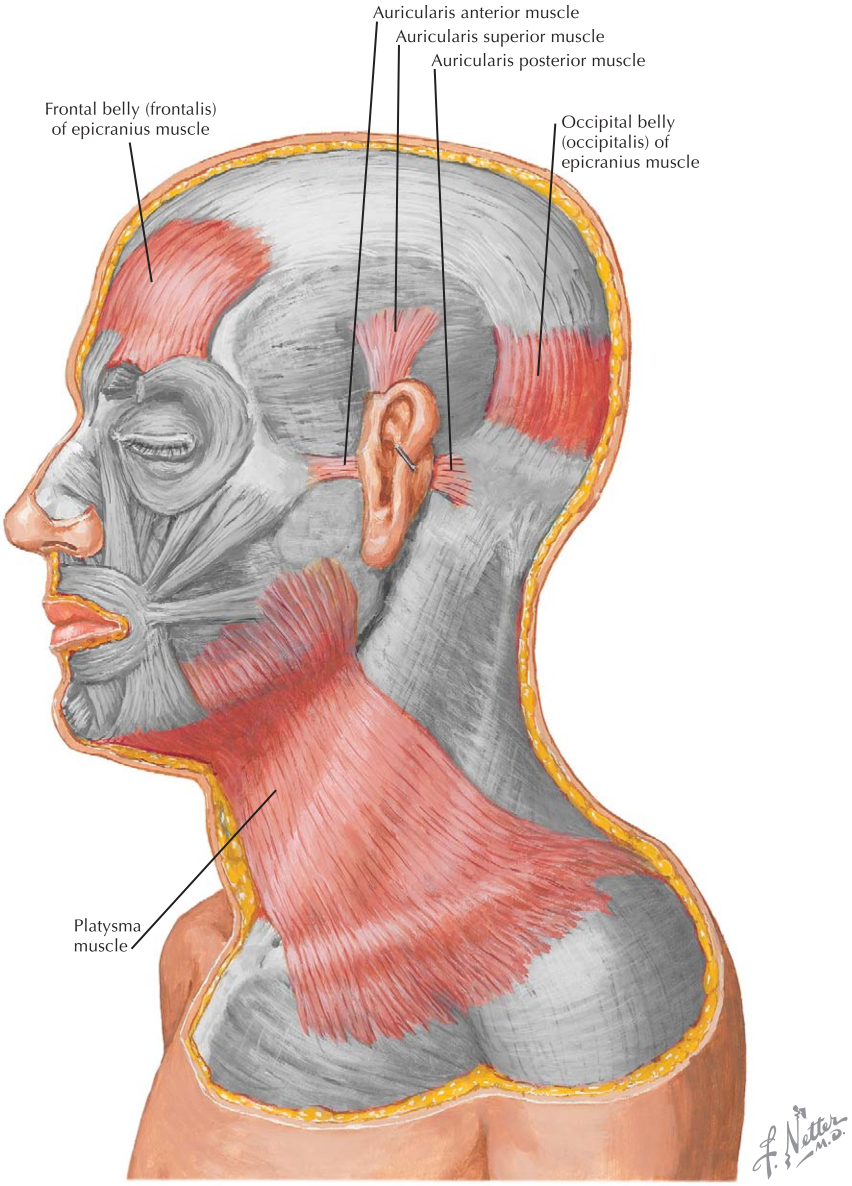
Muscle	Origin	Insertion	Actions	Nerve	Comment
Frontalis	Galea aponeurosis	Galea aponeurosis	Elevates eyebrows Wrinkles forehead Wrinkles the back of the head	Facial n.: temporal branch	Has no bony attachment Surgical management important in cosmetic surgery
Occipitalis	Superior nuchal line Mastoid process			Facial n.: posterior auricular branch	

NECK GROUP

Muscle	Origin	Insertion	Actions	Nerve	Comment
Platysma	Fascia of upper part of the pectoralis major m. and deltoid	Inferior border of the mandible Some fibers blend with the skin of the neck and lower face	Wrinkles the skin of the neck	Facial n.: cervical branch	The external jugular lies deep to the platysma m.

Overview of Muscles of Facial Expression

AURICULAR GROUP *CONTINUED*



5 Vascular Supply of the Face

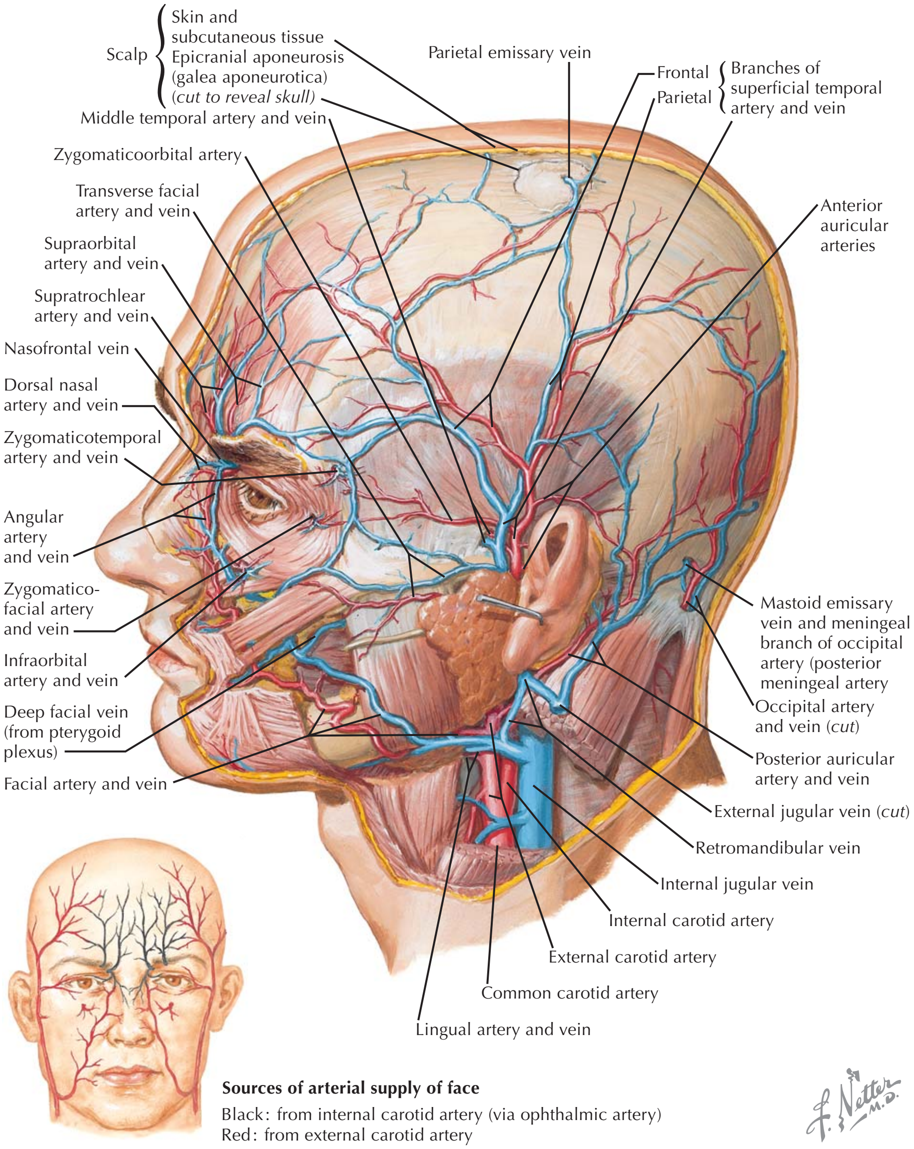
GENERAL INFORMATION

Most of the arterial supply to the face arises from the superficial temporal artery and facial branches of the external carotid artery

The maxillary branch of the external carotid supplies most areas that the superficial temporal and facial branches do not supply

The internal carotid artery supplies the anterior portion of the forehead and dorsal surface of the nose via ophthalmic artery branches

The arteries of the face anastomose freely



Sources of arterial supply of face

Black: from internal carotid artery (via ophthalmic artery)
Red: from external carotid artery

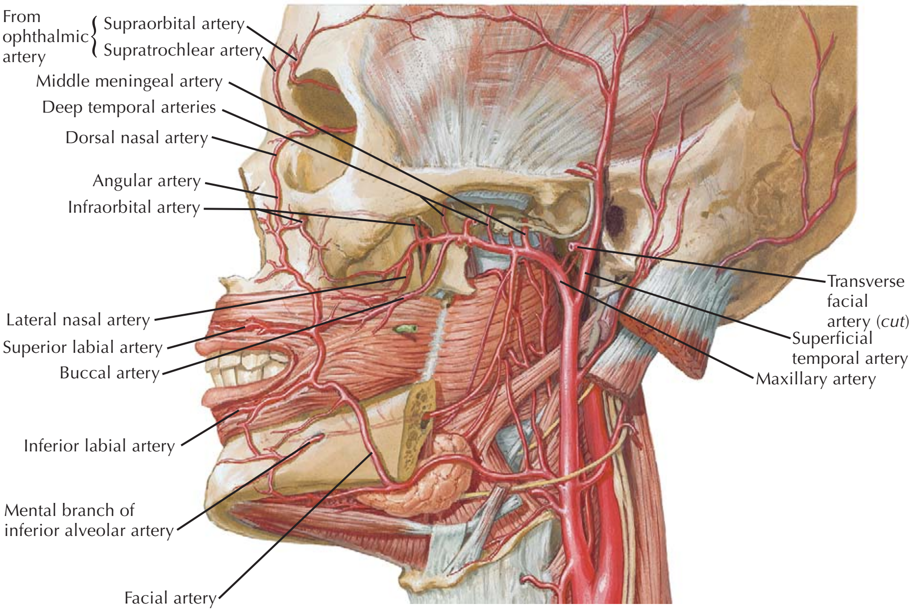
Vascular Supply of the Face

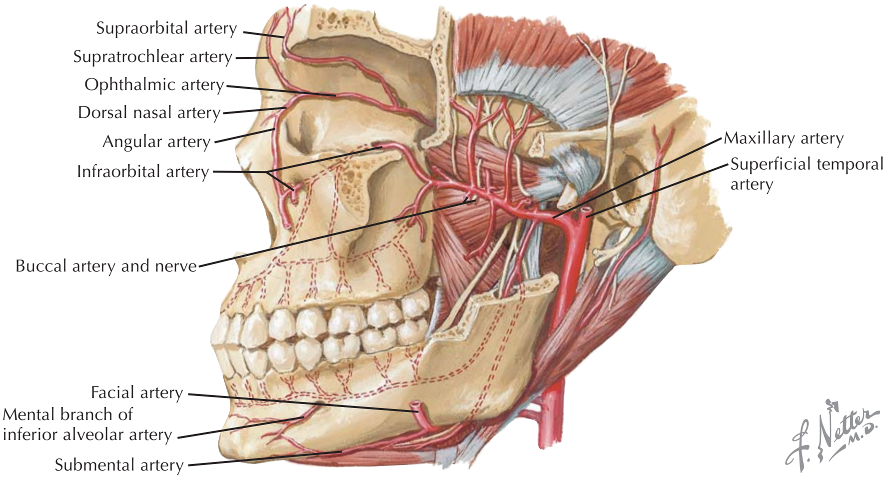
ARTERIAL SUPPLY

EXTERNAL CAROTID ARTERY AND ITS BRANCHES IN THE FACE		
Artery	**Source**	**Course**
Facial	External carotid a.	Arises in the carotid triangle of the neck Passes superiorly immediately deep to the posterior belly of the digastric m. and the stylohyoid mm. Passes along the submandibular gland, giving rise to the submental a. that helps supply the gland Passes superiorly over the body of the mandible at the masseter m. Continues anterosuperiorly across the cheek to the angle of the mouth, giving rise to the *superior and inferior labial* aa. Passes superiorly along the side of the nose, giving rise to the *lateral nasal* a. Continues on the side of the nose as the *angular* a. to terminate along the medial aspect of the eye Tortuous
● Superior labial	Facial a.	Supplies the upper lip Gives rise to the septal branch that travels to the nasal septum
● Inferior labial		Supplies the lower lip
● Lateral nasal		Supplies the ala and nose
● Angular		The facial a.'s terminal branch Passes superiorly to terminate at the medial angle of the orbit
Superficial temporal	External carotid a.	1 of the 2 terminal branches of the external carotid Arises posterior to the neck of the mandible and travels superiorly as a continuation of the external carotid a. Joined by the auriculotemporal n.
● Transverse facial	Superficial temporal a.	Passes transversely before it exits the parotid gland Passes immediately superior to the parotid duct across the masseter m. and face
Maxillary	External carotid a.	1 of the 2 terminal branches of the external carotid a. Gives rise to a series of branches; only 3 provide blood supply to the face: the infraorbital, buccal, and mental
● Infraorbital	Maxillary a.	The continuation of the 3rd part of the maxillary a. Accompanied by the infraorbital n. and v. Passes forward in the infraorbital groove and infraorbital canal and exits the infraorbital foramen On exiting the infraorbital foramen, it lies between the levator labii superioris and levator anguli oris mm. and follows the branching pattern of the nerve: Inferior palpebral (supplies the lower eyelid) Nasal (supplies the lateral side of the nose) Superior labial (supplies the upper lip)
Buccal		A branch of the 2nd part of the maxillary A small artery that runs obliquely in an anterior direction between the medial pterygoid m. and the insertion of the temporalis m. until it reaches the outer surface of the buccinator m. to supply it and the face
Mental		A terminal branch of the inferior alveolar a., which arises from the 1st part of the maxillary a. Emerges from the mental foramen to supply the chin region

Vascular Supply of the Face

ARTERIAL SUPPLY *CONTINUED*



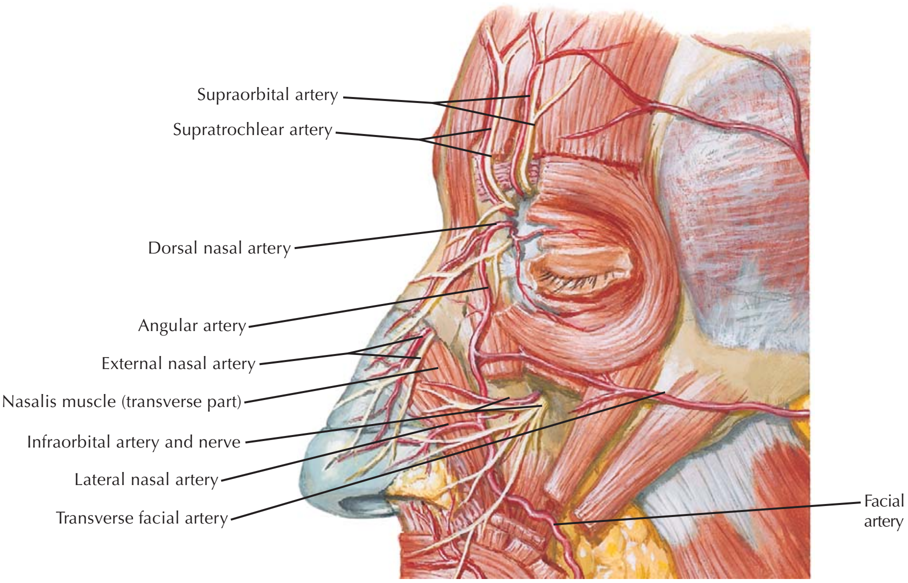


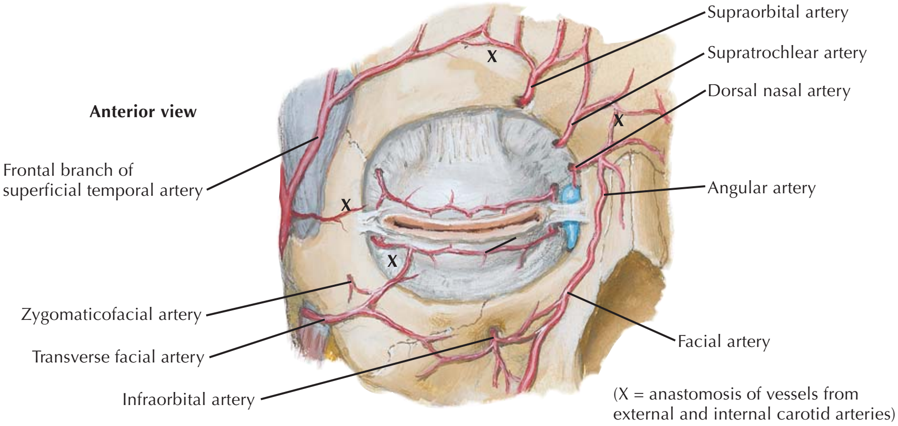
Vascular Supply of the Face

ARTERIAL SUPPLY

OPHTHALMIC ARTERY AND ITS BRANCHES	
Artery	**Course**
Ophthalmic	A branch of the internal carotid Enters the orbit through the optic foramen immediately inferior and lateral to the optic n. Crosses the optic n. to reach the medial part of the orbit *Within the orbit, besides the orbital branches, it gives rise to 5 major branches that supply the face*: ● Supratrochlear ● Supraorbital ● Lacrimal ● Anterior ethmoid ● Dorsal nasal
Supratrochlear	Exits the orbit at the medial angle accompanied by supratrochlear n. Ascends on the scalp, anastomosing with the supraorbital and supratrochlear aa. from the opposite side
Supraorbital	Arises as the ophthalmic passes the optic n. Passes on the medial side of the levator palpebrae superioris and superior rectus mm. to join the supraorbital n. Passes through the supraorbital foramen (notch) and ascends superiorly along the scalp Anastomoses with the supratrochlear and superficial temporal aa.
Lacrimal	Arises near the optic foramen One of the largest branches of the ophthalmic a. Follows the lacrimal n. along the superior border of the lateral rectus m. of the eye to reach and supply the lacrimal gland Gives rise to a series of terminal branches that pass to the eyelids and conjunctivae Gives rise to a zygomatic branch that divides into the zygomaticotemporal and zygomaticofacial aa., to supply those facial regions
External nasal	A terminal branch of the anterior ethmoid a. Supplies the area along the external nose at the junction of the nasal bone and the lateral nasal cartilage
Dorsal nasal	One of the terminal branches of the ophthalmic a. Exits the orbit along the superomedial border along with the infratrochlear n. Supplies the area along the bridge of the nose

ARTERIAL SUPPLY *CONTINUED*





(X = anastomosis of vessels from external and internal carotid arteries)

Vascular Supply of the Face

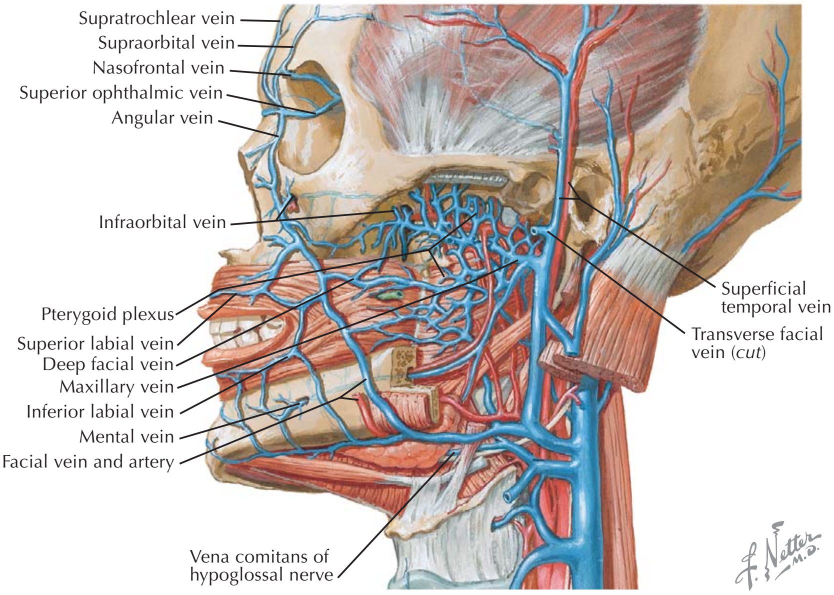
VENOUS DRAINAGE

Facial veins have similar distribution pattern to that for the arteries

Highly variable

Connect to the deeper vessels such as the pterygoid plexus and cavernous sinus

SUPERFICIAL VEINS	
Vein	**Course**
Facial	Begins as the angular v. Passes inferiorly along the side of the nose, receiving the lateral nasal v. Continues posteroinferiorly across the angle of the mouth to the cheek, receiving the superior and inferior labial vv. While passing toward the mandible, the deep facial v. connects it to the pterygoid plexus In the submandibular triangle, it joins the anterior branch of the retromandibular to form the common facial v. Has no valves that can allow blood to backflow
● Superior labial	Drains the upper lip and joins the facial v.
● Inferior labial	Drains the lower lip and joins the facial v.
● Lateral nasal	Drains the ala and nose and joins the facial v.
● Angular	Forms from the confluence of the supraorbital and supratrochlear vv. along the medial part of the eye Travels along the lateral aspect of the nose to become the facial v.
Supraorbital	Begins on the forehead, where it communicates with the superficial temporal Passes inferiorly superficial to the frontalis m. and joins the supratrochlear v. at the medial angle of the orbit to form the angular v.
Supratrochlear	Begins on the forehead, where it communicates with the superficial temporal vv. Passes inferiorly along the forehead parallel with the vein of the opposite side At the medial angle of the orbit, it joins the supraorbital v. to form the angular v.
Superficial temporal	Descends posterior to the zygomatic root of the temporal bone alongside the auriculotemporal n. to enter the substance of the parotid gland Unites with the maxillary v. to form the retromandibular v.
Transverse facial	Travels posteriorly to enter the parotid gland and join the superficial temporal v.
Buccal	Drains the cheek and joins the pterygoid plexus
Mental	Drains the chin and joins the pterygoid plexus



VENOUS DRAINAGE *CONTINUED*

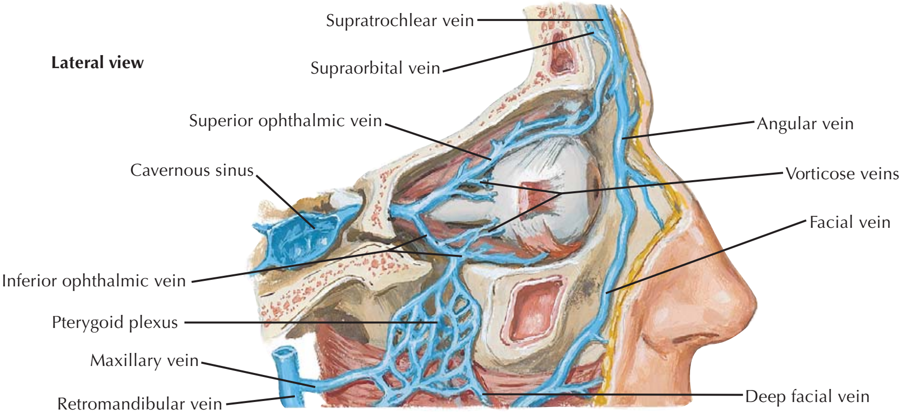
COMMUNICATING VEINS	
Vein	**Course**
Superior ophthalmic	Receives blood from the roof of the orbit and the scalp Travels posteriorly to communicate with the pterygoid plexus and cavernous sinus
Inferior ophthalmic	Receives blood from the floor of the orbit Travels posteriorly with the infraorbital v., which passes through the inferior orbital fissure to communicate with the pterygoid plexus and the cavernous sinus
Infraorbital	Receives blood from the midface via the lower eyelid, lateral aspect of the nose, and the upper lip Eventually communicates with the pterygoid plexus
Deep facial	Connects the facial v. with the pterygoid plexus

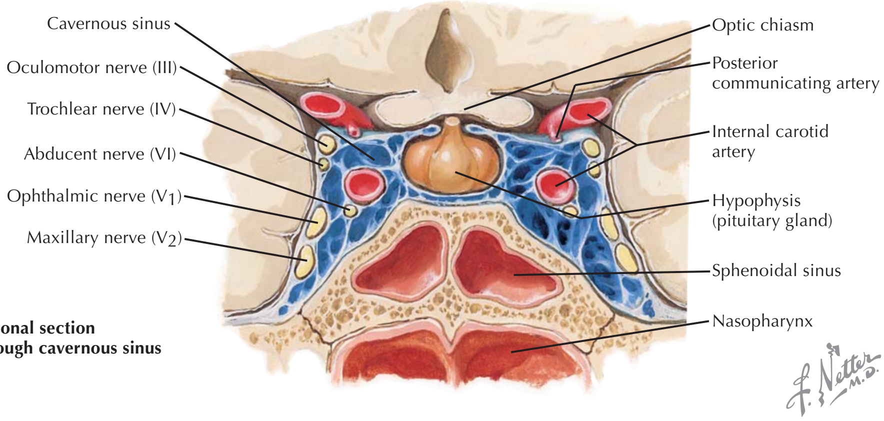
DEEP VEINS	
Vein	**Course**
Cavernous sinus	A reticulated venous structure on the lateral body of the sphenoid bone Drains posteriorly into the superior and inferior petrosal sinuses Receives blood from the superior and inferior ophthalmic vv. The oculomotor and trochlear nn. and ophthalmic and maxillary divisions of the trigeminal n. lie along the lateral wall of the sinus Abducens n. and internal carotid artery lie in the sinus
Pterygoid plexus	An extensive network of veins that parallels the 2nd and 3rd parts of the maxillary a. Receives branches that correspond to the maxillary a.'s branches Tributaries of the pterygoid plexus eventually converge to form a short maxillary v. Communicates with the cavernous sinus, pharyngeal venous plexus, facial v. via the deep facial v., and ophthalmic vv.

Vascular Supply of the Face

VENOUS DRAINAGE *CONTINUED*

Lateral view





Coronal section through cavernous sinus

5 Nerve Supply of the Face

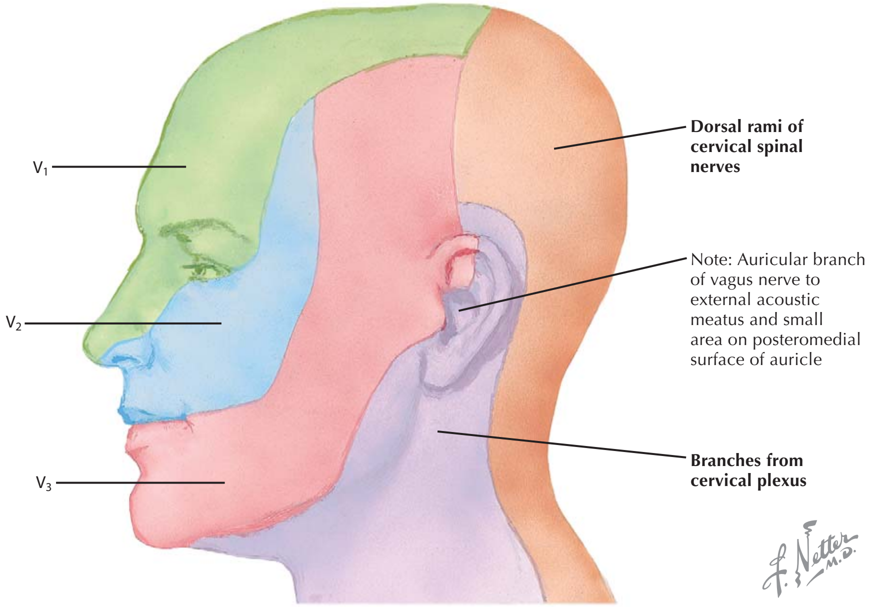
GENERAL INFORMATION

Many motor and sensory nerves supply the face

All motor nerves are from the facial nerve and supply the muscles of facial expression

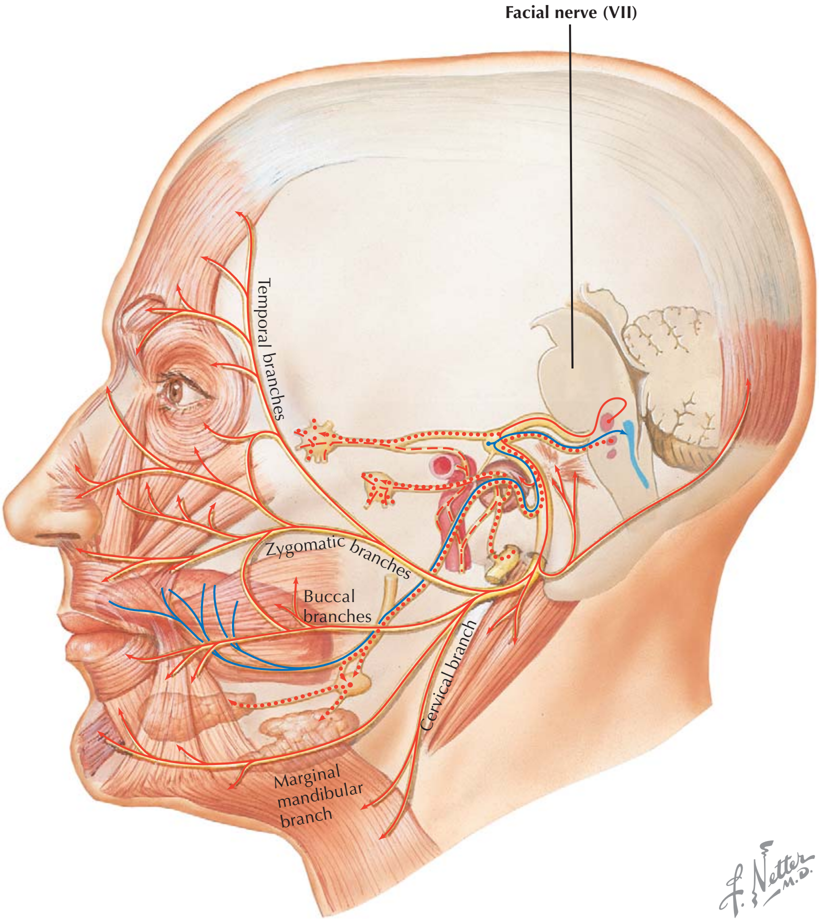
Sensory nerves of the face are derived mainly from the 3 divisions of the trigeminal nerve (V_1, V_2, V_3)

Some sensory branches are from the cervical plexus



Nerve Supply of the Face

GENERAL INFORMATION *CONTINUED*



5 Nerve Supply of the Face

SENSORY INNERVATION

TRIGEMINAL NERVE: OPHTHALMIC DIVISION

Nerve	Source	Course
Ophthalmic division	Trigeminal n. in the middle cranial fossa	Passes anteriorly on the lateral wall of the cavernous sinus immediately inferior to the oculomotor and trochlear nn., but superior to the maxillary division of the trigeminal n. Immediately before entering the orbit, through the superior orbital fissure, it divides into 3 major branches: *lacrimal*, *frontal*, and *nasociliary*
Supratrochlear	From the ophthalmic division; the 2 terminal branches of the frontal n. in the orbit	Continues to pass anteriorly toward the trochlea, once the supratrochlear a. joins it within the orbit In the trochlear region, it often supplies the frontal sinus before exiting the orbit Ascends along the scalp, at first deep to the musculature in the region, before piercing it to reach the cutaneous innervation along the scalp
Supraorbital		Passes between the levator palpebrae superioris m. and orbital periosteum Continues anteriorly to the supraorbital foramen (notch) At the level of the supraorbital margin, it sends nerve supply to the frontal sinus and ascends superiorly along the scalp Divides into medial and lateral branches that travel up to the vertex of the scalp
Lacrimal	The smallest branch of the ophthalmic division	Passes anteriorly to enter the orbit through the superior orbital fissure Travels in the orbit on the superior border of the lateral rectus with the lacrimal a. Before reaching the lacrimal gland, it communicates with the zygomatic branch of the maxillary division of the trigeminal n. to receive autonomic nervous fibers Enters the lacrimal gland and supplies it and the conjunctivae before piercing the orbital septum to supply the skin of the upper eyelid
Infratrochlear	One of the terminal branches of the nasociliary	Passes anteriorly on the superior border of the medial rectus m. Passes inferior to the trochlea toward the medial angle of the eye Supplies the skin of the eyelids and bridge of the nose, the conjunctivae, and all of the lacrimal structures
External nasal	Arises from the anterior ethmoid n. (from the nasociliary n.)	Terminal branch of the anterior ethmoid n. Exits between the lateral nasal cartilage and the inferior border of the nasal bone Supplies the skin of the ala and apex of the nose around the nares

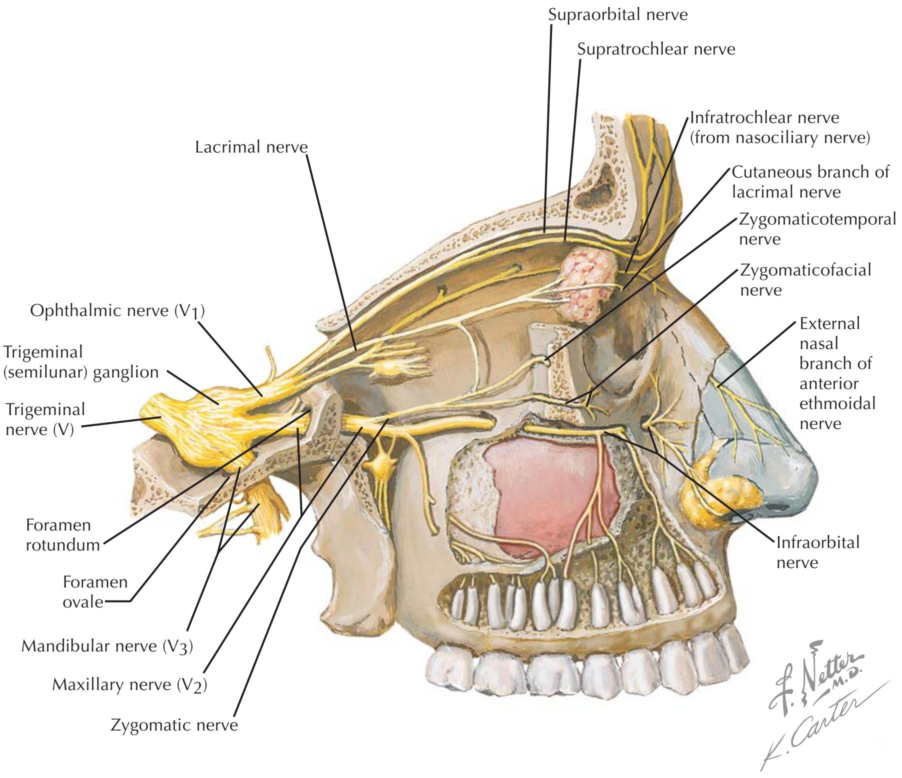
TRIGEMINAL NERVE: MAXILLARY DIVISION

Nerve	Source	Course
Maxillary division	Trigeminal n. in the middle cranial fossa	Travels along the lateral wall of the cavernous sinus Before exiting the middle cranial fossa, it gives off a meningeal branch that innervates the dura mater Passes from the middle cranial fossa into the pterygopalatine fossa via the foramen rotundum Within the pterygopalatine fossa, it gives rise to 4 branches: *posterior superior alveolar n.*, *zygomatic n.*, *ganglionic branches*, and *infraorbital n.*
• Zygomaticotemporal	Zygomatic branch of the maxillary division	Arises from the zygomatic n. in the pterygopalatine fossa, which passes through the inferior orbital fissure to enter the orbit, dividing into the zygomaticotemporal and zygomaticofacial Passes on the lateral wall of the orbit in a groove in the zygomatic bone, then through a foramen in the zygomatic bone to enter the temporal fossa region Within the temporal fossa, it passes superiorly between the bone and the temporalis m. to pierce the temporal fascia superior to the zygomatic arch Continues along the skin of the side of the scalp

Nerve Supply of the Face

SENSORY INNERVATION *CONTINUED*

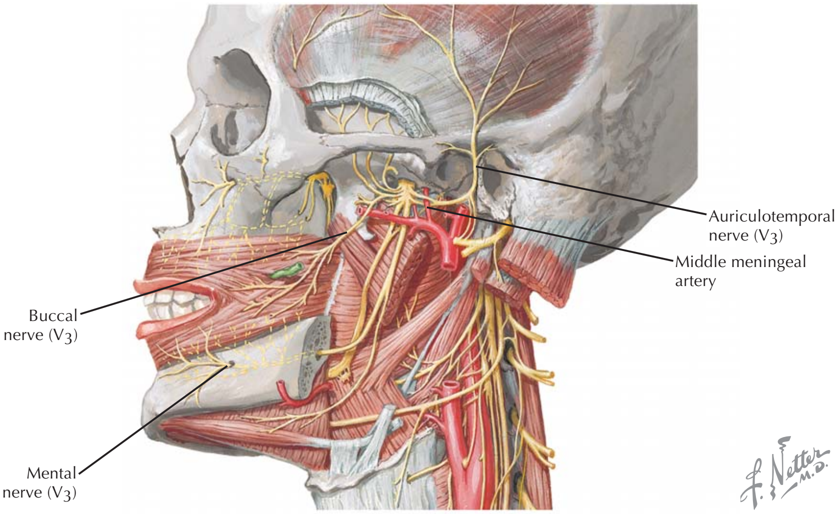
TRIGEMINAL NERVE: MAXILLARY DIVISION		
Nerve	**Source**	**Course**
• Zygomaticofacial	Zygomatic branch of the maxillary division	Passes on the lateral wall of the orbit before emerging on the face through the zygomaticofacial foramen in the zygomatic bone Supplies the skin on the prominence of the cheek
• Infraorbital	The continuation of the maxillary division of the trigeminal n.	Passes through the inferior orbital fissure to enter the orbit, then anteriorly through the infraorbital groove, infraorbital canal, and exits onto the face via the infraorbital foramen Within the infraorbital canal, it gives rise to the anterior superior alveolar and middle superior alveolar nn. It exits onto the face and divides into 3 terminal branches: • Inferior palpebral (supplies the skin of the lower eyelid) • Nasal (supplies the ala of the nose) • Superior labial (supplies the skin of the upper lip)



SENSORY INNERVATION *CONTINUED*

TRIGEMINAL NERVE: MANDIBULAR DIVISION

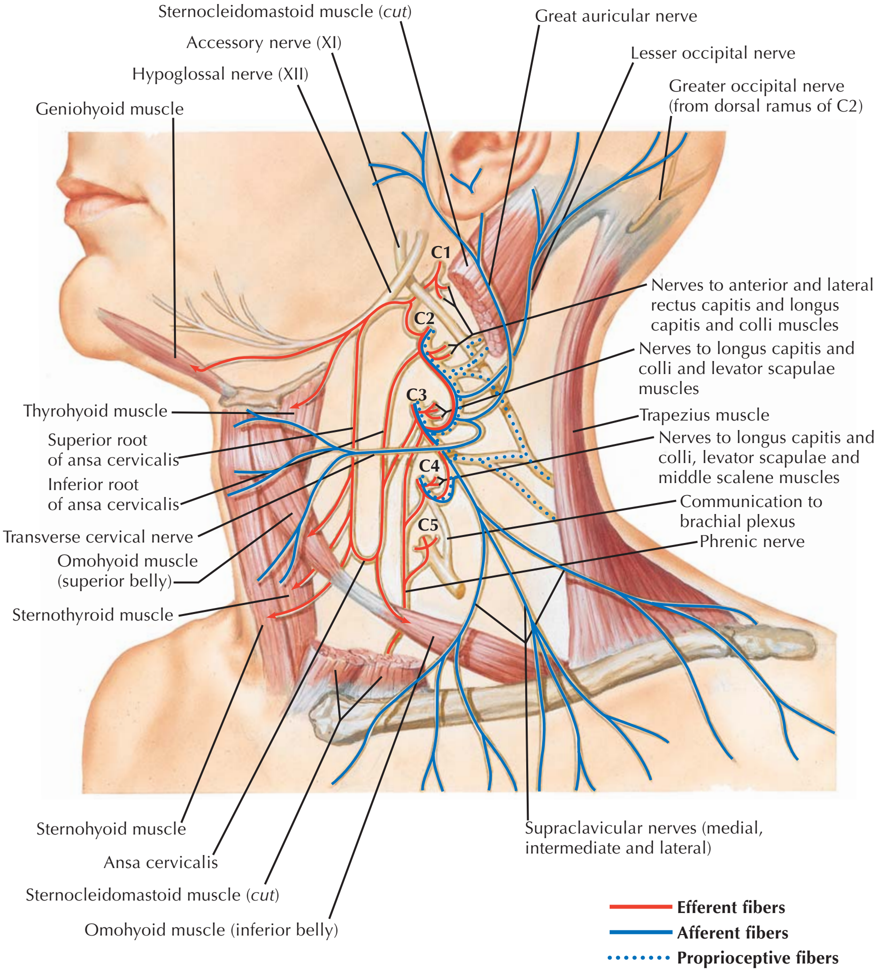
Nerve	Source	Course
Mandibular division	Trigeminal n. in the middle cranial fossa	The largest of the trigeminal n.'s 3 divisions Created by a large sensory and a small motor root that unite just after passing through the foramen ovale to enter the infratemporal fossa It immediately gives rise to 4 branches—*meningeal*, *medial pterygoid*, *tensor tympani*, and *tensor veli palatini*—before it divides into an anterior and a posterior division • Anterior division—smaller and mainly motor, with 1 sensory branch (buccal n.) • Posterior division—larger and mainly sensory, with 1 motor branch (mylohyoid n.)
• Auriculotemporal	Posterior part of mandibular division	Normally arises by 2 roots, between which the middle meningeal a. passes Runs posteriorly just inferior to the lateral pterygoid and continues to the medial aspect of the neck of the mandible Turns superiorly with the superficial temporal vessels between the auricle and the condyle of the mandible deep to the parotid gland On exiting the substance of the parotid gland, it ascends over the zygomatic arch and divides into superficial temporal branches
• Buccal	Anterior part of the mandibular division	Passes anterior between the 2 heads of the lateral pterygoid m. Descends inferiorly along the lower part of the temporalis to emerge deep to the anterior border of the masseter m. Supplies the skin over the buccinator m. before passing through it to supply the mucous membrane lining its inner surface and the gingiva along the mandibular molars
• Mental	1 of the 2 terminal branches of the inferior alveolar n.	Emerges through the mental foramen of the mandible in the region of the 2nd mandibular premolar Supplies the skin of the lower lip, chin, and facial gingiva as far posteriorly as the 2nd mandibular premolar



Nerve Supply of the Face

SENSORY INNERVATION *CONTINUED*

CERVICAL PLEXUS		
Nerve	**Source**	**Course**
Great auricular	Arises from the cervical plexus formed by contributions of C2 and C3 ventral rami	After passing posterior to the sternocleidomastoid at Erb's point, it ascends along the sternocleidomastoid dividing into anterior and posterior branches Anterior branch continues along the superficial aspect of the parotid gland's inferior part Innervates the superficial and inferior portions of the parotid gland
Transverse cervical		After passing posterior to the sternocleidomastoid at Erb's point, it crosses the sternocleidomastoid to pass anteriorly toward the neck Perforates the investing layer of deep cervical fascia, dividing deep to the platysma m. into ascending and descending branches Innervates the skin to the anterolateral region of the neck and lower face around the mandible



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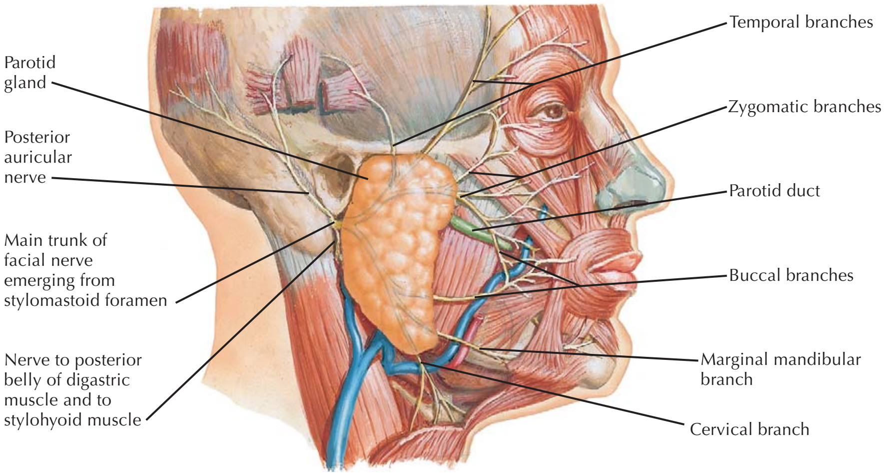
5 Nerve Supply of the Face

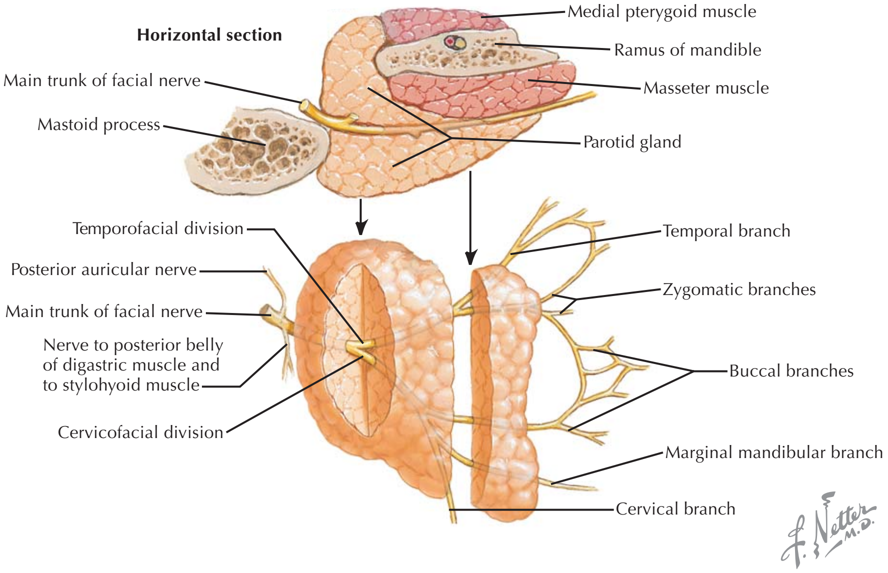
MOTOR INNERVATION

Nerve	Course
Facial	Exits the stylomastoid foramen and gives rise to the posterior auricular n. Enters the parotid fossa by passing between the stylohyoid m. and posterior belly of the digastric m. Small muscular branches innervate the stylohyoid m., the posterior belly of the digastric m., and the auricularis mm. Once in the fossa, it splits the parotid gland into a superficial lobe and a deep lobe that are connected by an isthmus Within the gland, it divides into temporofacial and cervicofacial trunks The trunks form a loop anterior to the gland superficial to the parotid duct and give rise to 5 major branches before emerging from the gland: *temporal*, *zygomatic*, *buccal*, *mandibular*, and *cervical*
Temporal	Exits the superior portion of the parotid gland from the temporofacial trunk Crosses the zygomatic arch along the temporal fossa to innervate the forehead
Zygomatic	The zygomatic branches from the temporofacial trunk pass across the zygomatic bone to the lateral angle of the orbit Innervates muscles in the region
Buccal	Branches arise from both the temporofacial and the cervicofacial trunks Innervates muscles of the cheek
Mandibular	Branches arise from the cervicofacial trunk and pass anteriorly Innervates muscles of the lower lip and chin
Cervical	Branches arise from the cervicofacial trunk and pass anteriorly and inferiorly to innervate the platysma m.

Nerve Supply of the Face

MOTOR INNERVATION *CONTINUED*





Clinical Correlate

TRIGEMINAL NEURALGIA

Also called tic douloureux

Usually affects the maxillary (V_2) or mandibular (V_3) division of the trigeminal nerve; rarely affects the ophthalmic division (V_1)

Bilateral involvement suggests other factors such as multiple sclerosis

More common in the 5th and 6th decades of life

Cause is unknown—theories involve nerve irritation from abnormal vascularity or tumor compression, or a nerve injury

CLINICAL MANIFESTATIONS

Periods of intense (lasting 1 to 2 minutes), paroxysmal pain along one of the divisions of the trigeminal nerve

Usually unilateral

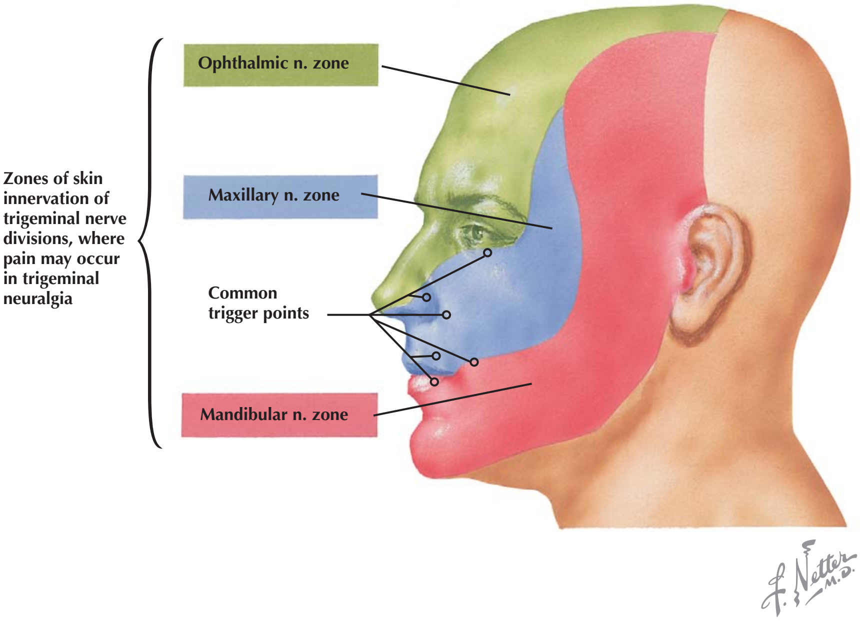
Pain normally is initiated by a particular sensory stimulus, such as light touch (putting on makeup, washing the face, shaving, a light breeze), mastication, or brushing teeth

TREATMENT

Commonly, trigeminal neuralgia is treated pharmacologically with anticonvulsants, such as carbamazepine (Tegretol)

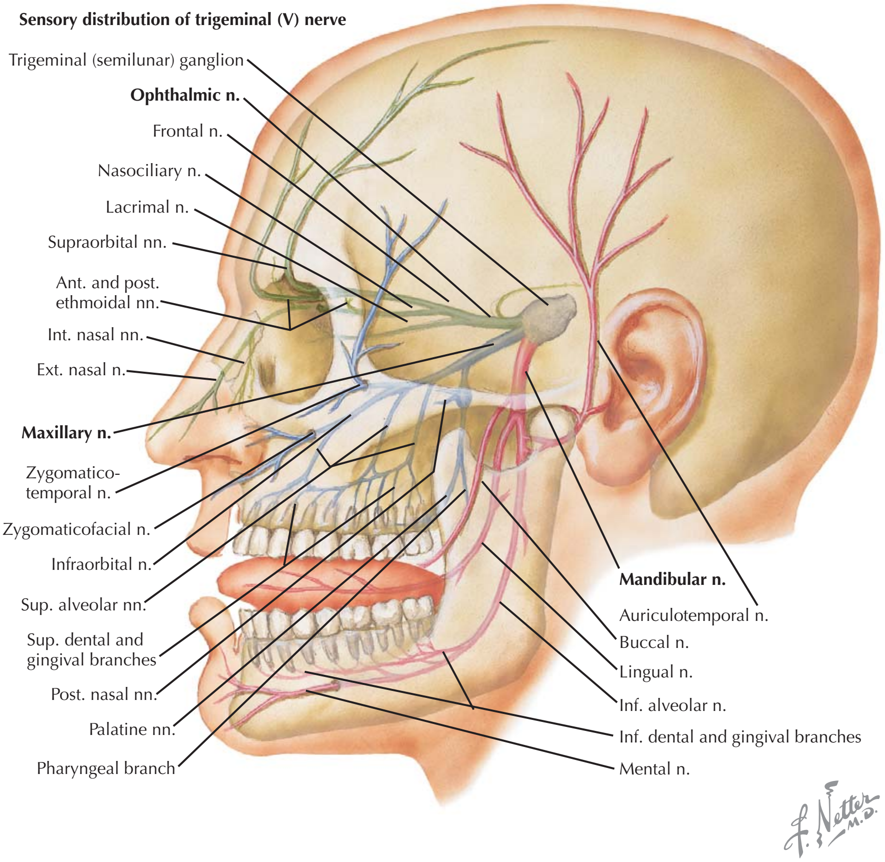
If drug therapy is unsuccessful, neurosurgery may be required, such as percutaneous radiofrequency rhizotomy of the nerve, glycerol injection of the trigeminal ganglion, or nerve decompression

Alternative and complementary medicine treatments have included acupuncture and meditation



Clinical Correlate

TRIGEMINAL NEURALGIA *CONTINUED*



Sensory distribution of trigeminal (V) nerve

CAVERNOUS SINUS SYNDROME

Pathologic condition involving the cavernous sinus that is often caused by a thrombosis, tumor, aneurysm, fistula, or trauma

When caused by a thrombosis, the syndrome usually occurs as a sepsis from the central portion of the face or paranasal sinuses from their connection to the cavernous sinus

Before the advent of antibiotics, death was the normal outcome from the sepsis

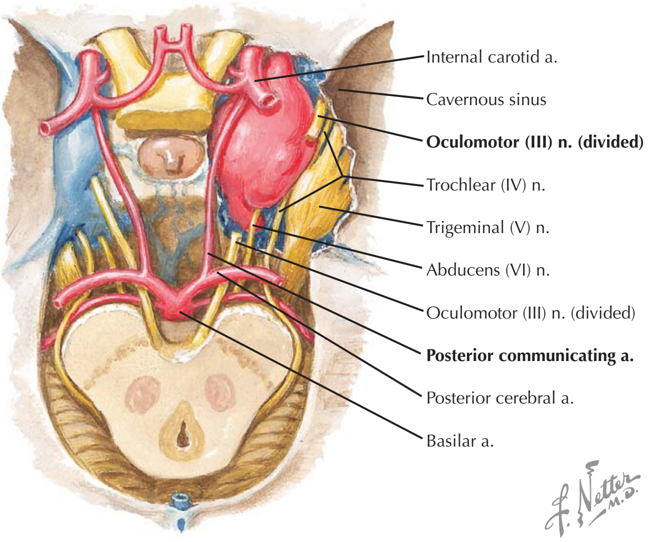
It affects the contents of the cavernous sinus, including:

- Internal carotid artery with sympathetics
- Cranial nerve III
- Cranial nerve IV
- Cranial nerve V_1
- Cranial nerve V_2
- Cranial nerve VI

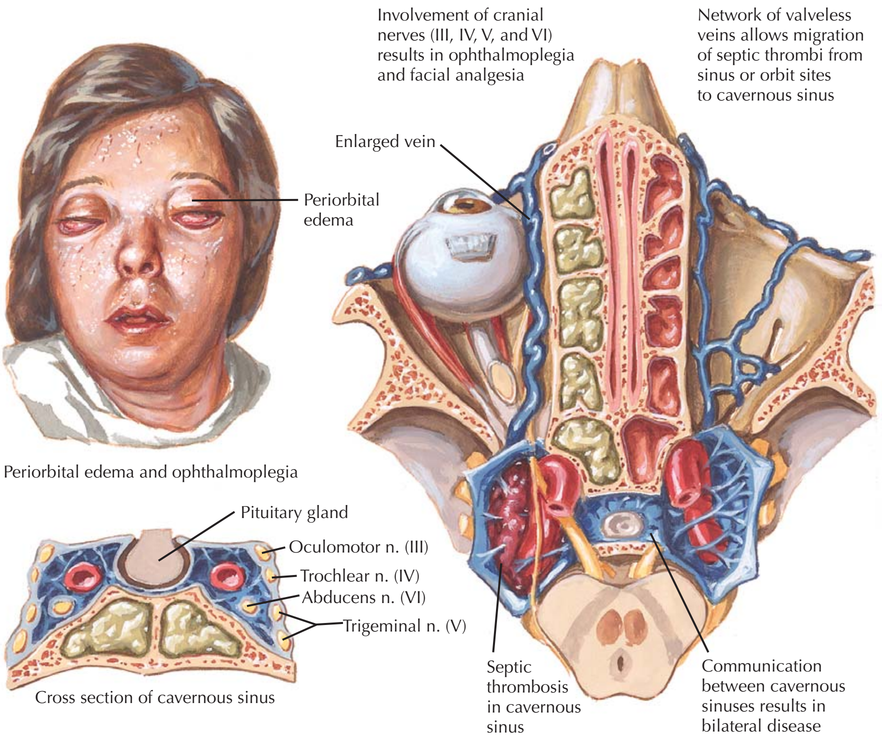
Common clinical manifestations include:

- Ophthalmoplegia with diminished pupillary light reflexes
- Venous congestion leading to periorbital edema
- Exophthalmos

CAVERNOUS SINUS SYNDROME *CONTINUED*



Cavernous sinus thrombosis



Periorbital edema and ophthalmoplegia

Cross section of cavernous sinus

CHAPTER 6

PAROTID BED AND GLAND

Overview and Topographic Anatomy

GENERAL INFORMATION

The largest of all the major salivary glands

Entirely serous in secretion

Pyramidal in shape, with up to 5 processes (or extensions)

The gland's capsule is from the deep cervical fascia

ANATOMIC LANDMARKS

Approximately 75% or more of the parotid gland overlies the masseter muscle; the rest is retromandibular

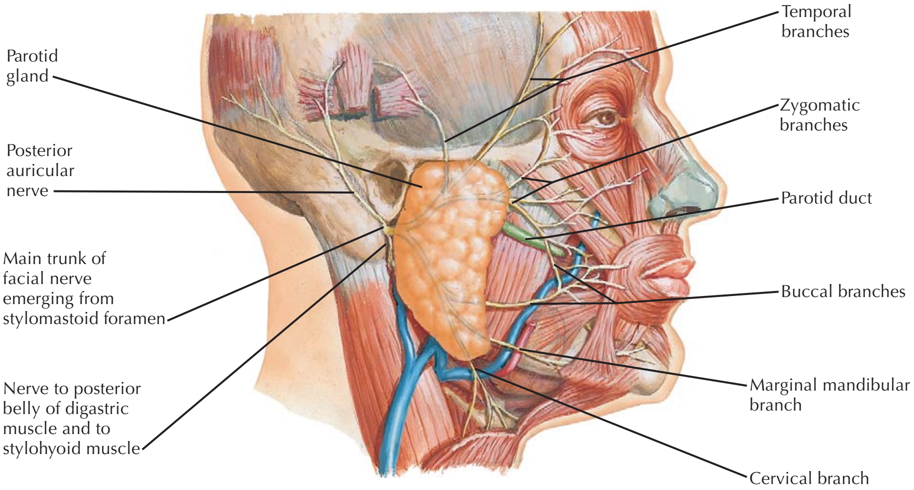
Facial nerve enters the parotid fossa by passing between the stylohyoid muscle and the posterior belly of the digastric muscle, then splits the gland into a superficial lobe and a deep lobe that are connected by an isthmus

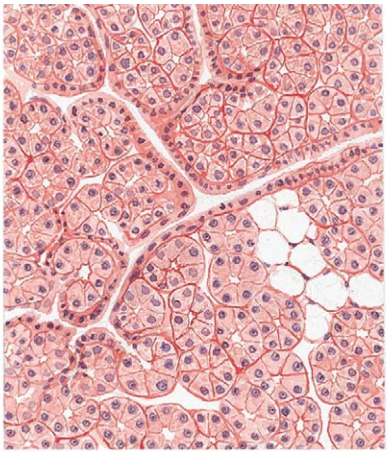
Deep lobe lies adjacent to the lateral pharyngeal space

Transverse facial artery parallels the parotid duct slightly superior to the duct

Buccal and zygomatic branches of the facial nerve form an anastomosing loop superficial to the parotid duct

GENERAL INFORMATION *CONTINUED*





Parotid gland: totally serous

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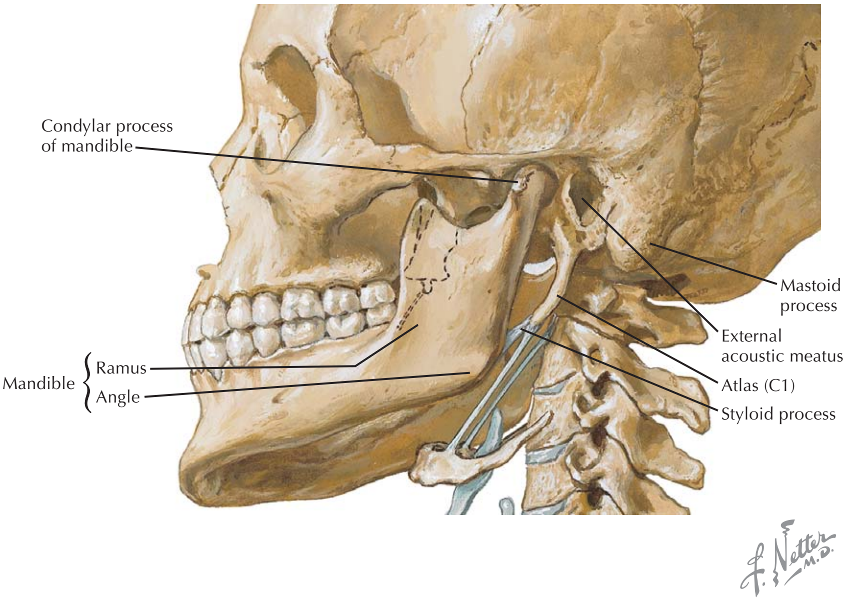
6 Recess of the Parotid Bed

BORDERS AND STRUCTURES

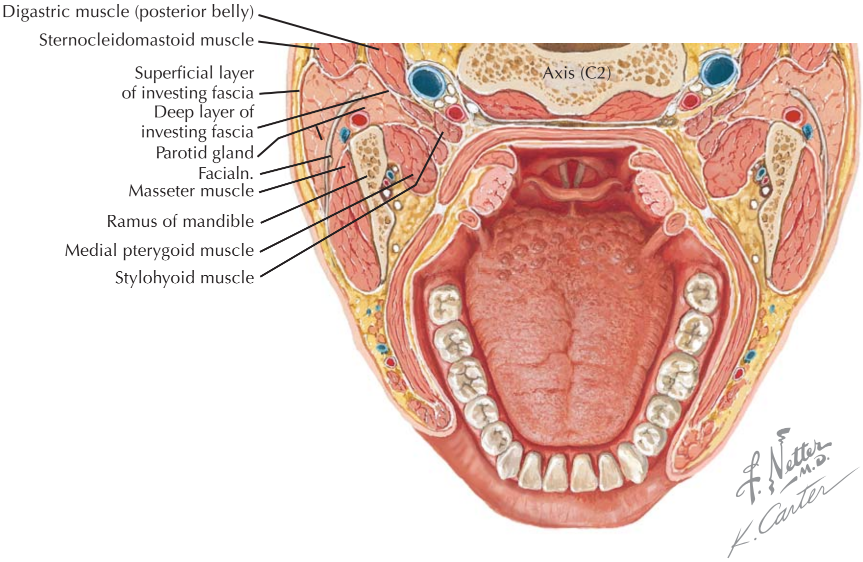
Borders	Structures
Anterior	Masseter m. Ramus of mandible
Anteromedial	Medial pterygoid m. Stylomandibular fascia
Medial	Styloid process superomedially Transverse process of the atlas inferomedially
Posteromedial	Stylohyoid m. Posterior belly of the digastric m.
Posterior	Mastoid process of the temporal bone Sternocleidomastoid m.
Lateral	Investing layer of deep cervical fascia helping form the capsule
Superior	External acoustic meatus Condylar head of the mandible articulating in the glenoid fossa
Inferior	Angular tract of Eisler between the angle of the mandible and the sternocleidomastoid m.

Recess of the Parotid Bed

BORDERS AND STRUCTURES *CONTINUED*



Horizontal section below lingula of mandible (superior view) demonstrating bed of parotid gland



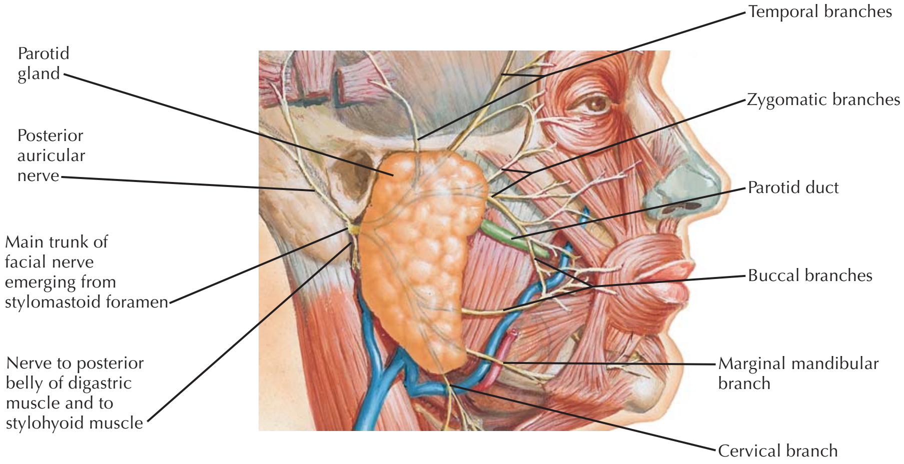
6 Contents of the Parotid Bed

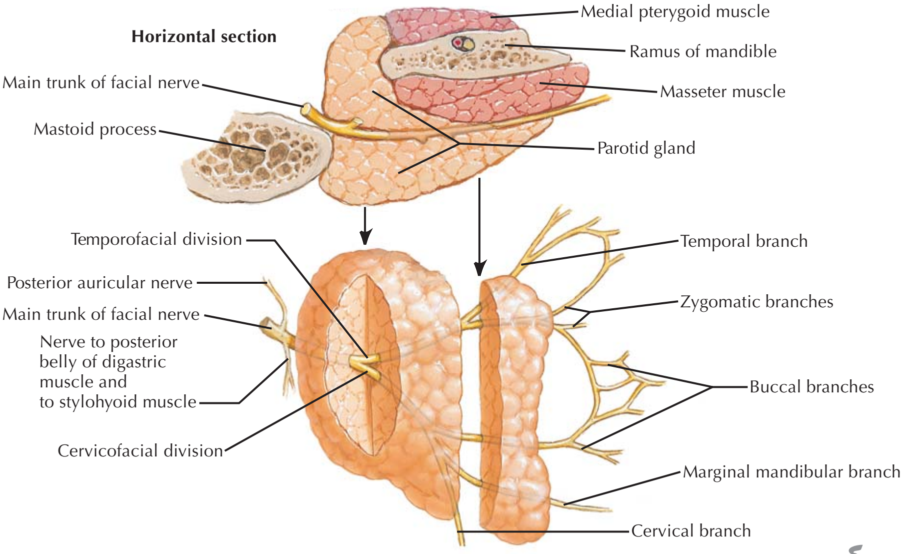
MAJOR STRUCTURES

Structure	Features
Parotid gland	The largest of all of the major salivary glands, entirely serous in secretion Pyramidal in shape, with up to 5 processes (or extensions) The gland's capsule is from the deep cervical fascia About 75% or more of the parotid gland overlies the masseter m.; the rest is retromandibular
Facial nerve	Facial n. exits the stylomastoid foramen and gives rise to the posterior auricular n. Enters the parotid fossa by passing between the stylohyoid m. and the posterior belly of the digastric m. Small muscular branches innervate the stylohyoid m., the posterior belly of the digastric m., and the auricularis mm. Once in the fossa, it splits the parotid gland into a superficial lobe and a deep lobe that are connected by an isthmus Parotid gland's deep lobe lies adjacent to the lateral pharyngeal space Within the gland, the facial n. divides into temporofacial and cervicofacial trunks The trunks form a loop anterior to the gland superficial to the parotid duct and give rise to 5 major branches before emerging from the gland: temporal, zygomatic, buccal, mandibular, and cervical Although it passes through the parotid gland, the facial n. does not provide any innervation to it Buccal and zygomatic branches of the facial n. form an anastomosing loop superficial to the parotid duct
Parotid duct	Also known as Stensen's duct Forms within the deep lobe and passes from the anterior border of the gland across the masseter superficially, through the buccinator into the oral cavity opposite the 2nd maxillary molar Accessory parotid tissue often follows the parotid duct

Contents of the Parotid Bed

MAJOR STRUCTURES *CONTINUED*

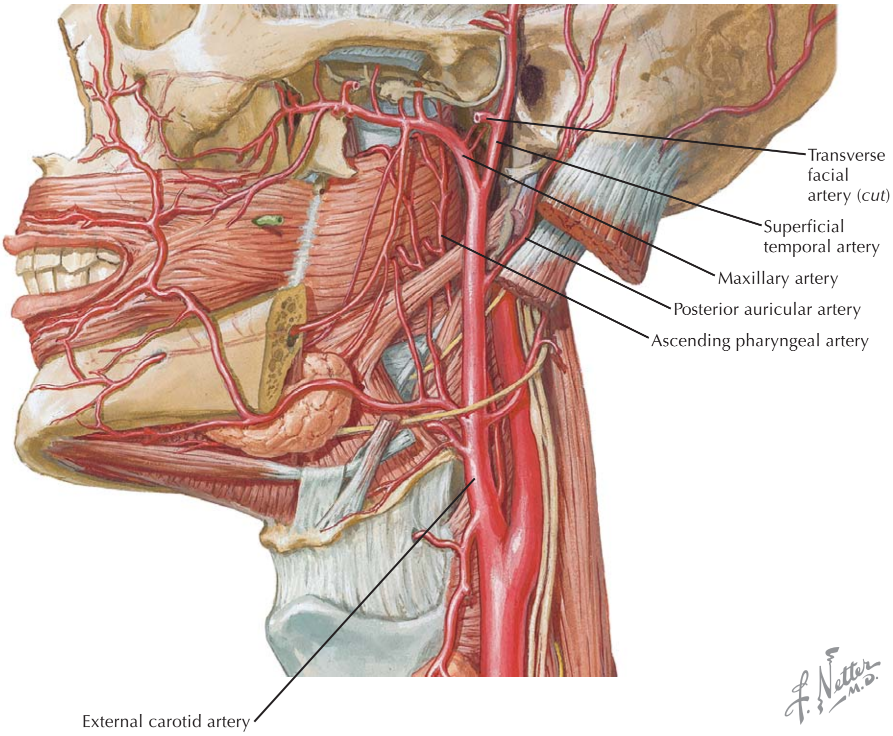




6 Contents of the Parotid Bed

VASCULAR SUPPLY

ARTERIAL SUPPLY		
Artery	**Source**	**Course**
External carotid	The bifurcation of the common carotid a. at vertebral level C3	Ascends superiorly posterior to the mandible and deep to the posterior belly of the digastric m. and the stylohyoid m. to enter the parotid gland Within the parotid gland, it gives branches to the gland and the posterior auricular a. Then branches into the superficial temporal and maxillary aa. within the gland The transverse facial a. arises from the superficial temporal a. within the gland
Posterior auricular	External carotid a. within the parotid gland	Passes superiorly between the mastoid process and cartilage of the ear
Maxillary	The 2 terminal branches of the external carotid a.	Begins posterior to the neck of the mandible and travels anteromedially between the sphenomandibular lig. and the ramus of the mandible On exiting the parotid gland, passes either superficial or deep to the lateral pterygoid muscle
Superficial temporal		Begins posterior to the neck of the mandible and travels superiorly as a continuation of the external carotid Joined by the auriculotemporal n.
Transverse facial	Superficial temporal a. before it exits the parotid gland	Passes transversely to exit the gland Passes immediately superior to the parotid duct across the masseter m. and face



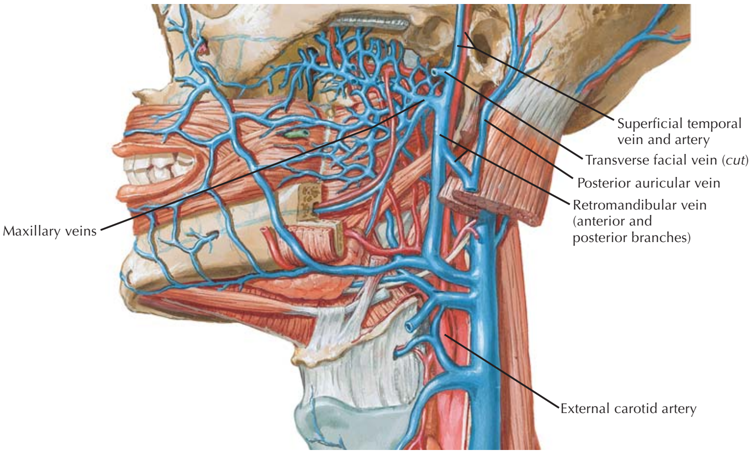
Contents of the Parotid Bed

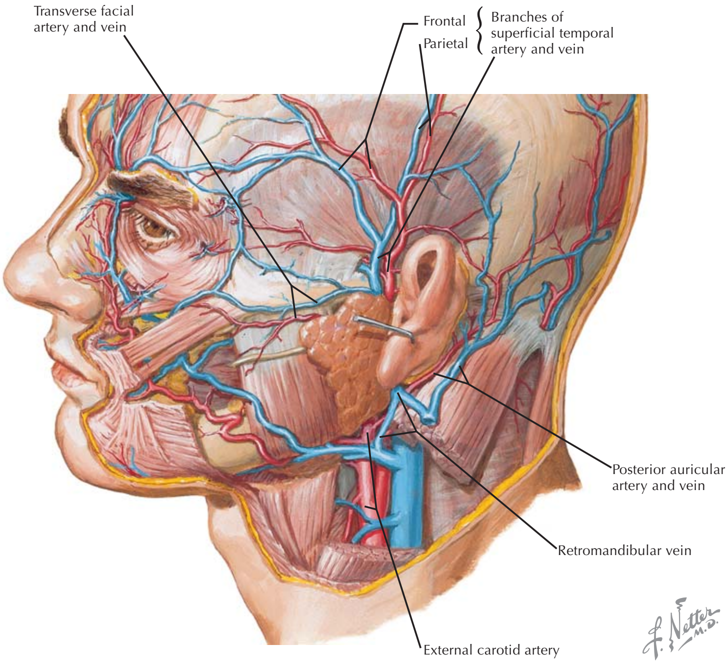
VASCULAR SUPPLY *CONTINUED*

VENOUS DRAINAGE	
Vein	**Course**
Superficial temporal	Descends posterior to the zygomatic root of the temporal bone alongside the auriculotemporal n. to enter the parotid gland Unites with the maxillary v. to form the retromandibular v.
Transverse facial	Travels posteriorly to enter the parotid gland and join the superficial temporal v.
Maxillary	A short, sometimes paired vein, formed by the convergence of the tributaries of the pterygoid plexus Enters the parotid gland traveling posteriorly between the sphenomandibular lig. and the neck of the mandible Unites with the superficial temporal v. to form the retromandibular v.
Retromandibular	Arises from the joining of the superficial temporal and maxillary vv. within the parotid gland Descends superficial to the external carotid a. in the gland, where it branches into the anterior and posterior divisions of the retromandibular vv.
Posterior auricular	Arises from a plexus of veins created by the occipital and superficial temporal vv. Descends posterior to the auricle to unite with the posterior division of the retromandibular v. to form the external jugular v.

6 Contents of the Parotid Bed

VASCULAR SUPPLY *CONTINUED*

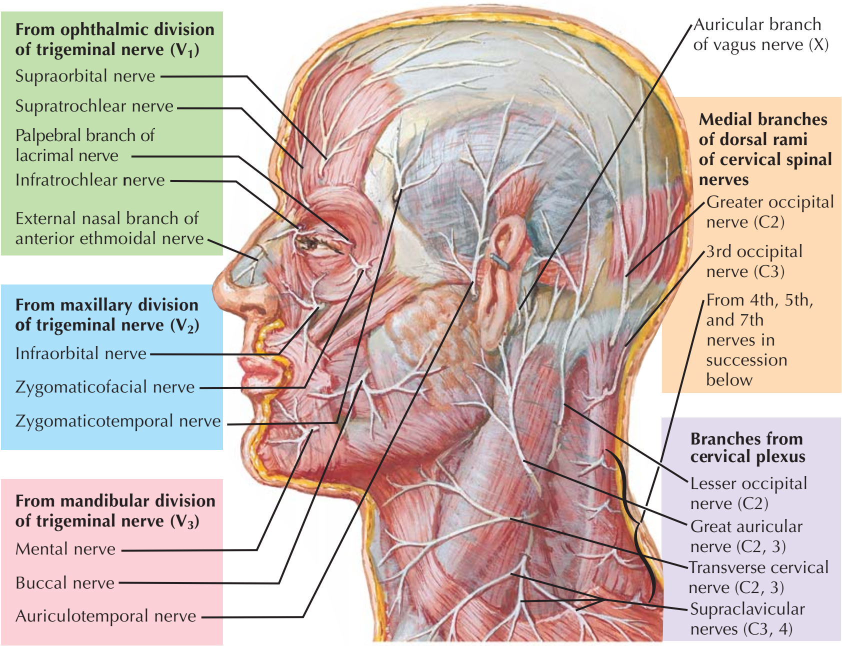




Contents of the Parotid Bed

NERVE SUPPLY

SENSORY NERVES OF THE PAROTID		
Nerve	**Source**	**Course**
Auriculotemporal	Mandibular division of the trigeminal n.	Often arises as 2 roots surrounding the middle meningeal a. that unite Passes inferior to the lateral pterygoid toward the neck of the mandible Passes posterior to the neck of the mandible to ascend with the superficial temporal a. Supplies the parotid gland's deep and superior portions
Great auricular	The cervical plexus formed by contributions of C2 and C3 ventral rami	After passing posterior to the sternocleidomastoid at Erb's point, it ascends along the sternocleidomastoid m., dividing into anterior and posterior branches The anterior branch continues along the superficial aspect of the inferior part of the parotid gland Supplies the parotid gland's superficial and inferior portions



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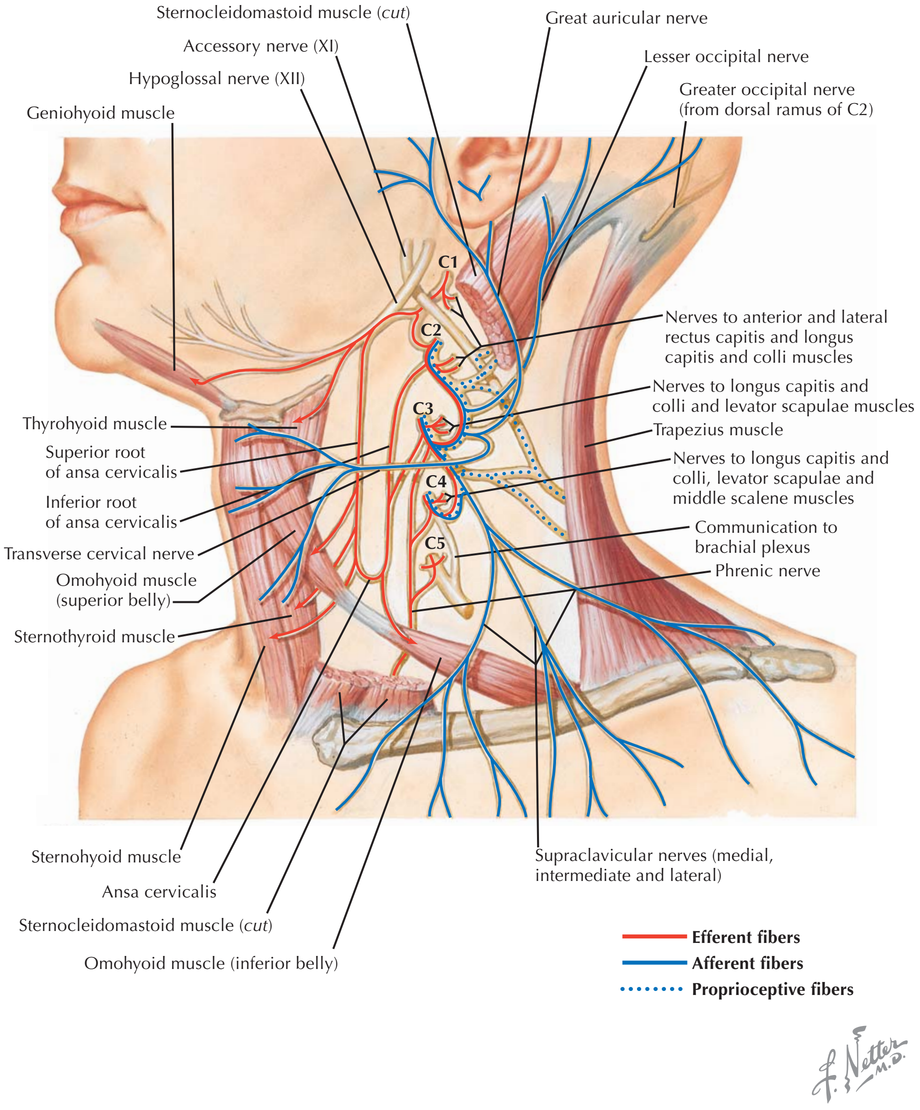
Sternocleidomastoid muscle (cut)
Accessory nerve (XI)
Hypoglossal nerve (XII)
Geniohyoid muscle
Great auricular nerve
Lesser occipital nerve
Greater occipital nerve (from dorsal ramus of C2)
C1
C2
C3
C4
C5
Nerves to anterior and lateral rectus capitis and longus capitis and colli muscles
Nerves to longus capitis and colli and levator scapulae muscles
Trapezius muscle
Nerves to longus capitis and colli, levator scapulae and middle scalene muscles
Communication to brachial plexus
Phrenic nerve
Thyrohyoid muscle
Superior root of ansa cervicalis
Inferior root of ansa cervicalis
Transverse cervical nerve
Omohyoid muscle (superior belly)
Sternothyroid muscle
Sternohyoid muscle
Ansa cervicalis
Sternocleidomastoid muscle (cut)
Omohyoid muscle (inferior belly)
Supraclavicular nerves (medial, intermediate and lateral)
Efferent fibers
Afferent fibers
Proprioceptive fibers
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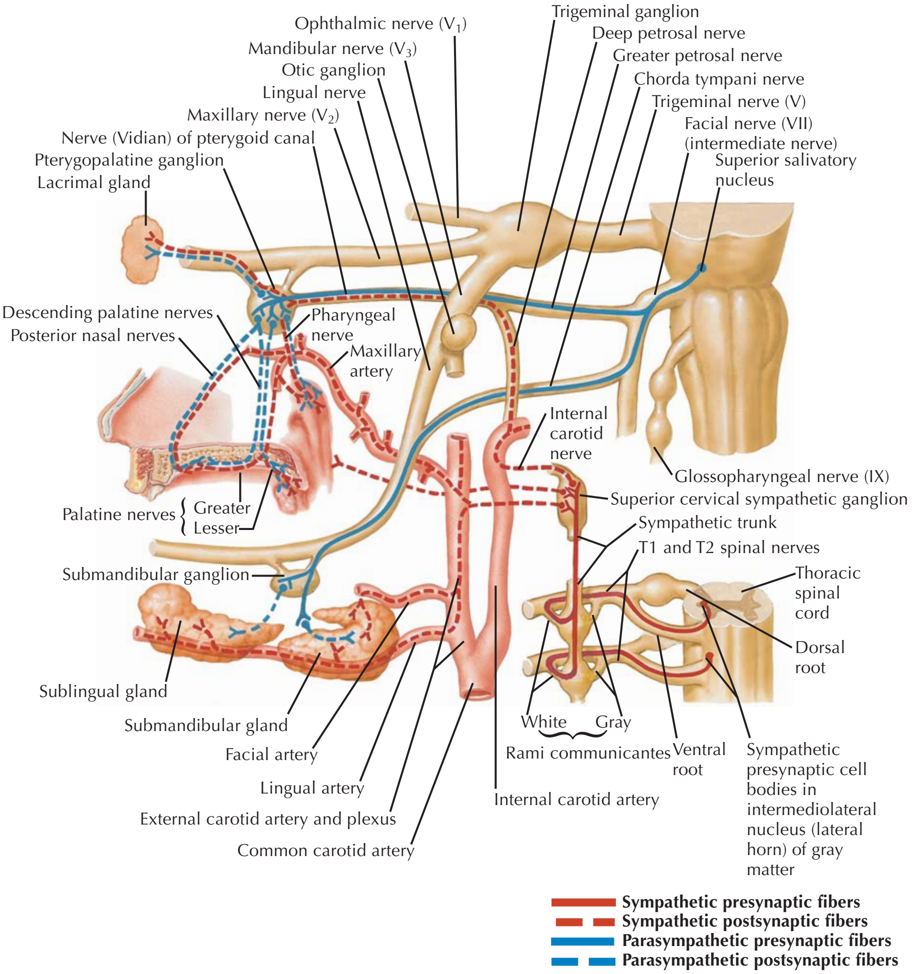
Contents of the Parotid Bed

NERVE SUPPLY *CONTINUED*

ANATOMIC PATHWAY FOR PARASYMPATHETICS OF THE PAROTID GLAND			
Type of Neuron	**Name of Cell Body**	**Characteristics of the Cell Body**	**Course of the Neuron**
Preganglionic neuron	Inferior salivatory nucleus	A collection of nerve cell bodies located in the medulla	Preganglionic parasympathetic fibers arise from the inferior salivatory nucleus in the medulla These fibers travel through the glossopharyngeal n. and exit the jugular foramen Gives rise to the tympanic branch of IX, which reenters the skull via the tympanic canaliculus Tympanic branch of IX forms the tympanic plexus along the promontory of the ear The plexus re-forms as the lesser petrosal n., typically exiting the foramen ovale to enter the infratemporal fossa Lesser petrosal n. joins the otic ganglion
Postganglionic neuron	Otic ganglion	A collection of nerve cell bodies located inferior to the foramen ovale medial to the mandibular division of the trigeminal n.	Postganglionic parasympathetic fibers arise in the otic ganglion These fibers travel to the auriculotemporal branch of the trigeminal n. Auriculotemporal n. travels to the parotid gland Postganglionic parasympathetic fibers innervate the parotid gland

ANATOMIC PATHWAY FOR SYMPATHETICS OF THE PAROTID GLAND			
Type of Neuron	**Name of Cell Body**	**Characteristics of the Cell Body**	**Course of the Neuron**
Preganglionic neuron	Intermediolateral horn nucleus	Collection of nerve cell bodies located in the lateral horn nucleus of the spinal cord between spinal segments T1 and T3 (and possibly T4)	Arise from the intermediolateral horn nuclei from T1 and T3(4) Travel through the ventral root of the spinal cord to the spinal nerve Enter the sympathetic chain via white rami communicantes Once in the sympathetic chain, the preganglionic fibers for the eye will ascend and synapse with postganglionic fibers in the superior cervical ganglion
Postganglionic neuron	Superior cervical ganglion	Collection of nerve cell bodies located in the superior cervical ganglion, which is located at the base of the skull	Arise in the superior cervical ganglion Postganglionic fibers will follow the external carotid a. Branches from the external carotid follow the arteries that supply the parotid gland


Ophthalmic nerve (V_1)
Mandibular nerve (V_3)
Otic ganglion
Lingual nerve
Maxillary nerve (V_2)
Nerve (Vidian) of pterygoid canal
Pterygopalatine ganglion
Lacrimal gland
Trigeminal ganglion
Deep petrosal nerve
Greater petrosal nerve
Chorda tympani nerve
Trigeminal nerve (V)
Facial nerve (VII)
(intermediate nerve)
Superior salivatory
nucleus
Descending palatine nerves
Posterior nasal nerves
Pharyngeal
nerve
Maxillary
artery
Internal
carotid
nerve
Glossopharyngeal nerve (IX)
Superior cervical sympathetic ganglion
Sympathetic trunk
T1 and T2 spinal nerves
Palatine nerves
Greater
Lesser
Submandibular ganglion
Thoracic
spinal
cord
Dorsal
root
Sublingual gland
Submandibular gland
Facial artery
Lingual artery
External carotid artery and plexus
Common carotid artery
White
Gray
Rami communicantes
Ventral
root
Internal carotid artery
Sympathetic
presynaptic cell
bodies in
intermediolateral
nucleus (lateral
horn) of gray
matter
Sympathetic presynaptic fibers
Sympathetic postsynaptic fibers
Parasympathetic presynaptic fibers
Parasympathetic postsynaptic fibers

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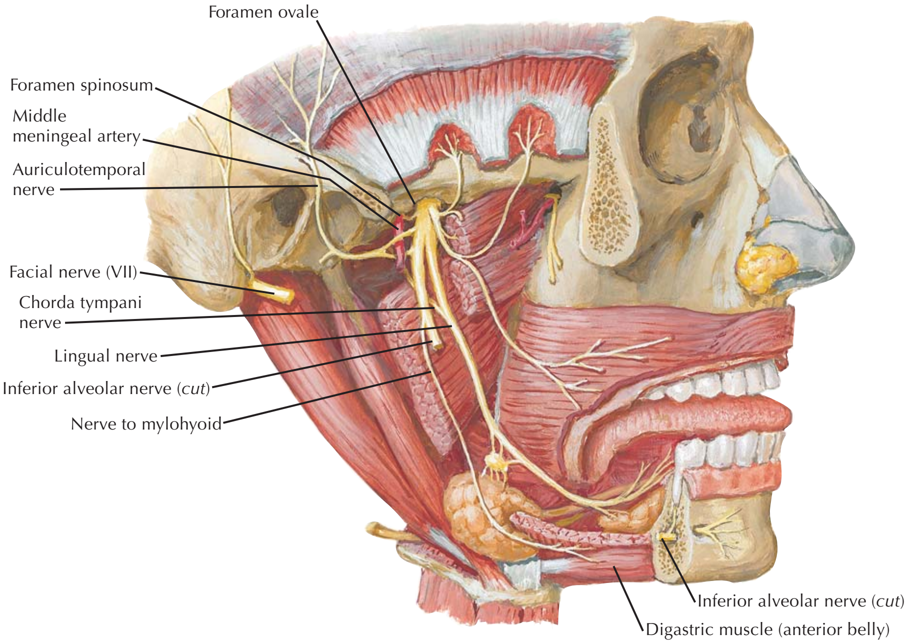
Contents of the Parotid Bed

NERVE SUPPLY *CONTINUED*

Lateral view



6 Clinical Correlate

BELL'S PALSY

Unilateral facial paralysis from facial nerve (cranial nerve VII) damage

CAUSES

Approximately 80% of cases have unclear etiology

Evidence suggests herpes simplex virus (HSV-1) infection is a cause

- *Proposed mechanism*: When the virus becomes active at the facial nerve, if the inflammation is in the bony facial canal, limited room for expansion results in nerve compression

Bacterial infections also have been implicated

- In some cases of otitis media, bacteria may enter the facial canal, and any resulting inflammatory response could compress the facial nerve

Temporary Bell's palsy can result from dental procedures if inferior alveolar nerve block anesthetic is improperly administered in the parotid fossa; signs and symptoms disappear when the anesthetic effects wear off

PROGNOSIS

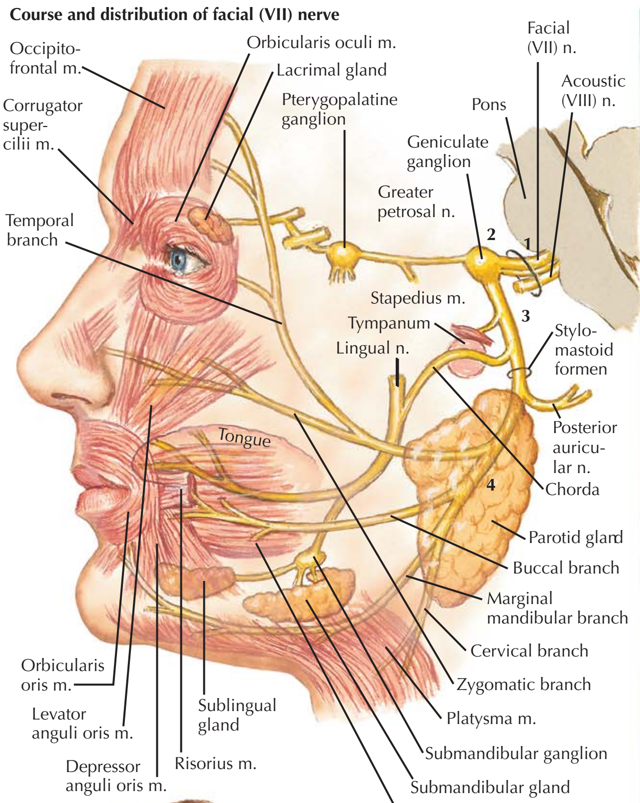
Mild cases produce a facial nerve neurapraxia; the prognosis for complete recovery is very good, usually within 2 to 3 weeks

In more moderate cases, an axonotmesis may occur, producing wallerian degeneration; full recovery may take 2 to 3 months

In a small percentage of cases, function is never completely recovered

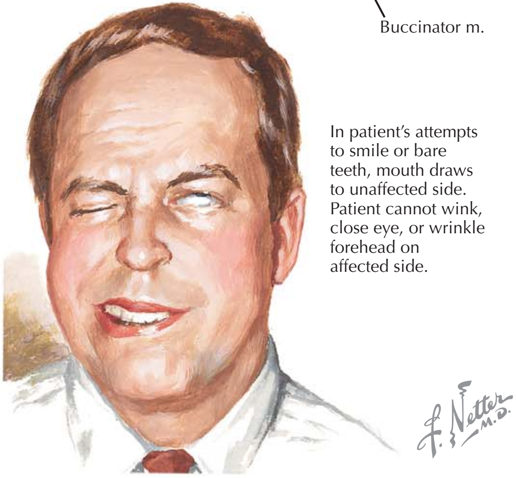
Clinical Correlate

BELL'S PALSY *CONTINUED*



Sites of lesions and their manifestations

1. Intracranial and/or internal auditory meatus. All symptoms of 2, 3, and 4, plus deafness due to involvement of eighth cranial nerve.
2. Geniculate ganglion. All symptoms of 3 and 4, plus pain behind ear. Herpes of tympanum and of external auditory meatus may occur.
3. Facial canal. All symptoms of 4, plus loss of taste in anterior tongue and decreased salivation on affected side due to chorda tympani involvement. Hyperacusia due to effect on nerve branch to stapedius muscle.
4. Below stylomastoid foramen (parotid gland tumor, trauma) Facial paralysis (mouth draws to opposite side; on affected side, patient unable to close eye or wrinkle forehead; food collects between teeth and cheek due to paralysis of buccinator muscle).


In patient's attempts to smile or bare teeth, mouth draws to unaffected side. Patient cannot wink, close eye, or wrinkle forehead on affected side.


Hyperacusia: patient holds phone away from ear because of painful sensitivity to sound

6 Clinical Correlate

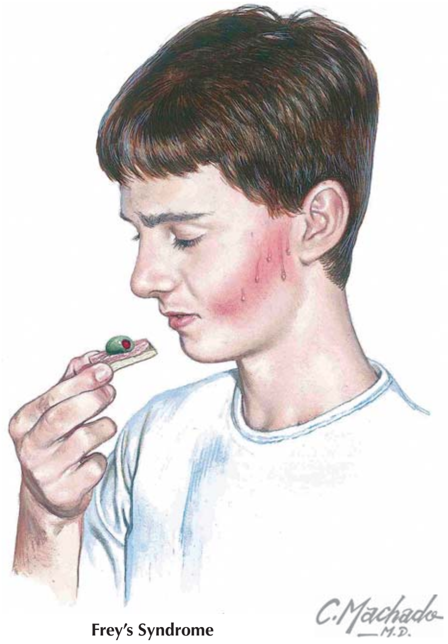
FREY'S SYNDROME

Caused by regeneration of the auriculotemporal autonomic fibers in an abnormal fashion, innervating the sweat glands near the parotid gland after a parotidectomy

Symptoms include sweating and redness in the distribution of the auriculotemporal nerve during eating

Diagnosis is via Minor's starch iodine test—creates a dark spot over the gustatory sweating area

Treatments include tympanic neurectomy (severing the parasympathetic component) and the topical anticholinergic glycopyrrolate (Robinul)



Frey's Syndrome

Clinical Correlate

TUMORS OF THE PAROTID GLAND

80% of parotid tumors are benign

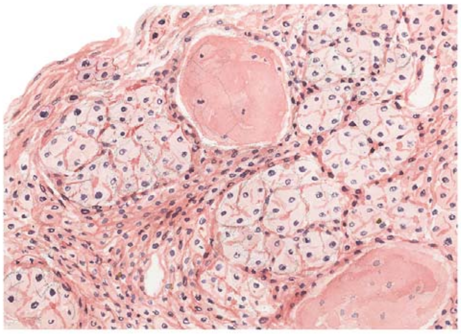
The most common benign tumor is a pleomorphic adenoma, which, if present for many years, can convert to a highly malignant carcinoma

When pleomorphic adenomas extend through the capsule, they must be removed to reduce recurrence

Because of the proximity, these tumors can extend into the lateral pharyngeal space

Removal of the tumor with its surrounding capsule and tissue is important to obtain a low recurrence rate

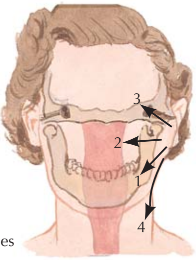
- Histologically, pleomorphic adenomas have extensions through the tumor capsule into adjacent tissue, so simple enucleation would allow recurrence from tumor cells left behind



Mixed tumor

Lymphosarcoma

Adenocarcinoma of Parotid gland



Local spread of carcinoma of parotid

1. Mandible
2. Pharynx
3. Base of skull and middle ear
4. Cervical lymph nodes

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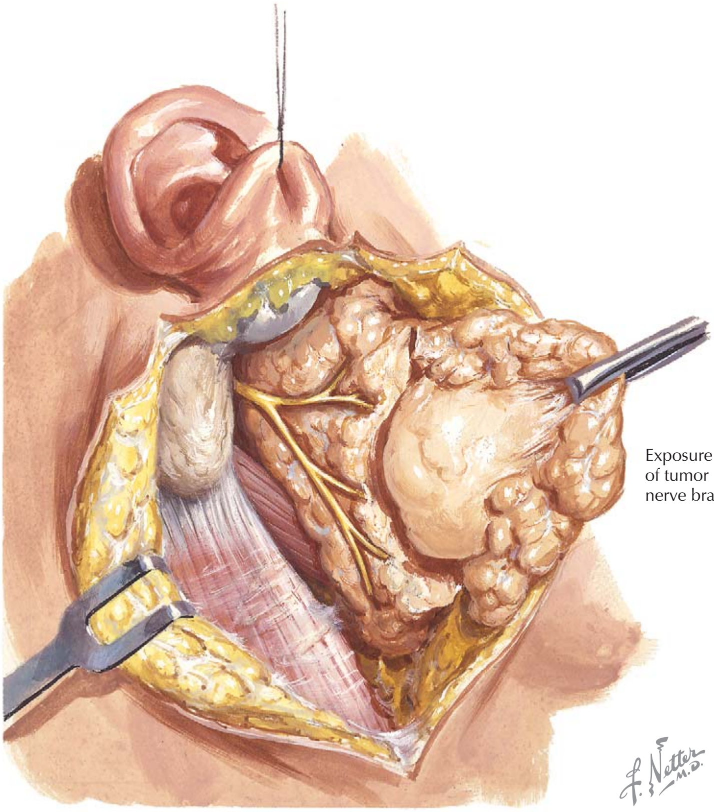
TUMORS OF THE PAROTID GLAND *CONTINUED*



Exposure and resection of tumor sparing facial nerve branches

Clinical Correlate

PAROTITIS/MUMPS

An inflammation of the parotid glands that typically is caused by a bacterial or viral infection

Can also be caused by other diseases, such as Sjögren's syndrome, tuberculosis, and human immunodeficiency virus (HIV) infection

Pain through mandibular movement is the result of the compression of the deep lobe of the gland by the mandibular ramus

BACTERIAL PAROTITIS

Less common since the introduction of antibiotics, proper hydration, and better oral hygiene

Mortality rate in the early 19th century was as high as 70% to 80%

Most cases now seen in patients on anticholinergic medication, especially the elderly, because it inhibits the salivary flow, which makes it easier for the bacteria to be transported in retrograde fashion along the parotid duct into the gland, where they may settle to cause an infection

VIRAL PAROTITIS

Known as mumps

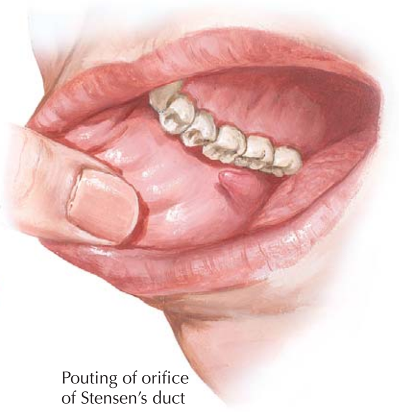
Causative virus is a paramyxovirus that infects different body parts, notably the parotid glands

Usually is spread through saliva, coughing, and sneezing

Parotid glands typically swell and become very painful

With the introduction of mumps vaccination in the 1970s, now rare in most developed nations

Parotitis
(obstruction or
ascending infection)



Pouting of orifice
of Stensen's duct

6 Clinical Correlate

XEROSTOMIA

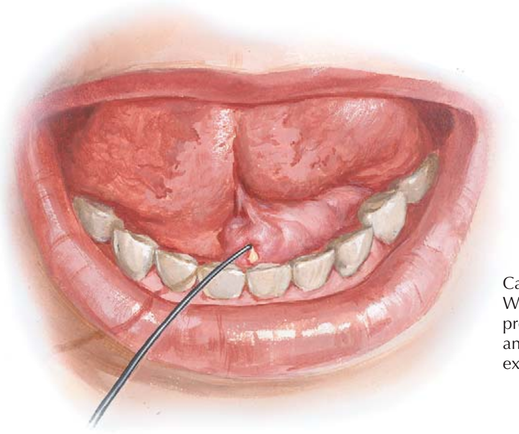
Xerostomia: "dry mouth"

Dry mouth is a symptom that increases the affected person's susceptibility to dental caries

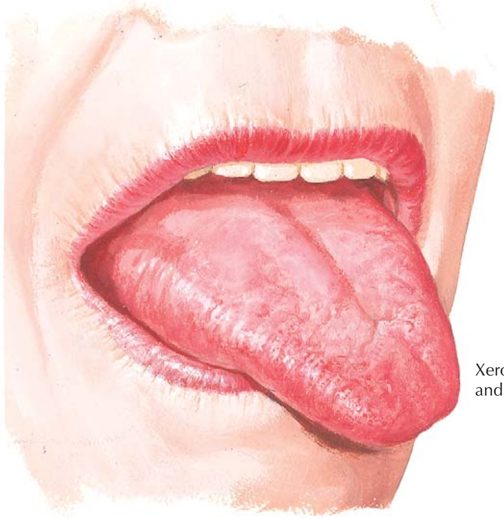
Can be caused by any medication that reduces salivary outflow, commonly: many antihistamines, antidepressants, chemotherapeutic agents (including radiation therapy), antihypertensives, and analgesics

Occurs in disease processes such as depression, stress, endocrine disorders, Sjögren's syndrome, and improper nutrition

Can lead to the formation of sialoliths, calculi that form in the duct or gland, although they are more commonly associated with infections of the submandibular gland than of the parotid gland and duct



Calculus in Wharton's duct probe inserted and drop of pus exuding



Xerostomia and glossitis

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Clinical Correlate

FISTULAS AND SIALOCELES

Parotid fistula: a communication between the skin and the parotid gland or duct that may lead to the formation of a *sialocele*, a cyst filled with a collection of mucoid saliva in the tissues surrounding the gland

CAUSES

Both parotid fistulas and sialoceles often occur as the result of trauma

May also be caused by:

- Section or injury of the duct or one of its branches during operation for cancer of the cheek or face
- Removal of parotid tumors, especially those of the accessory lobe
- Primary or secondary malignant tumors that ulcerate the skin
- Incision and drainage for acute bacterial parotitis
- Ulceration and infection associated with large salivary calculi
- Fistula may develop after a mastoid or fenestration operation
- Congenital
- Infection (actinomycosis, tuberculosis, syphilis, cancrum oris)

TREATMENT

Fistulas that lead directly into the oral cavity need no treatment

Fistulas on the skin may or may not need surgical intervention

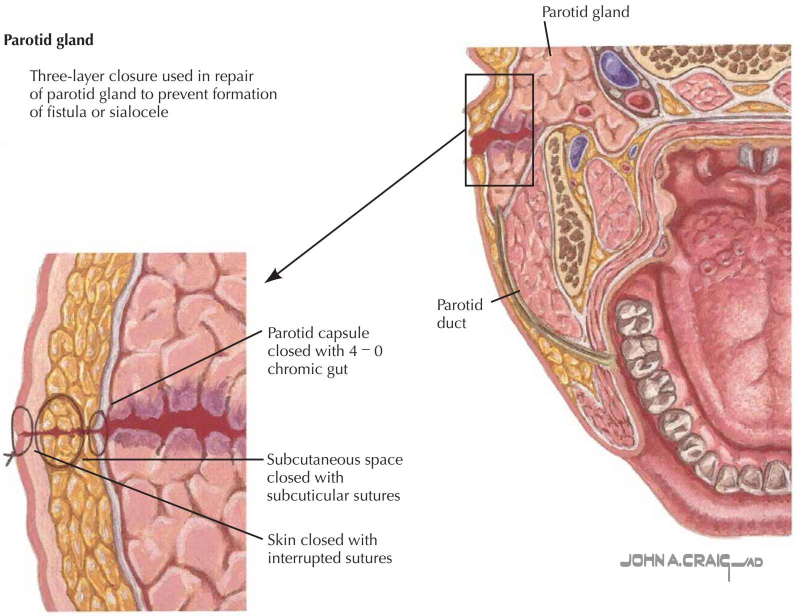
Anticholinergics are useful agents to diminish the salivation during treatment

Sialoceles often resolve with aspiration or compression and normally do not require drain placement

Injury to the parotid gland or duct should be repaired to prevent formation of fistulas and sialoceles

3 COMMON REPAIRS

- Repair of the duct using a stent
- Ligation of the duct
- Creating a fistula from the duct into the oral cavity



Parotid gland

Three-layer closure used in repair of parotid gland to prevent formation of fistula or sialocele

CHAPTER 7

TEMPORAL AND INFRATEMPORAL FOSSAE

7 Overview and Topographic Anatomy

GENERAL INFORMATION

TEMPORAL FOSSA

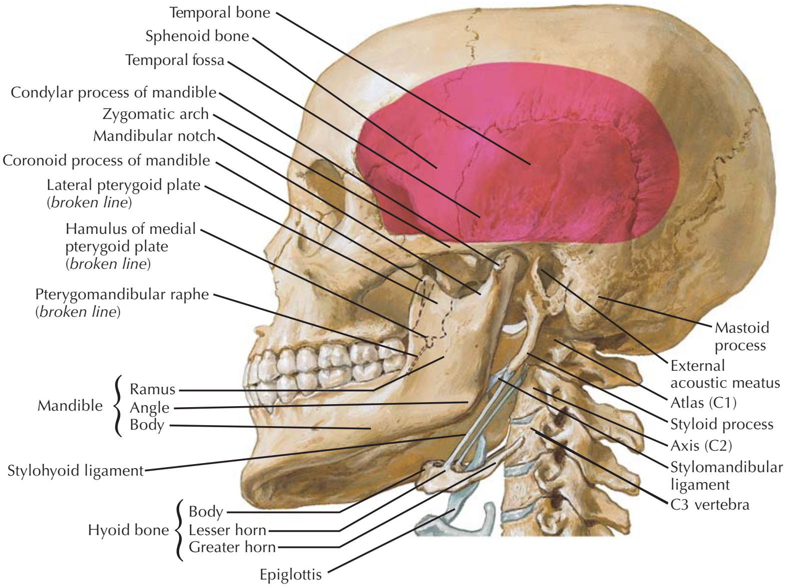
Related to the temple of the head

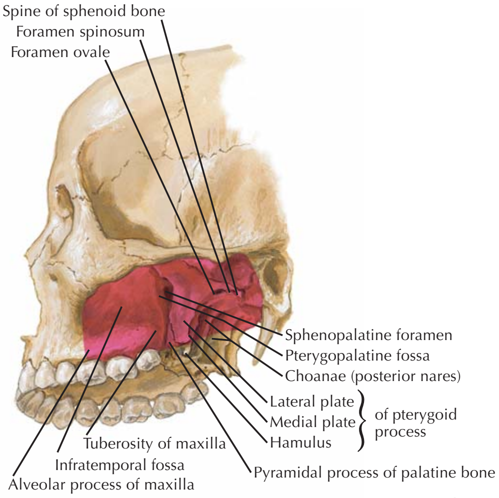
Communicates with the infratemporal fossa beneath the zygomatic arch

INFRATEMPORAL FOSSA

An irregularly shaped fossa inferior and medial to the zygomatic arch

Communicates with the pterygopalatine fossa at the pterygomaxillary fissure

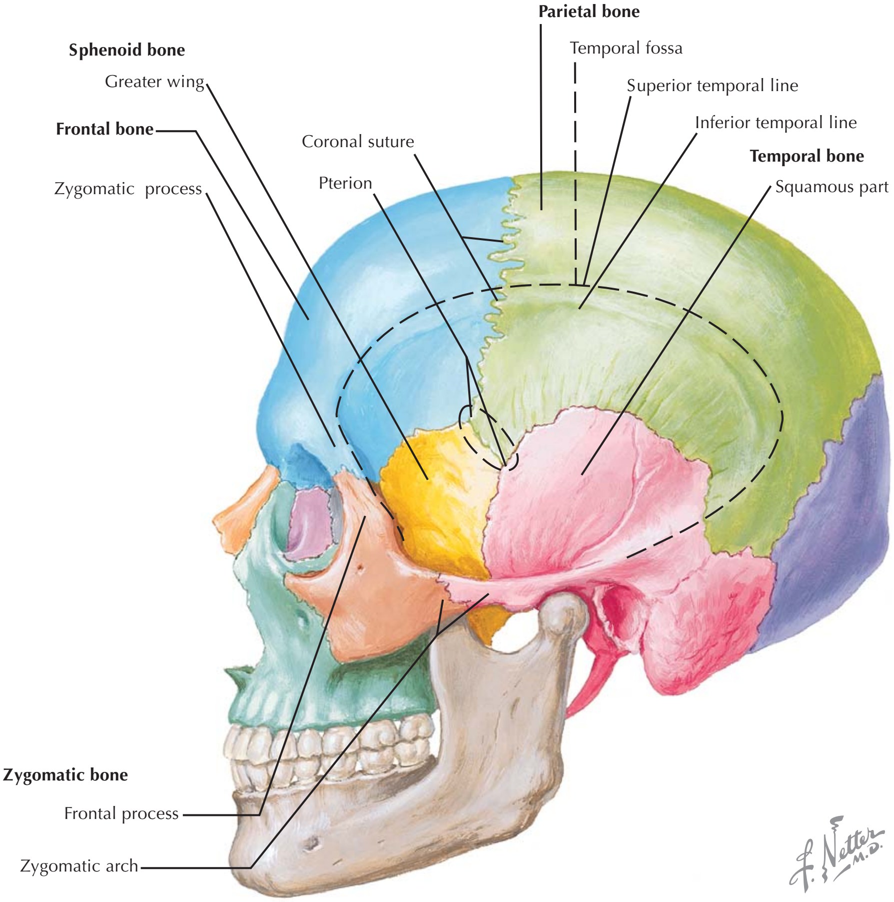




Borders of the Temporal Fossa

OVERVIEW

Border	Structures
Superior	Superior temporal line of the skull
Inferior	Zygomatic arch
Anterior	Frontal process of the zygoma Zygomatic process of the frontal bone
Posterior	Superior temporal line of the skull
Floor	Frontal, greater wing of the sphenoid Parietal and squamous part of the temporal bones (including the pterion)



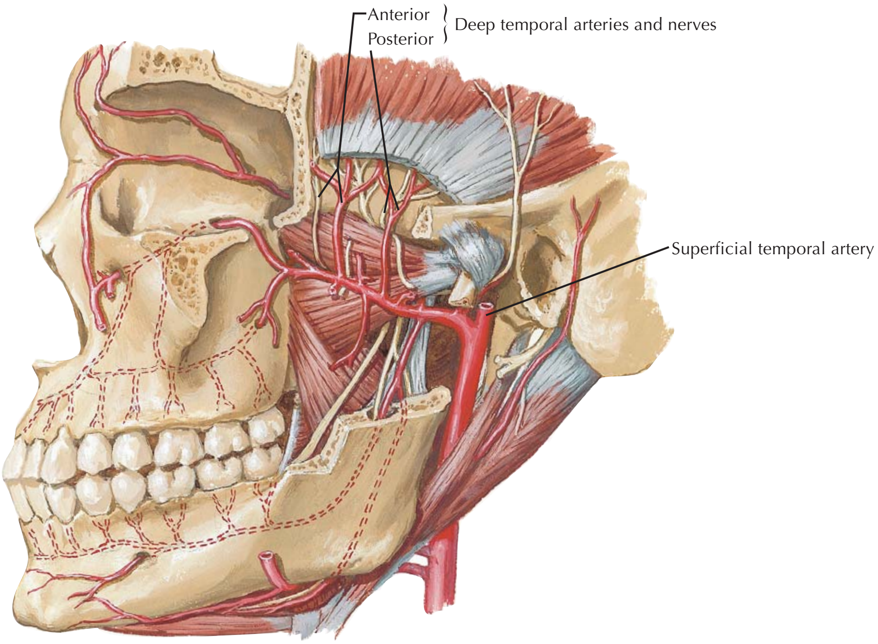
Contents of the Temporal Fossa

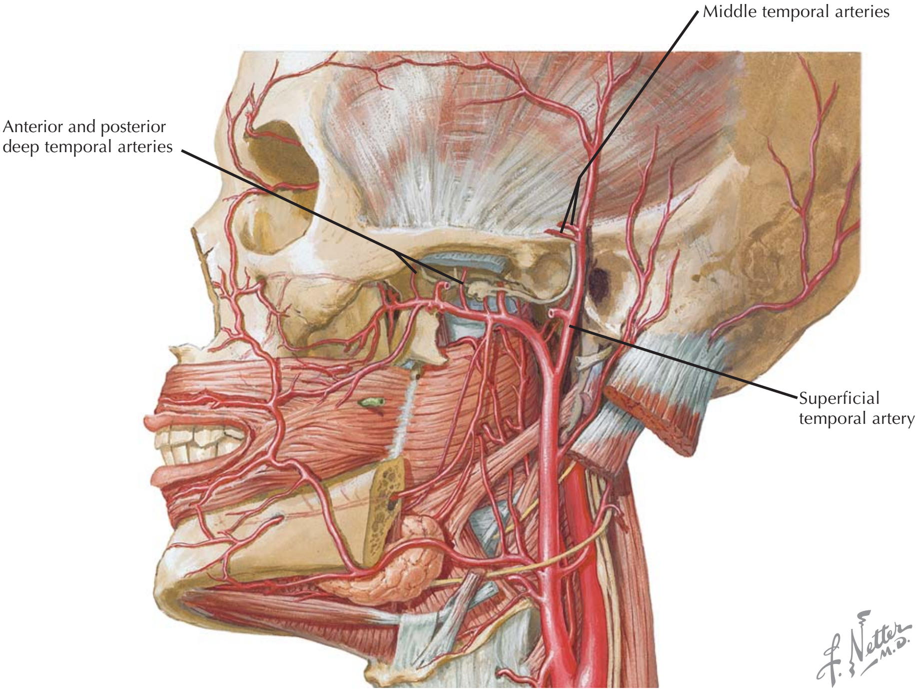
VASCULAR SUPPLY

ARTERIAL SUPPLY		
Artery	**Source**	**Course**
Superficial temporal	A terminal branch of the external carotid a. that arises within the parotid gland	Within the substance of the parotid gland, it gives off a transverse facial a. Emerges from the superior part of the parotid gland immediately posterior to the temporomandibular joint and anterior to the external auditory meatus Passes superficial to the root of the zygomatic arch just anterior to the auriculotemporal n. and the auricle Immediately superior to the root of the zygomatic arch, it gives rise to the middle temporal a. that pierces deep into the temporalis fascia and muscle As it continues to pass superiorly, it divides into anterior and posterior branches
Middle temporal	Superficial temporal a. after it passes superior to the root of the zygomatic arch	Passes deep into the temporalis fascia and temporalis m., where it anastomoses with the anterior and posterior deep temporal vessels
Anterior and posterior deep temporal	Branches of the 2nd part of the maxillary a.	Pass between the skull and the temporalis m. Supply the temporalis throughout their course While ascending, they anastomose with the middle temporal a.

Contents of the Temporal Fossa

VASCULAR SUPPLY *CONTINUED*

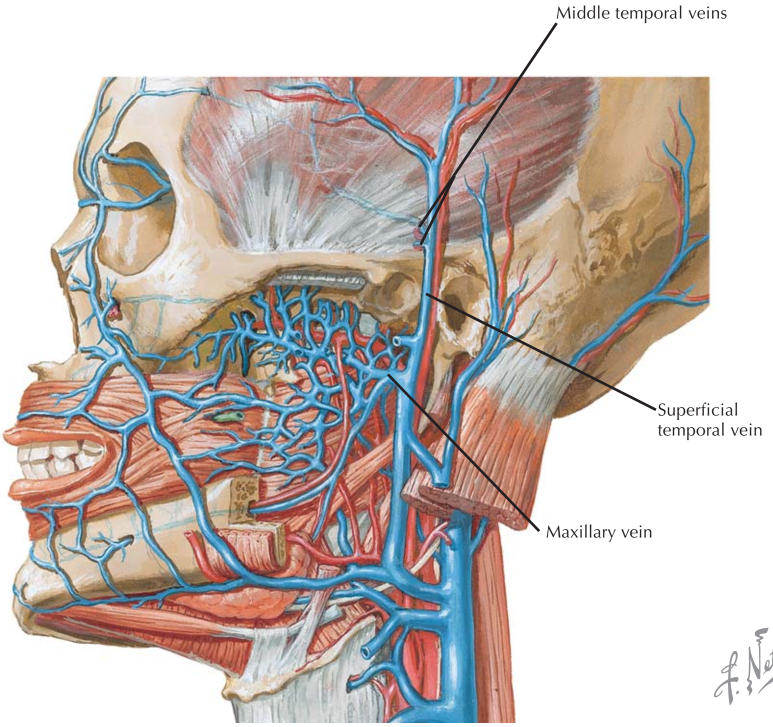




Contents of the Temporal Fossa

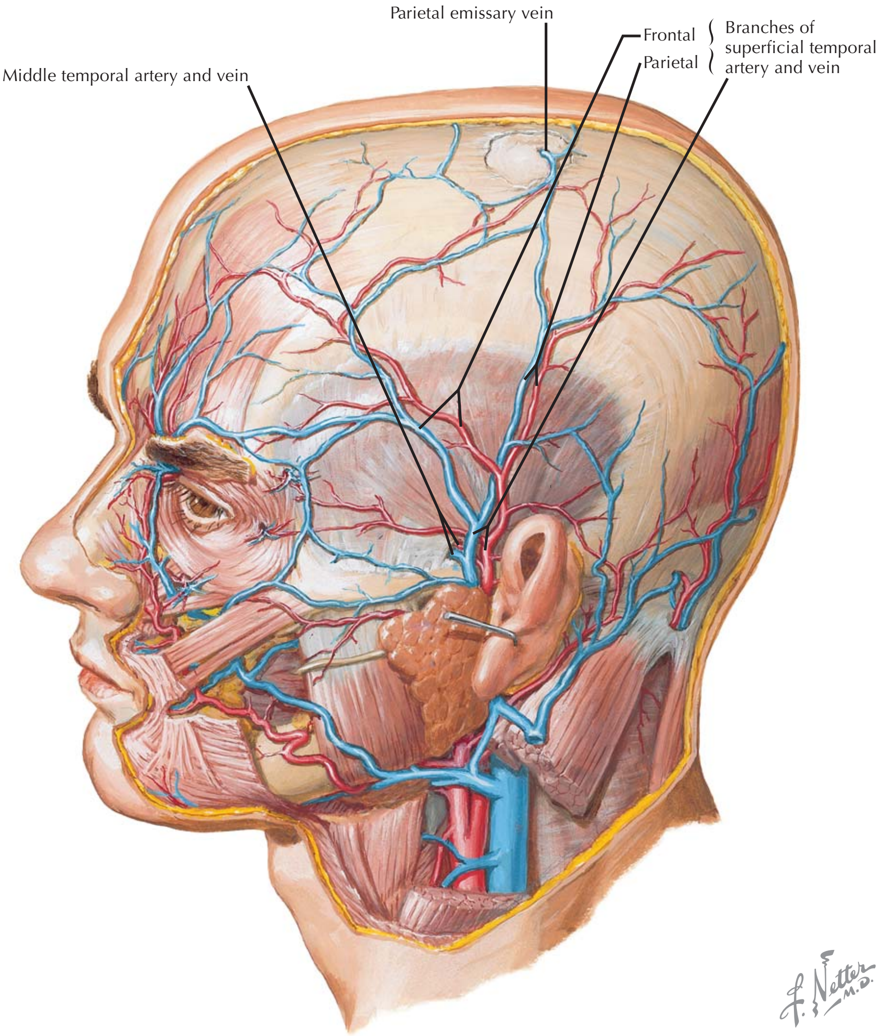
VASCULAR SUPPLY

VENOUS DRAINAGE	
Vein	**Course**
Superficial temporal	Begins at the vertex and lateral aspect of the skull Forms a venous plexus along the scalp by communicating with the supraorbital, posterior auricular, occipital vv. and corresponding veins from the opposite side Forms an anterior and a posterior branch of the superficial temporal v. that pass inferiorly immediately anterior to the artery A middle temporal v. joins the superficial temporal before the vessel passes inferior to the root of the zygomatic arch Enters the parotid gland, where it receives the transverse facial v. Joins the maxillary v. to form the retromandibular v.
Middle temporal	Arises deep within the temporalis m. and fascia Within the temporalis m. and fascia, it anastomoses with the anterior and posterior deep temporal vessels Joins the superficial temporal a. immediately before it passes inferior to the root of the zygomatic arch
Anterior and posterior deep temporal	Drain into the pterygoid plexus of veins Also communicate with the middle temporal v.
Maxillary	A short branch formed by a confluence of the pterygoid plexus of veins Joins the superficial temporal v. to form the retromandibular v.



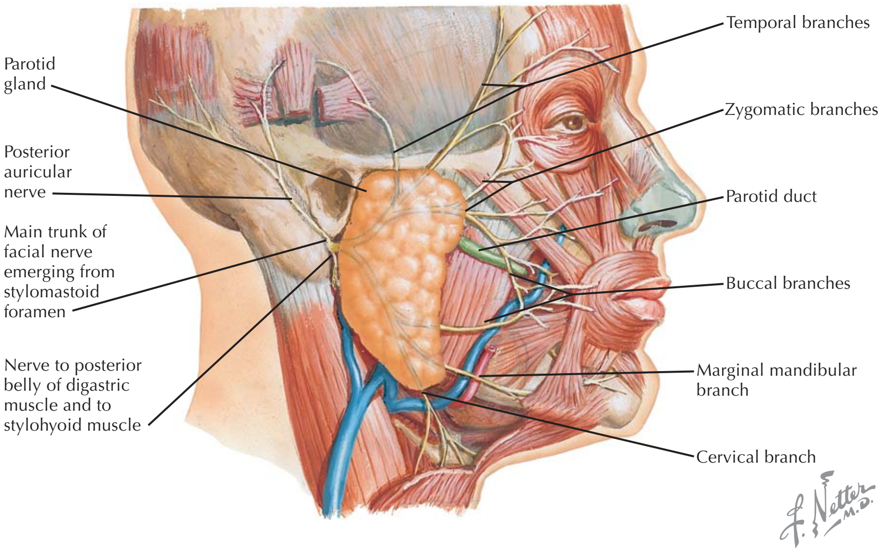
Contents of the Temporal Fossa

VASCULAR SUPPLY *CONTINUED*



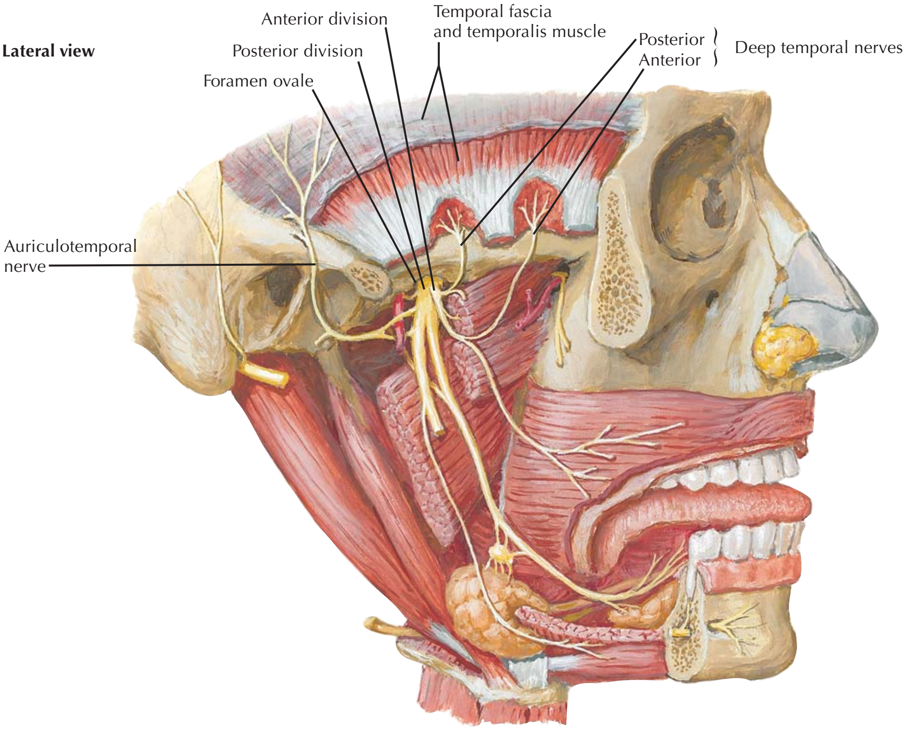
NERVE SUPPLY

Nerve	Source	Course
Mandibular division of the trigeminal	The largest of the 3 divisions of the trigeminal n. Created by a large sensory and small motor root that unite just after passing through the foramen ovale to enter the infratemporal fossa	Immediately gives rise to a meningeal branch, medial pterygoid branch, tensor tympani branch, and tensor veli palatini branch before it divides into anterior and posterior divisions The anterior division is smaller and mainly motor, with 1 sensory branch (buccal n.) The posterior division is larger and mainly sensory, with 1 motor branch (mylohyoid n.)
Anterior and posterior deep temporal	Arise from the anterior part of the mandibular division of the trigeminal n.	Pass superior to the lateral pterygoid m. between the skull and the temporalis m. while passing deep to the muscle to innervate it
Auriculotemporal	Arises from the posterior part of the mandibular division of the trigeminal n.	Normally arises from 2 roots, between which the middle meningeal a. passes Runs posteriorly just inferior to the lateral pterygoid and continues to the medial side of the neck of the mandible Turns superiorly with the superficial temporal vessels between the auricle and the condyle of the mandible deep to the parotid gland On exiting the substance of the parotid gland, it ascends over the zygomatic arch and divides into superficial temporal branches
Temporal branches of the facial	Motor branches that arise in the substance of the parotid gland	Cross the zygomatic arch to the temporal region Supply the muscles in the area, including the auricularis frontalis, orbicularis oculi, and the corrugator supercilii mm.

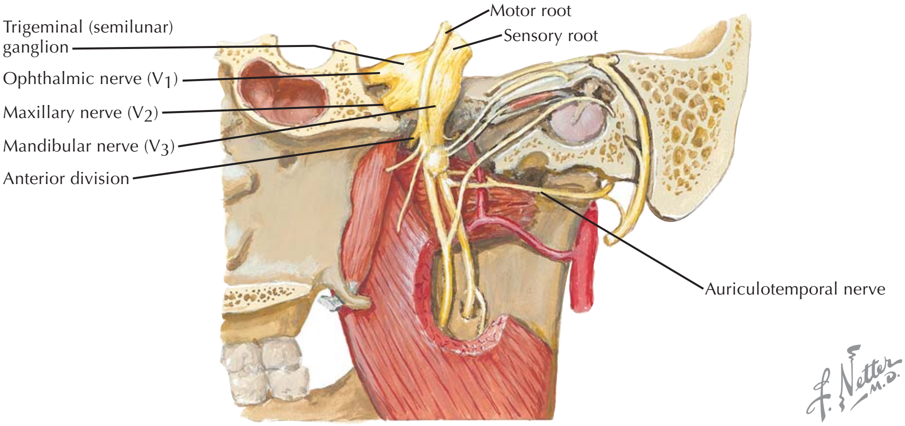


Contents of the Temporal Fossa

NERVE SUPPLY *CONTINUED*



Lateral view



Medial view

7 Borders of the Infratemporal Fossa

OVERVIEW

Borders	Structures
Lateral	Ramus of the mandible and coronoid process of the mandible
Medial	Lateral pterygoid plate of the sphenoid, the superior constrictor m., and the pyramidal process of the palatine bone
Superior	Infratemporal surface of the greater wing of the sphenoid with the foramen ovale and foramen spinosum
Anterior	Posterior portion of the maxilla
Posterior	Styloid process and condylar process of the mandible
Inferior	No anatomic floor as the boundary of the fossa ends where the medial pterygoid attaches to the mandible

CONTENTS OF THE INFRATEMPORAL FOSSA

MUSCLES

- Temporalis
- Lateral pterygoid
- Medial pterygoid

ARTERIES

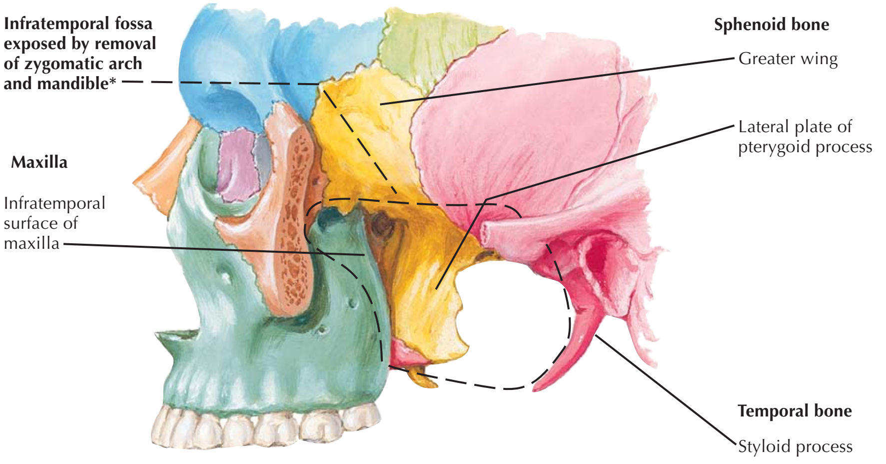
- Maxillary and its branches

VEINS

- Pterygoid plexus of veins and tributaries

NERVES

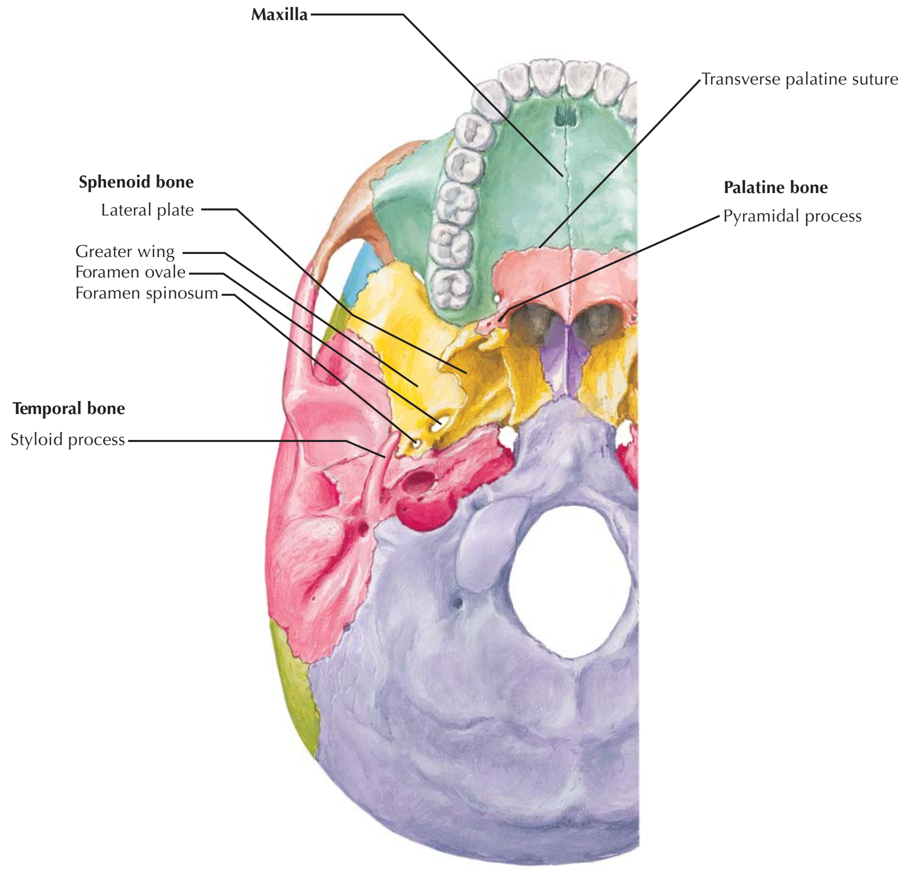
- Mandibular division of the trigeminal
- Posterior superior alveolar
- Chorda tympani branch of the facial
- Otic ganglion
- Lesser petrosal

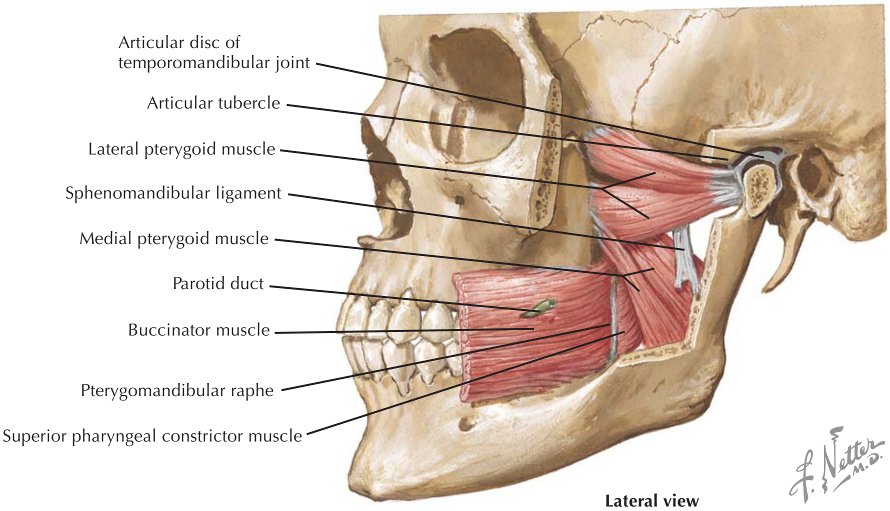


*Superficially, mastoid process forms posterior boundary

Borders of the Infratemporal Fossa

OVERVIEW *CONTINUED*





Lateral view

VASCULAR SUPPLY

MAXILLARY ARTERY
The larger of the 2 terminal branches of the external carotid a. (superficial temporal a.) Arises posterior to the condylar neck of the mandible within the parotid gland Exits the parotid gland and passes anteriorly between the ramus of the mandible and the sphenomandibular lig. within the infratemporal fossa Takes a course that is either superficial or deep to the lateral pterygoid until reaching the pterygopalatine fossa via the pterygomaxillary fissure Supplies the deep structures of the face and may be divided into 3 parts as it passes medially through the infratemporal fossa: • 1st part—mandibular part • 2nd part—pterygoid part • 3rd part—pterygopalatine part

MAXILLARY ARTERY: 1ST PART (MANDIBULAR PART)

Artery	Course
1st part (mandibular part)	Passes between the ramus of the mandible and the sphenomandibular lig. Lies parallel to and inferior to the auriculotemporal n. Crosses the inferior alveolar n. and passes on the inferior border of the lateral pterygoid Gives rise to 5 branches: anterior tympanic, deep auricular, middle meningeal, accessory meningeal, and the inferior alveolar
Deep auricular	Given off in the same area as the anterior tympanic Lies in the parotid gland, posterior to the temporomandibular joint, where it gives branches to supply the temporomandibular joint
Anterior tympanic	Given off in the same area as for the the deep auricular a. Passes superiorly immediately posterior to the temporomandibular joint Enters the tympanic cavity through the petrotympanic fissure and aids in supplying the tympanic membrane, along with branches of the posterior auricular a., artery of the pterygoid canal, and caroticotympanic branch from the internal carotid a.
Middle meningeal	Passes superiorly between the sphenomandibular lig. and the lateral pterygoid between the 2 roots of the auriculotemporal n. to the foramen spinosum of the sphenoid bone In the middle cranial fossa, passes anteriorly in a groove on the greater wing of the sphenoid, dividing into an anterior and posterior branch
Accessory meningeal	Arises from the maxillary or middle meningeal Enters the skull through the foramen ovale to supply the trigeminal ganglion and dura mater
Inferior alveolar	Descends inferiorly following the inferior alveolar n. to enter the mandibular foramen

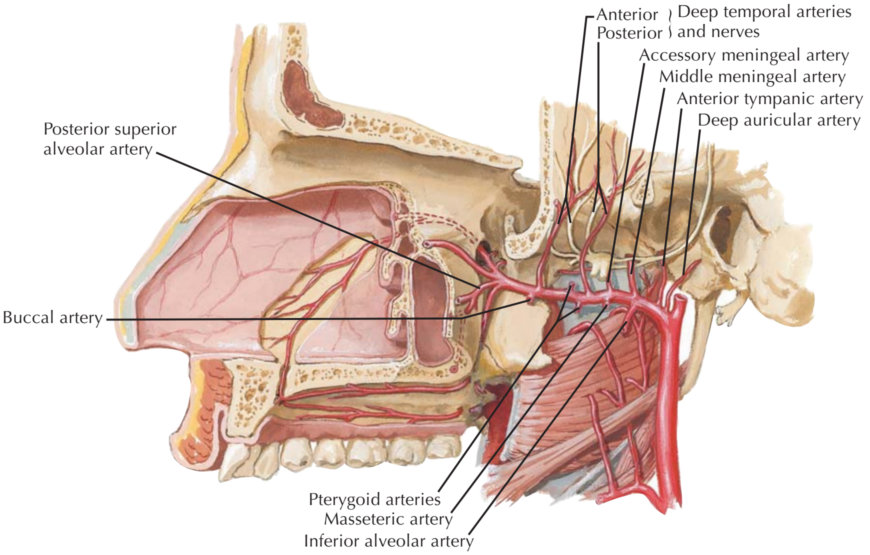
MAXILLARY ARTERY: 2ND PART (PTERYGOID PART)

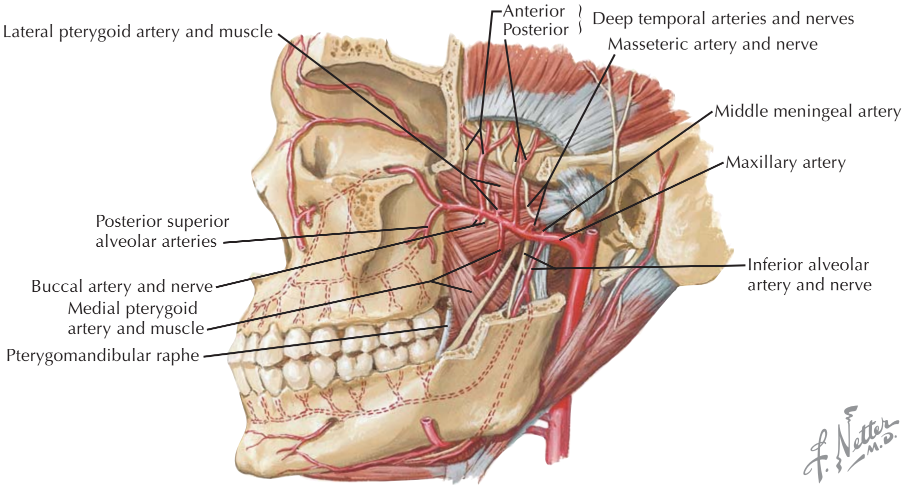
Artery	Course
2nd part (pterygoid part)	Passes obliquely and anterosuperiorly between the ramus of the mandible and insertion of the temporalis m. Then passes on the superficial surface of the lateral pterygoid to travel between the muscle's 2 heads Has 5 branches: anterior and posterior deep temporal, masseteric, pterygoid, and buccal
Anterior and posterior deep temporal	Pass between the skull and the temporalis m. Supply the temporalis throughout their course While ascending, these arteries anastomose with the middle temporal a. from the superficial temporal a.
Masseteric	Small; passes laterally through the mandibular notch to supply the deep surface of the masseter m.
Pterygoid	An irregular number of arteries supplying the pterygoid mm.
Buccal	A small artery that runs obliquely in an anterior direction between the medial pterygoid m. and the insertion of the temporalis m. until it reaches the outer surface of the buccinator m. to supply it

Contents of the Infratemporal Fossa

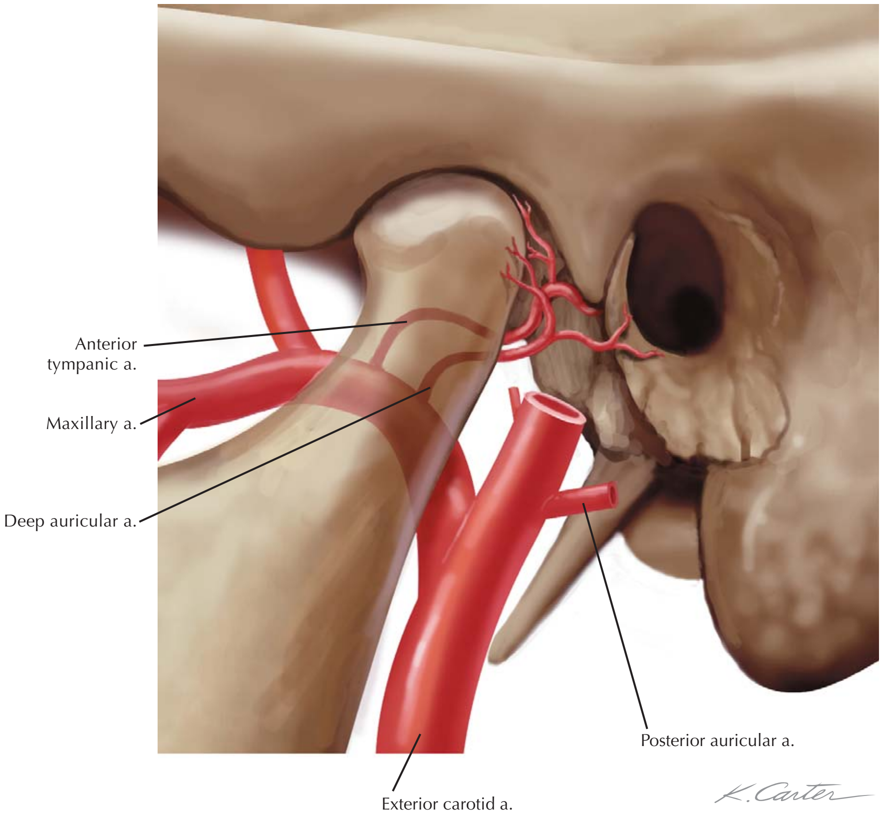
VASCULAR SUPPLY *CONTINUED*

MAXILLARY ARTERY: 3RD PART (PTERYGOPALATINE PART)	
Artery	**Course**
3rd part (pterygopalatine part)	Passes from the infratemporal fossa into the pterygopalatine fossa via the pterygomaxillary fissure Before passing through the pterygomaxillary fissure, it gives off the posterior superior alveolar a. (the only artery off the 3rd part of the maxillary a. that does not normally branch off within the pterygopalatine fossa)
Posterior superior alveolar	Arises in the infratemporal fossa Descends on the maxillary tuberosity to enter the posterior surface of the maxilla to supply the molars and premolars, lining of the maxillary sinus, and the gums





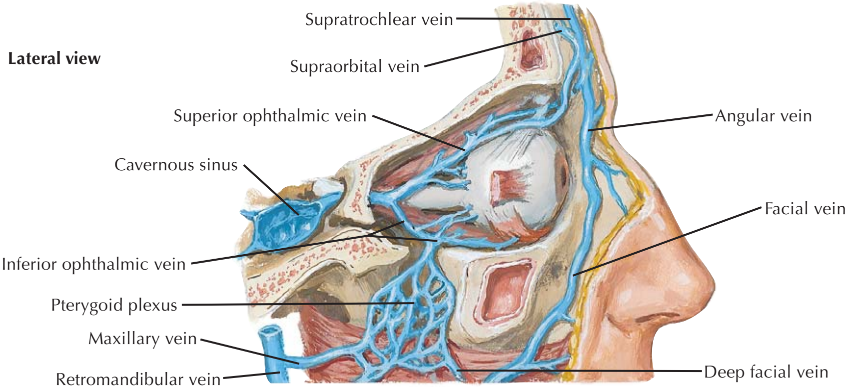
VASCULAR SUPPLY *CONTINUED*

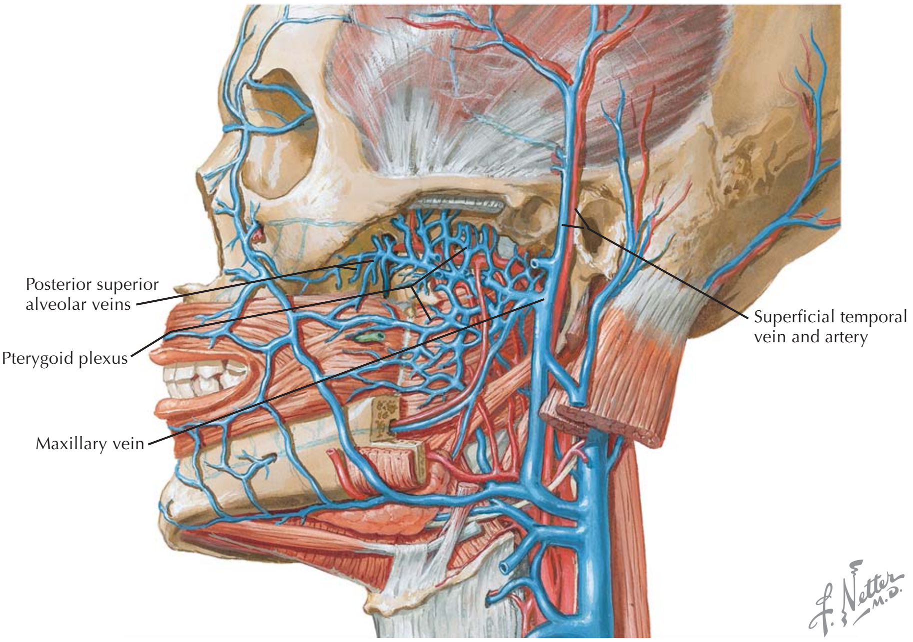


Contents of the Infratemporal Fossa

VASCULAR SUPPLY *CONTINUED*

VENOUS DRAINAGE	
Vein	**Course**
Pterygoid plexus	An extensive network of veins that parallel the 2nd and 3rd parts of the maxillary a. Receives branches that correspond with the same branches of the maxillary a. The tributaries of the pterygoid plexus eventually converge to form a short maxillary v. Communicates with the cavernous sinus, pharyngeal venous plexus, facial v. via the deep facial v., and ophthalmic vv.





7 Contents of the Infratemporal Fossa

NERVOUS STRUCTURES

MANDIBULAR NERVE

The largest of the 3 divisions of the trigeminal n.

Has motor *and* sensory functions

Created by a large sensory and a small motor root that unite just after passing through the foramen ovale to enter the infratemporal fossa

Immediately gives rise to a meningeal branch and then divides into anterior and posterior divisions

Anterior Division

Smaller; mainly motor with 1 sensory branch (buccal):
- Masseteric
- Anterior and posterior deep temporal
- Medial pterygoid
- Lateral pterygoid
- Buccal

Posterior Division

Larger, mainly sensory with 1 motor branch (mylohyoid n.):
- Auriculotemporal
- Lingual
- Inferior alveolar
- Mylohyoid n.

ANTERIOR DIVISION OF THE MANDIBULAR NERVE

Branch	Course
Masseteric	Passes laterally superior to the lateral pterygoid Lies anterior to the temporomandibular joint and posterior to the tendon of the temporalis m. Crosses the mandibular notch with the masseteric a. to innervate the masseter m. Also provides a small branch to the temporomandibular joint
Anterior and posterior deep temporal	Pass superior to the lateral pterygoid m. between the skull and the temporalis m. while passing deep to the muscle to innervate it
Medial pterygoid	Enters the deep surface of the muscle
Lateral pterygoid	Passes into the deep surface of the muscle Often arises from the buccal n.
Buccal	Passes anteriorly between the 2 heads of the lateral pterygoid m. Descends inferiorly along the lower part of the temporalis m. to appear from deep to the anterior border of the masseter m. Supplies the skin over the buccinator m. before passing through it to supply the mucous membrane lining its inner surface and the gingiva along the mandibular molars

POSTERIOR DIVISION OF THE MANDIBULAR NERVE

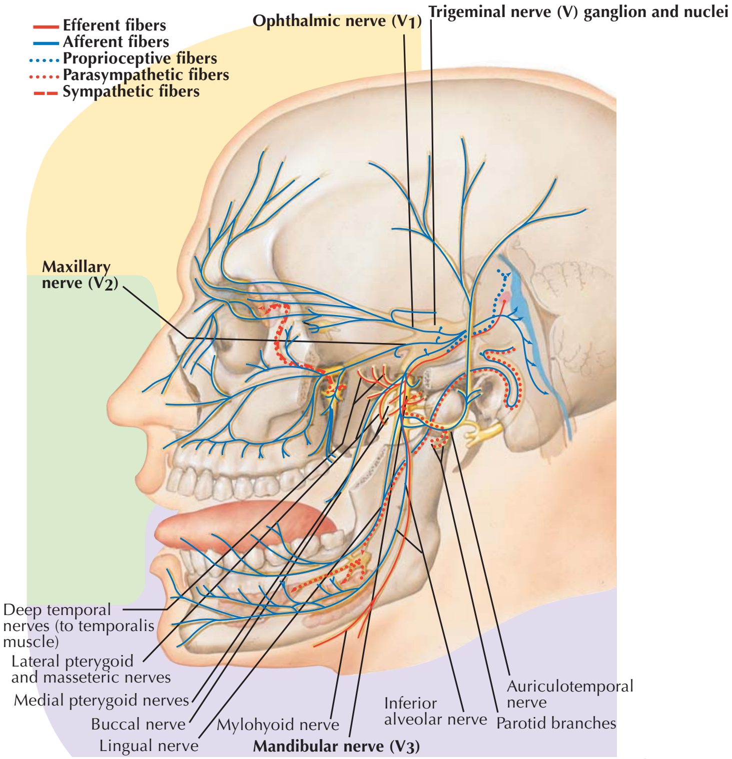
Branch	Course
Auriculotemporal	Normally arises from 2 roots, between which the middle meningeal a. passes Runs posteriorly just inferior to the lateral pterygoid and continues to the medial aspect of the neck of the mandible Then it turns superiorly with the superficial temporal vessels between the auricle and condyle of the mandible deep to the parotid gland On exiting the parotid gland, it ascends over the zygomatic arch and divides into superficial temporal branches
Lingual	Lies inferior to the lateral pterygoid and medial and anterior to the inferior alveolar n. The chorda tympani n. also joins the posterior part The lingual n. passes between the medial pterygoid and the ramus of the mandible to pass obliquely to enter the oral cavity bounded by the superior pharyngeal constrictor m., medial pterygoid m., and the mandible Supplies the mucous membrane of the anterior 2/3 of the tongue and gingiva on the lingual aspect of the mandibular teeth

Contents of the Infratemporal Fossa

NERVOUS STRUCTURES *CONTINUED*

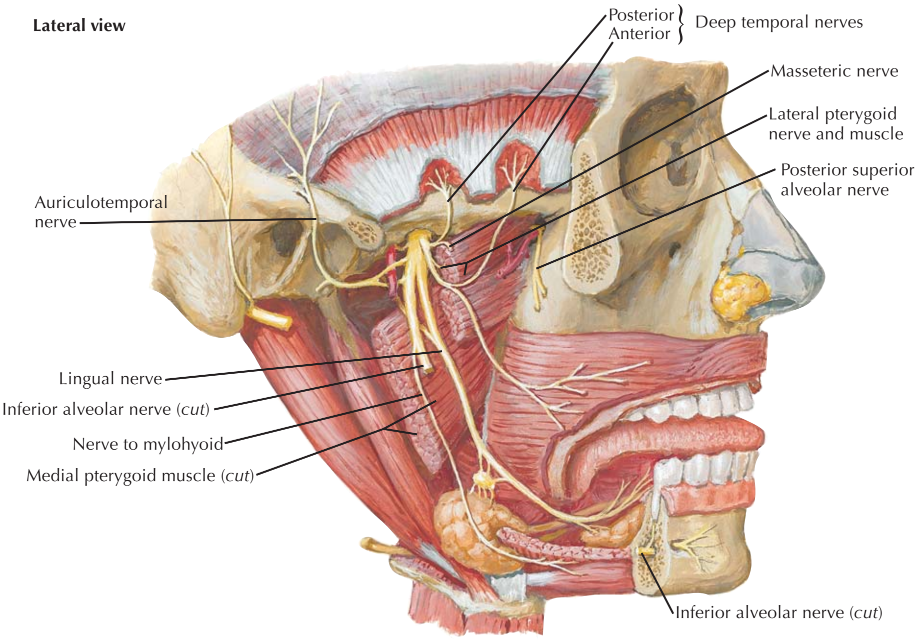
POSTERIOR DIVISION OF THE MANDIBULAR NERVE *CONTINUED*	
Branch	**Course**
Inferior alveolar	The largest branch of the mandibular division Descends following the inferior alveolar a. inferior to the lateral pterygoid and, finally, between the sphenomandibular lig. and the ramus of the mandible until it enters the mandibular foramen Innervates all mandibular teeth and the gingiva from the premolars anteriorly to the midline
Mylohyoid	Branches from the inferior alveolar n. immediately before it enters the mandibular foramen Descends in a groove on the deep side of the ramus of the mandible until it reaches the superficial surface of the mylohyoid m. Supplies the mylohyoid m. and the anterior belly of the digastric m.

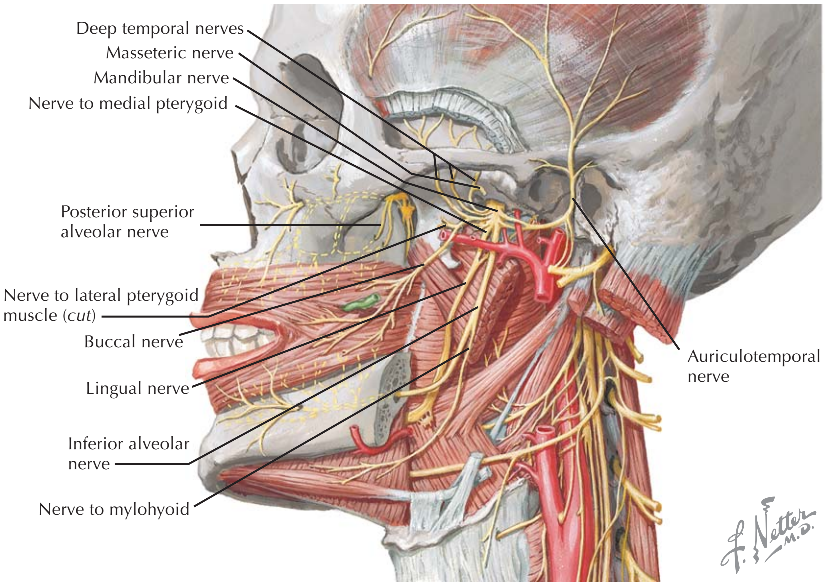
MAXILLARY NERVE	
Branch	**Course**
Posterior superior alveolar	Passes through the pterygomaxillary fissure to enter the infratemporal fossa In the infratemporal fossa, it passes on the posterior surface of the maxilla along the region of the maxillary tuberosity Gives rise to a gingival branch that innervates the buccal gingiva alongside the maxillary molars Enters the posterior surface of the maxilla and supplies the maxillary sinus and the maxillary molars with the possible exception of the mesiobuccal root of the first maxillary molar



Contents of the Infratemporal Fossa

NERVOUS STRUCTURES *CONTINUED*





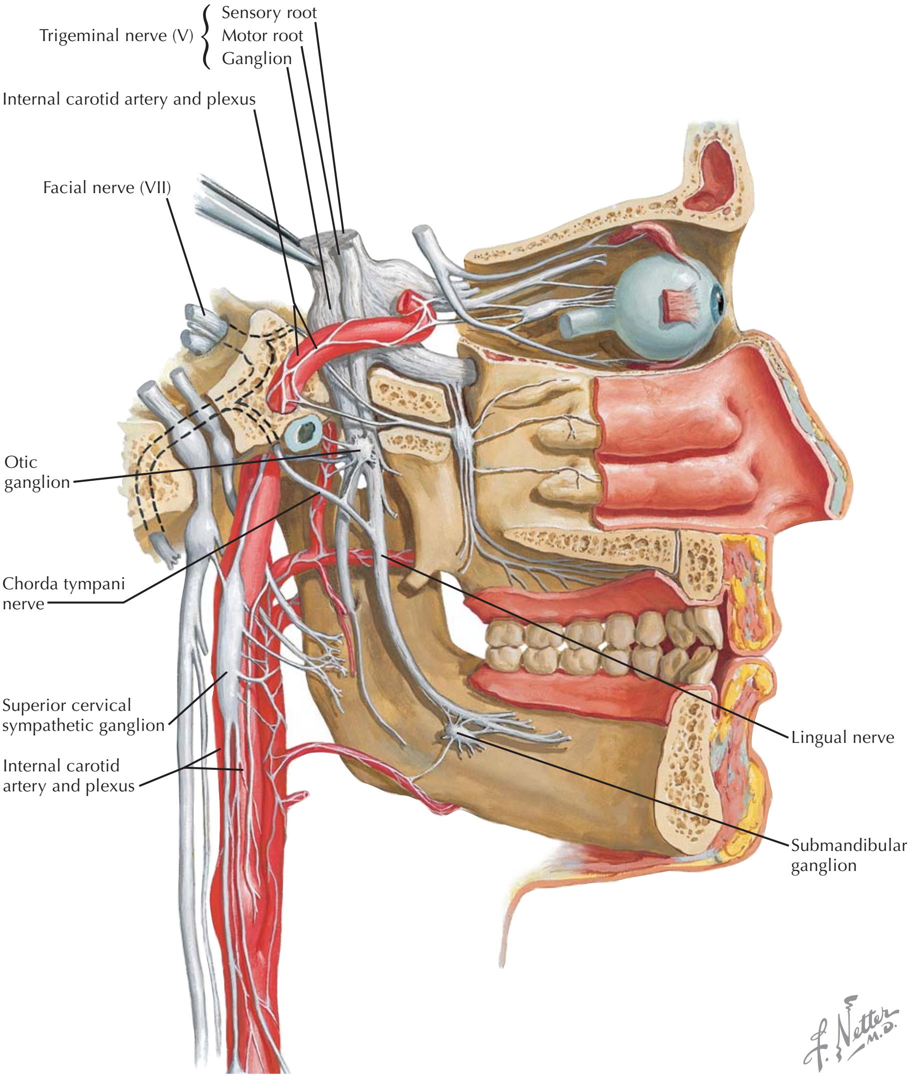
Contents of the Infratemporal Fossa

NERVOUS STRUCTURES *CONTINUED*

CHORDA TYMPANI, LESSER PETROSAL NERVE, AND OTIC GANGLION

Nerve	Source	Course
Chorda tympani	Branch from the facial n. in the tympanic cavity	Carries the preganglionic parasympathetic fibers to the submandibular ganglion and taste fibers to the anterior 2/3 of the tongue Passes anteriorly to enter the tympanic cavity and lies along the tympanic membrane and malleus until exiting the petrotympanic fissure Once it exits the petrotympanic fissure, it joins the posterior border of the lingual n. in the infratemporal fossa The lingual n. is distributed to the anterior 2/3 of the tongue and the SVA* fibers from the chorda tympani travel to the taste buds in this region
Lesser petrosal	Tympanic plexus along the promontory of the ear re-forms as the lesser petrosal n.	Forms in the middle ear cavity Carries the preganglionic parasympathetic (from the tympanic branch of IX) and postganglionic sympathetic (from the caroticotympanic branch of the internal carotid a. plexus) that are traveling to the parotid gland The nerve passes along the groove for the lesser petrosal n. on the petrous portion of the temporal bone toward the foramen ovale Normally enters the infratemporal fossa by passing through the foramen ovale Joins the otic ganglion
Nerve Cell Body	**Characteristics of the Cell Body**	**Course**
Otic ganglion	A collection of nerve cell bodies located in the infratemporal fossa This very small stellate-shaped ganglion is inferior to the foramen ovale and medial to the mandibular division of the trigeminal n.	Postganglionic parasympathetic fibers arise in the otic ganglion and travel to the auriculotemporal branch of the trigeminal n. Auriculotemporal n. travels to the parotid gland These postganglionic parasympathetic fibers innervate the: Parotid gland—secretion of saliva

*SVA, special visceral afferent. See Chapter 3 for a discussion of the SVA and other functional columns.


Trigeminal nerve (V)
Sensory root
Motor root
Ganglion
Internal carotid artery and plexus
Facial nerve (VII)
Otic ganglion
Chorda tympani nerve
Superior cervical sympathetic ganglion
Internal carotid artery and plexus
Lingual nerve
Submandibular ganglion
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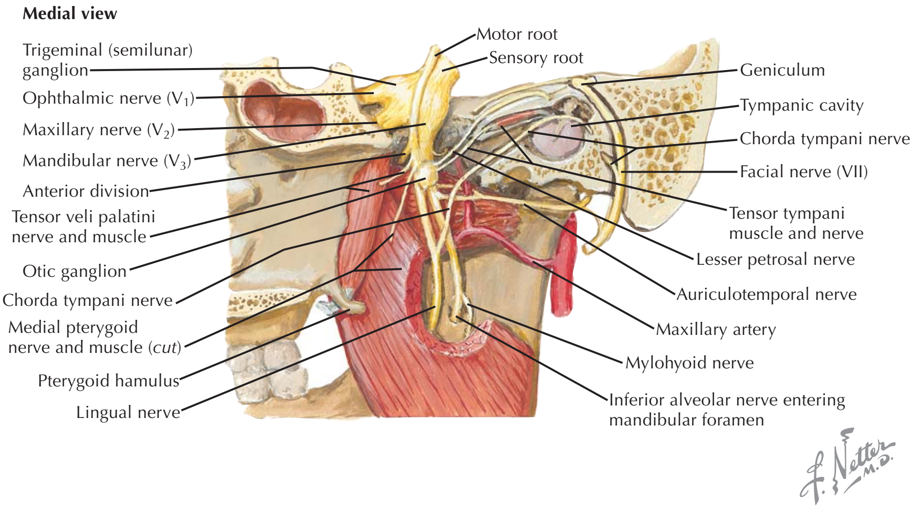
Contents of the Infratemporal Fossa

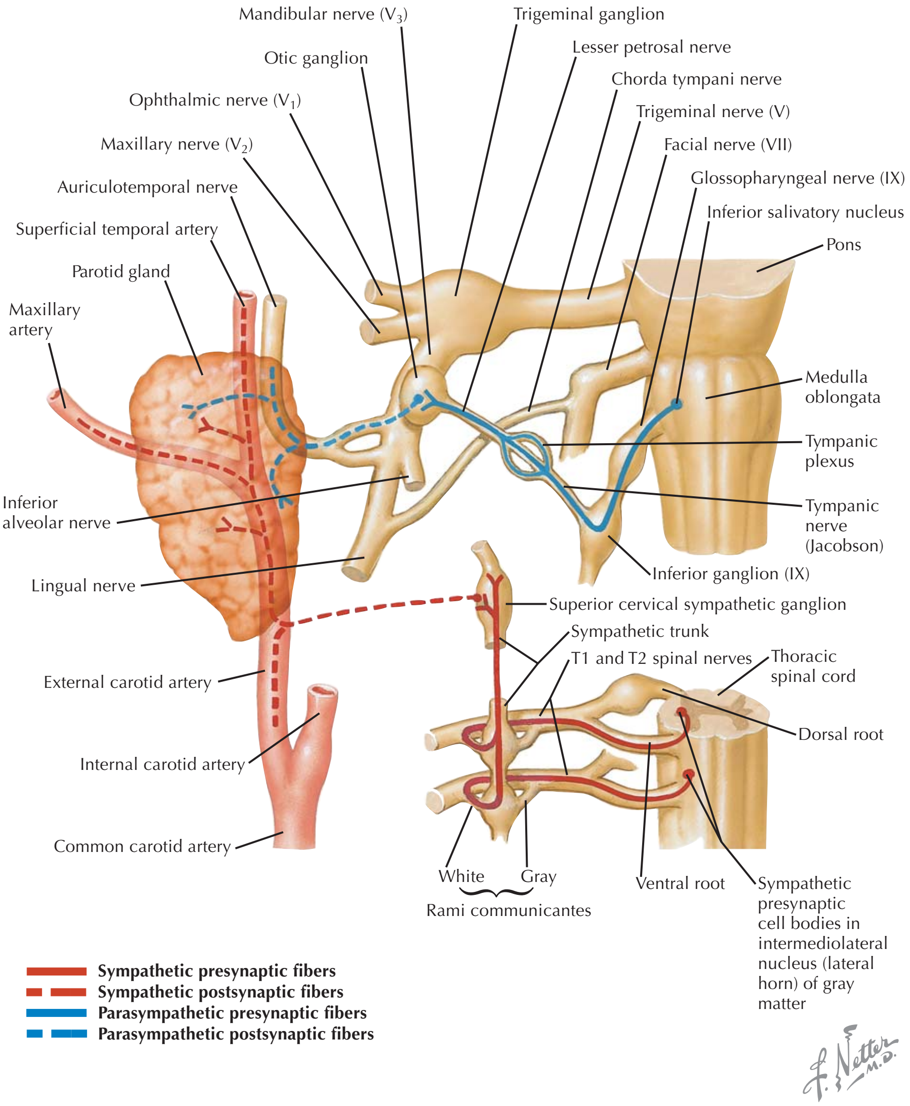
NERVOUS STRUCTURES *CONTINUED*



ANATOMIC PATHWAY FOR PARASYMPATHETICS OF THE PAROTID GLAND			
Type of Neuron	**Name of Cell Body**	**Characteristics of the Cell Body**	**Course of the Neuron**
Preganglionic neuron	Inferior salivatory nucleus	A collection of nerve cell bodies located in the medulla	Preganglionic parasympathetic fibers arise from the inferior salivatory nucleus in the medulla Travel through the glossopharyngeal n. and exit the jugular foramen The glossopharyngeal nerve gives rise to the tympanic branch of IX, which reenters the skull via the tympanic canaliculus Tympanic branch of IX forms the tympanic plexus along the promontory of the ear The plexus re-forms as the lesser petrosal n., which typically exits the foramen ovale to enter the infratemporal fossa Lesser petrosal n. joins the otic ganglion
Postganglionic neuron	Otic ganglion	A collection of nerve cell bodies This very small stellate-shaped ganglion is located inferior to the foramen ovale, medial to the mandibular division of the trigeminal n.	Postganglionic parasympathetic fibers arise in the otic ganglion These fibers travel to the auriculotemporal branch of the trigeminal n. Auriculotemporal n. travels to the parotid gland These postganglionic parasympathetic fibers innervate the: Parotid gland—secretion of saliva

7 Contents of the Infratemporal Fossa

NERVOUS STRUCTURES *CONTINUED*



CHAPTER 8

MUSCLES OF MASTICATION

8 Overview and Topographic Anatomy

GENERAL INFORMATION

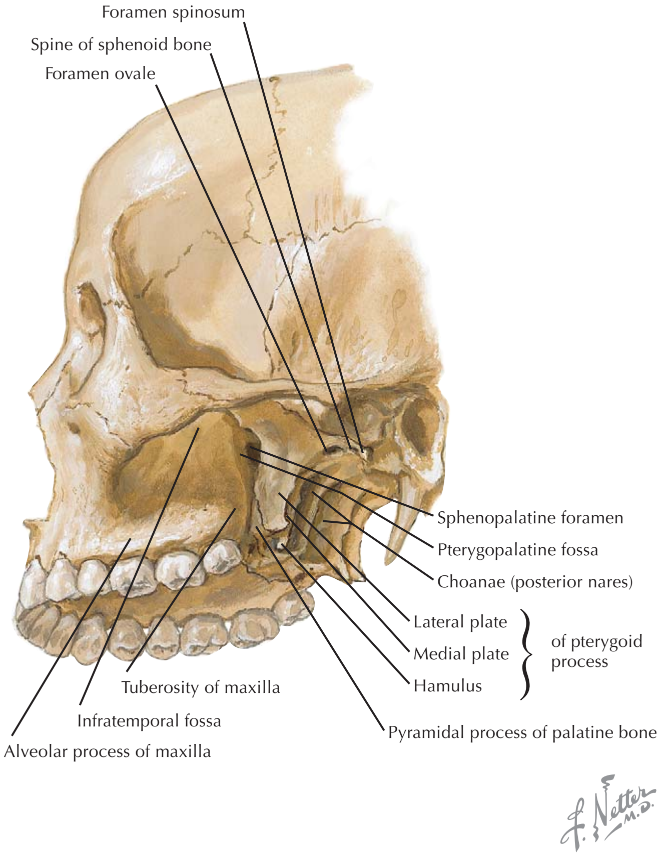
Mastication is the process of chewing food in preparation for deglutition (swallowing) and digestion

All muscles of mastication originate on the skull and insert on the mandible

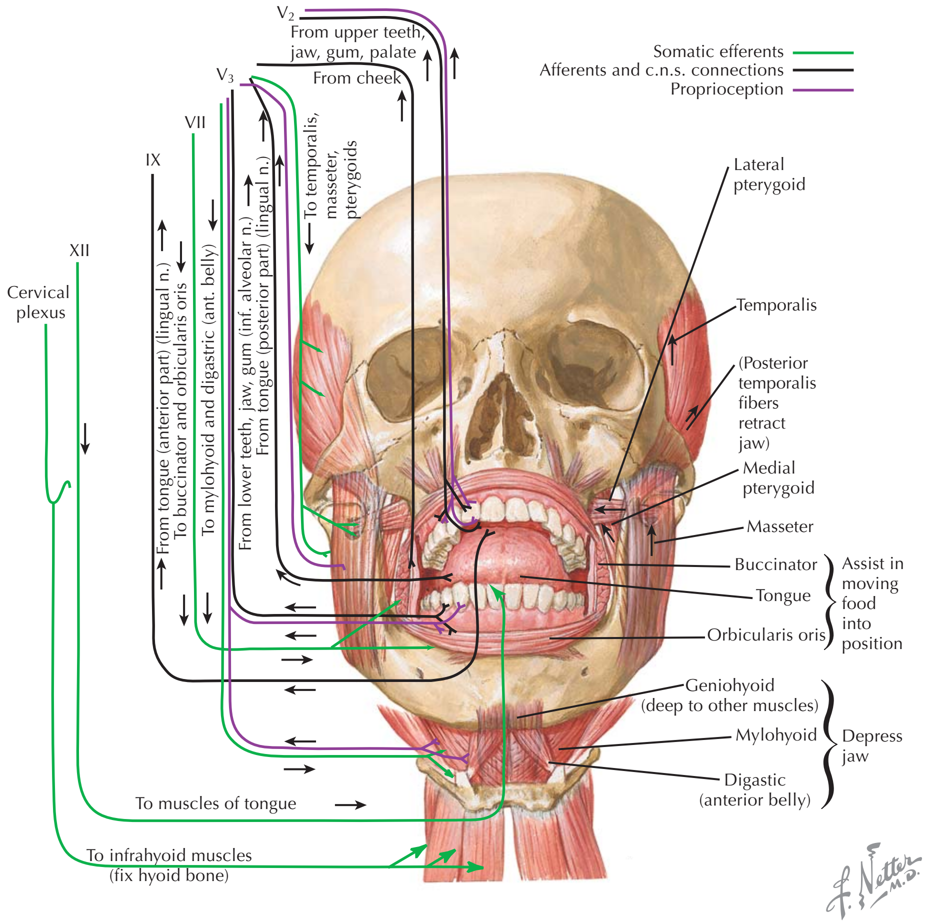
All muscles of mastication are innervated by the mandibular division of the trigeminal nerve

All muscles of mastication are derivatives of the 1st pharyngeal arch

Movements of the mandible are classified as:
- Elevation
- Depression
- Protrusion
- Retrusion
- Side-to-side excursion



GENERAL INFORMATION *CONTINUED*



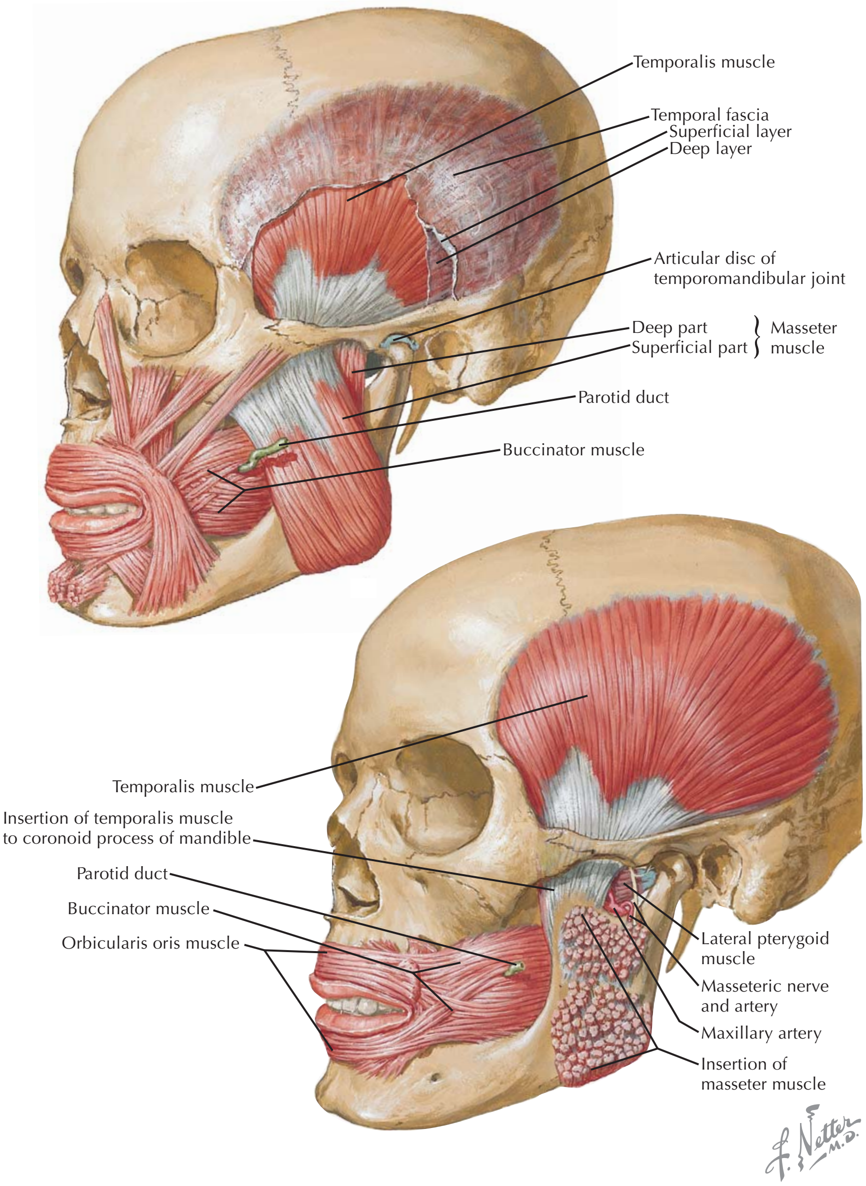
8 Muscles of Mastication

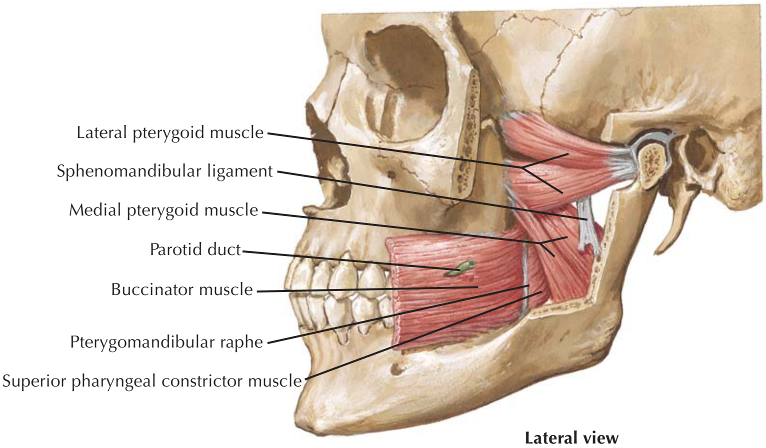
OVERVIEW

Muscle	Origin	Insertion	Main Actions	Nerve Supply	Comments
Masseter: superficial head (larger part)	Inferior border of the anterior 2/3 of the zygomatic arch	Angle of mandible Inferior and lateral parts of the mandibular ramus	Elevates mandible	Masseteric branch from the mandibular division of the trigeminal n.	Superficial head's fibers run posteroinferiorly The parotid duct, transverse facial a., and branches of the facial n. pass superficial to the masseter m.
Masseter: deep head (smaller part)	Medial border of the zygomatic arch Inferior border of the posterior 1/3 of the zygomatic arch	Superolateral mandibular ramus Coronoid process			
Temporalis	Entire temporal fossa: along the inferior temporal line including the temporal fascia	Coronoid process: along the apex, anterior and posterior borders, medial surface extending inferiorly on the anterior border of the mandibular ramus (temporal crest) to the 3rd molar tooth	Elevates mandible Retrudes mandible (posterior fibers)	Anterior and posterior deep temporal branches from the mandibular division of the trigeminal n.	The main postural muscle—maintains the mandible in rest position
Medial pterygoid: deep head	Medial surface of lateral pterygoid plate	Medial surface of ramus and angle of the mandible (pterygoid tubercles)	Elevate mandible Protrude mandible Lateral excursion of the mandible	Medial pterygoid branch from the mandibular division of the trigeminal n.	The deepest muscle of mastication
Medial pterygoid: superficial head	Maxillary tuberosity Pyramidal process of the palatine				
Lateral pterygoid: upper head	Greater wing of the sphenoid Infratemporal crest	Articular disc and capsule of the temporomandibular joint	Depress and protrude mandible Lateral excursion of the mandible	Lateral pterygoid branches (for each head) from the mandibular division of the trigeminal n., which exits the foramen ovale, lying medial to the lateral pterygoid	Maxillary a. runs either superficial or deep to it Surrounded by the pterygoid venous plexus Buccal branch of the trigeminal n. passes between the 2 heads
Lateral pterygoid: lower head	Lateral surface of the lateral pterygoid plate	Pterygoid fovea on the neck of the condyle of the mandible			

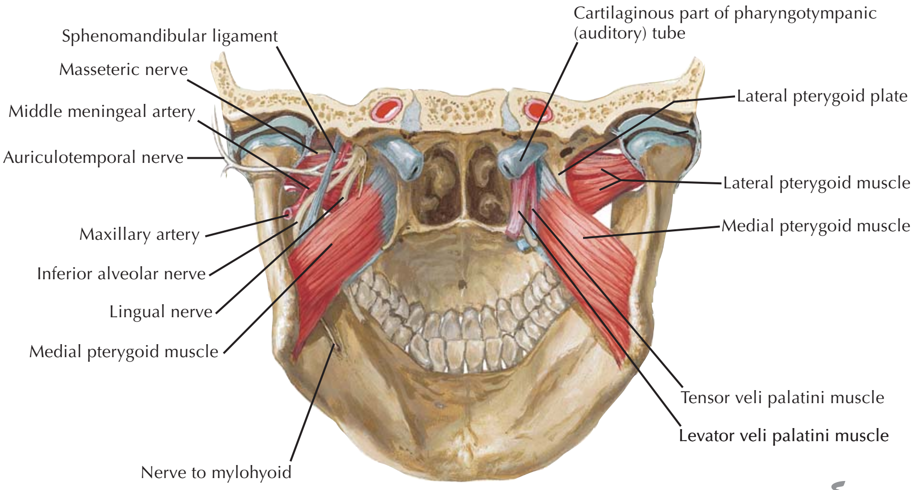
Muscles of Mastication

OVERVIEW *CONTINUED*





Lateral view



Posterior view

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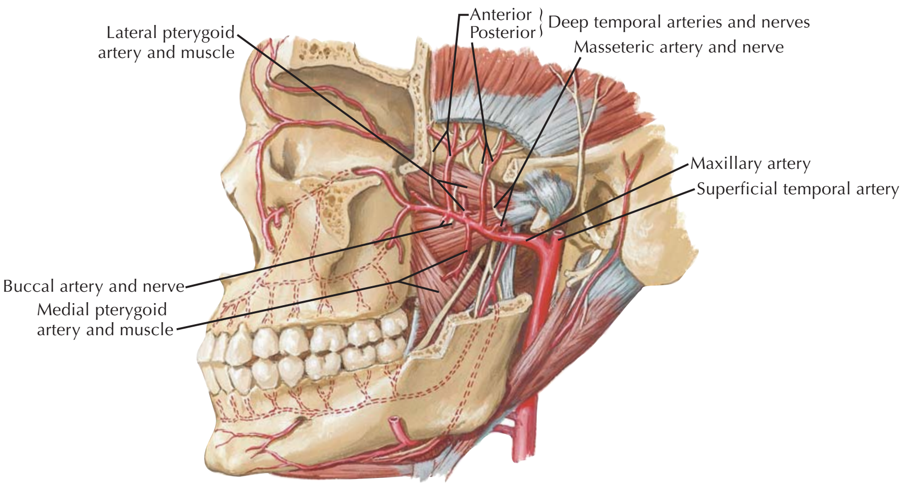
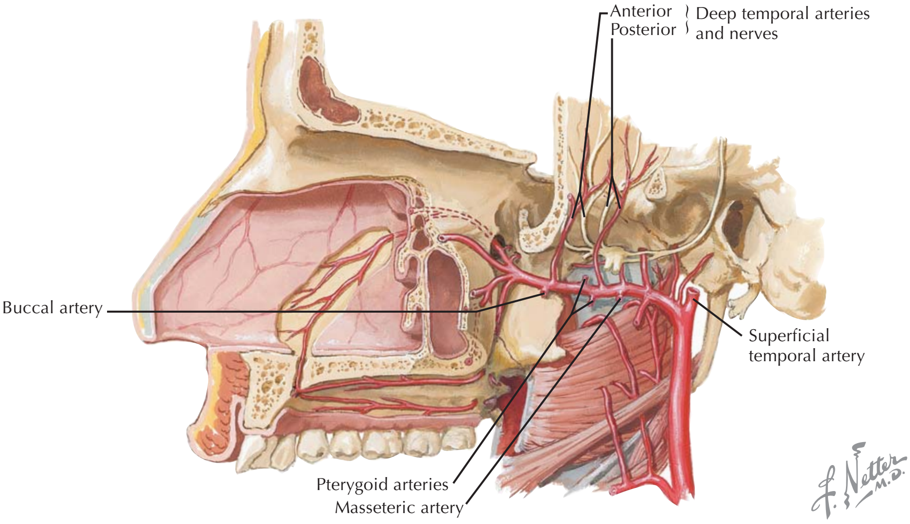
Vascular Supply

ARTERIAL SUPPLY

Artery	Source	Course
Maxillary	Larger of the 2 terminal branches of the external carotid a. (superficial temporal a. is the other terminal branch)	Arises posterior to the condylar neck of the mandible within the parotid gland Exits the parotid gland and passes anteriorly between the ramus of the mandible and the sphenomandibular ligament within the infratemporal fossa Takes a course that is either superficial or deep to the lateral pterygoid until reaching the pterygopalatine fossa via the pterygomaxillary fissure Supplies the deep structures of the face and is divided into 3 parts as it passes medially through the infratemporal fossa: • 1st part: mandibular • 2nd part: pterygoid • 3rd part: pterygopalatine 1st and 3rd parts do not supply the muscles of mastication 2nd part also feeds the buccinator m., which is not a muscle of mastication
2nd part: (pterygoid part)	External carotid a.	Passes obliquely in an anterior and superior direction between the ramus of the mandible and insertion of the temporalis m. Courses on the superficial surface of the lateral pterygoid m. to travel between the 2 heads of the muscle Provides the muscular branches to the muscles of mastication and the buccinator m. Gives rise to 5 branches: anterior and posterior deep temporal, masseteric, pterygoid branches, and buccal
• Anterior and posterior deep temporal	Pterygoid (2nd part of the maxillary a.)	Pass between the skull and the temporalis m. Supply the temporalis throughout their course While ascending, they anastomose with the middle temporal a. from the superficial temporal a.
• Masseteric		Typically arises between the neck of the mandible and the sphenomandibular lig. Passes laterally through the mandibular notch with the nerve Supplies the deep surface of the masseter
• Pterygoid		A branch of the pterygoid a. (2nd part of the maxillary a.) An irregular number of branches supply the medial and lateral pterygoids
• Buccal		A branch of the pterygoid a. (2nd part of the maxillary a.) A small artery that runs obliquely in an anterior direction between the medial pterygoid and the insertion of the temporalis m. until it reaches the outer surface of the buccinator, which it supplies
Middle temporal	Superficial temporal a. after it passes superior to the root of the zygomatic arch	Passes deep into the temporalis fascia and temporalis m. Anastomoses with the anterior and posterior deep temporal vessels
Transverse facial	Superficial temporal a. before it exits the parotid gland	Passes transversely to exit the gland Passes immediately superior to the parotid duct across the masseter m. and face, providing vascular supply along the way


Lateral pterygoid artery and muscle
Anterior
Posterior
Deep temporal arteries and nerves
Masseteric artery and nerve
Maxillary artery
Superficial temporal artery
Buccal artery and nerve
Medial pterygoid artery and muscle


Anterior
Posterior
Deep temporal arteries and nerves
Buccal artery
Superficial temporal artery
Pterygoid arteries
Masseteric artery
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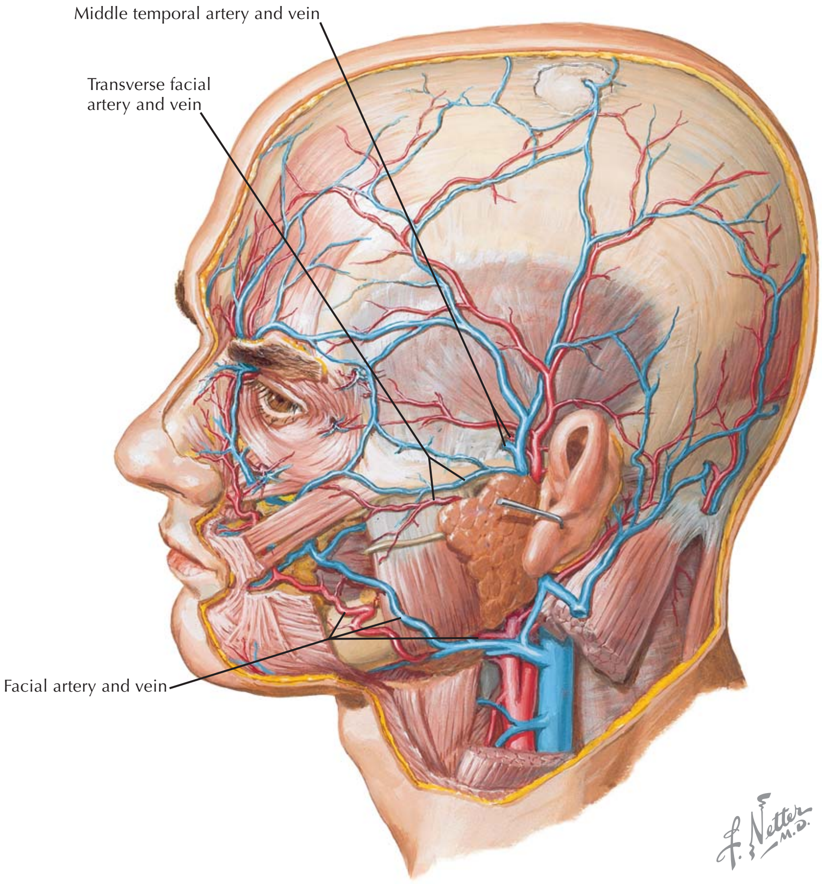
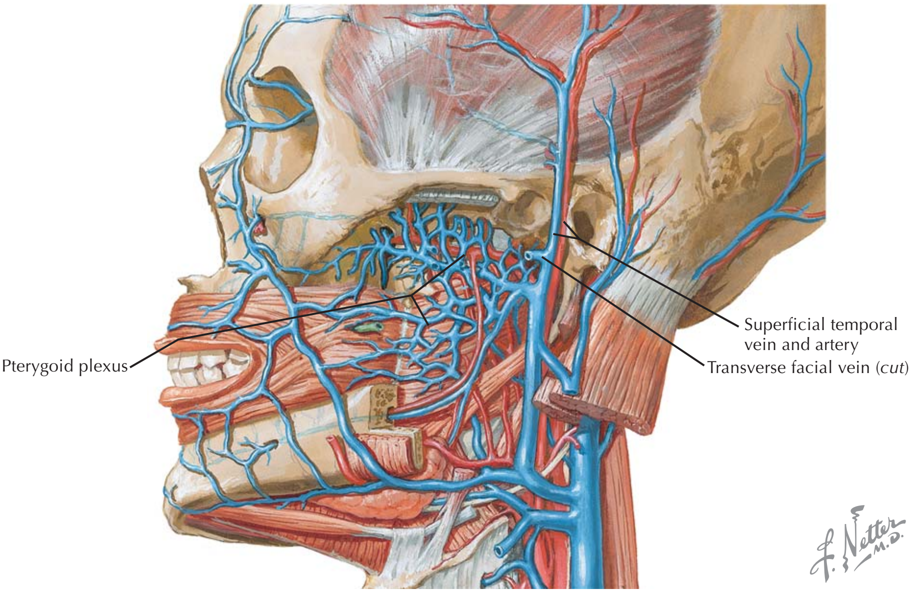
Vascular Supply

ARTERIAL SUPPLY *CONTINUED*



VENOUS DRAINAGE

Vein	Course
Pterygoid plexus	An extensive network of veins that parallel the 2nd and 3rd parts of the maxillary a. Receives branches that correspond with the same branches of the maxillary a. Tributaries of the pterygoid plexus eventually converge to form a short maxillary v. Communicates with the cavernous sinus, pharyngeal venous plexus, facial v. via the deep facial v., and ophthalmic vv.
Middle temporal	Arises from deep within the temporalis m. and fascia, where it anastomoses with the anterior and posterior deep temporal vessels Joins the superficial temporal v. immediately before it passes inferior to the root of the zygomatic arch
Transverse facial	Travels posteriorly to enter the parotid gland and join the superficial temporal v.
Anterior and posterior deep temporal	Join the pterygoid plexus of veins Also communicate with the middle temporal v.
Masseteric	Join the pterygoid plexus of veins
Pterygoid	
Buccal	

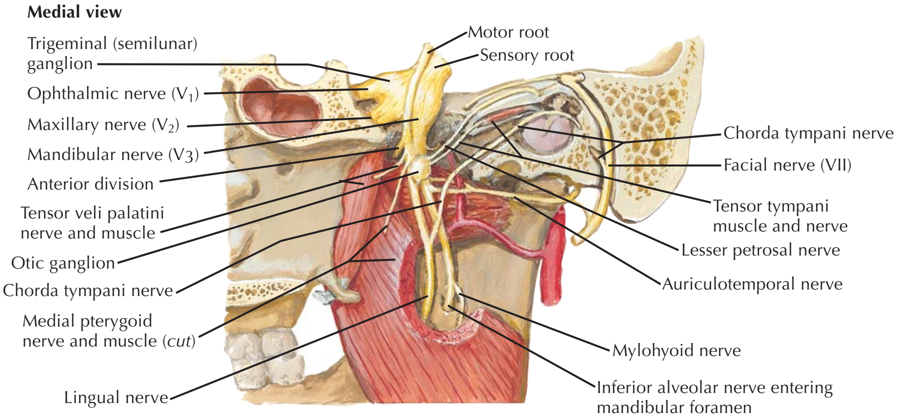


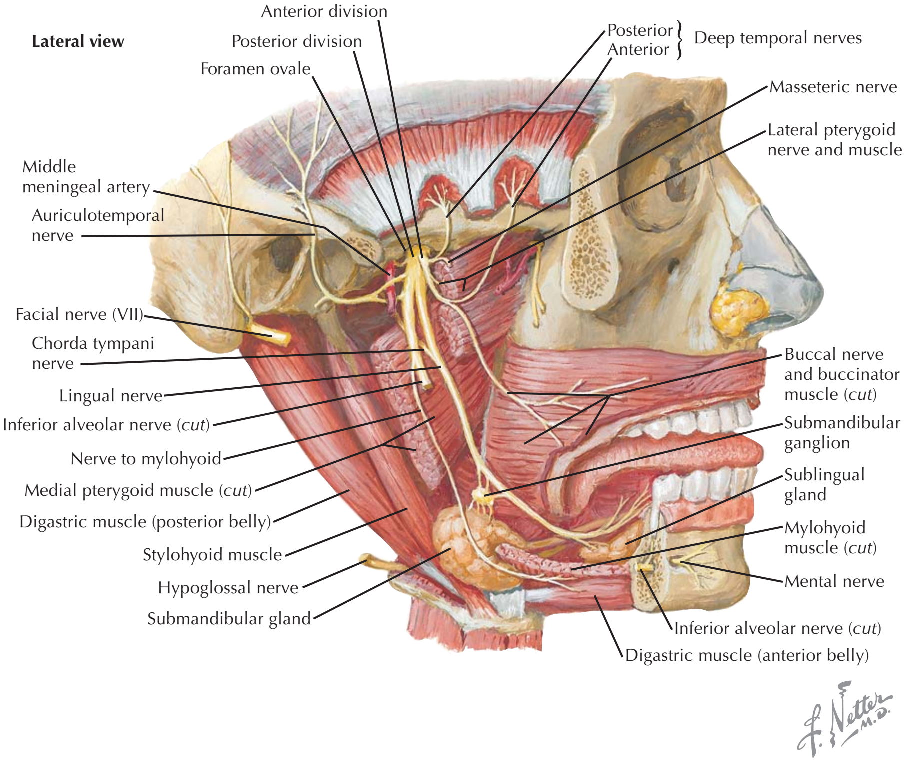
Nerve Supply

MOTOR BRANCHES OF THE TRIGEMINAL NERVE

Nerve	Source	Course
Mandibular division of the trigeminal	Largest of the 3 divisions of the trigeminal n. Created by a large sensory and a small motor root that unite just after passing through the foramen ovale to enter the infratemporal fossa	Immediately gives rise to 4 branches: meningeal, medial pterygoid, tensor tympani, and tensor veli palatini Divides into anterior and posterior divisions Anterior division (smaller)—mainly motor with 1 sensory branch (buccal n.) Posterior division (larger)—mainly sensory with 1 motor branch (mylohyoid n.)
Anterior and posterior deep temporal	The anterior part of the mandibular division of the trigeminal n. The anterior deep temporal n. sometimes arises from the buccal n.	Pass superior to the lateral pterygoid m. between the skull and the temporalis m. while passing deep to the temporalis to innervate it Innervates the temporalis
Masseteric	Arises from the anterior part of the mandibular division of the trigeminal n., but occasionally arises from a common branch with the posterior deep temporal n.	Runs superior to the lateral pterygoid m. and continues on the lateral aspect of the muscle as it approaches the mandible Lies anterior to the temporomandibular joint and posterior to the tendon of the temporalis m. Passes though the masseteric notch with the masseteric vessels Enters the masseter m.'s deep surface to innervate it Also provides a small branch to the temporomandibular joint
Medial pterygoid	Arises from the undivided trunk created by the large sensory and the small motor root of the mandibular division of the trigeminal n.	Passes through the otic ganglion to provide motor and proprioceptive innervation to the medial pterygoid m. Passes anteriorly and inferiorly to enter the medial pterygoid Connected to the otic ganglion but does not form a synapse at the ganglion
Lateral pterygoid	Arises from the anterior part of the mandibular division of the trigeminal n., but sometimes arises as a branch from the buccal n.	These branches, 1 for each muscular head, enter the deep surface of the lateral pterygoid m. to innervate it

MOTOR BRANCHES OF THE TRIGEMINAL NERVE *CONTINUED*


Medial view


Lateral view

Clinical Correlate

MASTICATION

Mastication prepares food by chewing for deglutition and digestion

It is the first step in the breakdown of food by:
- Making smaller pieces from larger pieces (thus increasing the surface area for digestive breakdown)
- Helping soften and lubricate the food with saliva

BONES INVOLVED

Base of the skull and the mandible

They articulate at the temporomandibular joint (between the squamous portion of the temporal bone [skull] and the condyle of the mandible)

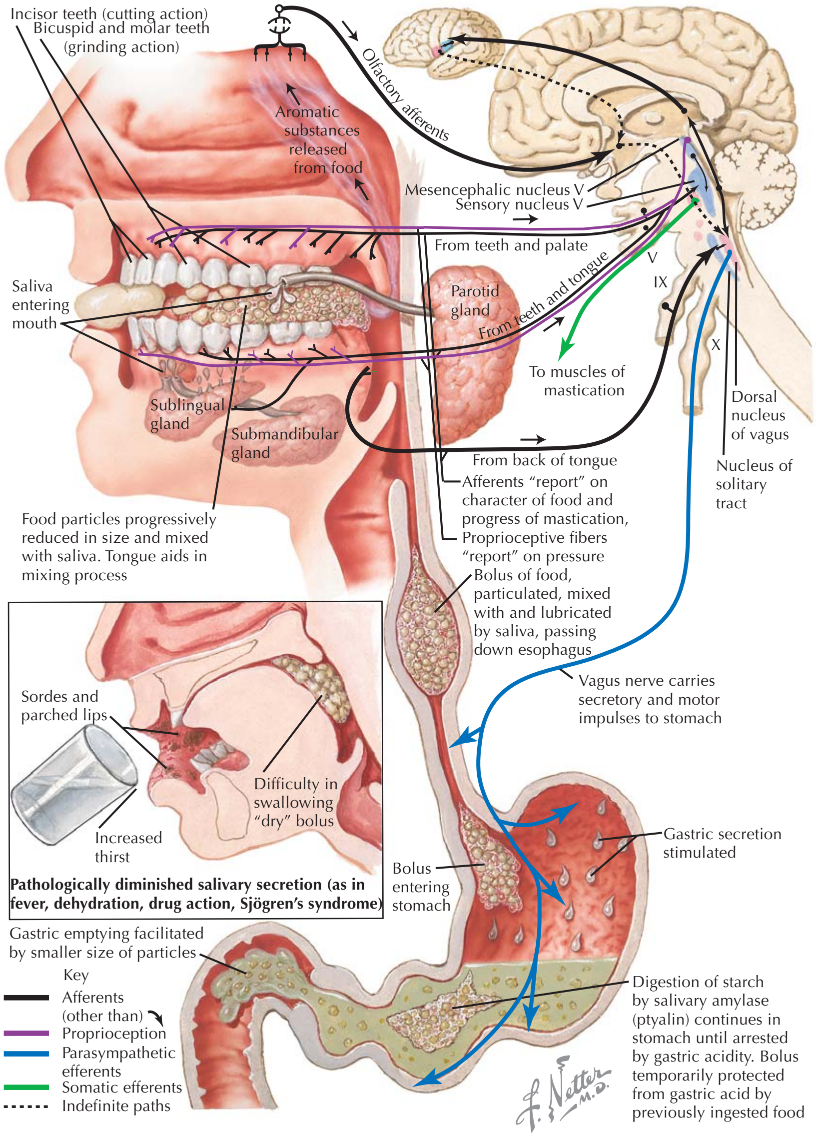
MUSCLES INVOLVED

4 muscles of mastication:
- Masseter
- Temporalis
- Medial pterygoid
- Lateral pterygoid

All muscles of mastication are innervated by the mandibular division of the trigeminal nerve (nerve of the first pharyngeal arch)

Mastication involves using the muscles of mastication to move the mandible in 1 of 3 planes in an antagonistic fashion:
- Elevation/depression
- Protrusion/retrusion
- Side-to-side excursion

Although the buccinator is not a muscle of mastication, it aids in keeping the bolus of food against the teeth to help in mastication


Incisor teeth (cutting action)
Bicuspid and molar teeth (grinding action)
Aromatic substances released from food
Olfactory afferents
Mesencephalic nucleus V
Sensory nucleus V
From teeth and palate
V
IX
Saliva entering mouth
Parotid gland
From teeth and tongue
To muscles of mastication
X
Dorsal nucleus of vagus
Sublingual gland
Submandibular gland
From back of tongue
Nucleus of solitary tract
Afferents "report" on character of food and progress of mastication,
Proprioceptive fibers "report" on pressure
Food particles progressively reduced in size and mixed with saliva. Tongue aids in mixing process
Bolus of food, particulated, mixed with and lubricated by saliva, passing down esophagus
Sordes and parched lips
Vagus nerve carries secretory and motor impulses to stomach
Difficulty in swallowing "dry" bolus
Increased thirst
Pathologically diminished salivary secretion (as in fever, dehydration, drug action, Sjögren's syndrome)
Gastric secretion stimulated
Bolus entering stomach
Gastric emptying facilitated by smaller size of particles
Key
Afferents (other than)
Proprioception
Parasympathetic efferents
Somatic efferents
Indefinite paths
Digestion of starch by salivary amylase (ptyalin) continues in stomach until arrested by gastric acidity. Bolus temporarily protected from gastric acid by previously ingested food
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CHAPTER 9

TEMPOROMANDIBULAR JOINT

9 Overview and Topographic Anatomy

GENERAL INFORMATION

The *temporomandibular joint* (TMJ) is the articulation between the squamous portion of the temporal bone and the condyle of the mandible

Structural Components

The TMJ comprises 2 types of synovial joints—*hinge* and *sliding*—and consists of the following:

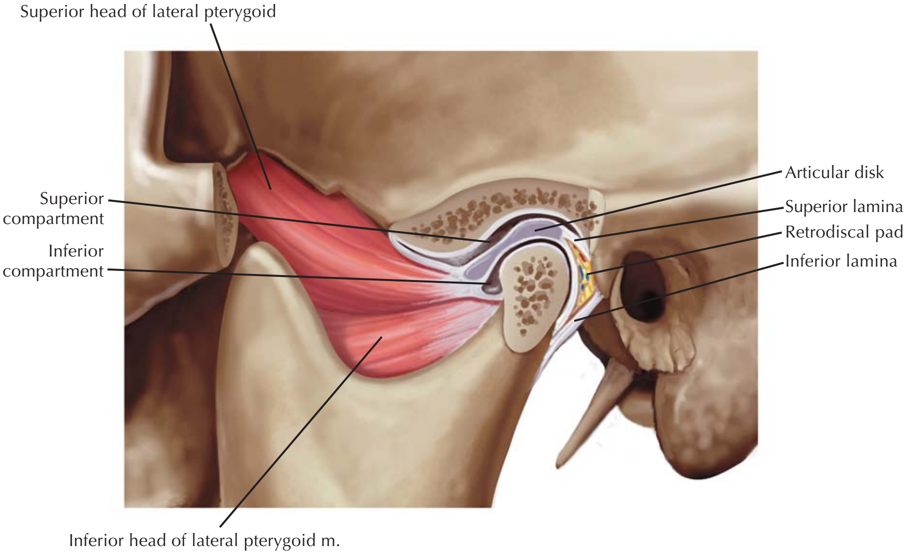
- Squamous portion of the temporal bone
- Articular disc (contained within the TMJ)
- Condyle of the mandible
- Ligaments (serve as boundaries)

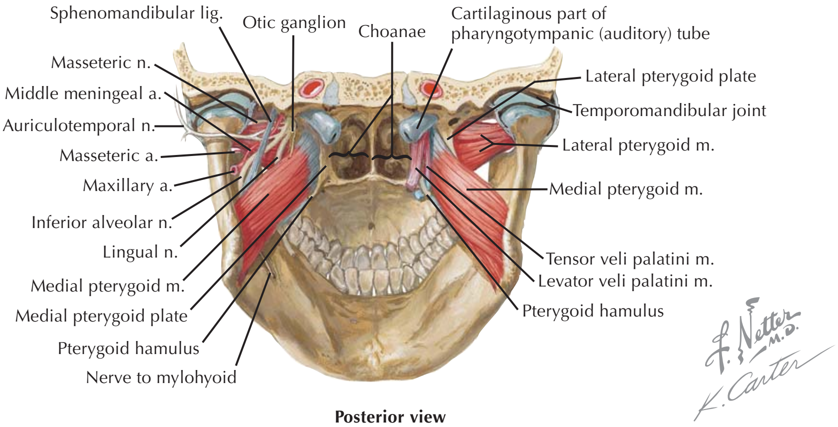
TMJ Dysfunction

Affects approximately 25% of the population and may be severe in a small subgroup

Causes include arthritis, trauma, infection, bruxism, and disc displacement

More common in females





Posterior view

Anatomy

ANATOMIC FEATURES

Feature	Comments
Squamous portion of the temporal bone	The TMJ articulation is located on the squamous portion of the temporal bone Has an avascular articular surface composed of fibrous connective tissue instead of hyaline cartilage The main load-bearing areas are on the lateral aspect of the squamous portion, condyle, and articular disc The dense fibrous connective tissue is thickest in the load-bearing areas Relations of the squamous portion of the temporal bone: ● Anterior—articular eminence becoming the articular tubercle ● Intermediate—glenoid fossa ● Posterior—tympanic plate tapering to the postglenoid tubercle Articular Eminence The strong bony prominence on the base of the zygomatic process Articular Tubercle Located on the lateral part of the articular eminence Provides attachment for the capsule and lateral temporomandibular ligament Glenoid Fossa The depression into which the condyle is located Superior to this thin plate of bone is the middle cranial fossa Tympanic Plate The vertical plate located anterior to the external auditory meatus Postglenoid Tubercle An inferior extension of the squamous portion of the temporal bone Makes the posterior aspect of the glenoid fossa Provides attachment for the capsule and retrodiscal pad
Mandibular condyles	Articulate with the articular disc Shaped like footballs: ● Mediolateral—20 mm ● Anteroposterior—10 mm Articular surface is avascular fibrous connective tissue instead of hyaline cartilage The main load-bearing areas are on the lateral aspect
Articular disc	Composed of dense fibrous connective tissue Located between the squamous portion of the temporal bone and the condyle Is avascular and aneural in its central part but is vascular and innervated in the peripheral areas, where load-bearing is minimal The main load-bearing areas are located on the lateral aspect; this is an area of potential perforation Merges around its periphery, attaching to the capsule Divided into 3 bands: ● Anterior—this thick band lies just anterior to the condyle with the mouth closed ● Intermediate—this band, the thinnest part, is located along the articular eminence with the mouth closed ● Posterior—this thick band is located superior to the disc with the mouth closed Additional attachments: ● Medial/lateral—strong medial and lateral collateral ligaments anchor the disc to the condyle ● Anterior—the disc is attached to the capsule and the superior head of the lateral pterygoid, but not the condyle, allowing the disc to rotate over the condyle in an anteroposterior direction ● Posterior—the disc is contiguous with the bilaminar zone that blends with the capsule

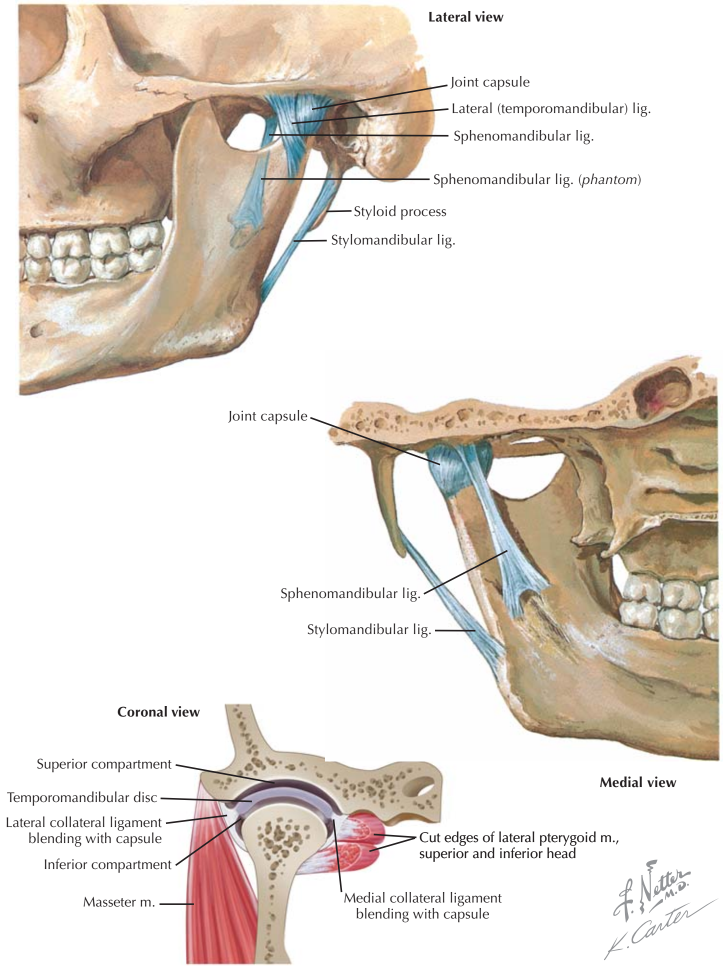
ANATOMIC FEATURES *CONTINUED*

Feature	Comments
Bilaminar zone (posterior attachment complex)	A bilaminar structure located posterior to the articular disc Highly distortable, especially on opening the mouth Composed of: • Superior lamina—contains elastic fibers and anchors the superior aspect of the posterior portion of the disc to the capsule and bone at the postglenoid tubercle and tympanic plate • Retrodiscal pad—the highly vascular and neural portion of the TMJ, made of collagen, elastic fibers, fat, nerves, and blood vessels (a large venous plexus fills with blood when the condyle moves anteriorly) • Inferior lamina—contains mainly collagen fibers and anchors the inferior aspect of the posterior portion of the disc to the condyle
TMJ compartments	**Overview** The articular disc divides the TMJ into superior and inferior compartments The internal surface of both compartments contain specialized endothelial cells that form a synovial lining that produces synovial fluid, making the TMJ a synovial joint Synovial fluid acts as: • A lubricant • An instrument for providing the metabolic requirements to the articular surfaces of the TMJ **Superior Compartment** Between the squamous portion of the temporal bone and the articular disc Volume = 1.2 mL Provides for the translational movement of the TMJ **Inferior Compartment** Between the articular disc and the condyle Volume = 0.9 mL Provides for the rotational movement of the TMJ
Capsule	Completely encloses the articular surface of the temporal bone and the condyle Composed of fibrous connective tissue Toughened along the medial and lateral aspects by ligaments Lined by a highly vascular synovial membrane Has various sensory receptors including nociceptors Attachments: • Superior—along the rim of the temporal articular surfaces • Inferior—along the condylar neck • Medial—blends along the medial collateral lig. • Lateral—blends along the lateral collateral lig. • Anterior—blends with the superior head of the lateral pterygoid m. • Posterior—along the retrodiscal pad
Ligaments	**Collateral Ligaments** • Composed of 2 ligaments: *Medial collateral ligament*—connects the medial aspect of the articular disc to the medial pole of the condyle *Lateral collateral ligament*—connects the lateral aspect of the articular disc to the lateral pole of the condyle • Frequently called the discal ligaments • Composed of collagenous connective tissue; thus, they do not stretch **Temporomandibular (Lateral) Ligament** • The thickened ligament on the lateral aspect of the capsule • Prevents lateral and posterior displacement of the condyle • Composed of 2 separate bands: *Outer oblique part*—largest portion; attached to the articular tubercle; travels posteroinferiorly to attach immediately inferior to the condyle; this limits the opening of the mandible

Anatomy

ANATOMIC FEATURES *CONTINUED*

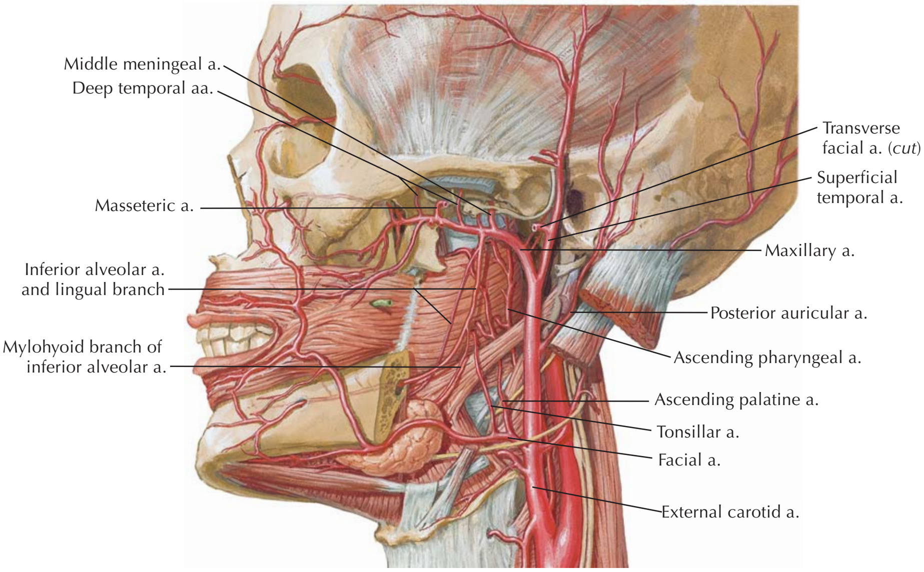
Feature	Comments
Ligaments	*Inner horizontal part*—smaller band attached to the articular tubercle running horizontally to attach to the lateral part of the condyle and disc; this limits posterior movement of the articular disc and the condyle **Stylomandibular Ligament** - Composed of a thickening of deep cervical fascia - Extends from the styloid process to the posterior margin of the angle and the ramus of the mandible - Helps limit anterior protrusion of the mandible **Sphenomandibular Ligament** - Remnant of Meckel's cartilage - Extends from the spine of the sphenoid to the lingula of the mandible - May help act as a pivot on the mandible by maintaining the same amount of tension during both opening and closing of the mouth

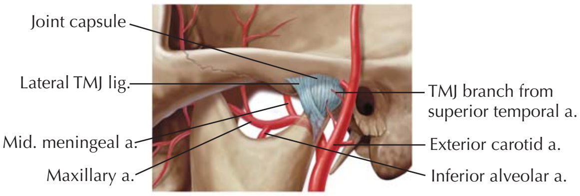


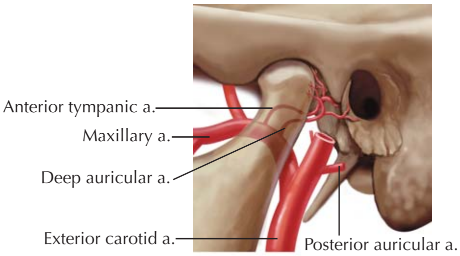
9 Vascular Supply

ARTERIAL SUPPLY

Artery	Source	Course
Superficial temporal	Terminal branch of the external carotid a.	Begins in the parotid gland and initially is located posterior to the mandible, where it provides small branches to the TMJ
Deep auricular	Maxillary a.	Arising in the same area as that of the anterior tympanic a. Lies in the parotid gland, posterior to the TMJ, where it gives branches to the TMJ
Anterior tympanic		Arising in the same area as that of the deep auricular a. Passes superiorly behind the TMJ to enter the tympanic cavity through the petrotympanic fissure, where it gives branches to the TMJ





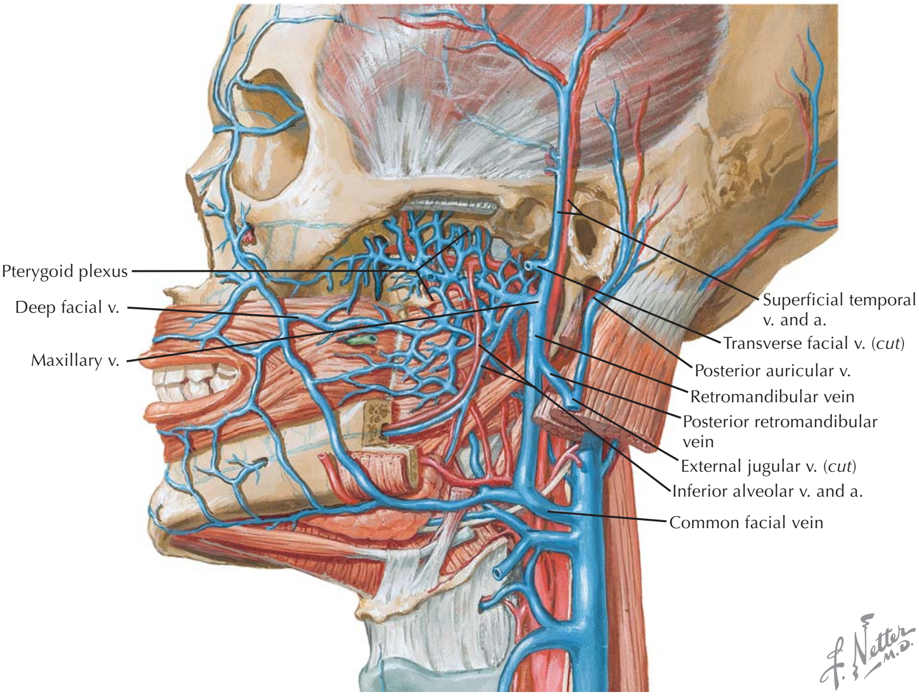


F. Netter M.D.
K. Carter

Vascular Supply

VENOUS DRAINAGE

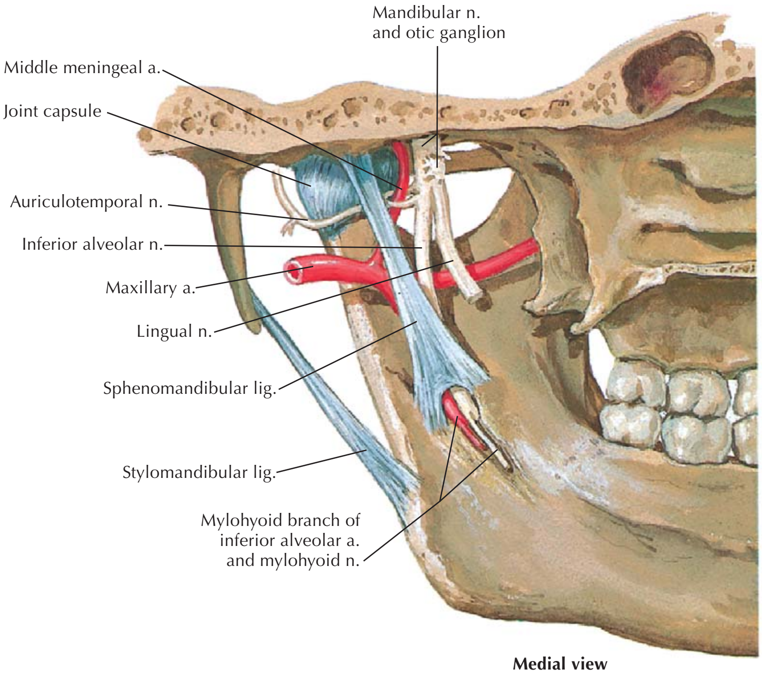
Vein	Course
Superficial temporal	Receives some branches from the TMJ Then joins the maxillary v. to form the retromandibular v.
Maxillary	Receives some branches from the TMJ Joins the superficial temporal v. to form the retromandibular v.



9 Nerve Supply

SENSORY INNERVATION

Nerve	Source	Comment
Auriculotemporal	Mandibular division of the trigeminal n.	From the posterior division of the mandibular division of the trigeminal n. Splits around the middle meningeal a. and passes between the sphenomandibular lig. and the condylar neck Supplies sensory branches all along the capsule Sensory but carries autonomic function to the parotid gland
Masseteric	Anterior division of the mandibular division of the trigeminal n.	Lies anterior to the TMJ and provides branches to the joint before passing over the masseteric notch to reach the masseter m. Sensory branches aid the auriculotemporal n.
Posterior deep temporal		Lies anterior to the TMJ and provides branches to the joint before innervating the temporalis m. Sensory branches aid the auriculotemporal n. in supplying the anterior part of the TMJ Mainly motor, but carries additional sensory function to the TMJ



Medial view

F. Netter M.D.

Clinical Correlate

OPENING THE MANDIBLE

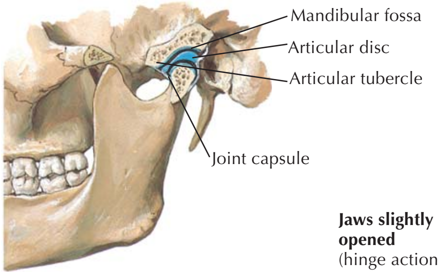
Opening the mandible involves a complex series of movements

Initial movement is *rotational,* which occurs in the lower TMJ compartment:

- Lateral pterygoid (inferior head) initiates the opening of the jaw (the superior head of the lateral pterygoid is described as being active during elevation of the mandible in a “power stroke”)
- As the mandible is depressed, the medial and collateral ligaments tightly attach the condyle to the articular disc, thereby allowing only for rotational movement
- Once the TMJ becomes taut, no further rotation of the condyle can occur
- Normally, rotational movement continues until the upper and the lower teeth are about 20 mm away from each other

For additional movement of the mandible, *translational* movement must occur:

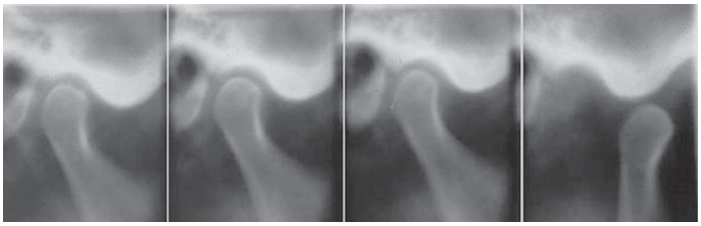
- A translational movement occurs in the upper TMJ compartment and provides for most of the mandible’s ability to open
- In this movement, the articular disc and the condyle complex slide inferiorly on the articular eminences, allowing for maximum depression of the mandible



Jaws closed

Jaws slightly opened (hinge action predominates)

Jaws widely opened (hinge and gliding action combined)



Clinical Correlate

MANDIBULAR DISLOCATION

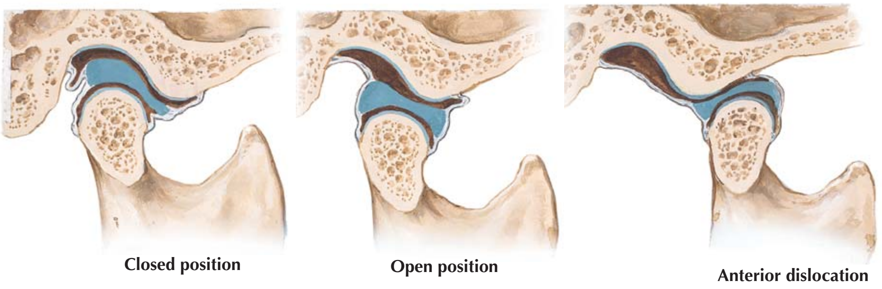
Mandibular dislocation (or subluxation of the TMJ) occurs when the condyle moves anterior to the articular eminence

- With dislocation, the mouth appears “wide open”
- Because the condyle is displaced anterior to the articular eminence, a depression can be palpated posterior to the condyle

Spontaneous dislocations can occur from a variety of actions ranging from an extended dental treatment to a simple yawn

Because the mandible is dislocated, the patient has a great deal of difficulty verbalizing his or her predicament

Relocation involves repositioning the condyle posterior to the articular eminence


Closed position

Open position

Anterior dislocation

f. Netter M.D.

ARTHRITIS AND ANKYLOSIS

ARTHRITIS

Arthritis is the most common cause of pathologic changes in the TMJ

When rheumatoid arthritis occurs, usually both TMJs are affected, and other joints tend to be affected before the TMJ

Radiologic images in the *initial* disease stages show decreased joint space without osseous changes

Radiologic images in the *late* disease stages show decreased joint space with osseous changes, possibly including ankylosis

In osteoarthritis, causes include normal wear, trauma, and bruxism, and clinical manifestations may range from mild to severe

ANKYLOSIS

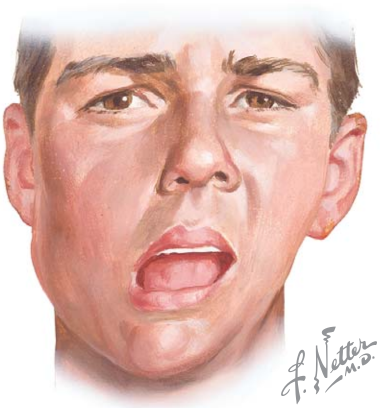
Ankylosis is an obliteration of the TMJ space with abnormal osseous morphologic features, which often occurs as a result of trauma or infection

Classified as either true (intracapsular) or false ankylosis (extracapsular condition usually associated with an abnormally large coronoid process or zygomatic arch)

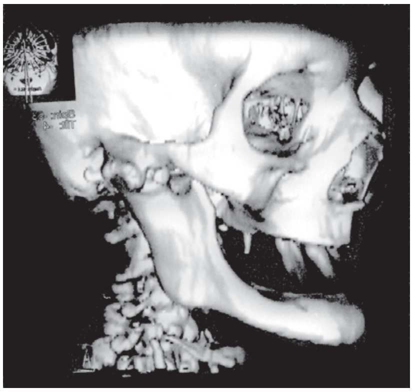
Treatment varies in accordance with the cause but may include a prosthetic replacement or condylectomy

Clinical Correlate

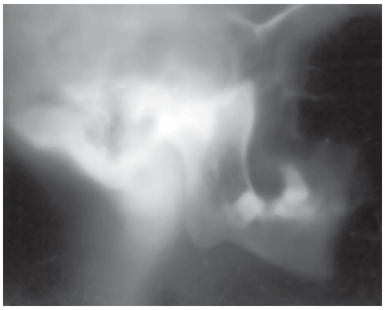
ARTHRITIS AND ANKYLOSIS *CONTINUED*



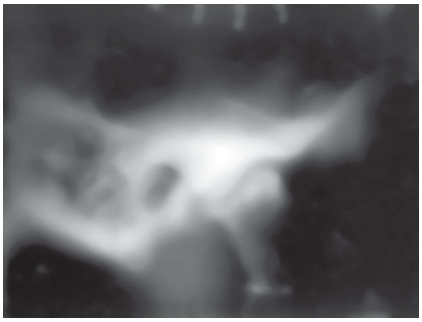
Unilateral ankylosis



Ankylosis



Ankylosis



Osteoarthritis

CHAPTER 10

PTERYGOPALATINE FOSSA

10 Overview and Topographic Anatomy

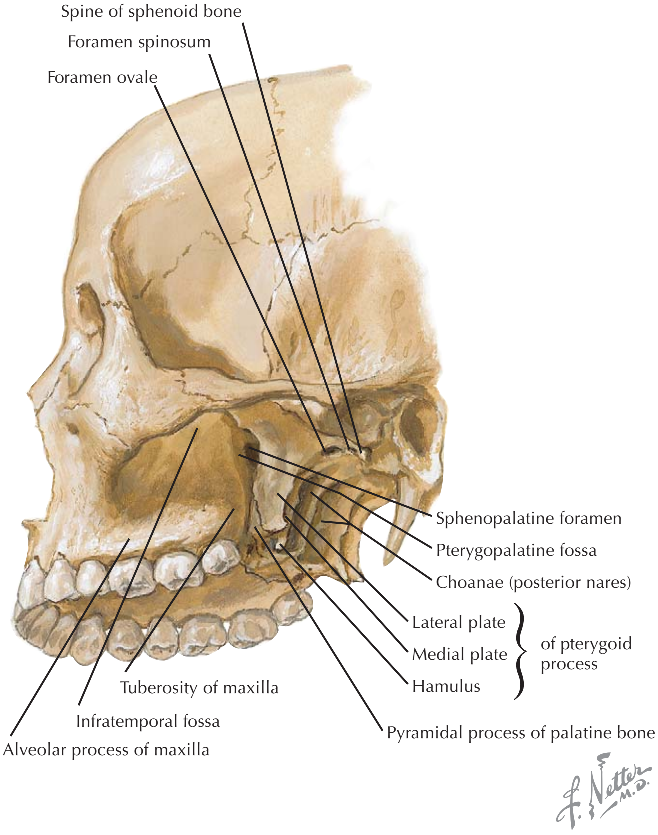
GENERAL INFORMATION

Pyramid-shaped fossa on the lateral aspect of the skull between the maxilla's infratemporal surface and the pterygoid process of the sphenoid

Contains major nerves and blood vessels that supply the nasal cavity, upper jaw, hard palate, and soft palate: the maxillary division of the trigeminal nerve, pterygopalatine (sphenopalatine, Meckel's) ganglion, and 3rd portion of the maxillary artery

Allows the infratemporal fossa, middle cranial fossa, foramen lacerum, nasopharynx, nasal cavity, orbital cavity, and oral cavity to communicate

7 foramina/fissures allow passage of nerves and vessels



Borders and Openings

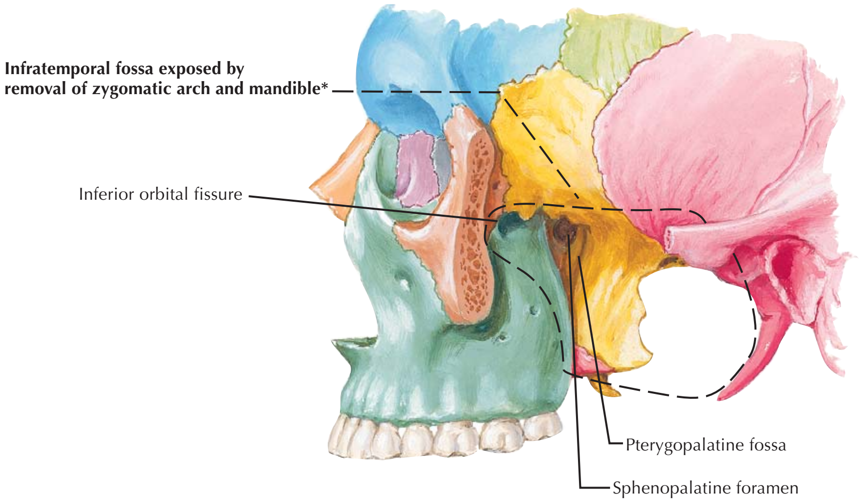
BORDERS

Border	Structures
Anterior wall	Infratemporal surface of the maxilla
Posterior wall	Pterygoid process of the sphenoid
Medial wall	Perpendicular plate of the palatine
Lateral wall	None (open to the pterygomaxillary fissure)
Superior wall	Inferior surface of the sphenoid and the orbital plate of the palatine bone
Inferior wall	Pyramidal process of the palatine

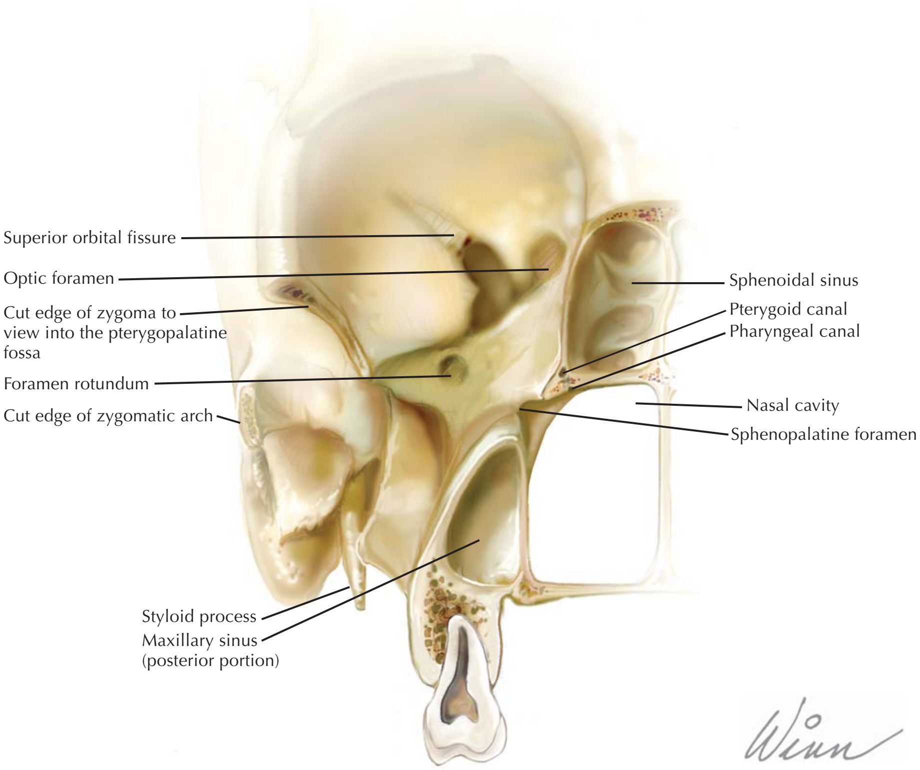
OPENINGS

Openings	Location	Transmitted Structures
Pterygomaxillary fissure	Lateral part of the pterygopalatine fossa Between the infratemporal fossa and the pterygopalatine fossa	Posterior superior alveolar n. from the pterygopalatine fossa into the infratemporal fossa 3rd part of the maxillary a. from the infratemporal fossa into the pterygopalatine fossa A variable network of veins, such as the sphenopalatine, into the pterygoid plexus of vv.
Sphenopalatine foramen	Medial wall of the pterygopalatine fossa Between the nasal cavity and the pterygopalatine fossa Often located posterior to the middle nasal concha	Nasopalatine n. Posterior superior nasal nn. Sphenopalatine vessels
Inferior orbital fissure	Superior part of the pterygopalatine fossa Between the pterygopalatine fossa and the orbit Continues posteriorly with the superior part of the pterygomaxillary fissure	Infraorbital n. from the maxillary division of the trigeminal n. Zygomatic n. from the maxillary division of the trigeminal Infraorbital vessels Inferior ophthalmic v. that connects with the pterygoid plexus of veins
Palatine canal	Inferior part of the pterygopalatine fossa Between the pterygopalatine fossa and the hard and the soft palate Eventually terminates into the greater and lesser palatine foramina	Greater palatine n. and vessels (through the greater palatine foramen) onto the hard palate Lesser palatine n. and vessels (through the lesser palatine foramen) onto the soft palate
Foramen rotundum	Posterolateral part of the pterygopalatine fossa Between the pterygopalatine fossa and the middle cranial fossa	Maxillary division of the trigeminal n.
Pterygoid canal	Posterior part of the pterygopalatine fossa Between the pterygopalatine fossa and the foramen lacerum Inferior and medial to the foramen rotundum	Nerve of the pterygoid canal (vidian n.) An accompanying artery
Pharyngeal canal	Posteromedial part of the pterygopalatine fossa Between the pterygopalatine fossa and the nasopharynx Medial to the pterygoid canal	Pharyngeal n. Pharyngeal vessels

OPENINGS *CONTINUED*

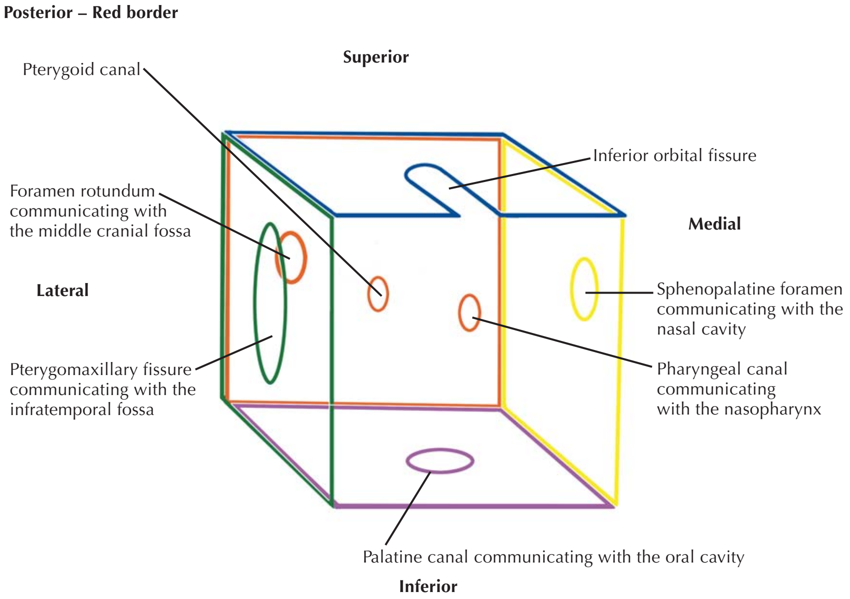


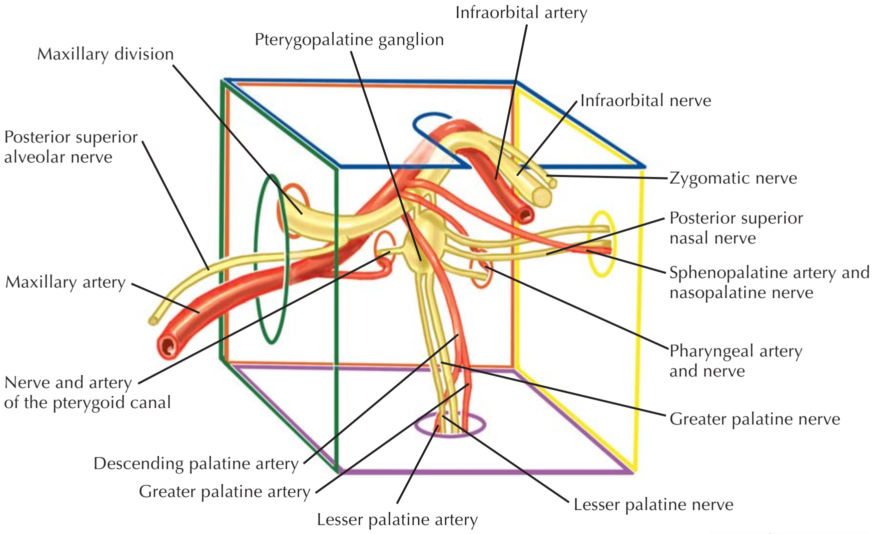
*Superficially, mastoid process forms posterior boundary



Borders and Openings

OPENINGS *CONTINUED*





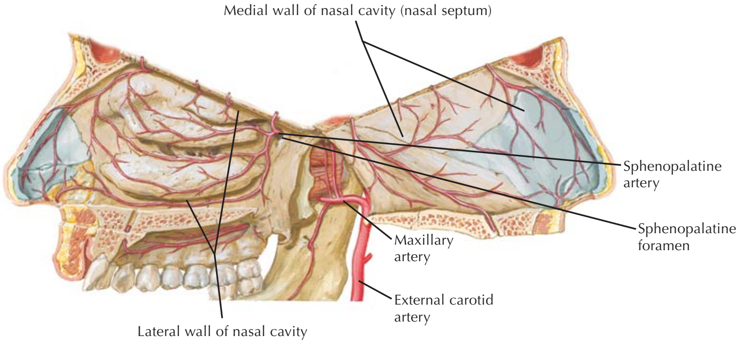
Winn

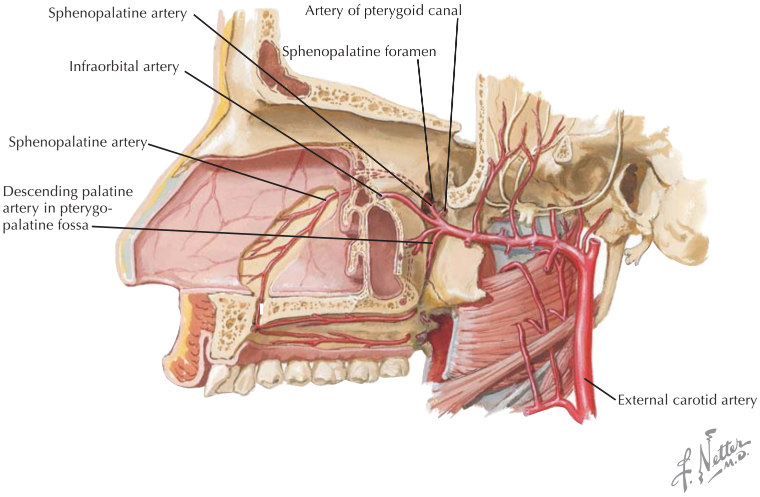
VASCULAR SUPPLY

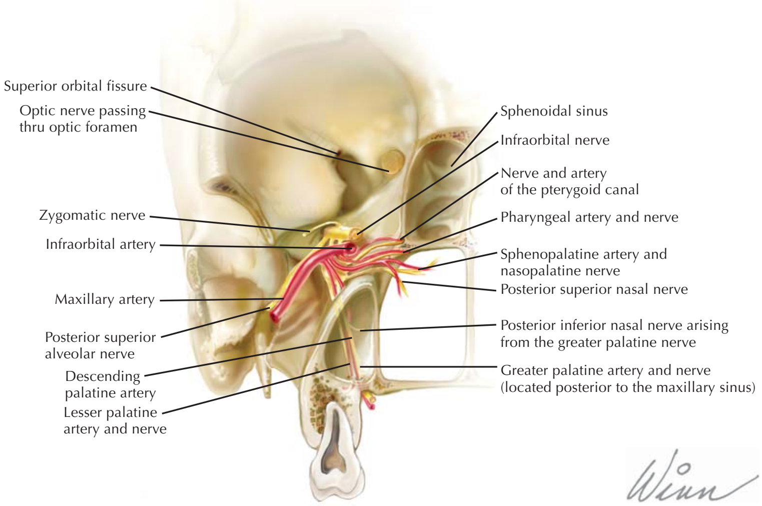
ARTERIAL SUPPLY		
Artery	**Source**	**Course**
Maxillary (3rd part)	External carotid a.	Passes from the infratemporal fossa into the pterygopalatine fossa via the pterygomaxillary fissure Prior to passing through the pterygomaxillary fissure, it gives off the posterior superior alveolar a. (the only artery from the 3rd part of the maxillary a. that does not normally branch off within the pterygopalatine fossa)
Infraorbital	The continuation of the 3rd part of the maxillary a.	Accompanied by the infraorbital n. and v. The artery passes forward in the infraorbital groove, infraorbital canal, and exits the infraorbital foramen In the infraorbital canal, it gives rise to various orbital branches that aid in supplying the lacrimal gland and extraocular muscles In the infraorbital canal, it also gives rise to the anterior and middle (if present) superior alveolar aa. that supply the maxillary teeth from the central incisors to the premolars (where they anastomose with the posterior superior alveolar a.) and the mucous membrane of the maxillary sinus On exiting the infraorbital foramen, the artery is located between the levator labii superioris and levator anguli oris mm. and follows the branching pattern of the nerve: • Inferior palpebral branch (supplies the lower eyelid) • Nasal branch (supplies the lateral side of the nose) • Superior labial branch (supplies the upper lip)
Descending palatine	3rd part of the maxillary a.	Descends into the palatine canal Within the canal, the artery splits into the greater and lesser palatine aa. Greater palatine a. exits the greater palatine foramen and passes anteriorly towards the incisive foramen and supplies the hard palate gingiva, mucosa, and palatal glands and anastomoses with the terminal branch of the sphenopalatine a. that exits the incisive foramen Lesser palatine a. supplies the soft palate and palatine tonsil
Artery of the pterygoid canal		Passes posteriorly into the pterygoid canal, accompanying the nerve of the pterygoid canal (vidian n.) Helps supply the auditory tube and sphenoid sinus
Pharyngeal		Passes posteromedially into the pharyngeal canal Helps supply the auditory tube and nasopharynx
Sphenopalatine		Passes medially into the sphenopalatine foramen to enter the nasal cavity It then gives rise to the posterior lateral nasal branches and posterior septal branches, which supply the nasal concha, mucous membranes, and nasal septum The sphenopalatine a. continues along the nasal septum to enter the hard palate via the incisive canal

Contents of the Pterygopalatine Fossa

VASCULAR SUPPLY *CONTINUED*



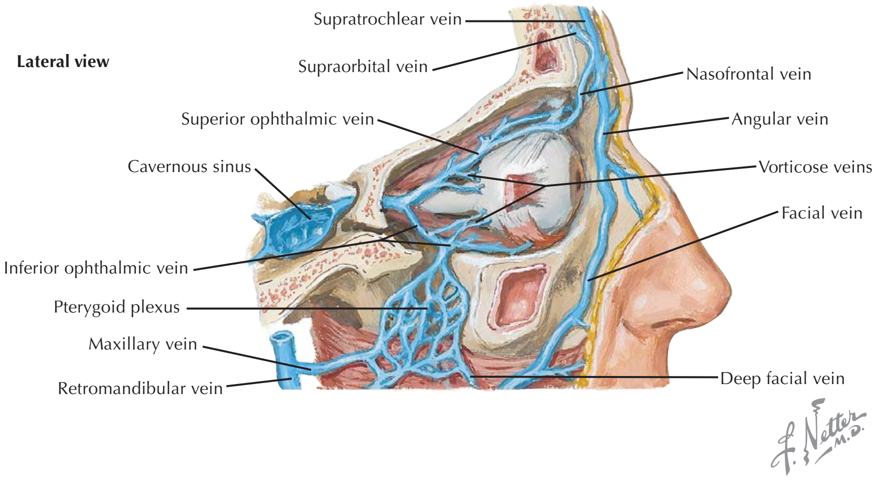




10 Contents of the Pterygopalatine Fossa

VASCULAR SUPPLY *CONTINUED*

VENOUS DRAINAGE		
Vein	**Course**	
Posterior superior alveolar	Receives blood from the posterior teeth and soft tissue	Eventually communicate with the pterygoid plexus of veins
Pharyngeal	Receives blood from the nasopharynx	
Descending palatine	Receives blood from the hard and soft palate	
Infraorbital	Receives blood from the midface via the lower eyelid, lateral side of the nose, and the upper lip	
Sphenopalatine	Receives blood from the nasal cavity and the nasal septum	
Vein of the pterygoid canal	Receives blood from the foramen lacerum region and the sphenoid sinus	
Inferior ophthalmic	Receives blood from the floor of the orbit Branches into 2 parts The first branch travels posteriorly with the infraorbital v. that passes through the inferior orbital fissure to communicate with the pterygoid plexus and the cavernous sinus The main branch travels posteriorly to communicate with the superior ophthalmic vein in the superior orbital fissure or travels posteriorly in the fissure to join the cavernous sinus	
Pterygoid plexus	An extensive network of veins that parallels the 2nd and 3rd parts of the maxillary a. The tributaries of the pterygoid plexus eventually converge to form a short maxillary v.	



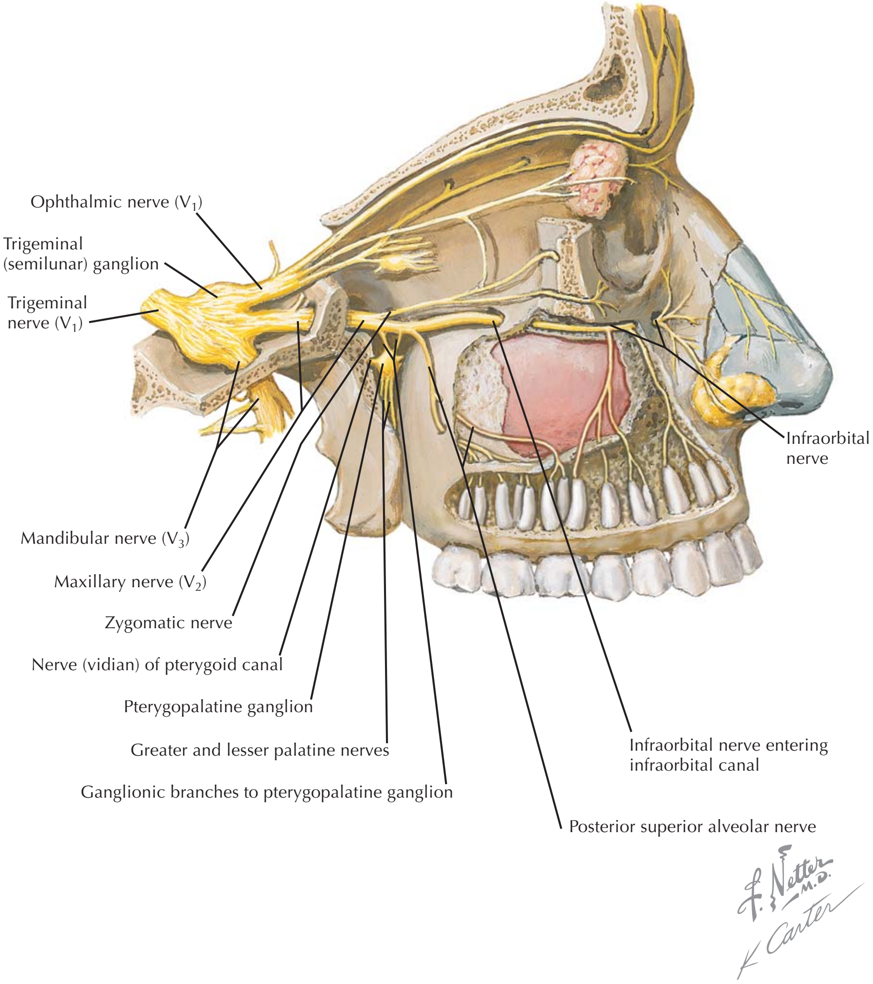
Contents of the Pterygopalatine Fossa

NERVE SUPPLY

MAXILLARY NERVE		
Nerve	**Source**	**Course**
Maxillary division of the trigeminal n.	Trigeminal n.	Sensory in function Travels along the lateral wall of the cavernous sinus Before exiting the middle cranial fossa, it gives off a meningeal branch that innervates the dura mater Passes from the middle cranial fossa into the pterygopalatine fossa via the foramen rotundum Within the pterygopalatine fossa, gives rise to 4 branches: • Posterior superior alveolar n. • Zygomatic n. • Ganglionic branches • Infraorbital n.
Posterior superior alveolar	Maxillary division of the trigeminal n. in pterygopalatine fossa	Passes through the pterygomaxillary fissure to enter the infratemporal fossa In the infratemporal fossa, it passes on the posterior surface of the maxilla along the region of the maxillary tuberosity Gives rise to a gingival branch that innervates the buccal gingiva alongside the maxillary molars Enters the posterior surface of the maxilla and supplies the maxillary sinus and the maxillary molars with the possible exception of the mesiobuccal root of the 1st maxillary molar
Zygomatic		Passes through the inferior orbital fissure to enter the orbit Passes on the lateral wall of the orbit and branches into the zygomaticotemporal and zygomaticofacial branches A communicating branch from it joins the lacrimal n. from the ophthalmic division of the trigeminal to carry autonomics to the lacrimal gland
Ganglionic branches		Usually 1 or 2 ganglionic branches that connect the maxillary division of the trigeminal to the pterygopalatine ganglion Contain sensory fibers that pass through the pterygopalatine ganglion (without synapsing) to be distributed with the nerves that arise from the pterygopalatine ganglion Also contain postganglionic autonomic fibers to the lacrimal gland that pass through the pterygopalatine ganglion (Parasympathetic fibers form a synapse here between the preganglionic fibers from the vidian n. and the postganglionic fibers)
Infraorbital	Considered the continuation of the maxillary division of the trigeminal n.	Passes through the inferior orbital fissure to enter the orbit Passes anteriorly through the infraorbital groove, infraorbital canal, and exits onto the face via the infraorbital foramen Within the infraorbital canal, it gives rise to: • Anterior superior alveolar (supplies the maxillary sinus; maxillary central incisor, lateral incisor, and canine; gingival and mucosa alongside the same teeth) • A small branch of the anterior superior alveolar (supplies the nasal cavity) • Middle superior alveolar (present about 70% of the time; supplies the maxillary sinus, maxillary premolars and often the mesiobuccal root of the 1st maxillary molar, and gingival and mucosa alongside the same teeth)

10 Contents of the Pterygopalatine Fossa

NERVE SUPPLY *CONTINUED*



Contents of the Pterygopalatine Fossa

NERVE SUPPLY *CONTINUED*

BRANCHES OF THE MAXILLARY DIVISION OF THE TRIGEMINAL NERVE ASSOCIATED WITH THE PTERYGOPALATINE GANGLION

A parasympathetic ganglion named because it is a collection of cell bodies in the peripheral nervous system (postganglionic cell bodies)

The ganglionic branches are of the maxillary division of the trigeminal n. that pass through the pterygopalatine ganglion

The vidian n. connects to the pterygopalatine ganglion

3 sets of nerve fibers travel through the pterygopalatine ganglion:

- General sensory fibers from the trigeminal n. (without synapsing)
- Postganglionic sympathetic fibers (carried to the pterygopalatine ganglion via the vidian n, without synapsing)
- Preganglionic parasympathetic fibers (carried to the pterygopalatine ganglion via the vidian n. and formed by synapsing in the pterygopalatine ganglion)

All branches arising from the pterygopalatine ganglion carry these 3 sets of fibers to the areas where they terminate

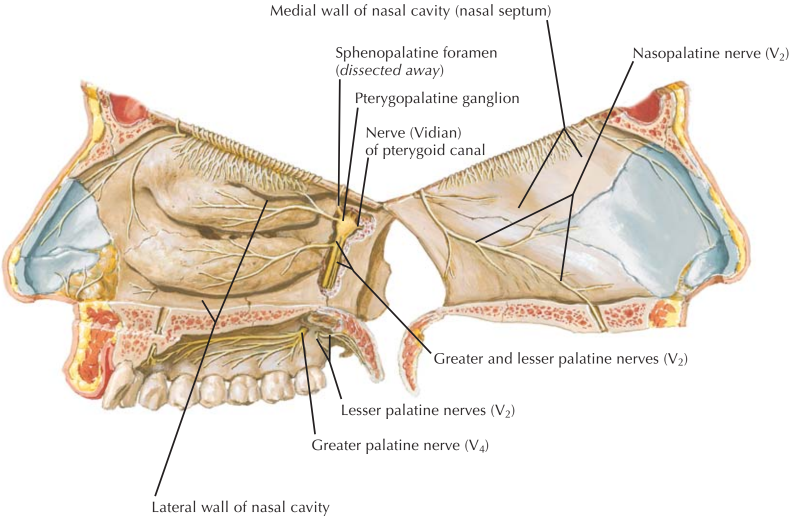
These nerves of the maxillary division travel through the pterygopalatine ganglion:

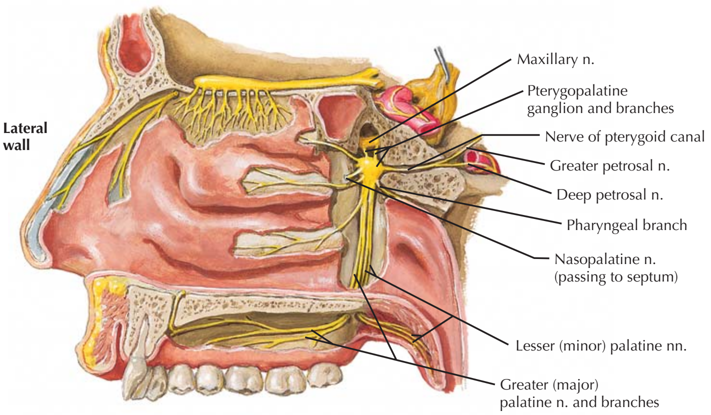
- Nasopalatine n.
- Posterior superior nasal n.
- Greater palatine n.
- Lesser palatine n.
- Pharyngeal n.

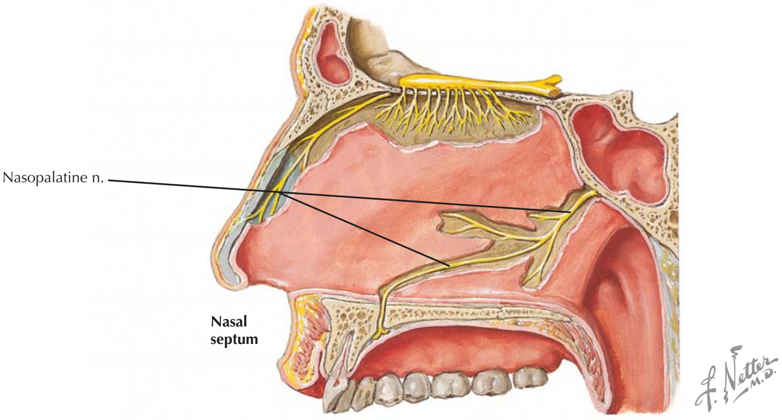
Branch	Source	Course
Vidian (nerve of the pterygoid canal)	Formed by the greater and deep petrosal nn.	An autonomic nerve: • Greater petrosal n. carries the preganglionic parasympathetic fibers • Deep petrosal n. carries the postganglionic sympathetic fibers Communicates with the pterygopalatine ganglion, which allows the autonomics to be distributed along any nerve connected to the ganglion
Nasopalatine	Branches of the pterygopalatine ganglion in the pterygopalatine fossa	Passes through the sphenopalatine foramen to enter the nasal cavity Passes along the superior portion of the nasal cavity to the nasal septum; then travels anteroinferiorly to the incisive canal Exits the incisive foramen on the hard palate and supplies the palatal gingiva and mucosa from the region of the central incisors to the canines
Posterior superior nasal		Passes through the sphenopalatine foramen to enter the nasal cavity, where it divides into 2 nerves: • Lateral posterior superior (supplies the lateral wall of the nasal cavity) • Medial posterior superior nasal (supplies the posterosuperior portion of the nasal septum)
Greater palatine		Passes through the palatine canal to enter the hard palate via the greater palatine foramen Supplies the palatal gingiva and mucosa from the area in the premolar region to the posterior border of the hard palate to the midline
Lesser palatine		Passes through the palatine canal to enter and supply the soft palate via the lesser palatine foramen
Pharyngeal		Passes through the pharyngeal canal to enter and supply the nasopharynx

10 Contents of the Pterygopalatine Fossa

NERVE SUPPLY *CONTINUED*





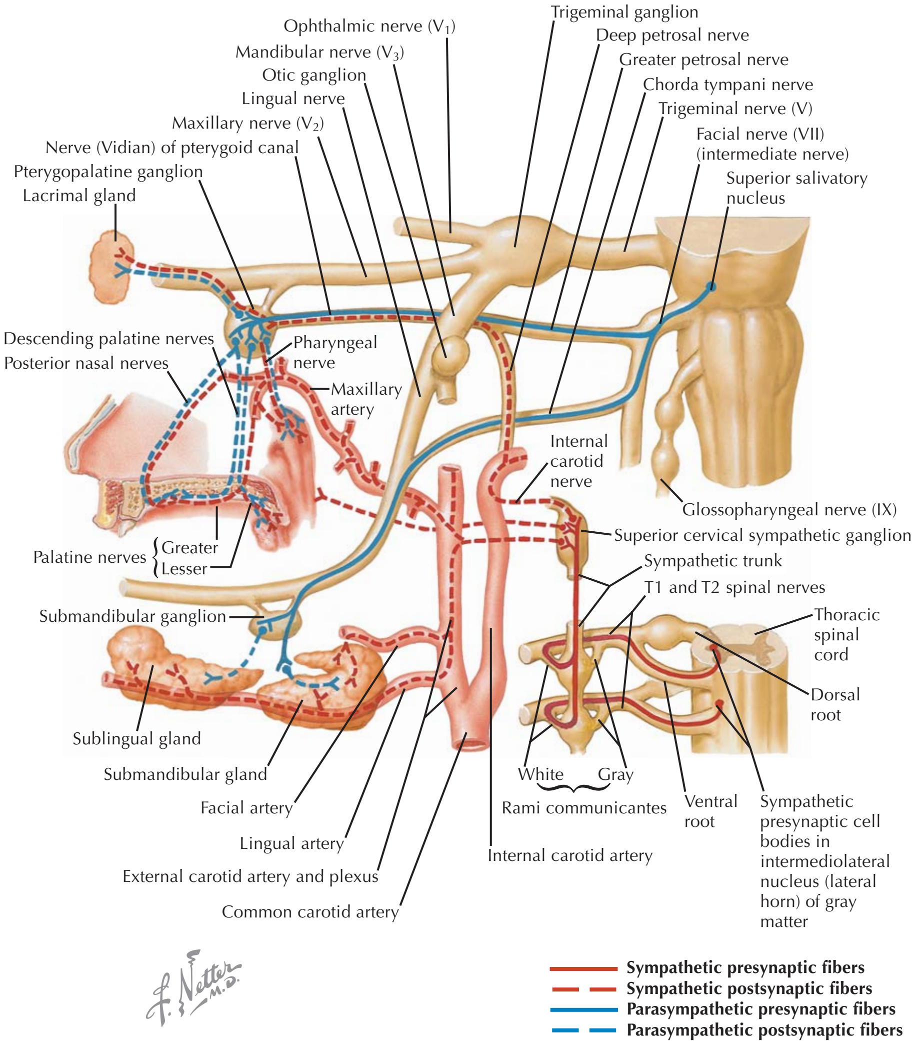


Contents of the Pterygopalatine Fossa

NERVE SUPPLY *CONTINUED*

AUTONOMICS TRAVERSING THE PTERYGOPALATINE FOSSA			
Type of Neuron	**Name of Cell Body**	**Characteristics of the Cell Body**	**Course of the Neuron**
Anatomic Pathway for Parasympathetics Associated with the Maxillary Division of the Trigeminal Nerve			
Preganglionic neuron	Superior salivatory nucleus	A collection of nerve cell bodies located in the pons Travel through the nervus intermedius of the facial n. into the internal acoustic meatus In the facial canal, the facial n. gives rise to 2 parasympathetic branches: • Greater petrosal n. • Chorda tympani n.	**Greater Petrosal Nerve** Greater petrosal n. exits along the hiatus for the greater petrosal n. toward the foramen lacerum, where it joins the deep petrosal n. (sympathetics) to form the nerve of the pterygoid canal (vidian n.) Vidian n. passes through the pterygoid canal and enters the pterygopalatine fossa, where it joins with the pterygopalatine ganglion
Postganglionic neuron	Pterygopalatine ganglion	Pterygopalatine ganglion is a collection of nerve cell bodies located in the pterygopalatine fossa Postganglionic parasympathetic fibers that arise in the pterygopalatine ganglion are distributed to the ophthalmic and maxillary divisions of the trigeminal n. to the: • Lacrimal gland • Nasal glands • Palatine glands • Pharyngeal glands	**Ophthalmic Division Distribution** Postganglionic fibers travel along the zygomatic branch of the maxillary division for a short distance to enter the orbit A short communicating branch joins the lacrimal n. of the ophthalmic division of the trigeminal n. These fibers innervate the lacrimal gland to cause the secretion of tears **Maxillary Division Distribution** Postganglionic fibers travel along the maxillary division of the trigeminal n. to be distributed along its branches that are located in the nasal cavity, oral cavity, and pharynx (e.g., nasopalatine, greater palatine) These fibers innervate: • Nasal glands • Palatine glands • Pharyngeal glands

NERVE SUPPLY *CONTINUED*



Contents of the Pterygopalatine Fossa

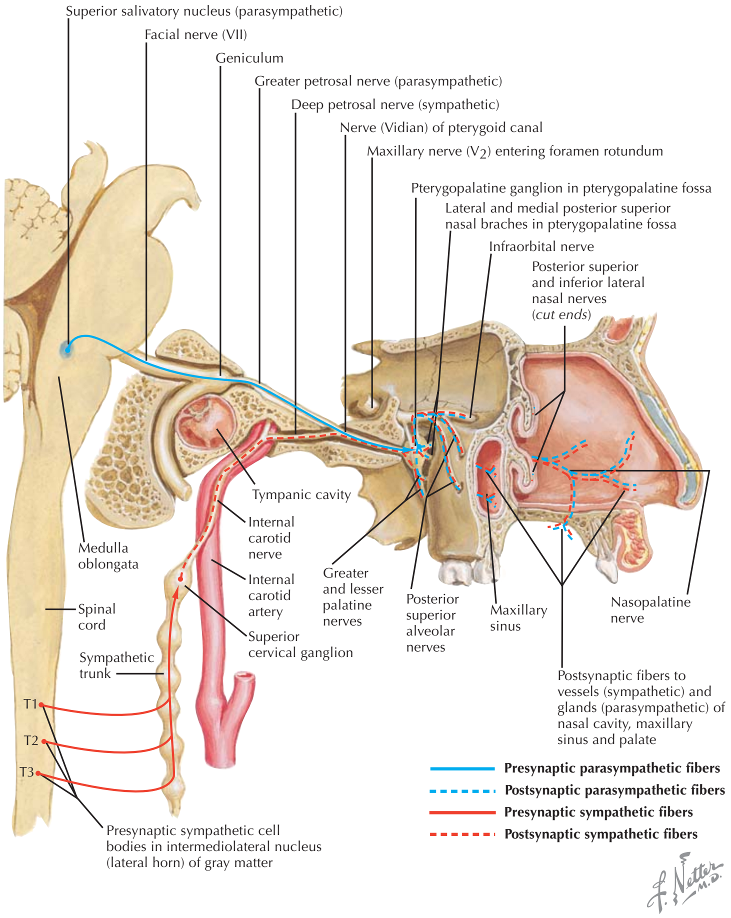
NERVE SUPPLY *CONTINUED*

AUTONOMICS TRAVERSING THE PTERYGOPALATINE FOSSA			
Type of Neuron	**Name of Cell Body**	**Characteristics of the Cell Body**	**Course of the Neuron**
Anatomic Pathway for Sympathetics Associated with the Maxillary Division of the Trigeminal Nerve			
Preganglionic neuron	Intermediolateral horn nucleus	Collection of nerve cell bodies located in the lateral horn nucleus of the spinal cord between spinal segments T1 and T3 (and possibly T4)	Arise from the intermediolateral horn nuclei from T1 to T3 (4) Travel through the ventral root of the spinal cord to the spinal n. Enter the sympathetic chain via a white ramus communicantes Once in the sympathetic chain, the preganglionic fibers for the eye will ascend and synapse with postganglionic fibers in the superior cervical ganglion
Postganglionic neuron	Superior cervical ganglion	Collection of nerve cell bodies located in the superior cervical ganglion, which is located at the base of the skull Postganglionic sympathetic fibers follow the internal carotid or external carotid a. to pass near their respective effector organs (e.g., nasal cavity)	**Nasal Cavity and Palate** Postganglionic sympathetic fibers follow both the internal and external carotid aa. Postganglionic sympathetic fibers from the internal carotid branch in the region of the foramen lacerum to form the deep petrosal n. The deep petrosal n. joins the greater petrosal n. (parasympathetics) to form the nerve of the pterygoid canal (vidian n.) Postganglionic sympathetic fibers travel along the branches of the maxillary division of the trigeminal n. associated with the pterygopalatine ganglion to be distributed along its branches in the nasal cavity and palate Postganglionic sympathetic fibers from the external carotid branch and follow the maxillary a. These fibers travel along the branches of the maxillary a. to be distributed along the nasal cavity and palate **Lacrimal Gland** Postganglionic sympathetic fibers follow the internal carotid a. Postganglionic sympathetic fibers from the internal carotid branch off in the region of the foramen lacerum to form the deep petrosal n.

10 Contents of the Pterygopalatine Fossa

NERVE SUPPLY *CONTINUED*

AUTONOMICS TRAVERSING THE PTERYGOPALATINE FOSSA			
Type of Neuron	**Name of Cell Body**	**Characteristics of the Cell Body**	**Course of the Neuron**
Anatomic Pathway for Sympathetics Associated with the Maxillary Division of the Trigeminal Nerve			
Postganglionic neuron			The deep petrosal n. joins the greater petrosal n. (parasympathetics) to form the nerve of the pterygoid canal (vidian n.) Postganglionic fibers travel along the zygomatic branch of the maxillary division for a short distance to enter the orbit A short communicating branch joins the lacrimal n. of the ophthalmic division of the trigeminal n. These fibers are distributed to the lacrimal gland



CHAPTER 11

NOSE AND NASAL CAVITY

11 Overview and Topographic Anatomy

GENERAL INFORMATION

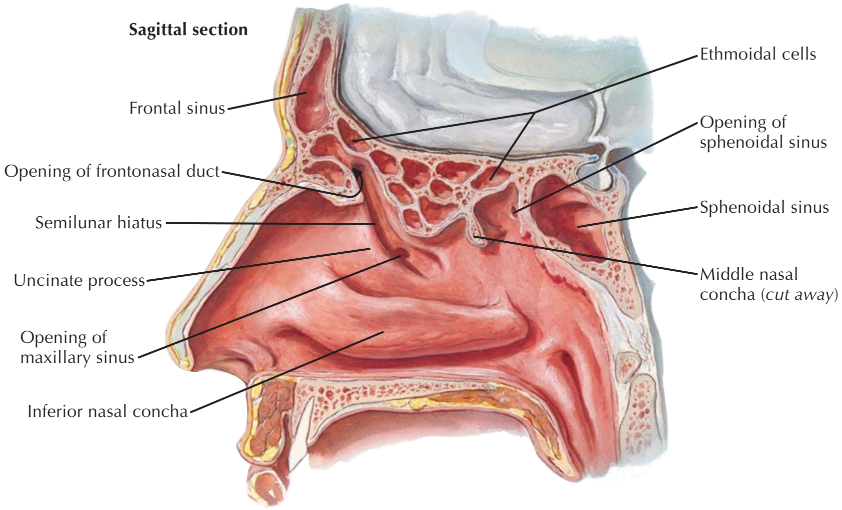
Nose
The prominent anatomic structure located inferior and medial to the eyes

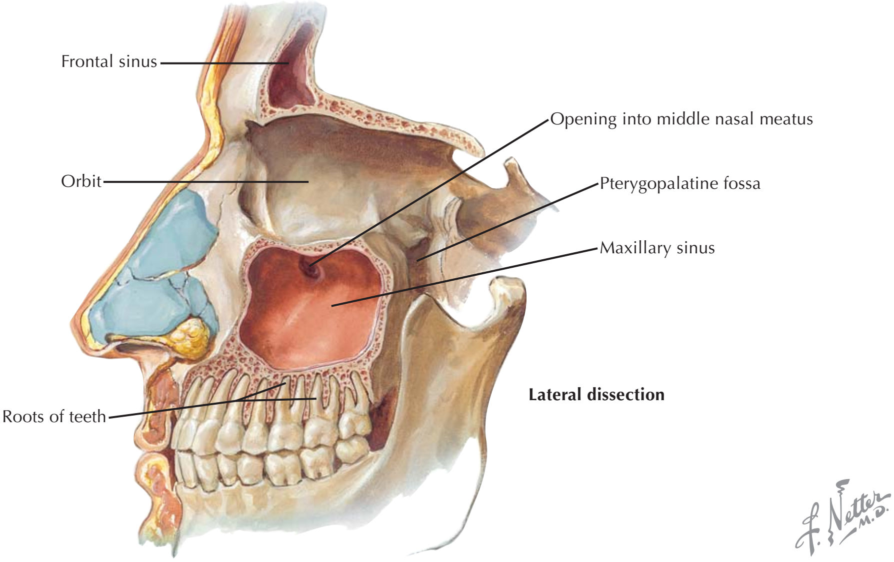
Helps in breathing and olfaction

Nasal Cavity
The complex chamber located posterior to the vestibule and atrium of the nose

Respiratory Epithelium
Highly vascular and easily congested

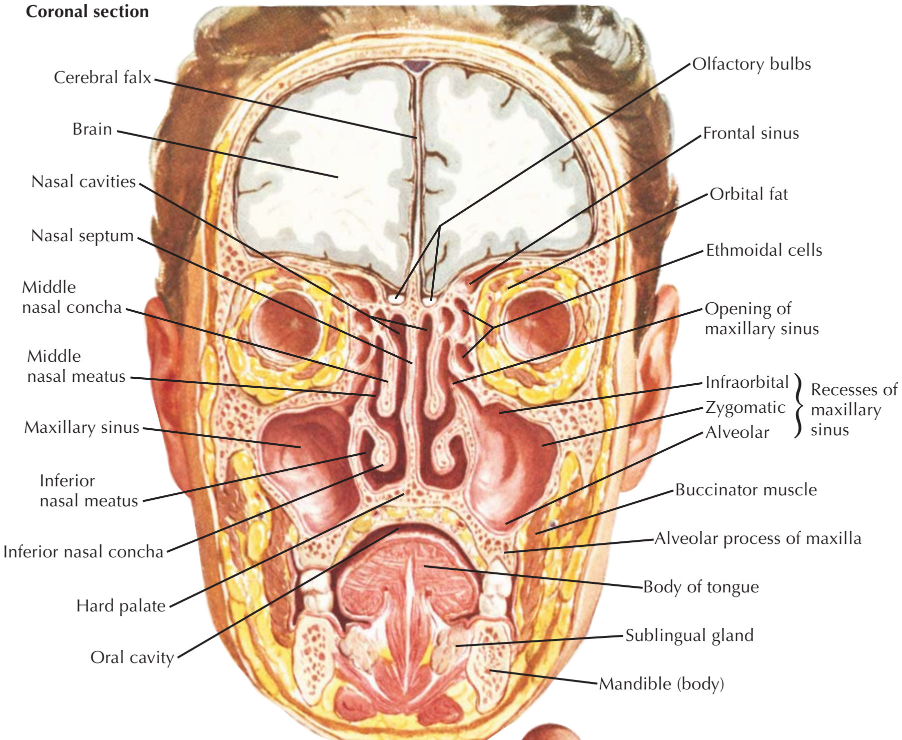
When this tissue is irritated, its blood vessels reflexively dilate and the glands secrete, normally leading to sneezing

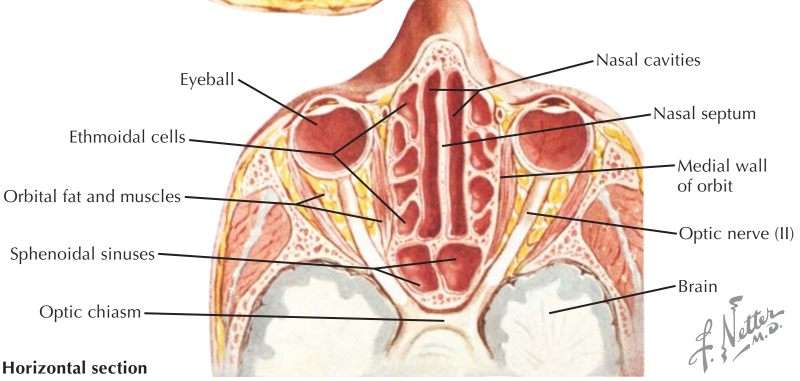




GENERAL INFORMATION *CONTINUED*

Coronal section





Horizontal section

11 Nose

ANATOMY OF THE NOSE

The nose is pyramidal in form

3 pairs of *bones* form the root of the nose:
- Frontal (nasal process)
- Maxilla (frontal process)
- Nasal

Because the root of the nose is made of bone, it is fixed

3 different *cartilages* form the dorsum and apex of the nose:
- Septal
- Lateral nasal
- Alar

Because the dorsum and apex are cartilaginous, the nose is quite mobile

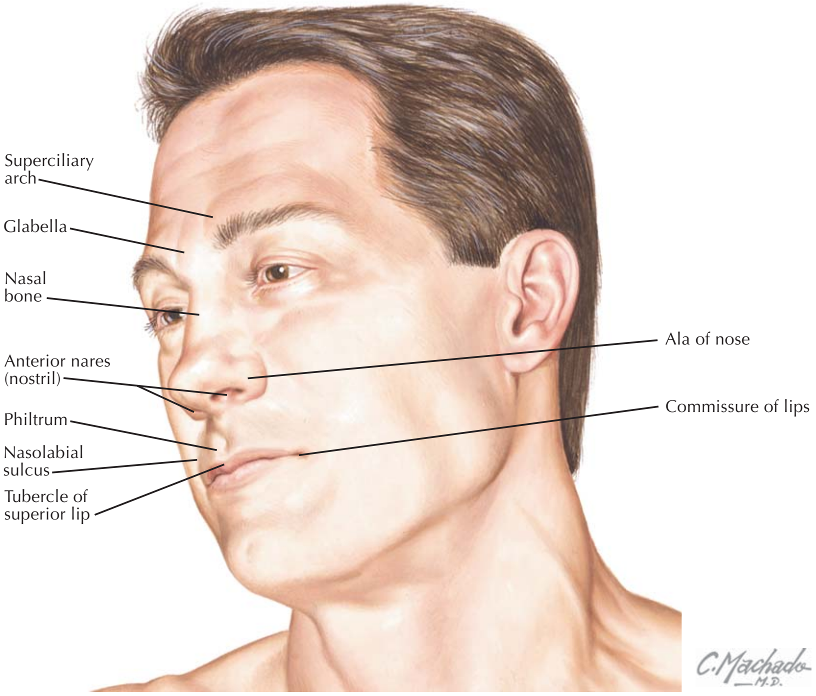
The cavity of the nose opposite the alar cartilage is called the vestibule and is lined by many coarse hairs called vibrissae

The cavity superior to the vestibule is the atrium

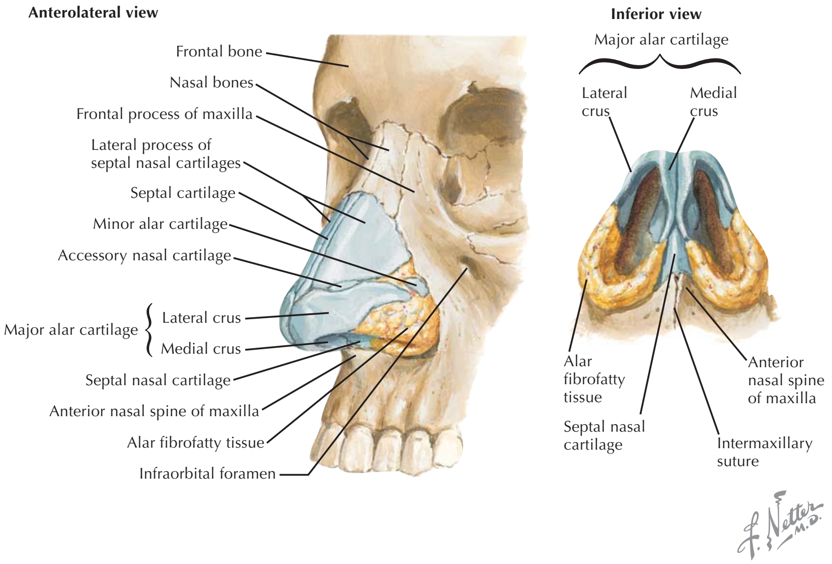
At the apex are found the 2 nostrils, or anterior nares, which are separated by the septum connecting the apex to the philtrum of the upper lip

Fibrous tissue helps connect the cartilages together and posteriorly to the maxilla

The primary lymphatic drainage of the nose is into the submandibular lymph nodes



ANATOMY OF THE NOSE *CONTINUED*



VASCULAR SUPPLY OF THE NOSE

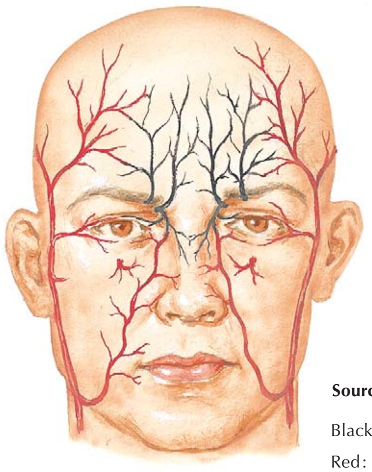
The blood supply to the nose arises from 3 major *arteries:*

- Ophthalmic
- Maxillary
- Facial

These vessels are derived from the external and internal carotid arteries

These arteries anastomose along the nose

Many nosebleeds are due to trauma to the septal branch of the superior labial artery from the facial artery

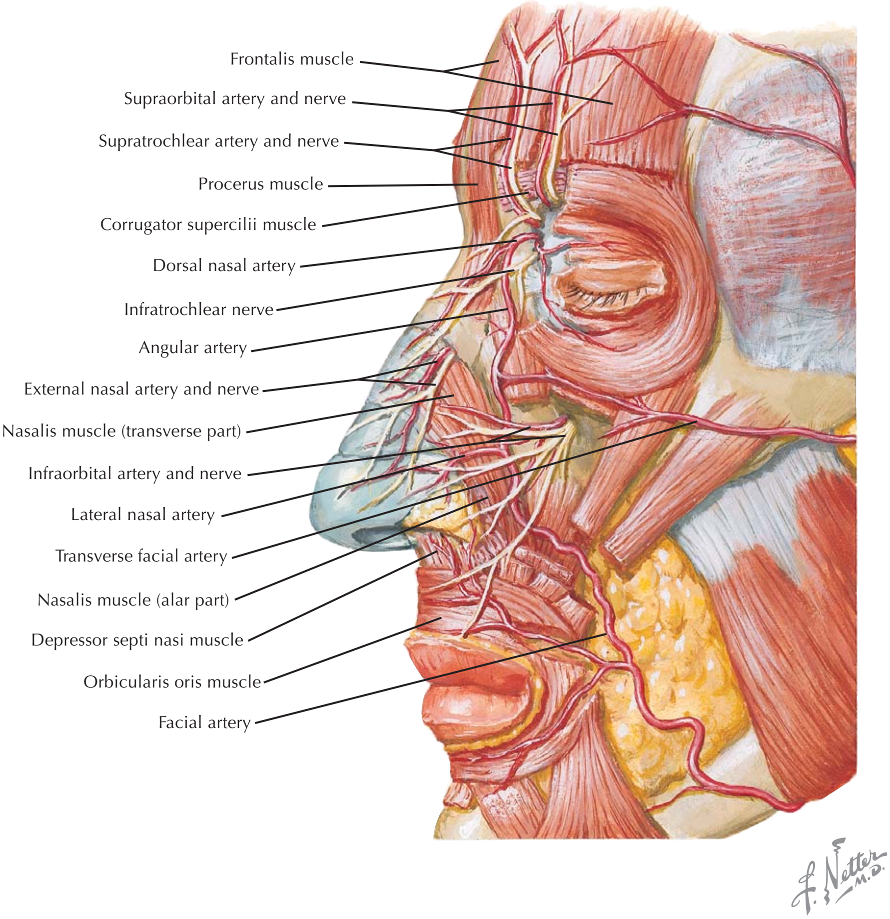


Sources of arterial supply of face

Black: from internal carotid artery (via ophthalmic artery)

Red: from external carotid artery

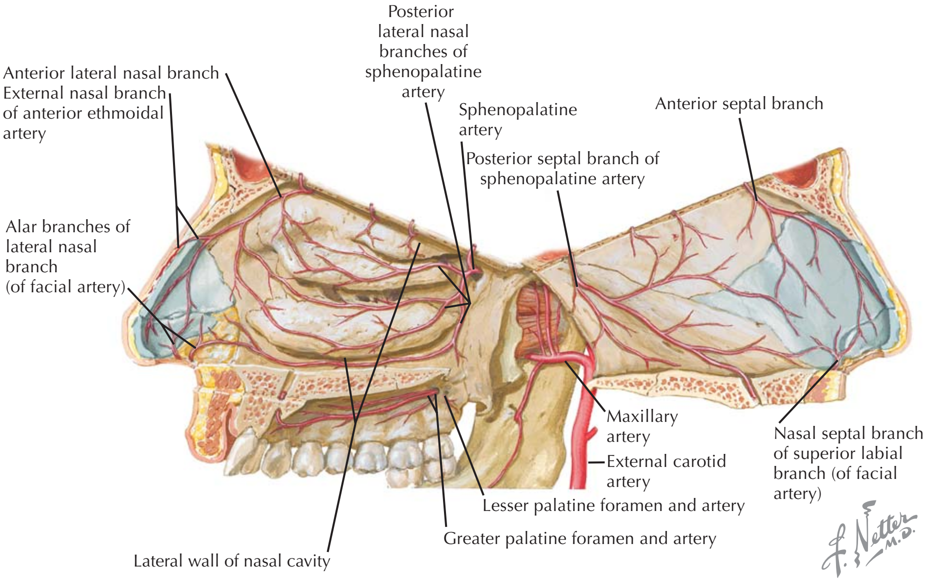
VASCULAR SUPPLY OF THE NOSE *CONTINUED*



ARTERIAL SUPPLY		
Artery	**Source**	**Course**
Ophthalmic	Internal carotid a.	Enters the orbit through the optic foramen immediately inferior and lateral to the optic n. Crosses the optic n. to reach the medial part of the orbit While in the orbit, besides other branches including the orbital vessels, it gives rise to 2 major branches that supply the nose: ● Dorsal nasal ● External nasal from the anterior ethmoidal a.
Dorsal nasal (infratrochlear)	1 of the terminal branches of the ophthalmic a.	Exits the orbit along the superomedial border along with the infratrochlear n. Supplies the area along the bridge of the nose
External nasal	A terminal branch of the anterior ethmoid a.	Supplies the area along the external nose at the junction between the nasal bone and the lateral nasal cartilage

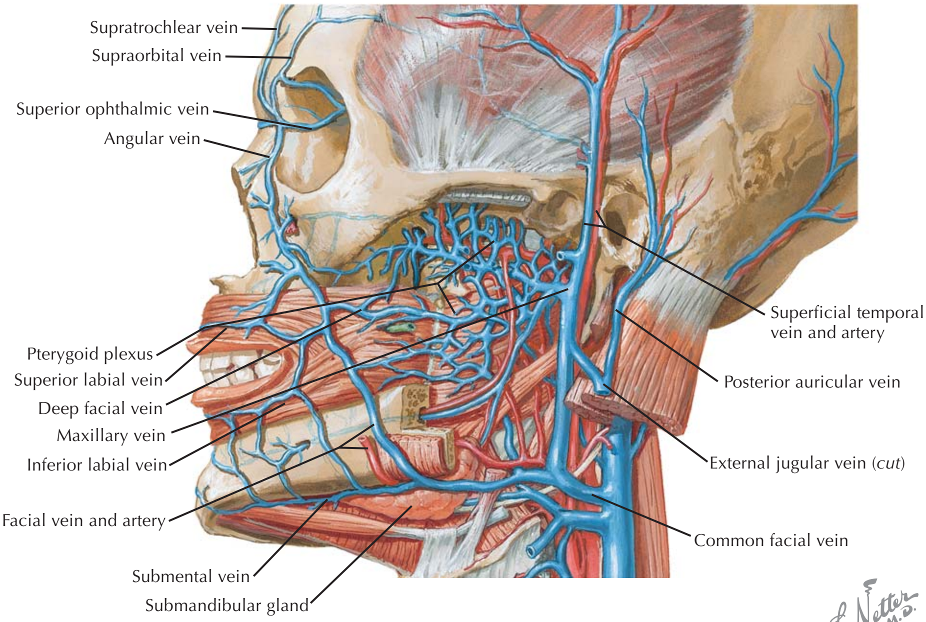
VASCULAR SUPPLY OF THE NOSE *CONTINUED*

ARTERIAL SUPPLY		
Artery	**Source**	**Course**
Maxillary	1 of 2 terminal branches of the external carotid a.	Gives rise to a series of branches; only 1 provides blood supply to the nose: nasal branch of the infraorbital a.
Nasal branch of the infraorbital	Infraorbital, the continuation of the 3rd part of the maxillary a.	Arises with the inferior palpebral branch and the superior labial branch Supplies the lateral aspect of the nose
Facial	External carotid a. in the carotid triangle of the neck	Passes superiorly immediately deep to the posterior belly of the digastric m. and the stylohyoid m. Passes along the submandibular gland, giving rise to the submental a., which helps supply the gland Passes superiorly over the body of the mandible at the masseter Continues anterosuperiorly across the cheek to the angle of the mouth, giving rise to the superior and inferior labial aa. Passes superiorly along the side of the nose, giving rise to the lateral nasal a. Continues on the side of the nose as the angular a. that terminates along the medial side of the eye Tortuous
Septal	Superior labial a.	Supplies the septum
Alar	Superior labial a. off of the facial a.	Supplies the ala of the nose
Lateral nasal	Facial a.	Supplies the ala and dorsal surface of nose



VASCULAR SUPPLY OF THE NOSE *CONTINUED*

VENOUS DRAINAGE	
Vein	**Course**
Facial	Begins as the angular v. Passes inferiorly along the side of the nose, receiving the lateral nasal v. Continues in a posteroinferior path across the angle of the mouth to the cheek, receiving the superior and inferior labial vv. While passing toward the mandible, the deep facial v. connects the facial vein to the pterygoid plexus In the submandibular triangle, the facial v. joins the anterior branch of the retromandibular to form the common facial v. Has no valves that can allow blood to backflow
Angular	From the confluence of the supraorbital and supratrochlear vv. along the medial part of the eye Travels along the lateral side of the nose to become the facial v.
Superior ophthalmic	Receives blood from the roof of the orbit and the scalp Anastomoses with the angular v. Travels posteriorly to communicate with the pterygoid plexus
Inferior ophthalmic	Receives blood from the floor of the orbit Anastomoses with the angular v. Travels posteriorly with the infraorbital v. that passes through the inferior orbital fissure to communicate with the pterygoid plexus



F. Netter M.D.

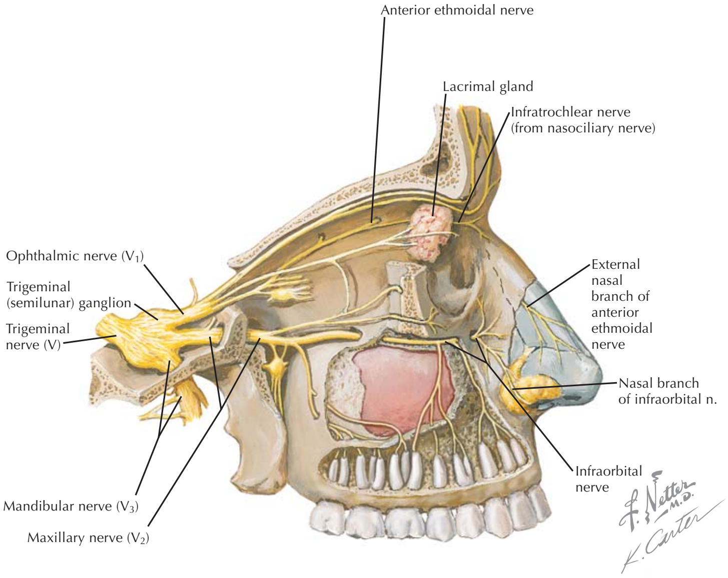
Nose

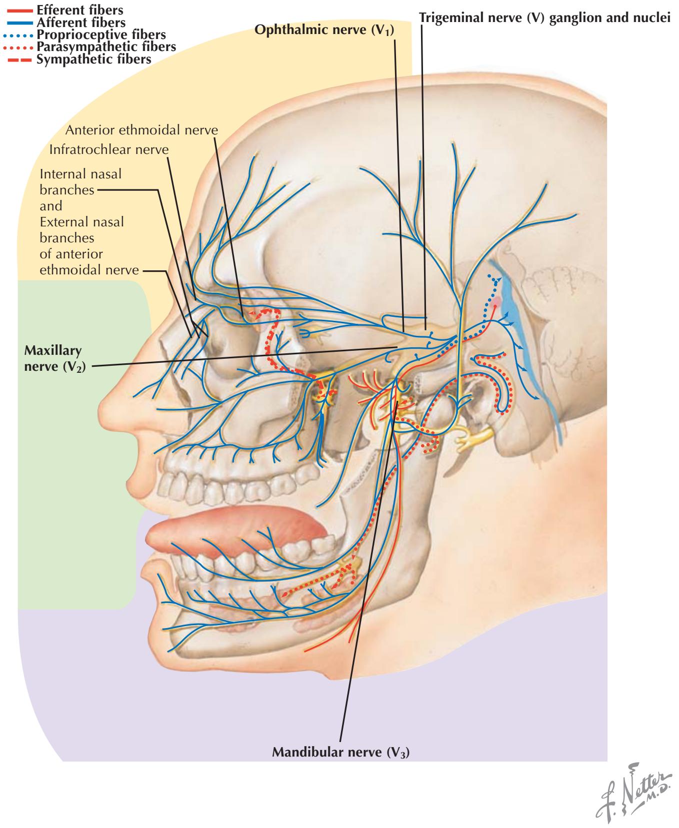
NERVE SUPPLY OF THE NOSE

The sensory supply to the nose arises from branches of the ophthalmic and maxillary divisions of the trigeminal nerve

Nerve	Source	Course
Ophthalmic division of the trigeminal	Trigeminal n. Arises from the main nerve in the middle cranial fossa	Passes anterior on the lateral wall of the cavernous sinus immediately inferior to the oculomotor and trochlear nn., but superior to the maxillary division of the trigeminal n. Immediately prior to entering the orbit, through the superior orbital fissure, the ophthalmic division divides into 3 major branches: lacrimal, frontal, and nasociliary
External nasal	Terminal branches of the anterior ethmoid nerve from the ophthalmic division of the trigeminal n.	Exits between the lateral nasal cartilage and the inferior border of the nasal bone Supplies the skin of the ala and apex of the nose around the nares
Internal nasal		Supplies the skin on the internal surface of the vestibule
Infratrochlear	One of the terminal branches of the nasociliary branch of the ophthalmic division of the trigeminal n.	Passes anteriorly on the superior border of the medial rectus m. Passes inferior to the trochlea toward the medial angle of the eye Supplies the skin of the bridge of the nose, in addition to the eyelids, the conjunctiva, and all lacrimal structures
Maxillary division of the trigeminal	Trigeminal n.	Travels along the lateral wall of the cavernous sinus Passes from the middle cranial fossa into the pterygopalatine fossa via the foramen rotundum *4 branches*: ● Infraorbital—this is the continuation of the maxillary division ● Posterior superior alveolar ● Zygomatic ● Ganglionic
Infraorbital	The continuation of the maxillary division of the trigeminal n.	Passes through the inferior orbital fissure to enter the orbit Passes anteriorly through the infraorbital groove and infraorbital canal and exits onto the face via the infraorbital foramen Once it exits onto the face, it divides into *3 terminal branches*: ● Nasal (supplies the ala of the nose) ● Inferior palpebral (supplies the skin of the lower eyelid) ● Superior labial (supplies the skin of the upper lip)
Nasal branch of the infraorbital	Infraorbital n.	Supplies the ala of the nose

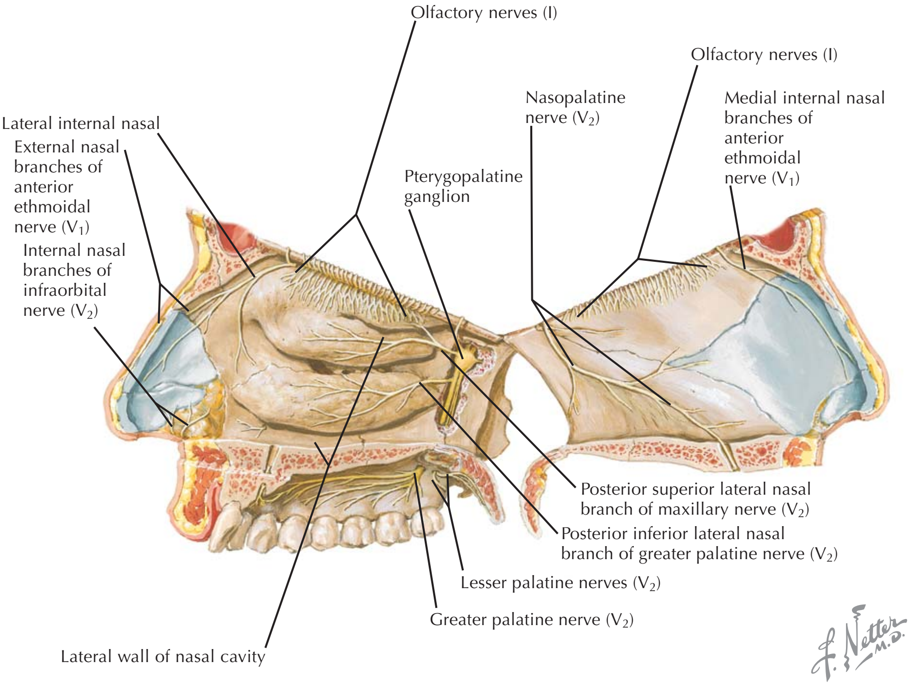
NERVE SUPPLY OF THE NOSE *CONTINUED*





Nose

NERVE SUPPLY OF THE NOSE *CONTINUED*



11 Nasal Cavity

ANATOMY

Lined by pseudostratified columnar epithelium with cilia

Inferior portion is larger than superior portion

Olfactory epithelium is located at the superior part of the nasal cavity around the cribriform plate

Piriform Aperture

Anterior opening bounded by the nasal bones and maxilla

Nasal Septum

Frequently deviates to 1 side, giving rise to unequal chambers

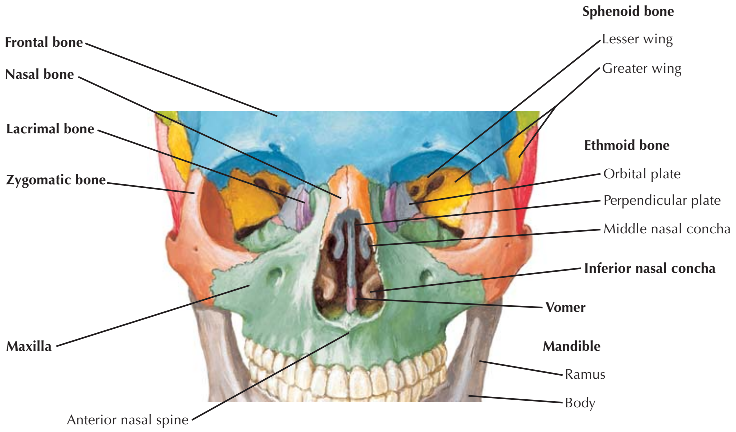
Lateral Walls

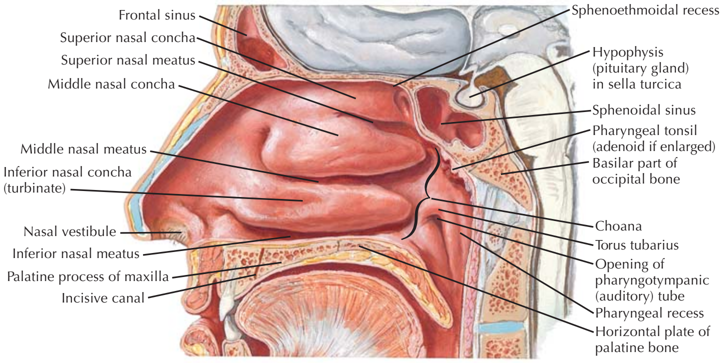
Composed of large venous plexuses that have the appearance of erectile tissue

3 large elevations, known as conchae, protrude from the lateral wall

All of the paranasal sinuses and the nasolacrimal duct drain into the lateral walls of the nasal cavity

The sphenopalatine foramen, located in the posterior portion of the lateral walls, connects the nasal cavity to the pterygopalatine fossa

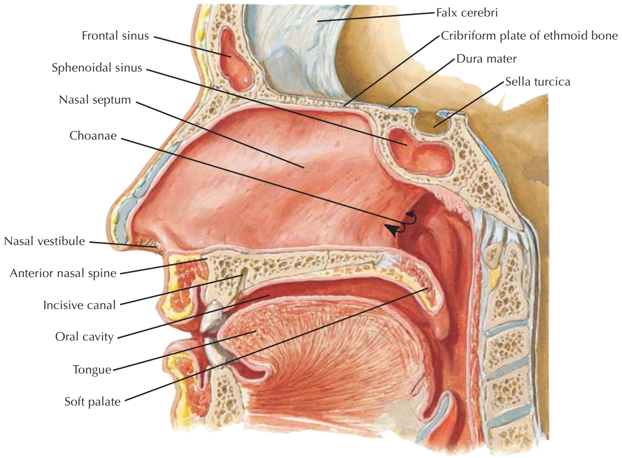


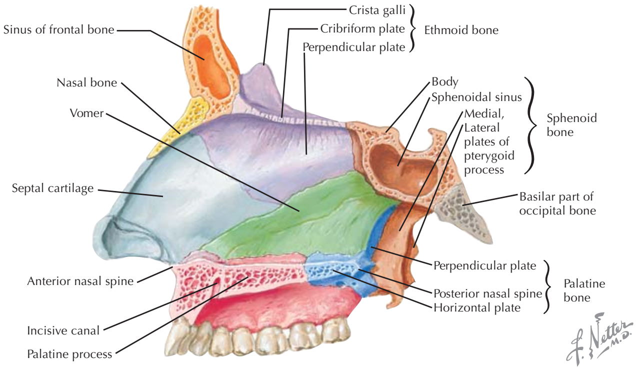


Nasal Cavity

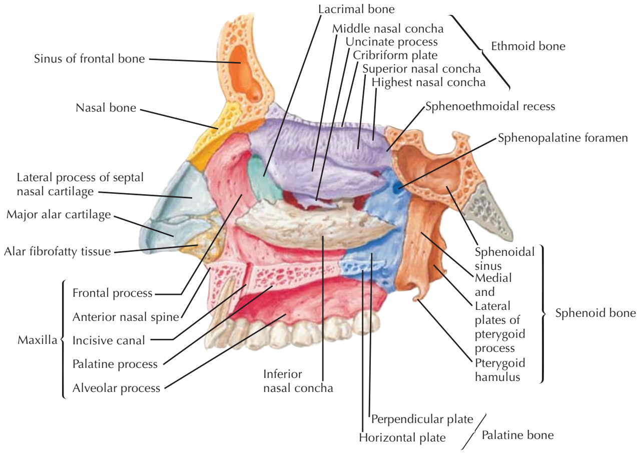
BOUNDARIES AND RELATIONS OF THE NASAL CAVITY

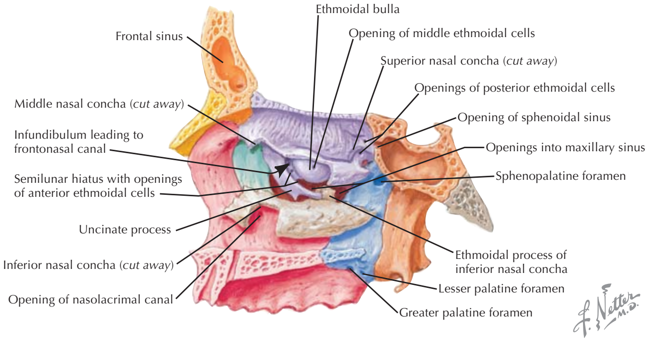
RELATIONS	
Border	**Structures**
Superior	Frontal sinus, sphenoid sinus, anterior cranial fossa with frontal lobe of the brain
Inferior	Palate, oral cavity
Medial	Other half of nasal cavity
Lateral	Maxillary sinus, ethmoid sinuses, orbit, and pterygopalatine fossa
BOUNDARIES	
Border	**Structures**
Superior	Nasal, frontal, cribriform plate of the ethmoid, body of the sphenoid
Inferior	Palatine process of the maxilla, horizontal plate of the palatine
Anterior	External nose
Posterior	Choanae





BOUNDARIES AND RELATIONS OF THE NASAL CAVITY *CONTINUED*

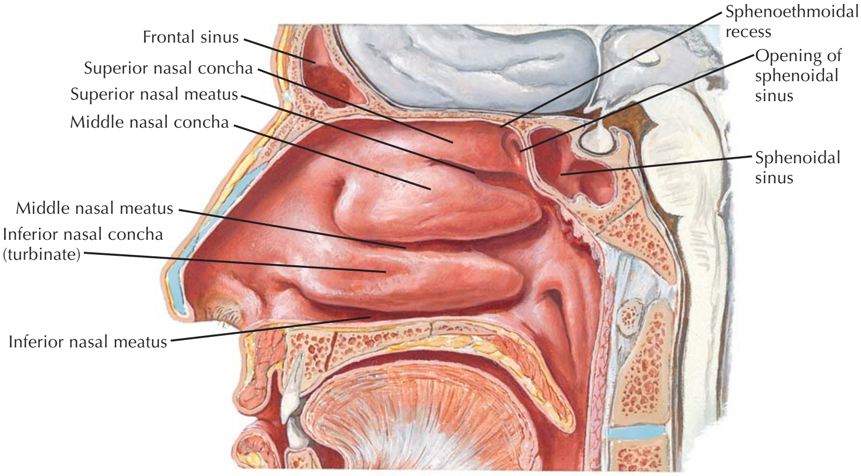


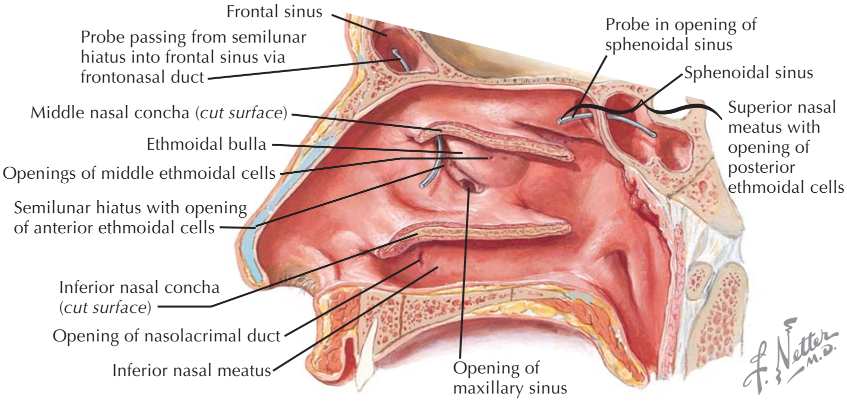


Nasal Cavity

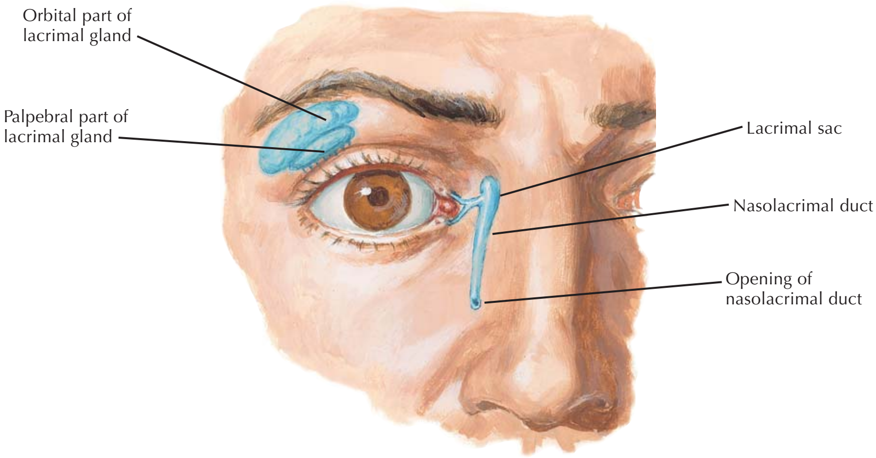
CONCHAE OF THE NASAL CAVITY

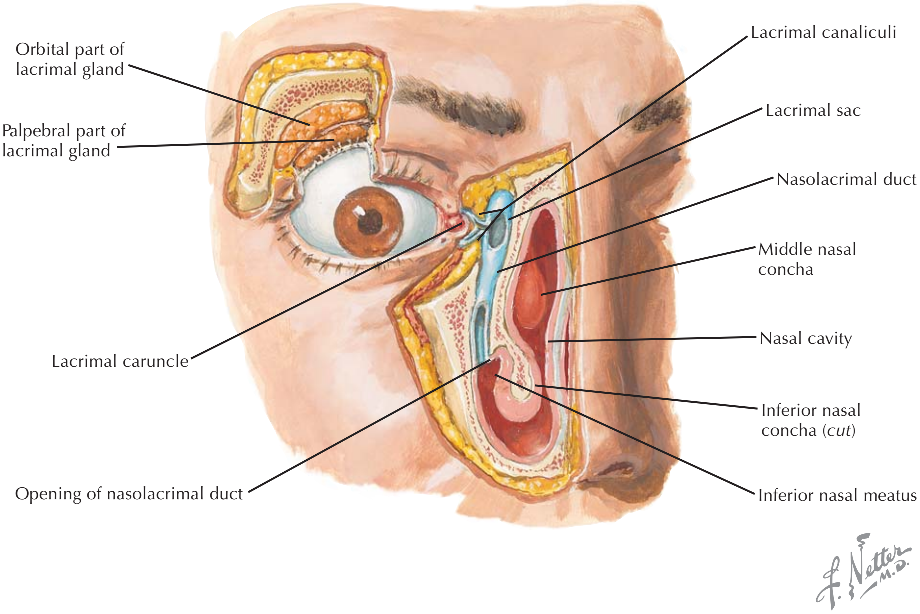
Concha	Regions Drained	Location	Structures Drained
Superior	Sphenoethmoidal recess	Superior to the superior meatus	Sphenoidal sinus
	Superior meatus	Inferior to the superior meatus	Posterior ethmoid sinus
Middle	Middle meatus	Inferior to the middle meatus	Anterior ethmoidal sinus Middle ethmoidal sinus Maxillary sinus Frontal sinus
Inferior	Inferior meatus	Inferior to the inferior meatus	Nasolacrimal duct





CONCHAE OF THE NASAL CAVITY *CONTINUED*





Nasal Cavity

VASCULAR SUPPLY OF THE NASAL CAVITY

The blood supply to the nasal cavity arises from 3 major *arteries*:

- Ophthalmic
- Maxillary
- Facial

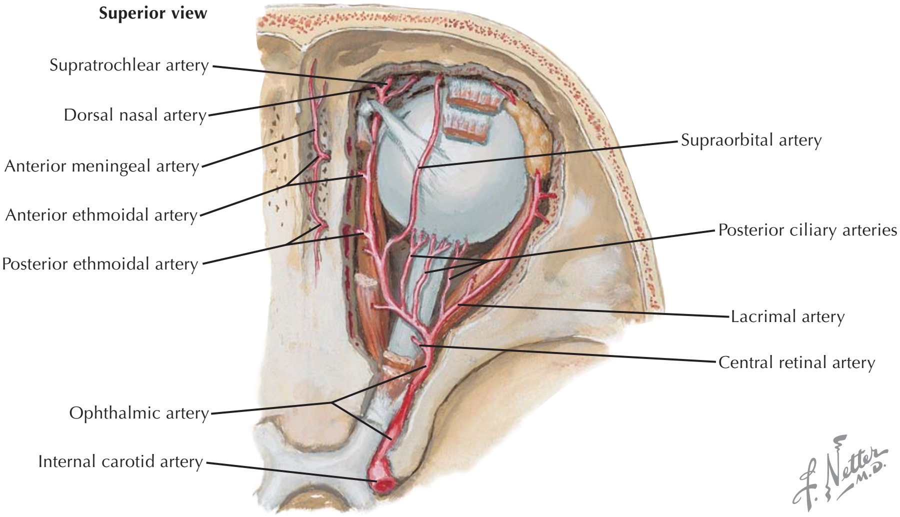
These 3 vessels are derived from the external and internal carotid arteries and generally follow the paths of the nerves

The *veins* generally correspond to the arteries

ARTERIAL SUPPLY		
Artery	**Source**	**Course**
Ophthalmic	Internal carotid a.	Enters the orbit through the optic foramen immediately inferior and lateral to the optic n. Crosses the optic n. to reach the medial part of the orbit While in the orbit, besides the orbital branches, it gives rise to 2 major branches that supply the nasal cavity: • Anterior ethmoid • Posterior ethmoid
Anterior ethmoid	Ophthalmic a.	Travels with the nasociliary n. through the anterior ethmoidal foramen Enters the anterior cranial fossa, where it gives rise to a meningeal branch and nasal branches that descend into the nasal cavity Supplies branches to the lateral wall and septum of the nose before giving rise to the external nasal a., which supplies the nose
Posterior ethmoid	Ophthalmic a.	Travels through the posterior ethmoidal foramen Enters the anterior cranial fossa, where it gives rise to a meningeal branch and nasal branches that descend into the nasal cavity through the cribriform plate Supplies part of the lateral wall near the superior nasal concha and the posterosuperior portion of the nasal septum
Maxillary	1 of 2 terminal branches of the external carotid a.	Gives rise to a series of branches; 2 provide blood supply to the nasal cavity: • Sphenopalatine • Greater palatine
Sphenopalatine	3rd part of the maxillary a.	After passing through the sphenopalatine foramen, enters the nasal cavity, where it gives rise to the posterior superior nasal branches • The posterior superior *lateral* branch supplies the nasal concha, mucous membranes, and lateral wall • The posterior superior *medial* branch continues along the nasal septum to enter the hard palate via the incisive canal
Greater palatine	A branch of the descending palatine, arising from the 3rd part of the maxillary a.	Travels in the palatine canal, where it splits into the lesser palatine a. (supplies the soft palate and palatine tonsil), and greater palatine a., which exits the greater palatine foramen and passes anteriorly toward the incisive foramen (supplies the hard palate gingiva, mucosa, and palatal glands) and anastomoses with the terminal branch of the sphenopalatine a. that exits the incisive foramen Also provides branches that supply the area of the inferior meatus

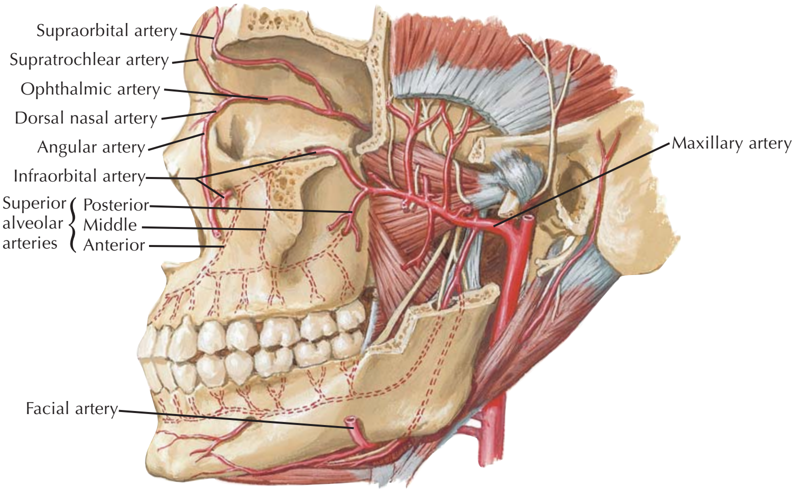
VASCULAR SUPPLY OF THE NASAL CAVITY *CONTINUED*

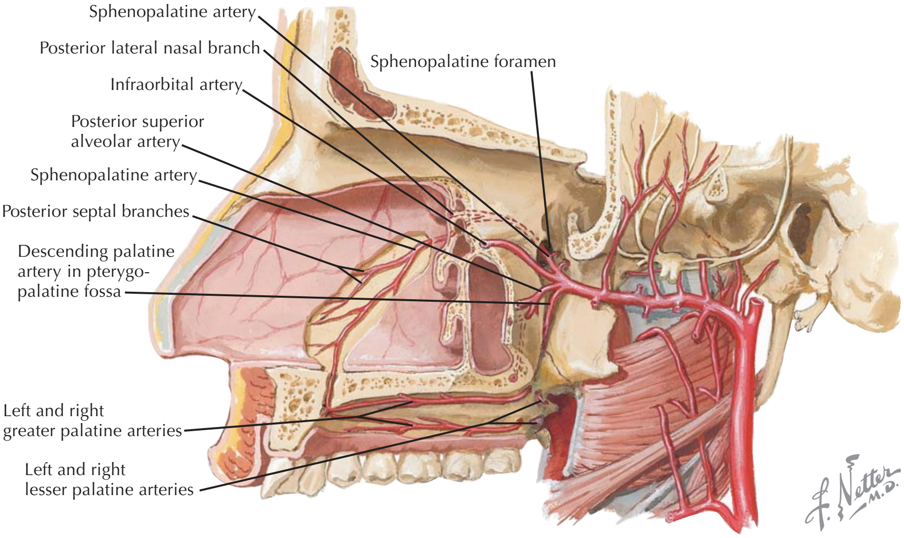
ARTERIAL SUPPLY		
Artery	**Source**	**Course**
Facial	External carotid a. in the carotid triangle of the neck	Tortuous Passes superiorly immediately deep to the posterior belly of the digastric and the stylohyoid mm. Passes along the submandibular gland giving rise to the submental a. that helps supply the gland Passes superiorly over the body of the mandible at the masseter m. Continues anterosuperiorly across the cheek to the angle of the mouth, giving rise to the superior and inferior labial aa. Passes superiorly along the side of the nose, giving rise to the lateral nasal a. Continues on the side of the nose as the angular a. that terminates along the medial side of the eye
Superior labial	Facial	Supplies the upper lip Gives rise to the septal branch that travels to the nasal septum The major blood supply to the anterior part of the nasal septum



Nasal Cavity

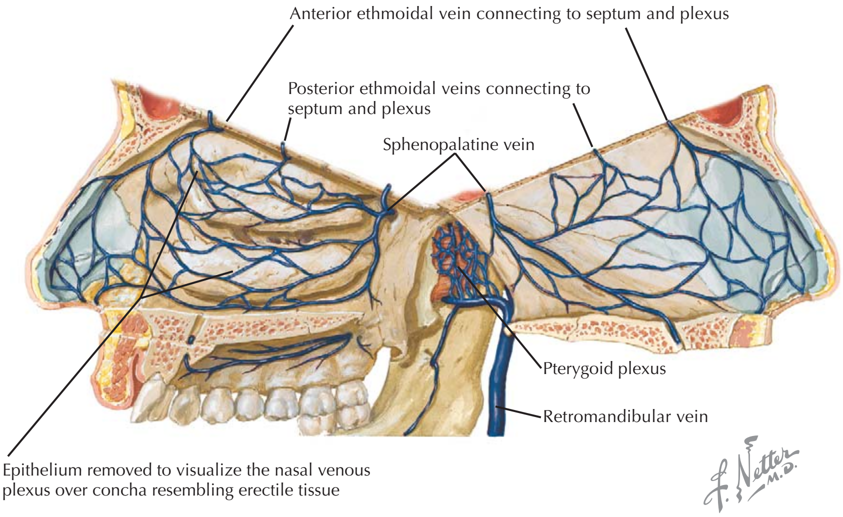
VASCULAR SUPPLY OF THE NASAL CAVITY *CONTINUED*





VASCULAR SUPPLY OF THE NASAL CAVITY *CONTINUED*

VENOUS DRAINAGE	
Vein	**Course**
A well-developed cavernous plexus lies deep to the mucous membrane The plexus drains into the following series of veins	
Emissary	Vein from the cavernous plexus in the nasal cavity passes through the foramen cecum to drain into the superior sagittal sinus
Sphenopalatine	Blood from the venous plexus along the posterior portion of the nasal cavity drains to the sphenopalatine v. Travels through the sphenopalatine foramen to enter the pterygoid plexus
Ethmoidal branches	Blood from the venous plexus in the anterior portion of the nasal cavity drains into ethmoid branches, which follow the ethmoid aa. to terminate in the ophthalmic v. and/or facial v.

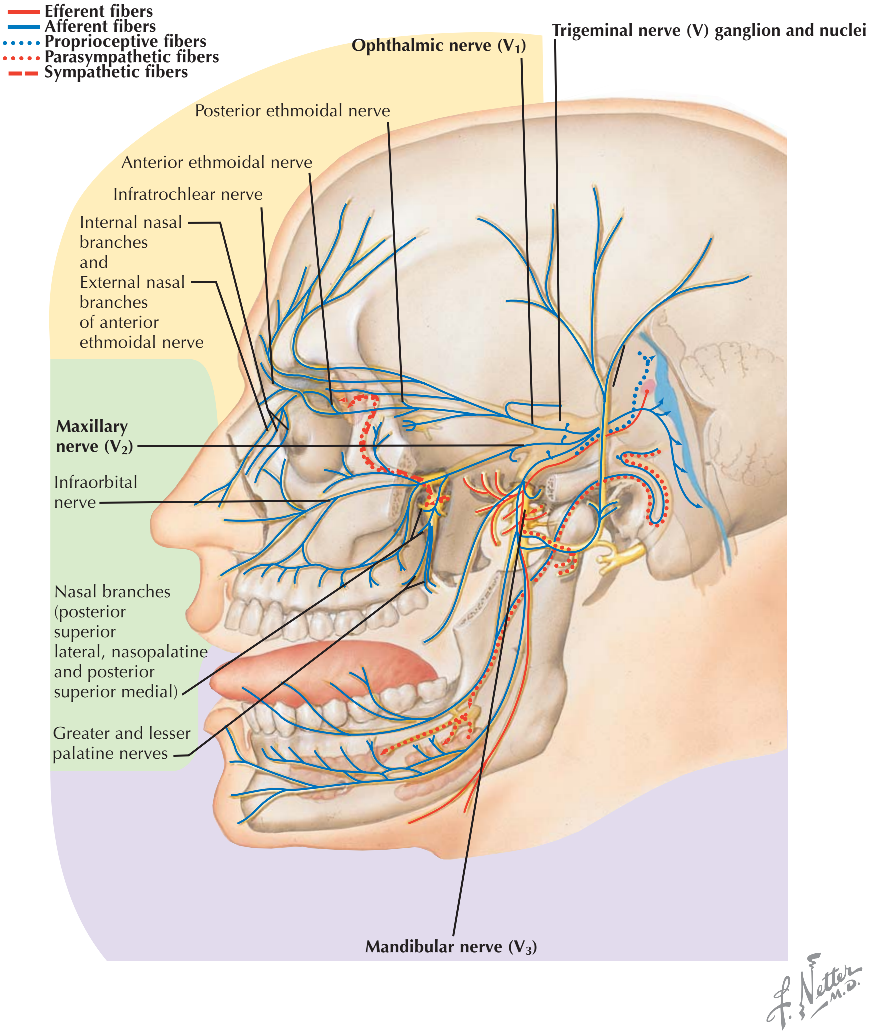


Nasal Cavity

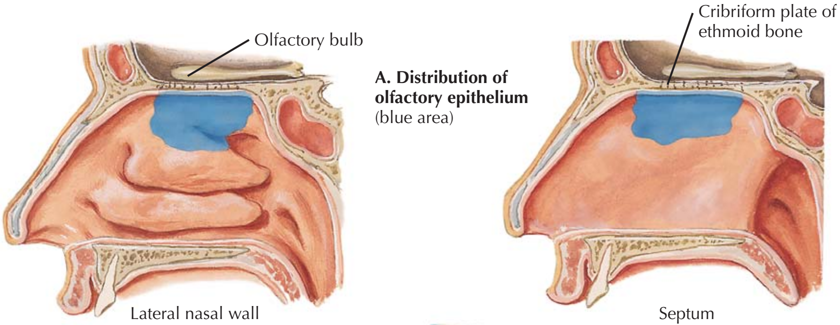
NERVE SUPPLY OF THE NASAL CAVITY

2 major types of sensory innervation to the nasal cavity:

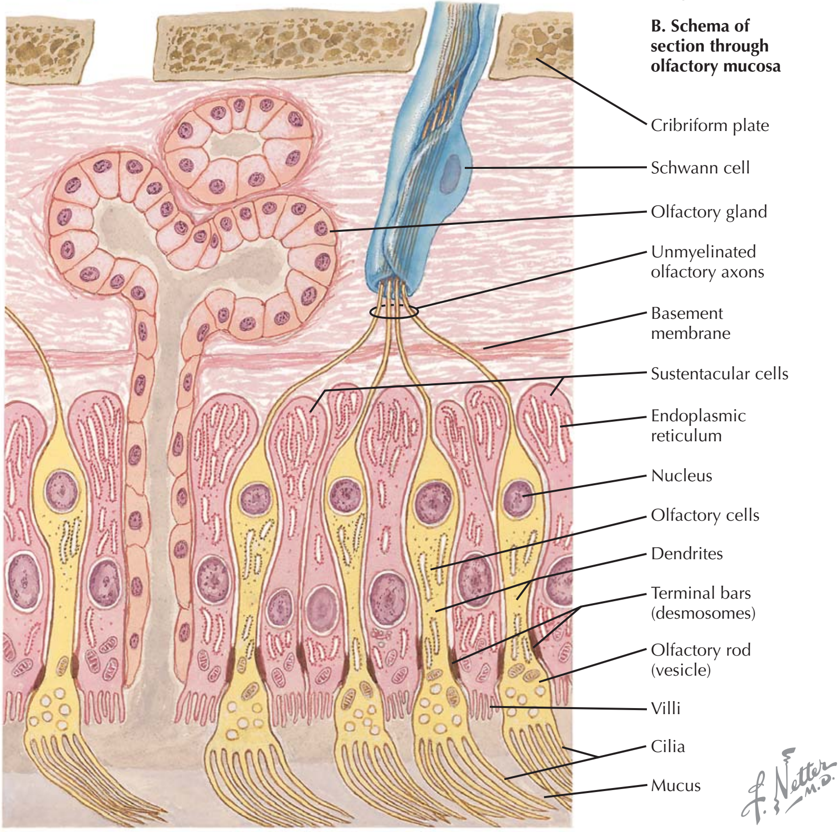
- Olfaction (special visceral afferent) via the olfactory nerve
- General sensation (general somatic afferent) via ophthalmic and maxillary divisions of the trigeminal nerve



NERVE SUPPLY OF THE NASAL CAVITY *CONTINUED*



A. Distribution of olfactory epithelium (blue area)



B. Schema of section through olfactory mucosa

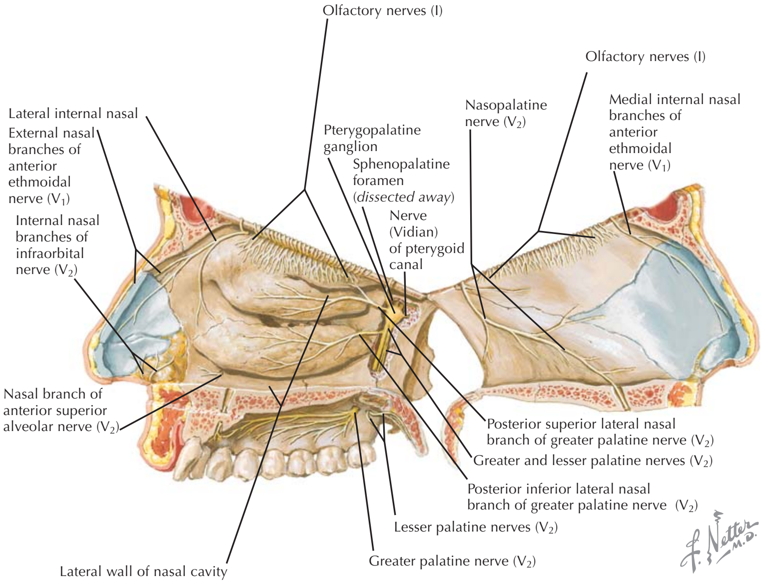
Nasal Cavity

NERVE SUPPLY OF THE NASAL CAVITY *CONTINUED*

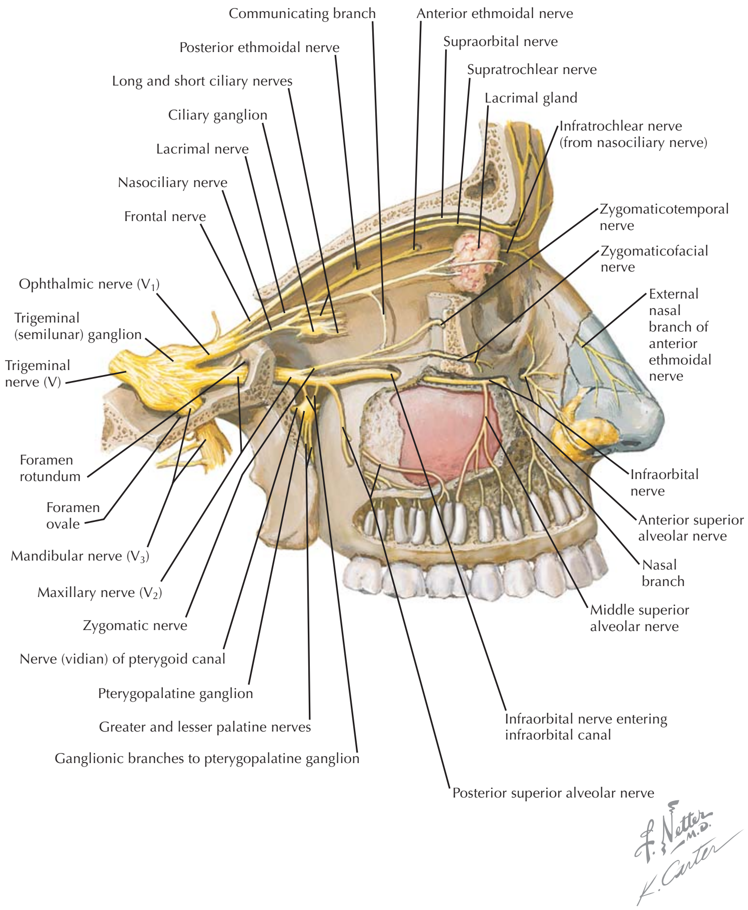
<table>
<tr><th colspan="3">SENSORY INNERVATION</th></tr>
<tr><th colspan="3">Olfaction</th></tr>
<tr><td colspan="3">The olfactory epithelium is found in the roof of the nasal cavity including the adjacent superior portions of the lateral wall of the nasal cavity and the nasal septum
Roughly 20 to 25 small olfactory n. fibers, which collectively form the olfactory nerves per side, travel superiorly through the cribriform plate into the anterior cranial fossa to join the olfactory bulb</td></tr>
<tr><th colspan="3">GENERAL SENSATION</th></tr>
<tr><th>Nerve</th><th>Source</th><th>Course</th></tr>
<tr><td>Ophthalmic division of the trigeminal</td><td>Trigeminal n.</td><td>Sensory
Arises from the main nerve in the middle cranial fossa
Passes anterior on the lateral wall of the cavernous sinus immediately inferior to the oculomotor and trochlear nn., but superior to the maxillary division of the trigeminal n.
Immediately before entering the orbit, through the superior orbital fissure, it divides into 3 major branches:
• Lacrimal
• Frontal
• Nasociliary</td></tr>
<tr><td><i>Anterior ethmoid</i></td><td>Nasociliary n. on the medial wall of the orbit</td><td>Enters the anterior ethmoid foramen and travels through the canal to enter the anterior cranial fossa
While descending toward the nasal cavity, it provides innervation to the anterior parts of the middle and inferior conchae, as well as the region anterior to the nasal concha</td></tr>
<tr><td>Maxillary division of the trigeminal</td><td>Trigeminal n.</td><td>Sensory
Travels along the lateral wall of the cavernous sinus
Passes from the middle cranial fossa into the pterygopalatine fossa via the foramen rotundum
Within the pterygopalatine fossa, it gives rise to 4 branches:
• Infraorbital—this is the continuation of the maxillary
• Posterior superior alveolar
• Zygomatic
• Ganglionic</td></tr>
<tr><td><i>Infraorbital</i></td><td>Maxillary division of the trigeminal n.</td><td>Passes through the inferior orbital fissure to enter the orbit
Passes anteriorly through the infraorbital groove and infraorbital canal and exits onto the face via the infraorbital foramen
While in the infraorbital canal, it gives rise to the anterior superior alveolar n., which has a small branch that supplies the nasal cavity in the region of the inferior meatus and inferior corresponding portion of the nasal septum (in addition to supplying the maxillary sinus; the maxillary central incisor, lateral incisor, and canine teeth; and the gingiva and mucosa alongside these teeth)</td></tr>
<tr><td><i>Nasopalatine</i></td><td rowspan="2">Pterygopalatine ganglion in the pterygopalatine fossa</td><td>Passes through the sphenopalatine foramen to enter the nasal cavity
Passes along the superior portion of the nasal cavity to the nasal septum, where it travels anteroinferiorly to the incisive canal supplying the septum</td></tr>
<tr><td><i>Posterior inferior nasal branch of the greater palatine</i></td><td>Passes through the palatine canal to enter the hard palate via the greater palatine foramen
While descending in the palatine canal, it gives rise to a posterior inferior nasal branch
Supplies the posterior part of the lateral wall of the nasal cavity in the region of the middle meatus</td></tr>
</table>

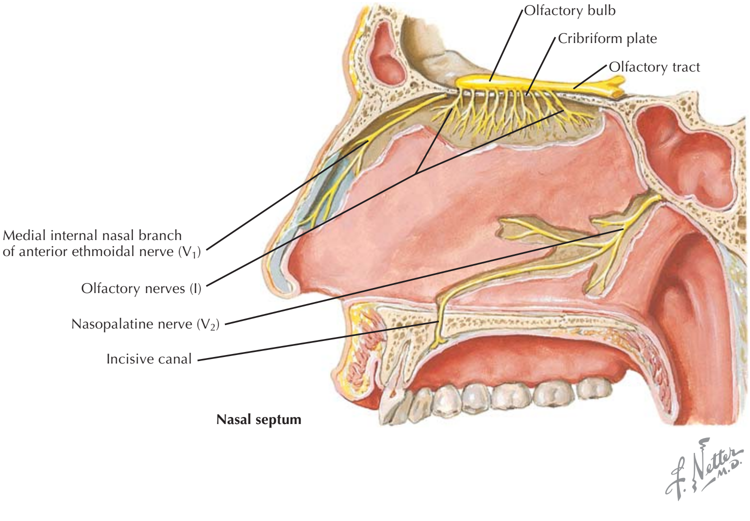
NERVE SUPPLY OF THE NASAL CAVITY *CONTINUED*

GENERAL SENSATION		
Nerve	**Source**	**Course**
Posterior superior nasal	Arises from the pterygopalatine ganglion in the pterygopalatine fossa	Passes through the sphenopalatine foramen to enter the nasal cavity and branches into 2 nerves: ● Posterior medial superior nasal ● Posterior lateral superior nasal
Posterior lateral superior nasal	Posterior superior nasal n. from the pterygopalatine ganglion	Supplies the posterosuperior portion of the lateral wall of the nasal cavity in the region of the superior and middle concha
Posterior medial superior nasal		Supplies the posterior portion of the nasal septum



NERVE SUPPLY OF THE NASAL CAVITY *CONTINUED*





Nasal septum

NERVE SUPPLY OF THE NASAL CAVITY *CONTINUED*

Autonomic fibers are distributed through the sensory branches of the maxillary division of the trigeminal nerve via the pterygopalatine ganglion (parasympathetics) and the superior cervical ganglion (sympathetics)

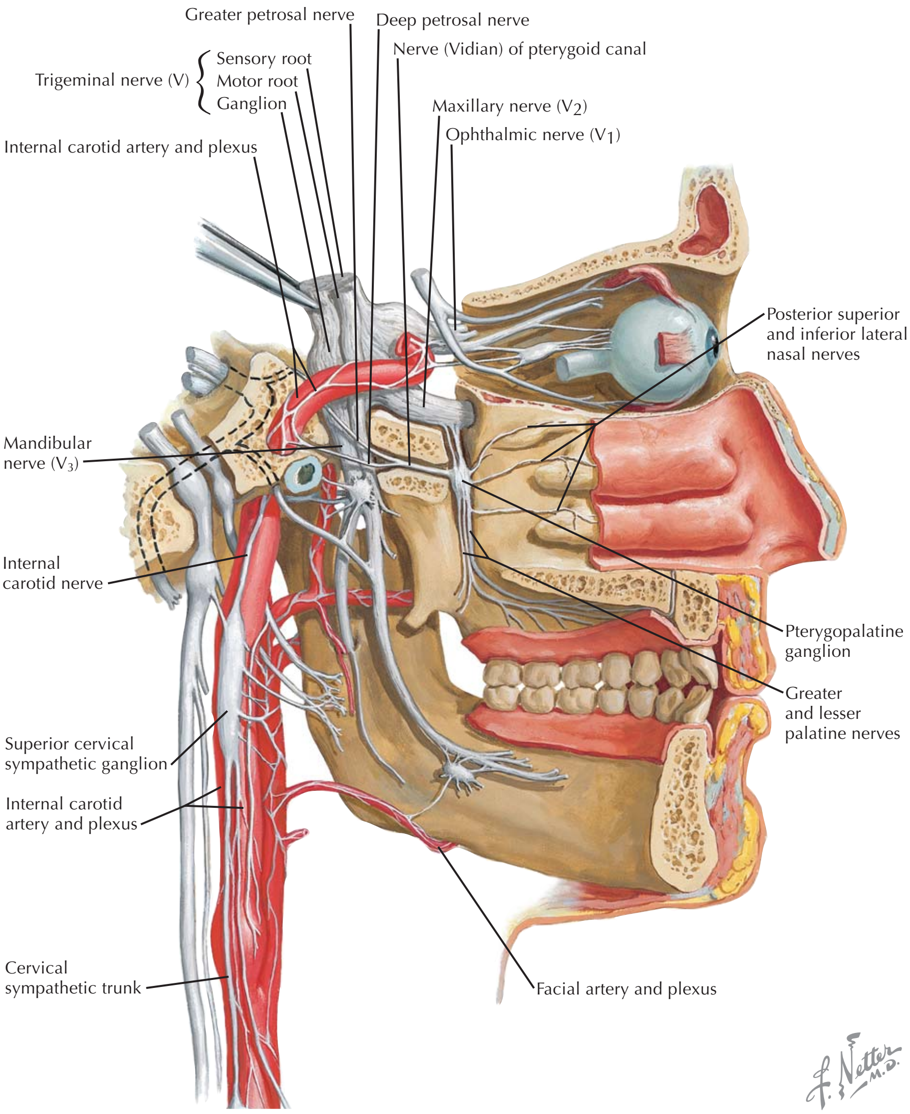
Autonomics travel to the glands and blood vessels of the nasal cavity

AUTONOMIC INNERVATION			
Type of Neuron	Name of Cell Body	Characteristics of the Cell Body	Course of the Neuron
Autonomics: Anatomic Pathway for Parasympathetics of the Nasal Cavity			
Preganglionic neuron	Superior salivatory nucleus	A collection of nerve cell bodies located in the pons Travel through the nervus intermedius of the facial nerve into the internal acoustic meatus In the *facial canal,* the facial nerve gives rise to 2 parasympathetic branches: • Greater petrosal n. • Chorda tympani n.	**Greater Petrosal Nerve** Greater petrosal n. exits the hiatus for the greater petrosal n. toward the foramen lacerum, where it joins the deep petrosal n. (sympathetics) to form the nerve of the pterygoid canal (vidian n.) Vidian n. passes through the pterygoid canal and enters the pterygopalatine fossa, where it joins with the pterygopalatine ganglion
Postganglionic neuron	Pterygopalatine ganglion	Pterygopalatine ganglion is a collection of nerve cell bodies located in the pterygopalatine fossa Postganglionic parasympathetic fibers that arise in the pterygopalatine ganglion are distributed to the ophthalmic and maxillary divisions of the trigeminal n. to the: • Lacrimal gland • Nasal glands • Palatine glands • Pharyngeal glands	**Maxillary Division Distribution** Postganglionic fibers travel along the maxillary division of the trigeminal n. to be distributed along its branches that are located in the nasal cavity, oral cavity, and pharynx (e.g., nasopalatine, greater palatine) These fibers innervate: • Nasal glands • Palatine glands • Pharyngeal glands
AUTONOMICS: ANATOMIC PATHWAY FOR SYMPATHETICS OF THE NASAL CAVITY			
Type of Neuron	Name of Cell Body	Characteristics of the Cell Body	Course of the Neuron
Preganglionic neuron	Intermediolateral horn nucleus	Collection of nerve cell bodies located in the lateral horn nucleus of the spinal cord between spinal segments T1 and T3 (and possibly T4)	Arise from the intermediolateral horn nuclei from T1 to T3 (4) Travel through the ventral root of the spinal cord to the spinal nerve Enter the sympathetic chain via a white ramus communicantes Once in the sympathetic chain, the preganglionic fibers for the eye ascend and synapse with postganglionic fibers in the superior cervical ganglion

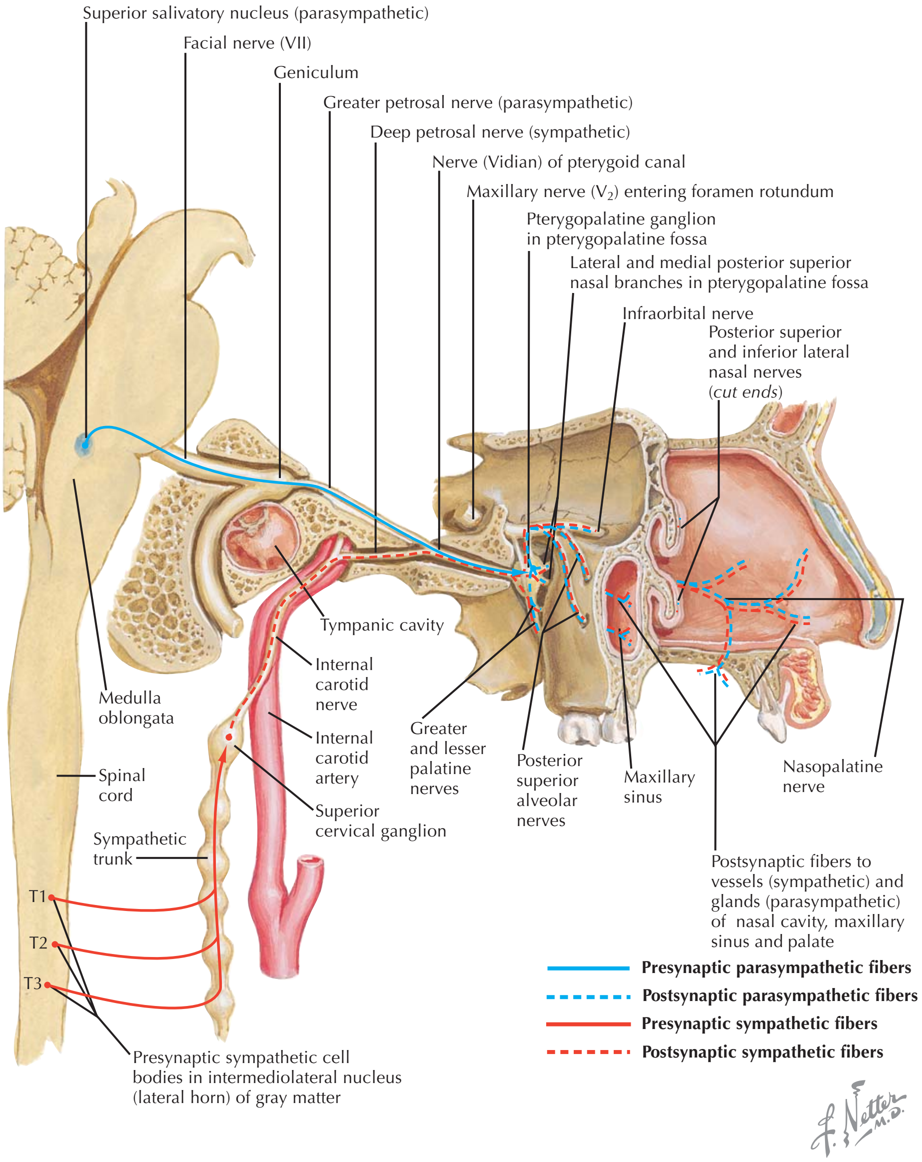
NERVE SUPPLY OF THE NASAL CAVITY *CONTINUED*

AUTONOMICS: ANATOMIC PATHWAY FOR SYMPATHETICS OF THE NASAL CAVITY			
Type of Neuron	**Name of Cell Body**	**Characteristics of the Cell Body**	**Course of the Neuron**
Postganglionic neuron	Superior cervical ganglion	Collection of nerve cell bodies located in the superior cervical ganglion, which is located at the base of the skull Postganglionic sympathetic fibers follow the internal carotid or external carotid a. to pass near their respective effector organs (e.g., nasal cavity)	**Nasal Cavity and Palate** Postganglionic sympathetic fibers follow both the *internal* and *external* carotid aa.: • Postganglionic sympathetic fibers from the internal carotid branch in the region of the foramen lacerum to form the deep petrosal n. The deep petrosal n. joins the greater petrosal n. (parasympathetics) to form the nerve of the pterygoid canal (vidian n.) Postganglionic sympathetic fibers travel along the branches of the maxillary division of the trigeminal n., associated with the pterygopalatine ganglion, to be distributed along its branches in the nasal cavity and palate • Postganglionic sympathetic fibers from the external carotid branch and follow the maxillary a. These fibers travel along the branches of the maxillary a., to be distributed along the nasal cavity and palate

NERVE SUPPLY OF THE NASAL CAVITY *CONTINUED*



NERVE SUPPLY OF THE NASAL CAVITY *CONTINUED*



11 Clinical Correlate

EPISTAXIS

Epistaxis, or nosebleed, is a hemorrhage from the nasal cavity or nose

Classified by bleeding location:
- Anterior
- Posterior

Causes
- Trauma (blows to the face, fractures, nose picking)
- Sinus infections
- Rhinitis
- Arid environment
- Hypertension
- Hematologic disorders
- Neoplasms

Anterior Epistaxis

The most common form (in about 90% of cases)

Usually found along the nasal septum and results from bleeding along Kiesselbach's plexus

Many nosebleeds are due to trauma to the septal branch of the superior labial artery from the facial artery

Typically managed with local pressure

May be controlled with cautery via a silver nitrate stick or anterior nasal packing if bleeding is persistent

With anterior epistaxis, another treatment, although somewhat drastic, is septal dermoplasty
- The thin septal mucosa is replaced by a thicker graft of skin
- Often used to treat nosebleeds caused by hereditary hemorrhagic telangiectasia or septal perforations

Posterior Epistaxis

Usually found along the posterior part of the nasal cavity

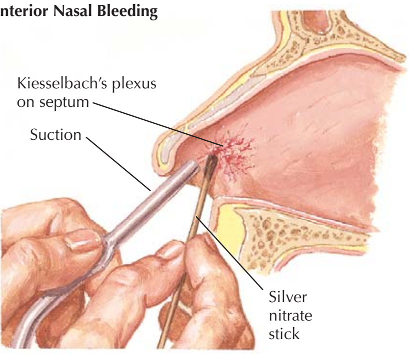
More difficult to treat and may be accomplished with posterior nasal packing or a balloon catheter

Severe posterior epistaxis may require ligation of the maxillary artery

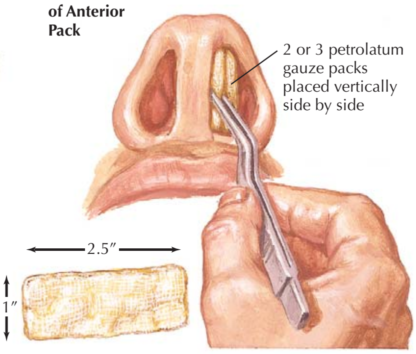
Clinical Correlate

EPISTAXIS *CONTINUED*

Cauterization of Anterior Nasal Bleeding



Placement of Anterior Pack



Septal Dermoplasty for Recurrent Severe Anterior Epistaxis

A. Incision

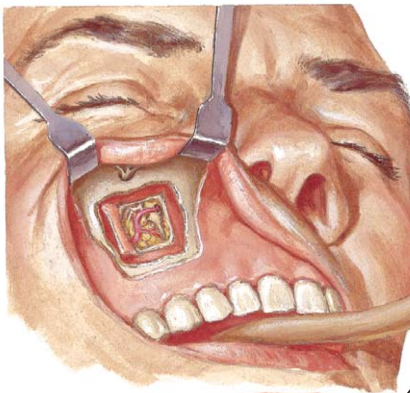
B. Flap elevated exposing telangiectasia on septal mucosa

C. Septal mucosa excised in area of telangiectasia; perichondrium preserved

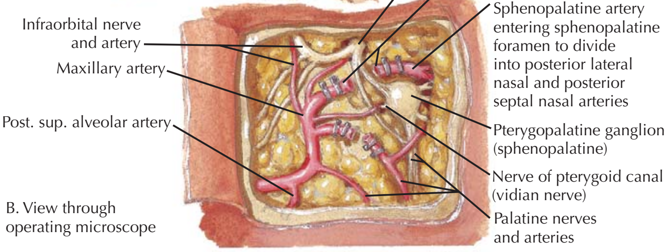
D. Split-thickness skin graft applied

E. Flap sutured; intranasal pack (finger cot) then applied over Silastic sheet

Transantral Ligation of Maxillary Artery



A. 3rd part of maxillary artery exposed via supragingival transantral approach



B. View through operating microscope

11 Clinical Correlate

DEVIATED SEPTUM

A severe shift of the nasal septum from the midline

Causes

- Trauma
- Birth defects

Results

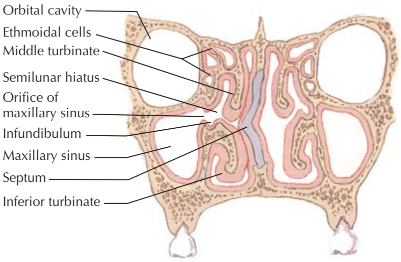
Occlusion of one side, either partial or complete, producing difficulty in breathing or blocked air flow on that side

May also cause:

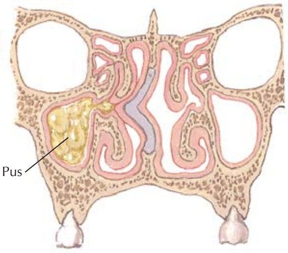
- Sinusitis
- Epistaxis
- Nasal congestion

Treatment

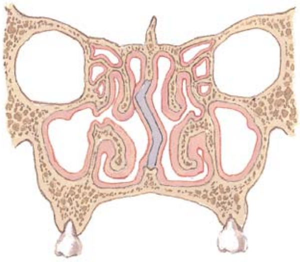
May be treated by septoplasty



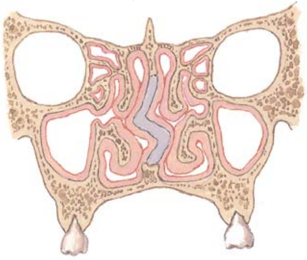
A. Septal bulge occluding airway unilaterally



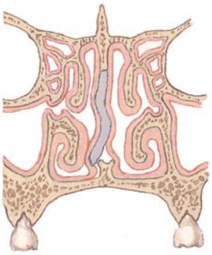
B. Septum occluding semilunar hiatus and obstructing outflow from maxillary sinus with resultant infection



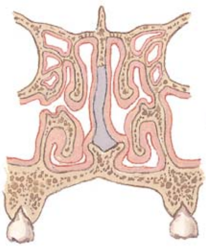
C. Septum impinging on middle turbinate and causing pain via maxillary division of trigeminal nerve



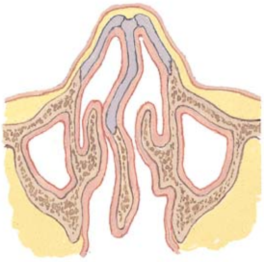
D. S-shaped septal deformity occluding airway bilaterally



E. Septum dislocated from maxillary crest



F. Excessive "wings" on maxillary crest



G. Anteroposterior S-shaped septal bulge (horizontal section)

Clinical Correlate

RHINITIS

An inflammation of the mucosa of the nasal cavity that results in:

- Nasal congestion
- Sneezing
- Rhinorrhea
- Nasal itching

May involve the eyes, ears, sinuses, and throat and cause headaches

Most commonly caused by allergic rhinitis

Allergic Rhinitis

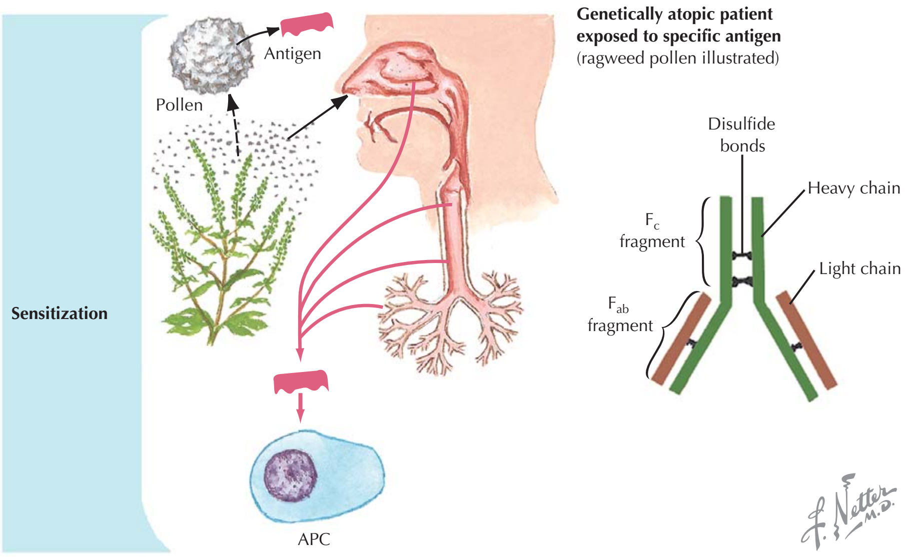
Can be associated with nasal polyps, deviated septum, and asthma

Caused by an allergen inducing an immunoglobulin E (IgE)-mediated response on the mast cells

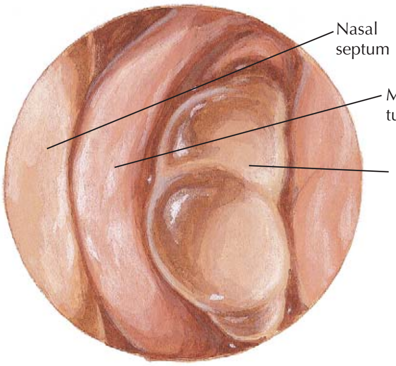
Because mast cells are located on the nasal mucosa, an allergen can bind to the mast cell, resulting in the release of histamines, prostaglandins, cytokines, and leukotrienes

Typically treated with decongestants, antihistamines, and steroids

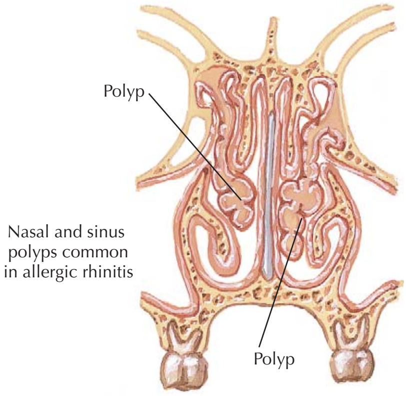
Mechanism of Type 1 (Immediate) Hypersensitivity



RHINITIS *CONTINUED*



Endoscopic view of nasal polyp protruding from middle meatus



Nasal polyps most often bilateral in allergic sinusitis

CHAPTER 12

PARANASAL SINUSES

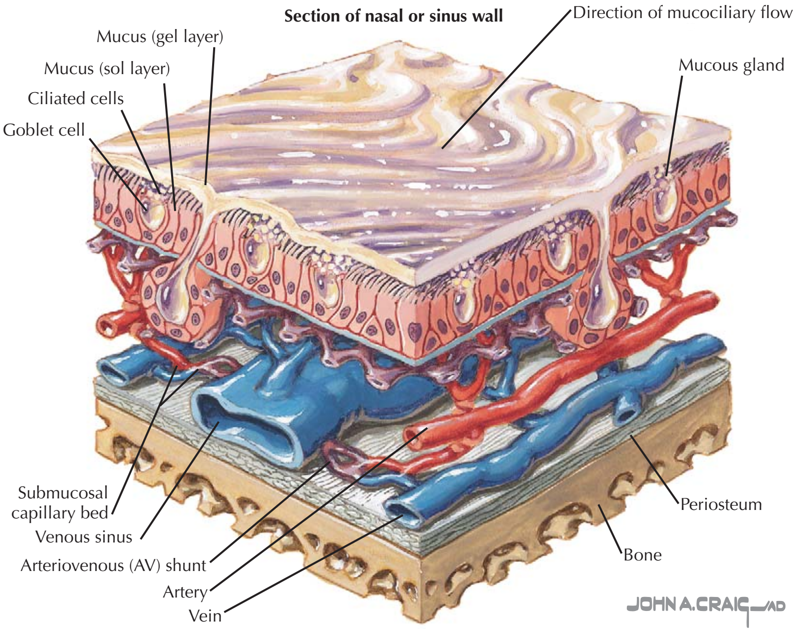
Overview and Topographic Anatomy

GENERAL INFORMATION

Paranasal sinuses: invaginations from the nasal cavity that drain into spaces associated with the lateral nasal wall

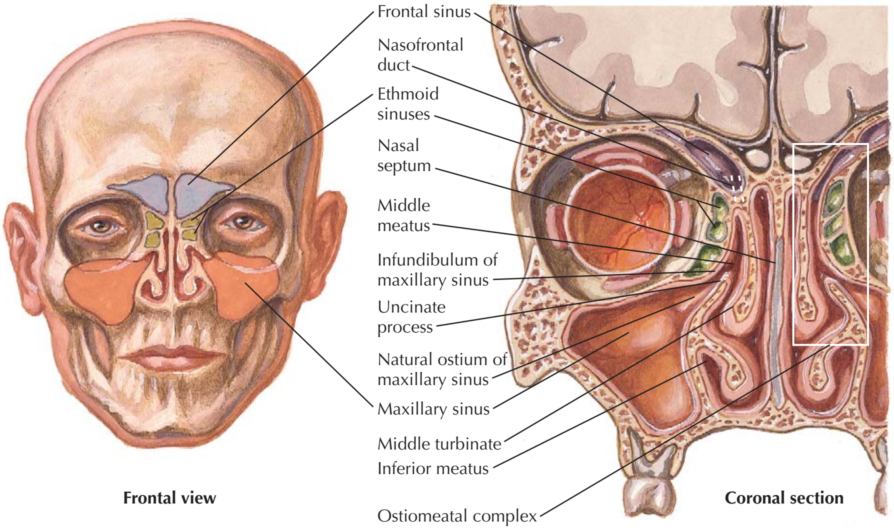
Each is lined by a respiratory epithelium

Morphology of the sinuses is highly variable



Paranasal sinus infection that spreads to skull bones

GENERAL INFORMATION *CONTINUED*

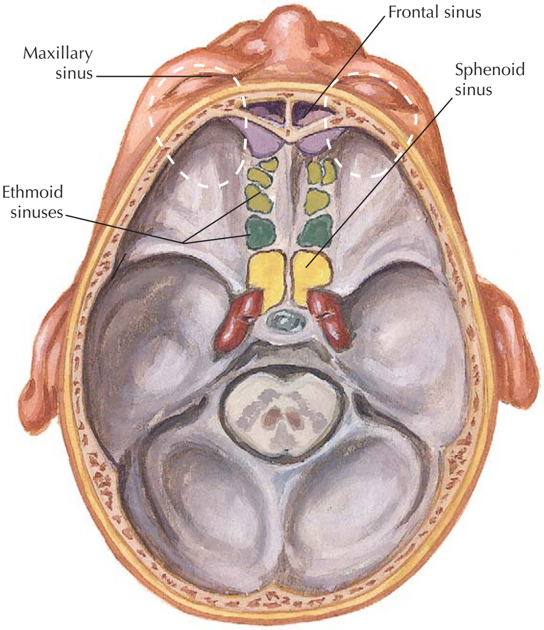


Frontal view

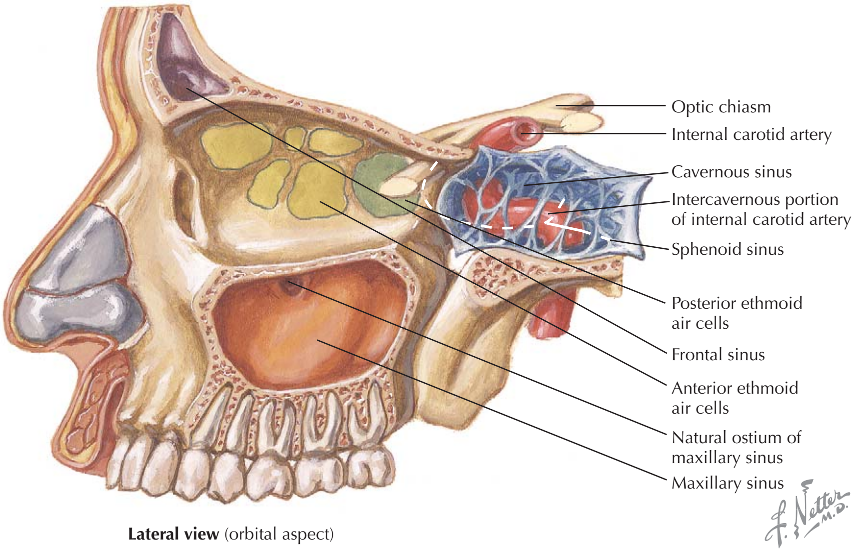
Coronal section

FEATURES OF THE PARANASAL SINUSES				
Sinus	**Location**	**Comment**	**Artery**	**Nerve**
Frontal	Within frontal bone	Flattened triangular shape	Ophthalmic branches	Ophthalmic division of the trigeminal n.
Maxillary	Within maxillary bone	Pyramidal shape, 1st to develop	Maxillary branches	Maxillary division of the trigeminal n.
Ethmoid	Within ethmoid bone	3 to 18 irregularly shaped cells	Ophthalmic and maxillary branches	Ophthalmic and maxillary divisions of the trigeminal n.
Sphenoid	Within sphenoid bone	Cuboid shape		

GENERAL INFORMATION *CONTINUED*



Superior view



Lateral view (orbital aspect)

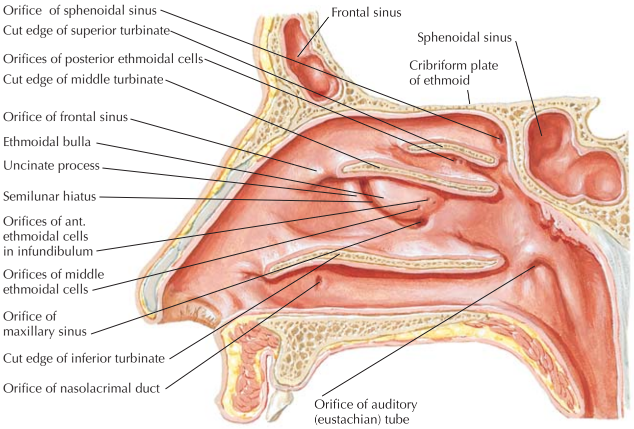
DRAINAGE OF THE PARANASAL SINUSES AND ASSOCIATED STRUCTURES

All paranasal sinuses drain into the nasal cavity

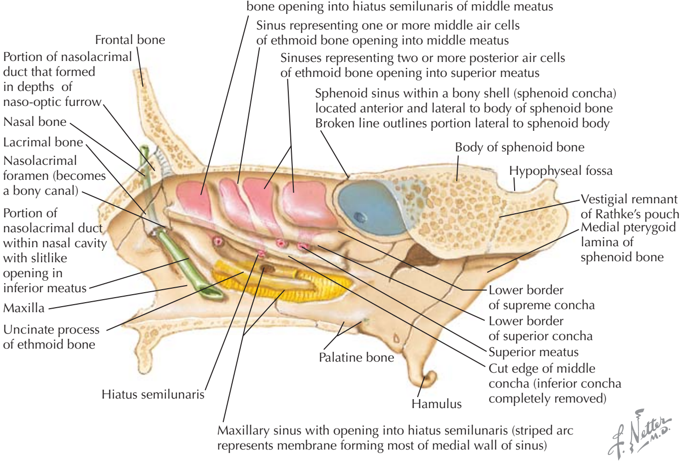
Different sinuses serve as drainage conduits for different regions

SUMMARY OF PARANASAL SINUS DRAINAGE		
Region Drained	**Location**	**Structure(s) Drained**
Sphenoethmoidal recess	Superior to the superior concha	Sphenoid sinus
Superior meatus	Inferior to the superior concha	Posterior ethmoid sinus
Middle meatus	Inferior to the middle concha	Anterior ethmoid sinus Middle ethmoid sinus Maxillary sinus Frontal sinus
Inferior meatus	Inferior to the inferior concha	Nasolacrimal duct

Anatomy of the Nose



Bones of nasal cavity and nasal sinuses



12 Frontal Sinus

GENERAL INFORMATION

The two frontal sinuses typically are asymmetrical

Rudimentary at birth and usually well-developed by the age of 7 or 8 years

Display a prime expansion when the 1st deciduous molars erupt and another when the permanent molars begin to appear at about age 6

Drainage varies; often drain in front of, above, or into the ethmoidal infundibulum

Primary lymphatic drainage is to the submandibular lymph nodes

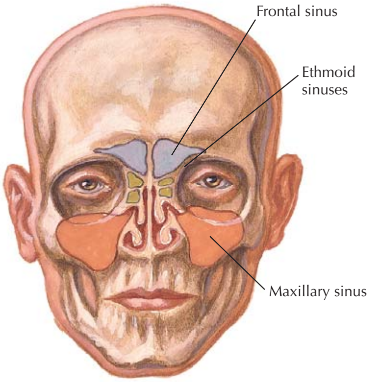
The frontal sinus receives its nerve supply from branches of the ophthalmic division of the trigeminal nerve

Relations of Sinus

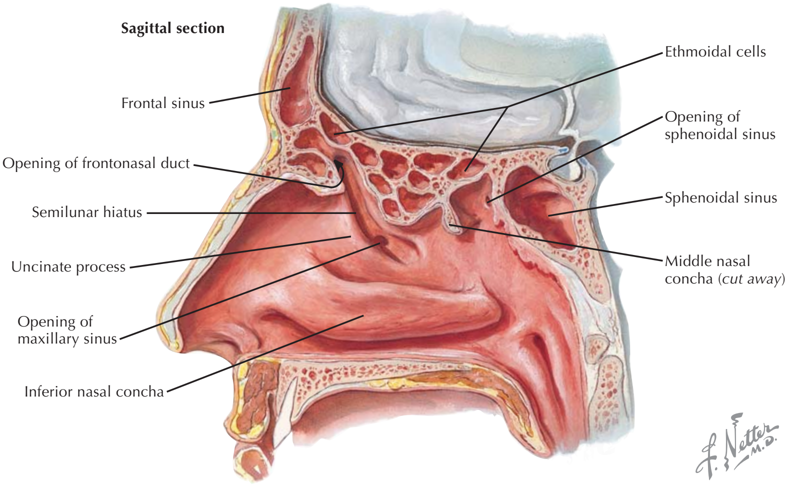
- *Superior:* anterior cranial fossa and contents
- *Inferior:* orbit, anterior ethmoidal sinuses, nasal cavity
- *Anterior:* forehead, superciliary arches
- *Posterior:* anterior cranial fossa and contents
- *Medial:* other frontal sinus

Location of Ostium

Middle meatus



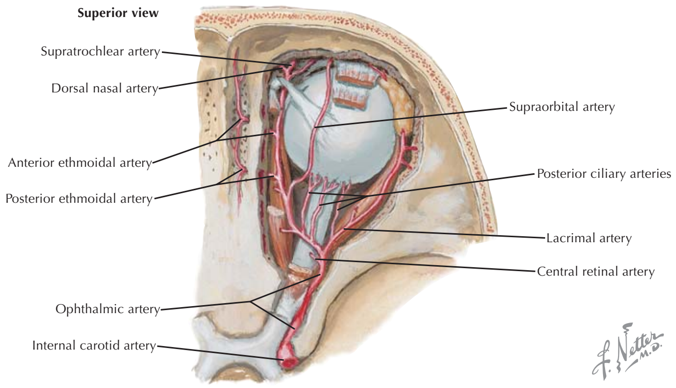
Frontal view

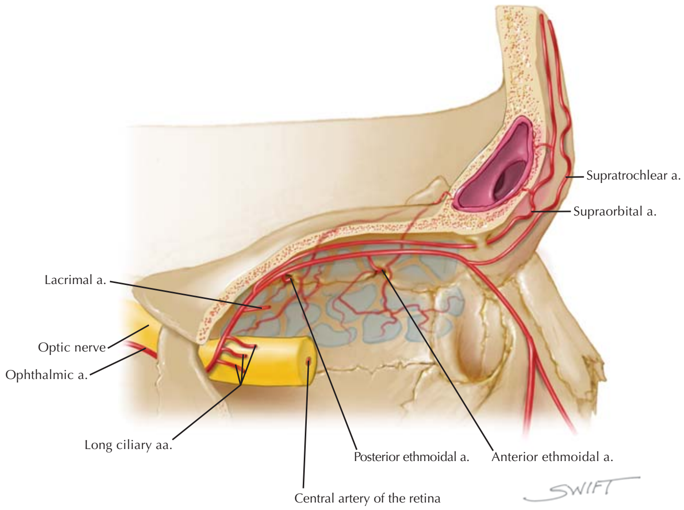


Frontal Sinus

ARTERIAL SUPPLY

Artery	Source	Course
Anterior ethmoid	Ophthalmic a. (from the internal carotid a.)	Enters the anterior ethmoid foramen with the nerve to pass through the canal At this location, it supplies the anterior and middle ethmoid air cells and the frontal sinus
Supraorbital		Branches from the ophthalmic a. when crossing the optic n. Ascends medial to both the levator palpebrae superioris and the superior rectus mm. At this location, it runs with the supraorbital n. and is found between the levator palpebrae superioris m. and the periosteum of the orbit Travels to the supraorbital foramen (notch) At the level of the supraorbital margin, it supplies the frontal sinus
Supratrochlear		One of the terminal branches of the ophthalmic a. in the orbit Ascends to meet the supratrochlear n. While passing anteriorly in the orbit toward the trochlea, the supratrochlear a. supplies the frontal sinus

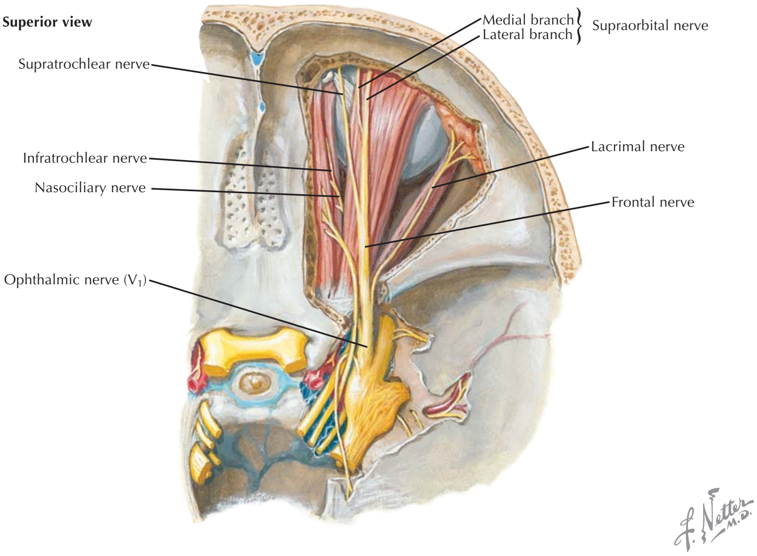


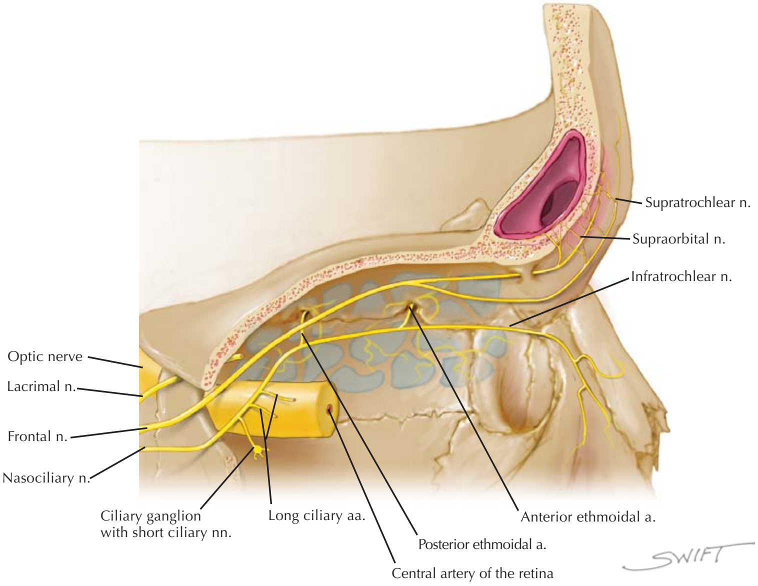


Frontal Sinus

NERVE SUPPLY

Nerve	Source	Course
Supraorbital	Ophthalmic division of the trigeminal n.	Passes between the levator palpebrae superioris m. and periosteum of the orbit Continues anteriorly to the supraorbital foramen (notch) At the level of the supraorbital margin, it sends nerve supply to the frontal sinus
Supratrochlear		Once the supratrochlear a. joins it, the nerve continues to pass anteriorly toward the trochlear n. There it often supplies the frontal sinus





Ethmoid Sinus

GENERAL INFORMATION

May find 3 to 18 ethmoid air cells on each side

Ethmoid air cells may invade any of the other 3 sinuses

The middle ethmoid air cells produce the swelling on the lateral wall of the middle meatus called the ethmoid bulla

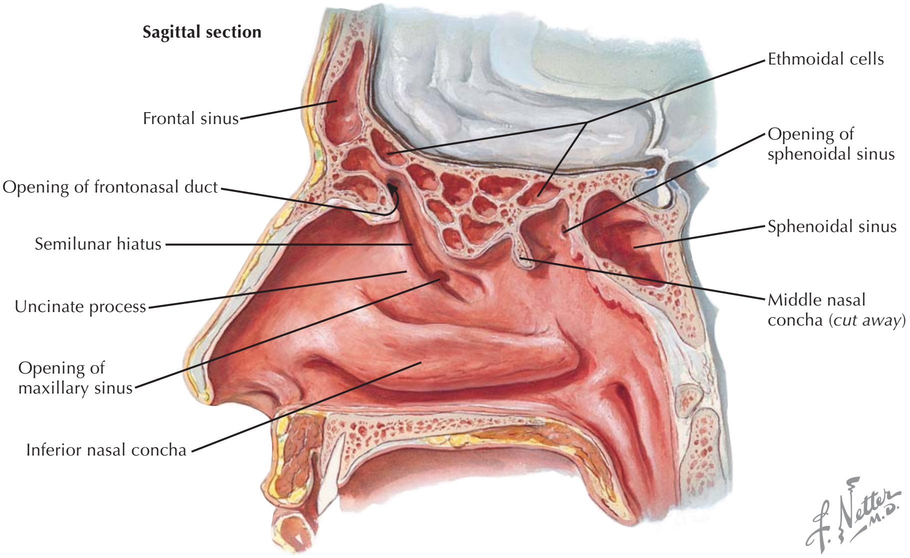
Primary lymphatic drainage is to the submandibular lymph nodes for the anterior and middle ethmoid sinuses; and the retropharyngeal lymph nodes for the posterior ethmoid sinus

Relations of Sinus

- *Superior:* anterior cranial fossa and contents, frontal bone with sinus
- *Medial:* nasal cavity
- *Lateral:* orbit

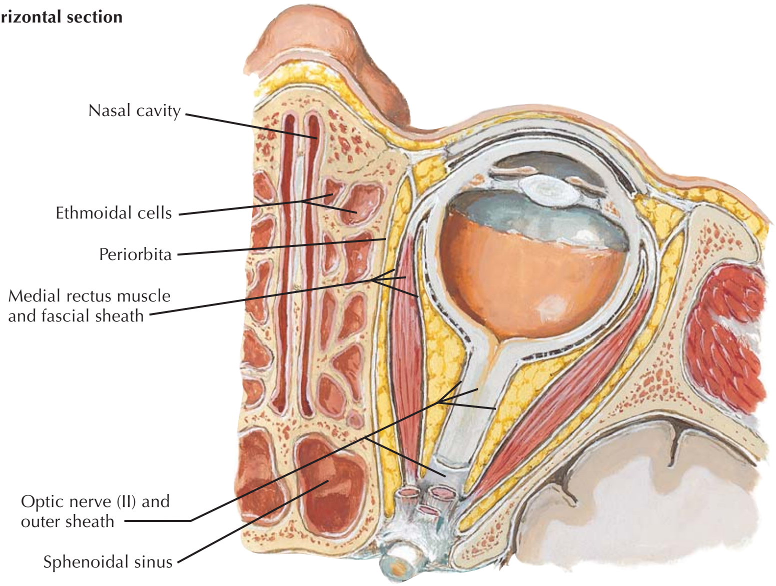
Location of Ostium

- *Anterior:* middle meatus (frontonasal duct or ethmoidal infundibulum)
- *Middle:* middle meatus (on or above ethmoid bulla)
- *Posterior:* superior meatus

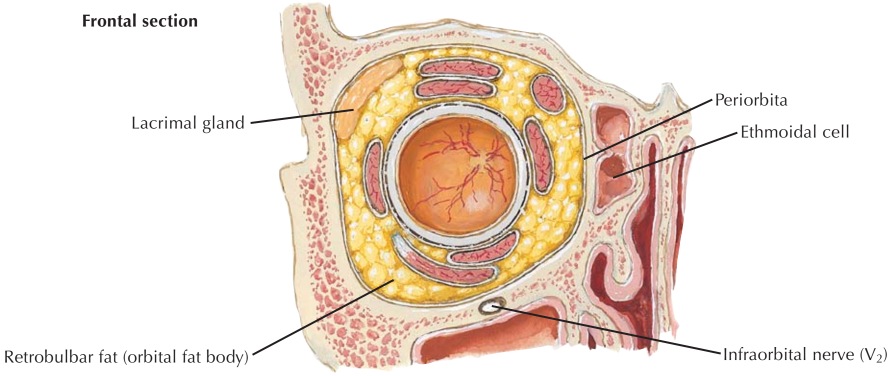


GENERAL INFORMATION *CONTINUED*

Horizontal section



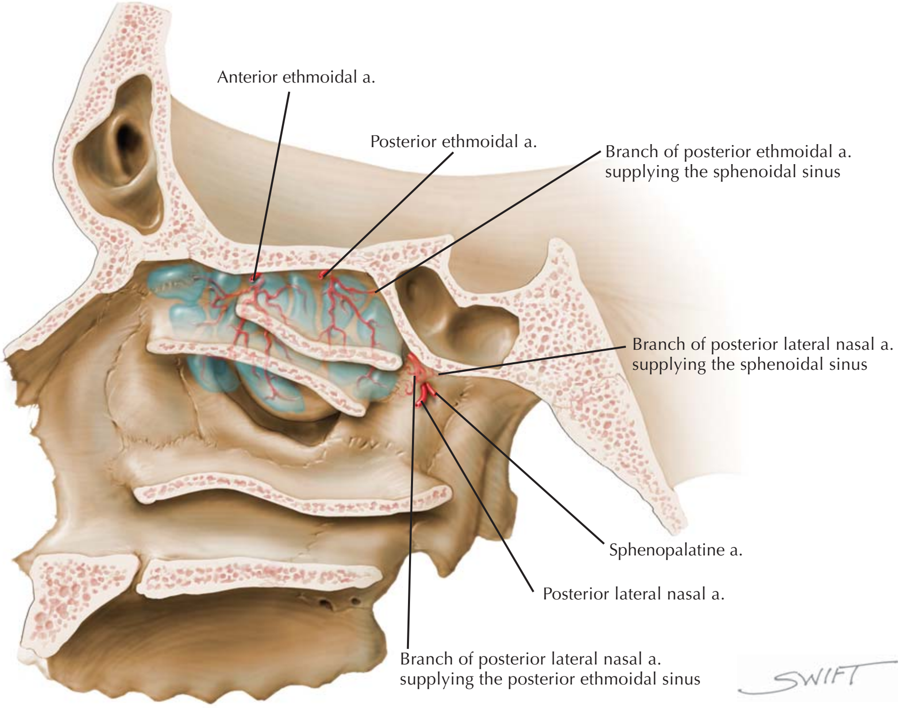
Frontal section



Ethmoid Sinus

ARTERIAL SUPPLY

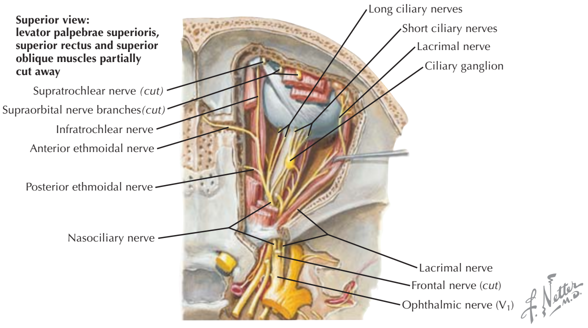
Artery	Source	Course
Anterior ethmoid	Ophthalmic a. (from the internal carotid)	Enters the anterior ethmoid foramen with the nerve to pass though the canal There it supplies the anterior and middle ethmoid air cells and sometimes the frontal sinus.
Posterior ethmoid		Passes through the posterior ethmoid foramen to enter the canal There it supplies the posterior ethmoid air cells and sphenoid sinus
Posterior lateral nasal branches	Sphenopalatine a. (from the maxillary a. from the external carotid a.)	Anastomose with the ethmoidal arteries to help supply the ethmoid air cells and sphenoid sinus

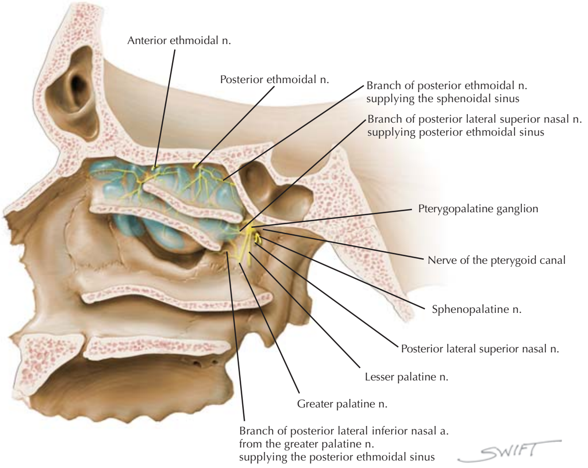


12 Ethmoid Sinus

NERVE SUPPLY

Nerve	Source	Course
Anterior ethmoid	Nasociliary n. on the medial wall of the orbit (from the ophthalmic division of the trigeminal n.)	Enters the anterior ethmoid foramen and travels through the canal to enter the anterior cranial fossa While descending toward the nasal cavity, it provides innervation to the anterior and middle ethmoid air cells
Posterior ethmoid		Enters the posterior ethmoid foramen to supply the posterior ethmoid air cell Also innervates the sphenoid sinus at this location
Posterior lateral superior nasal	Pterygopalatine ganglion in the pterygopalatine fossa (from the maxillary division of the trigeminal n.)	Pass through the sphenopalatine foramen to enter the nasal cavity Branches supply the posterior ethmoid air cells at this location
Posterior lateral inferior nasal	Greater palatine n. as it descends through the palatine canal (from the maxillary division of the trigeminal n.)	May send branches to the ethmoid air cells





Maxillary Sinus

GENERAL INFORMATION

Large pyramidal cavity

Thin walls

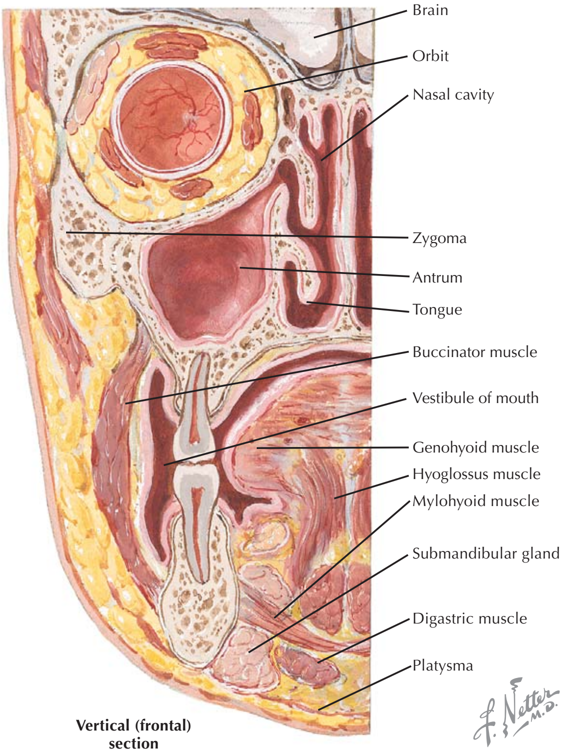
Primary lymphatic drainage is to the submandibular lymph nodes

Relations of Sinus

- *Superior:* orbit, infraorbital nerve and vessels
- *Inferior:* roots of molars and premolars
- *Medial:* nasal cavity
- *Lateral and anterior:* cheek
- *Posterior:* infratemporal fossa, pterygopalatine fossa and contents

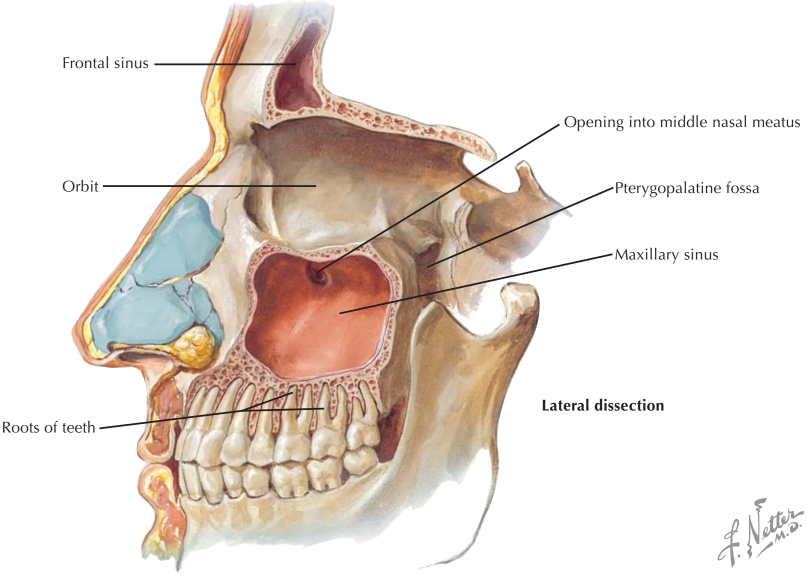
Location of Ostium

Middle meatus



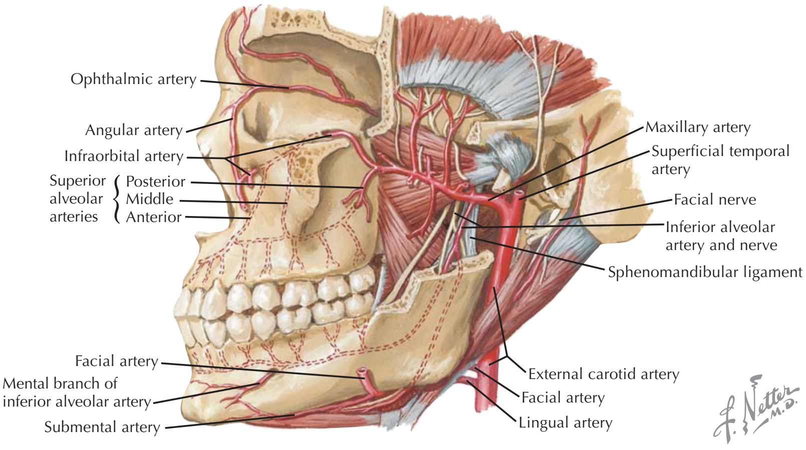
Vertical (frontal) section

GENERAL INFORMATION *CONTINUED*



ARTERIAL SUPPLY

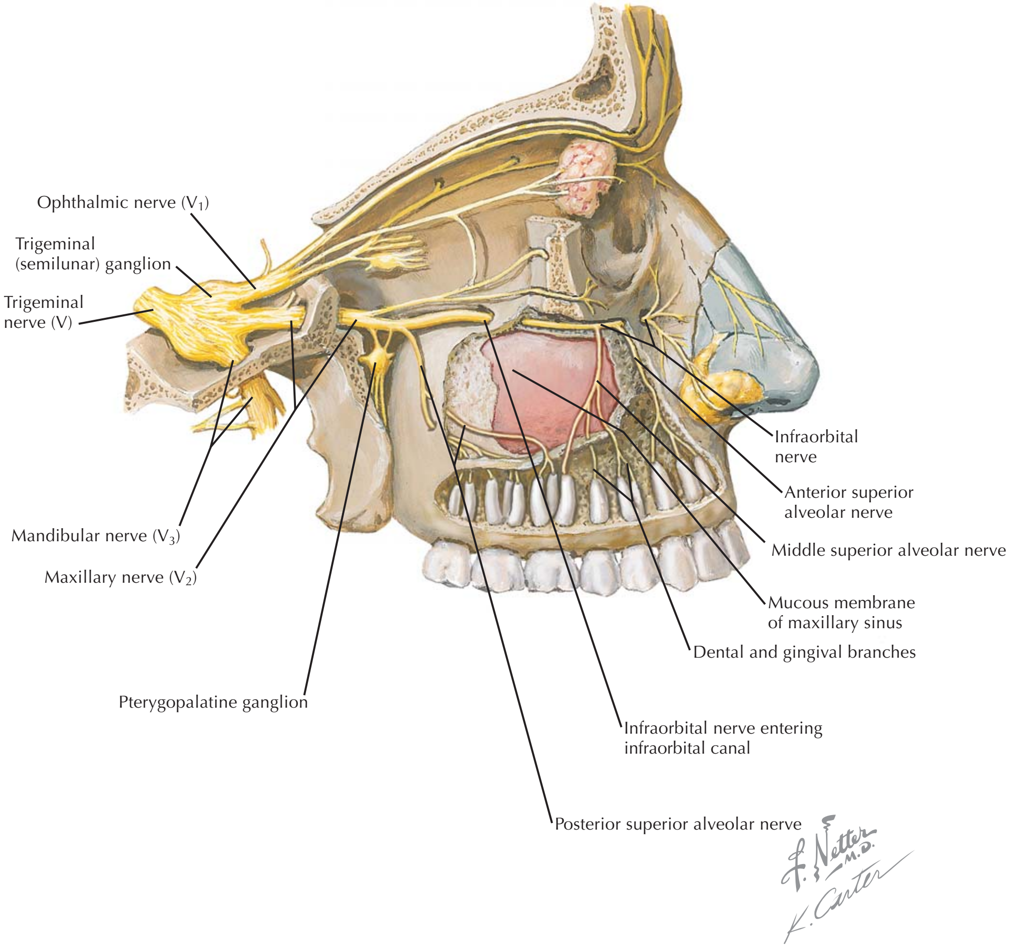
Artery	Source	Course
Anterior superior alveolar	Maxillary a. from the external carotid a.	Arises from the infraorbital a. of the maxillary a. after it passes through the inferior orbital fissure and into the infraorbital canal Descends via the alveolar canals to supply the sinus
Middle superior alveolar		When present, it arises from the infraorbital a. of the maxillary a. after passing through the inferior orbital fissure and into the infraorbital canal Descends via the alveolar canals to supply the sinus
Posterior superior alveolar		Arises from the 3rd part of the maxillary a. before the maxillary a. enters the pterygopalatine fossa Enters the infratemporal surface of the maxilla to supply the sinus



Maxillary Sinus

NERVE SUPPLY

Nerve	Source	Course
Posterior superior alveolar	Infraorbital n. which is the continuation of the maxillary division of the trigeminal n.	Branches from the infraorbital n. as it travels in the infraorbital canal As it descends to form the superior dental plexus, it innervates part of the maxillary sinus
Middle superior alveolar		When present, it branches from the infraorbital n. as it travels in the infraorbital canal As it descends to form the superior dental plexus, it innervates part of the maxillary sinus
Anterior superior alveolar	Maxillary division of the trigeminal n.	Arises in the pterygopalatine fossa Travels laterally through the pterygomaxillary fissure to enter the infratemporal fossa Enters the infratemporal surface of the maxilla As it descends to form the superior dental plexus, it innervates part of the maxillary sinus



12 Sphenoid Sinus

GENERAL INFORMATION

Two large, irregularly-shaped cavities

Separated by an irregular septum

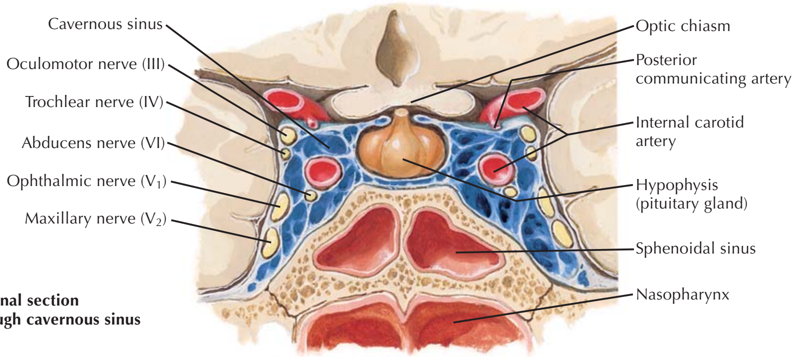
Primary lymphatic drainage is to the retropharyngeal lymph nodes

Relations of Sinus

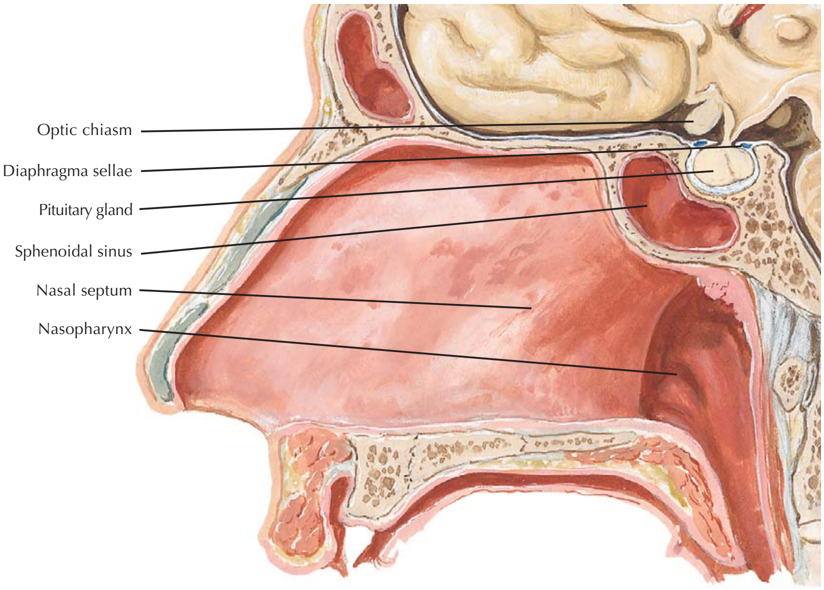
- *Superior:* hypophyseal fossa, pituitary gland, optic chiasm
- *Inferior:* nasopharynx, pterygoid canal
- *Medial:* other sphenoid bone
- *Lateral:* cavernous sinus, internal carotid artery, cranial nerves III, IV, V_1, V_2, and VI
- *Anterior:* nasal cavity

Location of Ostium

Sphenoethmoidal recess



Coronal section through cavernous sinus



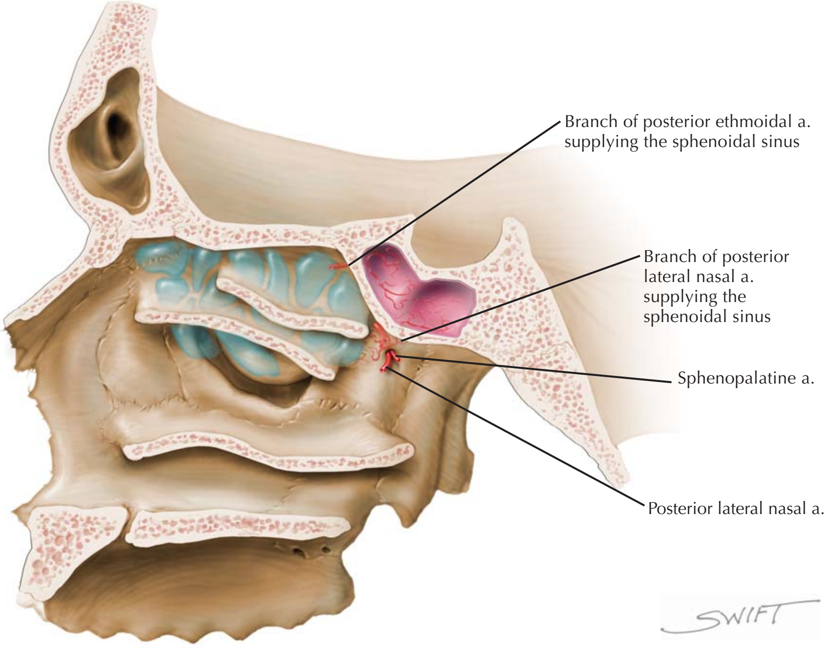
Anatomy and relations of the pituitary gland

F. Netter M.D.

Sphenoid Sinus

ARTERIAL SUPPLY

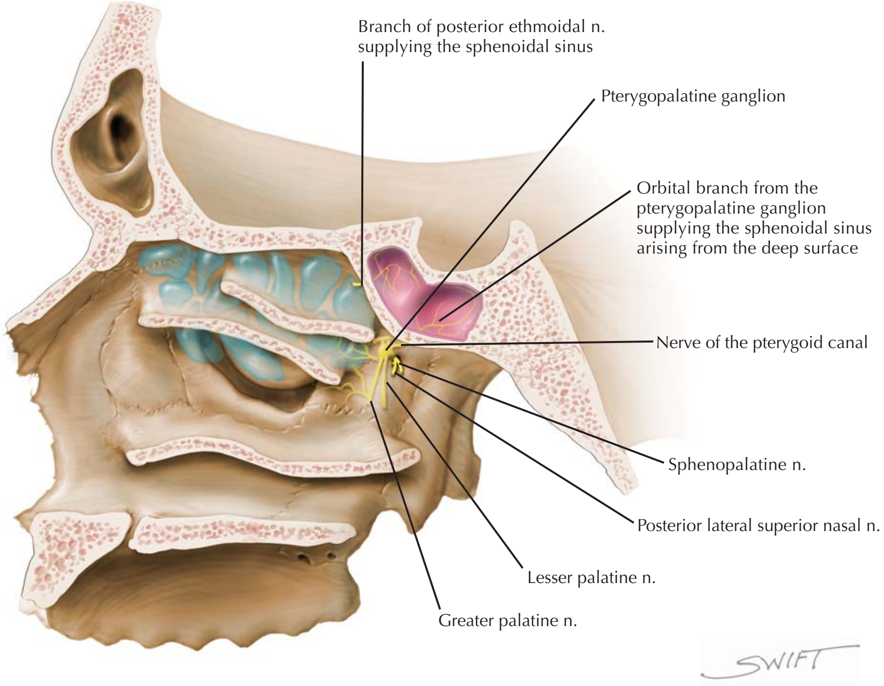
Artery	Source	Course
Posterior ethmoid	Ophthalmic a. (from the internal carotid a.)	Passes through the posterior ethmoid foramen to enter the canal There it supplies the sphenoid sinus and the posterior ethmoid air cells
Posterior lateral nasal branches	Sphenopalatine a. from the maxillary a. (from the external carotid a.)	These branches anastomose with the ethmoidal arteries to help supply the sphenoid sinus and the ethmoid air cells



Sphenoid Sinus

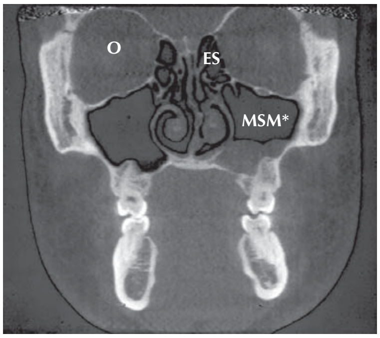
NERVE SUPPLY

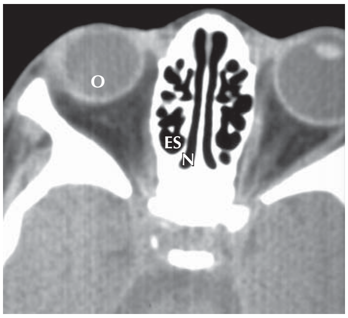
Nerve	Source	Course
Posterior ethmoid	Ophthalmic division of the trigeminal n.	A branch of the nasociliary n. that lies on the medial wall of the orbit Enters the posterior ethmoid foramen to supply the sphenoid sinus Also innervates the posterior ethmoid air cell at this location
Orbital branch from the pterygopalatine ganglion	Maxillary division of the trigeminal n.	Orbital branches arising from the pterygopalatine ganglion enter the orbit through the inferior orbital fissure Some of these branches supply the sphenoid sinus at this location

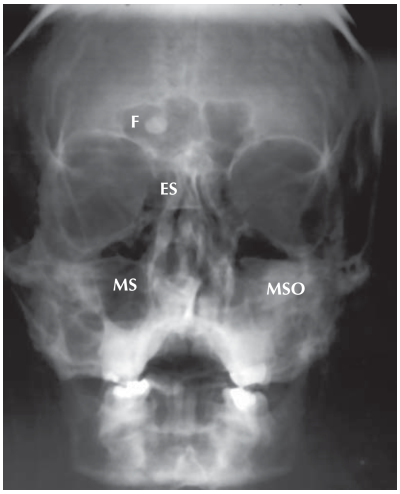


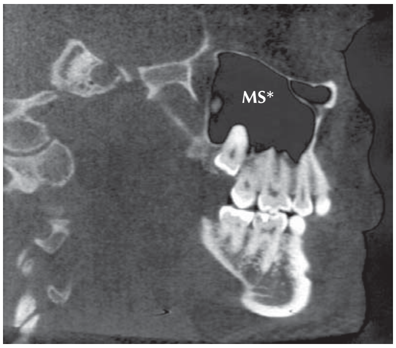
Imaging of the Paranasal Sinuses

12









**Root of third maxillary molar protruding into sinus*

ES	Ethmoid sinus
F	Frontal sinus with osteosarcoma
MS*	Maxillary sinus
MSM*	Maxillary sinus with mucocele
O	Orbit
N	Nasal cavity
MSO	Maxillary sinus with osteosarcoma

12 Clinical Correlate

SINUSITIS

An inflammation of the membrane of the sinus cavities caused by infections (by bacteria or viruses) or noninfectious means (such as allergy)

2 types of sinusitis: acute and chronic

Common clinical manifestations include sinus congestion, discharge, pressure, face pain, headaches

Acute Sinusitis

The most common form of sinusitis

Typically caused by a cold that results in inflammation of the sinus membranes

Normally resolves in 1 to 2 weeks

Sometimes a secondary bacterial infection may settle in the passageways after a cold; bacteria normally located in the area (*Streptococcus pneumoniae* and *Haemophilus influenzae*) may then begin to increase, producing an acute bacterial sinusitis

Chronic Sinusitis

An infection of the sinuses that is present for longer than 1 month and requires longer-duration medical therapy

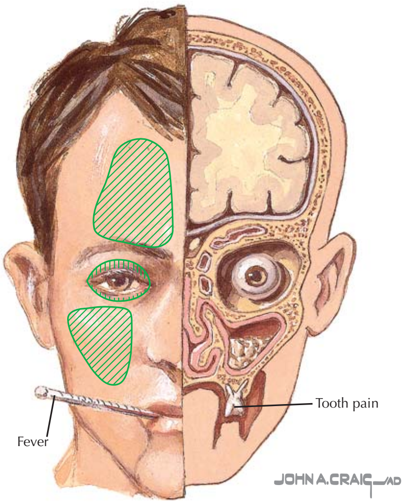
Typically either chronic bacterial sinusitis or chronic noninfectious sinusitis

Chronic bacterial sinusitis is treated with antibiotics

Chronic noninfectious sinusitis often is treated with steroids (topical or oral) and nasal washes

Locations

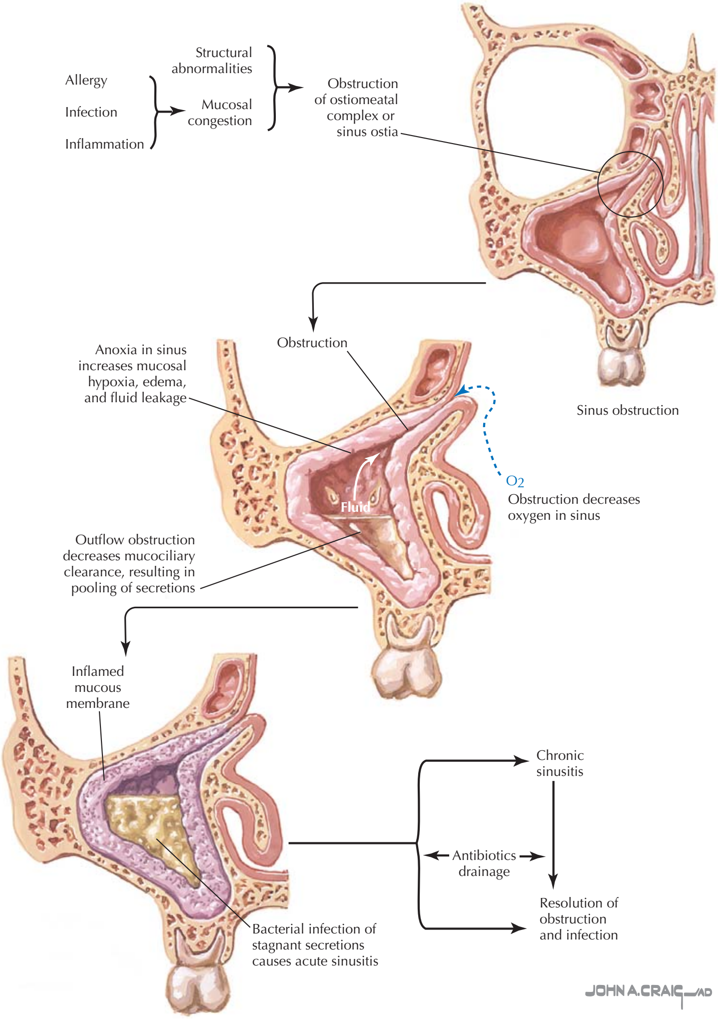
- Maxillary: the most common location for sinusitis; associated with all of the common signs and symptoms but also results in tooth pain, usually in the molar region
- Sphenoid: rare, but in this location can result in problems with the pituitary gland, cavernous sinus syndrome, and meningitis
- Frontal: usually associated with pain over the forehead and possibly fever; rare complications include osteomyelitis
- Ethmoid: potential complications include meningitis and orbital cellulitis



Areas of pain and tenderness (*green*). Pain caused by pressure in obstructed sinus

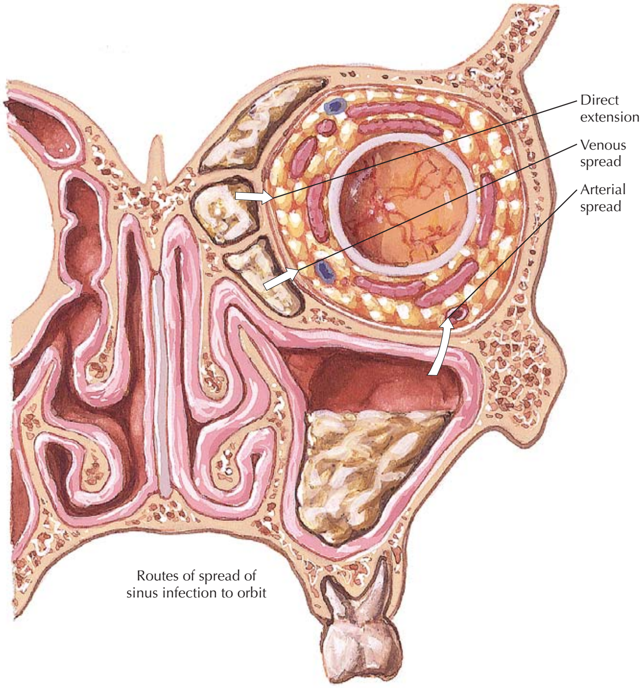
Clinical Correlate

SINUSITIS *CONTINUED*

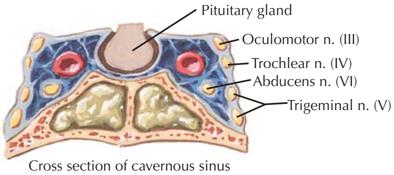


Clinical Correlate

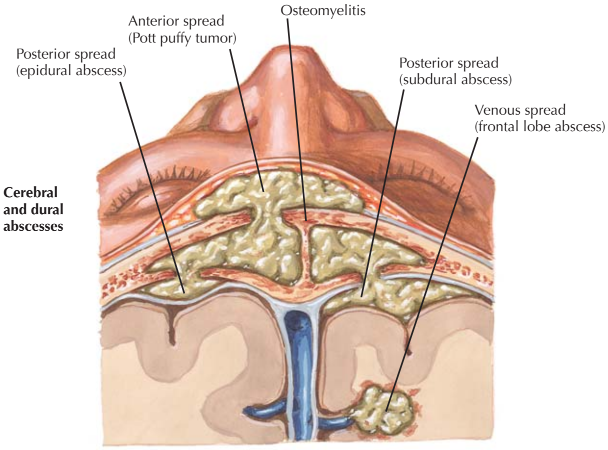
POTENTIAL SPREAD OF INFECTION VIA THE PARANASAL SINUSES



Routes of spread of sinus infection to orbit



Cross section of cavernous sinus



Routes of intracranial spread of frontal sinusitis

Clinical Correlate

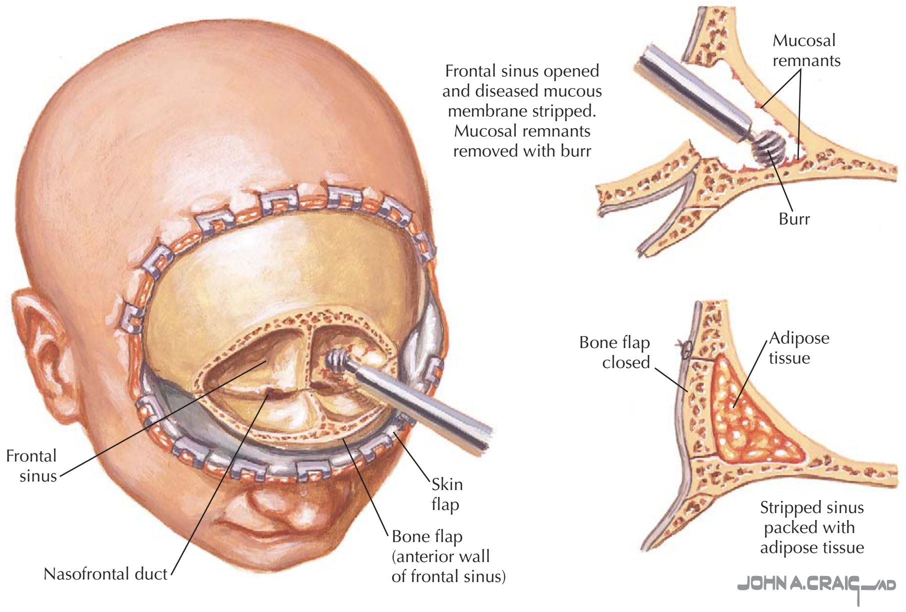
SURGICAL PROCEDURES

FRONTAL SINUS OBLITERATION

A procedure in which the frontal sinus is completely removed to treat problematic cases of frontal sinus infection, osteomyelitis, and trauma

Once the sinus is opened, all of the sinus membrane is removed with a burr; otherwise, any remaining membrane may form a mucocele

The remaining area often is filled with adipose tissue from the patient because it is thought to impede regrowth of the mucoperiosteum



Clinical Correlate

SURGICAL PROCEDURES *CONTINUED*

CALDWELL-LUC PROCEDURE

This intraoral procedure allows direct entry into the maxillary sinus

Also provides access to the ethmoid sinus

The maxillary sinus is entered through the canine fossa above the maxillary premolar teeth

The maxillary antrum is opened, the sinus membrane is stripped, and an additional antrostomy is made between the maxillary sinus and the inferior meatus

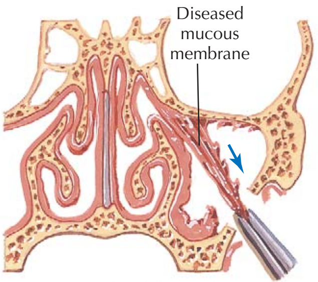
Conditions Treated

The antrostomy allows drainage of the maxillary sinus into the nasal cavity

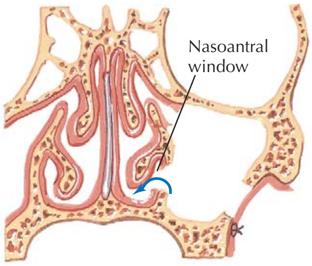
With the advent of functional endoscopic sinus surgery for antrostomies, the Caldwell-Luc procedure often is used for exposure and removal of tumors

Used to be commonly performed to treat chronic maxillary sinusitis

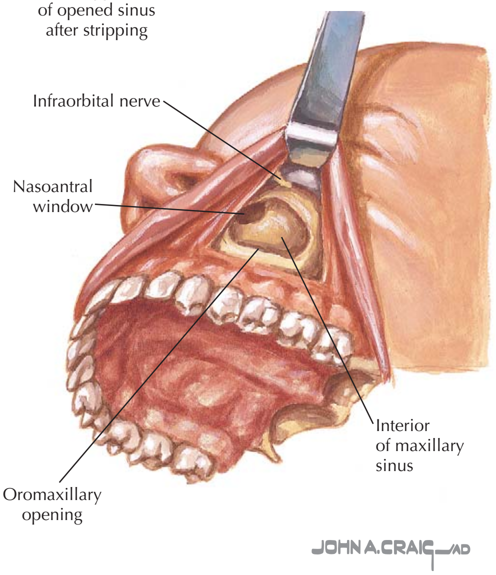
Was also used for procedures such as removal of benign tumors and foreign bodies, access to the pterygopalatine fossa, and closure of dental fistulas into the maxillary sinus



Sinus opened and diseased mucous membrane stripped



Nasoantral window created and oromaxillary opening closed



Clinical appearance of opened sinus after stripping

Clinical Correlate

SURGICAL PROCEDURES *CONTINUED*

MAXILLARY IMPLANTS

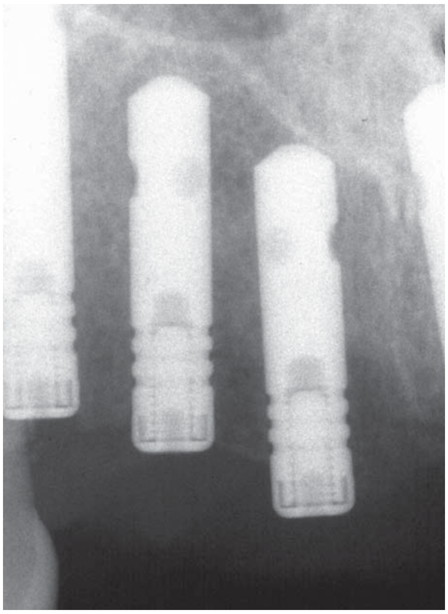
Common dental procedure to add fixed maxillary teeth to the oral cavity

Patient should be in relatively good health

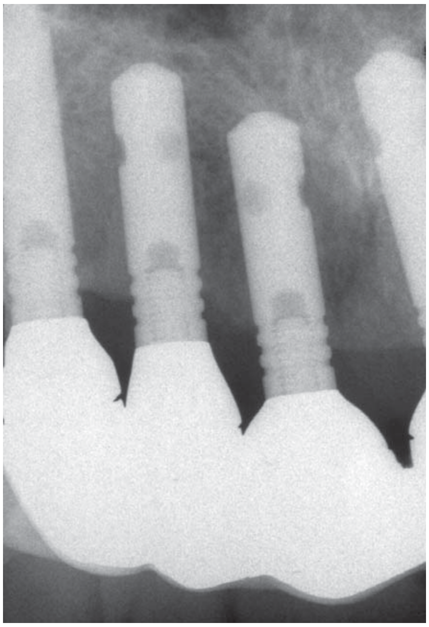
Patient must have sufficient bone in a location suitable for placing an implant

It is becoming more common to use bone grafting before the surgical implant is placed

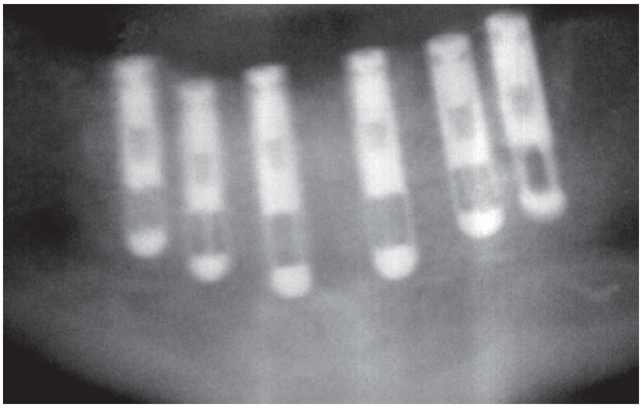
Bone grafts to provide adequate bed for implants may be harvested from the body or as allografts, or may be supplied as xenografts or synthetic bone substitutes



Maxillary implants
before teeth are placed



Maxillary implants
after teeth are placed on
the implant



Mandibular implants

SURGICAL PROCEDURES *CONTINUED*

FUNCTIONAL ENDOSCOPIC SINUS SURGERY

Uses an endoscope inserted into the nose to view the nasal cavity and sinuses, thereby eliminating an external incision

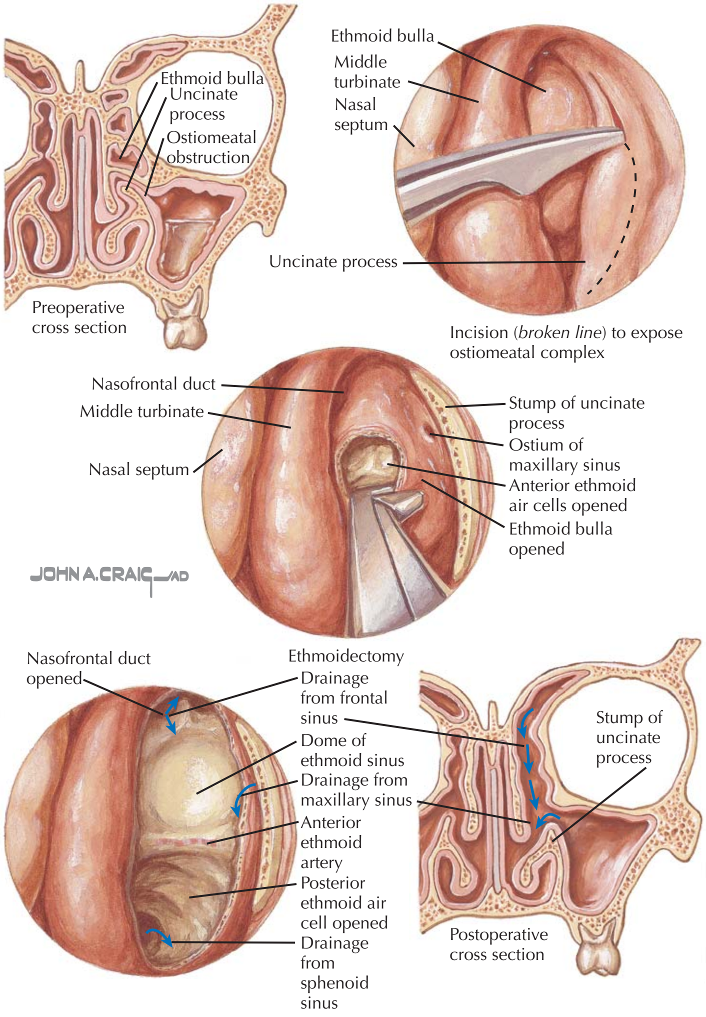
Often an outpatient procedure

Provides increased visualization of the area, making it easier to remove diseased tissue and leave a greater amount of normal tissue intact

Standard surgical treatment for sinusitis for people whose chronic sinus problems do not respond to medical therapy

Also used for removal of polyps, mucoceles, tumors, and foreign bodies and for control of epistaxis

Functional Endoscopic Sinus Surgery



CHAPTER 13

ORAL CAVITY

13 Overview and Topographic Anatomy

GENERAL INFORMATION

Oral cavity: the space located between the lips and cheeks on the external surface to the palatoglossal fold on the internal surface

The oral cavity is important in mastication, tasting, and talking

The area of the oral cavity can be divided into:

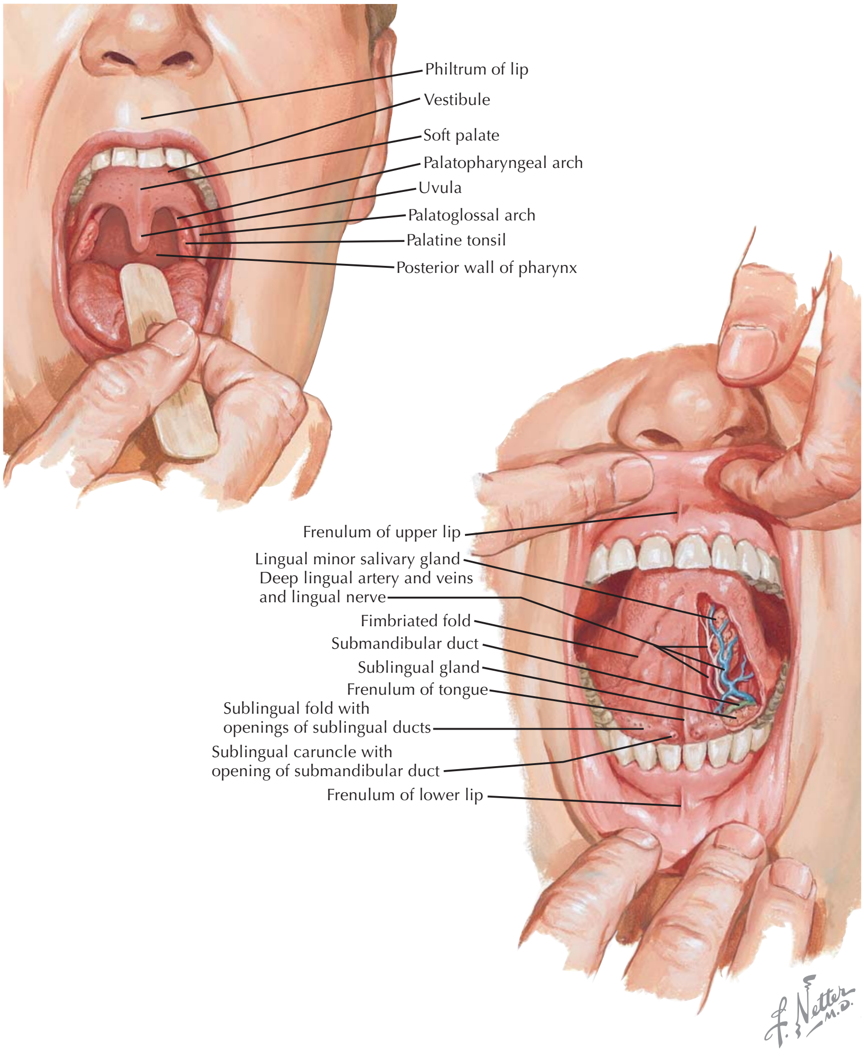
- Vestibule—the area between the teeth and lips or cheek
- Oral cavity proper—the area located internal to the teeth

Posteriorly, the oral cavity is continuous with the oropharynx

The hard palate and the soft palate are important boundaries within the oral cavity

The tongue is a major structure located on the oral cavity floor

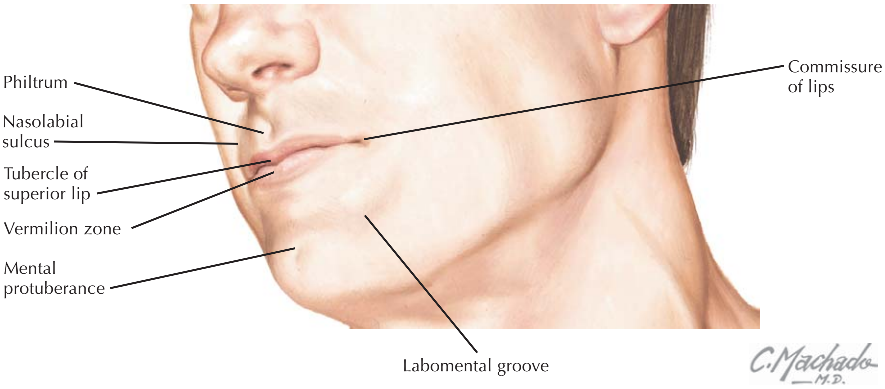
All of the major salivary glands—parotid, submandibular, and sublingual—drain into the oral cavity



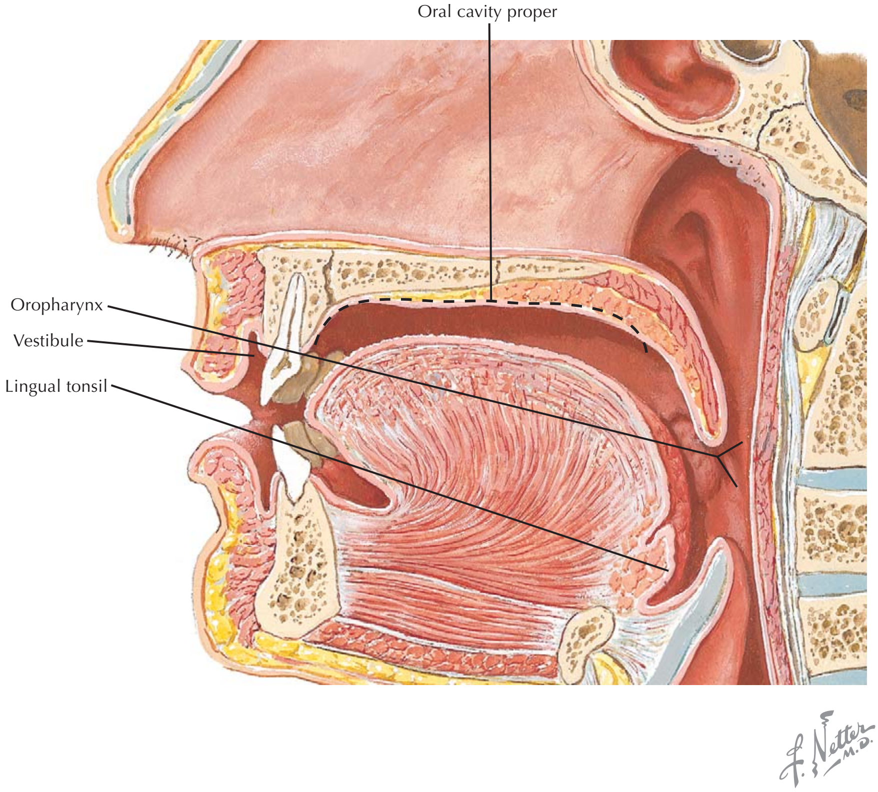
External Anatomy

EXTERNAL FEATURES

Structure	Comments
Lips	Divided into an upper and a lower lip that surround the opening of the oral cavity Both lips have a muscular "skeleton" composed of the orbicularis oris m. Upper lip is separated from the cheek by the nasolabial groove Lower lip is separated from the chin by the labiomental groove Upper and lower lips meet at the labial commissures *Vermilion zone*—the red area of the lip that is clearly demarcated from the skin of the face at the vermilion border; also known as the red zone *Philtrum*—the depressed area located between the base of the nose and the vermilion border of the upper lip Many mucus-secreting labial glands are located within the submucosal layer of the lips at the area of transition to mucous membrane of the oral cavity, which is nonkeratinized stratified squamous epithelium *Vestibule*—the region between the lips and cheeks and the teeth The fold of tissue created by the vestibule between the lip and teeth is called the vestibular or mucolabial fold As the vestibular fold reflects on the alveolar bone holding the teeth, the mucous membrane abruptly changes into the gingiva Within the vestibular fold are bands of tissue known as labial frenula The labial frenula are pronounced at the maxillary and mandibular midline as the upper and lower frenula, respectively Other accessory frenula also are located in the vestibule
Cheek	Located between the labial commissure and the mucosa overlying the ramus of the mandible Has a muscular "skeleton" composed of the buccinator m. Many mucus-secreting glands, known as molar glands, are located within the submucosal layer of the inside of the cheeks, which is lined by mucous membrane of the oral cavity (nonkeratinized stratified squamous epithelium) Vestibule continues from the region between the lips and teeth posteriorly, to be located between the cheek and the teeth The fold of tissue created by the vestibule between the lip and the teeth is called the vestibular or mucobuccal fold The retromolar region is the only area in which the vestibule and the oral cavity proper communicate The parotid duct drains into the oral cavity at the parotid papilla, located along the mucous membrane of the cheek opposite the 2nd maxillary molar Fordyce's spots, ectopic sebaceous glands found in the mucosa of the cheeks appearing as yellowish spots, can be observed in the cheek



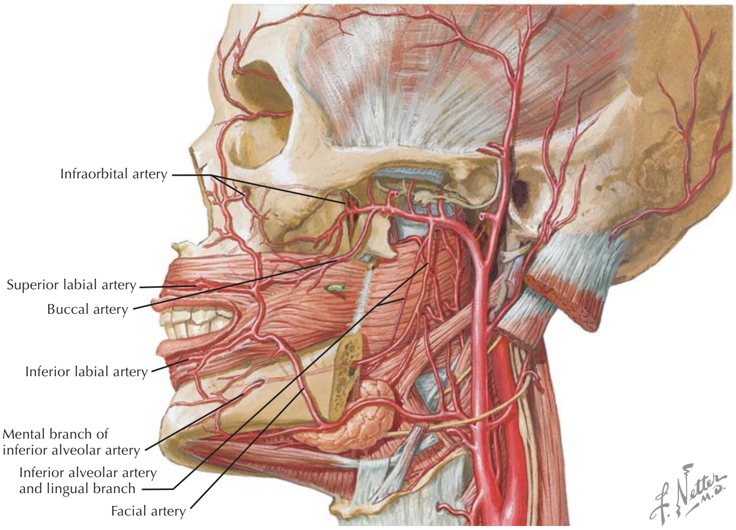
EXTERNAL FEATURES *CONTINUED*



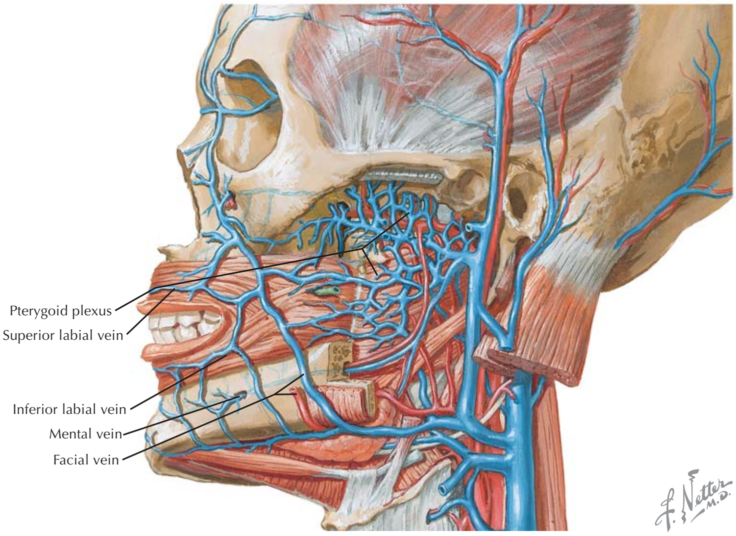
VASCULAR SUPPLY OF THE LIPS AND CHEEK

ARTERIAL SUPPLY		
Artery	**Source**	**Comments**
Superior labial branch of the facial	Facial a. off the external carotid a.	Supplies the structures associated with the upper lip Gives rise to the septal branch that travels to the nasal septum
Superior labial branch of the infraorbital	Infraorbital a. off the maxillary a.	A continuation of the 3rd part of the maxillary a. One of the 3 terminal branches of the infraorbital a., along with the inferior palpebral branch and the nasal branch Accompanied by the nerve and vein of the same name Helps supply the upper lip
Inferior labial branch of the facial	Facial a. off the external carotid a.	Supplies the structures associated with the lower lip
Mental	Inferior alveolar a.	A terminal branch from the inferior alveolar a., which arises from the 1st part of the maxillary a. Emerges from the mental foramen to supply the chin region
Buccal	Maxillary a.	A branch of the 2nd part of the maxillary a. A small artery that runs obliquely in an anterior direction between the medial pterygoid and the insertion of the temporalis m. until it reaches the outer surface of the buccinator m. to supply that muscle and the face

VASCULAR SUPPLY OF THE LIPS AND CHEEK *CONTINUED*

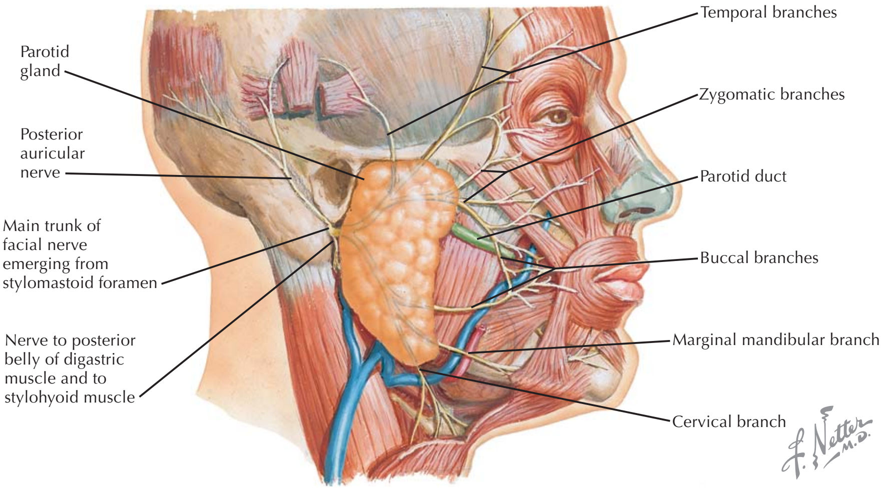


VENOUS DRAINAGE	
Vein	**Comments**
Superior labial branch of the facial	Drains the upper lip and joins the facial v.
Inferior labial branch of the facial	Drains the lower lip and joins the facial v.
Mental	Drains the chin and lower lip and joins the pterygoid plexus of veins
Buccal	Drains the cheek and joins the pterygoid plexus of veins



NERVE SUPPLY

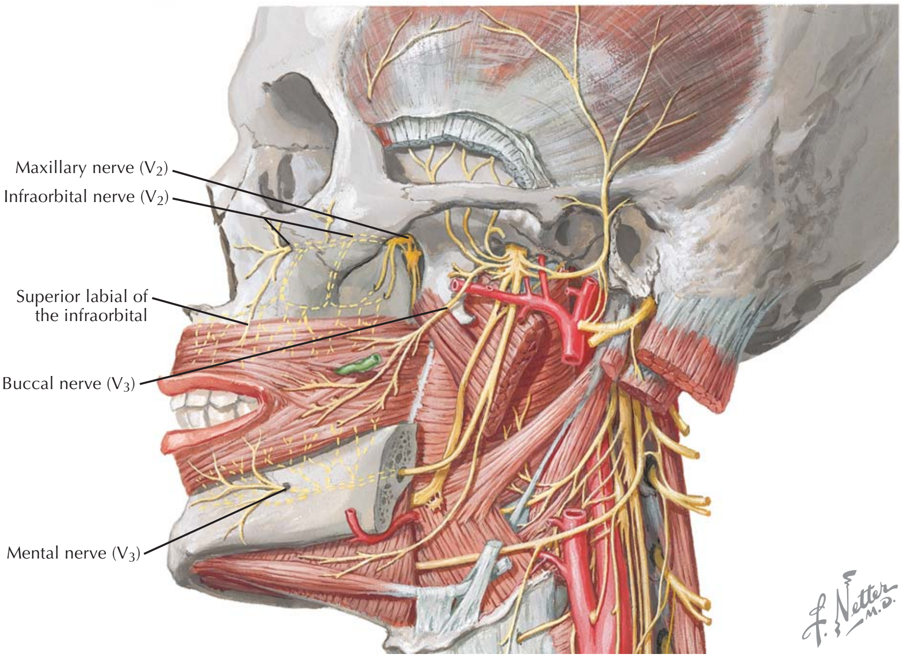
MOTOR INNERVATION		
Nerve	**Source**	**Course**
All muscles of facial expression are innervated by the facial n.		
Buccal branch of the facial	Facial n.	Arise from both the temporofacial and cervicofacial trunks of the facial n. These branches supply the muscles along the muscular part of the cheek, including the buccinator and the orbicularis oris mm.
Mandibular branch of the facial		Arises from the cervicofacial trunk and passes anteriorly, supplying the muscles of the lower lip and chin, including the orbicularis oris m.



External Anatomy

NERVE SUPPLY *CONTINUED*

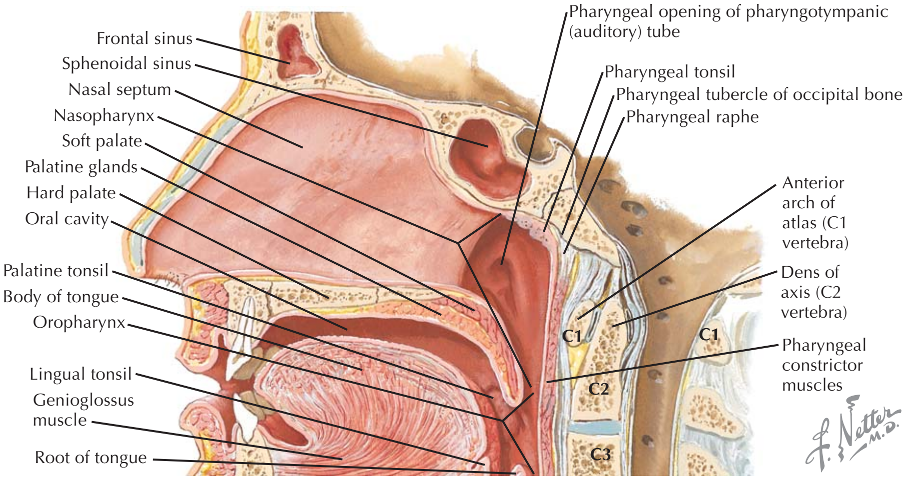
SENSORY INNERVATION		
Nerve	**Source**	**Course**
All sensory innervation to the skin of this region is supplied by the trigeminal n.		
Superior labial branch of the infraorbital	Infraorbital n. (a continuation of the maxillary division of the trigeminal n.)	One of the 3 terminal branches of the infraorbital n., along with the inferior palpebral and the nasal, as it exits onto the face via the infraorbital foramen Supplies the skin of the upper lip
Mental	Inferior alveolar n.	1 of the 2 terminal branches of the inferior alveolar n. Emerges through the mental foramen of the mandible in the region of the 2nd mandibular premolar Supplies the skin of the lower lip, chin, and facial gingiva as far posteriorly as the 2nd mandibular premolar
Buccal branch of the mandibular division of the trigeminal	Mandibular division of the trigeminal n.	Passes anteriorly between the 2 heads of the lateral pterygoid m. Descends inferiorly along the lower part of the temporalis m. to emerges from deep to the anterior border of the masseter m. Supplies the skin over the buccinator m. before passing through it to supply the mucous membrane lining its inner surface and the gingiva along the mandibular molars



13 Boundaries of the Oral Cavity

GENERAL INFORMATION

Boundary	Structure
Superior	The roof is the hard palate
Posterosuperior	Soft palate
Lateral	Cheeks
Inferior	The floor is located along the lingual border of the mandible forming a horseshoe-shaped region



SUPERIOR BORDER: HARD PALATE

The superior border (or roof) of the oral cavity is the hard palate, comprising the anterior 2/3 of the entire palate

Separates the oral cavity from the nasal cavity

Composed of:

- Palatal process of the maxilla
- Horizontal process of the palatine

In the anterior midline, an incisive foramen is located on the right and left sides that transmits the terminal branches of the nasopalatine nerve and sphenopalatine vessels

In the posterolateral region of the hard palate, the greater and lesser palatine foramina are located or the right and left sides; these openings transmit the greater and lesser palatine nn. and vessels

The bones of the hard palate are covered by a thick mucous membrane

The mucous membrane has a small elevation in the anterior midline called the incisive papilla that overlies the incisive foramen

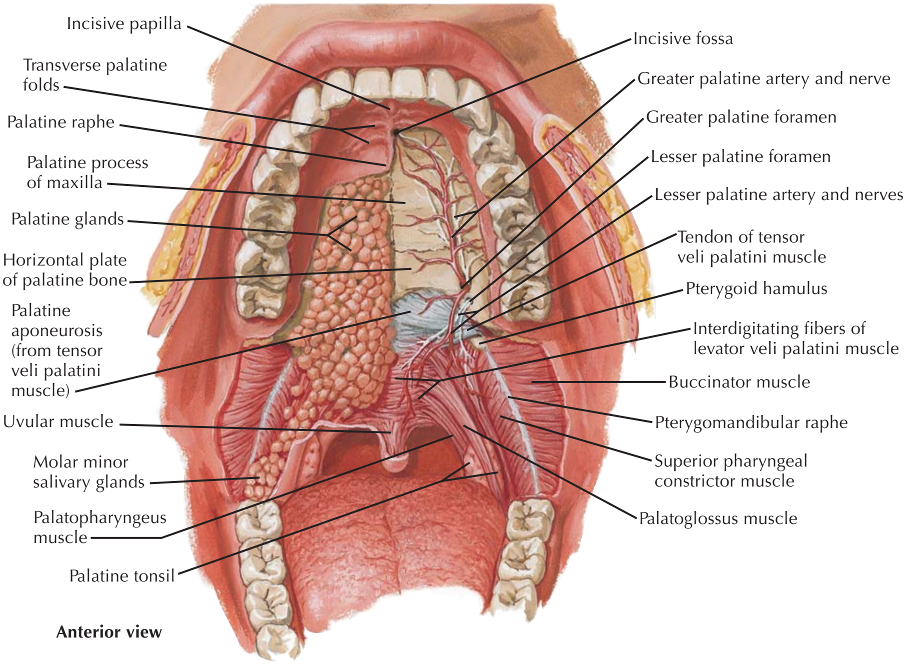
Moving posteriorly from the incisive papilla, the mucous membrane has a thick midline palatal raphe

Lateral transverse ridges called transverse rugae (plicae) are located along the mucous membrane of the hard palate

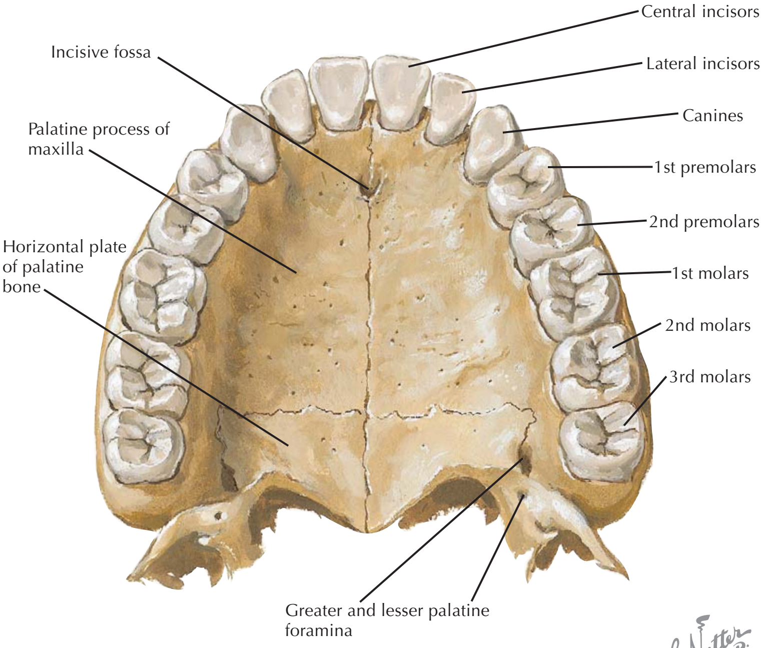
Deep to the mucous membrane of the hard palate are numerous mucus-secreting glands called palatal glands

Boundaries of the Oral Cavity

SUPERIOR BORDER: HARD PALATE *CONTINUED*



Anterior view



Upper permanent teeth

13 Boundaries of the Oral Cavity

POSTEROSUPERIOR BORDER: SOFT PALATE

The posterosuperior border of the oral cavity is the soft palate

The soft palate is the continuation of the palate posteriorly and makes up approximately 1/3 of the entire palate

The soft palate separates the oral cavity from the nasopharynx

An abundance of mucus-secreting palatal glands, which are continuous with the hard palate, are located in the soft palate

The soft palate has 3 margins:

- Anteriorly, it is continuous with the hard palate at the vibrating line
- Posterolaterally, it forms the superior portion of the palatoglossal and palatopharyngeal folds
- Posteriorly, the uvula hangs in the center of the posterior free margin

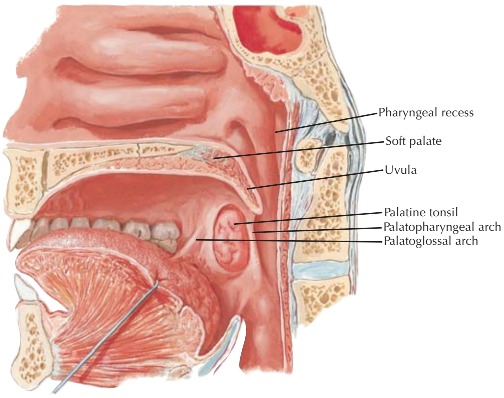
The thick palatine aponeurosis forms the foundation of the soft palate

The soft palate is composed of 5 muscles:

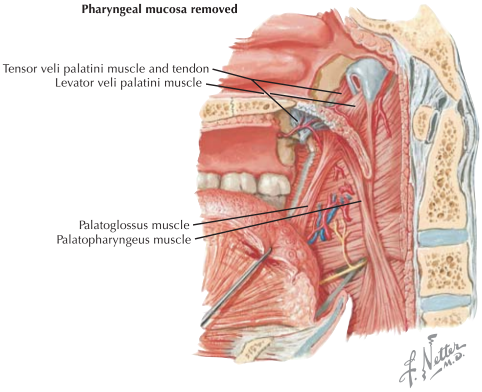
- Musculus uvulae
- Tensor veli palatini
- Levator veli palatini
- Palatopharyngeus
- Palatoglossus (sometimes considered in the grouping of tongue muscles)

The soft palate helps close off the nasopharynx during deglutition by forming a seal at the fold of Passavant

Medial view
Median (sagittal) section



Pharyngeal mucosa removed



Boundaries of the Oral Cavity

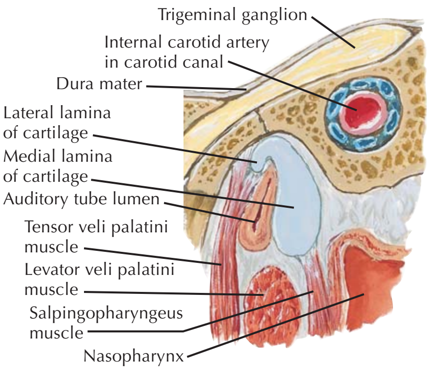
POSTEROSUPERIOR BORDER: SOFT PALATE *CONTINUED*

MUSCLES OF THE SOFT PALATE					
Muscle	**Origin**	**Insertion**	**Actions**	**Nerve Supply**	**Comment**
Tensor veli palatini	Cartilaginous part of the auditory tube Scaphoid fossa of the sphenoid	Palatine aponeurosis	Pulls the soft palate laterally, which broadens it	A muscular branch from the mandibular division of the trigeminal n.	The tendon of the tensor veli palatini m. wraps around the pterygoid hamulus
Musculus uvulae	Posterior nasal spine Palatine aponeurosis	Fibers insert into the muscle of the opposite side	Elevates uvula Pulls uvula laterally	Pharyngeal plexus (motor portion from the vagus n. and cranial part of the accessory nn.)	May be bifid
Levator veli palatini	Cartilaginous portion of the auditory tube Petrous portion of the temporal bone	Palatine aponeurosis Fibers also insert into the muscle of the opposite side	Elevates soft palate Pulls soft palate posteriorly, which acts to help close the nasopharynx		The levator veli palatini m. passes through an aperture superior to the superior constrictor m.
Palatopharyngeus	Posterior border of hard palate Palatine aponeurosis	Posterior border of the lamina of the thyroid cartilage	Elevates the pharynx and larynx Acts to help close the nasopharynx		Grouped either with soft palate muscles or with muscles of the pharynx
Palatoglossus	Palatine aponeurosis	Side of the tongue where the fibers mix with the intrinsic muscles of the tongue	Elevates the tongue Narrows the oropharyngeal isthmus for deglutition		Grouped either with extrinsic muscles of the tongue or with muscles of the soft palate

13 Boundaries of the Oral Cavity

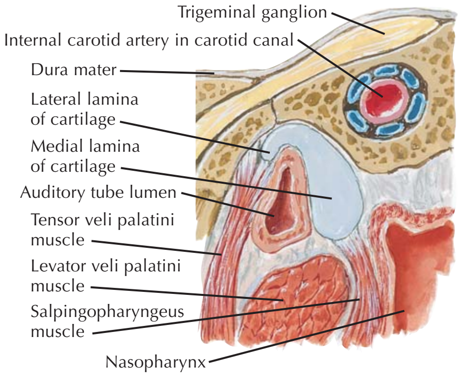
POSTEROSUPERIOR BORDER: SOFT PALATE *CONTINUED*

Section through cartilaginous part of pharyngotympanic (auditory) tube, with tube closed

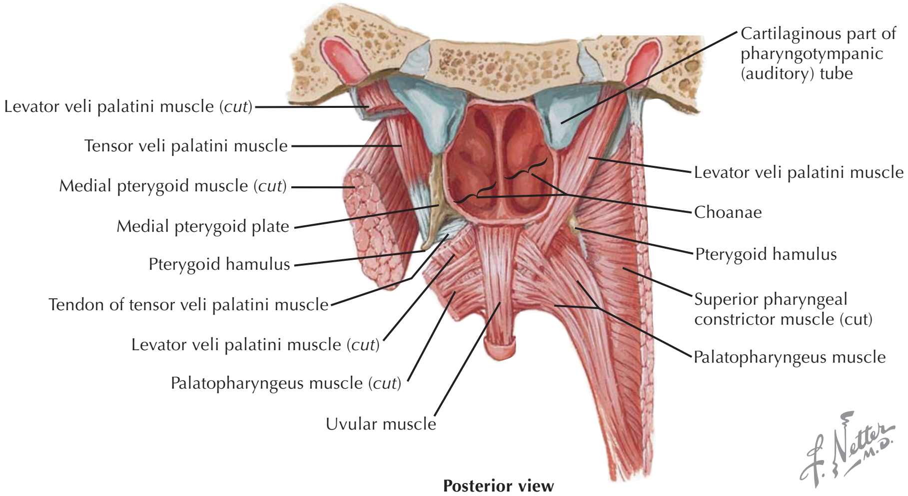


Pharyngotympanic (auditory) tube closed by elastic recoil of cartilage, tissue turgidity and tension of salpingopharyngeus muscles

Section through cartilaginous part of pharyngotympanic (auditory) tube, with tube open



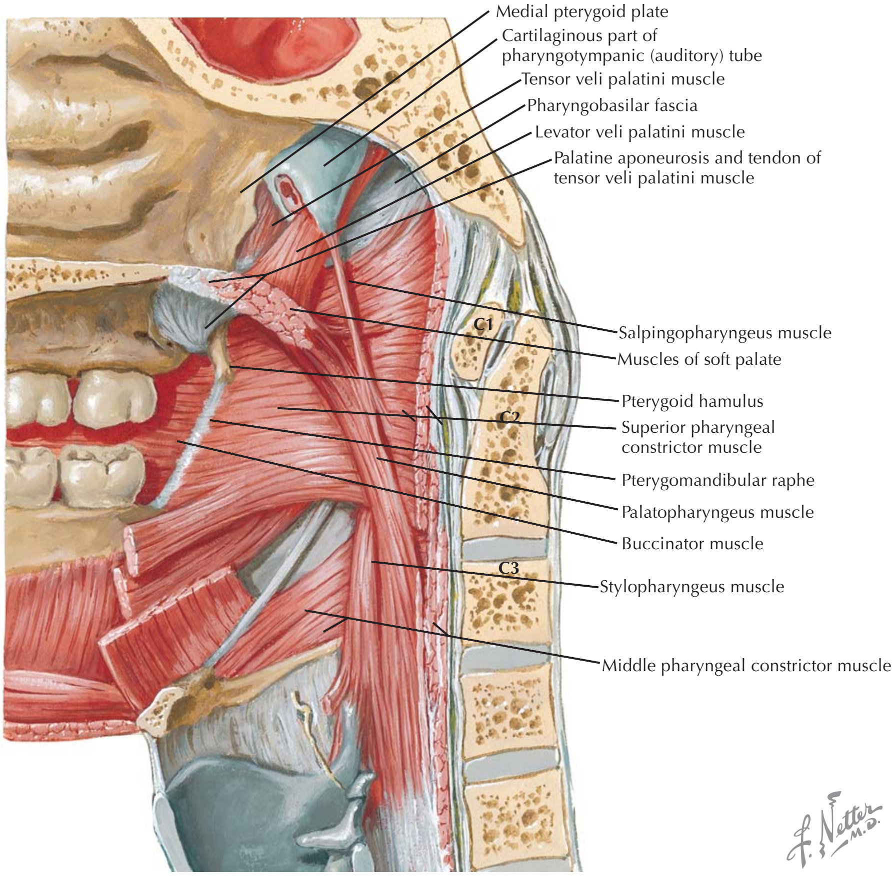
Lumen opened chiefly when attachment of tensor veli palatini muscle pulls wall of tube laterally during swallowing



Posterior view

Boundaries of the Oral Cavity

POSTEROSUPERIOR BORDER: SOFT PALATE *CONTINUED*



LATERAL BORDER: CHEEK

The lateral border of the oral cavity

Extends anteriorly from the labial commissure, posteriorly to the ramus of the mandible

Superior limit of the cheek is the maxillary vestibule; inferior limit is the mandibular vestibule

Mucous membrane of the cheek is stratified squamous epithelium

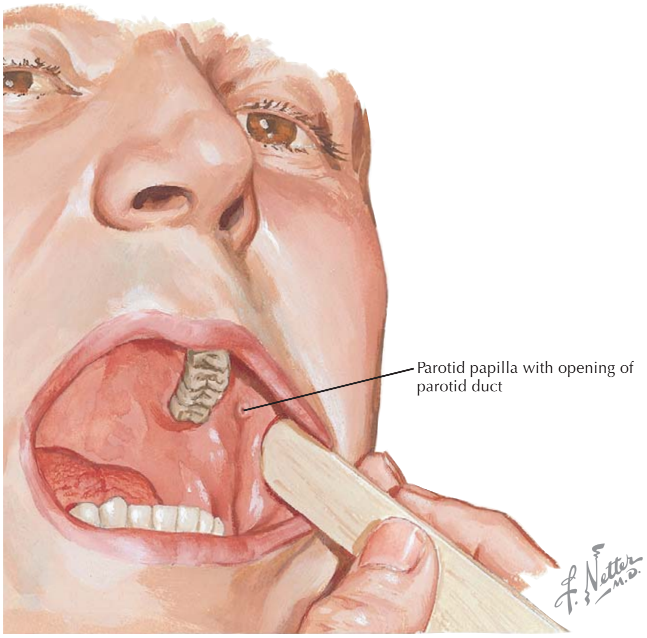
Fordyce’s spots are ectopic sebaceous glands that may be observed on the inner surface of the cheek

Parotid papilla is located in the cheek opposite the maxillary 2nd molar

Pterygomandibular raphe is located in the posterior portion and serves as a landmark for the pterygomandibular space

Boundaries of the Oral Cavity

LATERAL BORDER: CHEEK *CONTINUED*



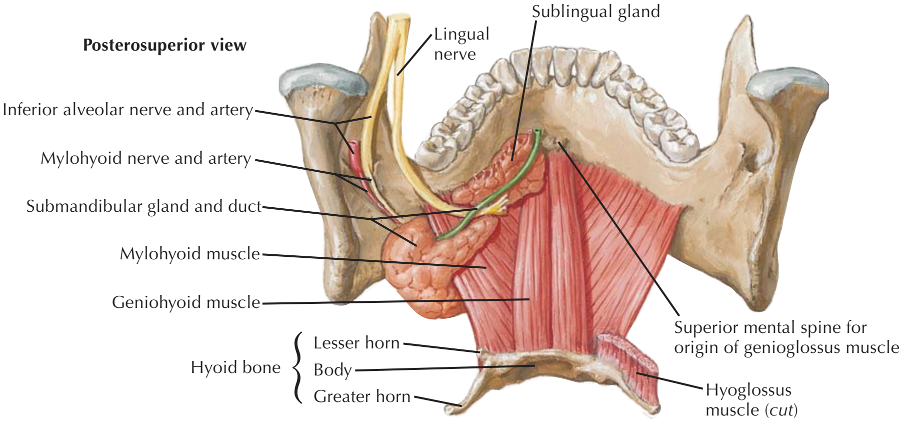
INFERIOR BORDER: FLOOR OF THE ORAL CAVITY

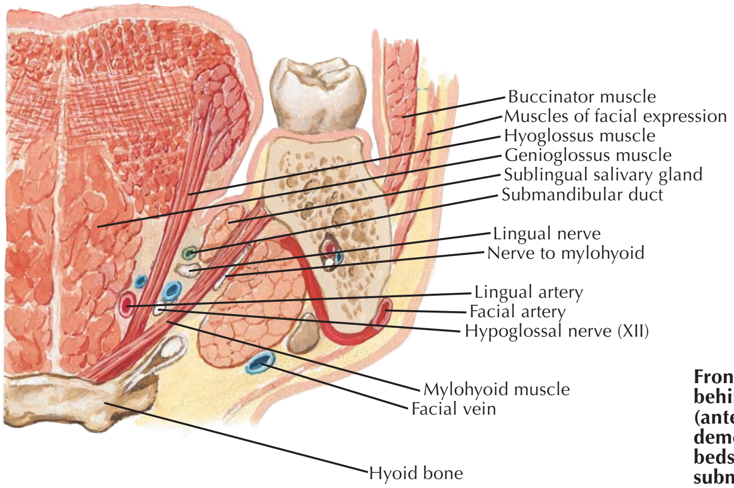
Structure	Comments
Floor	Inferior border of the oral cavity Located along the lingual border of the mandible forming a horseshoe-shaped region
Tongue	Largest structure in the floor
Lingual frenulum	A midline fold of tissue located at the base of the tongue and extends along the inferior surface of the tongue
Mucous membrane	Stratified squamous epithelium that extends from the tongue to the mandible
Sublingual papilla	A swelling located on both sides of the lingual frenulum at the base of the tongue Marks the entrance of the saliva from the submandibular glands into the oral cavity Continuous with the sublingual folds overlying the sublingual glands on the floor of the oral cavity
Submandibular duct	Lies along the sublingual gland
Lingual n.	Crosses the submandibular duct passing lateral, inferior, and medial to the duct to reach the tongue
Plica fimbriata	Fimbriated folds located lateral to the lingual frenulum
Mylohyoid m.	Forms the muscular sling of the floor of the oral cavity Passes from the mylohyoid line of the mandible to the opposite mylohyoid m. in the midline at the mylohyoid raphe and attaches posteriorly to the hyoid bone
Geniohyoid mm.	Lie superior to the mylohyoid mm. Attach from the inferior genial tubercles of the mandible to the hyoid bone

Boundaries of the Oral Cavity

INFERIOR BORDER: FLOOR OF THE ORAL CAVITY *CONTINUED*

MUSCLES OF THE FLOOR OF THE ORAL CAVITY					
Muscle	**Origin**	**Insertion**	**Actions**	**Nerve Supply**	**Comment**
Mylohyoid	Mylohyoid line of the mandible	Symphysis menti Mylohyoid raphe Body of the hyoid bone	Raises the floor of the oral cavity Can elevate the hyoid bone	Mylohyoid n. from the inferior alveolar branch of the mandibular division of the trigeminal n.	Forms the sling of the oral cavity
Geniohyoid	Inferior genial tubercle	Body of the hyoid bone	Elevates the hyoid bone	C1 ventral ramus, which follows the hypoglossal n.	Superior to the mylohyoid m.

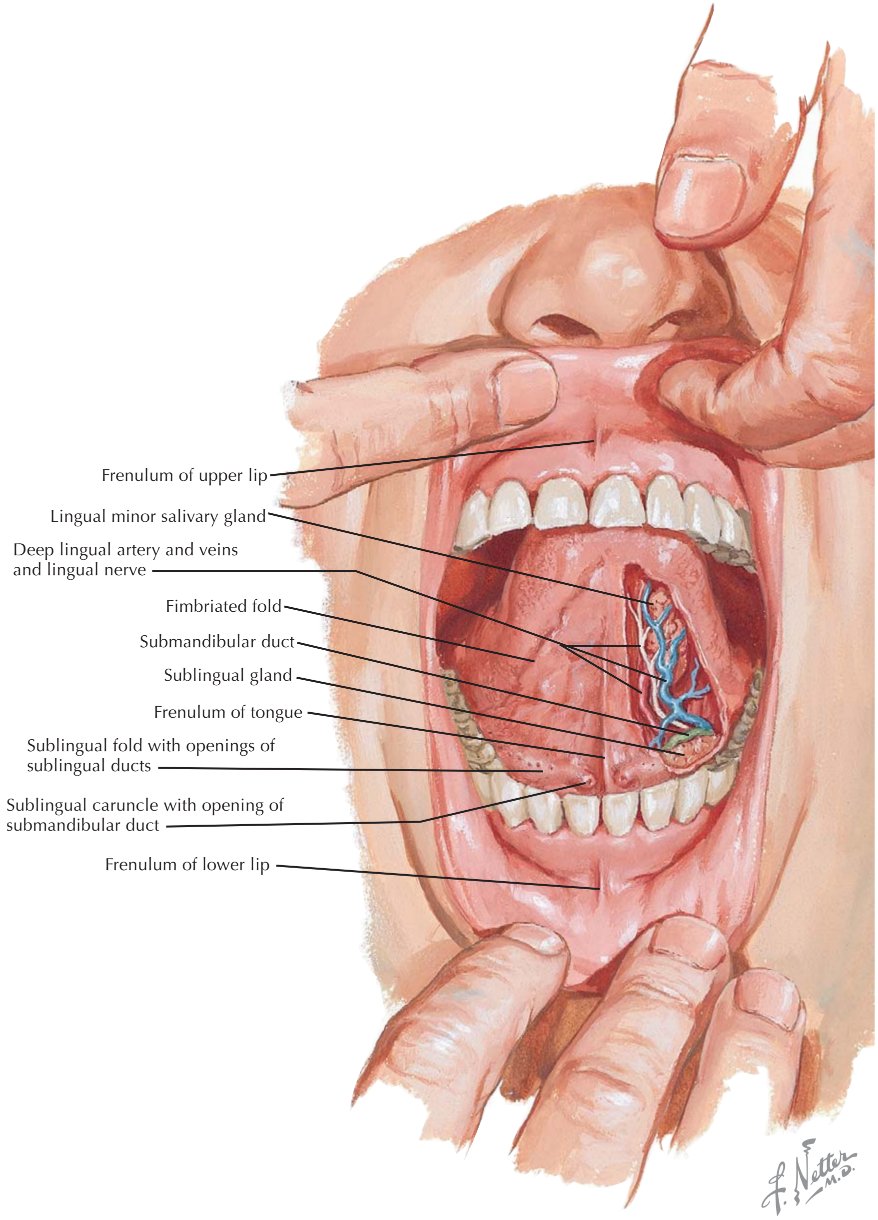




Frontal section behind 1st molar tooth (anterior view) demonstrating beds of sublingual and submandibular glands

F. Netter M.D.

INFERIOR BORDER: FLOOR OF THE ORAL CAVITY *CONTINUED*



Teeth

GENERAL INFORMATION

Teeth are hard structures attached to the jaws and involved primarily in eating

2 arches contain the teeth:
- Maxillary arch
- Mandibular arch

Humans have 2 sets of teeth during a lifetime:
- Deciduous teeth—the primary dentition
- Permanent teeth—the secondary dentition

Between the ages of 6 and 12 years, there is a mixed dentition, in which both primary and permanent teeth are present in the oral cavity at the same time

Deciduous Teeth

There are 20 total deciduous teeth: 2 incisors, 1 canine, and 2 molars in each of the 4 quadrants of the oral cavity

The primary dentition is represented by the formula $I\frac{2}{2}C\frac{1}{1}\ M\frac{2}{2}$, which specifies the total number of teeth (10) on each side of the oral cavity

No deciduous teeth are present at birth; however, by the 3rd year of life, all 20 deciduous teeth have erupted

Permanent Teeth

There are 32 total permanent teeth: 2 incisors, 1 canine, 2 premolars, and 3 molars in each of the 4 quadrants of the oral cavity

The permanent dentition is represented by the formula $I\frac{2}{2}C\frac{1}{1}P\frac{2}{2}M\frac{3}{3}$, which specifies the total number of teeth (16) on each side of the oral cavity

The first permanent tooth to erupt into the oral cavity normally is the mandibular 1st molar
- This eruption occurs at about 6 years of age
- It erupts distal to the primary dentition

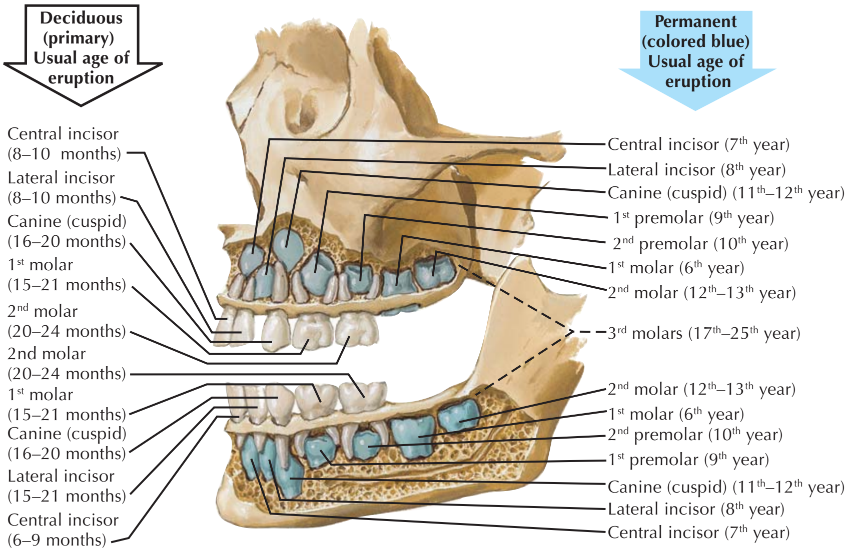
The primary teeth eventually are replaced by the permanent teeth

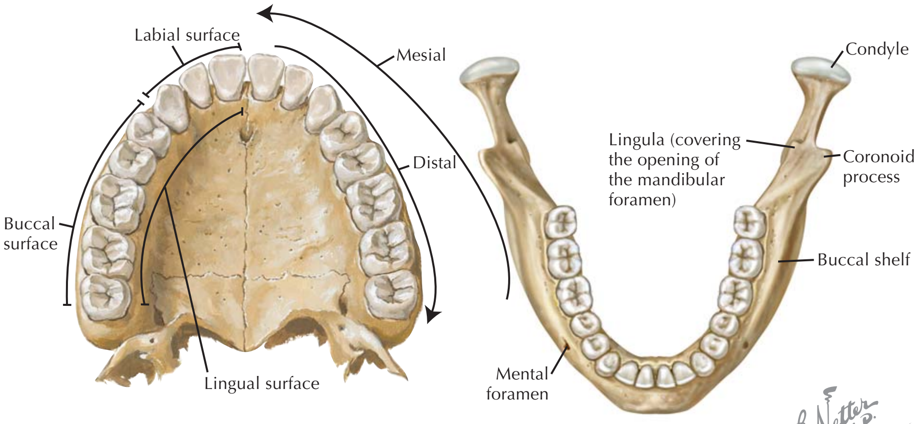
The replacement teeth are termed succedaneous teeth

SURFACES OF A TOOTH

Labial	The surface of the anterior teeth that is closest to the lip
Buccal	The surface of the posterior teeth that is closest to the cheek
Facial	Used as a synonym for labial or buccal
Lingual	Opposite the tongue in the mandibular arch and opposite the hard palate of the maxillary arch
Mesial	Closest to the midline of the dental arch
Distal	Farthest from the midline of the dental arch
Occlusal	Used for chewing in posterior teeth
Incisal	The cutting edge of anterior teeth

SURFACES OF A TOOTH *CONTINUED*





Lower permanent teeth

F. Netter M.D.
K. Carter

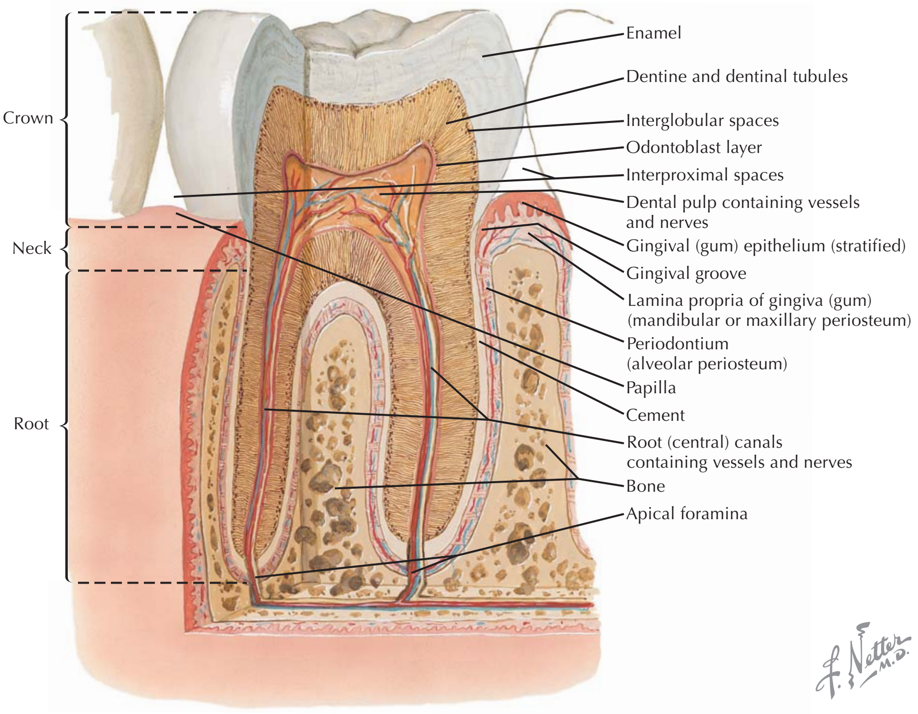
BASIC ANATOMY OF A TOOTH

Crown	*Anatomic crown*: the portion of the tooth that has a surface of enamel *Clinical crown*: the portion of the tooth that is exposed within the oral cavity
Root	*Anatomic root*: the portion of the tooth that has a surface of cementum *Clinical root*: the portion of the tooth that is entrenched within the maxilla or mandible and is not exposed to the oral cavity
Apex of the root	The end tip of the root, which also is the location of a small aperture at the point of each root, which provides an entrance for the neurovascular connective tissue into the pulp cavity

Teeth

BASIC ANATOMY OF A TOOTH *CONTINUED*

Cervical line	The anatomic demarcation between the crown and the root It often is termed the cementoenamel junction (CEJ)
Enamel	The hard, shiny surface of the anatomic crown The hardest portion of the tooth Made of small hexagonal rods, called enamel prisms, that are parallel to one another
Cementum	A thin, dull layer on the surface of the anatomic root Similar in structure and chemical composition to bone With age, cementum increases in thickness
Dentin	The hard tissue that underlies both the enamel and cementum and constitutes the major portion of the tooth A modification of osseous tissue Composed of a number of dental tubules (small wavy and branching tubes) that are located in a dense matrix
Cusp	An elevation on the occlusal surface of molars and premolars that makes up a divisional part of the tooth The incisal edge of canines is referred to as a cusp and is used for prehension (grasping and tearing) of food
Pulp cavity	Contains the dental pulp (highly neurovascular connective tissue) Separated into the *pulp chamber*, located in the coronal portion of the tooth, and the *pulp canal*, located in the root portion of the tooth
Cingulum	A convex elevation that is located on the lingual surface of the crowns of anterior teeth just incisal to the CEJ

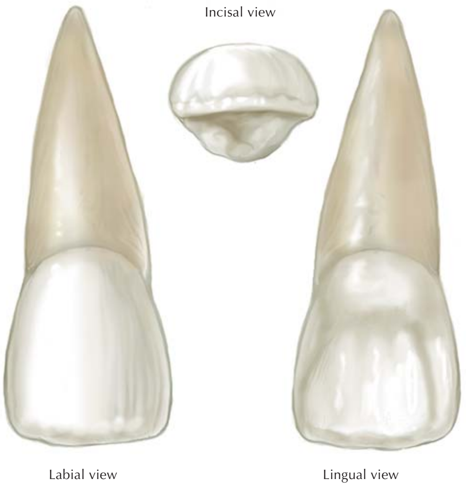


13 Teeth

TYPES OF TEETH IN THE PERMANENT DENTITION

MAXILLARY INCISORS				
Tooth	**Crown**	**Surfaces**	**Root(s)**	**Comments**
Central incisor	The widest of all of the anterior teeth, nearly as wide as it is long *Cingulum:* well-developed	From a labial view, the distal surface is more convex than the mesial surface *Mamelons:* 3 elevations on the incisal edge of anterior teeth that denote centers of formation Observed in central incisors before they are worn away during function	1 conical root that is triangular in cross section	Incisors are cutting teeth
Lateral incisor	More narrow than the central incisor in a mesial-to-distal measurement	*Labial surface:* convex *Incisal edges* on the mesial and distal surfaces: more convex than central incisors *Mamelons:* tend to be less prominent on the lateral incisor *Lingual surface:* more concave than on the central incisors *Mesial and distal marginal ridges* more prominent than central incisor and typically demonstrates a lingual pit	One conical root that is oval in cross section	
MAXILLARY CANINE				
Tooth	**Crown**	**Surfaces**	**Root(s)**	**Comments**
Canine	*Cingulum:* prominent	*Labial surface:* convex *Incisal edge:* rounded into a cusp that displays a mesial and distal cusp ridge *Lingual surface:* exhibits a strong ridge from the cusp tip to the cingulum, which divides the lingual surface into a mesial and a distal fossa	1 long and conical root that is rectangular in cross section, with depressions on the mesial and distal surfaces	Also called cuspid; longest tooth in the oral cavity Prehensile tooth

TYPES OF TEETH IN THE PERMANENT DENTITION *CONTINUED*



Maxillary central incisor (right side)

Maxillary lateral incisor (right side)

TYPES OF TEETH IN THE PERMANENT DENTITION *CONTINUED*

Maxillary canine (right side)

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MAXILLARY PREMOLARS				
Tooth	**Crown**	**Surfaces**	**Root(s)**	**Comments**
1st premolar	Shorter than the anterior teeth Wider in a facial-lingual dimension than in a mesial-distal dimension	Has a lingual and a facial cusp *Facial surface:* convex *Facial cusp:* long and similar in appearance to the cusp of the canine *Lingual cusp:* shorter than the facial cusp and positioned mesial of the mesial distal midline Displays a mesial marginal developmental groove	Usually 2 roots—a facial and a lingual root	Often referred to as bicuspid teeth, but a more accepted designation would be premolar teeth Prehensile tooth
2nd premolar	Not as angular in shape as the 1st premolar	*Facial surface:* convex Has a lingual and a facial cusp • *Facial cusp:* not as sharp as the facial cusp of the 1st premolar • *Lingual cusp:* nearly equal in size and similar in shape to the facial cusp	Usually 1 root	Occlusal surface contains supplemental grooves, which gives it a wrinkled appearance Supplements the molars in function

TYPES OF TEETH IN THE PERMANENT DENTITION *CONTINUED*

Maxillary 1st premolar (right side)

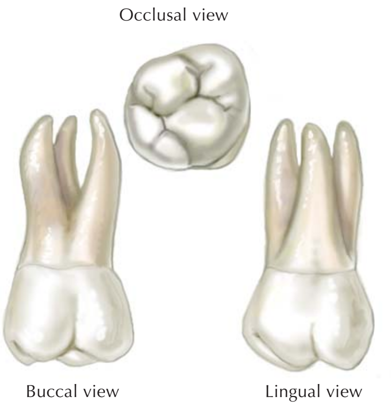
Maxillary 2nd premolar (right side)

TYPES OF TEETH IN THE PERMANENT DENTITION *CONTINUED*

MAXILLARY MOLARS				
Tooth	**Crown**	**Surfaces**	**Root(s)**	**Comments**
The molar teeth are used for crushing and chewing				
1st molar	Larger in a facial-lingual dimension than it is in a mesial-distal dimension From an occlusal view, the crown is rhomboidal in form	5 cusps: • Mesiobuccal cusp • Distobuccal cusp • Mesiolingual cusp • Distolingual cusp • 5th cusp: present on the lingual surface of the mesiolingual cusp and termed the cusp of Carabelli	3 roots: • Mesiobuccal root • Distobuccal root (smallest) • Lingual root (largest)	Usually the largest of the molar teeth
2nd molar	Supplements the 1st molar in function 2 forms: • Resembles the 1st molar with a more extreme rhomboidal form • A heart-shaped form with a poorly developed distolingual cusp	4 cusps: • Mesiobuccal cusp • Distobuccal cusp • Mesiolingual cusp • Distolingual cusp (sometimes absent) There is no fifth cusp	3 roots: • Mesiobuccal root • Distobuccal root • Lingual root	Smaller than the 1st molar
3rd molar	Great variation in the crown (it may resemble the 1st or 2nd molar)	3-cusp form is more common: • Mesiobuccal cusp • Distobuccal cusp • Mesiolingual cusp	3 roots: • Mesiobuccal root • Distobuccal root • Lingual root The roots usually are fused, functioning as 1 large root	Variable in size Often extracted as a preventive measure

Teeth

TYPES OF TEETH IN THE PERMANENT DENTITION *CONTINUED*



Maxillary 1st molar (right side)

Maxillary 2nd molar (right side)

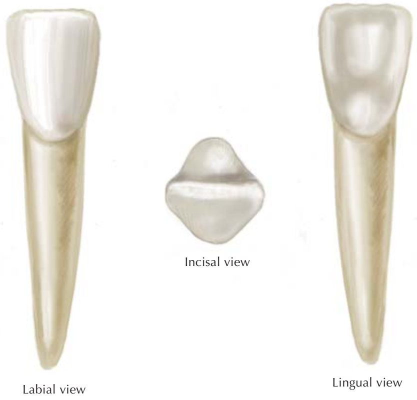
Maxillary 3rd molar (right side)

MANDIBULAR CANINE				
Tooth	**Crown**	**Surfaces**	**Root(s)**	**Comments**
Canine	Longer than the maxillary canine *Cingulum:* not as prominent as on the maxillary canine	*Incisal edge:* rounded into a cusp *Mamelons:* not usually located on canine teeth *Mesial surface* of crown and root: relatively straight, without much convexity	1 long and conical root	Also called cuspids Smaller and more symmetrical than the maxillary canine

TYPES OF TEETH IN THE PERMANENT DENTITION *CONTINUED*

MANDIBULAR INCISORS				
Tooth	**Crown**	**Surfaces**	**Root(s)**	**Comments**
Central incisor	2/3 the width of the maxillary central incisor Appears bilaterally symmetrical *Cingulum:* small and poorly developed	*Labial surface:* convex *Lingual surface:* concave *Mamelons:* observed in central incisors before wear *Lingual fossa:* poorly developed	1 root that is flattened and is wide in a facial-lingual direction	Incisors are cutting teeth
Lateral incisor	Not bilaterally symmetrical	*Labial surface:* convex *Lingual fossa:* poorly developed	1 root similar in shape to the central incisor	When viewed from the incisal aspect, the crown appears twisted distally on the root Incisors are cutting teeth

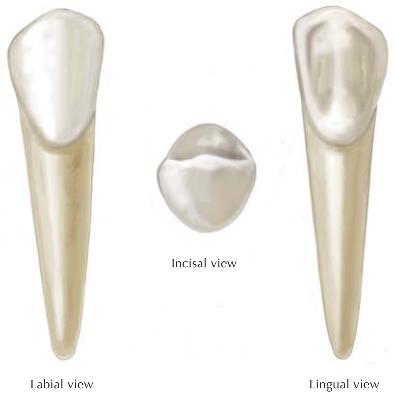
Mandibular central incisor (right side)



Mandibular lateral incisor (right side)

Winn

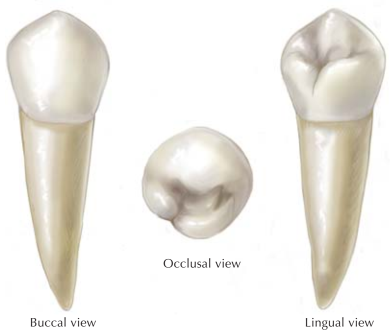
TYPES OF TEETH IN THE PERMANENT DENTITION *CONTINUED*



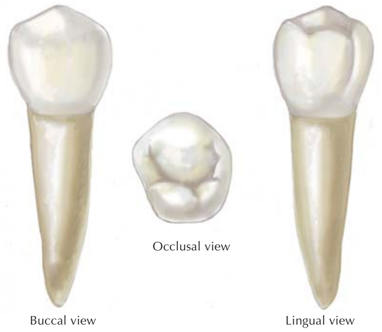
Mandibular canine (right side)

MANDIBULAR PREMOLARS				
Tooth	**Crown**	**Surfaces**	**Root(s)**	**Comments**
1st premolar	Diamond-shaped	*Facial surface:* convex Has a lingual and a buccal cusp • Buccal cusp—well developed • Lingual cusp—small and not well developed Displays a mesial lingual developmental groove	1 root that is oval in cross section, with a slight lingual taper	The smallest of the premolar teeth
2nd premolar	Convex	Demonstrates either of 2 occlusal schemes: • A 2-cusp form, with a facial and a lingual cusp • A 3-cusp form, with 2 lingual cusps and a single facial cusp—predominant form Facial and lingual surfaces are convex *Facial cusp* is not as sharp as that of the 1st premolar *Lingual cusp(s)* are smaller than the facial cusp	1 root that is oval in cross section, with a slight lingual taper	Differs in appearance from the 1st premolar Much larger than the 1st premolar

TYPES OF TEETH IN THE PERMANENT DENTITION *CONTINUED*



Mandibular 1st premolar (right side)



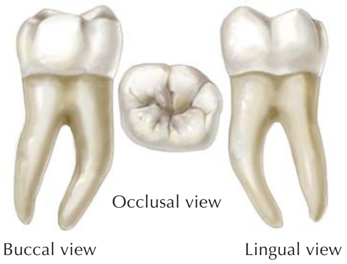
Mandibular 2nd premolar (right side)

MANDIBULAR MOLARS

Tooth	Crown	Surfaces	Root(s)	Comments
1st molar	Wider in a mesial-distal dimension than in a facial-lingual length	5 cusps: • Mesiobuccal cusp (largest) • Distobuccal cusp • Distal cusp (smallest) • Mesiolingual cusp • Distolingual cusp	2 roots: • Mesial root (containing 2 pulp canals) • Distal root (containing 1 pulp canal)	Used for crushing and chewing
2nd molar	Normally the 2nd molar is smaller than the 1st molar	4 cusps: • Mesiobuccal cusp • Distobuccal cusp • Mesiolingual cusp • Distolingual cusp	2 roots: • Mesial root (containing 2 pulp canals) • Distal root (containing 1 pulp canal)	Supplements the 1st molar in function
3rd molar	Development is similar to that of the 2nd molar	4 cusps of variable shape and size	2 roots: • Mesial root • Distal root Roots are often fused	Variable, but not as variable as the maxillary 3rd molar Often the smallest of the molar teeth Often extracted as a preventive measure

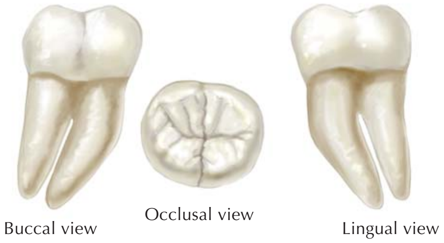
Teeth

TYPES OF TEETH IN THE PERMANENT DENTITION *CONTINUED*



Mandibular 1st molar (right side)

Mandibular 2nd molar (right side)



Mandibular 3rd molar (right side)

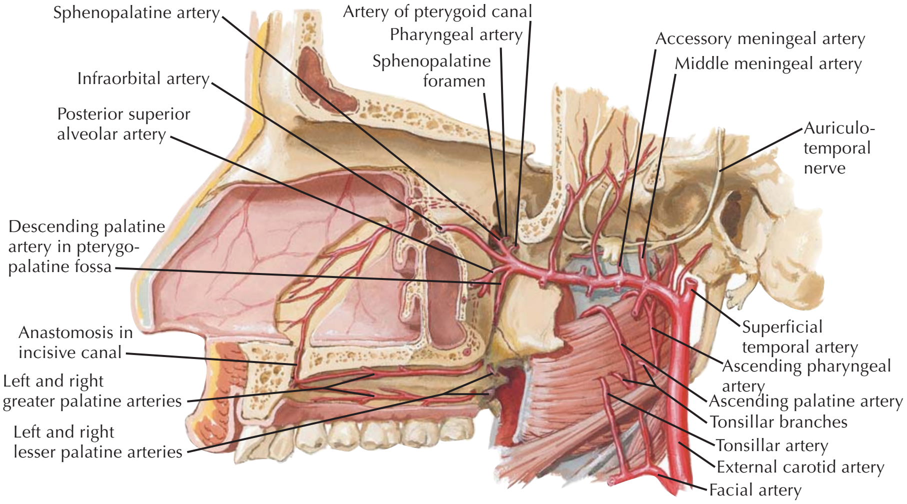
13 Vascular Supply of the Oral Cavity

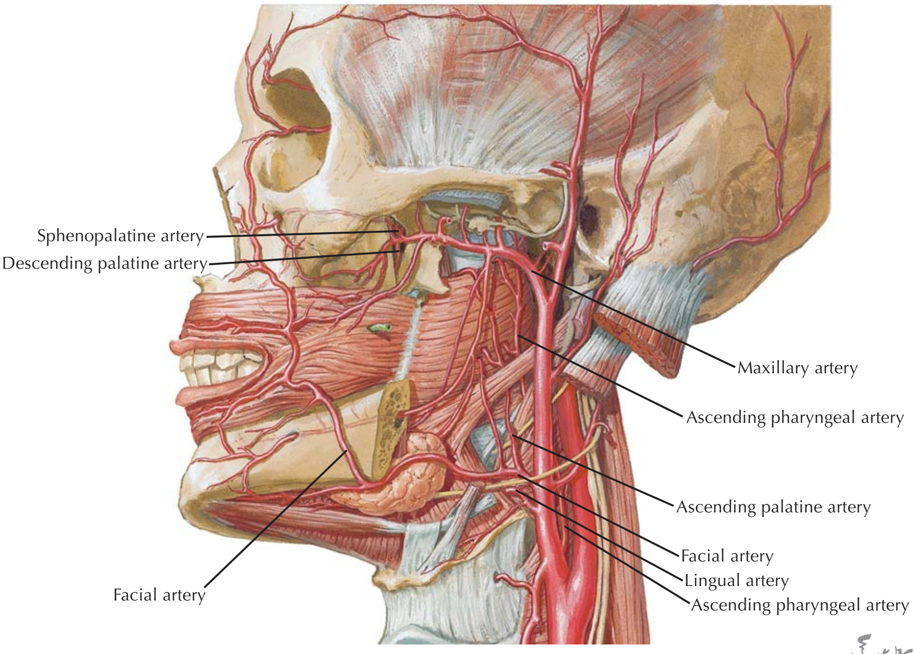
ARTERIAL SUPPLY

ARTERIAL SUPPLY OF THE PALATE		
Artery	**Source**	**Course**
Maxillary	External carotid a.	Gives rise to a series of branches; 3 supply the palate: • Sphenopalatine • Greater palatine • Lesser palatine Gives rise to 3 branches that supply the maxillary arch: • Anterior superior alveolar • Middle superior alveolar • Posterior superior alveolar Gives rise to 1 branch that supplies the mandibular arch: • Inferior alveolar
Sphenopalatine	3rd part of the maxillary a.	Enters the nasal cavity after passing through the sphenopalatine foramen On entering the nasal cavity, gives rise to the posterior superior nasal branches: • Posterior superior lateral branch • Posterior superior medial branch, which continues along the nasal septum to enter the hard palate via the incisive canal
Greater palatine	Descending palatine a. from the 3rd part of the maxillary a.	A branch of the descending palatine a. that travels in the palatine canal Within the canal, the descending palatine a. splits into the: • Lesser palatine a. • Greater palatine a. The greater palatine a. exits the greater palatine foramen and passes anteriorly toward the incisive foramen to supply the hard palate gingiva, mucosa, and palatal glands and anastomose with the terminal branch of the sphenopalatine a., which exits the incisive foramen
Lesser palatine	Descending palatine a. from the 3rd part of the maxillary a.	A branch of the descending palatine a. that travels in the palatine canal Within the canal, the descending palatine a. splits into the: • Greater palatine a. • Lesser palatine a. Lesser palatine a. supplies the soft palate and palatine tonsil
Facial	External carotid a.	Arises in the carotid triangle of the neck Passes superiorly immediately deep to the posterior belly of the digastric m. and the stylohyoid m. Passes along the submandibular gland, giving rise to the submental a., which helps supply the gland Passes superiorly over the body of the mandible at the masseter
Ascending palatine	Facial a.	Supplies the soft palate Ascends between the styloglossus and stylopharyngeus mm. along the side of the pharynx Divides near the levator veli palatini m. A branch follows the levator veli palatini, supplying the soft palate and the palatine glands A 2nd branch pierces the superior constrictor m. to supply the palatine tonsil and auditory tube Anastomoses with the ascending pharyngeal and tonsillar aa.
Ascending pharyngeal	External carotid a.	Arises in the carotid triangle of the neck Lies deep to the other branches of the external carotid a. and under the stylopharyngeus m. Gives rise to pharyngeal, inferior tympanic, posterior meningeal, and palatine branches The palatine branch passes over the superior constrictor m. and sends branches to the soft palate, tonsil, and auditory tube

Vascular Supply of the Oral Cavity

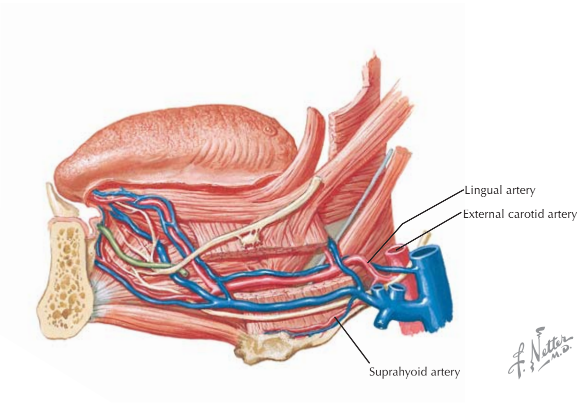
ARTERIAL SUPPLY *CONTINUED*





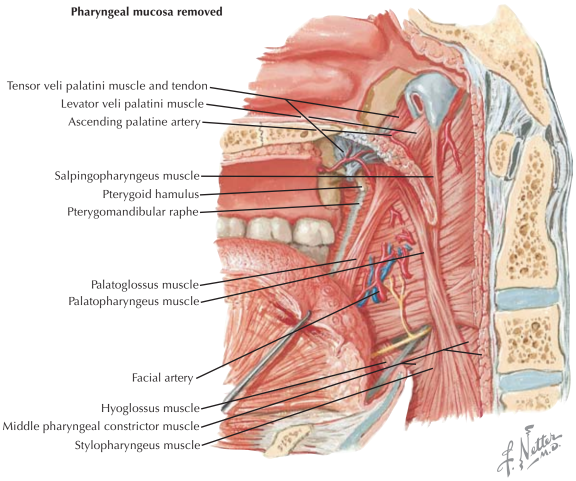
ARTERIAL SUPPLY *CONTINUED*

ARTERIAL SUPPLY OF THE FLOOR OF THE ORAL CAVITY		
Artery	**Source**	**Course**
Facial	External carotid a.	Arises in the carotid triangle of the neck Passes superiorly immediately deep to the posterior belly of the digastric m. and the stylohyoid m. Passes along the submandibular gland, giving rise to the submental a. that helps supply the gland Passes superiorly over the body of the mandible at the masseter m.
Ascending palatine	Facial a.	Supplies the soft palate Ascends between the styloglossus and stylopharyngeus mm. along the side of the pharynx Divides near the levator veli palatini m. A branch follows the levator veli palatini, supplying the soft palate and the palatine glands A 2nd branch pierces the superior constrictor m. to supply the palatine tonsil and auditory tube Anastomoses with the ascending pharyngeal and tonsillar aa.
Submental	Facial a.	Arises in the submandibular triangle of the neck Supplies the submandibular gland and surrounding muscles
Lingual	External carotid a.	Passes superiorly and medially toward the hyoid bone Curves inferiorly and anteriorly, forming a loop that lies on the middle constrictor m. and is passed superficially by the hypoglossal n. Passes deep to the posterior belly of the digastric m. and the stylohyoid m., traveling anteriorly Passes deep to the hyoglossus m. and ascends along the tongue Gives rise to dorsal lingual branches, a sublingual branch, and the deep lingual branch Sublingual branch begins at the anterior margin of the hyoglossus and travels anteriorly between the genioglossus and mylohyoideus mm. to supply the sublingual gland, surrounding muscles, and mucous membrane of the oral cavity and gingiva Deep lingual branch passes anteriorly under the surface of the tongue, then anastomoses with the opposite deep lingual a. at the tip of the tongue



Vascular Supply of the Oral Cavity

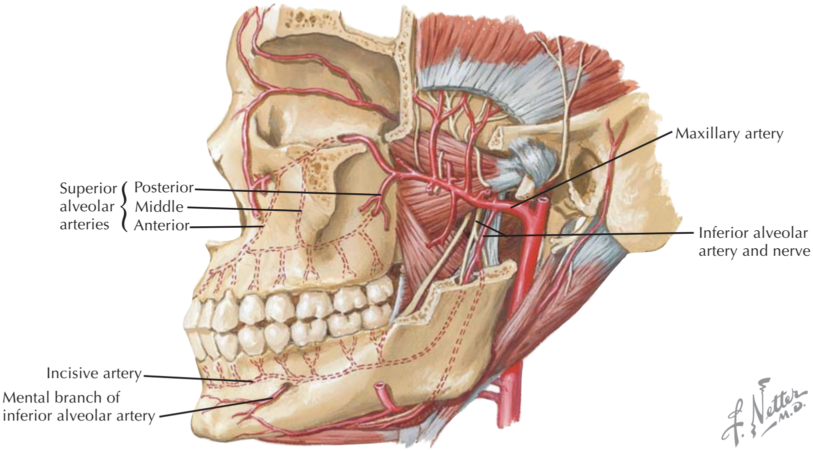
ARTERIAL SUPPLY *CONTINUED*



ARTERIAL SUPPLY OF THE MAXILLARY AND MANDIBULAR TEETH		
Artery	**Source**	**Course**
Maxillary	External carotid a.	Gives rise to 3 branches that form a plexus to supply the maxillary arch: ● Anterior superior alveolar ● Middle superior alveolar ● Posterior superior alveolar Gives rise to 1 branch that supplies the mandibular arch: ● Inferior alveolar
MAXILLARY TEETH		
Anterior superior alveolar	Infraorbital a. (of the maxillary a.)	Arises after the infraorbital a. passes through the inferior orbital fissure and into the infraorbital canal Descends via the alveolar canals to supply part of the maxillary arch Supplies the maxillary sinus and the anterior teeth
Middle superior alveolar	Infraorbital a.	May or may not be present If present, arises from the infraorbital a. of the maxillary after it passes through the inferior orbital fissure and into the infraorbital canal Descends via the alveolar canals to supply the maxillary sinus and supplies the plexus at the canine
Posterior superior alveolar	3rd part of the maxillary a.	Arises before the maxillary a. enters the pterygopalatine fossa Enters the infratemporal surface of the maxilla to supply the maxillary sinus, premolars, and molars
MANDIBULAR TEETH		
Inferior alveolar	3rd part of the maxillary a.	Descends inferiorly following the inferior alveolar n. to enter the mandibular foramen Terminates into the mental and incisive aa. at the region of the 2nd premolar Supplies all of the mandibular teeth
Mental	Inferior alveolar a.	Supplies the labial gingiva of the anterior teeth
Incisive	Inferior alveolar a.	Supplies the anterior teeth

Vascular Supply of the Oral Cavity

ARTERIAL SUPPLY *CONTINUED*



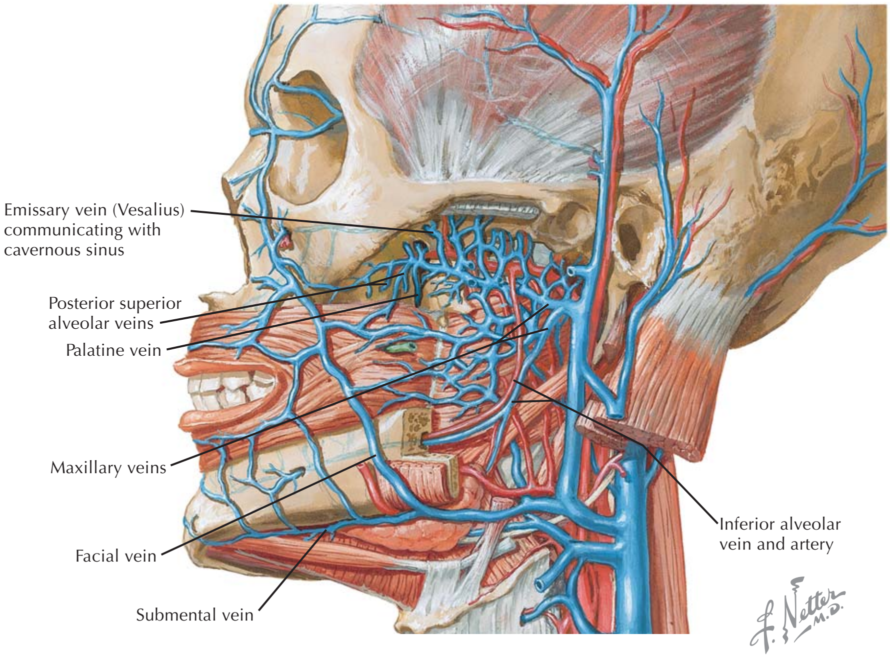
VENOUS DRAINAGE OF THE ORAL CAVITY

VENOUS DRAINAGE OF THE PALATE AND FLOOR OF THE ORAL CAVITY	
Vein	**Course**
Greater palatine	Connect to the pterygoid plexus
Lesser palatine	
Sphenopalatine	
Lingual	Receives tributaries from the deep lingual vv. on the ventral surface, and dorsal lingual vv. from the dorsal surface of the tongue Passes with the lingual a., deep to the hyoglossus m., and ends in the internal jugular v. The vena comitans nervi hypoglossi, or accompanying vein of the hypoglossal n., begins at the apex of the tongue and may either join the lingual v. or accompany the hypoglossal n. and enter the common facial v., which empties into the internal jugular v.
Submental	Anastomoses with the branches of the lingual v. and the inferior alveolar v. Parallels the submental a. on the superficial surface of the mylohyoid m. Ends in the facial v.
Pharyngeal plexus	Located along the lateral pterygoid m. Most of the vessels in the infratemporal fossa and oral cavity drain into the pterygoid plexus Connected to the cavernous sinus, the pterygoid plexus of veins, and the facial v. Valveless Eventually drains into the maxillary v.

VENOUS DRAINAGE OF THE TEETH	
Vein	**Course**
Anterior superior alveolar	Drain onto the pterygoid plexus of veins
Middle superior alveolar	
Posterior superior alveolar	
Inferior alveolar	

Vascular Supply of the Oral Cavity

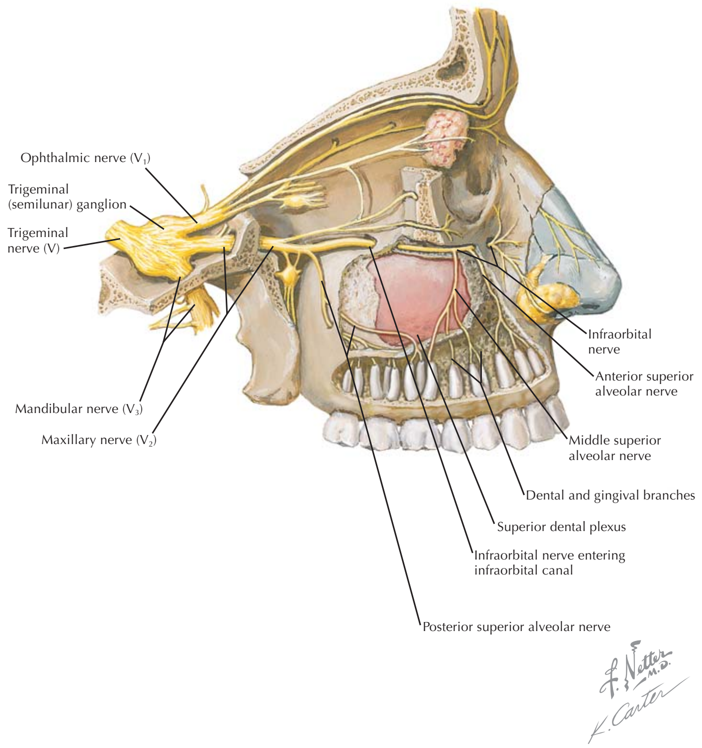
VENOUS DRAINAGE OF THE ORAL CAVITY *CONTINUED*

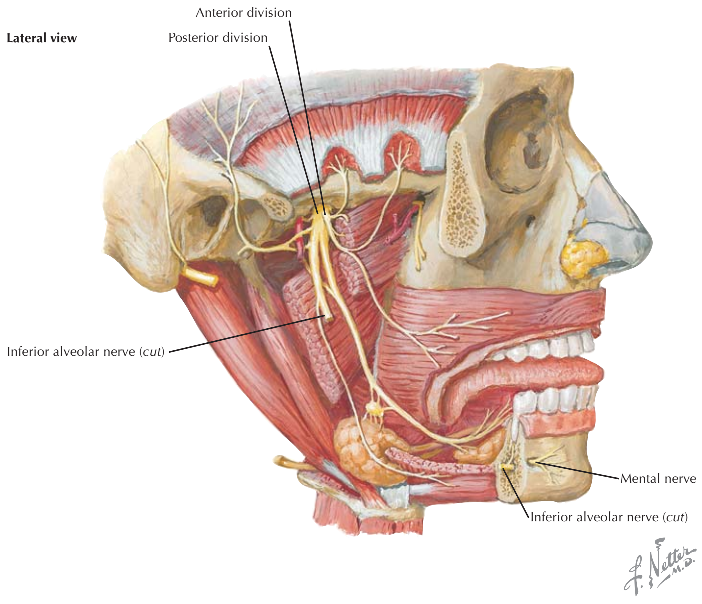


13 Nerve Supply of the Oral Cavity

GENERAL INFORMATION

The oral cavity receives its sensory innervation from branches of the maxillary and mandibular divisions of the trigeminal nerve





Nerve Supply of the Oral Cavity

SENSORY INNERVATION OF THE MAXILLARY TEETH

Nerve	Source	Course
Maxillary	Trigeminal n.	Sensory in function Travels along the lateral wall of the cavernous sinus Passes from the middle cranial fossa into the pterygopalatine fossa via the foramen rotundum Within the pterygopalatine fossa, it gives rise to 4 branches: ● Infraorbital (continuation of the maxillary) ● Ganglionic ● Posterior superior alveolar ● Zygomatic The infraorbital n. gives rise to 2 branches that form a plexus with the posterior superior alveolar to supply the maxillary arch: ● Anterior superior alveolar ● Middle superior alveolar
Infraorbital	Continuation of the maxillary division of the trigeminal n.	Passes through the inferior orbital fissure to enter the orbit Passes anteriorly through the infraorbital groove and infraorbital canal and exits onto the face via the infraorbital foramen Once the infraorbital n. exits onto the face, it divides into 3 terminal branches: ● Nasal—supplies the ala of the nose ● Inferior palpebral—supplies the skin of the lower eyelid ● Superior labial—supplies the skin of the upper lip
Anterior superior alveolar	Infraorbital n. as it travels in the infraorbital canal	As it descends to form the superior dental plexus, it innervates part of the maxillary sinus and generally the incisors and canines
Middle superior alveolar		A variable nerve As it descends to form the superior dental plexus, it innervates part of the maxillary sinus and the premolars and possibly the mesiobuccal root of the 1st molar
Posterior superior alveolar	Maxillary n. in the pterygopalatine fossa	Travels laterally through the pterygomaxillary fissure to enter the infratemporal fossa Enters the infratemporal surface of the maxilla As it descends to form the superior dental plexus, it innervates part of the maxillary sinus and the molars, with the possible exception of the mesiobuccal root of the 1st molar

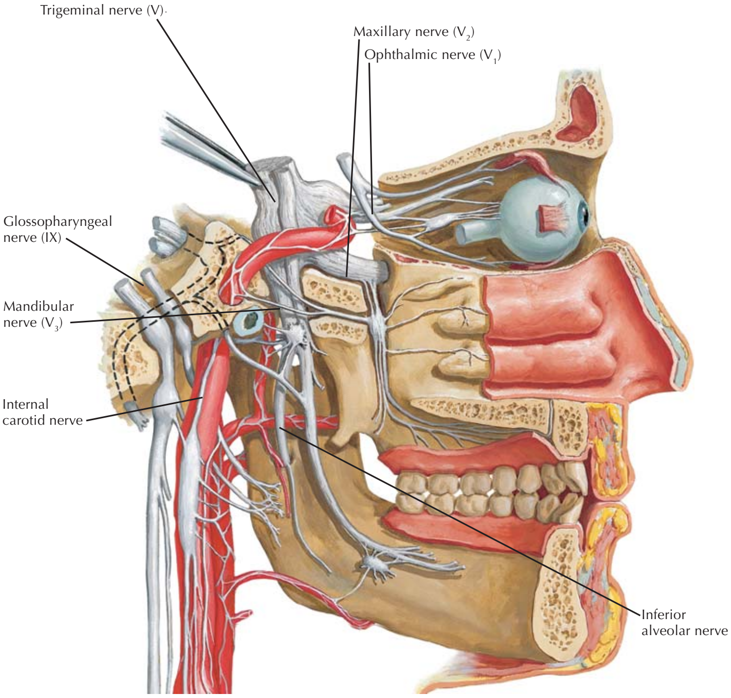
13 Nerve Supply of the Oral Cavity

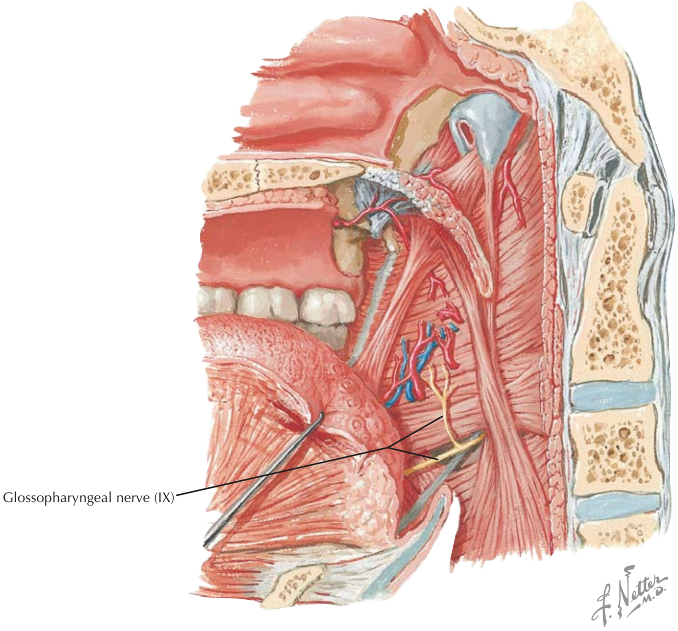
SENSORY INNERVATION OF THE MANDIBULAR TEETH

Nerve	Source	Course
Mandibular	Trigeminal n.	This division has motor function in addition to sensory function The largest of the 3 divisions of the trigeminal n. Created by a large sensory and a small motor root that unite just after passing through the foramen ovale to enter the infratemporal fossa Immediately gives rise to a meningeal branch and divides into an anterior and a posterior division Anterior division is smaller and mainly motor, with 1 sensory branch (buccal): • Masseteric • Anterior and posterior deep temporal • Medial pterygoid • Lateral pterygoid • Buccal Posterior division is larger and mainly sensory, with 1 motor branch (mylohyoid): • Auriculotemporal • Lingual • Inferior alveolar • Mylohyoid
Inferior alveolar	The largest branch of the mandibular division	Descends following the inferior alveolar a. inferior to the lateral pterygoid and, last, between the sphenomandibular ligament and the ramus of the mandible until it enters the mandibular foramen, where it terminates as the mental and incisive nn. in the area of the 2nd premolar Innervates all mandibular teeth (via inferior alveolar and incisive nn.), periodontal ligaments (via inferior alveolar and incisive nn.), and the gingiva from the premolars anteriorly to the midline (via the mental branch)
Mental	Inferior alveolar n.	Supplies the chin, lip, and facial gingiva and mucosa from the 2nd premolar anteriorly
Incisive		Supplies the teeth and periodontal ligaments from the 1st premolar anteriorly (depends on the location of the branching of the inferior alveolar n. into the incisive and mental nn.)

Nerve Supply of the Oral Cavity

SENSORY INNERVATION OF THE MANDIBULAR TEETH *CONTINUED*





13 Nerve Supply of the Oral Cavity

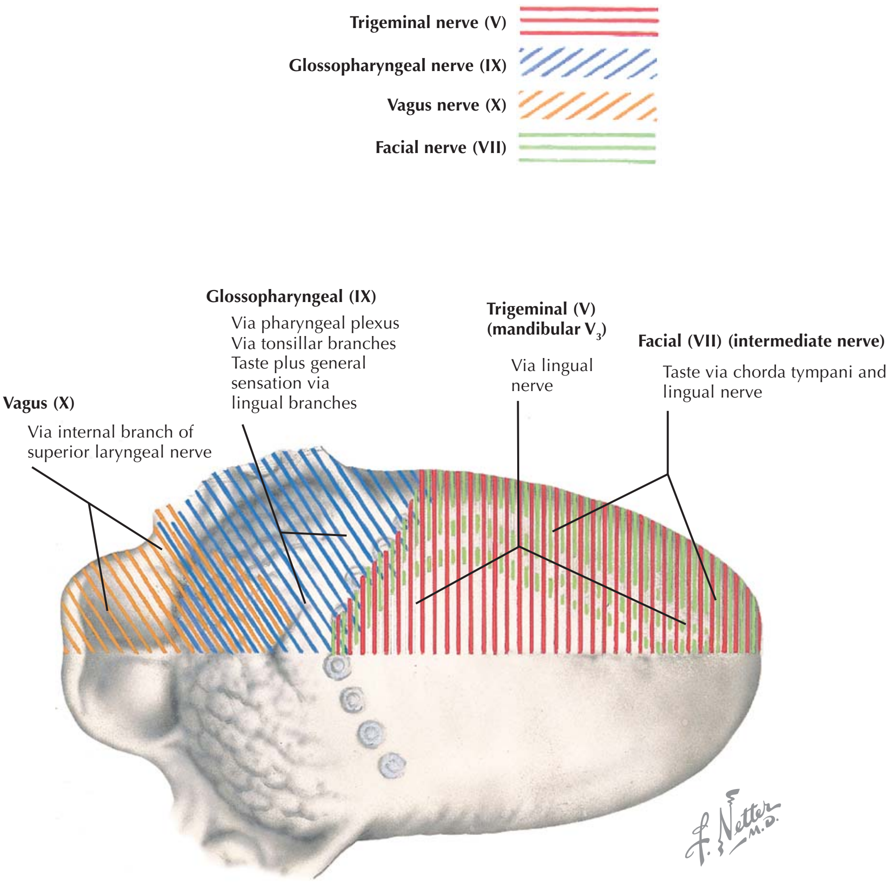
FLOOR OF THE ORAL CAVITY

Nerve	Source	Course
Lingual	Mandibular division of the trigeminal n.	Lies inferior to the lateral pterygoid and medial nn. and anterior to the inferior alveolar n. within the infratemporal fossa The chorda tympani branch of the facial n. also joins the posterior part of the lingual n. Passes between the medial pterygoid m. and the ramus of the mandible to pass obliquely to enter the oral cavity, bounded by the superior pharyngeal constrictor m., the medial pterygoid, and the mandible Enters the oral cavity lying against the lingual tuberosity of the mandible The submandibular ganglion is suspended from the lingual n. at the posterior border of the hyoglossus Continues anteriorly and passes on the lateral surface of the hyoglossus Passes from the lateral side, inferiorly, and medially to the submandibular duct to reach the mucosa of the tongue Supplies general somatic afferent (GSA) fibers to the mucous membrane and papilla of the anterior 2/3 of the tongue and gingiva and mucosa on the lingual side of the mandibular teeth
Glossopharyngeal	Medulla oblongata	Passes through the jugular foramen with the vagus and accessory nn. As it passes through the foramen, it passes between the internal carotid a. and the internal jugular v. Continues to pass inferiorly and travels posterior to the stylopharyngeus m. Passes anteriorly with the stylopharyngeus m. and travels between the superior and middle constrictor mm. to be located by the palatine tonsils Small lingual branches arise from it and distribute GSA fibers to the mucous membrane of the posterior 1/3 of the tongue, in addition to the pillars of the fauces In addition, small lingual branches arise from it and distribute special visceral afferent (SVA) fibers to the taste buds in the mucous membrane of the posterior 1/3 of the tongue and the circumvallate papillae
Internal laryngeal	Superior laryngeal branch of the vagus n.	Vagus n. branches from the medulla oblongata and passes through the jugular foramen with the glossopharyngeal and accessory nn. As the vagus n. passes through the foramen, it passes between the internal carotid a. and the internal jugular v. A series of nerves branch from the vagus in the neck, including the superior laryngeal n. Superior laryngeal n. travels inferiorly posterior to the internal carotid a. and on the side of the pharynx and divides into the internal and external laryngeal nn. Internal laryngeal n. passes inferiorly to the larynx and passes through the thyrohyoid membrane along with the superior laryngeal vessels Branches of the internal laryngeal n. distribute the GSA fibers to the base of the tongue at the epiglottic region and to the mucous membranes of the larynx as far inferiorly as the false vocal folds In addition, the branches distribute SVA fibers to the taste buds scattered at the base of the tongue at the epiglottic region

Nerve Supply of the Oral Cavity

FLOOR OF THE ORAL CAVITY *CONTINUED*

Nerve	Source	Course
Chorda tympani	Facial n. in the tympanic cavity	Carries the preganglionic parasympathetic fibers to the submandibular ganglion and taste fibers to the anterior 2/3 of the tongue Passes anteriorly to enter the tympanic cavity and lies along the tympanic membrane and malleus until exiting the petrotympanic fissure Once it exits the petrotympanic fissure, the chorda tympani joins the posterior border of the lingual n. The lingual n. is distributed to the anterior 2/3 of the tongue and the SVA fibers from the chorda tympani travel to the taste buds in this region



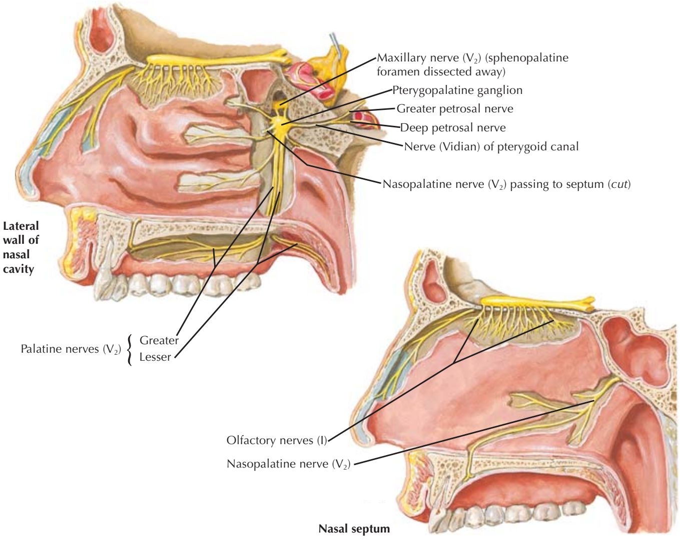
13 Nerve Supply of the Oral Cavity

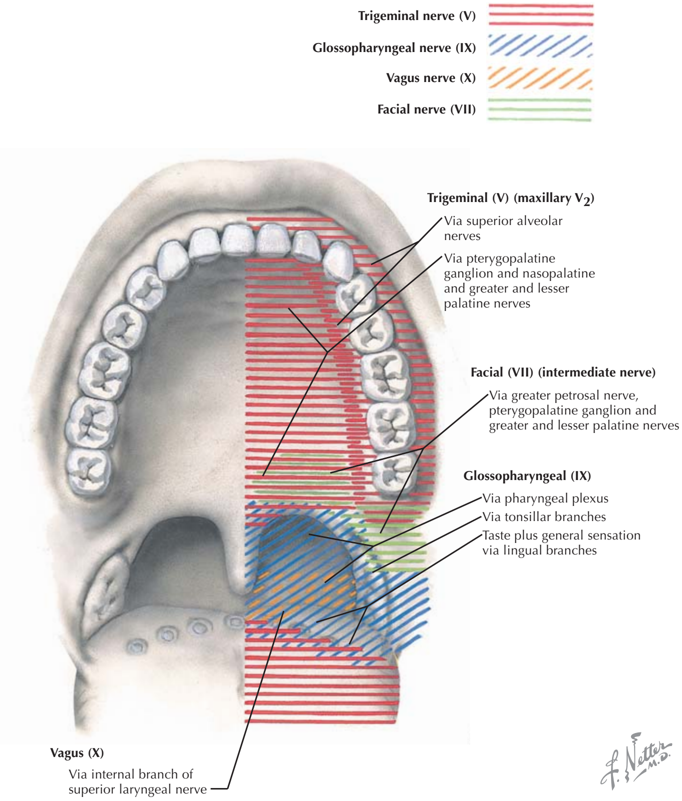
PALATE

Nerve	Source	Course
Maxillary	Trigeminal n.	Sensory in function Travels along the lateral wall of the cavernous sinus Passes from the middle cranial fossa into the pterygopalatine fossa via the foramen rotundum Within the pterygopalatine fossa, it gives rise to 4 branches: • Infraorbital (considered the continuation of the maxillary) • Ganglionic • Posterior superior alveolar • Zygomatic The infraorbital passes through the inferior orbital fissure to enter the orbit and passes anteriorly through the infraorbital groove and canal and exits onto the face via the infraorbital foramen Once the infraorbital n. exits onto the face, it divides into 3 terminal branches: • Nasal—supplies the ala of the nose • Inferior palpebral—supplies the skin of the lower eyelid • Superior labial—supplies the skin of the upper lip; 3 of its branches form a plexus to supply the maxillary arch: • Anterior superior alveolar • Middle superior alveolar • Posterior superior alveolar
Nasopalatine	Pterygopalatine ganglion in the pterygopalatine fossa	Passes through the sphenopalatine foramen to enter the nasal cavity Passes along the superior portion of the nasal cavity to the nasal septum, where it travels anteroinferiorly to the incisive canal supplying the septum Once entering the oral cavity, it provides sensory innervation to the palatal gingiva and mucosa from the area anterior to the premolars
Greater palatine		Passes through the palatine canal to enter the hard palate via the greater palatine foramen Provides sensory innervation to the palatal gingiva and mucosa from the premolars to the posterior border of the hard palate
Lesser palatine		Passes through the palatine canal to enter the hard palate via the lesser palatine foramen Provides sensory innervation to the soft palate
Glossopharyngeal	Medulla oblongata	Passes through the jugular foramen with the vagus and accessory nn. As it passes through the foramen, it passes between the internal carotid a. and internal jugular v. Continues to pass inferiorly and travels posterior to the stylopharyngeus m. Passes anteriorly with the stylopharyngeus and travels between the superior and middle constrictor mm. to be located by the palatine tonsils Small lingual branches arise from it and distribute general somatic afferent fibers to the mucous membrane of the posterior 1/3 of the tongue, in addition to the pillars of the fauces

Nerve Supply of the Oral Cavity

PALATE *CONTINUED*





13 Salivary Glands

GENERAL INFORMATION

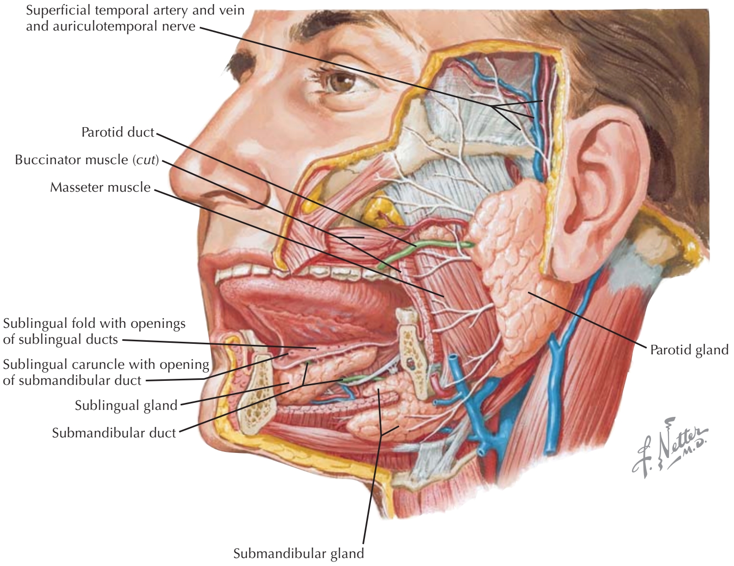
There are 3 pairs of major salivary glands:

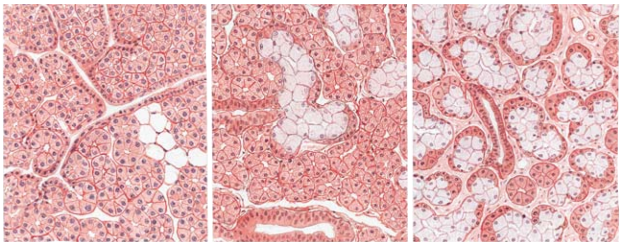
- Parotid gland
- Submandibular gland
- Sublingual gland

They secrete saliva into the oral cavity to aid in the digestion, mastication, and deglutition of food

Saliva is mucous or serous in consistency

Many minor salivary glands are ubiquitously distributed throughout the oral mucosa of the oral cavity





Parotid gland: totally serous

Submandibular gland: mostly serous, partially mucous

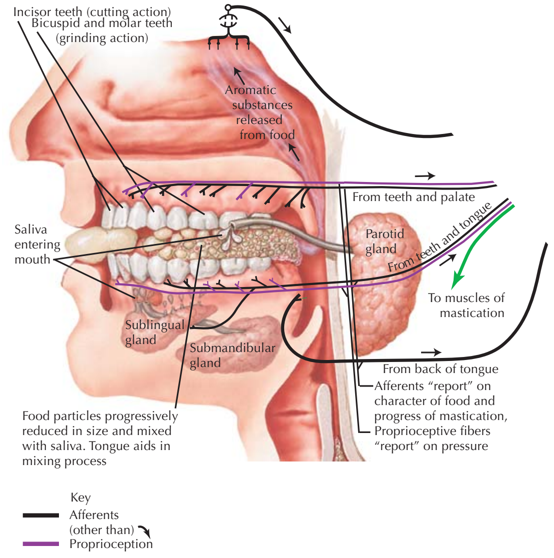
Sublingual gland: almost completely mucous

Salivary Glands

GENERAL INFORMATION *CONTINUED*

FEATURES OF THE MAJOR SALIVARY GLANDS			
Gland	**Duct**	**Comment**	**Autonomic Innervation**
Parotid	Parotid duct (Stensen's duct)	The largest salivary gland Pyramidal in shape, with up to 5 processes (or extensions) Saliva created by the parotid is serous Facial n. splits the parotid gland into a superficial lobe and a deep lobe, which are connected by an isthmus The parotid duct (Stensen's duct) forms within the deep lobe and passes from the anterior border of the gland across the masseter m. superficially, through the buccinator m. into the oral cavity opposite the 2nd maxillary molar	Glossopharyngeal n.
Submandibular	Submandibular duct (Wharton's duct)	2nd largest salivary gland A mixed salivary gland, secreting both serous and mucous saliva, but predominantly serous-secreting Wraps around the posterior border of the mylohyoid m., to be located in the submandibular triangle of the neck and the floor of the oral cavity The part of the submandibular gland located in the submandibular triangle is referred to as the superficial portion and is surrounded by the investing layer of deep cervical fascia Facial a. crosses between the submandibular gland and the mandible before giving off the submental a., while the facial v. normally lies superficial to the gland Deep portion of the submandibular gland lies in the oral cavity between the hyoglossus m. and the mandible and ends at the posterior border of the sublingual gland The submandibular duct lies along the sublingual gland and empties into the oral cavity at the sublingual papilla	Facial n.
Sublingual	Numerous small ducts opening along the sublingual fold	Smallest of the 3 major salivary glands A mixed salivary gland, secreting both mucous and serous saliva, but predominantly mucus-secreting Located in the oral cavity between the mucosa of the oral cavity and the mylohyoid m. Creates a sublingual fold in the floor of the oral cavity Lies between the sublingual fossa of the mandible and the genioglossus m. of the tongue The submandibular duct lies on the sublingual gland Bartholin's duct, a common duct that drains the anterior part of the gland in the region of the sublingual papilla, may be present	

GENERAL INFORMATION *CONTINUED*

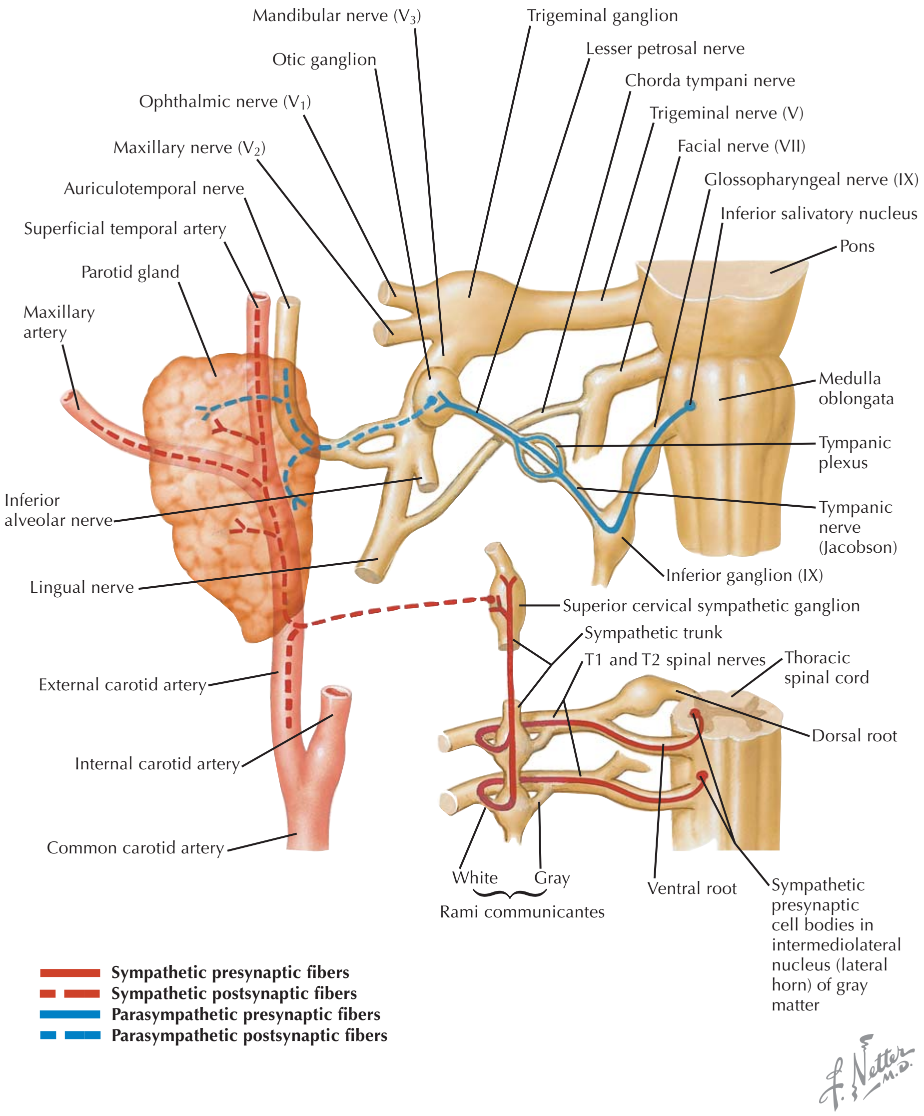


AUTONOMICS OF THE SALIVARY GLANDS

PARASYMPATHETICS OF THE PAROTID GLAND

Type of Neuron	Name of Cell Body	Characteristics of the Cell Body	Course of the Neuron
Preganglionic neuron	Inferior salivatory nucleus	A collection of nerve cell bodies located in the medulla	Preganglionic parasympathetic fibers arise from the inferior salivatory nucleus in the medulla Travel through the glossopharyngeal n. and exit the jugular foramen Gives rise to the tympanic branch of cranial n. IX, which reenters the skull via the tympanic canaliculus The tympanic branch of IX forms the tympanic plexus along the promontory of the ear The plexus re-forms as the lesser petrosal n., typically exiting the foramen ovale to enter the infratemporal fossa Lesser petrosal n. joins the otic ganglion
Postganglionic neuron	Otic ganglion	A collection of nerve cell bodies located inferior to the foramen ovale, medial to the mandibular division of the trigeminal	Postganglionic parasympathetic fibers arise in the otic ganglion These fibers travel to the auriculotemporal branch of the trigeminal n. Auriculotemporal n. travels to parotid gland Postganglionic parasympathetic fibers innervate the: • Parotid gland

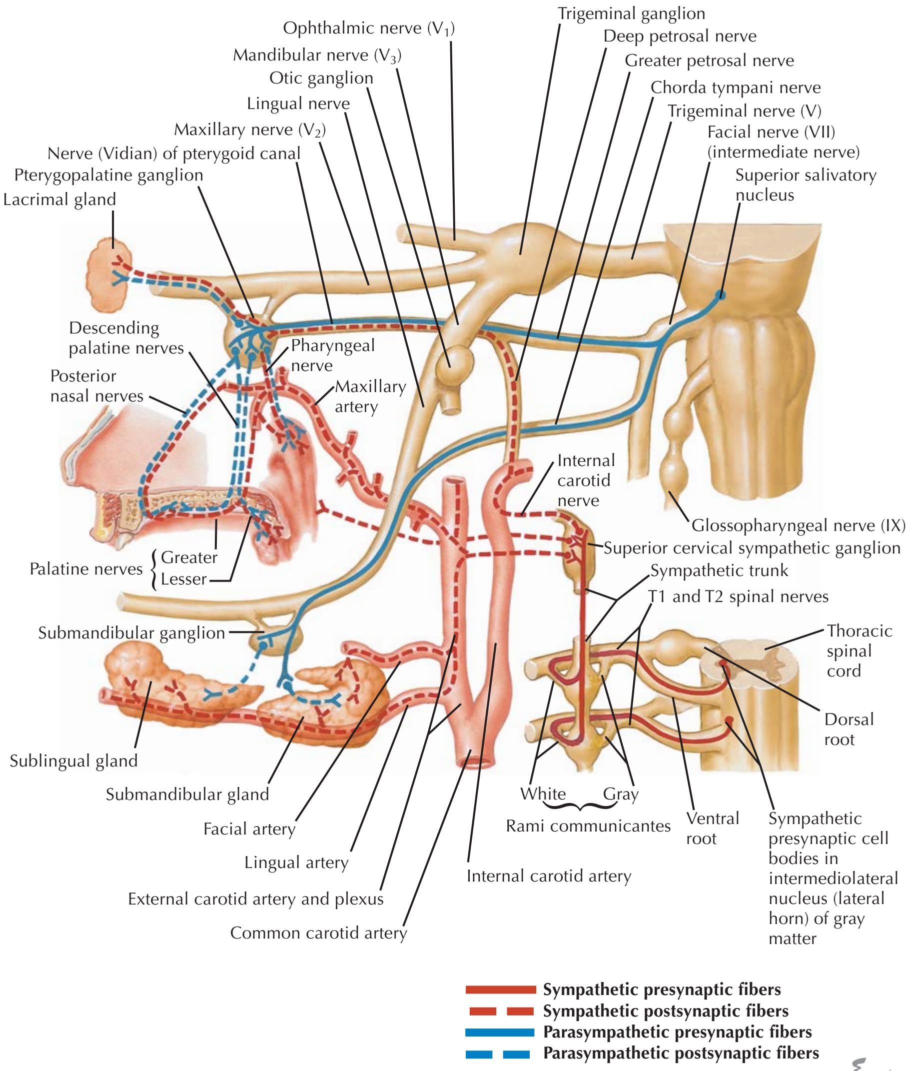
AUTONOMICS OF THE SALIVARY GLANDS *CONTINUED*



AUTONOMICS OF THE SALIVARY GLANDS *CONTINUED*

PARASYMPATHETICS OF THE SUBMANDIBULAR, SUBLINGUAL, AND MINOR SALIVARY GLANDS			
Type of Neuron	**Name of Cell Body**	**Characteristics of the Cell Body**	**Course of the Neuron**
Preganglionic neuron	Superior salivatory nucleus	A collection of nerve cell bodies located in the pons Travel through the nervus intermedius of the facial n. into the internal acoustic meatus In the facial canal, the facial n. gives rise to 2 parasympathetic branches: • Greater petrosal n. • Chorda tympani n.	**Greater Petrosal Nerve** • Exits along the hiatus for the greater petrosal n. toward the foramen lacerum, where it joins the deep petrosal n. (sympathetics) to form the nerve of the pterygoid canal (vidian n.) • Vidian n. passes through the pterygoid canal and enters the pterygopalatine fossa, where it joins with the pterygopalatine ganglion **Chorda Tympani Nerve** • Exits the petrotympanic fissure to enter the infratemporal fossa, where it joins the lingual n. • Preganglionic fibers travel with the lingual n. into the floor of the oral cavity, where it joins with the submandibular ganglion
Postganglionic neuron	Pterygopalatine ganglion	A collection of nerve cell bodies located in the pterygopalatine fossa Postganglionic parasympathetic fibers that arise in the pterygopalatine ganglion are distributed to the ophthalmic and maxillary divisions of the trigeminal n. to the: • Lacrimal gland • Nasal glands • Palatine glands • Pharyngeal glands	**Ophthalmic and Maxillary Division Distribution** Postganglionic fibers travel along the zygomatic branch of the maxillary division for a short distance to enter the orbit A short communicating branch joins the lacrimal n. of the ophthalmic division of the trigeminal n. These fibers innervate: • Lacrimal gland, to cause the secretion of tears **Maxillary Division Distribution** Postganglionic fibers travel along the maxillary division of the trigeminal n. to be distributed along its branches that are located in the nasal cavity, oral cavity, and pharynx (e.g., nasopalatine, greater palatine) These fibers innervate: • Nasal glands • Palatine glands • Pharyngeal glands
	Submandibular ganglion	A collection of nerve cell bodies in the oral cavity Suspended from the lingual n. at the posterior border of the mylohyoid m. immediately superior to the deep portion of the submandibular gland	Postganglionic parasympathetic fibers arise in the submandibular ganglion and are distributed to the: • Submandibular gland • Sublingual gland

AUTONOMICS OF THE SALIVARY GLANDS *CONTINUED*



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13 Clinical Correlate

GINGIVITIS

Gingivitis: an inflammation of the gingiva that occurs when bacteria accumulate between the teeth and gingiva

In addition to the inflammation, the gums may demonstrate irritation and bleeding

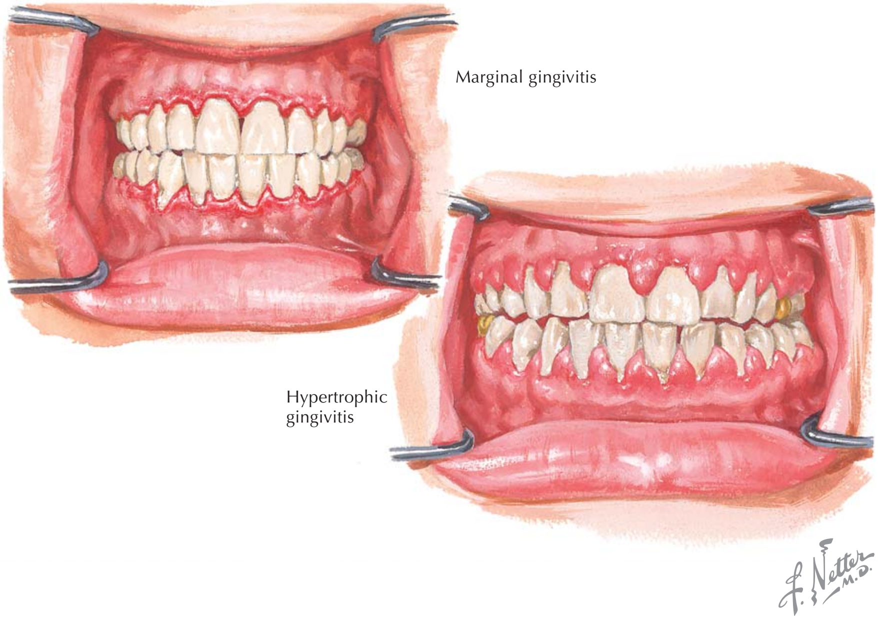
When plaque (composed of bacteria, food debris, and saliva) is deposited on the teeth, it can form tartar if it is not removed

Plaque and tartar cause irritation to the gingiva, and the bacteria (and their toxins) further irritate the gingiva, leading to bleeding and swelling

If gingivitis remains untreated, it may progress to more serious gingival diseases, such as periodontitis

Long-term untreated gingivitis may lead to damage of bone and loss of teeth

Risk factors for gingivitis include poor dental hygiene, pregnancy, diabetes, illness, and human immunodeficiency virus (HIV) infection



Clinical Correlate

DENTAL CARIES

Dental caries (tooth decay), leading to “cavities,” is caused by bacteria in the oral cavity

The bacteria convert foods into acids and help form plaque (made of bacteria, food debris, and saliva), which is deposited on the teeth

Plaque that is not removed from the teeth can mineralize to form tartar

Plaque is most prominent on difficult-to-reach teeth, such as the posterior molars

Acids formed in the plaque begin to erode the enamel on the surface of the tooth, causing a “cavity”

If not treated, the cavity grows in size, with onset of pain as the nerves and blood vessels of the affected teeth become irritated

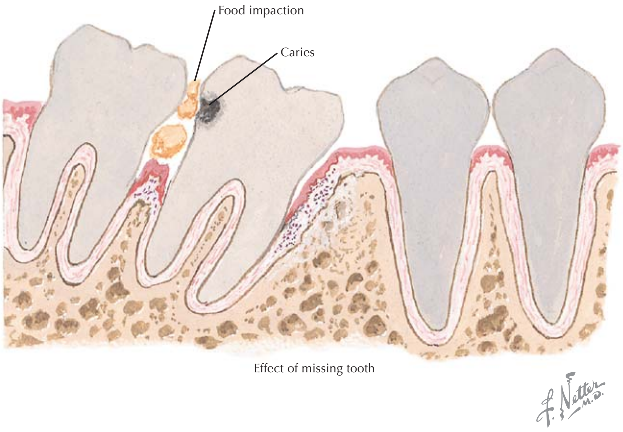
Consuming foods rich in sugar and starch increases the risk of dental caries

Dental caries can be detected on routine dental examinations

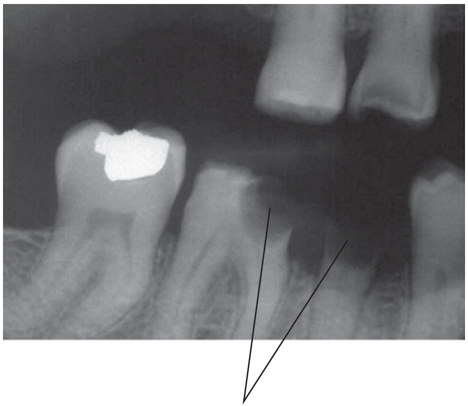
The damage associated with dental caries cannot be repaired by the affected tooth, which now must be restored

Fluoride is used to reduce the risk of dental caries by inhibiting demineralization and promoting remineralization of tooth structure

Saliva helps promote the remineralization process; medications that decrease salivary flow (such as anticholinergics) promote dental caries



Effect of missing tooth



Clinical Correlate

TORUS

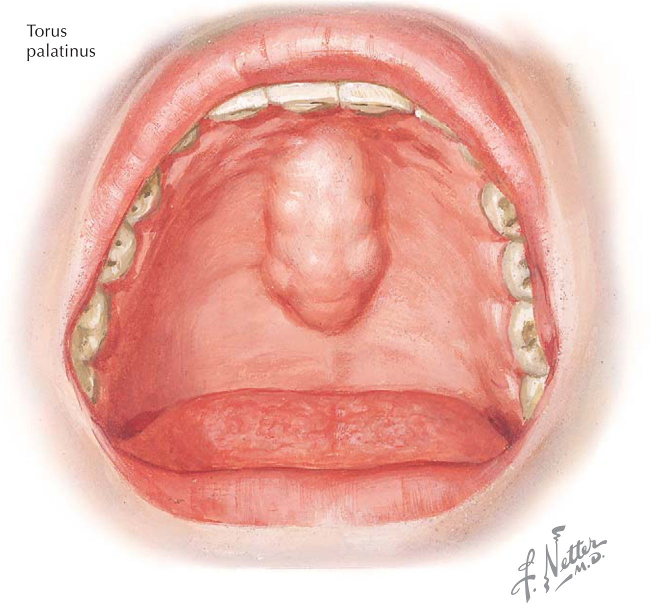
Torus: a nonpathologic bony elevation that occurs in the oral cavity

The presence of a torus does not impede eating or verbal communication but can cause difficulty in the application of a dental appliance, such as a denture

2 major types:

- Palatine—a downgrowth of bone in the midline of the hard palate
- Mandibular—an outgrowth of bone that occurs on the lingual surface of the mandible

A torus does not require treatment unless it interferes with normal function or application of dental appliances



Clinical Correlate

MUCOCELE

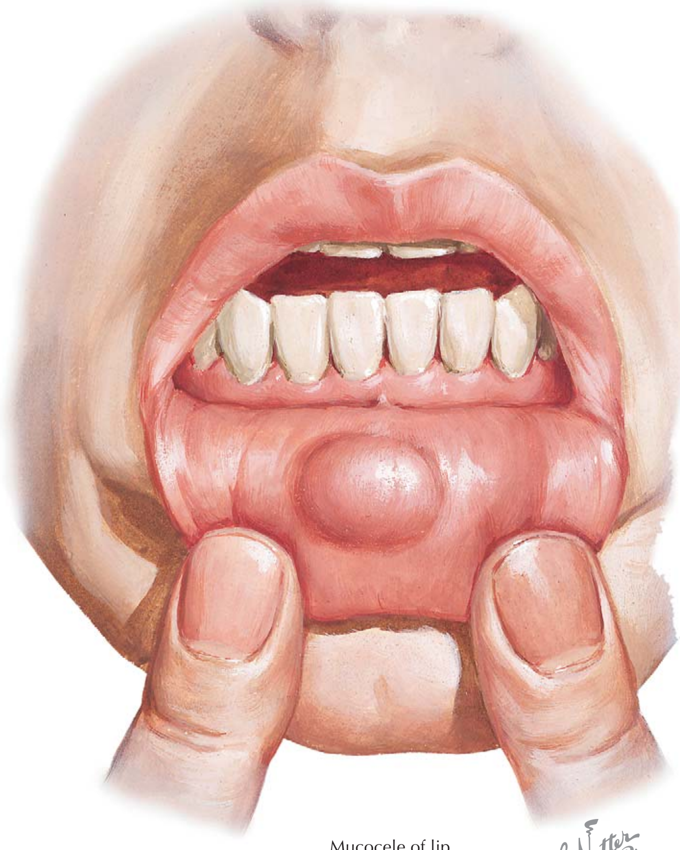
Mucocele: a mucous cyst that results from obstruction of the ducts of minor salivary glands (this lesion also can be associated with blockage of the major salivary glands)

Often caused by trauma to the duct system

Usually located on the lingual aspect of the lip

These lesions contain mucin and granulation tissue

Persistent mucoceles often are excised



Mucocele of lip

13 Clinical Correlate

HERPES SIMPLEX

Herpes simplex is the most common cause of viral stomatitis

Caused by exposure to herpes simplex virus type 1 (HSV-1)

HSV-1 usually affects the regions above the waist, causing fever blisters

Most affected people acquire the infection as a child

During the primary infection with HSV-1, multiple vesicles appear on the lips, gingiva, hard palate, and tongue

These vesicles rupture, producing ulcers that heal in 7 to 10 days

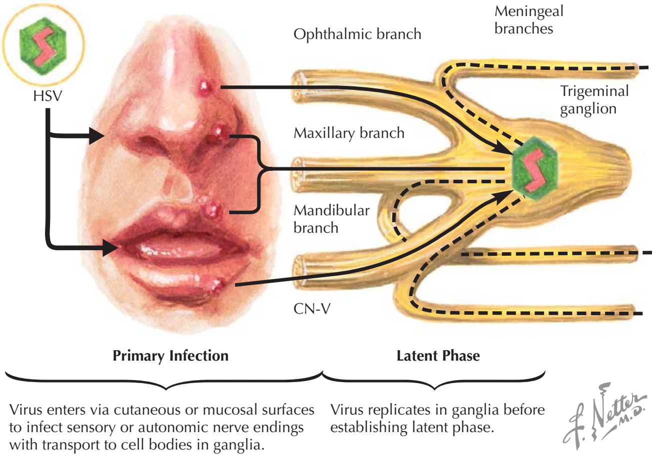
After initial exposure, the virus is transported along a retrograde path into the trigeminal ganglion, where it stays inactive and does not replicate

Episodes may recur

Some recurrence triggers:
- Stress
- Fever
- Anxiety
- Exposure to the sun
- Suppressed immune system

Infection can be spread through contact with infected lips

Systemic administration of antiviral agents, such as acyclovir, decreases the duration of the recurrent episodes



Clinical Correlate

TONSILLITIS

Tonsillitis: an inflammation of the tonsils, the lymph nodes located in the oral cavity and pharynx

There are 3 sets of tonsils:

- Pharyngeal (adenoids)
- Palatine (between the palatoglossal and palatopharyngeal arches)
- Lingual (on posterior 1/3 of the tongue)

These 3 sets of tonsils form Waldeyer's ring

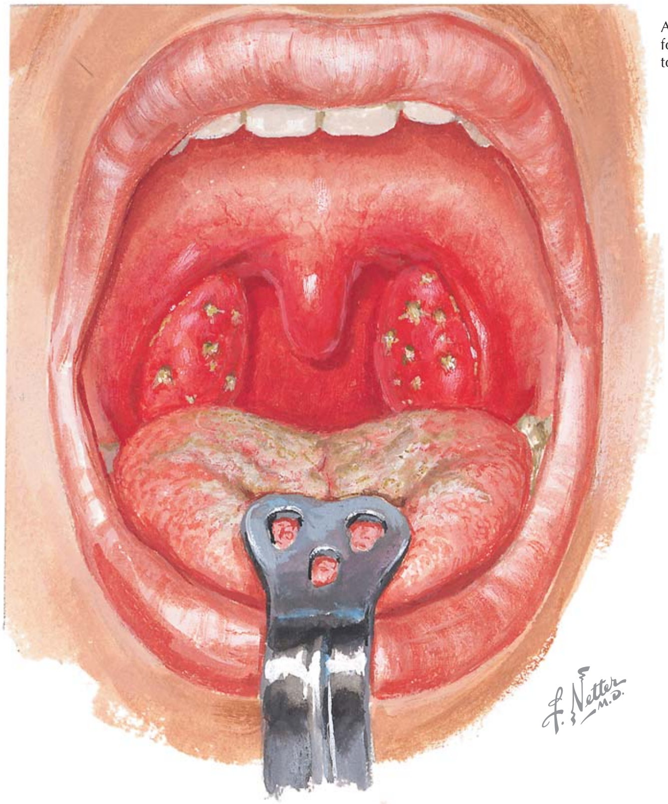
Symptoms of tonsillitis:

- Sore throat
- Dysphagia
- Fever
- Headache

Tonsillitis often is caused by a virus or bacterium

When caused by a bacterial infection, it may be treated by antibiotics

If necessary, a tonsillectomy is performed to remove the tonsils. Palatine tonsils are removed in a tonsillectomy (although the pharyngeal tonsils also may be removed at the same time, especially if they are obstructing nasal breathing)



Acute follicular tonsilitis

CHAPTER 14

TONGUE

14 Overview and Topographic Anatomy

GENERAL INFORMATION

Tongue: a muscular structure in the oral cavity, divided into 2 parts:

- Oral, movable part
- Pharyngeal, nonmovable part

Median fibrous septum is thick tissue separating the tongue into halves

Functions

- Mastication
- Taste
- Talking
- Deglutition

Appearance

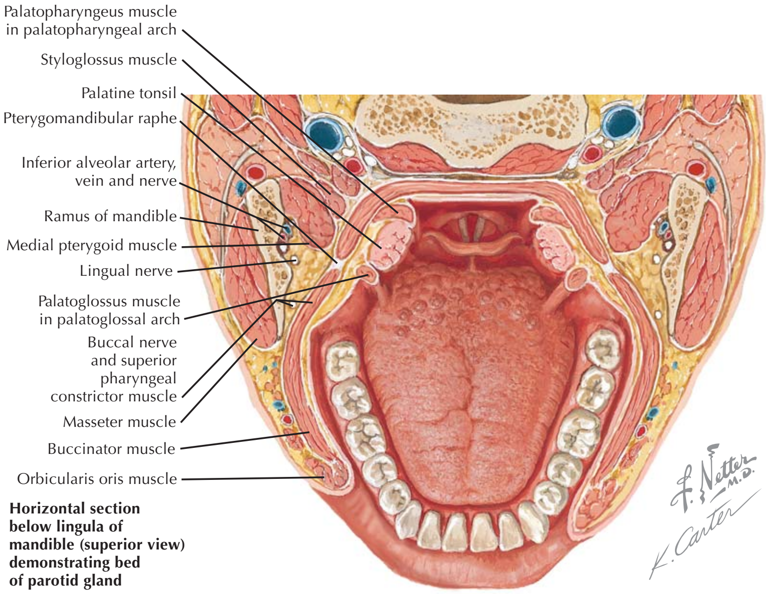
The appearance of the tongue may reflect health problems:

- Fissured tongue
- Black hairy tongue
- Geographic tongue

Muscle Types

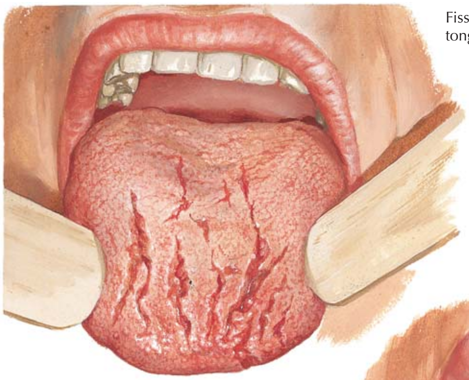
Extrinsic—move the tongue in the oral cavity

Intrinsic—change the tongue's shape

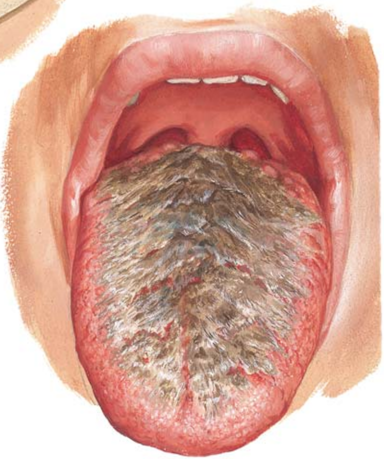


Horizontal section below lingula of mandible (superior view) demonstrating bed of parotid gland

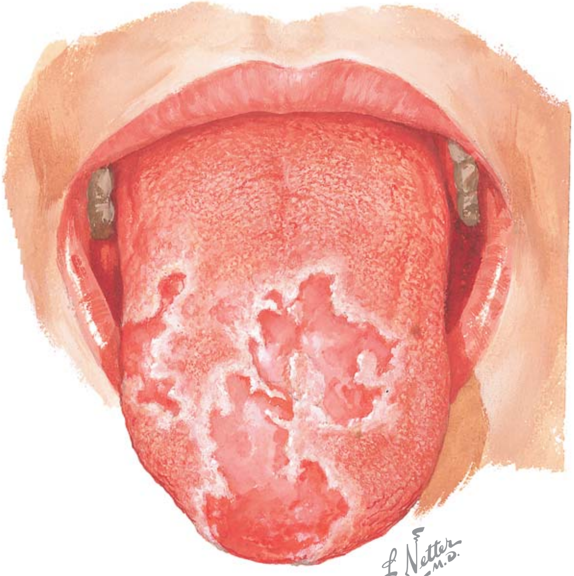
GENERAL INFORMATION *CONTINUED*



Fissured tongue



Hairy tongue



Geographic tongue

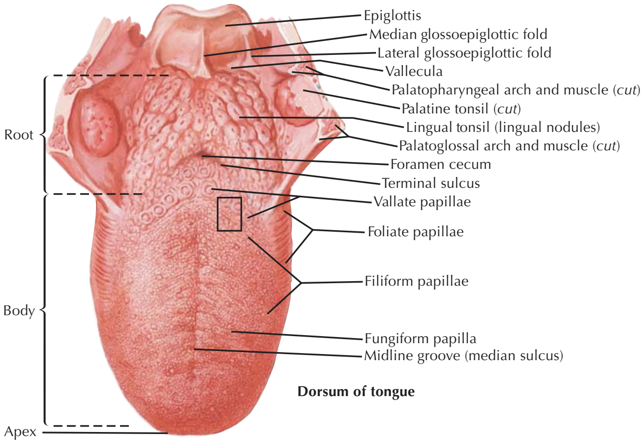
14 Gross Anatomy

DORSAL SURFACE

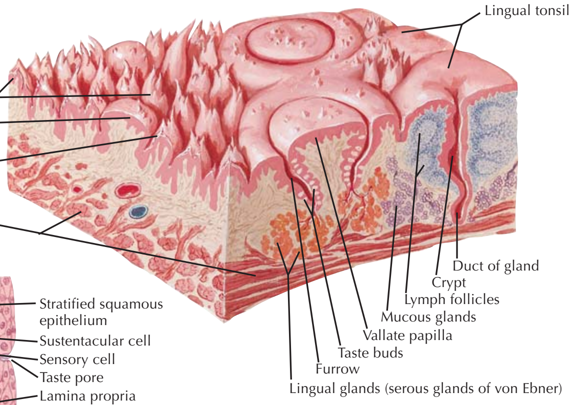
Structure	Description	Comments
Oral portion	Occupies tongue's anterior 2/3	Covered with keratinized stratified squamous epithelium
Pharyngeal portion	Occupies tongue's posterior 1/3	Covered with nonkeratinized stratified squamous epithelium
Sulcus terminalis	A V-shaped groove immediately posterior to the circumvallate papillae	Demarcates junction between the oral and the pharyngeal portions
Foramen cecum	The initial developmental site for the thyroid gland	Located at the angle of the V
Midline septum	Fibrous	Divides tongue into halves
Lingual tonsils	Large nodules of lymphatic tissue	Cover the pharyngeal surface of the tongue
Types of papillae on the tongue's oral portion	Filiform	Most numerous but lack taste buds
	Fungiform—have taste buds	Scattered throughout the dorsum of the tongue
	Foliate—have taste buds	Fairly rudimentary in humans
	Circumvallate—have taste buds	Lie in a row immediately anterior to the sulcus terminalis
Glossoepiglottic folds	Mucous membranes	Connect the posterior portion of the pharyngeal part of the tongue with the epiglottis of the larynx
Palatoglossal arches	Pass from the soft palate to the lateral aspects of the tongue	Also known as the anterior pillar of the fauces
Glands	Mucous and serous	Numerous

Gross Anatomy

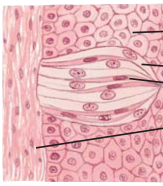
DORSAL SURFACE *CONTINUED*



Dorsum of tongue



Schematic stereogram: area indicated above



Section of taste bud

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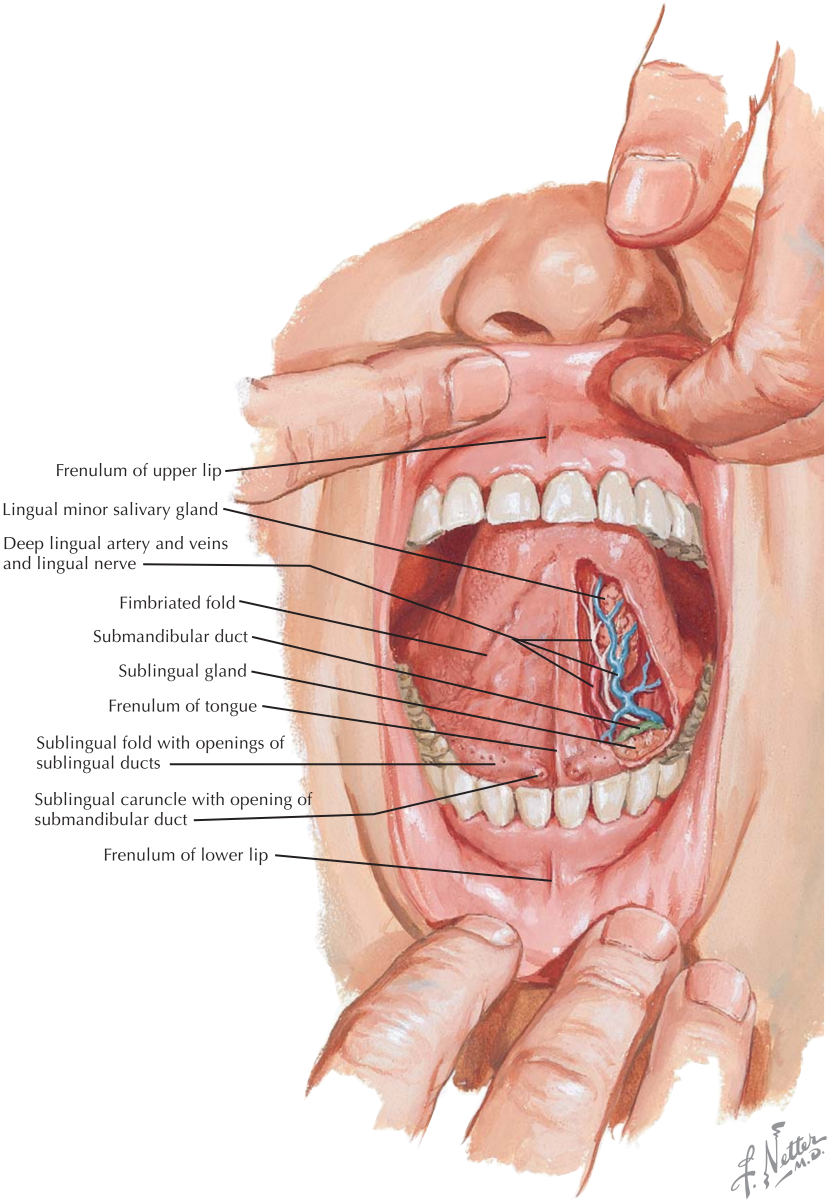
VENTRAL SURFACE

Structure	Description	Comments
Epithelium	Nonkeratinized stratified squamous	Covers ventral surface
Lingual frenulum	A midline fold	Connects the ventral surface of the tongue to the floor of the oral cavity
Sublingual papilla	A swelling on both sides of the lingual frenulum at the tongue base	Marks the entrance of saliva from the submandibular glands into the oral cavity Continuous with the sublingual folds overlying the sublingual glands on the floor of the oral cavity
Plica fimbriata	Fimbriated folds	Lateral to the lingual frenulum
Deep lingual veins	(See table on Venous Drainage later on)	Can be observed through the mucosa between the plica fimbriata and the lingual frenulum

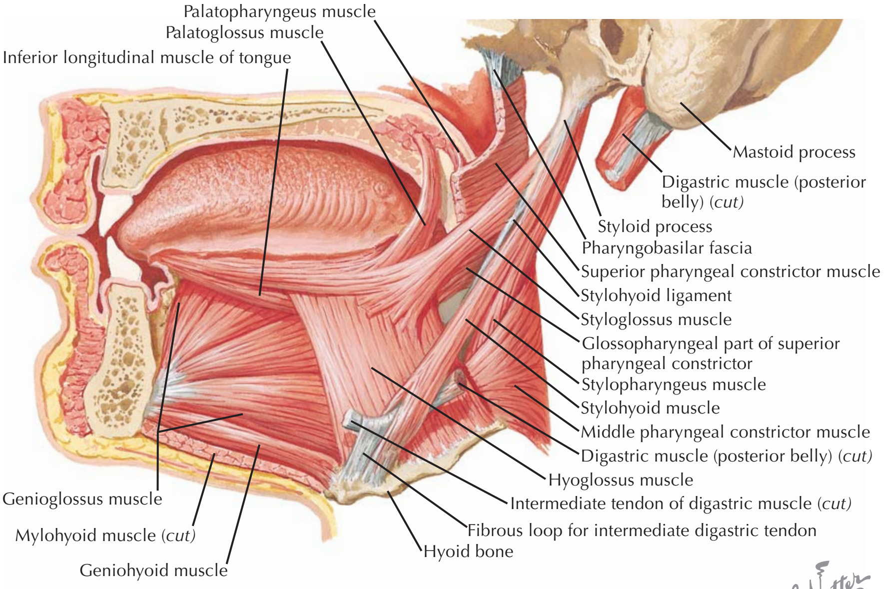
VENTRAL SURFACE *CONTINUED*



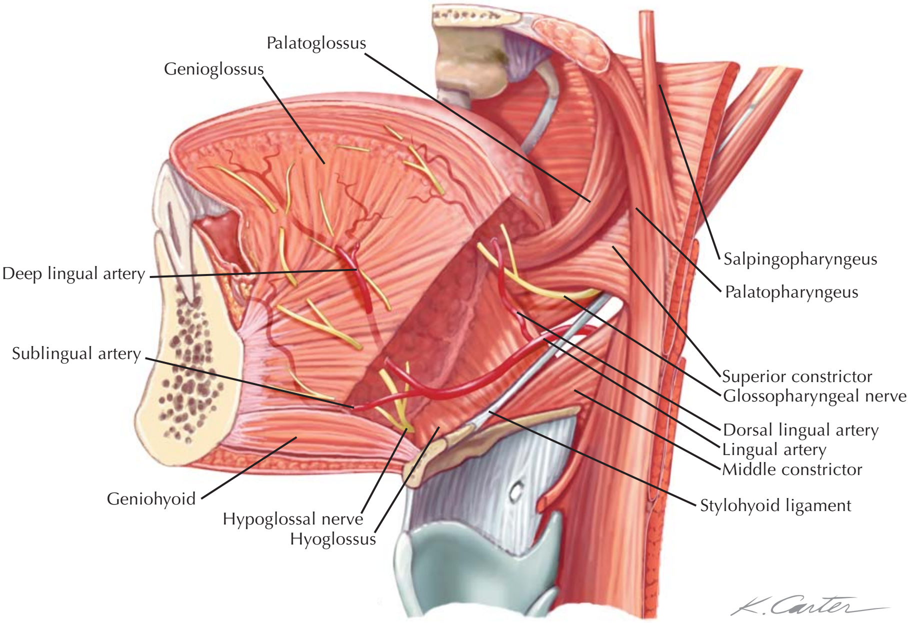
Muscles

EXTRINSIC TONGUE MUSCLES

Muscle	Origin	Insertion	Actions	Nerve	Comment
Genioglossus	Superior genial tubercle of the mandible	Fibers fan into the tongue substance Some fibers insert into the body of the hyoid	Protracts Depresses	Hypoglossal n.	The lingual a. is located between the genioglossus and hyoglossus mm.
Hyoglossus	Greater and lesser cornu and body of the hyoid	Side of the tongue where fibers mix with the styloglossus m.	Depresses		The lingual n., hypoglossal n., and submandibular duct are located on the lateral surface of the hyoglossus m.
Styloglossus	Tip of styloid process	Side of the tongue where fibers mix with the hyoglossus m.	Retracts Elevates		Smallest of the extrinsic tongue muscles
Palatoglossus	Palatine aponeurosis	Side of the tongue where fibers mix with the intrinsic muscle	Elevates Narrows the oropharyngeal isthmus for deglutition	Pharyngeal plexus (motor portion from the vagus n. and cranial part of the accessory n.)	Grouped as either an extrinsic tongue muscle or a muscle of the soft palate



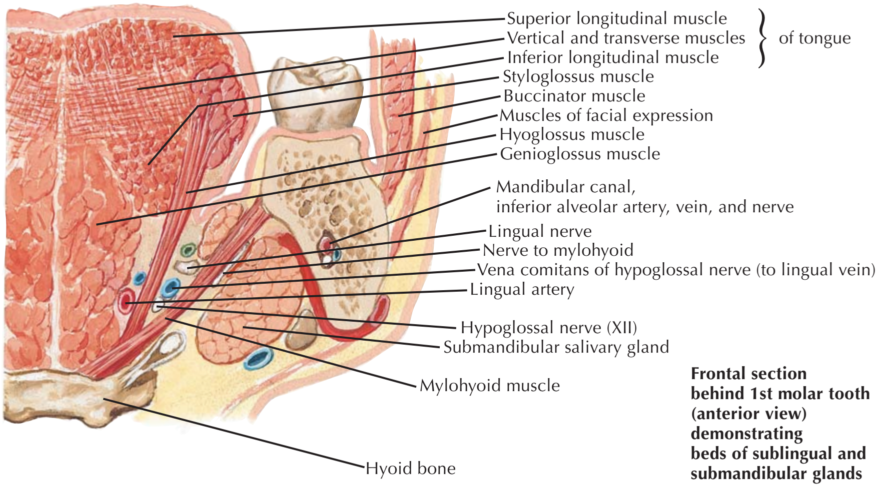
EXTRINSIC TONGUE MUSCLES *CONTINUED*



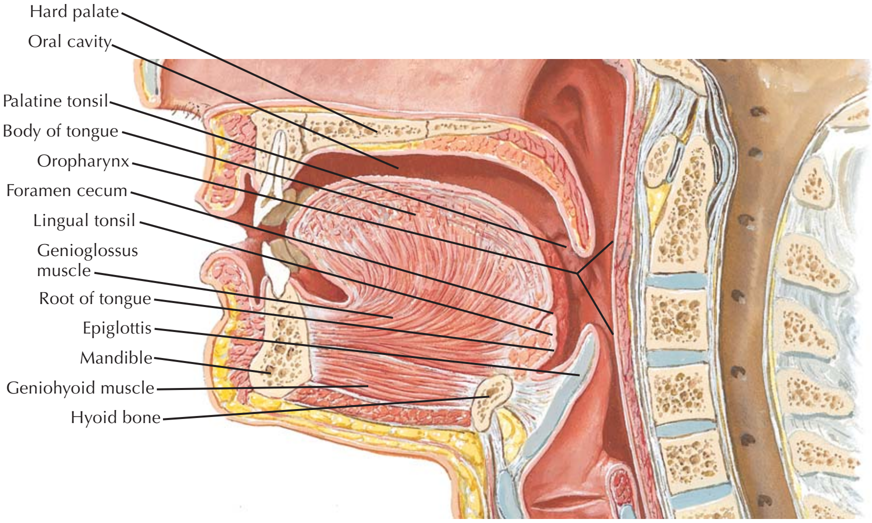
INTRINSIC TONGUE MUSCLES

Muscle	Origin	Insertion	Actions	Nerve	Comment
Superior longitudinal	Median fibrous septum Submucous layer near epiglottis	Submucosa along edges of the tongue	Shortens Curls the tongue's apex *upward*	Hypoglossal n.	Located immediately deep to the mucous membrane of the tongue's dorsal surface
Inferior longitudinal	Root of the tongue Body of the hyoid	Submucosa at the apex of the tongue	Shortens Curls the tongue's apex *downward*		Runs the length of the tongue between the hyoglossus and genioglossus mm.
Transverse	Median fibrous septum	Fibrous tissue in the submucosa of the sides of the tongue	Narrows Lengthens		Runs the width of the tongue
Vertical	Submucosa of upper layer of tongue	Submucosa of lower layer of tongue	Broadens Flattens		Runs from the superior to the inferior tongue surface

INTRINSIC TONGUE MUSCLES *CONTINUED*



Frontal section behind 1st molar tooth (anterior view) demonstrating beds of sublingual and submandibular glands



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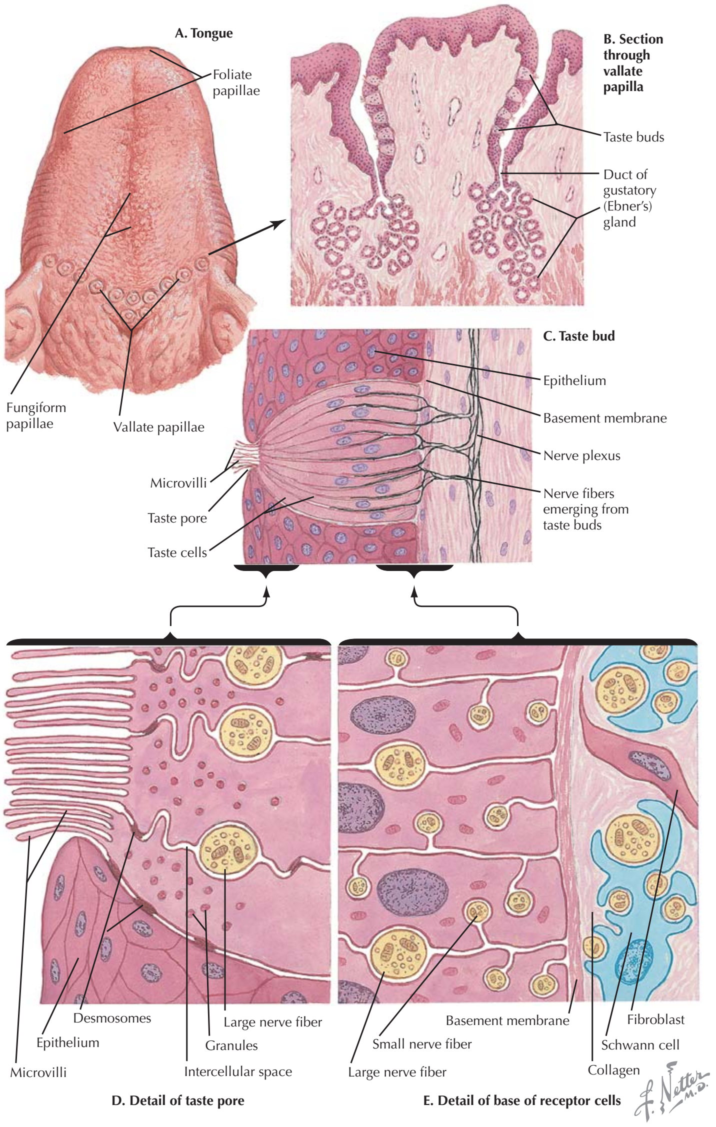
14 Nerve Supply

SENSORY INNERVATION

TYPES OF SENSORY NERVE SUPPLY

Type	Function	Nerves
General somatic afferent (GSA)	Pain, temperature, discriminative touch	Trigeminal (via lingual), glossopharyngeal, and vagus (via internal laryngeal), to innervate the epithelium and mucosa
Special visceral afferent (SVA)	Taste	Facial (via *chorda tympani*), glossopharyngeal, and vagus (via internal laryngeal), to innervate the taste buds


A. Tongue

B. Section through vallate papilla

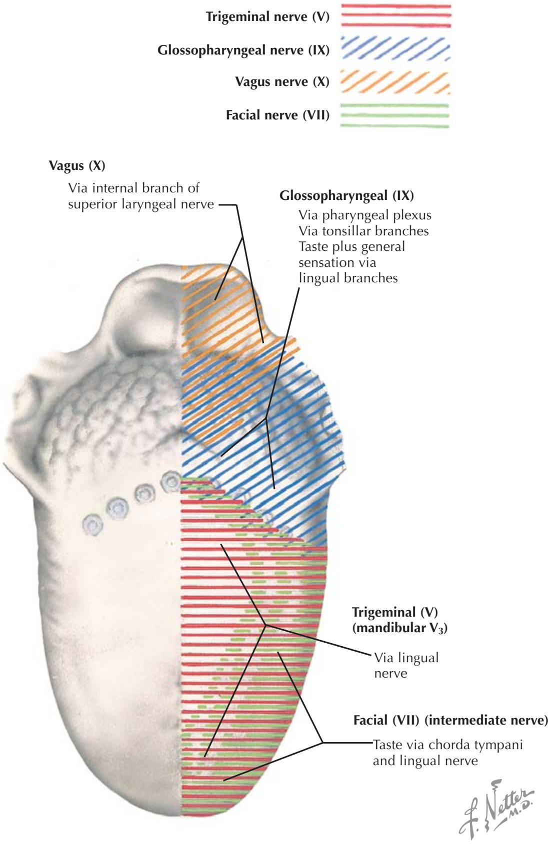
C. Taste bud

D. Detail of taste pore

E. Detail of base of receptor cells

Nerve Supply

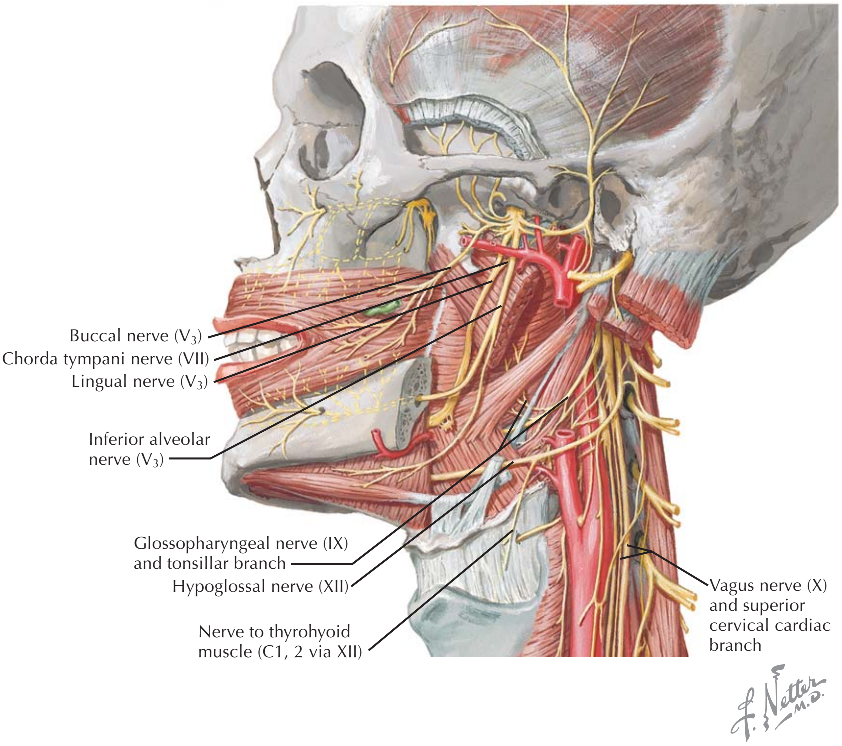
SENSORY INNERVATION *CONTINUED*



GENERAL SENSORY INNERVATION		
Nerve	**Source**	**Course**
Lingual	Mandibular division of the trigeminal n.	Lies inferior to the lateral pterygoid m. and medial and anterior to the inferior alveolar nn. within the infratemporal fossa Chorda tympani branch of the facial n. joins its posterior part Lingual n. passes between the medial pterygoid m. and the ramus of the mandible to pass obliquely, entering the oral cavity bounded by the superior pharyngeal constrictor m., the medial pterygoid, and the mandible Enters the oral cavity lying against the lingual tuberosity of the mandible The submandibular ganglion is suspended from the lingual n. at the posterior border of the hyoglossus m. Continues anteriorly and passes on the lateral surface of the hyoglossus Passes from the lateral side inferiorly and medial to the submandibular duct to reach the mucosa of the tongue Supplies GSA fibers to the epithelium and papillae of the tongue's anterior 2/3, mucosa along the floor of the oral cavity (linguoalveolar ridge), and gingiva on the lingual aspect of the mandibular teeth

SENSORY INNERVATION *CONTINUED*

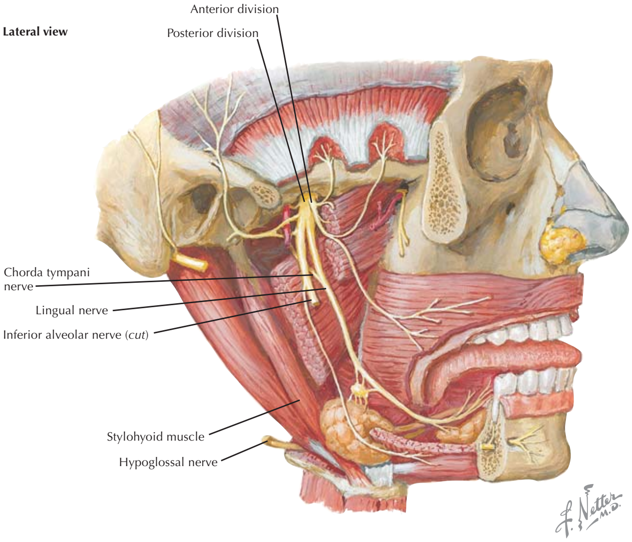
GENERAL SENSORY INNERVATION		
Nerve	**Source**	**Course**
Glossopharyngeal	Arises as a cranial nerve from the medulla oblongata	Passes through the jugular foramen with the vagus and accessory nn. Within the foramen, it passes between the internal carotid a. and the internal jugular v. Continues inferiorly and posteriorly relative to the stylopharyngeus m. Passes anteriorly with the stylopharyngeus and travels between the superior and middle constrictor mm. to be located by the palatine tonsils Small lingual branches distribute GSA fibers to the epithelium of the tongue's posterior 1/3, in addition to the fauces
Internal laryngeal	Superior laryngeal branch of the vagus n.	Vagus n. branches from the medulla oblongata and passes through the jugular foramen with the glossopharyngeal and accessory nn. Within the foramen, it passes between the internal carotid a. and the internal jugular v. A series of nerves branch from the vagus in the neck, including the superior laryngeal n., which travels inferiorly posterior to the internal carotid a. on the side of the pharynx and divides into the internal and external laryngeal nn. The internal laryngeal n. passes inferior to the larynx and passes through the thyrohyoid membrane with the superior laryngeal vessels Distribute GSA fibers to the tongue's base at the epiglottic region and the mucous membranes of the larynx as far inferiorly as the false vocal folds



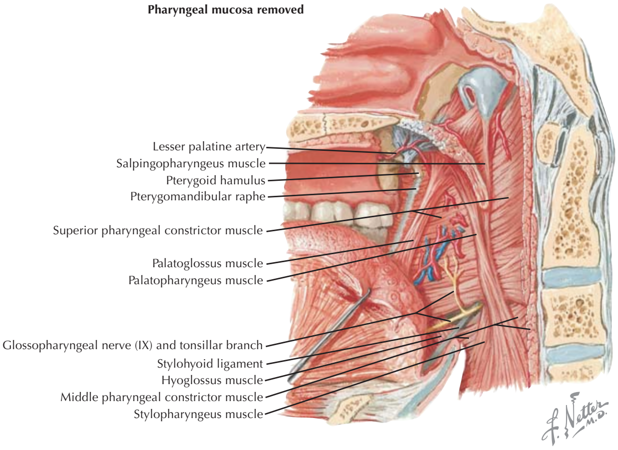
Nerve Supply

SENSORY INNERVATION *CONTINUED*

SPECIAL SENSORY INNERVATION		
Nerve	**Source**	**Course**
Chorda tympani	Facial n. in the tympanic cavity	Carries preganglionic parasympathetic fibers to the submandibular ganglion and taste fibers to the anterior 2/3 of the tongue Passes anteriorly to enter the tympanic cavity and lies along the tympanic membrane and malleus until exiting the petrotympanic fissure Joins the posterior border of the lingual n. Lingual n. is distributed to the anterior 2/3 of the tongue, and the SVA fibers from the chorda tympani travel to the taste buds in this region
Glossopharyngeal	Arises as a cranial nerve from the medulla oblongata	Passes through the jugular foramen with the vagus and accessory nn. Within the foramen, it passes between the internal carotid a. and the internal jugular v. Continues inferiorly and travels posterior to the stylopharyngeus m. Passes anteriorly with the stylopharyngeus and travels between the superior and middle constrictor mm., to be located by the palatine tonsils Small lingual branches distribute SVA fibers to the taste buds in the mucous membrane of the tongue's posterior 1/3 and the circumvallate papilla
Internal laryngeal	Superior laryngeal branch of the vagus n.	Vagus n. branches from the medulla oblongata and passes through the jugular foramen with the glossopharyngeal and accessory nn. Within the foramen, it passes between the internal carotid a. and the internal jugular v. A series of nerves branch from the vagus in the neck, including the superior laryngeal n., which travels inferiorly posterior to the internal carotid on the side of the pharynx and divides into the internal and external laryngeal nn. The internal laryngeal n. passes inferior to the larynx and passes through the thyrohyoid membrane with the superior laryngeal vessels Distributes SVA fibers to the taste buds scattered at the base of the tongue at the epiglottic region



SENSORY INNERVATION *CONTINUED*

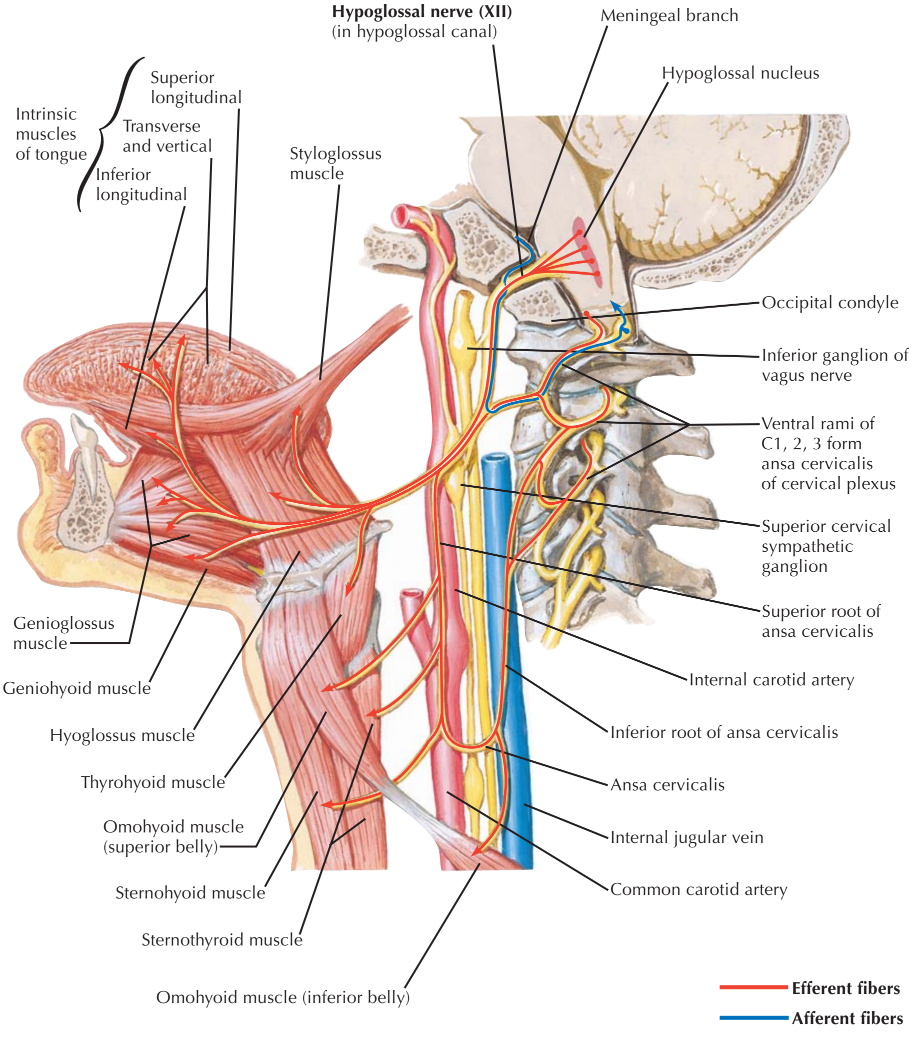


MOTOR INNERVATION

Nerve	Source	Course
Hypoglossal	Arises as a series of rootlets from the medulla oblongata and passes through the hypoglossal canal	Travels inferiorly and is located between the internal carotid a. and the internal jugular v. Passes anteriorly as it wraps around the occipital a. Passes superficial to the external carotid and the loop of the lingual a. in its anterior path Passes deep to the posterior belly of the digastric and the stylohyoid m. and lies superficial to the hyoglossus m. with the accompanying vein of the hypoglossal n. Passes deep to the mylohyoid m. and continues anterior in the genioglossus m. Muscular branches supply all intrinsic tongue muscles: hyoglossus, genioglossus, and styloglossus
Pharyngeal plexus	The motor part of the pharyngeal plexus arises from the pharyngeal branch of the vagus n. and the cranial part of the accessory n.	In the tongue, it innervates the palatoglossus m.
Pharyngeal branch of the vagus	Arises from the upper part of the inferior ganglion of the vagus n. and contains filaments from the cranial portion of the spinal accessory n.	Lies along the upper border of the middle constrictor m., where it forms the pharyngeal plexus Motor branches from the plexus are distributed to the muscles of the pharynx and soft palate (with the exception of the tensor veli palatini m.)
Cranial part of the spinal accessory n.	Emerges as 4 or 5 branches just inferior to the vagus n.'s roots	Passes laterally to the jugular foramen, where it merges with the fibers of the spinal part of the spinal accessory n. While united at this point for a short distance, it also is connected by 1 or 2 branches with the inferior ganglion of the vagus n. Exits through the jugular foramen, separates from the spinal part, and continues over the surface of the inferior ganglion of the vagus Distributed mainly to the pharyngeal branches of the vagus

Nerve Supply

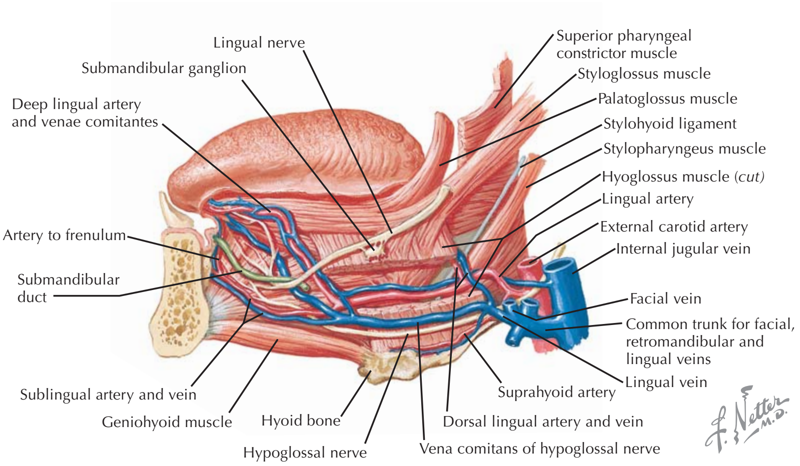
MOTOR INNERVATION *CONTINUED*



14 Vascular Supply

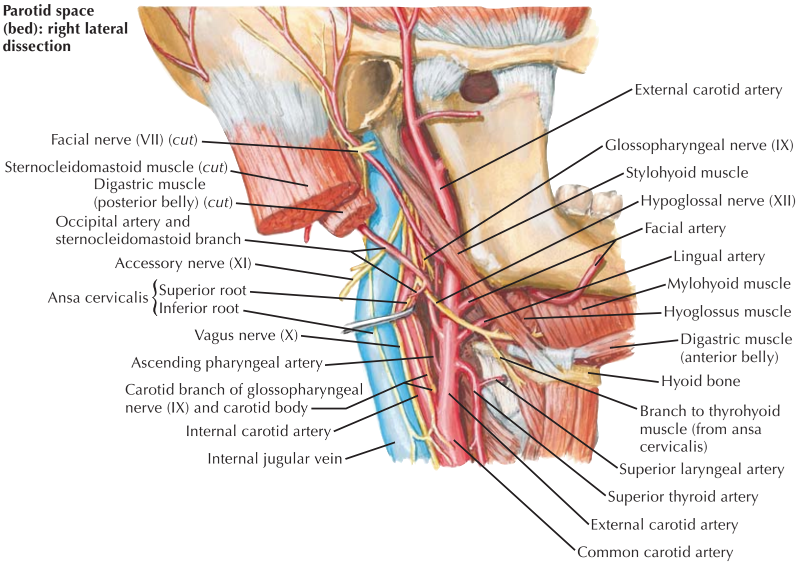
ARTERIAL SUPPLY

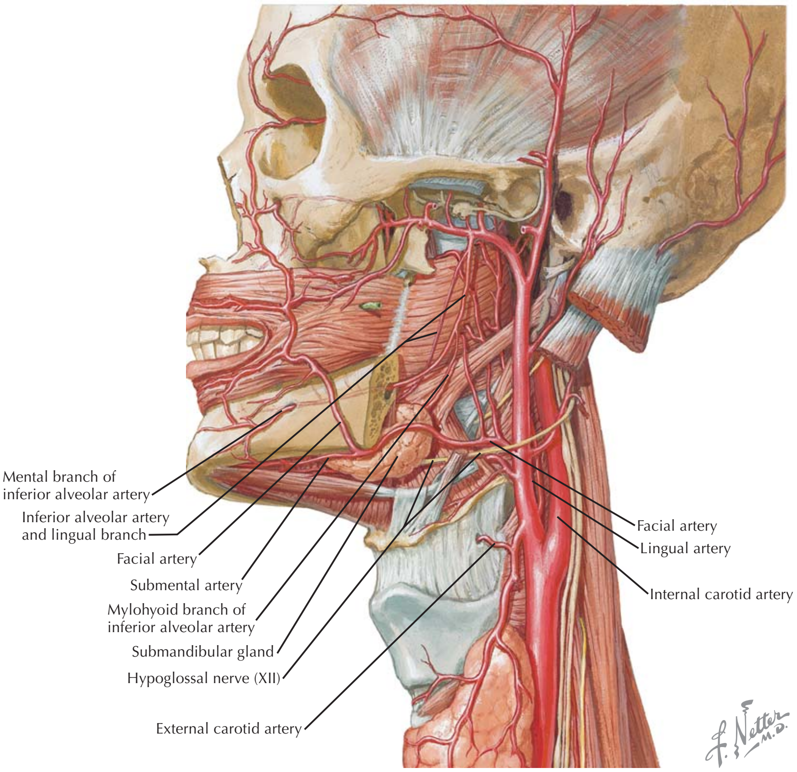
Artery	Source	Course
Lingual	External carotid a. within the carotid triangle	Passes superiorly and medially (obliquely) toward the greater cornu of the hyoid bone and makes a loop by passing anteriorly and inferiorly while traveling superficial to the middle constrictor m. While forming a loop, the artery is crossed superficially by the hypoglossal n. Passes deep to the posterior belly of the digastric m. and the stylohyoid m. as it travels anteriorly, where it gives off a suprahyoid branch that travels on the superior surface of the hyoid bone, supplying the muscles in that area The lingual a. passes deep to the hyoglossus m. and travels anteriorly between it and the genioglossus m. After passing deep to the hyoglossus, 2 to 3 small dorsal lingual aa. are given off at the posterior border of the hyoglossus; they pass in a superior direction to the posterior 1/3 of the dorsum of the tongue and provide vascular supply to the mucous membrane in this region, the palatoglossal arch, the palatine tonsil, the epiglottis, and the surrounding soft palate The lingual a. continues to pass anteriorly and gives off the sublingual branch at the anterior border of the hyoglossus; the sublingual a. passes anteriorly between the genioglossus and mylohyoid mm. to the sublingual gland and provides vascular supply to the gland and the muscles in the area The deep lingual a., the terminal branch or continuation of the lingual a. once the sublingual a. is given off, travels superiorly to reach the tongue's ventral surface Located between the inferior longitudinal m. of the tongue and the mucous membrane, the deep lingual is accompanied by branches of the lingual n., and it anastomoses with the deep lingual a. from the other side
Submental	A branch of the facial a. from the external carotid a.	Given off at the submandibular gland, travels anteriorly superficial to the mylohyoid m. Anastomoses with the sublingual branch of the lingual a. to help supply the tongue



Vascular Supply

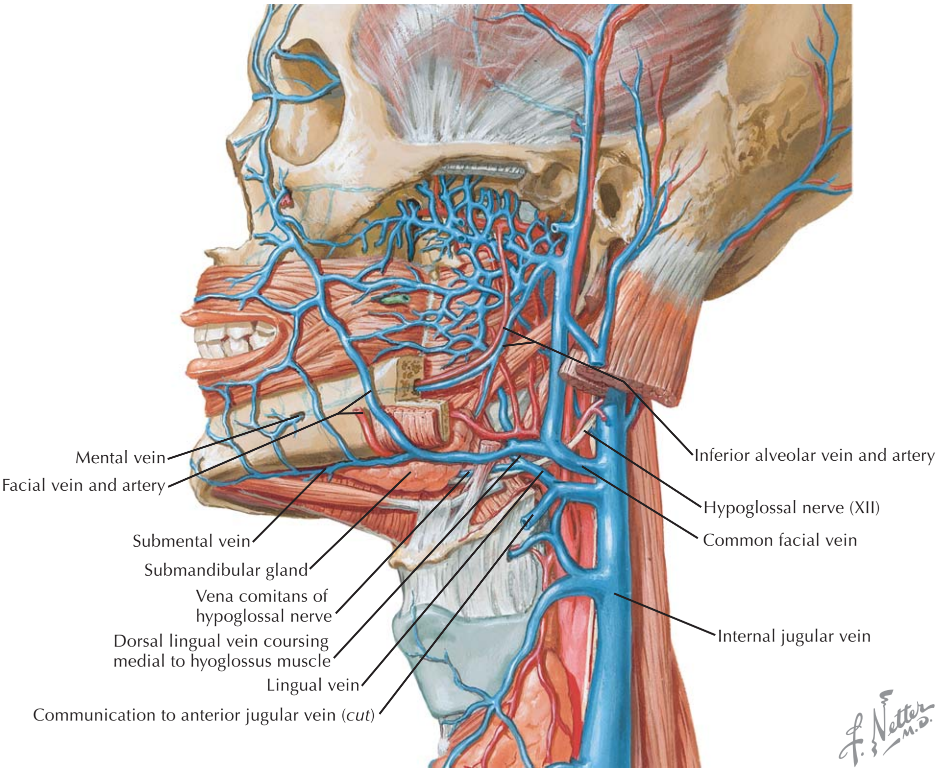
ARTERIAL SUPPLY *CONTINUED*


Parotid space (bed): right lateral dissection



VENOUS DRAINAGE

Vein	Course
Lingual	Receives tributaries from the deep lingual vv. on the ventral surface, and dorsal lingual vv. from the dorsal surface Passes with the lingual a., deep to the hyoglossus m., and ends in the internal jugular v. The vena comitans nervi hypoglossi, or accompanying vein of the hypoglossal n., begins at the tongue's apex and may either join the lingual v. or accompany the hypoglossal n. and enter the common facial v., which empties into the internal jugular
Submental	Anastomoses with the lingual v.'s branches Parallels the submental a. on the superficial surface of the mylohyoid m. and ends in the facial v.



Clinical Correlate

ANKYLOGLOSSIA

Also known as tongue-tie

Condition in which the lingual frenulum is restricted because of an increase in tissue, which leads to reduced tongue mobility

Presentations

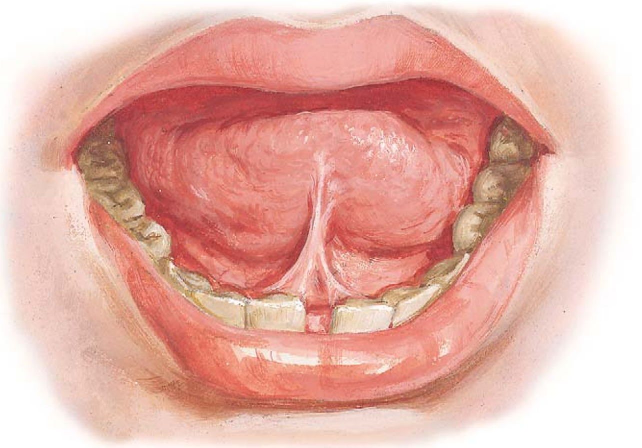
- Tongue may not be capable of protrusion beyond the incisors
- Tongue may not be capable of touching the palate
- Tongue may manifest a V-shaped notch or may appear bilobed on protrusion

Complications

- Causes problems for babies who breastfeed
- If the tongue cannot clear the oral cavity of food, caries, periodontal disease, and halitosis can result
- If condition is severe, can cause a speech impediment

Treatment

If necessary, the lingual frenulum may be cut (frenectomy)



Ankyloglossia

14 Clinical Correlate

HYPOGLOSSAL NERVE PARALYSIS

Hypoglossal nerve lesions paralyze the tongue on 1 side

On protrusion, the tongue deviates to the ipsilateral (same) or contralateral side, depending on the lesion site

LOWER MOTOR NEURON LESION

Lesions to the hypoglossal nerve causes paralysis on the ipsilateral side:

- Tongue deviates to the paralyzed side on protrusion (the paralyzed muscles will lag, causing the tip to deviate)
- Musculature atrophies on the paralyzed side
- Tongue fasciculations occur on the paralyzed side

Example: With a neck wound that cuts the right hypoglossal nerve, the tongue deviates to the right on protrusion, and the right half of the tongue will later demonstrate atrophy and fasciculations

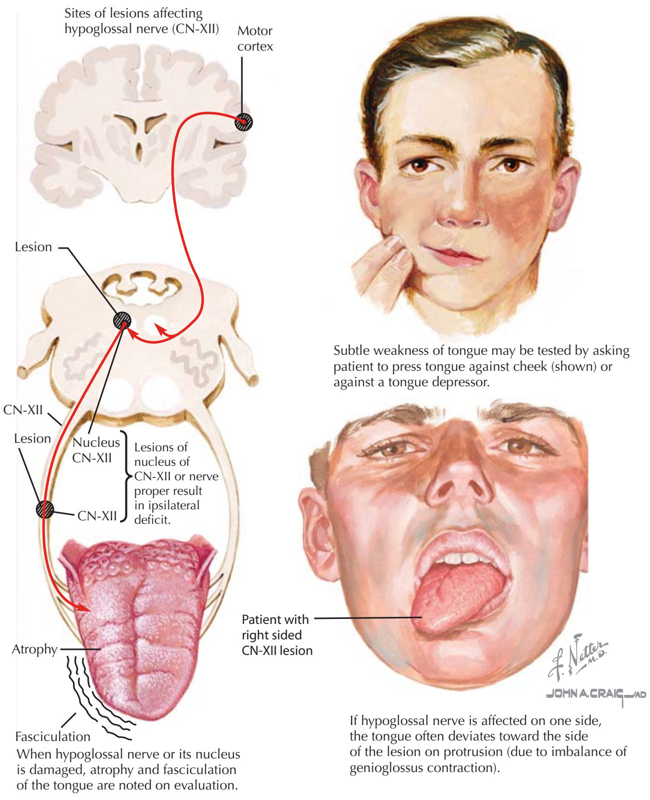
UPPER MOTOR NEURON LESION

Causes paralysis on the contralateral side:

- Tongue deviates to the side *opposite* the lesion
- Musculature atrophies on side *opposite* the lesion

Example: After a stroke on the right side of the brain that affects the right upper motor neurons, the tongue deviates to the left on protrusion, and the left half of the tongue will atrophy

Hypoglossal Nerve (CN-XII)



Lesions of nucleus of CN-XII or nerve proper result in ipsilateral deficit.

When hypoglossal nerve or its nucleus is damaged, atrophy and fasciculation of the tongue are noted on evaluation.

Subtle weakness of tongue may be tested by asking patient to press tongue against cheek (shown) or against a tongue depressor.

If hypoglossal nerve is affected on one side, the tongue often deviates toward the side of the lesion on protrusion (due to imbalance of genioglossus contraction).

Clinical Correlate

SQUAMOUS CELL CARCINOMA

Accounts for most cancers of the oral cavity

In the tongue, usually on the anterolateral aspect

Alcohol and tobacco use are risk factors

Premalignant lesions, such as erythroplasia and leukoplakia, should be identified, because early diagnosis and treatment are paramount in long-term survival

Radiographic imaging helps reveal the tumor's extent and location

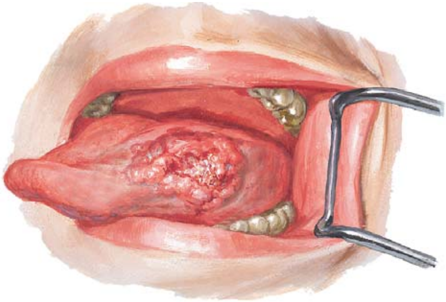
Staging of the tumor guides prognosis

Treatment

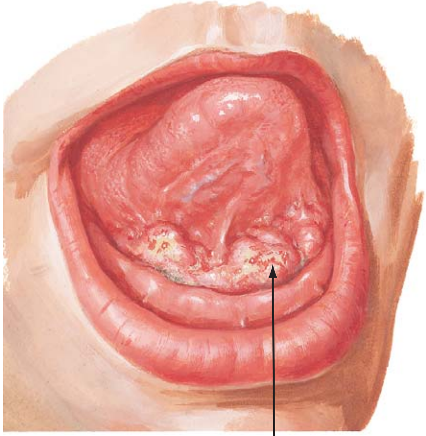
Excision or radiation therapy, or possibly a combination with chemotherapy

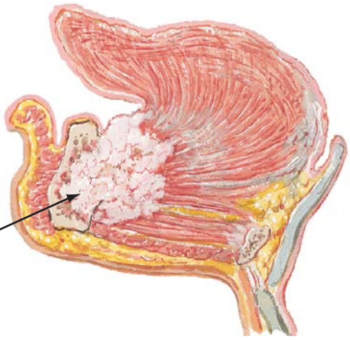
If lesion is detected early, excision may suffice

With later tumor stages, a second primary squamous cell carcinoma must be excluded



Squamous cell carcinoma of tongue





Squamous cell carcinoma of floor of mouth invading mandible

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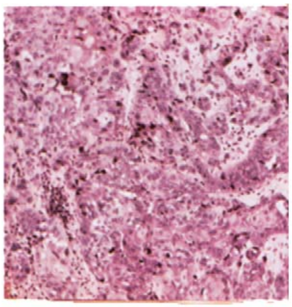
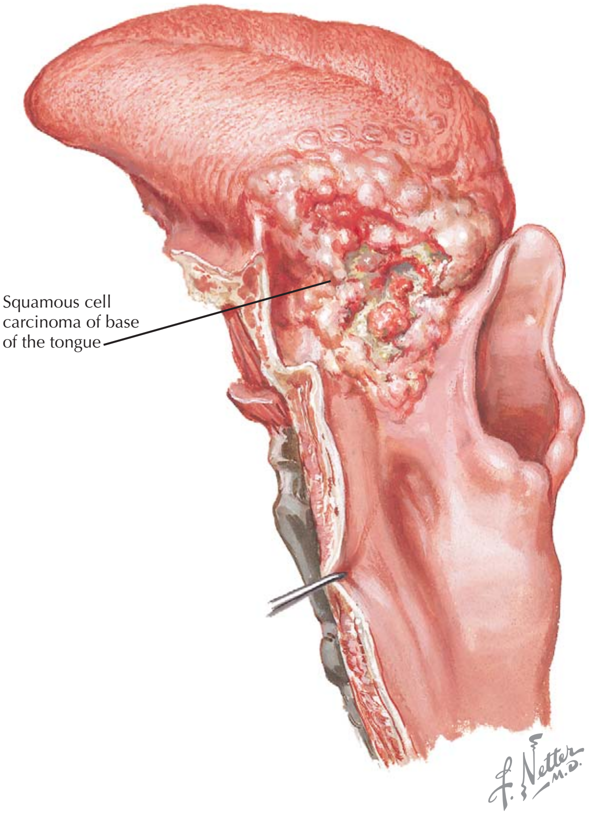
Clinical Correlate

SQUAMOUS CELL CARCINOMA *CONTINUED*



Squamous cell carcinoma



Clinical Correlate

LEUKOPLAKIA

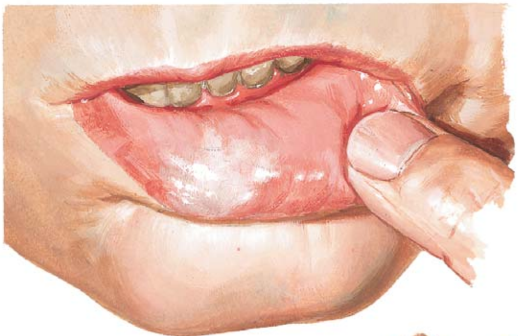
A common premalignant condition of the oral cavity involving the formation of white spots on the mucous membranes of the tongue and inside the mouth

Hairy leukoplakia is a type observed in persons with compromised immune systems

Risk factors:

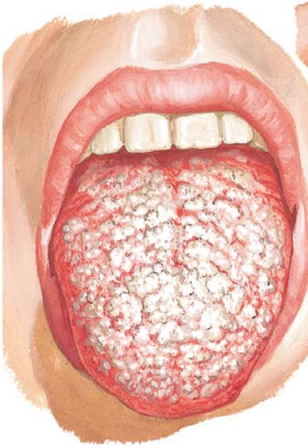
- Tobacco use
- Alcohol use
- Human immunodeficiency virus (HIV) infection
- Epstein-Barr virus infection

Although a precancerous lesion, it may not progress to oral cancer



Early leukoplakia

Moderately advanced leukoplakia of tongue and cheek



Advanced leukoplakia of tongue

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CHAPTER 15

PHARYNX

15 Overview and Topographic Anatomy

GENERAL INFORMATION

Pharynx: 5-inch muscular tube from base of the skull to the lower border of the cricoid cartilage (C6)

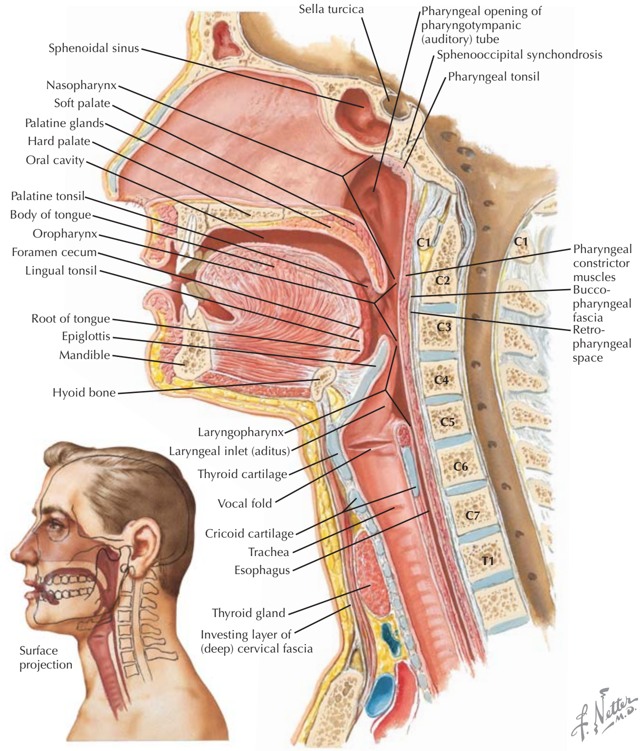
Posterior portion of the pharynx lies against the prevertebral fascia

Lies posterior to the nasal and oral cavities and the larynx and thus is divided into 3 parts:
- Nasopharynx
- Oropharynx
- Laryngopharynx

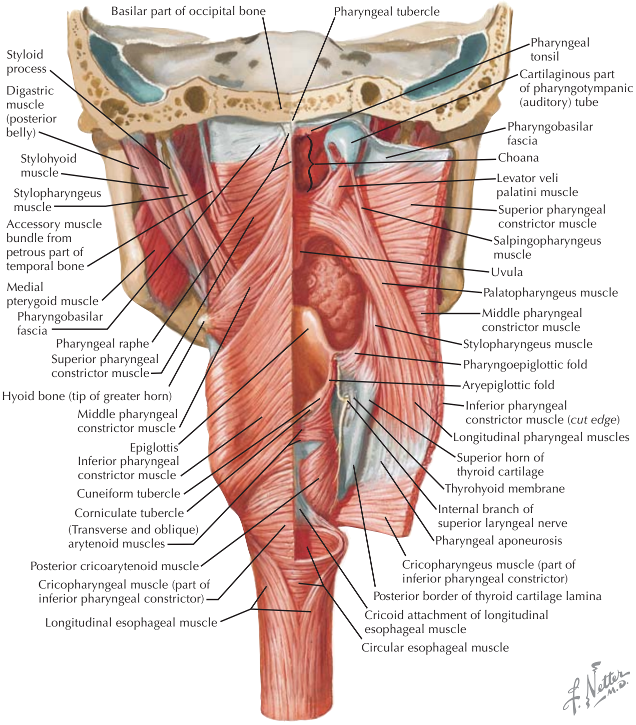
Responsible for properly conducting food to the esophagus and air to the lungs

Composed of:
- Three constrictor muscles
- Three longitudinal muscles
- Cartilaginous part of the pharyngotympanic tube
- Soft palate

The wall of the pharynx has 5 layers:
- Mucous membrane—the innermost layer
- Submucosa
- Pharyngobasilar fascia—the fibrous layer attached to the skull anchoring the pharynx
- Muscular—3 inner longitudinal and 3 outer circular (constrictor) muscles that overlap such that the superior constrictor is the innermost, whereas the inferior constrictor is the outermost muscle
- Buccopharyngeal fascia—loose layer of connective tissue continuous with the fascia over the buccinator and pharyngeal muscles, and the location of the pharyngeal plexus of nerves and the pharyngeal plexus of veins



GENERAL INFORMATION *CONTINUED*



15 Parts of the Pharynx

NASOPHARYNX

Boundaries	Major Anatomic Features	Comments
Roof—fornix *Floor*—soft palate *Anterior*—choanae of the nasal cavity *Posterior*—mucosa covering superior constrictor *Lateral*—mucosa covering superior	Ostium of the auditory tube opens into the nasopharynx Torus tubarius is an elevation formed by the base of the cartilaginous portion of the auditory tube, which lies superior to the ostium of the tube Salpingopharyngeal fold is mucous membrane that lies over the salpingopharyngeus m., connecting the torus tubarius to the lateral wall of the pharynx Pharyngeal recess is located posterior to the salpingopharyngeal fold and contains the pharyngeal tonsils (adenoids)	Has a respiratory function The auditory tube connects the middle ear with the nasopharynx and helps equalize air pressure on both sides of the tympanic membrane The cartilaginous portion of the auditory tube normally is closed, except during deglutition and yawning The auditory tube allows spread of infections between the middle ear and the nasopharynx

OROPHARYNX

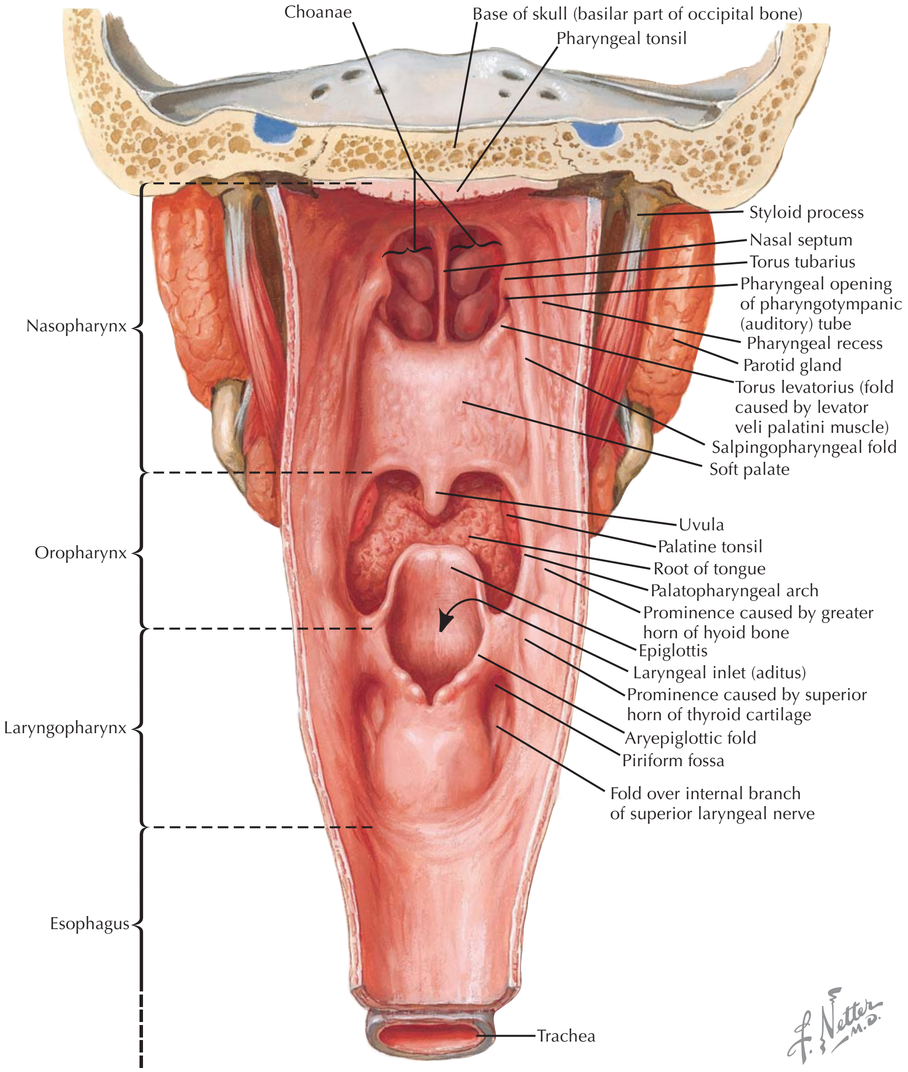
Boundaries	Major Anatomic Features	Comment
Superior—nasopharynx *Inferior*—posterior 1/3 of the tongue *Anterior*—palatoglossal fold of the oral cavity *Posterior*—mucosa covering the superior and middle constrictor mm. *Lateral*—mucosa covering the superior and middle constrictors	Palatine tonsils are located in the oropharynx between the palatoglossal and palatopharyngeal folds Epiglottic vallecula—the depression immediately posterior to the root of the tongue	Has a respiratory and a digestive function

LARYNGOPHARYNX

Boundaries	Major Anatomic Features	Comment
Superior—oropharynx *Anterior*—larynx and epiglottis *Posterior*—mucosa covering middle and inferior constrictor mm. *Lateral*—mucosa covering middle and inferior constrictors	Piriform recess is a small depression located on the lateral wall of the laryngopharyngeal cavity on either side of the entrance to the larynx	Communicates with the larynx The piriform recess is a potential location for objects to become lodged

Parts of the Pharynx

LARYNGOPHARYNX *CONTINUED*



15 Muscles

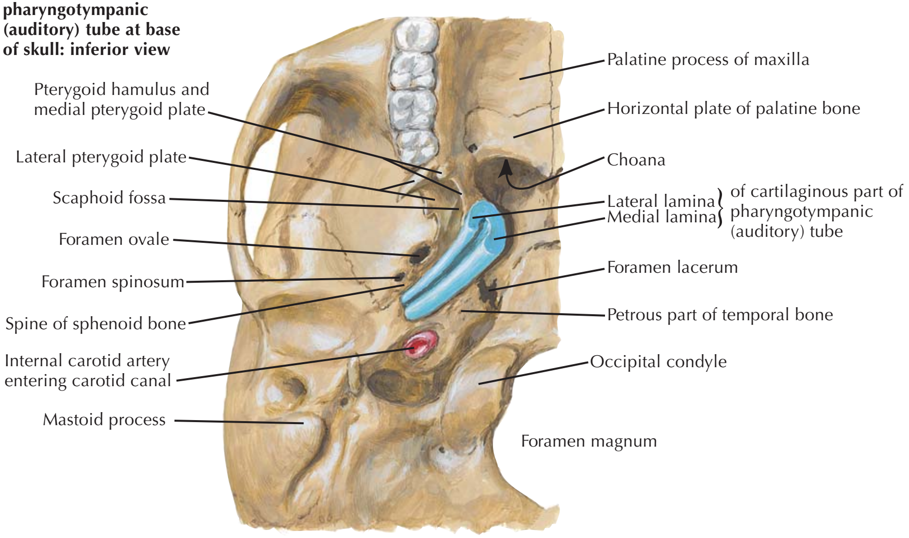
OVERVIEW

Muscle	Origin	Insertion	Actions	Nerve Supply
Superior constrictor	Pterygoid hamulus Pterygomandibular raphe Retromolar trigone of mandible Side of tongue	Pharyngeal tubercle Pharyngeal raphe	Constricts the *upper* portion of the pharynx	Pharyngeal plexus (the motor portion of this plexus is formed by the pharyngeal branch of the vagus n. and the cranial part of the spinal accessory n.)
Middle constrictor	Stylohyoid lig. Lesser cornu of hyoid Greater cornu of hyoid	Pharyngeal raphe	Constricts the *middle* portion of the pharynx	
Inferior constrictor	Oblique line of thyroid cartilage Side of cricoid cartilage		Constricts the *lower* portion of the pharynx	Pharyngeal plexus External laryngeal n. of the vagus Recurrent laryngeal n. of the vagus
Palatopharyngeus	Posterior border of hard palate Palatine aponeurosis	Posterior border of the lamina of the thyroid cartilage	Elevates pharynx Helps close the nasopharynx	Pharyngeal plexus (the motor portion of this plexus is formed by the pharyngeal branch of the vagus n. and the cranial part of the spinal accessory n.)
Salpingopharyngeus	Cartilage of auditory tube		Elevates the upper and lateral portions of the pharynx	
Stylopharyngeus	Medial aspect of base of styloid process		Elevates pharynx Expands the sides of the pharynx	Glossopharyngeal n.

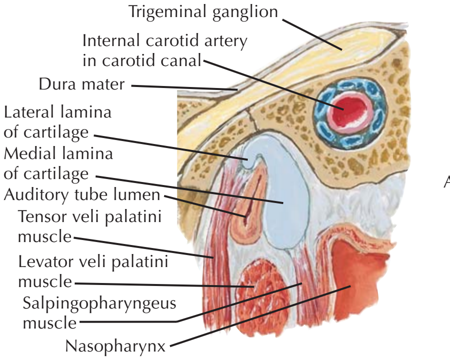
Muscles

OVERVIEW *CONTINUED*

Cartilaginous part of pharyngotympanic (auditory) tube at base of skull: inferior view

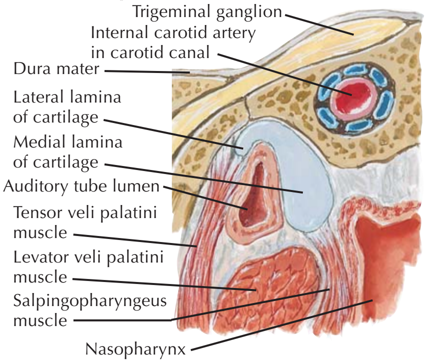


Section through cartilaginous part of pharyngotympanic (auditory) tube, with tube closed



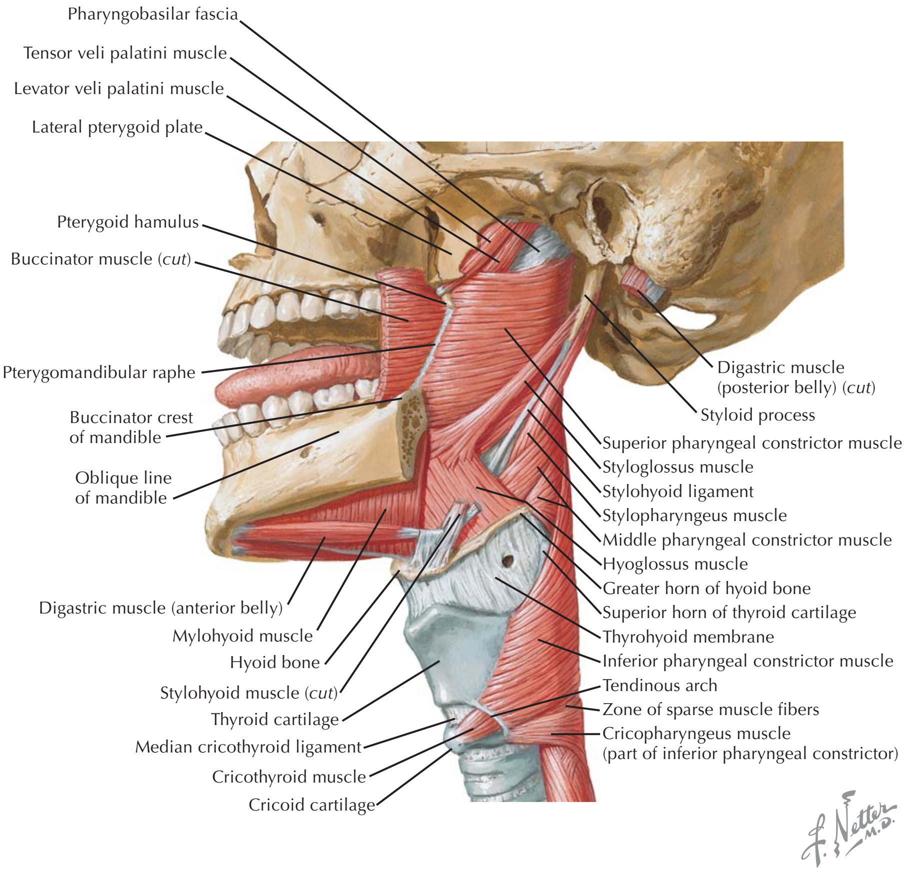
Pharyngotympanic (auditory) tube closed by elastic recoil of cartilage, tissue turgidity and tension of salpingopharyngeus muscles

Section through cartilaginous part of pharyngotympanic (auditory) tube, with tube open



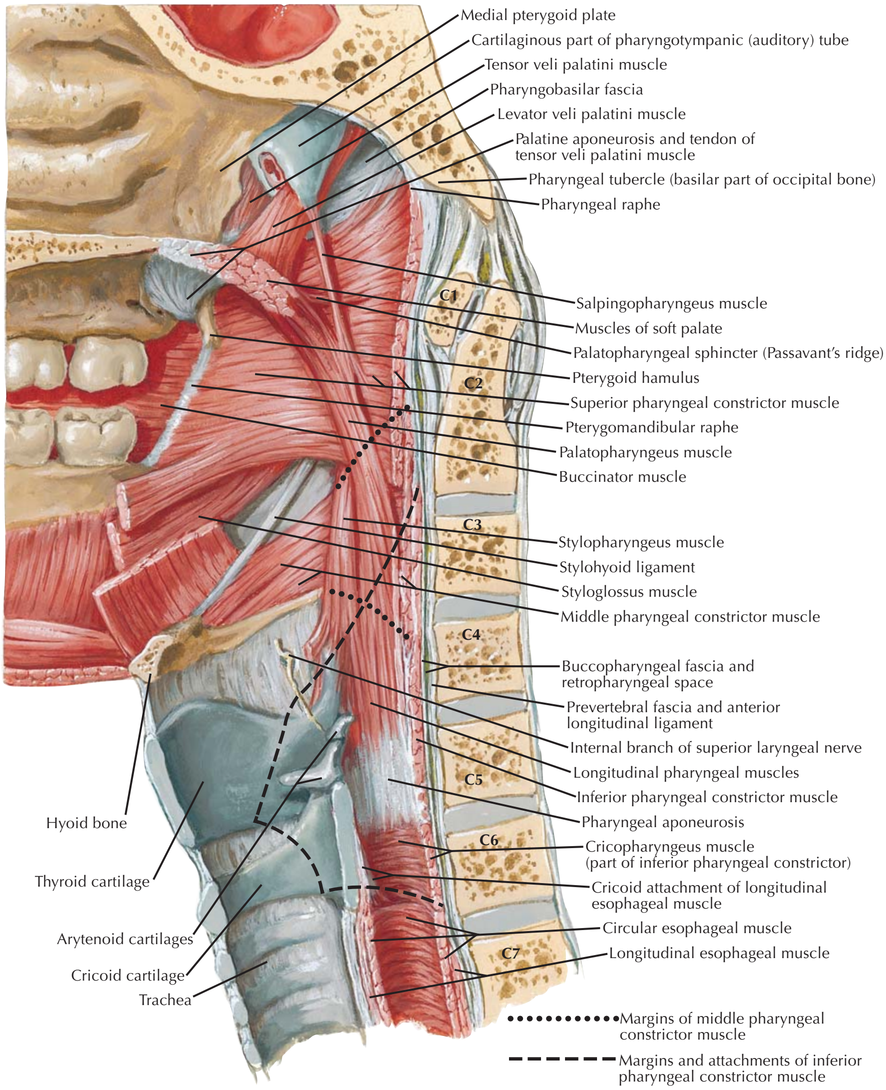
Lumen opened chiefly when attachment of tensor veli palatini muscle pulls wall of tube laterally during swallowing

OVERVIEW *CONTINUED*



Muscles

OVERVIEW *CONTINUED*



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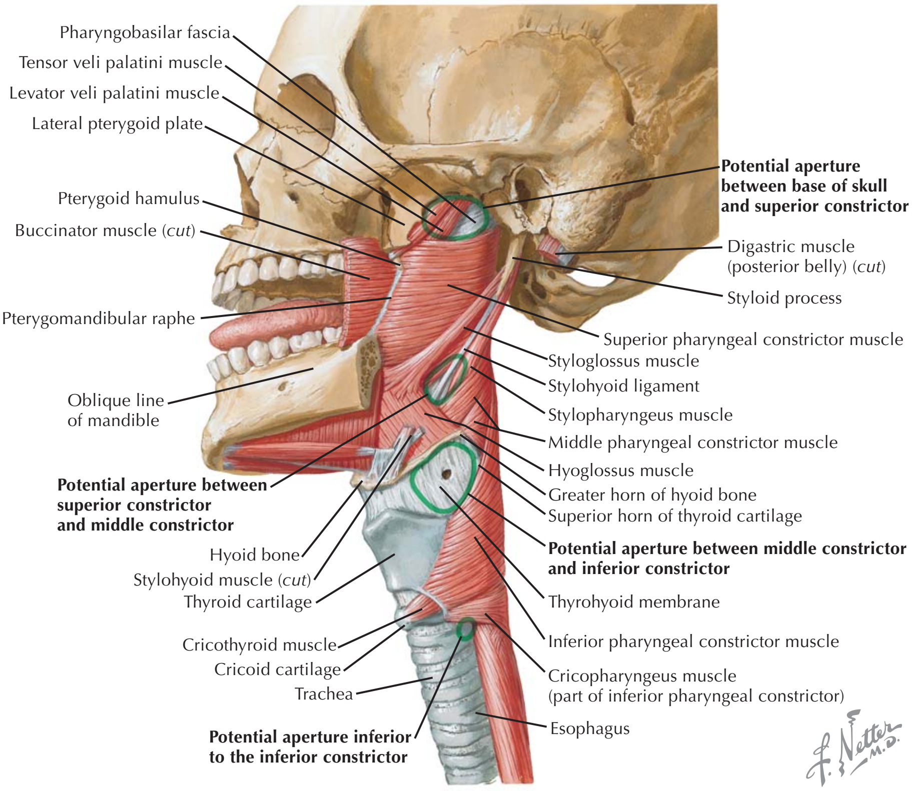
15 Potential Apertures in Pharyngeal Wall

LOCATIONS AND STRUCTURES

The overlapping arrangement of the 3 constrictor muscles leaves 4 potential apertures in the pharyngeal musculature

Anatomic structures enter and exit the pharynx through these potential apertures

OVERVIEW OF POTENTIAL APERTURES	
Location	**Anatomic Structures That Pass Through**
Between base of the skull and the superior constrictor m.	Auditory tube Levator veli palatini m. Ascending pharyngeal a. Ascending palatine a.
Between the superior and middle constrictor mm.	Stylopharyngeus m. Glossopharyngeal n. Tonsillar branch of the ascending palatine a. Stylohyoid lig.
Between the middle and inferior constrictor mm.	Internal laryngeal n. Superior laryngeal a. and v.
Inferior to the inferior constrictor m.	Recurrent laryngeal n. Inferior laryngeal a. and v.

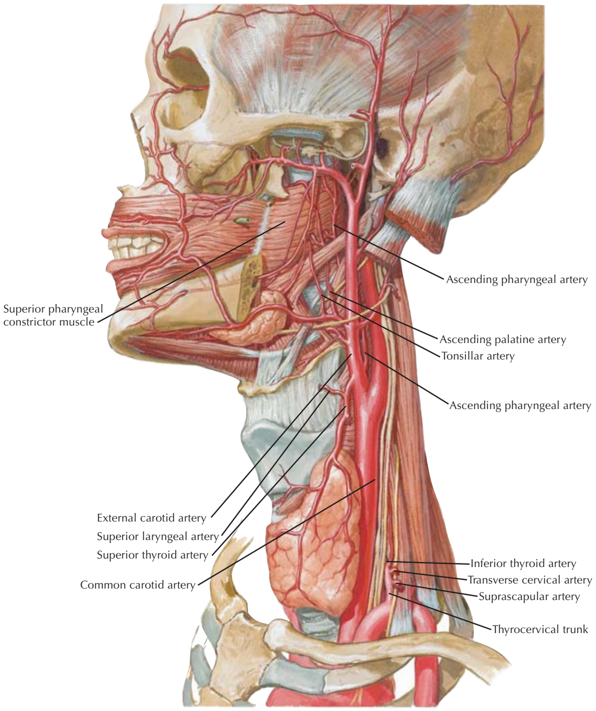


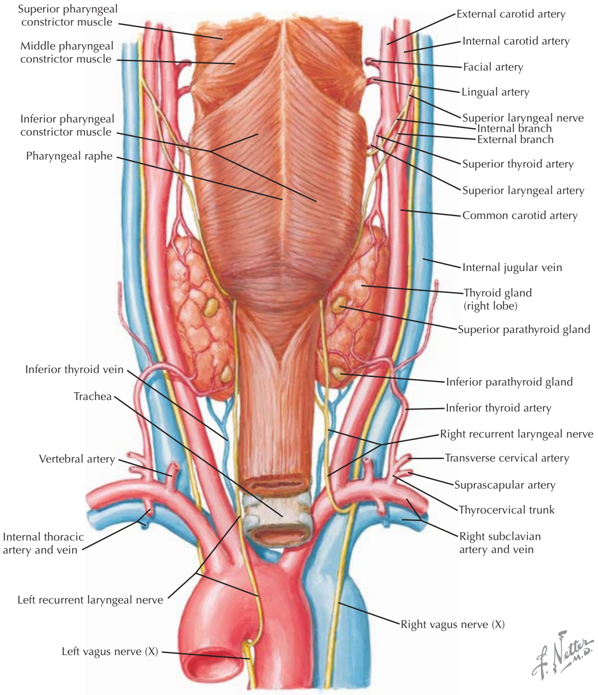
Vascular Supply

ARTERIAL SUPPLY

Artery	Source	Course
Ascending pharyngeal	The posterior portion of the external carotid a. near the bifurcation of the common carotid a.	The smallest branch arising from the external carotid a. Ascends superiorly between the lateral aspect of the pharynx and the internal carotid a. *Has 2 major sets of branches:* • Pharyngeal—a series of 3 small branches that supplies the stylopharyngeus and the middle and inferior constrictor mm. • Palatine—supplies the superior constrictor, palatine tonsil, soft palate, and auditory tube
Ascending palatine	Facial a.	Ascends superiorly along the lateral side of the pharynx, typically between the stylopharyngeus and the styloglossus mm. Passes through the aperture between the base of the skull and the superior constrictor m. to supply it and the soft palate
Tonsillar		While ascending superiorly along the lateral side of the pharynx, it passes into and supplies the superior constrictor m. until reaching the palatine tonsil and root of the tongue
Pharyngeal	The 3rd part of the maxillary a. in the pterygopalatine fossa	Passes posteriorly with the pharyngeal n. into the pharyngeal canal Emerges to supply the superior portion of the nasopharynx and the auditory tube
Superior thyroid	The 1st branch of the external carotid a.	Passes inferiorly along the inferior constrictor m. to supply the thyroid gland
Inferior thyroid	Thyrocervical trunk	Has a series of branches The pharyngeal branch supplies the pharynx

ARTERIAL SUPPLY *CONTINUED*

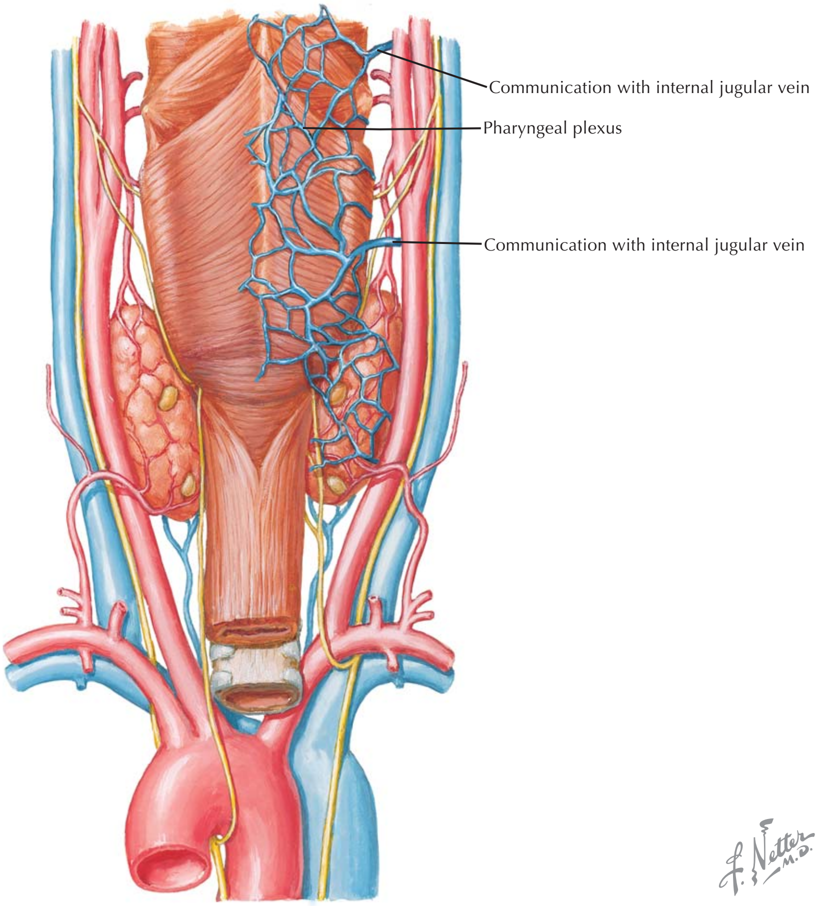




Vascular Supply

VENOUS DRAINAGE

Vein	Course
Pharyngeal plexus	Located on the outer surface of the pharynx in the buccopharyngeal fascia Gives rise to pharyngeal vv., which drain into the internal jugular v. and also into the pterygoid plexus of veins along the lateral pterygoid m. The pharyngeal vv. also may drain into the facial, lingual, or superior thyroid v.



15 Nerve Supply

GENERAL INFORMATION

Supplies motor and sensory innervation to most of the pharynx

Composed of:

- Pharyngeal branch of the glossopharyngeal nerve
- Pharyngeal branch of the vagus nerve
- Cranial part of the spinal accessory nerve

PHARYNGEAL PLEXUS

Nerve	Function	Course	Sensory	Motor
Pharyngeal branch of the glossopharyngeal	The major branch of the glossopharyngeal n. that contributes to the pharyngeal plexus Mainly sensory, but has motor function	3 or 4 filaments unite to form 1 pharyngeal branch opposite the middle constrictor m. This branch, along with the pharyngeal branch of the vagus and spinal accessory nn., forms the pharyngeal plexus	Sensory branches contributing to the plexus perforate the pharyngeal muscles and supply its mucous membranes (mainly oropharynx region)	Aids the pharyngeal branch of the vagus n. and cranial part of the spinal accessory n.
Pharyngeal branch of the vagus	The major branch of the vagus n. that contributes to the pharyngeal plexus Mainly motor, but has sensory function	Arises from the upper part of the inferior ganglion of the vagus n. and contains filaments from the cranial portion of the spinal accessory n. (cranial n. XI) Lies along the upper border of the middle constrictor m., where it forms the pharyngeal plexus From the plexus, the motor branches are distributed to the pharyngeal and soft palate muscles (with the exception of the tensor veli palatini m.)	Sensory branches contributing to the plexus perforate the pharyngeal muscles and supply the remainder of the pharyngeal mucous membranes	Superior constrictor, middle constrictor, inferior constrictor, palatopharyngeus, salpingopharyngeus mm.

Nerve Supply

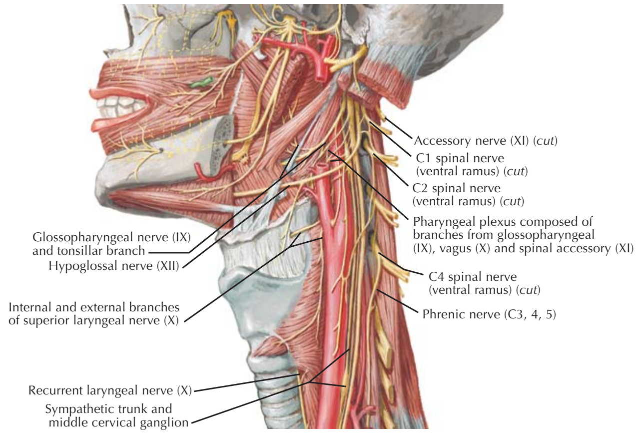
PHARYNGEAL PLEXUS *CONTINUED*

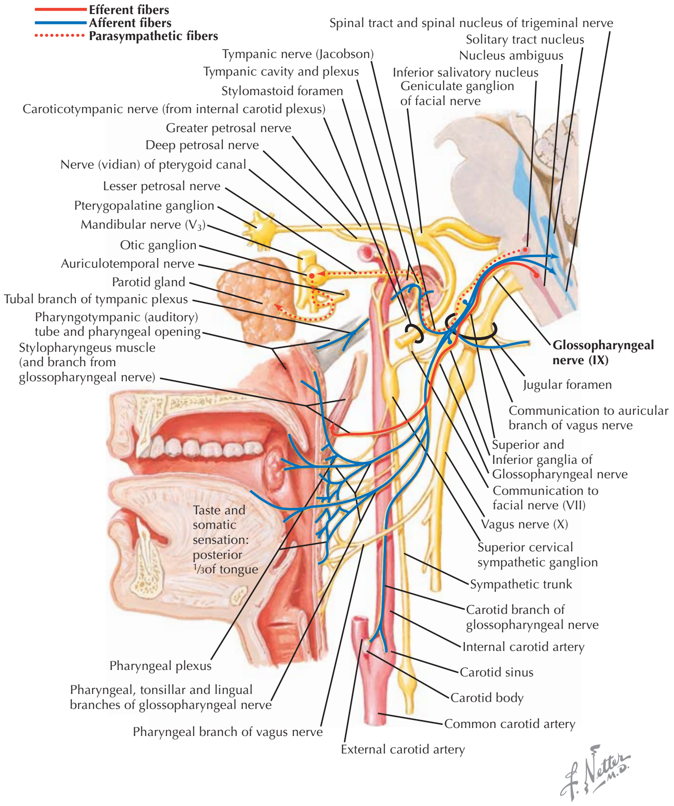
Nerve	Function	Course	Sensory	Motor
Cranial part of the spinal accessory	Contributes with the pharyngeal branch of the vagus to supply the major portion of the motor innervation of the muscles of the pharynx	Emerges as 4 or 5 branches just inferior to the roots of the vagus n. Passes laterally to the jugular foramen, where it merges with fibers of the spinal part of the spinal accessory While united for a short distance, it also is connected by 1 or 2 branches with the inferior ganglion of the vagus It then exits through the jugular foramen, separates from the spinal part, and continues over the surface of the inferior ganglion of the vagus to be distributed mainly to the pharyngeal branches of the vagus		Aids the pharyngeal branch of the vagus n.

OTHER INNERVATION OF THE PHARYNX

Nerve	Function	Course	Sensory	Motor
Recurrent laryngeal branch of the vagus	A small contributor to the motor innervation of the muscles of the pharynx Provides significant innervation to the larynx	Branch of the vagus Wraps around the aorta posterior to the ligamentum arteriosum on the left side Wraps around the right subclavian a. on the right side Ascends on the lateral side of the trachea until reaching the pharynx, where it passes deep to the inferior constrictor to reach the larynx		Part of the inferior constrictor
Pharyngeal	A small sensory nerve	Arises from the maxillary division of the trigeminal in the pterygopalatine fossa Passes posteriorly through the pharyngeal canal with the artery to enter the nasopharynx	Supplies sensory fibers to the nasopharynx and the auditory tube	

OTHER INNERVATION OF THE PHARYNX *CONTINUED*





Clinical Correlate

DEGLUTITION

Deglutition, or swallowing, is a combination of voluntary and involuntary muscular contractions to move a bolus of food from the oral cavity to the esophagus

Deglutition begins when the tip of the tongue is placed into contact with the anterior portion of the palate and the bolus is pushed posteriorly

The soft palate begins to elevate, and Passavant's ridge starts to form in the posterior wall of the pharynx and moves closer to the soft palate

As more of the tongue is pushed against the hard palate, the bolus is moved into the oropharynx, and the soft palate makes contact with Passavant's ridge to close off the nasopharynx from the oropharynx

Once the bolus reaches the epiglottic vallecula, the hyoid and larynx are elevated and the tip of the epiglottis is tipped down slightly over the laryngeal aditus

A "stripping wave" is created on the posterior wall of the pharynx to help move the bolus

Bolus splits into 2 streams that flow on either side of the epiglottis and unite to enter the esophagus

The soft palate is pulled down by the palatopharyngeus muscles and the pressure of the wave from the movement of the bolus, while the stripping wave continues to help move the bolus from the oropharynx

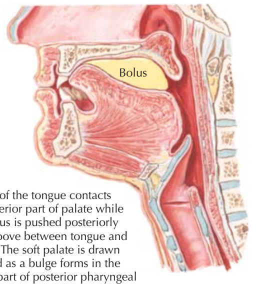
The cricopharyngeal portion of the inferior constrictor relaxes to help the bolus enter the esophagus

Laryngeal vestibule and rima glottidis are closed to prevent the bolus from entering the larynx

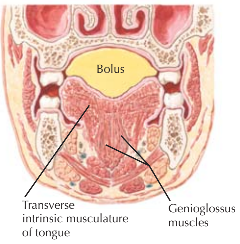
Stripping wave empties the last of the bolus from the epiglottic vallecula, and the major portion of the bolus is already in the esophagus

All structures return to their initial position as the stripping wave moves into the esophagus

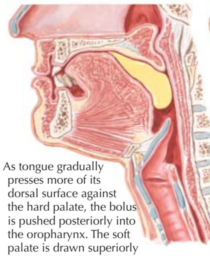
DEGLUTITION *CONTINUED*



A. The tip of the tongue contacts the anterior part of palate while the bolus is pushed posteriorly in a groove between tongue and palate. The soft palate is drawn upward as a bulge forms in the upper part of posterior pharyngeal wall (Passavant's ridge) and approaches the rising soft palate.

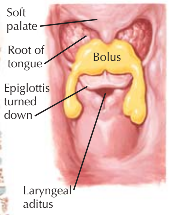


B. The bolus lies in a groove on the dorsal surface of the tongue created by contraction of genioglossus and transverse intrinsic mm.

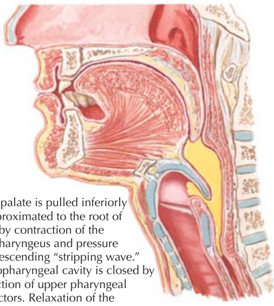


C. As tongue gradually presses more of its dorsal surface against the hard palate, the bolus is pushed posteriorly into the oropharynx. The soft palate is drawn superiorly to contact Passavant's ridge and closes off the nasopharynx. A receptive space is created in the oropharynx as the root of the tongue moves slightly anterior. The stylopharyngeus and upper pharyngeal constrictor mm contract to raise the pharyngeal wall over the bolus.

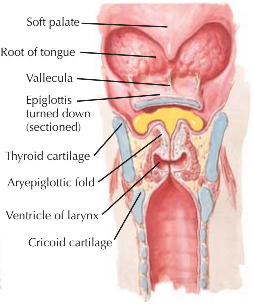
D. When the bolus has reached the vallecula, the hyoid and larynx move superior and anterior while the epiglottis is tipped inferiorly. A "stripping wave" on the posterior pharyngeal wall moves inferiorly.



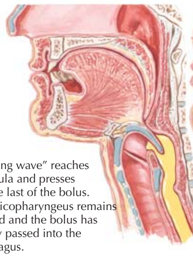
E. The epiglottis is tipped inferiorly over the laryngeal aditus but does not completely close it. The bolus flows in two streams around each side of epiglottis to the piriform fossae and unite to enter the esophagus. A trickle of food may enter the laryngeal adiuts.



F. The soft palate is pulled inferiorly and approximated to the root of tongue by contraction of the palatopharyngeus and pressure of the descending "stripping wave." The oropharyngeal cavity is closed by contraction of upper pharyngeal constrictors. Relaxation of the cricopharyngeus permits entry of the bolus into the esophagus. A trickle of food may enter the laryngeal aditus.



G. Laryngeal vestibule is closed by approximation of aryepiglottic and ventricular folds, preventing entry of food beyond aditus into the larynx.



H. "Stripping wave" reaches vallecula and presses out the last of the bolus. The cricopharyngeus remains relaxed and the bolus has largely passed into the esophagus.

I. "Stripping wave" passes the pharynx and the epiglottis begins to turn superiorly as the hyoid and larynx descend. Communication with the nasopharynx is re-established.

J. All structures of the pharynx return to their resting position as the "stripping wave" passes into the esophagus, pushing the bolus before it.

CHAPTER 16

LARYNX

16 Overview and Topographic Anatomy

GENERAL INFORMATION

Larynx: connection between the pharynx and the trachea

Prevents foreign bodies from entering the airways

Designed for the production of sound (phonation)

Shorter in women and children

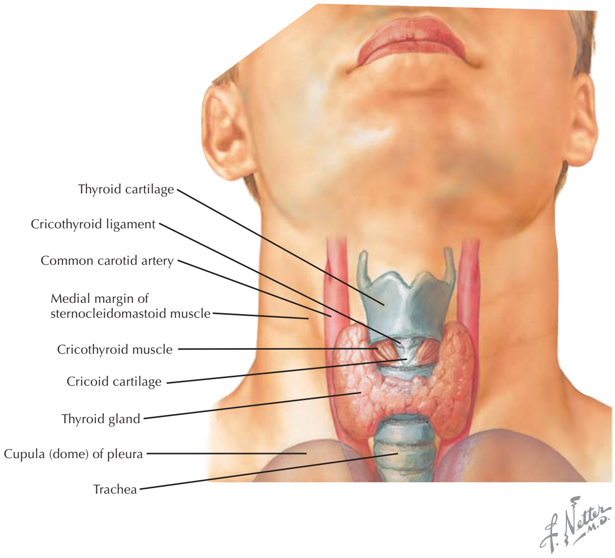
Formed by 9 cartilages: 3 paired and 3 unpaired

Located in the midline opposite the 3rd to the 6th cervical vertebrae

Regions of the larynx:
- Vestibule
- Ventricle
- Infraglottic

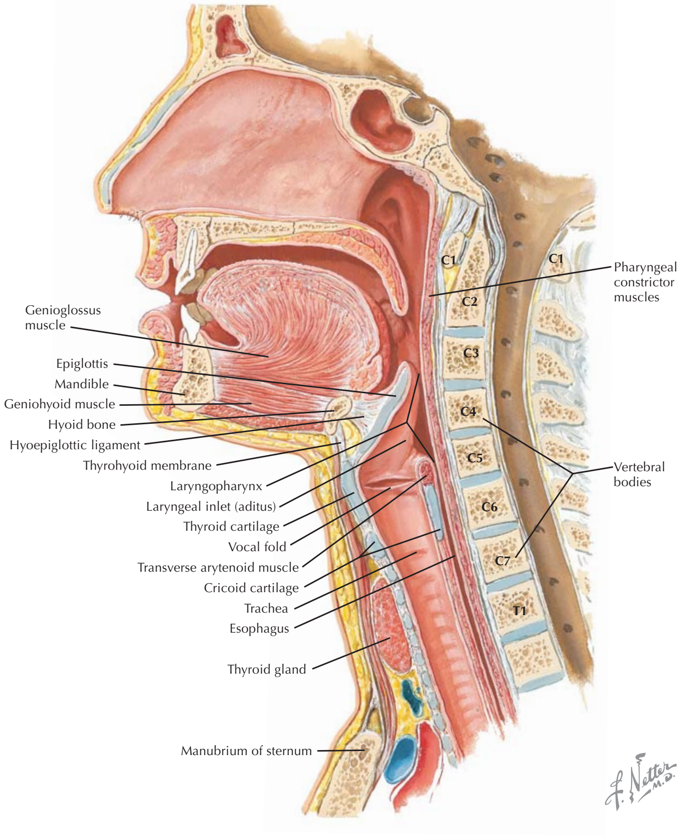
Relations of the Larynx

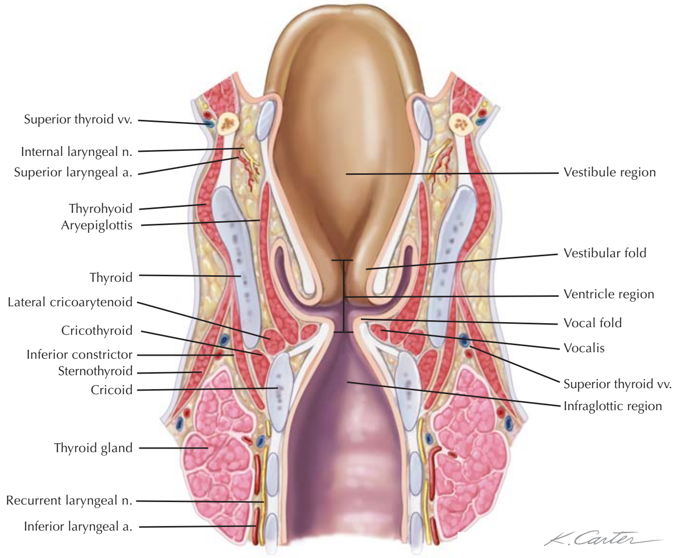
- Anterolateral—infrahyoid muscles, platysma
- Lateral—lobes of the thyroid gland, carotid sheath
- Posterior—it forms the anterior wall of the laryngopharynx
- Superior—base of tongue and vallecula
- Inferior—trachea



Overview and Topographic Anatomy

GENERAL INFORMATION *CONTINUED*

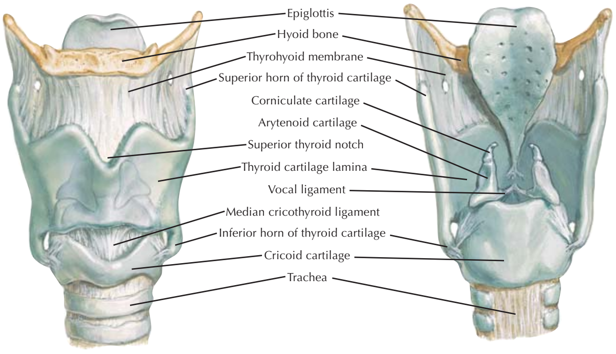




16 Cartilages

GENERAL INFORMATION

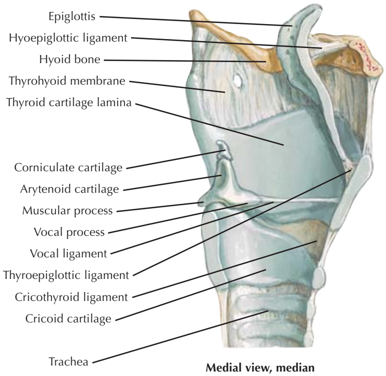
Cartilage	Cartilage Type	Paired	Comments
Thyroid	Hyaline	No	Largest of the laryngeal cartilages Connects to the hyoid bone via the thyrohyoid membrane, which allows the internal laryngeal n. and superior laryngeal vessels to pass through to enter the larynx Lies between C4 and C6
Cricoid			Only complete ring of cartilage in the respiratory system Signet in shape Both intrinsic and extrinsic laryngeal muscles attach to the cricoid Lies at C6
Arytenoid		Yes	Forms framework of the true vocal cord
Epiglottis	Elastic	No	Helps prevent foreign bodies from entering the larynx
Corniculate (minor)		Yes	Minor cartilages that lie in the aryepiglottic fold
Cuneiform (minor)			



Anterior view

Posterior view

Anterosuperior view

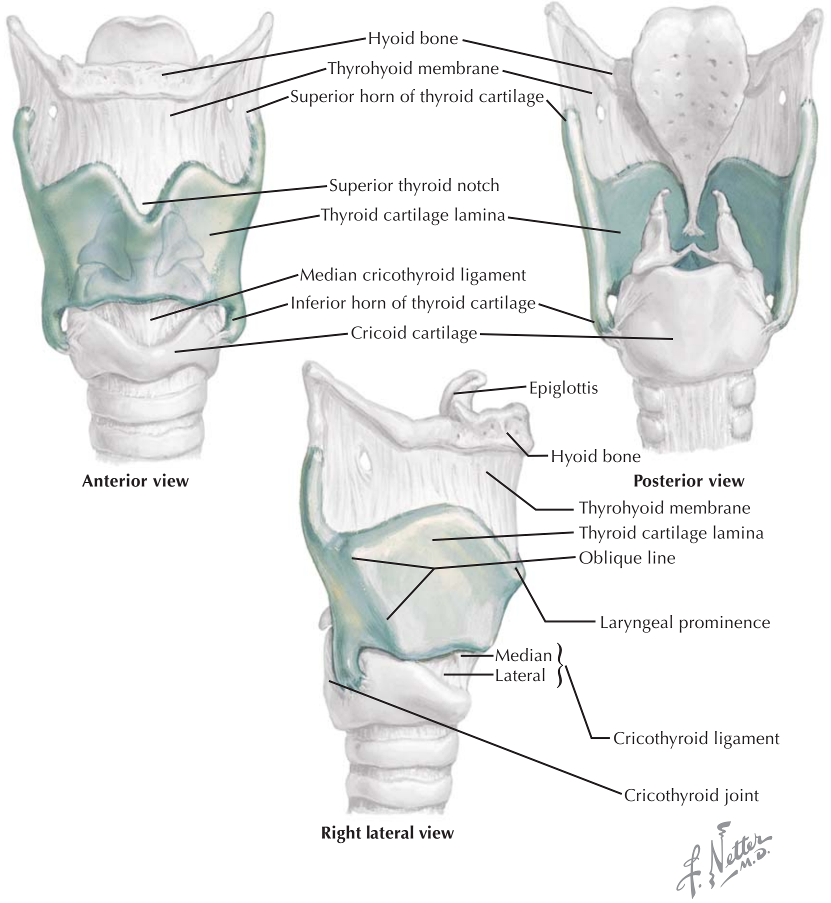


Medial view, median (sagittal) section

Cartilages

THYROID CARTILAGE

Anatomic Feature	Comments
2 lateral laminae	2 plates that meet at an acute angle in the anterior midline
Laryngeal prominence	Also known as the Adam's apple Formed by the fusion of the 2 lateral lamina Larger in males than in females
Thyroid notch	Superior portion of the laryngeal prominence, which forms a V shape
Superior tubercle	Superior border of the oblique line
Oblique line	Attachment for sternothyroid, thyrohyoid, and inferior constrictor mm. (extrinsic muscles of the larynx)
Inferior tubercle	Inferior border of the oblique line
Superior horn	Provides lateralmost attachment for the thyrohyoid membrane
Inferior horn	Articulates with the cricoid to form the cricothyroid joint



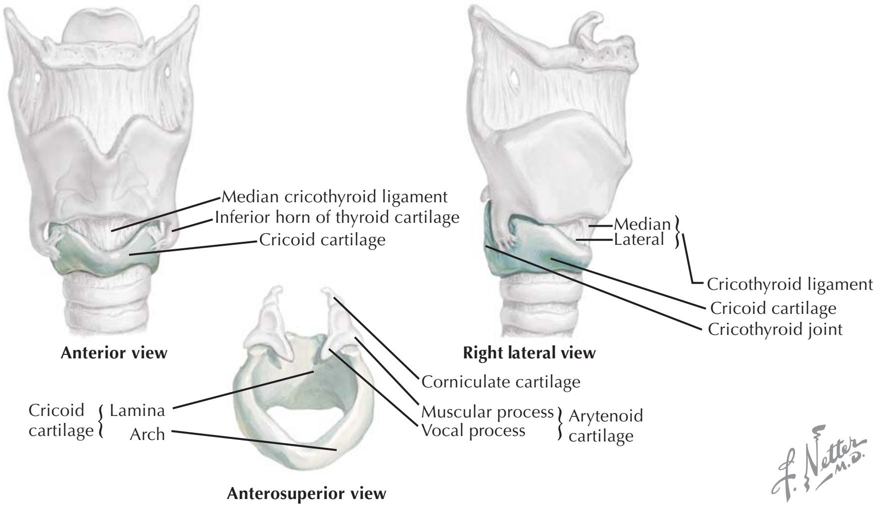
Anterior view

Posterior view

Right lateral view

CRICOID CARTILAGE

Anatomic Feature	Comments
Arch (anteriorly)	1 cm long Narrow
Lamina (posteriorly)	2 to 3 cm long
Superior border (on the lamina)	Articulates with the arytenoid cartilage to form the cricoarytenoid joint
Inferior border (on the lamina)	Articulates with the inferior cornu of the thyroid cartilage to form the cricothyroid joint



Anterior view

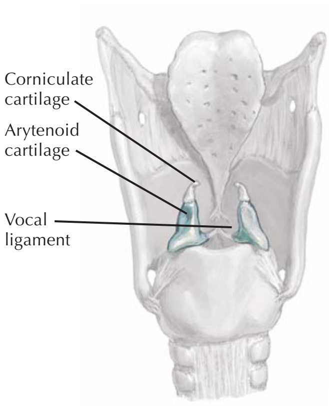
Right lateral view

Anterosuperior view

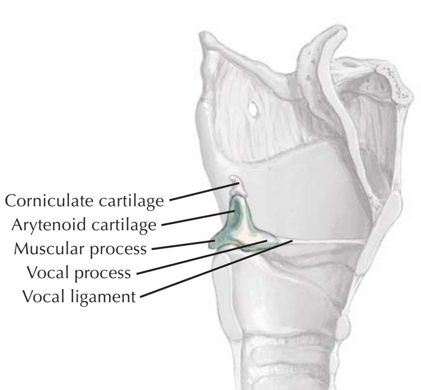
Cartilages

ARYTENOID CARTILAGE

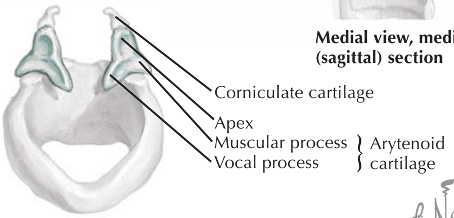
Anatomic Feature	Comments
3 processes: • Muscular (lateral) • Vocal (anterior) • Apex (superior)	Base articulates with cricoid to form the cricoarytenoid joint Vocal process gives rise to true vocal cord



Posterior view



Medial view, median (sagittal) section



Anterosuperior view

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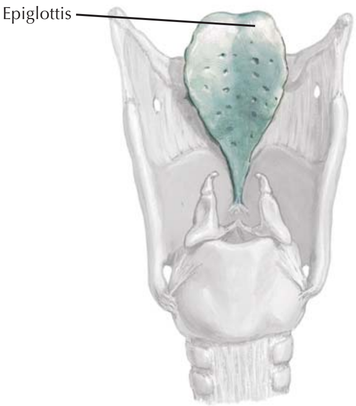
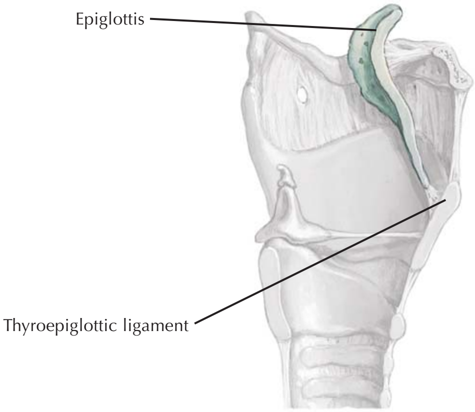
16 Cartilages

EPIGLOTTIS

Anatomic Feature	Comment
Epiglottic tubercle	Pear-shaped



Posterior view



Medial view, median (sagittal) section

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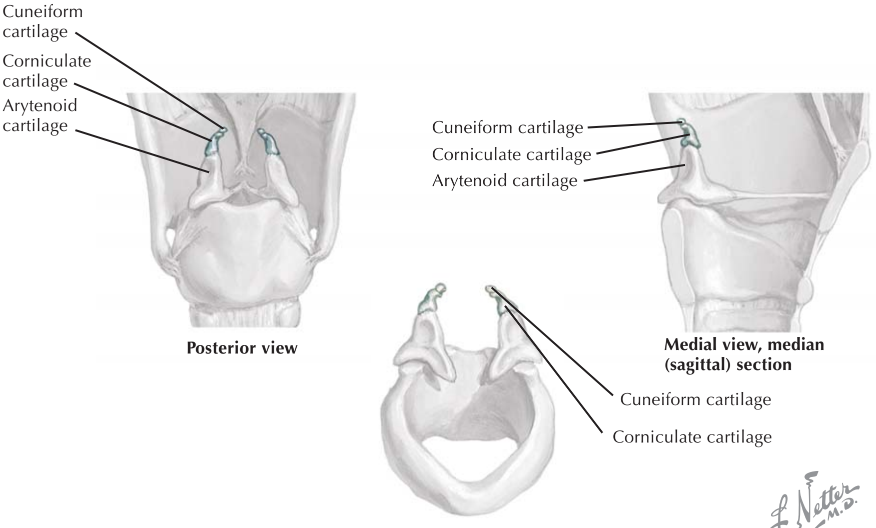
Cartilages

MINOR CARTILAGES

Cartilage	Comments
Corniculate	Lies on the apex of the arytenoid cartilage Helps support the aryepiglottic fold
Cuneiform	Lies superior to the corniculate cartilage Helps support the aryepiglottic fold



Posterior view

Medial view, median (sagittal) section

Anterosuperior view

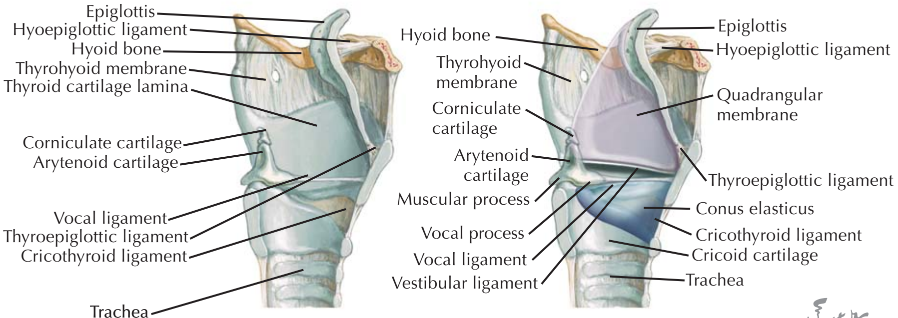
16 Membranes and Ligaments

MAJOR EXTRINSIC LIGAMENTS

Ligament(s)	Location	Comments
2 lateral thyrohyoid ligaments 1 median thyrohyoid ligament Thyrohyoid membrane	Thyroid cartilage to hyoid bone	The thyrohyoid membrane allows passage of the internal laryngeal n. and superior laryngeal vessels
Median cricothyroid ligament	Cricoid cartilage to thyroid cartilage	Primary site for establishing an emergency airway
Cricotracheal ligament	Cricoid cartilage to trachea	Attaches the cricoid cartilage to the first tracheal ring May be used in establishing an emergency airway

MAJOR INTRINSIC LIGAMENTS

Ligament	Location	Comments
Vocal ligament	Arytenoid (vocal) to thyroid cartilage	Help form *true* vocal cord
Conus elasticus	Superior—thyroid, vocal lig., arytenoid (vocal) Inferior—upper border of cricoid	
Quadrangular membrane	Arytenoid to epiglottis	Help form *false* vocal cord
Vestibular ligament	Free edge of quadrangular membrane	

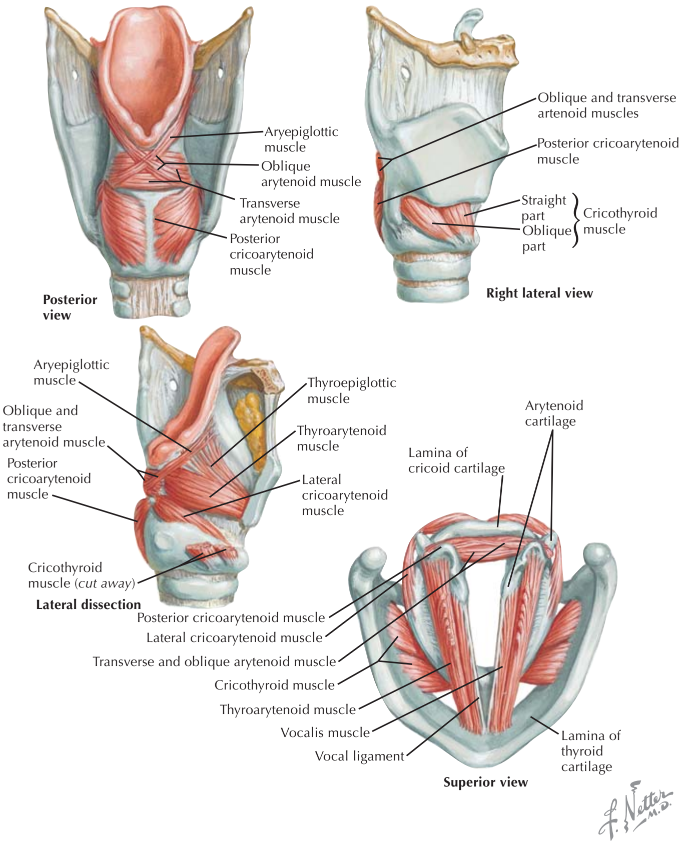


Medial view, median (sagittal) section

Muscles

OVERVIEW

Muscle	Origin	Insertion	Action(s)	Nerve Supply
Cricothyroid	Arch of cricoid	Lamina and inferior cornu of thyroid	Increases tension on vocal ligaments	External laryngeal n.
Thyroarytenoid	Angle of thyroid cartilage	Arytenoid (vocal process)	Decreases tension on vocal ligaments	Recurrent laryngeal n.
Posterior cricoarytenoid	Lamina of cricoid	Arytenoid (muscular process)	Opens rima glottidis	
Lateral cricoarytenoid	Arch of cricoid (lateral portion)		Closes rima glottidis	
Transverse arytenoid	Arytenoid (muscular process)	Opposite arytenoid (muscular process)		
Oblique arytenoid		Opposite arytenoid (apex)		
Aryepiglotticus	Arytenoid (apex)	Epiglottis	Helps close laryngopharyngeal opening	
Thyroepiglotticus	Thyroid lamina			



Posterior view

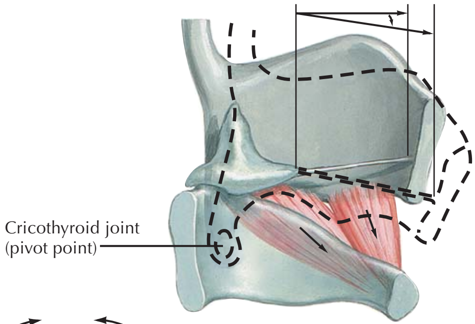
Right lateral view

Lateral dissection

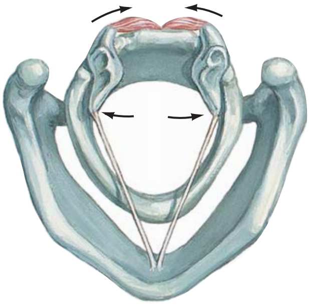
Superior view

OVERVIEW *CONTINUED*

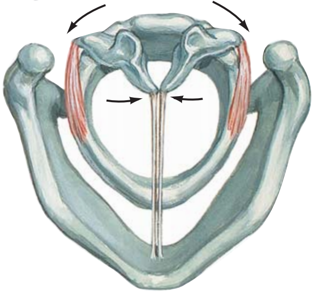
SUMMARY OF MUSCLE ACTIONS			
Altering the Rima Glottidis		**Altering Tension on the Vocal Cords**	
Muscle	**Action**	**Muscle**	**Action**
Posterior cricoarytenoid	*Opens* the rima glottidis	Cricothyroid	*Increasing* tension
Transverse arytenoids Oblique arytenoids Lateral cricoarytenoid	*Closes* the rima glottidis	Thyroarytenoid	*Decreasing* tension



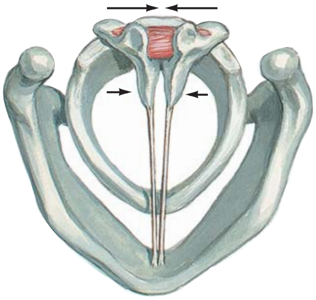
Action of cricothyroid muscles
Lengthening (increasing tension) of vocal ligaments



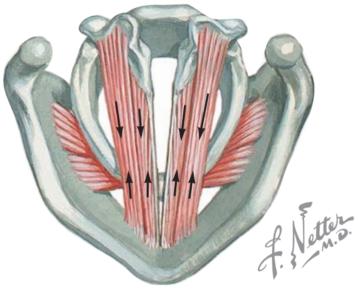
Action of posterior cricoarytenoid muscles
Abduction of vocal ligaments



Action of lateral cricoarytenoid muscles
Adduction of vocal ligaments



Action of transverse arytenoid muscles
Adduction of vocal ligaments

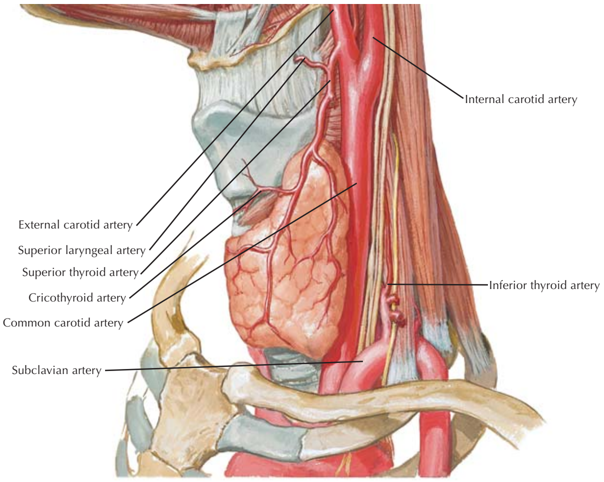


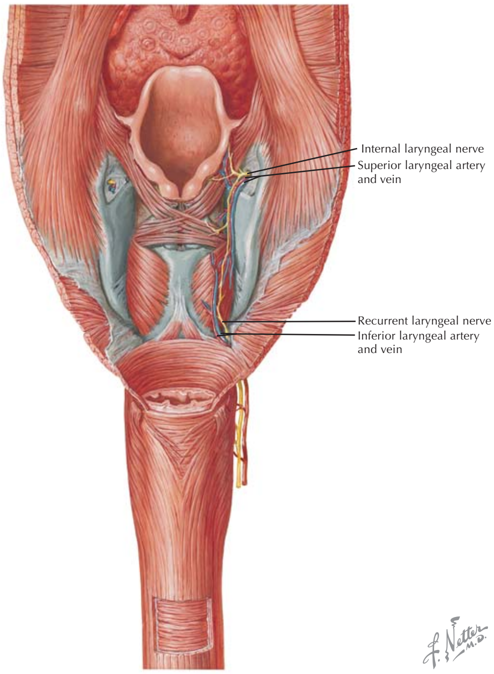
Action of vocalis and thyroarytenoid muscles
Shortening (relaxation) of vocal ligaments

Vascular Supply

ARTERIAL SUPPLY

Artery	Source	Course
Superior laryngeal	Superior thyroid a., which arises from the external carotid a.	Passes through the thyrohyoid membrane with the internal laryngeal n. to enter the deep surface of the larynx
Inferior laryngeal	Inferior thyroid a., which arises from the thyrocervical trunk	Passes superiorly on the trachea to reach the posterior border of the larynx Lies immediately deep to the inferior constrictor m. traveling beside the recurrent laryngeal n.





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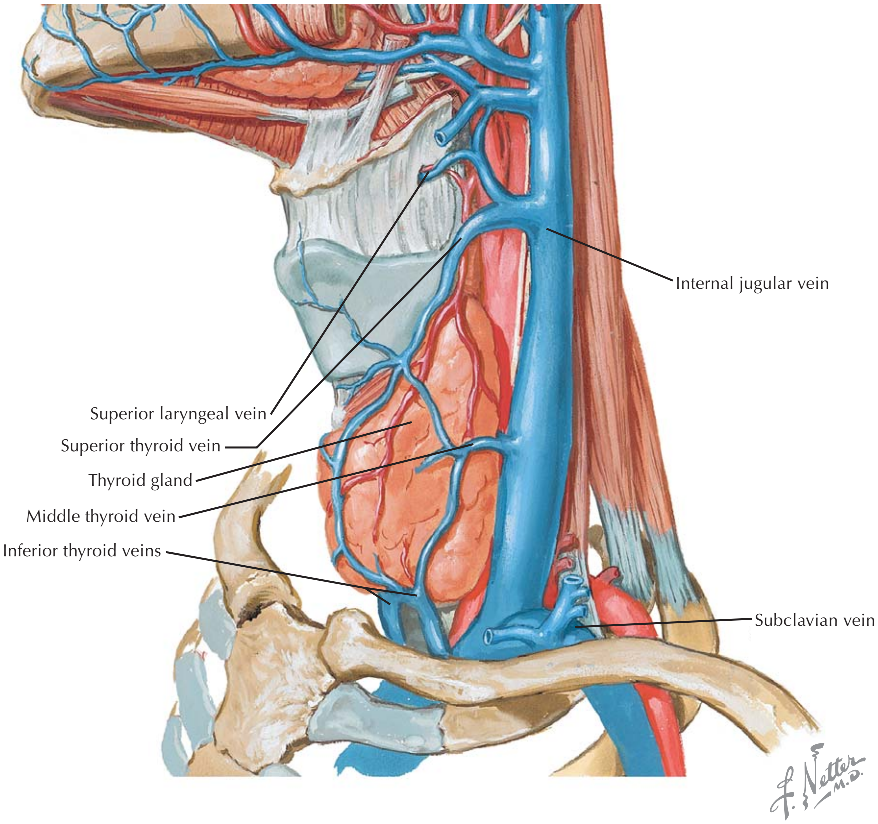
VENOUS DRAINAGE

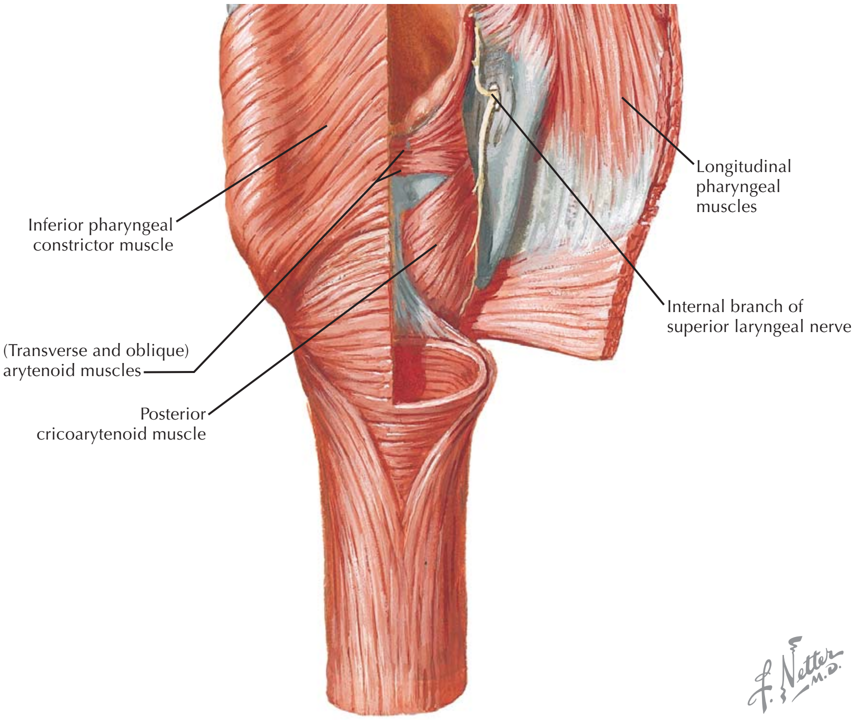
Vein	Course
Superior laryngeal	Begins in the deep surface of the superior part of the larynx Passes with the superior laryngeal a. and the internal laryngeal n. Passes through the thyrohyoid membrane to lie on the superficial surface of the larynx Drains into the superior thyroid v., which drains into the internal jugular v.
Inferior laryngeal	Arises within the deep surface of the inferior part of the larynx Passes with the inferior laryngeal a. and the recurrent laryngeal n. Passes inferiorly deep to the inferior constrictor to exit the larynx Drains into the inferior thyroid v., which drains into the brachiocephalic vv.



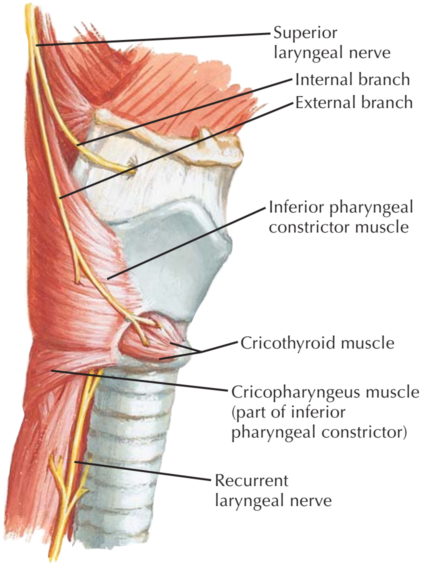
Nerve Supply

MOTOR AND SENSORY BRANCHES FROM THE VAGUS NERVE

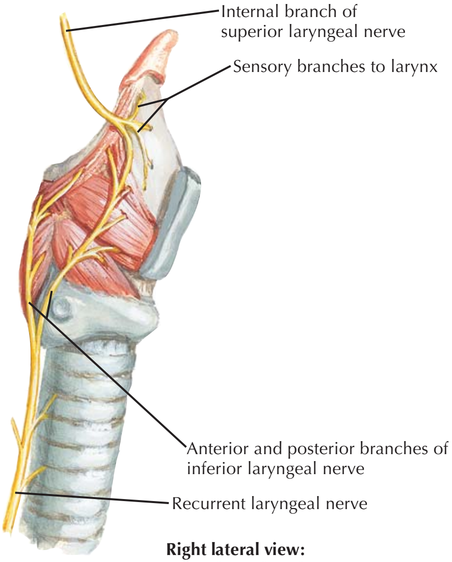
Nerve	Type	Sensory Target	Muscles Innervated	Comments
Internal laryngeal	Sensory	Membranes above the false vocal folds		Branch of superior laryngeal nerve from the vagus
Recurrent laryngeal	Sensory and motor	Membranes below the false vocal folds	Thyroarytenoid Posterior cricoarytenoid Lateral cricoarytenoid Transverse arytenoid Oblique arytenoid Aryepiglotticus Thyroepiglotticus	Branch of the vagus Wraps around the aorta posterior to the ligamentum arteriosum on the left side Wraps around the right subclavian artery on the right side Ascends on the lateral aspect of the trachea until reaching the pharynx, where it passes deep to the inferior constrictor to reach the larynx
External laryngeal	Motor		Cricothyroid	Branch of superior laryngeal nerve from the vagus



MOTOR AND SENSORY BRANCHES FROM THE VAGUS NERVE *CONTINUED*



Right lateral view



Right lateral view: thyroid cartilage lamina removed

Clinical Correlate

EMERGENCY AIRWAY: CRICOTHYROTOMY

Cricothyrotomy: a procedure for establishing an emergency airway when other methods are unsuitable

Once the anatomy of the larynx is identified, the procedure can be performed with 2 incisions:

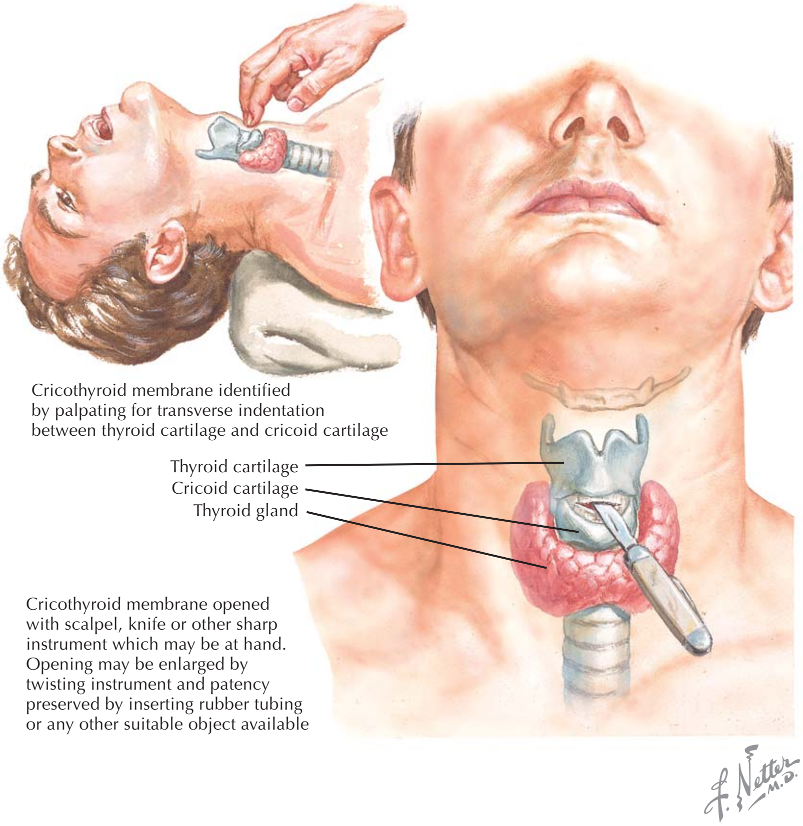
- Incision through the skin
- Incision through the cricothyroid membrane

The correct location for the incision is easiest to find by identifying the thyroid notch on the thyroid cartilage

By sliding the examining finger in an inferior direction, the groove between the thyroid and cricoid cartilages can be located

A 3-cm vertical incision is made through the skin, and the thyrohyoid membrane is located

A small midline incision is made, and a tracheostomy tube is inserted to establish an airway



Clinical Correlate

LARYNGITIS

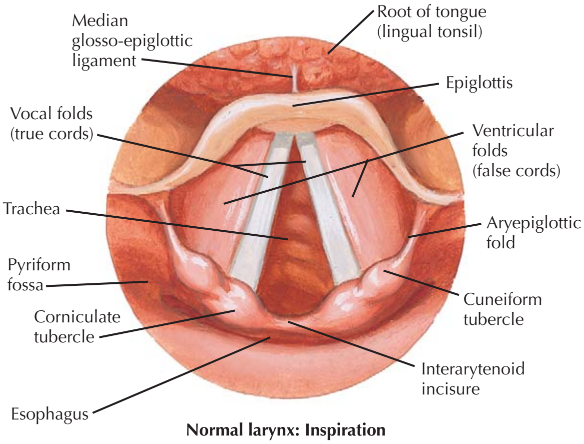
Laryngitis: an inflammation of the vocal cords in the larynx that typically does not persist longer than 7 days

Characterized by a weak and hoarse voice, sore throat, and cough

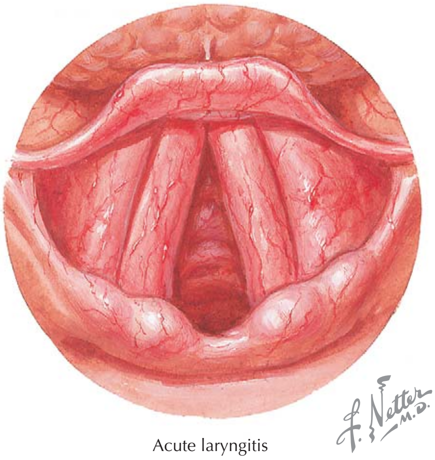
Most common cause is a viral infection, although it may be caused by a bacterial infection

Can also be caused excessive yelling (such as cheering at a sporting event) and smoking

Because most cases of laryngitis are viral in nature, antibiotics generally are not used as treatment



Normal larynx: Inspiration



Acute laryngitis

CHAPTER 17

CERVICAL FASCIA

17

Overview and Topographic Anatomy

GENERAL INFORMATION

Fascia: a band of connective tissue that surrounds structures (such as enveloping muscles), giving rise to potential tissue spaces and pathways that allow infection to spread

Superficial Fascia

Immediately deep to the skin

Contains fat

Deep Fascia

Deep to the superficial fascia

Aids muscle movements

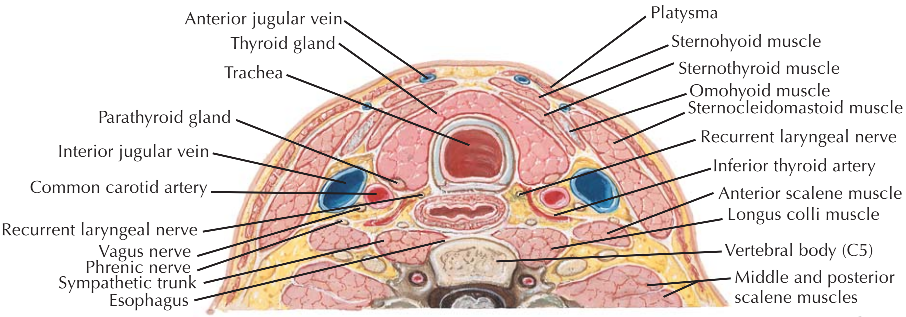
Provides passageways for nerves and vessels

Provides attachment for some muscles

In the neck, it is divided into *4 regions:*
- Visceral region
- Musculoskeletal region
- 2 neurovascular compartments

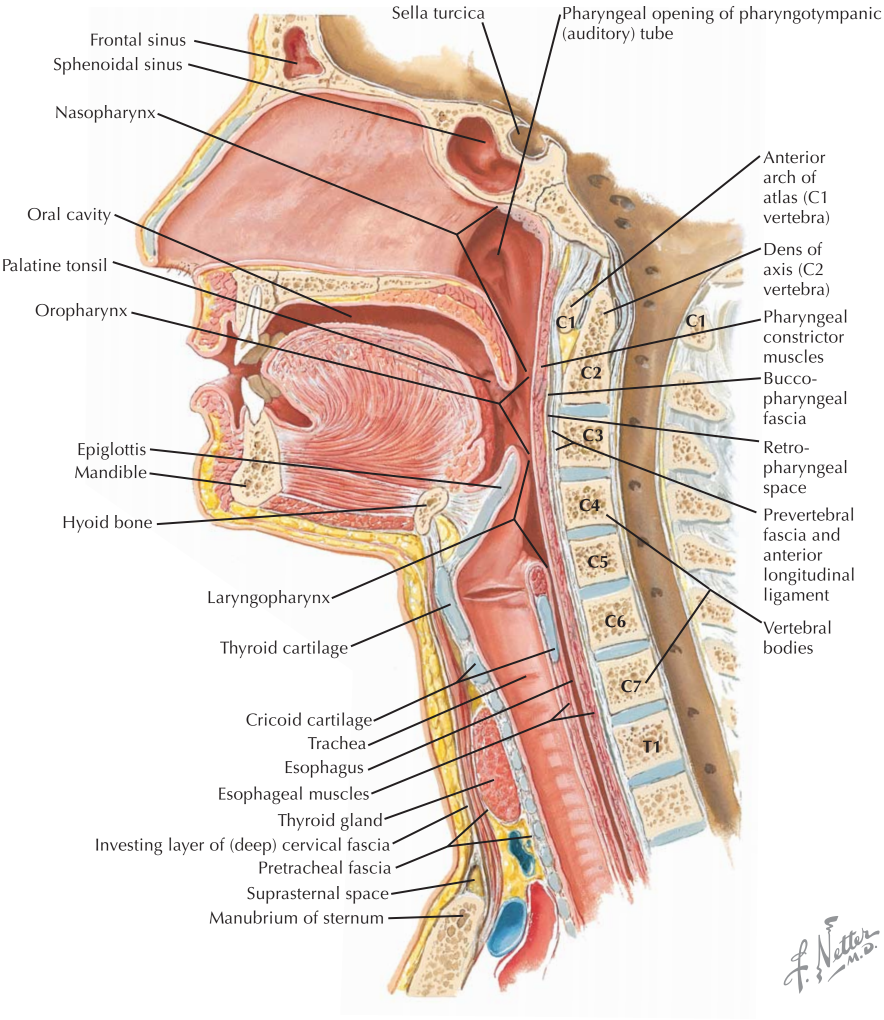
Also divided into *4 layers:*
- Superficial layer of deep cervical fascia (investing layer of deep cervical fascia)
- Middle layer of deep cervical fascia
- Deep layer of deep cervical fascia
- Carotid sheath (composed by the contribution of all 3 layers of deep cervical fascia)

There is no deep fascia in the face which allow free spread of fluid



Overview and Topographic Anatomy

GENERAL INFORMATION *CONTINUED*

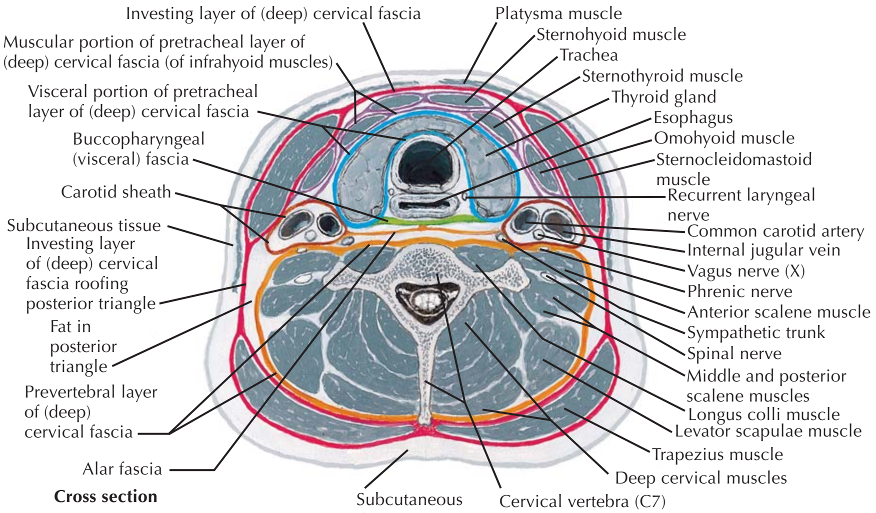


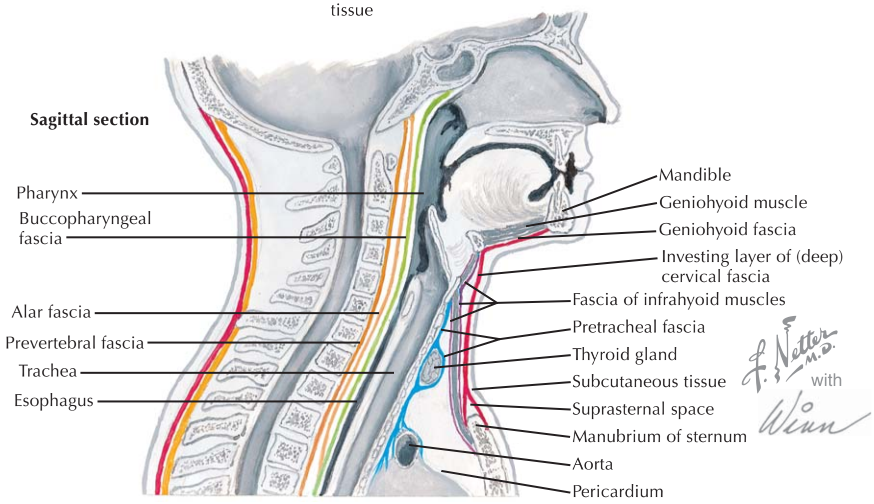
17 Fascia of the Neck

SUPERFICIAL FASCIA

Superficial fascia lies deep to the skin and contains the cutaneous vessels and nerves

In the neck, the platysma muscle lies within the deep fascia





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Fascia of the Neck

DEEP FASCIA

SUPERFICIAL LAYER OF DEEP CERVICAL FASCIA

Layer	Location	Attachment	Comments
Superficial layer of deep cervical fascia (also known as the investing layer of deep cervical fascia)	Immediately deep to the superficial fascia Encircles the neck completely When the layer approaches the sternocleidomastoid and the trapezius mm., it splits to lie on the superficial and deep surfaces	Anterior—chin, hyoid, sternum Posterior—spinous process of cervical vertebra and the ligamentum nuchae Superior—external occipital protuberance, superior nuchal line, mastoid process, inferior border of the zygomatic arch, inferior border of the mandible from the angle to the midline Inferior—sternum (splitting into anterior and posterior parts), clavicle, acromion of the scapula	Forms the roof of the posterior triangle In the area between the mastoid process and the angle of the mandible, this layer splits around the parotid gland to form the parotid fascia Helps define the masticator space

MIDDLE LAYER OF DEEP CERVICAL FASCIA

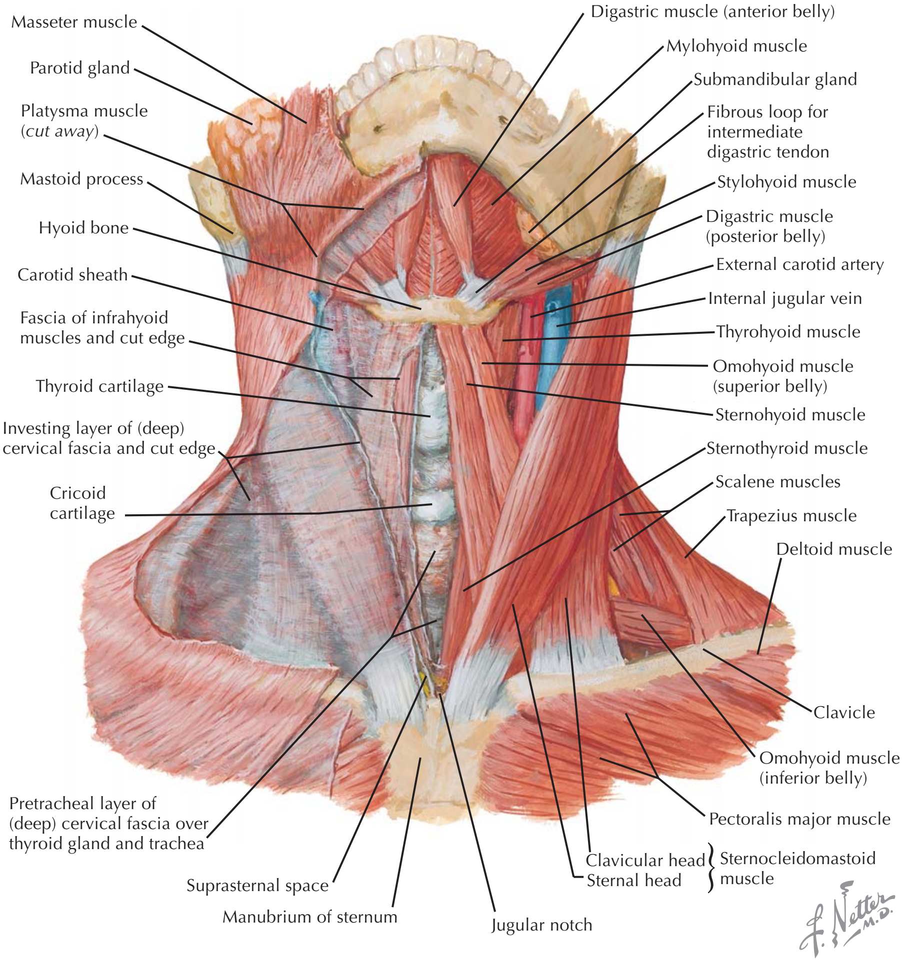
Layer	Location	Attachment	Comments
Muscular portion: *infrahyoid fascia*	Completely surrounds the strap muscles of the neck	Superior—hyoid bone and thyroid cartilage Inferior—sternum	Is continuous across the midline
Visceral portion: *buccopharyngeal fascia*	Deep to the superficial layer of deep cervical fascia posterior to the pharynx	Superior—base of the skull Inferior—superior mediastinum where the middle layer of deep cervical fascia joins the alar fascia	Posterior to the pharynx and the esophagus
Pretracheal layer of fascia	Deep to the superficial layer of deep cervical fascia	Superior—larynx Inferior—fibrous pericardium in the superior mediastinum of the thorax	Forms a covering around the visceral structures in the neck, such as the thyroid gland, esophagus, and trachea

DEEP LAYER OF DEEP CERVICAL FASCIA

Layer	Location	Attachment	Comments
Prevertebral layer of fascia	Completely encircles the cervical portion of the vertebral column with its associated pre- and postvertebral muscles	Superior—base of skull Inferior—coccyx	Forms the floor of the posterior triangle Encloses the vertebral muscles Forms the axillary sheath
Alar fascia	An anterior slip of prevertebral fascia found between the middle layer of deep cervical fascia and prevertebral layers of deep cervical fascia	Superior—base of skull Inferior—merges with visceral portion of the middle layer of deep cervical fascia at about the level of T2	Separates the retropharyngeal space from the danger space

DEEP FASCIA *CONTINUED*

COMBINATION OF ALL 3 LAYERS *CONTINUED*			
Layer	**Location**	**Attachment**	**Comments**
Carotid sheath	In the neck between the investing layer, pretracheal layer, and the prevertebral layer	Superior—base of skull Inferior—merges with connective tissue around arch of the aorta	Contains the internal or common carotid a., internal jugular v., and vagus n.



Fascial Spaces

GENERAL INFORMATION

Layers of fascia "create" potential fascial spaces

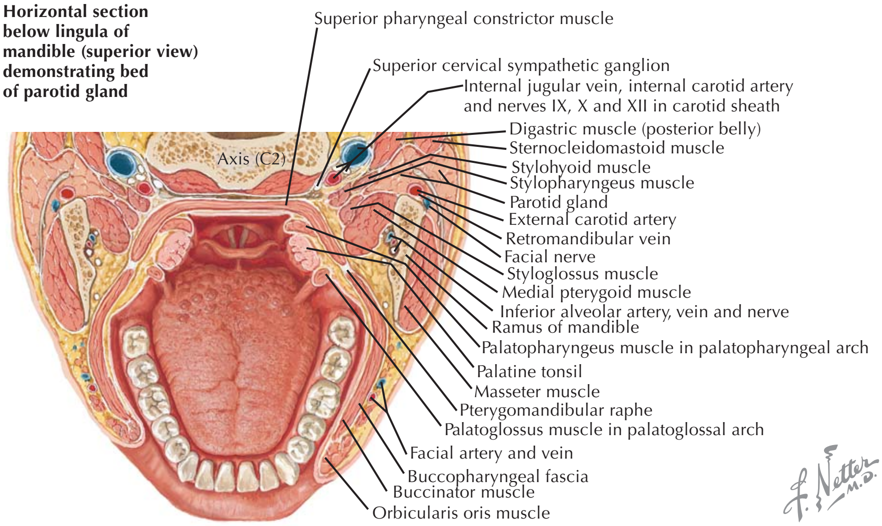
All are filled by loose areolar connective tissue

The hyoid bone is the most important anatomic structure in the neck that limits the spread of infection

Most are divided into spaces in relation to the hyoid bone:
- Suprahyoid
- Infrahyoid
- Entire length of the neck

Infections or other inflammatory conditions spread by the path of least resistance to reach the fascial spaces

Horizontal section below lingula of mandible (superior view) demonstrating bed of parotid gland



17 Fascial Spaces

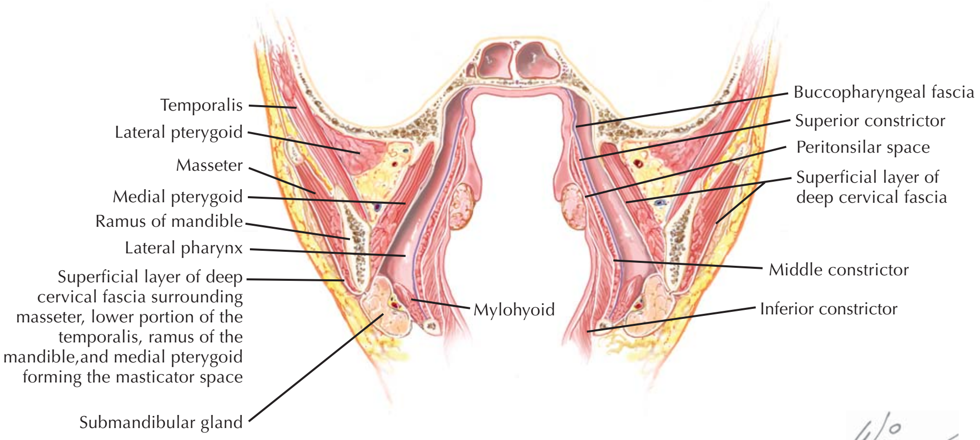
SUPRAHYOID FASCIAL SPACES

Space	Location	Comments and Potential for Infection
Submandibular	Anterior and lateral—mandible Posterior—hyoid bone Superior—mucosa of the floor of the oral cavity and the tongue Inferior—superficial layer of deep cervical fascia	The anterior part of the peripharyngeal spaces, which create a ring around the pharynx (the retropharyngeal and lateral pharyngeal spaces are the other components) Submandibular space is continuous with the lateral pharyngeal space Divided into *2 parts:* • Sublingual space • Submaxillary space
Sublingual	Between the mucosa and the mylohyoid m. Anterior and lateral—mandible Posterior—muscles along the base of the tongue Superior—mucosa of the floor of the oral cavity and the tongue Inferior—mylohyoid m.	Contains the: • Hypoglossal n. • Lingual n. • Sublingual gland • Deep part of the submandibular gland • Submandibular duct Continuous with the submaxillary space along the posterior free border on the mylohyoid m.
Submaxillary	Between the mylohyoid m. and the superficial layer of deep cervical fascia On the superficial surface of the mylohyoid between the anterior and posterior bellies of the digastric m. and the mandible	Contains the: • Submandibular gland • Anterior digastric m. Continuous with the sublingual space along the posterior free border of the mylohyoid m. Because the roots of the 1st, 2nd, and 3rd molars are inferior to the attachment of the mylohyoid on the mandible, infections of these teeth may pass into the submandibular space, which is continuous with the lateral pharyngeal space
Lateral pharyngeal	On the lateral aspect of the pharynx, continuous with the retropharyngeal space posteriorly and the submandibular space anteriorly Extends from the base of the skull to the hyoid bone Extends in an anterosuperior direction to the pterygomandibular raphe Bounded medially by the middle layer of deep cervical fascia (buccopharyngeal fascia) covering the superior constrictor m. of the pharynx and laterally by the superficial layer of deep cervical fascia covering the medial pterygoid m. and the deep portion of the parotid gland	Continuous with the submandibular space anteriorly Continuous with the retropharyngeal space posteriorly Very susceptible to the spread of infections from the teeth, jaws, and pharynx, including the nasopharynx, adenoids, and tonsils
Masticator	Formed when the superficial layer of deep cervical fascia splits to enclose the ramus of the mandible and overlies the masseter m. on the lateral surface and the medial pterygoid m. and lower portion of the temporalis m. on the medial surface	Contains the: • Masseter m. • Medial pterygoid m. • Lateral pterygoid m. • Lower portion (insertion) of the temporalis m. • Contents of the pterygomandibular space Continuous with the temporal space
Temporal	Formed when the superficial layer of deep cervical fascia encloses the temporalis m.	Can be further subdivided into a superficial and a deep space Continuous with the masticator space

Fascial Spaces

SUPRAHYOID FASCIAL SPACES *CONTINUED*

Space	Location	Comments and Potential for Infection
Peritonsillar	Anterior—palatoglossal fold Posterior—palatopharyngeal fold Medial—palatine tonsil capsule Lateral—superior constrictor m.	Located within the wall of the pharynx Infections of the peritonsillar space may extend into the lateral pharyngeal space
Parotid gland [space]	Formed when the superficial layer of deep cervical fascia encloses the parotid gland as a capsule	The parotid fascia is weaker on the medial side, and infections of this space can break through the fascia to enter the lateral pharyngeal space
Submandibular gland [space]	Formed when the superficial layer of deep cervical fascia encloses the submandibular gland as a capsule	The inner layer of the capsule is weaker, and infections of this space tend to break through the fascia to this side



17 Fascial Spaces

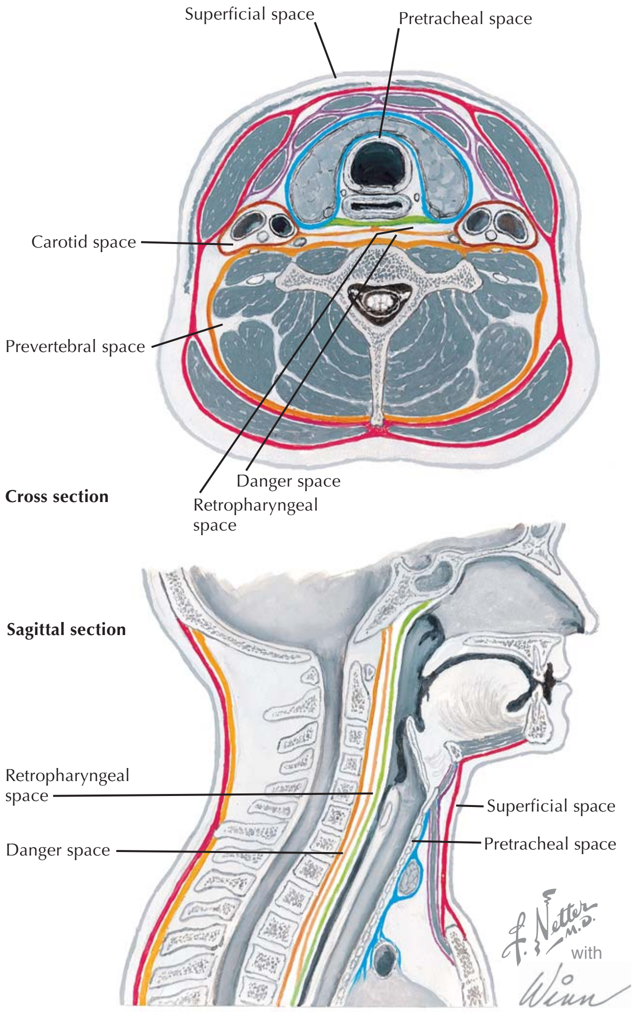
INFRAHYOID FASCIAL SPACES

Space	Location	Comments and Potential for Infection
Pretracheal (anterior visceral)	Superior—larynx Inferior—superior mediastinum Completely surrounds the trachea and also contains the thyroid and esophagus	Usually infections spread to the pretracheal space only by puncturing the esophagus anteriorly or by a perforation in the retropharyngeal space

FASCIAL SPACES TRAVERSING THE LENGTH OF THE NECK

Space	Location	Comments and Potential for Infection
Superficial	Between the superficial fascia and the superficial layer of deep cervical fascia Surrounds the platysma m.	Infections are superficial and often observed early Continuous with the face
Retropharyngeal	Posterior to the buccopharyngeal layer of the middle layer of cervical fascia covering the pharynx and esophagus, and anterior to the alar fascia Extends from the base of the skull to about the level of T2, where the 2 layers of fascia fuse The inferior portion of the retropharyngeal space (posterior to the esophagus) is sometimes called the retrovisceral space Continuous with the: • Lateral pharyngeal space • Sublingual space	Infections in this space often are the result of infections in Waldeyer's ring that spread to the retropharyngeal lymph nodes A cellulitis or abscess may eventually result Retropharyngeal infections may continue to spread posteriorly into the danger space
"Danger space"	Posterior to the alar fascia (and fascia where the alar fascia and middle layer of the cervical fascia fuse) and anterior to the prevertebral fascia Extends from the base of the skull to the diaphragm	Via the superior mediastinum, it allows infection to spread into the thorax
Prevertebral	Between the prevertebral fascia and the vertebral column	Closed off superiorly, laterally, and inferiorly, so spread of infections in this space is not common
Carotid sheath	A potential space is created by the carotid sheath Bounded superiorly by the skull base, inferiorly it merges with connective tissue around the aortic arch	Infections from visceral spaces may enter and pass within the carotid sheath

FASCIAL SPACES TRAVERSING THE LENGTH OF THE NECK *CONTINUED*



Clinical Correlate

LUDWIG'S ANGINA

A severe cellulitis due to bacterial infection (usually from *Streptococcus, Actinomyces, Prevotella, Fusobacterium,* or *Staphylococcus*) in the floor of the oral cavity under the tongue

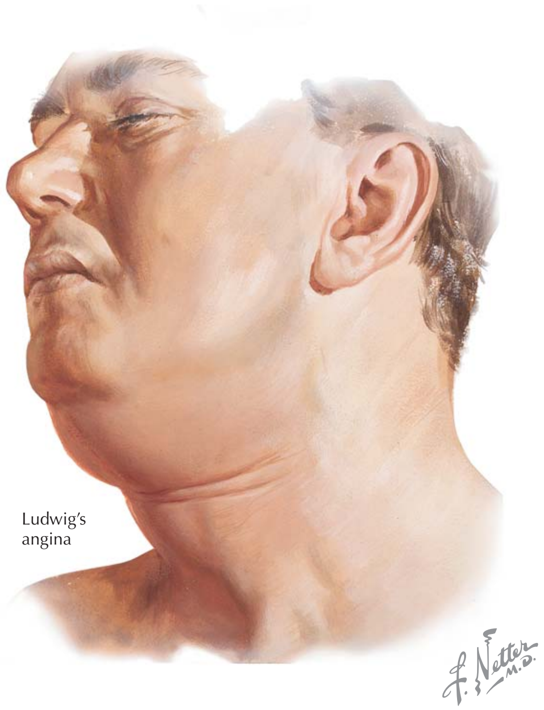
Often begins in the sublingual and submandibular spaces after infection of the premolar teeth or, more commonly, molar teeth (such as an abscess of a mandibular molar) because their roots extend inferior to the mylohyoid line of the mandible

May follow the planes of the fascial spaces to spread in the neck

May cause sufficient neck swelling to block the airway

More common in children

Antibiotic therapy, incision of the neck to drain the infection, and excision of the infected tooth are the possible treatments.



Clinical Correlate

ABSCESSES

May spread via the fascial planes of the neck to become more serious, such as in Ludwig's angina

Dentoalveolar Abscess (Periapical Abscess)

An acute lesion characterized by localization of pus in the structures surrounding the apex of a tooth

May originate in the dental pulp and be secondary to dental caries with erosion of enamel and dentin, or to traumatic injury to tooth, allowing bacteria to invade the dental pulp

Resulting pulpitis can progress to necrosis as bacteria invade the surrounding alveolar bone, causing formation of a local abscess

Periodontal Abscess

Typically involves the supporting structures of the teeth, such as the periodontal ligaments and alveolar bone, leading to formation of a local abscess

PERICORONITIS

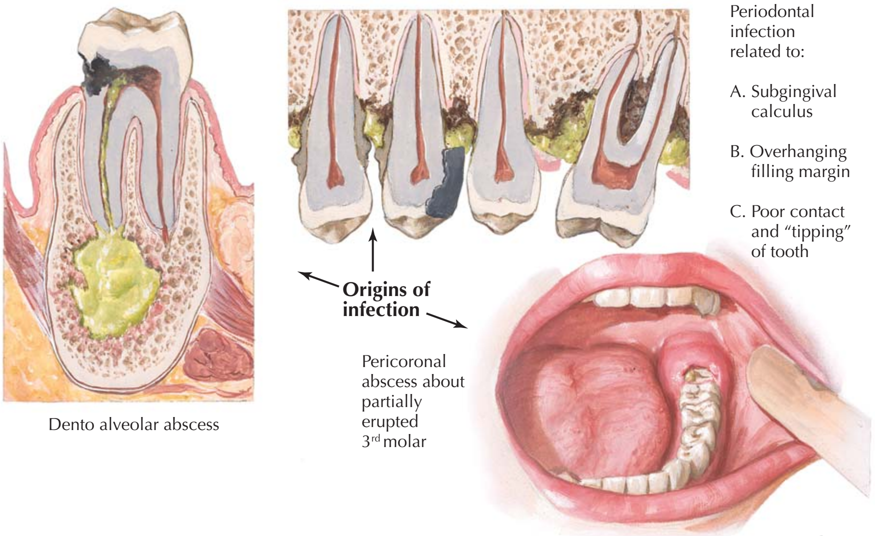
An inflammation around the crown of a tooth from an infection of the gingiva, leading to formation of an abscess

Most commonly affected tooth is a partially erupted 3rd mandibular molar

Abscess of the submandibular region

Clinical Correlate

ABSCESSES *CONTINUED*



CHAPTER 18

EAR

18 Overview and Topographic Anatomy

GENERAL INFORMATION

Dual functions:

- Maintains the balance of the body (vestibular)
- Perceives sound (auditory)

3 divisions:

- external ear
- middle ear
- inner ear

External Ear

The most superficial portion of the ear, the external ear includes the auricle, external acoustic meatus, and the tympanic membrane

Helps gather sound and direct it to the tympanic membrane

Middle Ear

Transmits sound vibrations from the tympanic membrane to the inner ear via the ear ossicles: malleus, incus, and stapes

Mainly within the petrous portion of the temporal bone

General shape resembles a biconcave lens

Composed of the tympanic cavity that connects anteriorly with the nasopharynx via the auditory tube and the mastoid air cells posteriorly

Tympanic cavity contains the ear ossicles (malleus, incus, and stapes), muscles (tensor tympani and stapedius muscles), nerves (chorda tympani, tympanic branch of the glossopharyngeal nerve, and lesser petrosal nerve), and tympanic plexus (parasympathetics from the glosspharyngeal nerve plus sympathetics from the superior cervical ganglion via the carotid plexus)

Inner Ear

Vestibular and auditory structures, which are filled with fluid, make up the inner ear:

- Auditory portion (cochlea) is stimulated by the movement of the fluid
- Vestibular portion (utricle, saccule, and semicircular canals) is stimulated by fluid movement within these chambers

Consists of a membranous labyrinth that lies within an osseous labyrinth

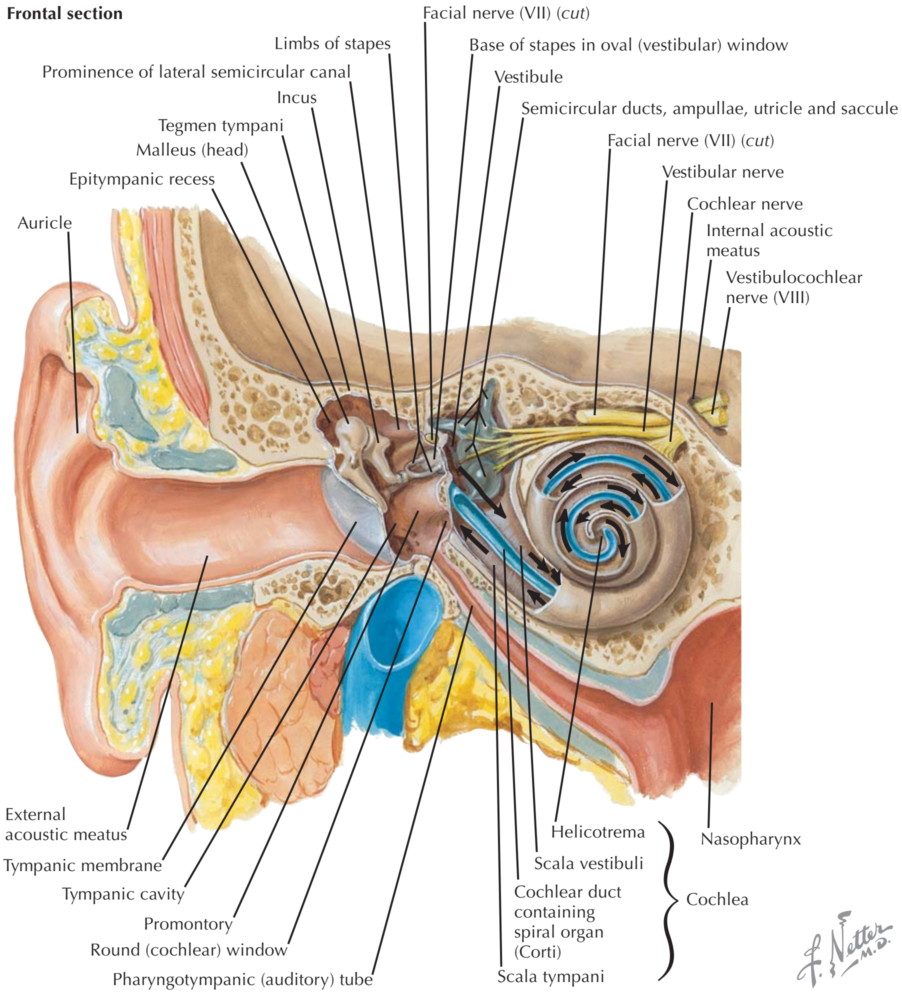
The receptors for auditory and vestibular function are located within the membranous labyrinth

Fluids located in the membranous labyrinth (endolymph) and osseous labyrinth (perilymph) stimulate the auditory and vestibular receptors

The vestibulocochlear nerve enters the internal ear via the internal acoustic meatus

GENERAL INFORMATION *CONTINUED*

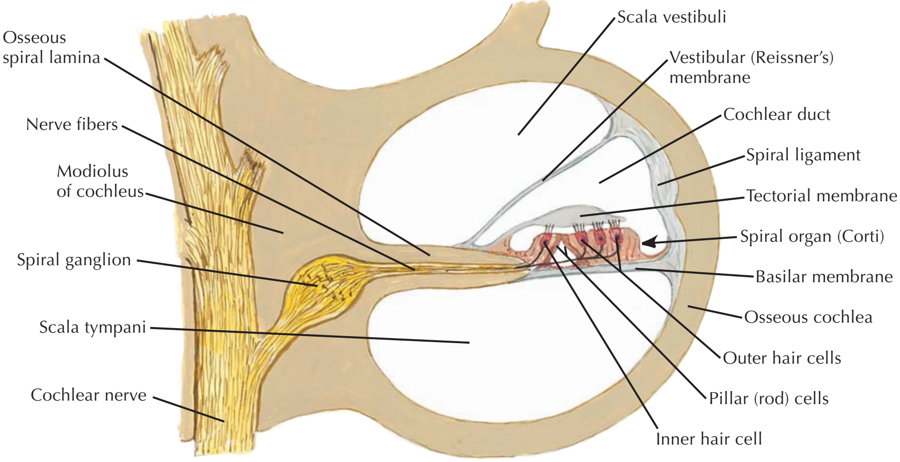
Frontal section



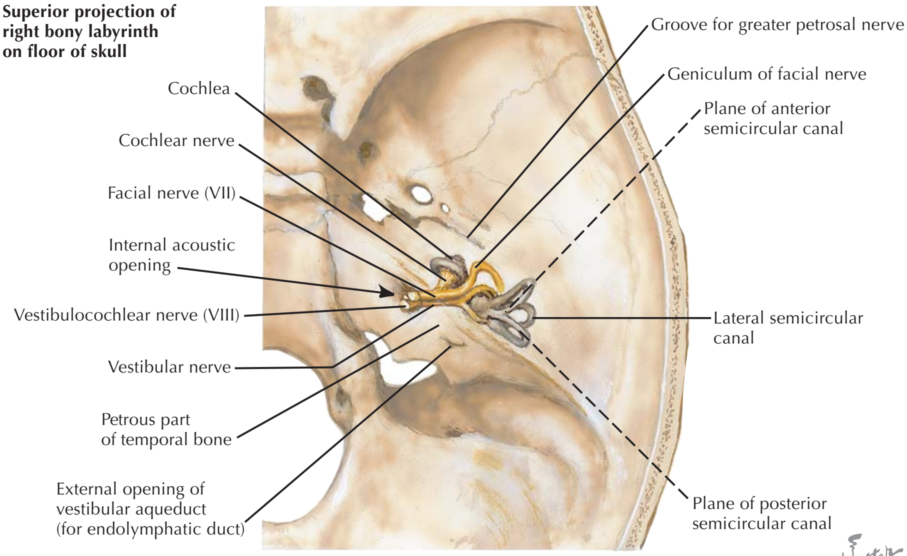
Note: Arrows indicate course of sound waves

GENERAL INFORMATION *CONTINUED*

Section through turn of cochlea



Superior projection of right bony labyrinth on floor of skull

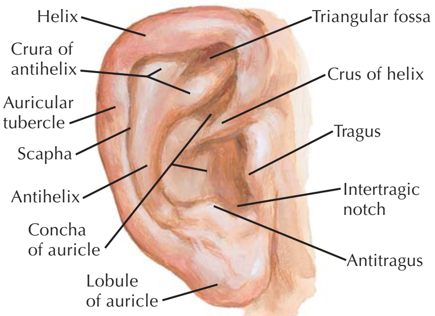


Structures and Boundaries

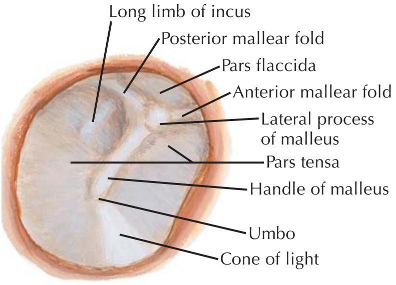
STRUCTURES OF THE EXTERNAL EAR

Structure	Comments
Auricle	An irregularly-shaped structure made of elastic cartilage and skin Superior portion has a skeleton of elastic cartilage Inferior portion, the lobule, has no cartilage *Helix:* the outermost curved rim of the auricle, continues anteriorly to blend with the head at the crus helix *Antihelix:* the portion of cartilage that follows along the helix from the inside *Scaphoid fossa:* the depressed area between the helix and antihelix *Concha:* demarcated by the antihelix, it is the depressed area that leads to the external acoustic meatus *Tragus:* extends from the face into the concha *Antitragus:* extends from the inferior portion of the antihelix into the concha and is separated from the tragus by the intertragic notch
External acoustic meatus	The passageway connecting the concha of the auricle to the tympanic membrane Covered by skin rich in sebaceous and cerumen-secreting glands About 2.5 cm in length *Lateral 1/3:* cartilaginous, extends into the temporal bone *Medial 2/3:* osseous, formed by the tympanic, squamous, and petrous portions of the temporal bone
Tympanic membrane	The most medial portion of the external ear that separates it from the middle ear Lies in a groove on the tympanic part of the temporal bone A thin, semitransparent, 3-layered membrane: • *External layer*—derived from skin; composed of stratified squamous epithelium • *Middle layer*—fibrous, with fibers attaching to the malleus • *Inner layer*—continuous with the mucous membrane of the middle ear cavity; composed of columnar epithelium with cilia Anterior and posterior malleolar folds lie on the superior portion of the tympanic membrane Tense and loose portions are called the pars tensa and pars flaccida, respectively

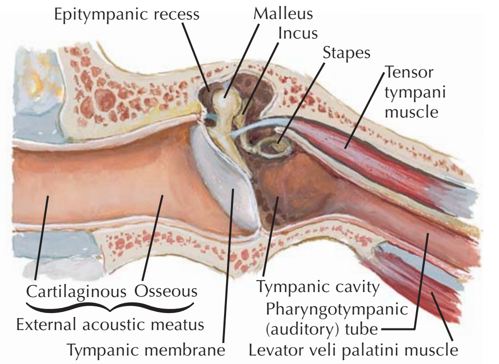
STRUCTURES OF THE EXTERNAL EAR *CONTINUED*



Right auricle



Right tympanic membrane (eardrum) viewed through speculum



Coronal oblique section of external acoustic meatus and middle ear

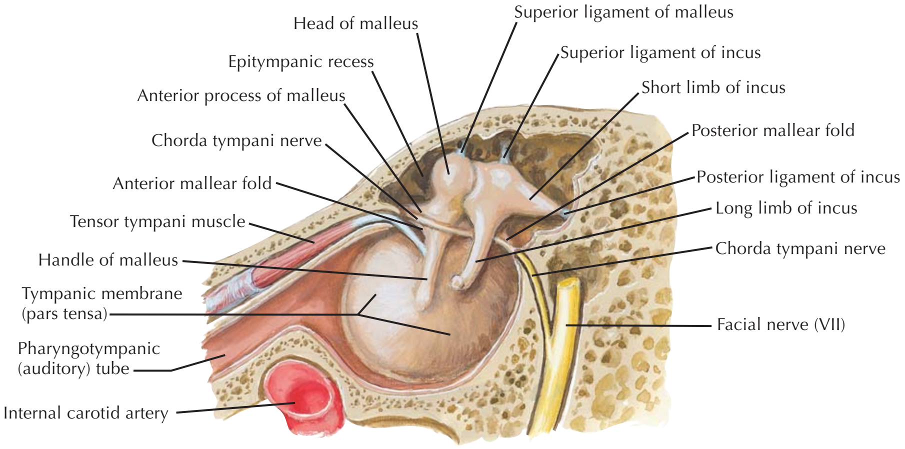
Structures and Boundaries

BOUNDARIES OF THE MIDDLE EAR

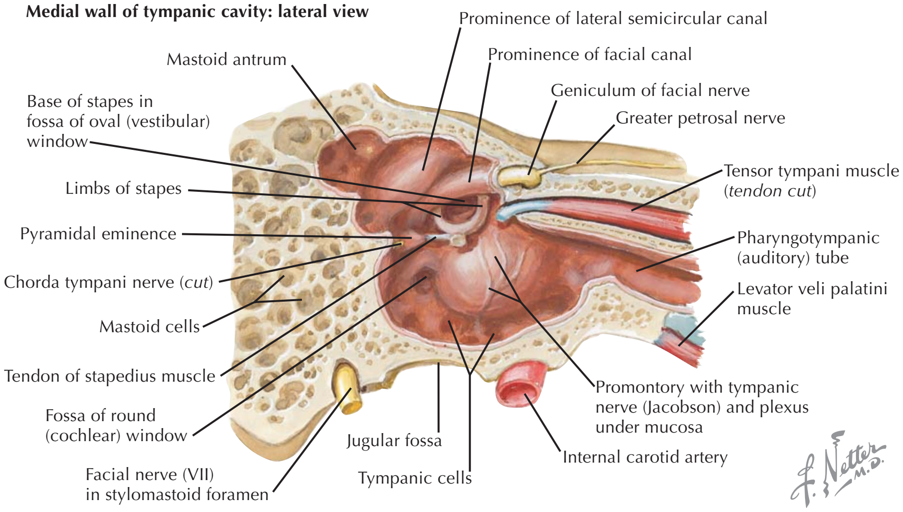
Boundary	Comments
Roof	Made by the tegmen tympani, separating the middle ear from the temporal lobe of the middle cranial fossa
Floor	Thin bone separates the middle ear from the internal jugular v. Tympanic canaliculus, located in the floor of the middle ear; allows the tympanic branch of the glossopharyngeal n. to enter the middle ear
Anterior wall	*Auditory tube:* located in the middle ear's anterior wall; connects the middle ear with the nasopharynx; equilibrates pressure on either side of the tympanic membrane, and allows proper drainage of the middle ear Lesser petrosal n. exits the middle ear through the anterior wall Postganglionic sympathetic nerve fibers from the internal carotid a. pass through the anterior wall to enter the middle ear
Posterior wall	*Facial canal:* passes superoinferiorly immediately posterior to the middle ear until it terminates at the stylomastoid foramen *Mastoid antrum:* located in the superior portion of the posterior wall near the junction with the roof of the middle ear *Pyramid:* a hollow projection from the posterior wall; contains the tendon of the stapedius m. Posterior cranial fossa and sigmoid sinus are located posterior to the posterior wall
Medial wall	The medial wall separates the middle ear from the inner ear *Promontory:* a large protuberance created by the cochlea of the inner ear In the superior portion of the medial wall is a protuberance formed by the lateral semicircular canal Inferior to the lateral semicircular canal on the opposite side of the medial wall is the horizontal portion of the facial canal Fenestra vestibuli (oval window—where the footplate of the stapes is located) and fenestra cochleae (round window—an opening covered by a membrane): located in a superior-inferior relationship on the medial wall posterior to the promontory Tendon of the tensor tympani m. enters the middle ear through the medial wall
Lateral wall	The lateral wall separates the middle ear from the external ear; mainly created by the tympanic membrane, with the malleus attached to the membrane at the umbo *Epitympanic recess:* the region superior to the tympanic membrane that houses portions of the malleus and incus Chorda tympani n. lies along the tympanic membrane and malleus until exiting the petrotympanic fissure

BOUNDARIES OF THE MIDDLE EAR *CONTINUED*

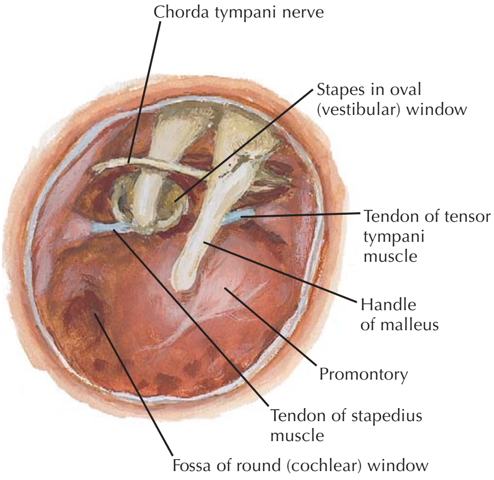
Lateral wall of tympanic cavity: medial (internal) view



Medial wall of tympanic cavity: lateral view

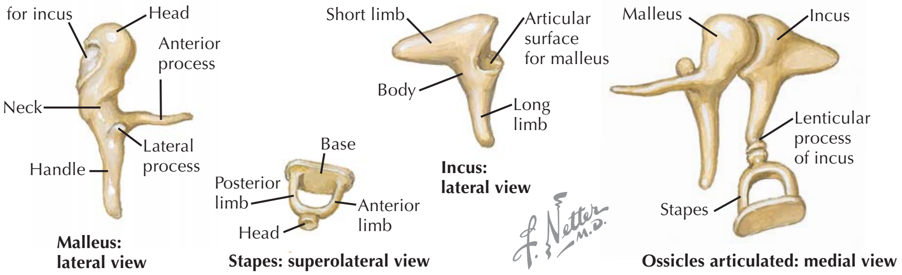


BOUNDARIES OF THE MIDDLE EAR *CONTINUED*



View into tympanic cavity after removal of tympanic membrane

Auditory ossicles



Malleus: lateral view

Stapes: superolateral view

Incus: lateral view

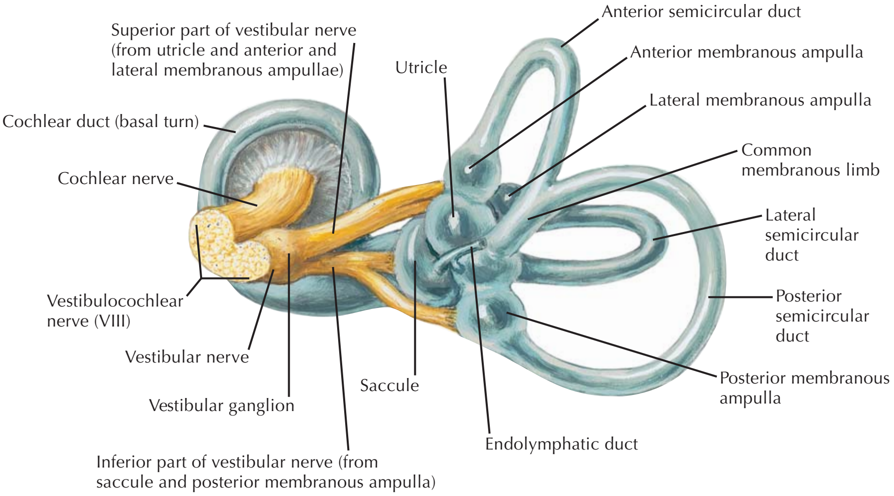
Ossicles articulated: medial view

STRUCTURES OF THE INNER EAR

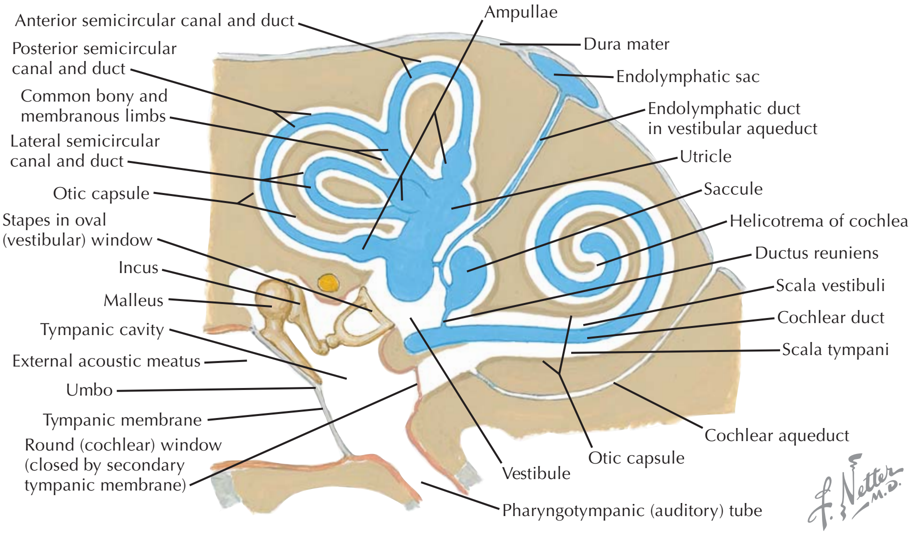
Structure	Description
Osseous labyrinth	Located in the petrous portion of the temporal bone Surrounds the membranous labyrinth and contains perilymph Connects to the middle ear via the fenestra vestibuli and the fenestra cochleae Divided into 3 parts: vestibule, cochlea, and semicircular canals
Vestibule	The middle portion of the osseous labyrinth, it contains the saccule and utricle of the membranous labyrinth Contains an opening for the vestibular aqueduct containing the endolymphatic duct
Cochlea	Anterior portion of the osseous labyrinth contains the cochlear duct of the membranous labyrinth Like a seashell, it spirals around a central point (the modiolus), which carries branches of the cochlear n. to the cochlear duct, for 2 and 3/4 turns, getting progressively smaller while approaching its apex As the cochlea spirals, the spiral lamina is raised from the modiolus Within the spiral lamina, the cochlear duct lies between the scala vestibuli and the scala tympani Scala vestibuli and scala tympani are continuous at the helicotrema at the apex An opening for the aqueduct of the cochlea allows perilymph to drain into the cerebrospinal fluid
Semicircular canals	The posterior portion of the osseous labyrinth *3 semicircular canals:* anterior, posterior, and lateral *Ampulla:* a dilated end of each Anterior and posterior semicircular canals have a common crus
Membranous labyrinth	Located within the osseous labyrinth; contains endolymph Divided into 4 parts: cochlear duct, saccule, utricle, and semicircular ducts
Cochlear duct	A spiral structure located within the cochlea Begins at a blind end of the cochlea at the apex and ends where it joins the saccule via the ductus reunions Triangular in shape, with a base created by the endosteum of the canal known as the spiral ligament and the stria vascularis Roof is formed by the vestibular membrane that separates the cochlear duct from the scala vestibuli Floor is formed by the basilar membrane, on which lies the organ of Corti; separates the duct from the scala tympani
Saccule	A small structure located within the vestibule of the osseous labyrinth Connected to the utricle via the utriculosaccular duct and the endolymphatic duct Sensory receptors (the maculae) are located in the saccule
Utricle	Located within the vestibule of the osseous labyrinth Sensory receptors (maculae) are located in the utricle
Semicircular ducts	Correspond to the semicircular canals of the osseous labyrinth (anterior, posterior, and lateral) Open into the utricle via 5 openings Sensory receptors known as crista are located in the ampullae of the semicircular ducts

STRUCTURES OF THE INNER EAR *CONTINUED*

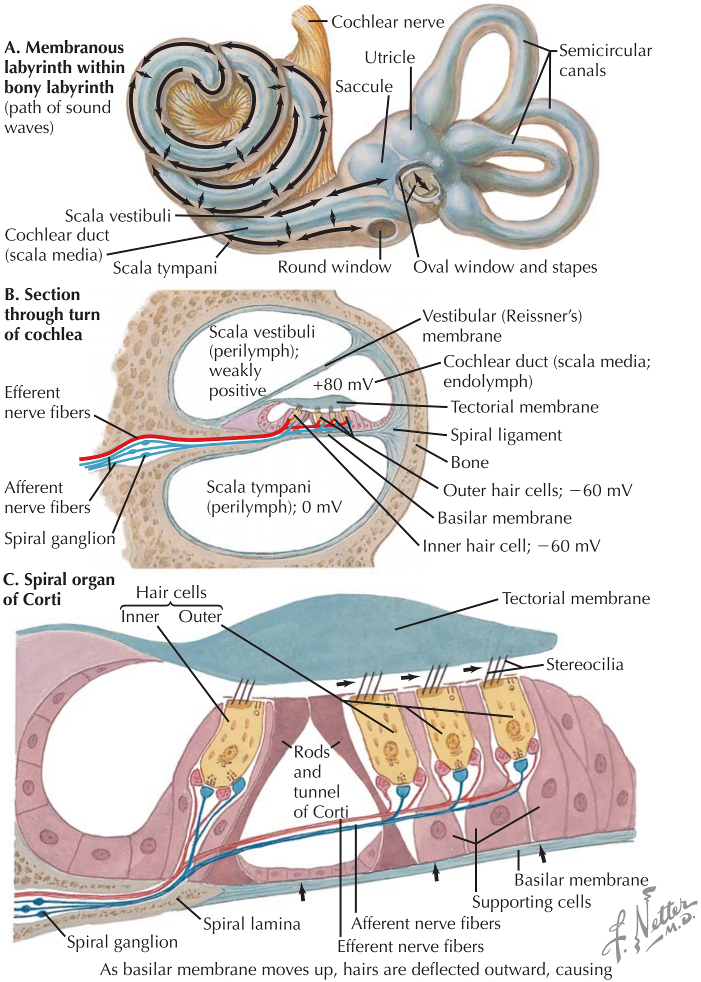
Right membranous labyrinth with nerves: posteromedial view



Bony and membranous labyrinths: schema



STRUCTURES OF THE INNER EAR *CONTINUED*



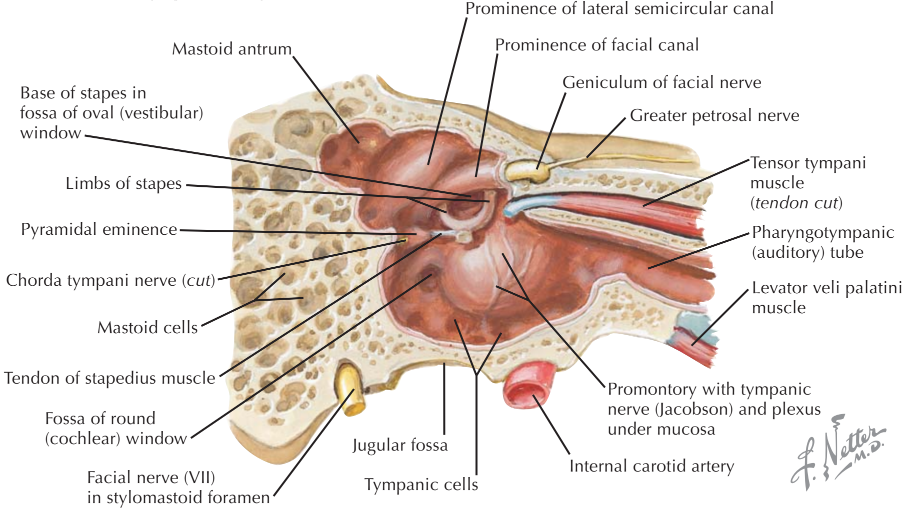
As basilar membrane moves up, hairs are deflected outward, causing depolarization of hair cells and increased firing of afferent nerve fibers

Muscles

OVERVIEW

Muscle	Origin	Insertion	Actions	Nerve Supply
Tensor tympani	Bony canal at auditory tube Cartilaginous part of auditory tube Greater wing of the sphenoid	Handle of the malleus	Tenses the tympanic membrane and helps dampen sound vibrations	Mandibular division of the trigeminal n.
Stapedius	Pyramid on posterior wall of the tympanic cavity	Neck of the stapes	Dampens excessive sound vibrations	Stapedius branch of the facial n.

Medial wall of tympanic cavity: lateral view

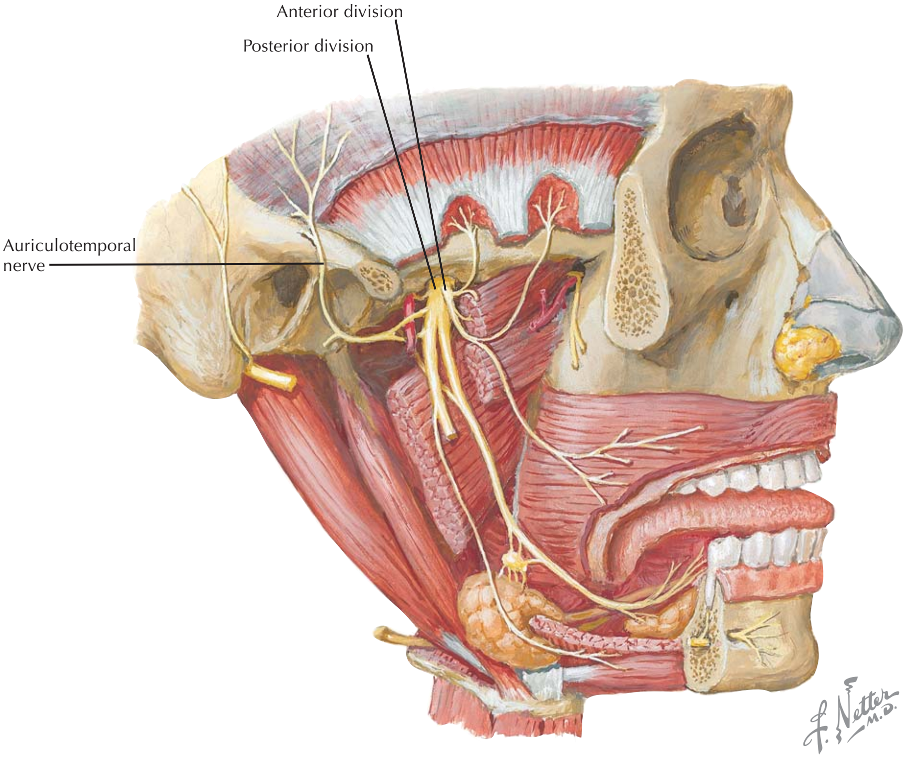


SENSORY INNERVATION OF THE EXTERNAL EAR

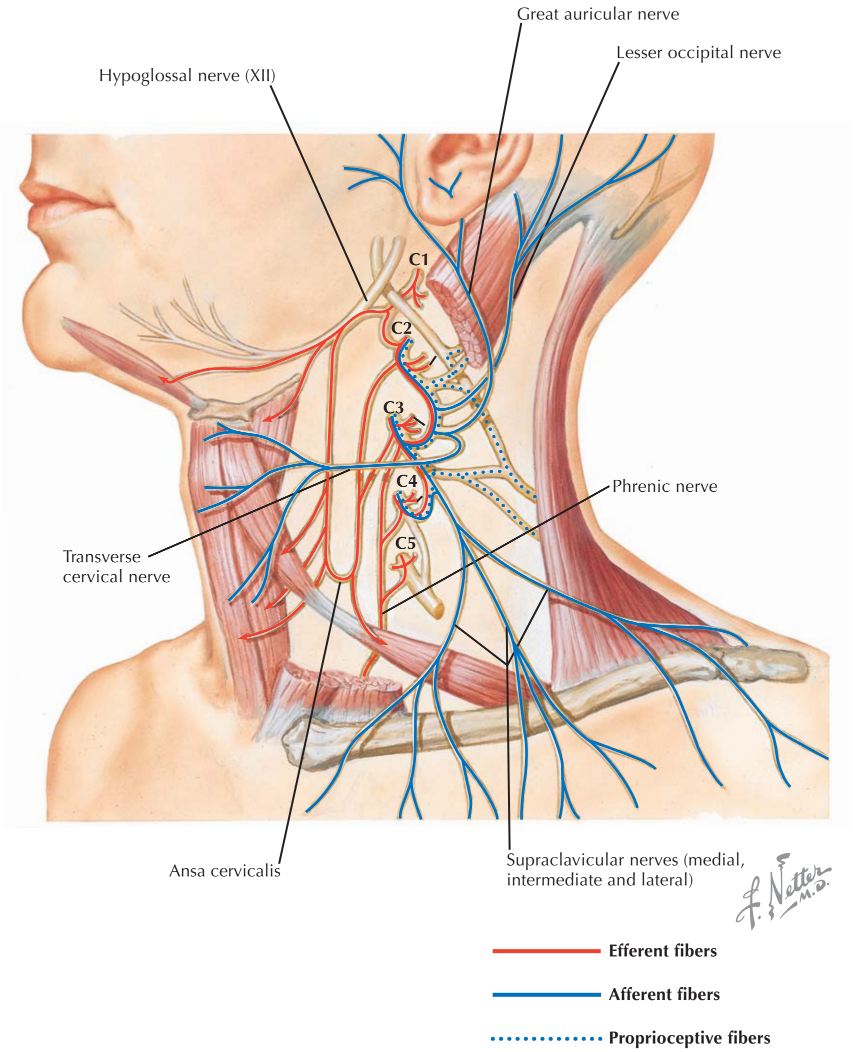
Nerve	Source	Course
Great auricular	Cervical plexus, formed by contributions of C2 and C3 ventral rami	After passing posterior to the sternocleidomastoid m. at Erb's point, it ascends along the sternocleidomastoid, dividing into anterior and posterior branches The posterior branch innervates the skin over the mastoid process, the posterior portion of the auricle, and the concha and lobule
Lesser occipital	Cervical plexus, formed by contributions from C2 ventral ramus	After passing posterior to the sternocleidomastoid m. at Erb's point, it ascends posterior to the sternocleidomastoid along the posterior portion of the head Continues on the head posterior to the auricle Supplies the skin posterior to the auricle
Auriculotemporal	Posterior part of the mandibular division of the trigeminal n.	Normally arises by 2 roots, between which the middle meningeal a. passes Runs posteriorly just inferior to the lateral pterygoid m. and continues to the medial aspect of the neck of the mandible Turns superiorly with the superficial temporal vessels between the auricle and condyle of the mandible deep to the parotid gland On exiting the parotid gland, ascends over the zygomatic arch Innervates the skin in the region of the tragus, crus helix, anterior portion of the external acoustic meatus, and outer surface of the tympanic membrane
Auricular branch of the vagus	Superior ganglion of the vagus n.	Travels posterior to the internal jugular v. and passes along the temporal bone Crosses the facial canal superior to the stylomastoid foramen Enters the mastoid canaliculus between the mastoid process and the tympanic part of the temporal bone and gives rise to 2 branches: • 1 branch joins the posterior auricular branch of the facial n. • The 2nd branch innervates the skin of the back of the auricle and the posterior portion of the external acoustic meatus
Tympanic branch of glossopharyngeal	Branches from the inferior ganglion of the vagus n., located in the petrous portion of the temporal bone	Passes superiorly through the tympanic canaliculus to enter the middle ear In the middle ear, it divides into branches that form part of the tympanic plexus Tympanic plexus gives rise to: • Preganglionic parasympathetic fibers to the parotid gland • Postganglionic sympathetic fibers to the parotid gland • Sensory fibers to the middle ear cavity, including the tympanic membrane and auditory tube (mainly from the tympanic branch of the glossopharyngeal n.)

Nerve Supply

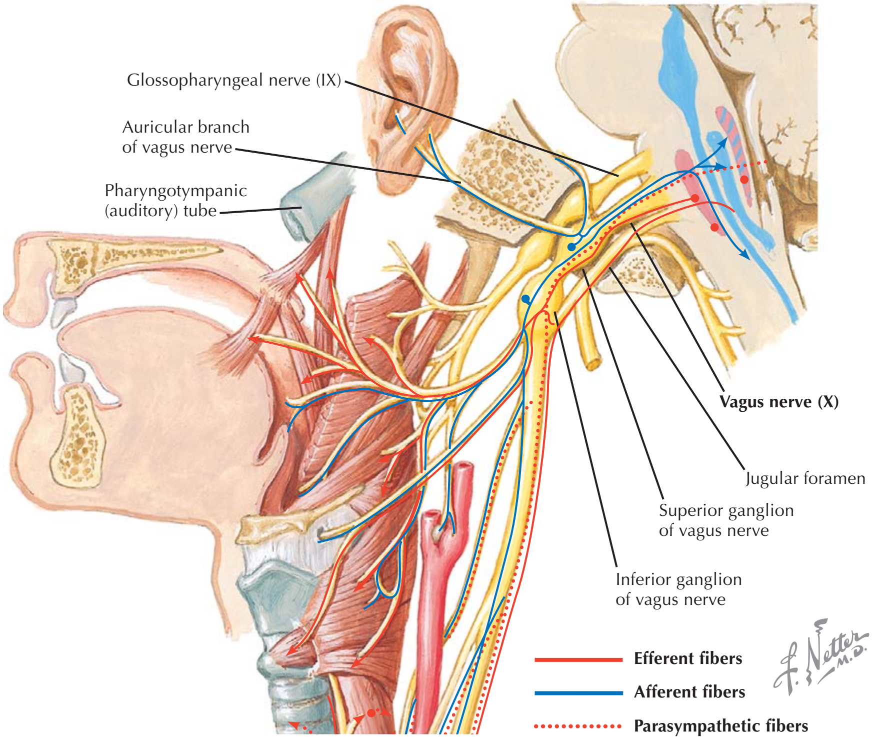
SENSORY INNERVATION OF THE EXTERNAL EAR *CONTINUED*



SENSORY INNERVATION OF THE EXTERNAL EAR *CONTINUED*

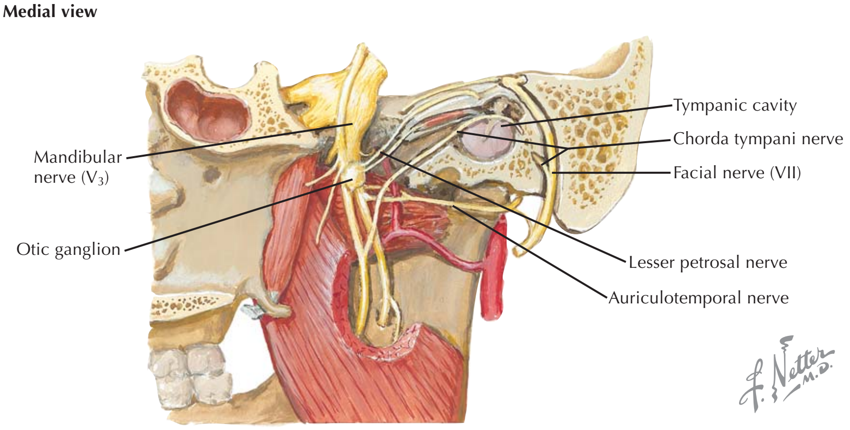


SENSORY INNERVATION OF THE EXTERNAL EAR *CONTINUED*



SENSORY INNERVATION OF THE MIDDLE EAR

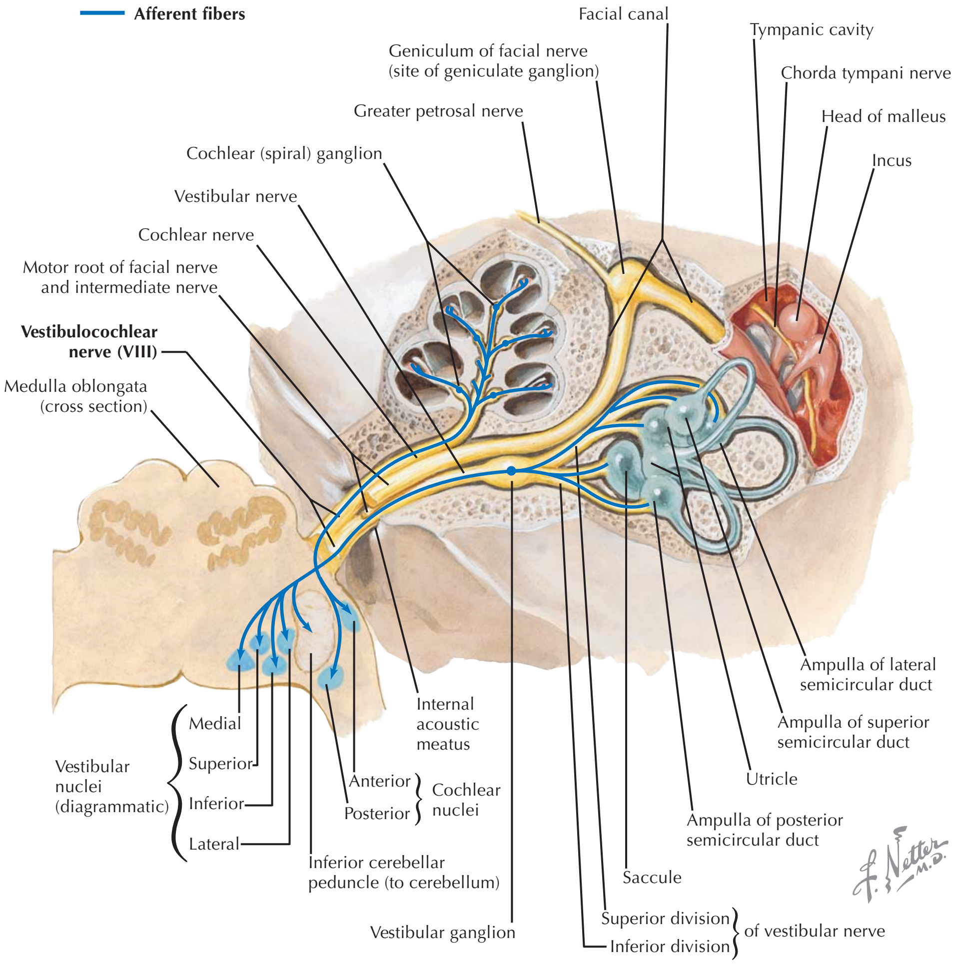
Nerve	Source	Course
Tympanic plexus	Formed by the: • Tympanic branch of the glossopharyngeal n. (arises from the inferior ganglion located in the petrous portion of the temporal bone) • Caroticotympanic nn. (arise from the carotid plexus on the internal carotid a.)	Tympanic branch of the glossopharyngeal n. passes superiorly through the tympanic canaliculus to enter the middle ear In the middle ear, it divides into branches that form the tympanic plexus Caroticotympanic nn. join the tympanic branch of the glossopharyngeal n. Tympanic plexus gives rise to: • Preganglionic parasympathetic fibers to the parotid gland • Postganglionic sympathetic fibers to the parotid gland • Sensory fibers to the middle ear cavity, including the tympanic membrane and auditory tube (mainly from the tympanic branch of the glossopharyngeal)
Facial	Cranial n. VII has multiple motor and sensory functions Created by: • Nervus intermedius, which contains the sensory fibers and the parasympathetic fibers • Motor portion that innervates the muscles derived from the 2nd pharyngeal arch	Nervus intermedius and motor portions—enter the internal acoustic meatus of the temporal bone Facial n. then passes through the facial canal until it exits the stylomastoid foramen, initially traveling horizontally along the outside of the medial wall of the middle ear; then it bends posteriorly and inferiorly to the middle ear Where the nerve changes direction is in the geniculate ganglion; here the greater petrosal n. is given off to travel anteriorly toward the pterygopalatine fossa Within the facial canal, the nerve gives rise to the nerve to the stapedius m. and the chorda tympani n. Chorda tympani passes anteriorly along the tympanic membrane and the malleus until it exits via the petrotympanic fissure Chorda tympani carries preganglionic parasympathetic fibers to the submandibular ganglion of the oral cavity, and taste fibers to the anterior 2/3 of the tongue Stapedius n. innervates the stapedius m.



Nerve Supply

SENSORY INNERVATION OF THE INNER EAR

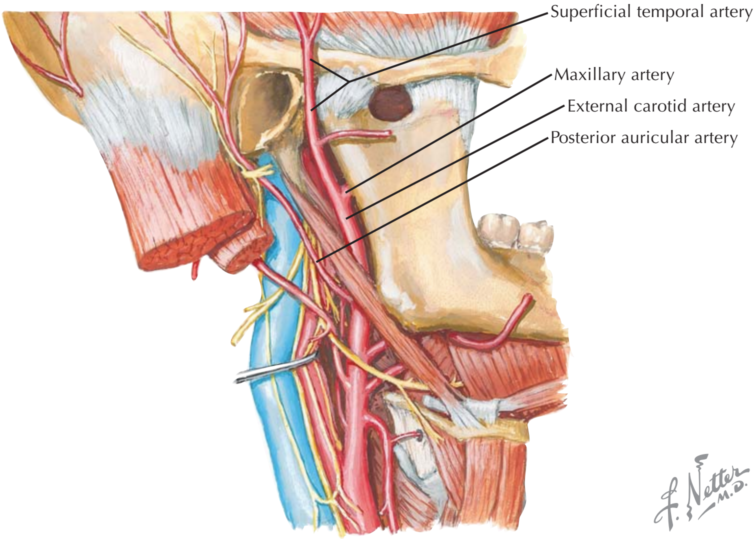
Nerve	Source	Course
Vestibulocochlear	Also called cranial n. VIII, it emerges between the pons and the medulla oblongata	Enters the internal acoustic meatus with the facial n. Within the internal acoustic meatus, it divides into vestibular branches and the cochlear branch
Vestibular	The vestibular portion has nerve cell bodies in the vestibular ganglion (Scarpa's ganglion)	Divides into superior and inferior branches: ● Superior vestibular branch innervates the maculae of the saccule and utricle and the ampulla of the anterior and lateral semicircular ducts ● Inferior vestibular branch innervates the macula of the saccule and the ampulla of the posterior semicircular duct
Cochlear	The cochlear portion has nerve cell bodies in the spiral ganglion	Utilizes the spiral ganglion within the modiolus to pass to the organ of Corti



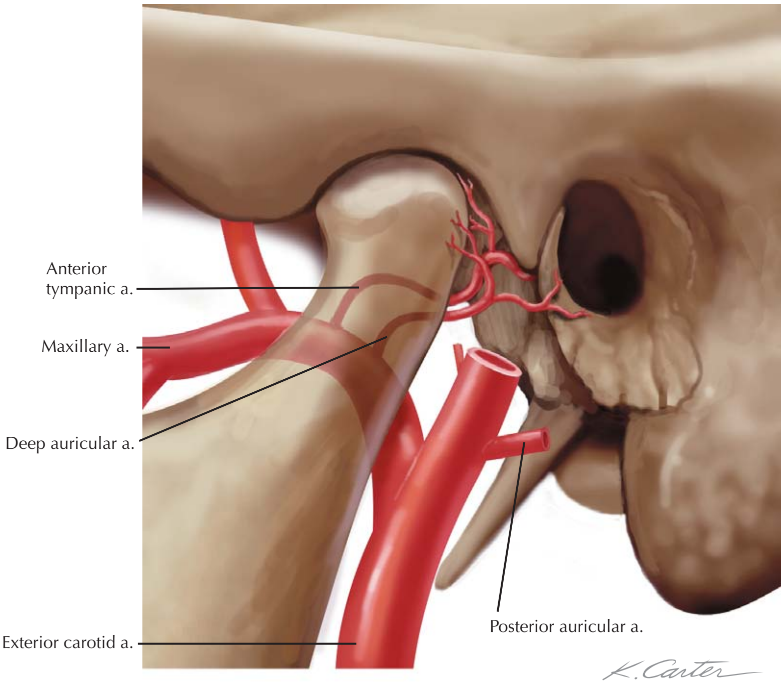
ARTERIAL SUPPLY OF THE EXTERNAL EAR

Artery	Source	Course
Superficial temporal	A terminal branch of the external carotid a that arises within the parotid gland	Within the parotid gland, it gives off a transverse facial a. Emerges from the superior part of the parotid gland immediately posterior to the temporomandibular joint and anterior to the external auditory meatus Passes superficial to the root of the zygomatic arch just anterior to the auriculotemporal n. and the auricle While passing superiorly, it gives off branches that supply the auricle and the external acoustic meatus
Posterior auricular	External carotid a. within the parotid gland	Passes superiorly between the mastoid process and cartilage of the ear During its path to anastomose with the superficial temporal and the occipital aa., it supplies the auricle and external acoustic meatus A stylomastoid branch arises from the posterior auricular and enters the stylomastoid foramen to supply the internal surface of the tympanic membrane
Deep auricular	A branch of the maxillary a. (1 of the terminal branches of the external carotid a.) Arises in the same area as for the anterior tympanic a.	Lies in the parotid gland, posterior to the temporomandibular joint, where it supplies that joint Passes into the external acoustic meatus to supply it; then supplies the outer surface of the tympanic membrane
Anterior tympanic	A branch of the maxillary a. (1 of the terminal branches of the external carotid a.)	Given off in the same area as for the deep auricular a. Passes superiorly immediately posterior to the temporomandibular joint Enters the tympanic cavity through the petrotympanic fissure Aids in supplying the inner surface of the tympanic membrane

Parotid space (bed): right lateral dissection



ARTERIAL SUPPLY OF THE EXTERNAL EAR *CONTINUED*

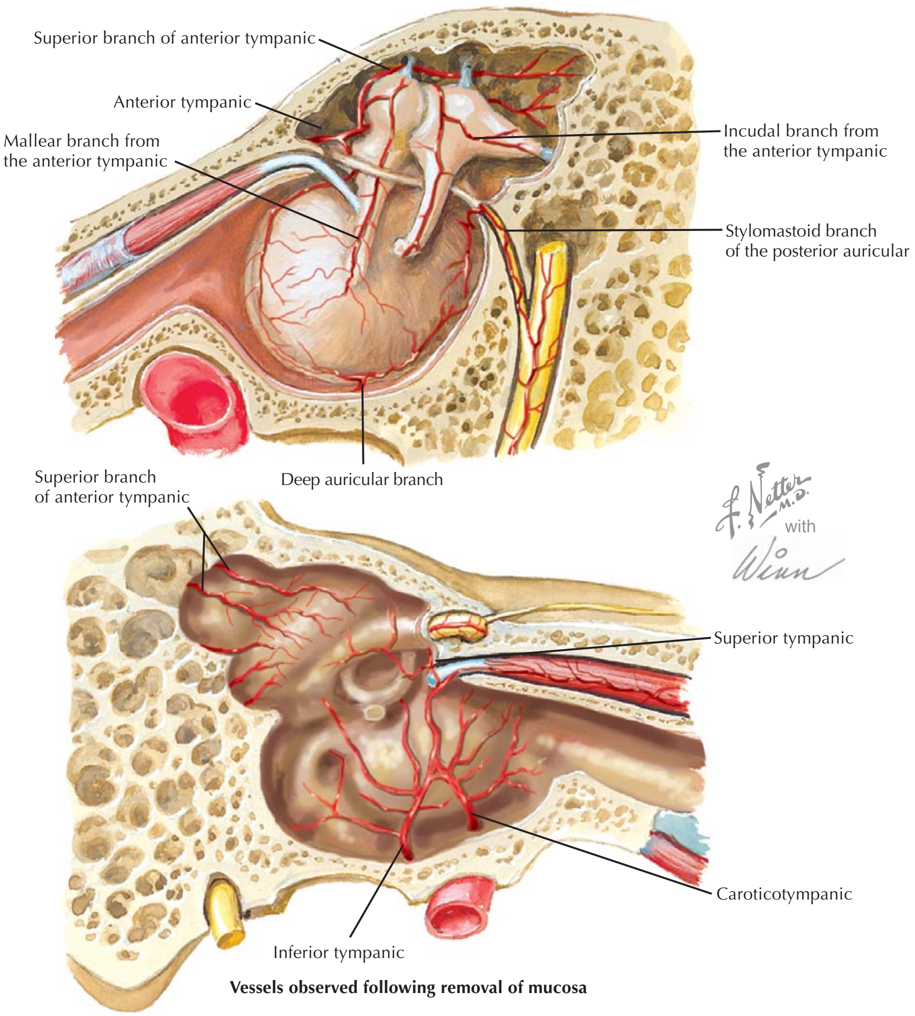


Vascular Supply

ARTERIAL SUPPLY OF THE MIDDLE EAR

Artery	Source	Course
Posterior and the auricular	External carotid a. within the parotid gland	Passes superiorly between the mastoid process cartilage of the ear During its path to anastomose with the superficial temporal and the occipital aa., it supplies the auricle and external acoustic meatus A stylomastoid branch arises from the posterior auricular a. and enters the stylomastoid foramen to supply the internal surface of the tympanic membrane
Anterior tympanic	Maxillary a. (1 of the terminal branches of the external carotid a.)	Given off in the same area as for the deep auricular a. Passes superiorly immediately posterior to the temporomandibular joint Enters the tympanic cavity through the petrotympanic fissure Aids in supplying the outer surface of the tympanic membrane and the anterior portion of the tympanic cavity
Inferior tympanic	Ascending pharyngeal a. of the external carotid a.	Ascends deep to the other branches of the external carotid a. and more superiorly to the stylopharyngeus m. Passes into the middle ear through the petrous portion of the temporal bone Helps supply the medial wall of the tympanic cavity
Superior tympanic	Middle meningeal a. of the maxillary a.	Arises from the middle meningeal a. immediately after passing through the foramen spinosum within the middle cranial fossa Passes in the canal of the tensor tympani m. to help supply the tensor tympani and its bony canal
Caroticotympanic branch of the internal carotid	Internal carotid a.	Passes into the tympanic cavity through an aperture in the carotid canal Helps supply the middle ear

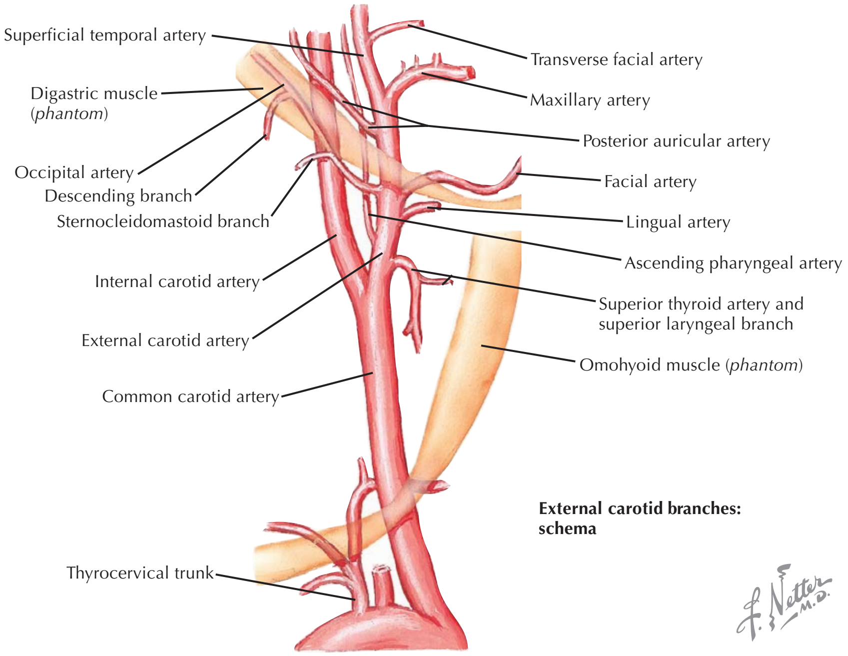
ARTERIAL SUPPLY OF THE MIDDLE EAR *CONTINUED*



Vessels observed following removal of mucosa

ARTERIAL SUPPLY OF THE INNER EAR

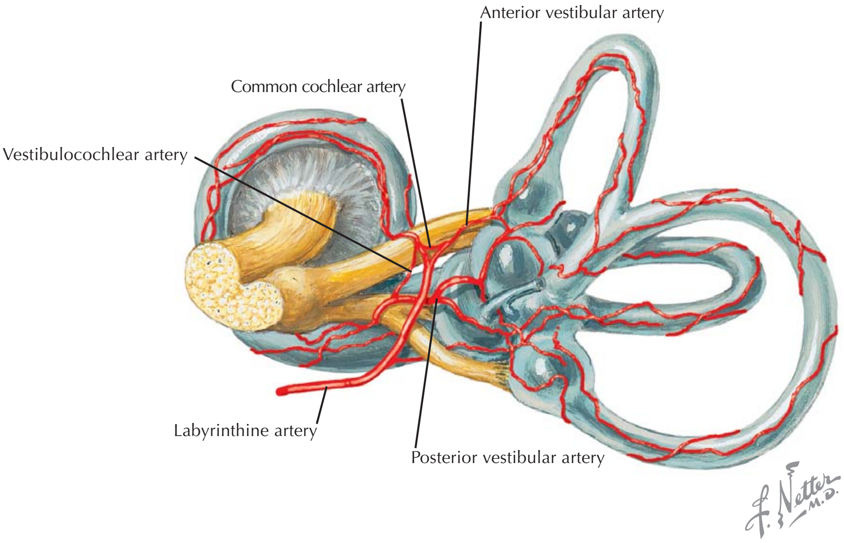
Artery	Source	Course
Labyrinthine	Basilar a., which gives rise to the circle of Willis	Passes through the internal acoustic meatus, where it further divides into cochlear and vestibular branches that supply the cochlear and vestibular structures
Posterior auricular	External carotid a. within the parotid gland	Passes superiorly between the mastoid process and cartilage of the ear Anastomoses with the superficial temporal and the occipital aa. A stylomastoid branch arises from the posterior auricular a., enters the stylomastoid foramen, and continues to the inner ear During its path to anastomose with the superficial temporal and the occipital aa., it supplies the auricle and external acoustic meatus Stylomastoid branch supplies the internal surface of the tympanic membrane and the posterior portion of the tympanic cavity; then helps supply the inner ear



External carotid branches: schema

Vascular Supply

ARTERIAL SUPPLY OF THE INNER EAR *CONTINUED*



VENOUS DRAINAGE OF THE EXTERNAL EAR

Vein	Comments
Superficial temporal	Descends posterior to the zygomatic root of the temporal bone alongside the auriculotemporal n. to enter the substance of the parotid gland Unites with the maxillary v. to form the retromandibular v. Along its path, receives tributaries from the auricle
Posterior auricular	Arises from a plexus of veins created by the occipital and superficial temporal vv. Descends posterior to the auricle to unite with the posterior division of the retromandibular v. to form the external jugular v. Along its path, receives blood from the stylomastoid branch of the posterior auricular v., which drains the auricle, external acoustic meatus, and tympanic membrane
Maxillary	A short vein, sometimes paired, formed by the convergence of the tributaries of the pterygoid plexus Enters the substance of the parotid gland, traveling posteriorly between the sphenomandibular lig. and the neck of the mandible Unites with the superficial temporal v. to form the retromandibular v. Helps drain blood from the external acoustic meatus and tympanic membrane
Pterygoid plexus	An extensive network of veins that parallels the 2nd and 3rd parts of the maxillary a. Receives branches that correspond to the same branches of the maxillary a. Tributaries eventually converge to form a short maxillary v. Communicates with the cavernous sinus, pharyngeal venous plexus, and facial vein via the deep facial v. and ophthalmic veins Helps drain the external acoustic meatus
Transverse sinus	One of the deep venous sinuses that helps drain the brain Aids in receiving blood from the tympanic membrane

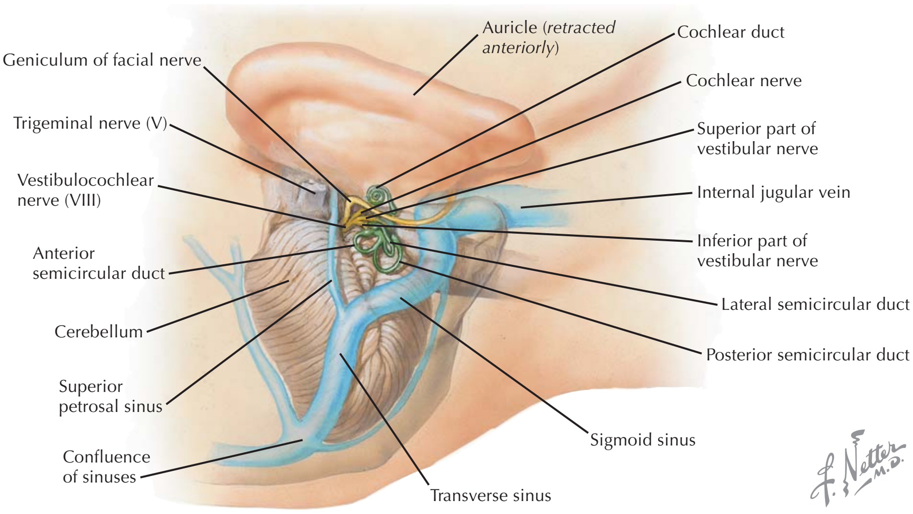
VENOUS DRAINAGE OF THE MIDDLE EAR

Pterygoid plexus	An extensive network of veins that parallels the 2nd and 3rd parts of the maxillary a. Receives branches that correspond to the same branches of the maxillary a. Tributaries eventually converge to form a short maxillary v. Communicates with the cavernous sinus, pharyngeal venous plexus, and facial vein via the deep facial v. and ophthalmic veins Helps drain the tympanic cavity
Superior petrosal sinus	! of the deep venous sinuses that helps drain the brain, running along the superior margin of the petrous portion of the temporal bone Aids in receiving blood from the tympanic cavity

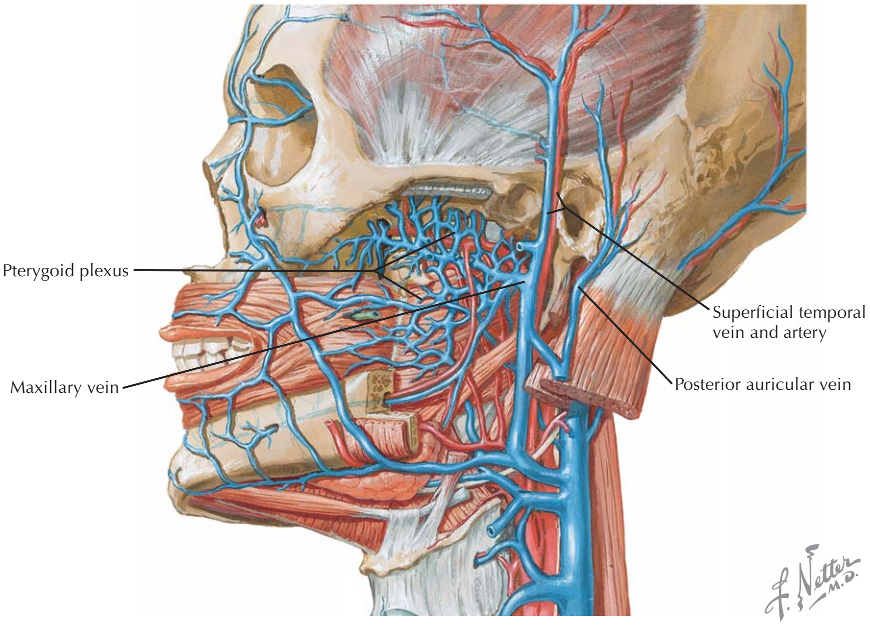
VENOUS DRAINAGE OF THE INNER EAR

Labyrinthine	Begins in the cochlear and vestibular structures and passes medially through the internal acoustic meatus alongside the labyrinthine a. Drains into the superior petrosal sinus

Lateral projection of right membranous labyrinth



VENOUS DRAINAGE OF THE INNER EAR *CONTINUED*



Clinical Correlate

ACUTE OTITIS EXTERNA

Infection or inflammation of the auricle and external auditory canal located in the external ear, causing ear pain (otalgia)

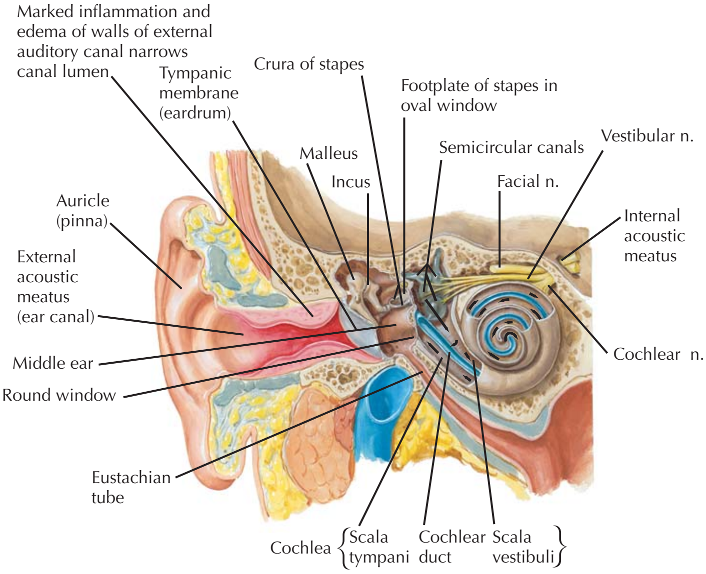
Also called "swimmer's ear"

2 major bacteria are involved: *Staphylococcus aureus* and *Pseudomonas aeruginosa*

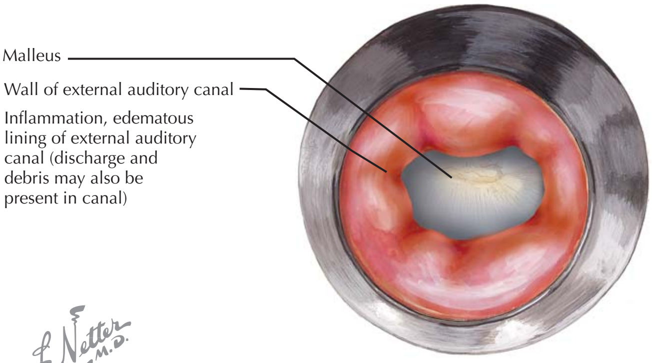
Pathogenesis

Excess water from swimming removes some of the ceruminous wax that lines the external auditory canal

Because the wax helps maintain a healthy canal, loss of the wax predisposes the canal to bacterial infections



In otitis externa, inflammation, edema, and discharge are limited to external auditory canal and its walls



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Otoscopic view demonstrating clinical appearance of otitis externa

Clinical Correlate

ACUTE OTITIS MEDIA

An inflammation of the middle ear cavity

More common in children

2 major bacteria are involved: *Streptococcus pneumoniae* and *Haemophilus influenzae*

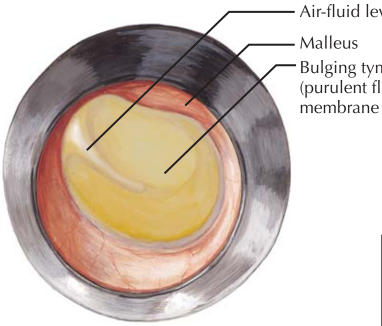
Pathogenesis

Often results from auditory tube dysfunction

Because the auditory tube allows drainage from the tympanic cavity into the nasopharynx, any blockage leads to a buildup of fluid in the tympanic cavity

When the fluid sits in the tympanic cavity, it predisposes the region to a bacterial infection

The resulting inflammation leads to ear pain (otalgia) and often diminished hearing



Otoscopic view demonstrating clinical appearance of otitis media

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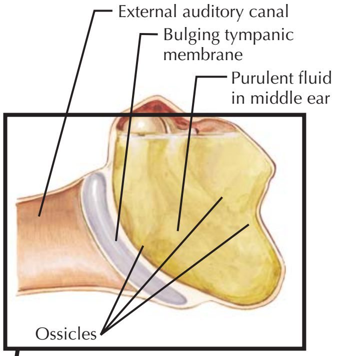
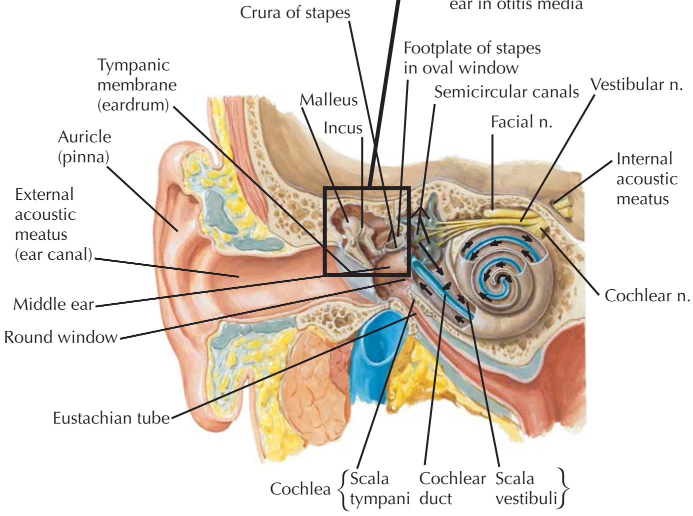


Section through middle ear in otitis media



18 Clinical Correlate

MASTOIDITIS

A bacterial infection of the mastoid air cells

More common in children than in adults

Pathogenesis

Although less common since the advent of antibiotics, formerly it often occurred as a complication of acute otitis media, when infection spread from the middle ear cavity to the mastoid air cells

Once within the mastoid air cells, the infection can lead to inflammation and destruction of the mastoid bone

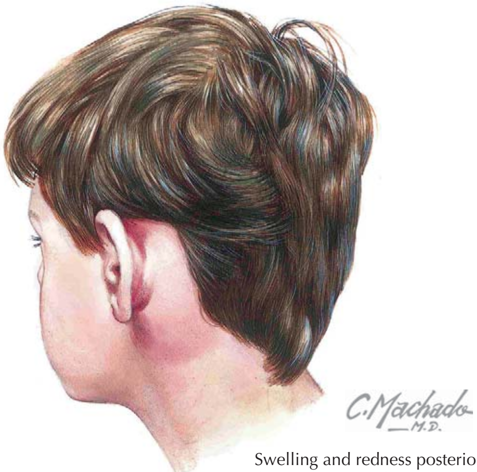
Because of the infection's location, it may lead to partial (or total) hearing loss, damage to the mastoid bone, or formation of an epidural abscess, or it may spread to involve the brain

Treatment

Can be difficult because medications cannot readily reach the mastoid air cells

In some cases, a mastoidectomy may be performed to drain the mastoid if antibiotic therapy is not successful

A myringotomy (creating an opening in the middle ear cavity through the tympanic membrane) is performed to drain the ear in acute otitis media



Swelling and redness posterior to the ear in mastoiditis

CHAPTER 19

EYE AND ORBIT

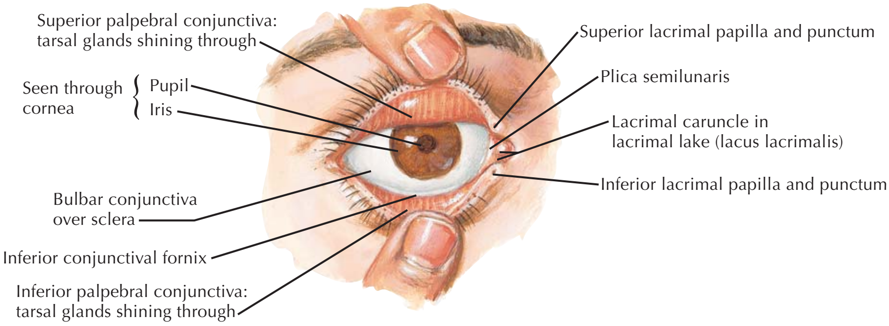
19 Overview and Topographic Anatomy of the Orbit

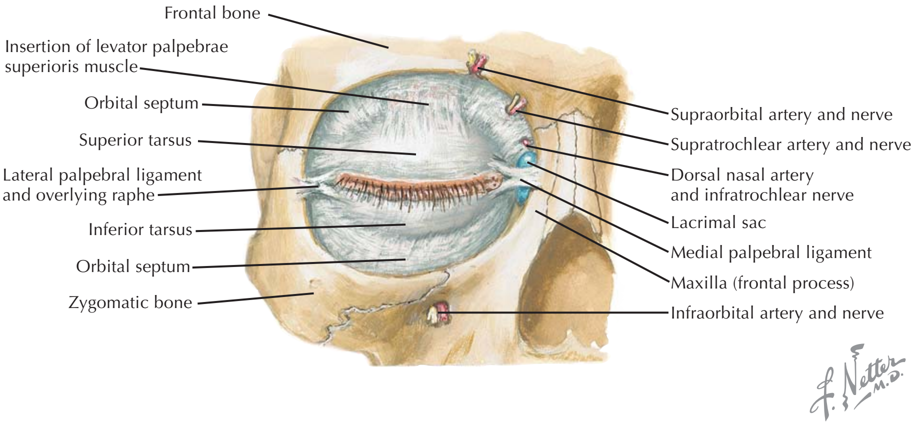
GENERAL INFORMATION

Orbit: a pyramid-shaped bony recess in the anterior part of the skull, lined by periosteum called the periorbital fascia

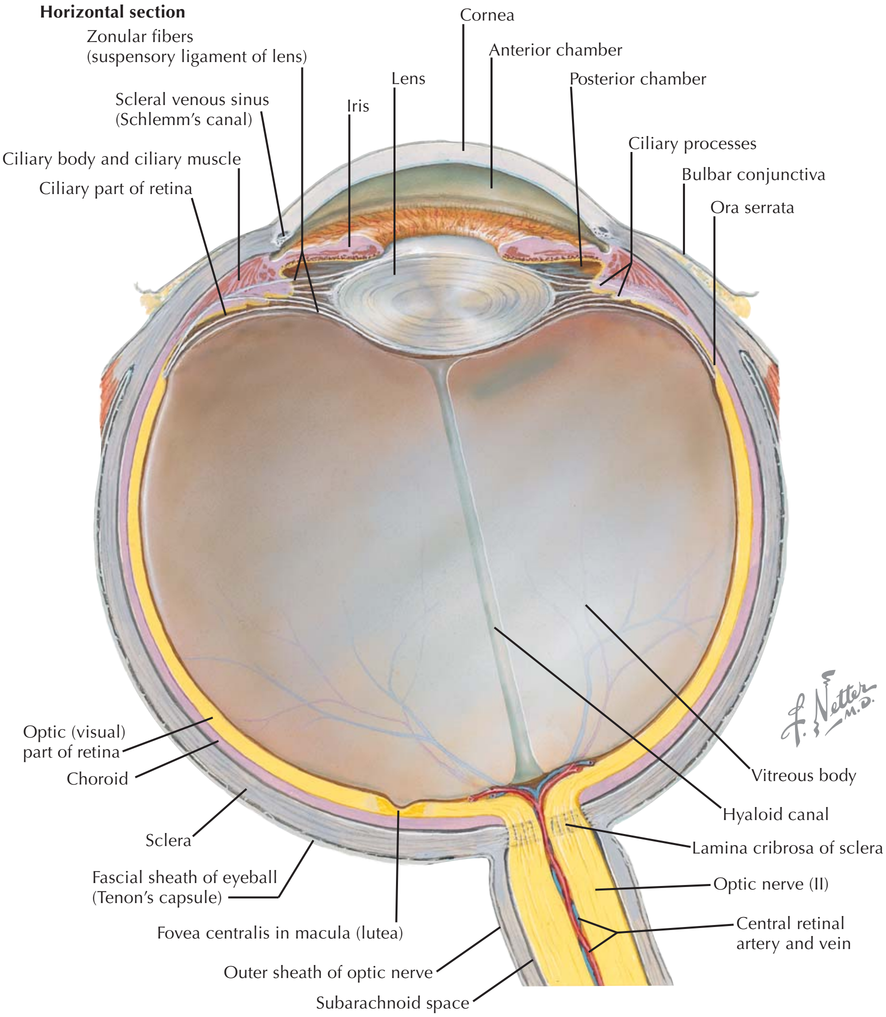
Contents include:

- Eye–organ associated with vision
- Extrinsic muscles
- Optic nerve
- Oculomotor nerve
- Ciliary ganglion
- Trochlear nerve
- Ophthalmic division of the trigeminal nerve
- Abducens nerve
- Ophthalmic artery and branches
- Superior and inferior ophthalmic veins
- Lacrimal apparatus
- Much fatty tissue





GENERAL INFORMATION *CONTINUED*



19 Osteology of the Orbit

OPENINGS IN THE ORBIT

Opening	Bony Boundaries	Structures Passing through Opening
Optic foramen	Lesser wing of the sphenoid	Optic n. Ophthalmic a.
Superior orbital fissure	Greater wing of the sphenoid Lesser wing of the sphenoid	Lacrimal branch of the trigeminal n.'s ophthalmic division Frontal branch of the trigeminal n.'s ophthalmic division Nasociliary branch of the trigeminal n.'s ophthalmic division Oculomotor n. Trochlear n. Abducens n. Superior ophthalmic v. Inferior ophthalmic v.
Inferior orbital fissure	Greater wing of the sphenoid Maxilla	Infraorbital n. and vessels Zygomatic n. Branch of inferior ophthalmic v. that connects to the pterygoid plexus
Supraorbital foramen	Frontal	Supraorbital n. and vessels Supratrochlear n. and vessels
Infraorbital groove and canal	Maxilla	Infraorbital n. and vessels
Zygomatic foramen (1or 2 openings)	Zygomatic	Branches of the zygomatic
Nasolacrimal canal	Lacrimal	Nasolacrimal duct
Anterior ethmoidal foramen	Ethmoid Frontal	Anterior ethmoidal n. and vessels
Posterior ethmoidal foramen	Ethmoid Frontal	Posterior ethmoidal n. and vessels

BONES CREATING THE ORBITAL MARGIN

Frontal
Zygomatic
Maxilla

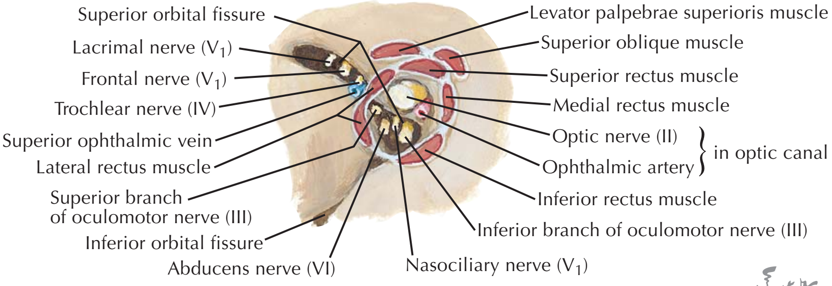
WALLS OF THE ORBIT

Superior	Frontal (orbital plate) Lesser wing of the sphenoid
Inferior	Maxilla Zygomatic Palatine (orbital process)
Medial	Ethmoid (lamina papyracea) Lacrimal Sphenoid Maxilla
Lateral	Zygomatic Greater wing of the sphenoid

WALLS OF THE ORBIT *CONTINUED*

Right orbit: frontal and slightly lateral view

Muscle attachments and nerves and vessels entering orbit



19 Contents of the Orbit

EYE

Eye: a spherical globe with a diameter of approximately 2.5 cm that lies in the orbit's anterior portion

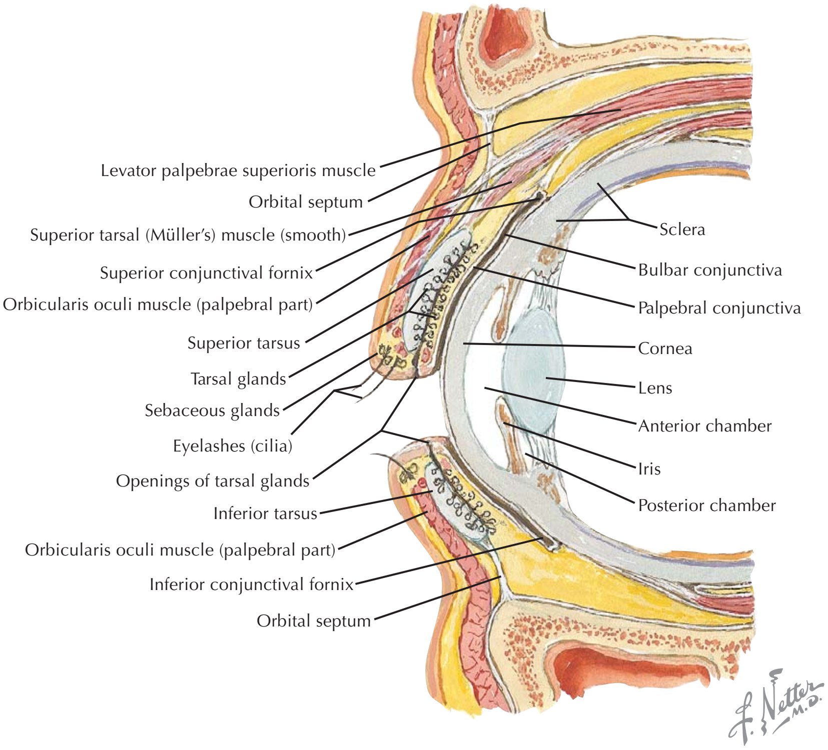
Surrounded by a thin capsule called the fascia bulbi (Tenon's capsule):
- Provides support
- Allows for movement

Composed of 3 coats:
- Sclera
- Uveal tract
- Retina

Divided into an anterior and a posterior segment:

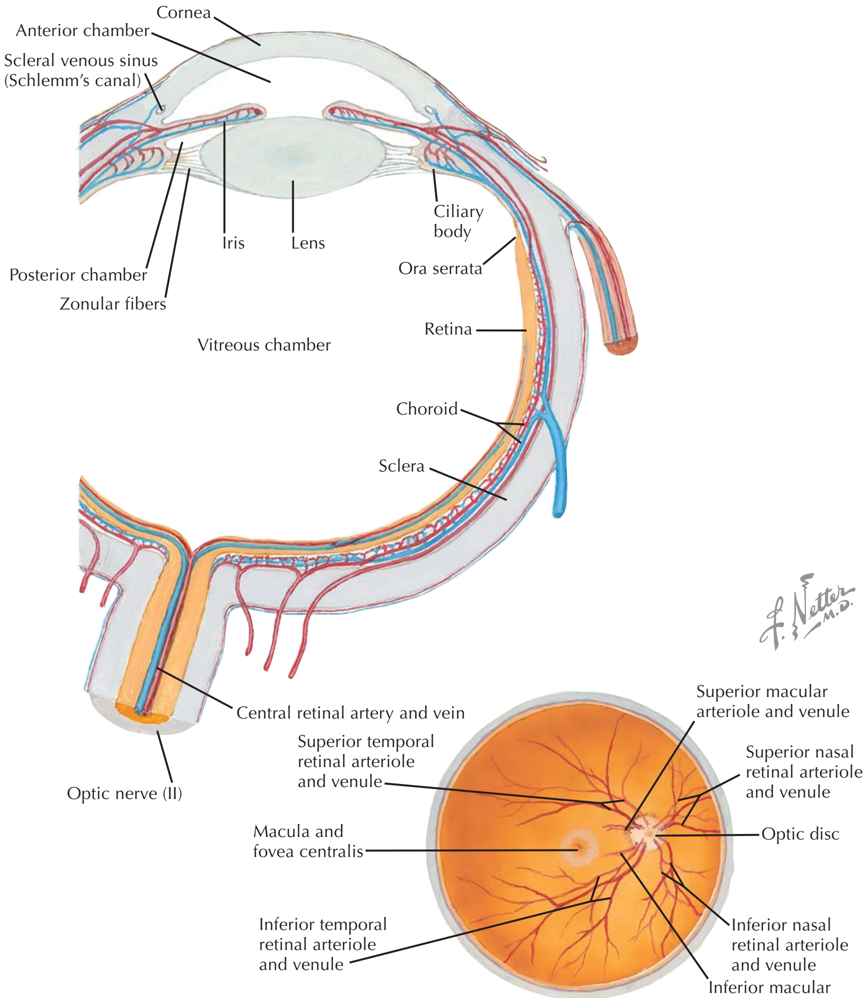
Anterior Segment:
- Filled with aqueous humor
- Separated into anterior and posterior chambers by the iris
- Contains aqueous humor secreted by the ciliary body and drained through a trabeculated network eventually into the superior ophthalmic vein
- Intraocular pressure is measured in the anterior segment, normally 10 to 20 mm Hg

Posterior Segment:
- Filled with vitreous fluid
- Called the vitreous cavity



Contents of the Orbit

EYE *CONTINUED*



Right retinal vessels: ophthalmoscopic view

EYE *CONTINUED*

COMPONENTS

Sclera

The outermost layer, very fibrous

White along the periphery, except for the anterior portion—the cornea, which is transparent

Uveal Tract

Composed of choroid layer, ciliary body, and iris

Choroid

- The pigmented vascular layer between the sclera and the retina
- Extends posteriorly from the region of the optic nerve anteriorly, where it is continuous with the ciliary body near the ora serrata (anterior margin of the retina)

Ciliary Body

- Located between the choroid and the iris
- Ring-shaped; has a series of transparent fibers that form the suspensory ligament of the lens
- Within it is the ciliary muscle, which changes the shape of the lens

Iris

- A thin disclike structure with a central opening—the pupil
- Separates the aqueous humor into the anterior chamber (anterior to the iris) and the posterior chamber (between the iris and the lens)
- Contains the sphincter and dilator pupillae muscles, which change the pupil's shape in response to light

Lens

Located posterior to the iris

A transparent biconcave structure responsible for focusing

Connected to the ciliary body by the suspensory ligaments

Retina

The innermost coat of the eye

Thin and highly vascular

Three areas located on the retina's posterior portion:

- Optic disc
- Macula lutea
- Fovea centralis

Optic Disc

Area where the optic nerve enters the retina is called the "blind spot"

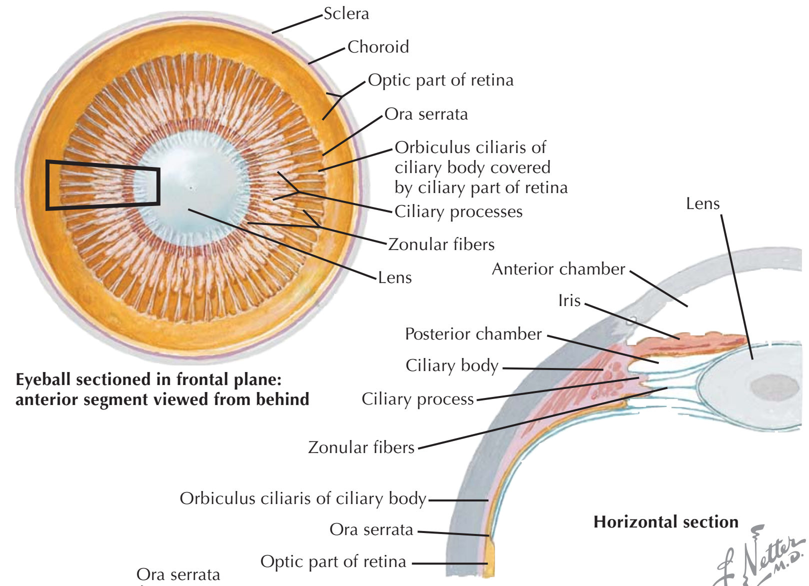
Retina's central artery enters the eye through the optic disc and divides into superior and inferior branches

Macula Lutea

Lateral to the optic disc

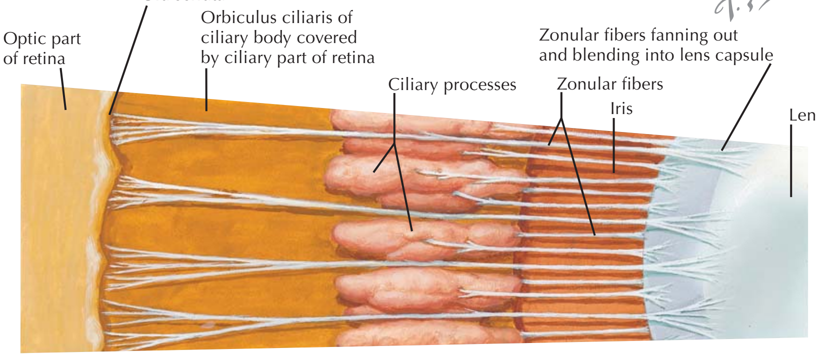
A depressed, yellow-appearing area that contains the fovea centralis in its center

EYE *CONTINUED*



Eyeball sectioned in frontal plane: anterior segment viewed from behind

Horizontal section



Enlargement of segment outlined in top illustration (semischematic)

19 Contents of the Orbit

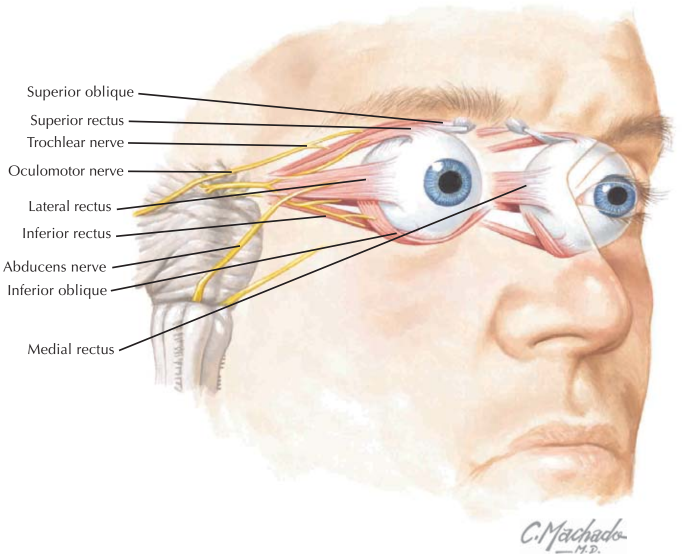
MUSCLES

ASSOCIATED EXTRINSIC MUSCLE OF THE ORBIT					
Muscle	**Origin**	**Insertion**	**Actions**	**Nerve**	**Comment**
Levator palpebrae superioris	Roof of the orbit	Skin of the upper eyelid	Raises the upper eyelid	Superior division of the oculomotor Sympathetic fibers to the smooth muscle	Opposed by the palpebral part of the orbicularis oculi m. There are smooth muscle fibers which insert into the superior tarsal plate which are innervated by sympathetic fibers Lesions of the sympathetics will lead to a ptosis, or drooping of the upper eyelid

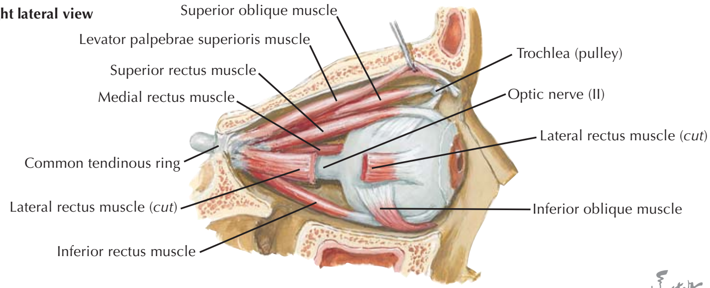
EXTRINSIC MUSCLES OF THE EYE					
Muscle	**Origin**	**Insertion**	**Actions on Eye**	**Nerve**	**Comment**
Superior rectus	Common tendinous ring on sphenoid	Superior sclera	Elevation Adduction Intorsion	Superior division of the oculomotor	A check ligament attaches it to the levator palpebrae superioris m. to help elevate the upper eyelid
Inferior rectus		Inferior sclera	Depression Adduction Extorsion	Inferior division of the oculomotor	A check ligament attaches it to the inferior tarsal plate to help depress the lower eyelid
Medial rectus		Medial sclera	Adduction		The most medial of the extraocular muscles
Lateral rectus		Lateral sclera	Abduction	Abducens	Impaired in abducens n. palsy
Superior oblique	Body of the sphenoid	Superior portion of the posterolateral sclera	Depression Abduction Intorsion	Trochlear	Tendon passes through the trochlea, a fibrocartilaginous pulley
Inferior oblique	Maxilla (lateral to the lacrimal groove)	Inferior portion of the posterolateral sclera	Elevation Abduction Extorsion	Inferior division of the oculomotor	Only extraocular muscle that attaches to the maxilla

Contents of the Orbit

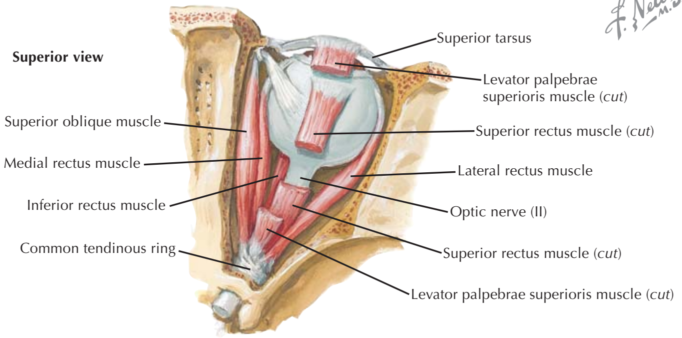
MUSCLES *CONTINUED*



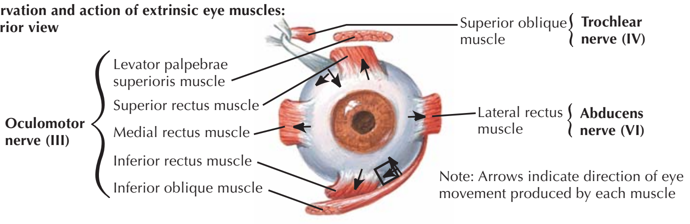
Right lateral view



Superior view

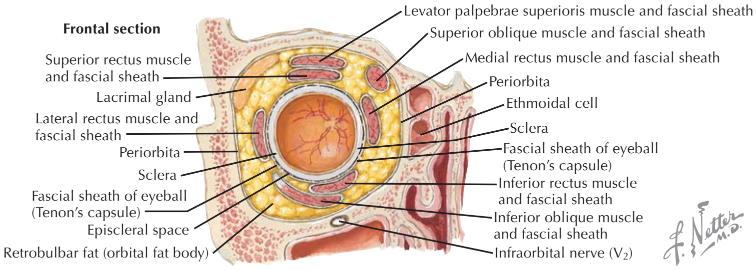


Innervation and action of extrinsic eye muscles: anterior view



Note: Arrows indicate direction of eye movement produced by each muscle

MUSCLES *CONTINUED*



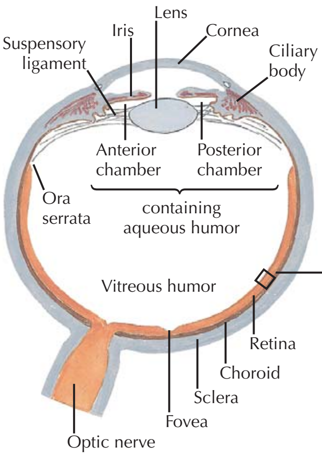
NERVE SUPPLY

ORBITAL INNERVATION	
Orbital Innervation	**Description**
Sensory	**2 Major Types** Vision (special somatic afferent) via the optic n. General sensation (general somatic afferent) via the ophthalmic (and some maxillary) division of the trigeminal n.
Motor	**2 Major Types** Motor to the extraocular muscles (general somatic efferent) via the oculomotor, trochlear, and abducens nn. Autonomics to the intrinsic muscles of the eye (general visceral efferent) via: • Parasympathetics associated with the ciliary ganglion • Sympathetics associated with the superior cervical ganglion
Cranial nn.	5 cranial nerves provide innervation to the orbit: • Optic—vision • Oculomotor—extraocular motor and autonomics to the intrinsic muscles of the eye • Trochlear—extraocular motor • Trigeminal—general sensation • Abducens—extraocular motor

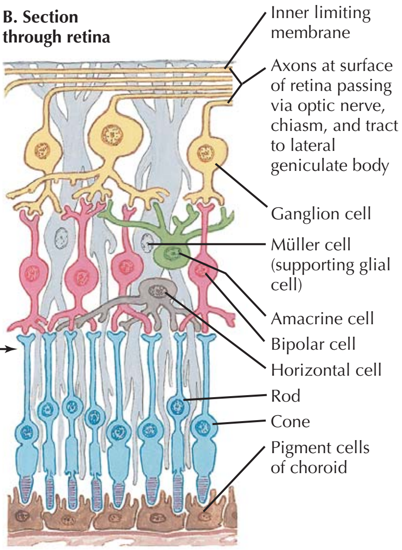
Contents of the Orbit

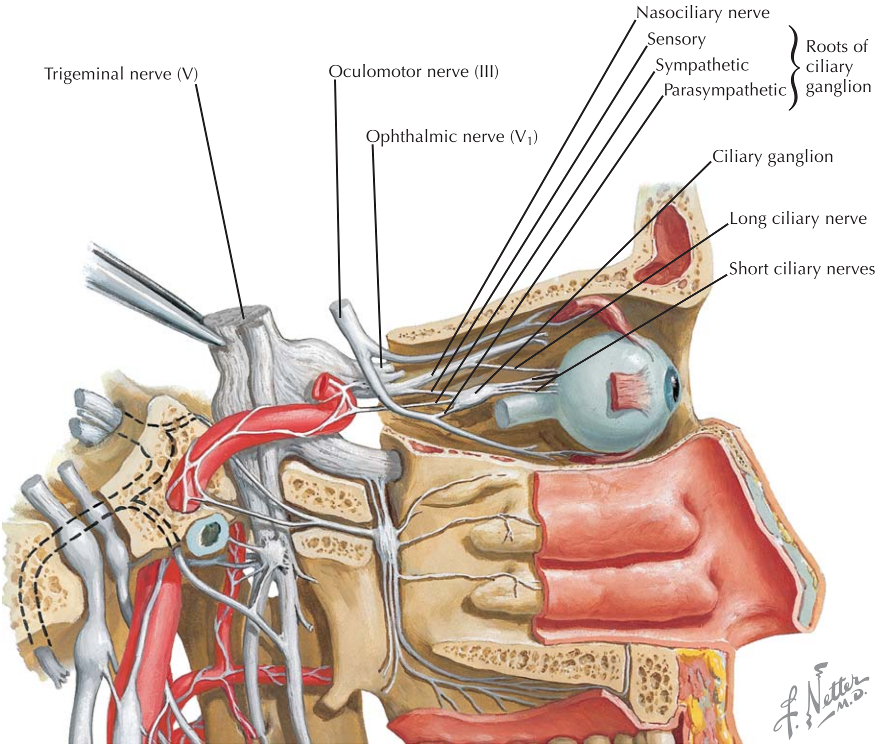
NERVE SUPPLY *CONTINUED*

A. Eyeball



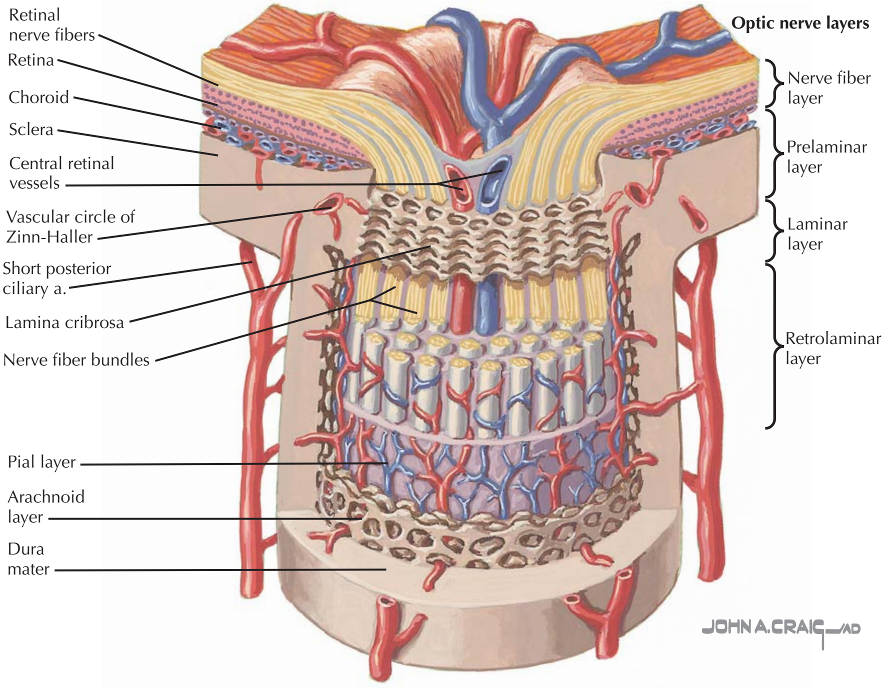
B. Section through retina





NERVE SUPPLY *CONTINUED*

OPTIC NERVE (VISION)
About 25 mm in length, allows for eye movement via the extraocular muscles Covered by an outer layer of dura mater and an inner layer of arachnoid, which attach anteriorly to the eye, where the optic n. enters the sclera, and posteriorly, where it merges with the periosteum lining the orbit at the optic foramen Central a. of the retina enters the optic n. posterior to the bulb of the eye
Course
Axons from the ganglionic cells of the retina comprise the optic n. and come together at the optic disc They leave the eye and travel as the optic n. posteriorly and medially through the orbit Posteriorly, the optic n. passes through the optic foramen to enter the cranial cavity The 2 optic nn. meet at the optic chiasm, located superior to the hypophyseal fossa Optic chiasm gives rise to the optic tracts, which terminate in the lateral geniculate nucleus of the thalamus before giving rise to the optic radiations that terminate in the occipital lobes



Contents of the Orbit

NERVE SUPPLY *CONTINUED*

GENERAL SENSATION

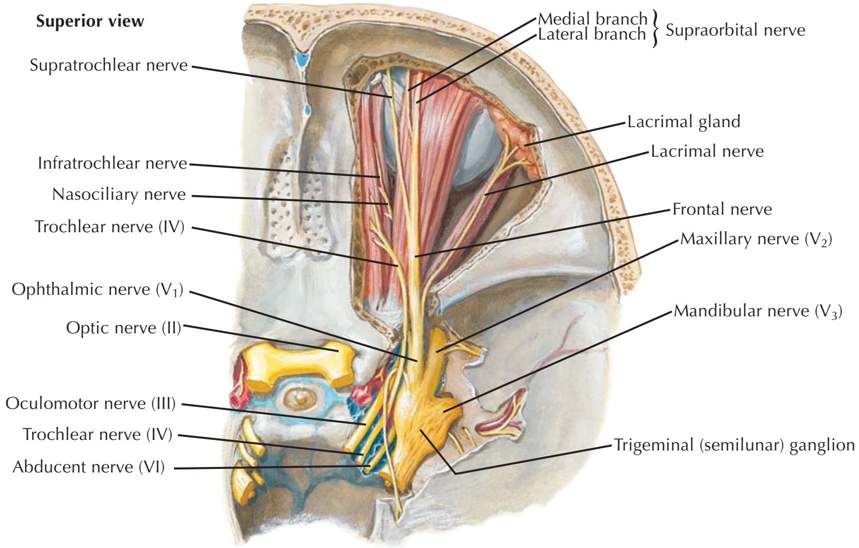
Ophthalmic Division of the Trigeminal Nerve

This division, being a branch of the trigeminal n., is sensory in function
Arises from the main nerve in the middle cranial fossa
Passes anterior on the lateral wall of the cavernous sinus immediately inferior to the oculomotor and trochlear nn., but superior to the maxillary division of the trigeminal
Immediately before entering the orbit, through the superior orbital fissure, it divides into 3 major branches: lacrimal, frontal, and the nasociliary nn.

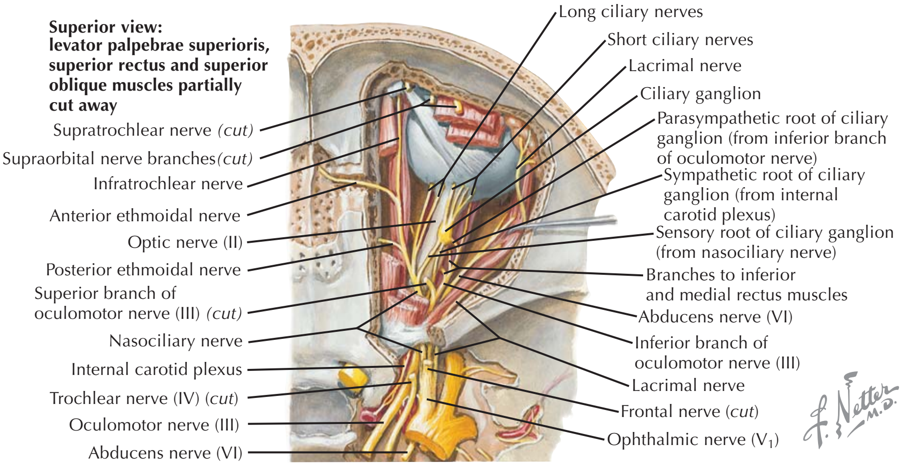
Nerve	Source	Course
Lacrimal	Ophthalmic division of the trigeminal n.	Smallest branch of the ophthalmic division of the trigeminal n. Passes anteriorly to enter the orbit through the superior orbital fissure In the orbit, it travels on the superior border of the lateral rectus m. with the lacrimal a. Before reaching the lacrimal gland, it communicates with the zygomatic branch of the maxillary division of the trigeminal to receive autonomic nervous fibers Enters the lacrimal gland and supplies it and the conjunctiva before piercing the orbital septum to supply the skin of the upper eyelid
Frontal		Largest branch of the ophthalmic division of the trigeminal n. Passes anteriorly to enter the orbit through the superior orbital fissure In the orbit it passes anteriorly between the periosteum of the orbit and the levator palpebrae superioris m. About halfway in the orbit, it divides into its 2 terminal nerves, the supraorbital and supratrochlear
Supraorbital	Frontal n.: the 2 terminal branches of the frontal n. in the orbit	Passes between the levator palpebrae superioris m. and periosteum of the orbit Continues anteriorly to the supraorbital foramen (notch) At the level of the supraorbital margin, it sends nerve supply to the frontal sinus and ascends superiorly along the scalp Divides into medial and lateral branches, which travel up to the vertex of the scalp
Supratrochlear		Once the supratrochlear a. joins it within the orbit, it continues to pass anteriorly toward the trochlear In the trochlear region, it often supplies the frontal sinus before exiting the orbit Ascends along the scalp, at first deep to the musculature in the region before piercing them to reach the cutaneous innervation along the scalp
Nasociliary	Ophthalmic division of the trigeminal n.	Passes anteriorly to enter the orbit through the superior orbital fissure Enters the orbit lateral to the optic n. Travels across the optic n. anteriorly and medially to lie between the medial rectus and the superior oblique mm. along the medial wall of the orbit All along its path, it gives rise to other nerves, including the sensory root of the ciliary ganglion, and the long ciliary and posterior ethmoidal nn., until terminating into the anterior ethmoidal and infratrochlear nn. near the anterior ethmoidal foramen
Sensory root of the ciliary ganglion	Nasociliary n.	Travels anteriorly on the lateral side of the optic n. to enter the ciliary ganglion Carries general sensory fibers, which are distributed by the short ciliary nn.
Long ciliary		There are 2 to 4 branches that travel anteriorly to enter the posterior part of the sclera of the eye

NERVE SUPPLY *CONTINUED*

Nerve	Source	Course
Posterior ethmoidal	Nasociliary n.	Travels deep to the superior oblique m. to pass through the posterior ethmoidal foramen Supplies the sphenoid sinus and the posterior ethmoidal sinus
Anterior ethmoidal		Arises on the medial wall of the orbit Enters the anterior ethmoidal foramen and travels through the canal to enter the anterior cranial fossa Supplies the anterior and middle ethmoidal sinuses before entering and supplying the nasal cavity Terminates as the external nasal n. on the face
Infratrochlear		1 of the terminal branches of the nasociliary n. Passes anteriorly on the superior border of the medial rectus m. Passes inferior to the trochlea toward the medial angle of the eye Supplies the skin of the eyelids and bridge of the nose, the conjunctiva, and all of the lacrimal structures



Superior view



Superior view: levator palpebrae superioris, superior rectus and superior oblique muscles partially cut away

Contents of the Orbit

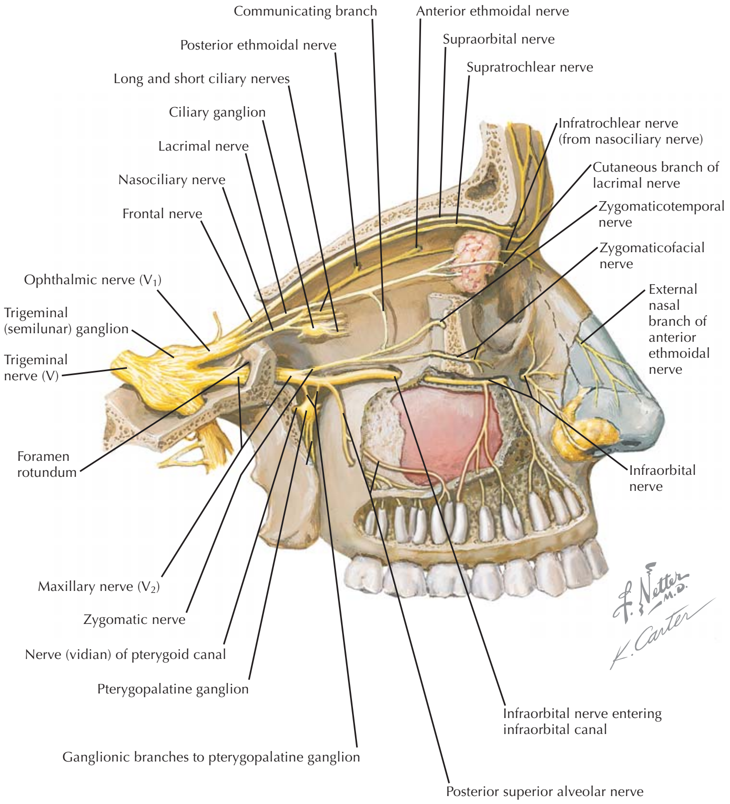
NERVE SUPPLY *CONTINUED*

GENERAL SENSATION

Maxillary Division of the Trigeminal Nerve

Travels along the lateral wall of the cavernous sinus
Before exiting the middle cranial fossa, it gives off a meningeal branch that innervates the dura mater
Passes from the middle cranial fossa into the pterygopalatine fossa via the foramen rotundum
Within the pterygopalatine fossa, it gives rise to *4 branches:*
posterior superior alveolar n., zygomatic n., ganglionic branches, and the infraorbital n.
The zygomatic and infraorbital continue within the orbit

Nerve	Source	Course
Zygomatic	Maxillary division of the trigeminal n.	Enters the orbit via the inferior orbital fissure Within the orbit, it divides into the zygomaticotemporal and zygomaticofacial branches, which exit the orbit along the lateral wall via 1 or 2 zygomatic foramen
Infraorbital		Considered the continuation of the maxillary division of the trigeminal n. Passes through the inferior orbital fissure to enter the orbit Passes anteriorly through the infraorbital groove and infraorbital canal and exits onto the face via the infraorbital foramen Within the infraorbital canal, it gives rise to the anterior superior alveolar and middle superior alveolar nn. Once the infraorbital n. exits onto the face, it divides into 3 terminal branches: ● Inferior palpebral—supplies the skin of the lower eyelid and conjunctiva ● Nasal—supplies the ala of the nose ● Superior labial—supplies the skin of the upper lip

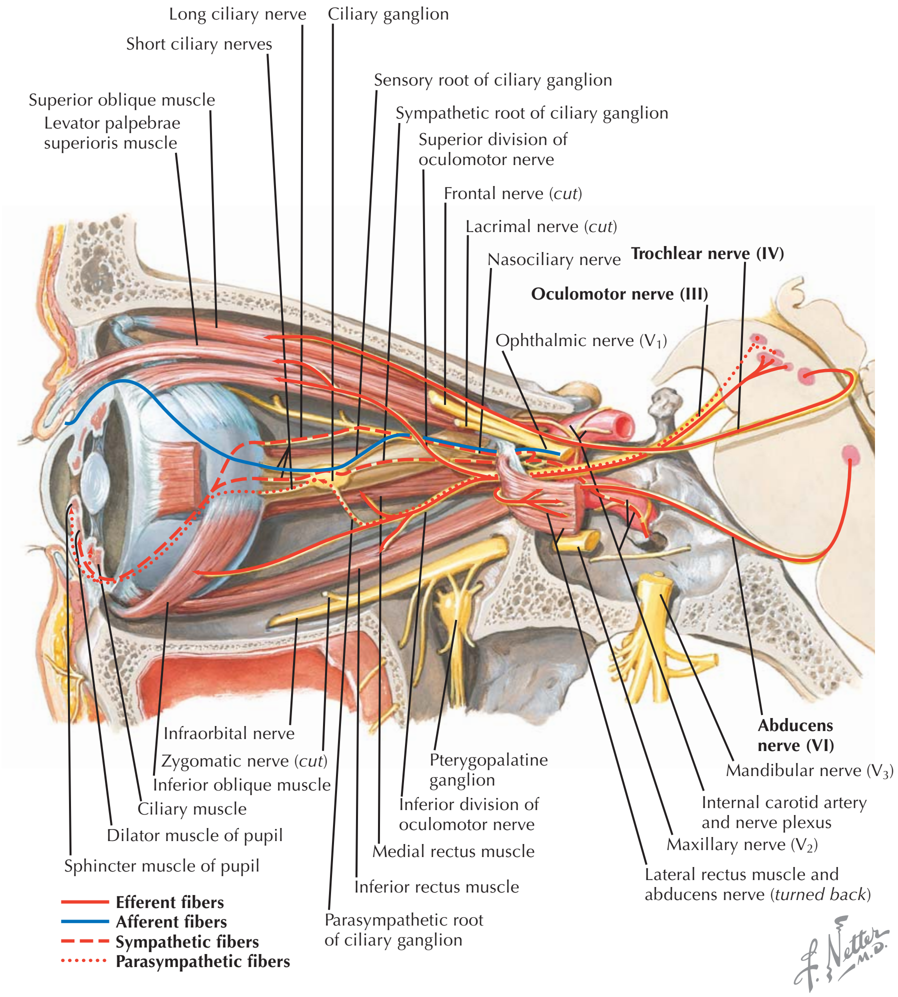


NERVE SUPPLY *CONTINUED*

GENERAL MOTOR		
Nerve	**Source**	**Course**
Oculomotor (cranial n. III)	Ventral surface of the midbrain	Innervates 4 of the extraocular muscles—superior rectus, inferior rectus, medial rectus, and the inferior oblique mm.—as well as the levator palpebrae superioris m. Also provides parasympathetic innervation to the intrinsic muscles of the eye Passes anterior on the lateral wall of the cavernous sinus immediately superior to the trochlear n. Immediately before entering the orbit, it divides into superior and inferior divisions; both enter the orbit through the superior orbital fissure
Superior division of the oculomotor	Oculomotor	Enters the orbit via the superior orbital fissure Travels superior to the optic n. to enter the inferior border of the superior rectus m. Passes through the superior rectus to give rise to a branch that enters the inferior surface of the levator palpebrae superioris m.
Inferior division of the oculomotor		Enters the orbit via the superior orbital fissure Immediately divides into 3 muscular branches that enter: • The lateral surface of the medial rectus • The superior surface of the inferior oblique • The superior surface of the inferior rectus Gives rise to the parasympathetic root of the ciliary ganglion
Trochlear (cranial n. IV)	Dorsal surface of the midbrain	Innervates the superior oblique Passes anterior on the lateral wall of the cavernous sinus immediately inferior to the oculomotor n. Enters the orbit via the superior orbital fissure and immediately enters the superior oblique to innervate it
Abducens (cranial n. VI)	Ventral surface of the pons	Travels anteriorly within the cavernous sinus beside the internal carotid a. Enters the orbit via the superior orbital fissure Travels anteriorly to enter the medial surface of the lateral rectus to innervate it

Contents of the Orbit

NERVE SUPPLY *CONTINUED*



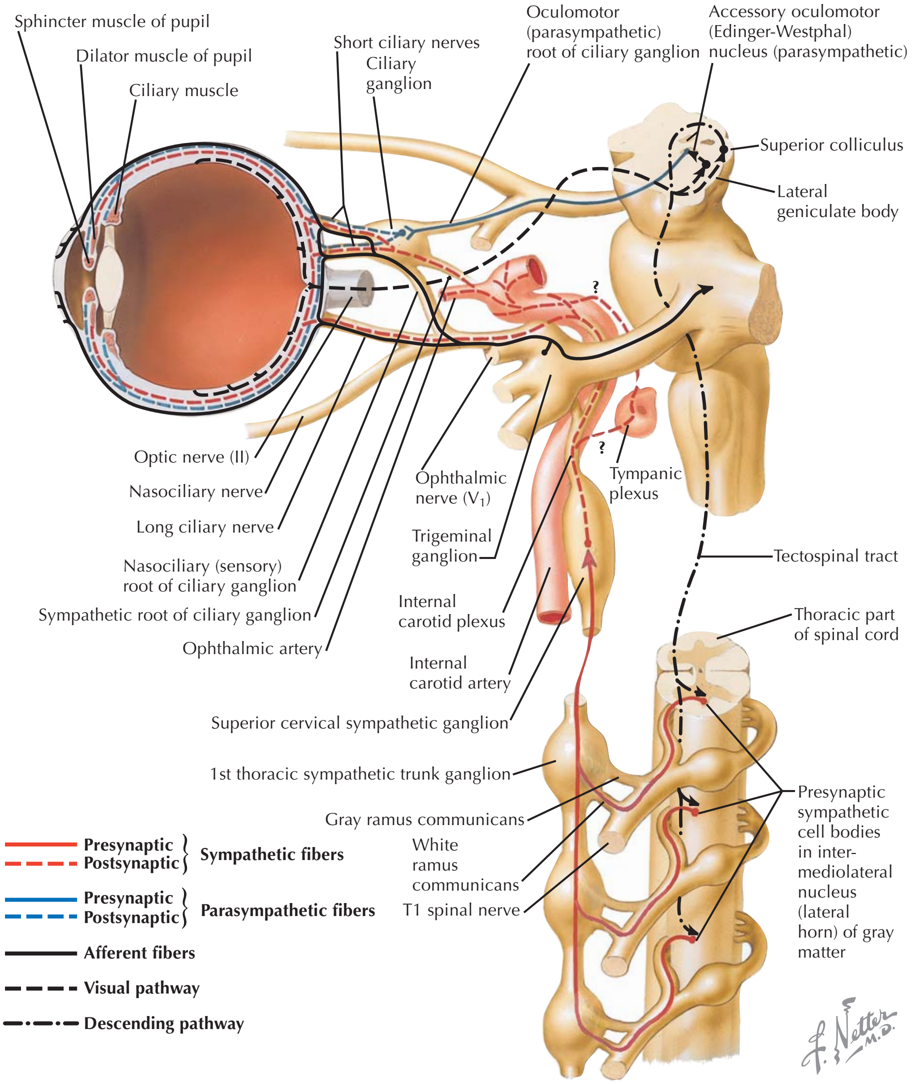
NERVE SUPPLY *CONTINUED*

PARASYMPATHETICS OF THE EYE

Type of Neuron	Location of Cell Body	Characteristics of the Cell Body	Course of the Neuron
Preganglionic neuron	Edinger-Westphal nucleus	A collection of nerve cell bodies located in the midbrain	Arise from the Edinger-Westphal nucleus in the midbrain from the oculomotor n. Oculomotor n. passes anteriorly on the lateral wall of the cavernous sinus immediately superior to the trochlear n. Immediately before entering the orbit, the nerve divides into the superior and inferior divisions Both the superior and inferior divisions of the oculomotor enter the orbit through the superior orbital fissure Preganglionic parasympathetic fibers travel in the inferior division A small parasympathetic root passes from the inferior division of the oculomotor to the ciliary ganglion, carrying the preganglionic parasympathetic fibers
Postganglionic neuron	Ciliary ganglion	Located anterior to the optic foramen between the optic n. and the lateral rectus *3 roots connect to the ciliary ganglion:* • Sensory root from the ophthalmic division of the trigeminal, which carries general sensation fibers to the eye via the short ciliary nn. • Parasympathetic root from the inferior division of the oculomotor, carrying preganglionic parasympathetic fibers to the ganglion • Sympathetic root that arises from the postganglionic sympathetic fibers, which were carried by the internal carotid a. • The short ciliary nn. usually number about 8 Short ciliary nn. arise from the ciliary ganglion to enter the posterior portion of the eye Fibers from all 3 roots pass through the ciliary ganglion and short ciliary nn. to enter the eye Only the parasympathetic fibers synapse in the ciliary ganglion	Arise in the ciliary ganglion, following a synapse with the preganglionic parasympathetic fibers Travel through the short ciliary nn. to enter the eye's posterior portion Innervate the sphincter pupillae m. and the ciliary muscles

Contents of the Orbit

NERVE SUPPLY *CONTINUED*



NERVE SUPPLY *CONTINUED*

ANATOMIC PATHWAY FOR SYMPATHETICS OF THE EYE			
Type of Neuron	**Name of Cell Body**	**Characteristics of the Cell Body**	**Course of the Neuron**
Preganglionic neuron	Intermediolateral horn nucleus	Collection of nerve cell bodies located in the lateral horn nucleus of the spinal cord between spinal segments T1 and T3 (and possibly T4)	Arise from the intermediolateral horn nuclei from T1 to T3 (4) Travel through the ventral root of the spinal cord to the spinal n. Enter the sympathetic chain via a white ramus communicantes Once in the sympathetic chain, the preganglionic fibers for the eye will ascend and synapse with postganglionic fibers in the superior cervical ganglion
Postganglionic neuron	Superior cervical ganglion	Collection of nerve cell bodies located in the superior cervical ganglion, which is located at the base of the skull	Arise in the superior cervical ganglion Postganglionic fibers will follow the internal carotid a. on the carotid plexus As the internal carotid nears the orbit, the postganglionic fibers branch and follow various structures that connect to the eye, such as the ophthalmic a. and its branches, and the long ciliary nn. that arise from the ophthalmic division of the trigeminal n. In the eye, the postganglionic fibers innervate the eye's dilator pupillae m.

VASCULAR SUPPLY

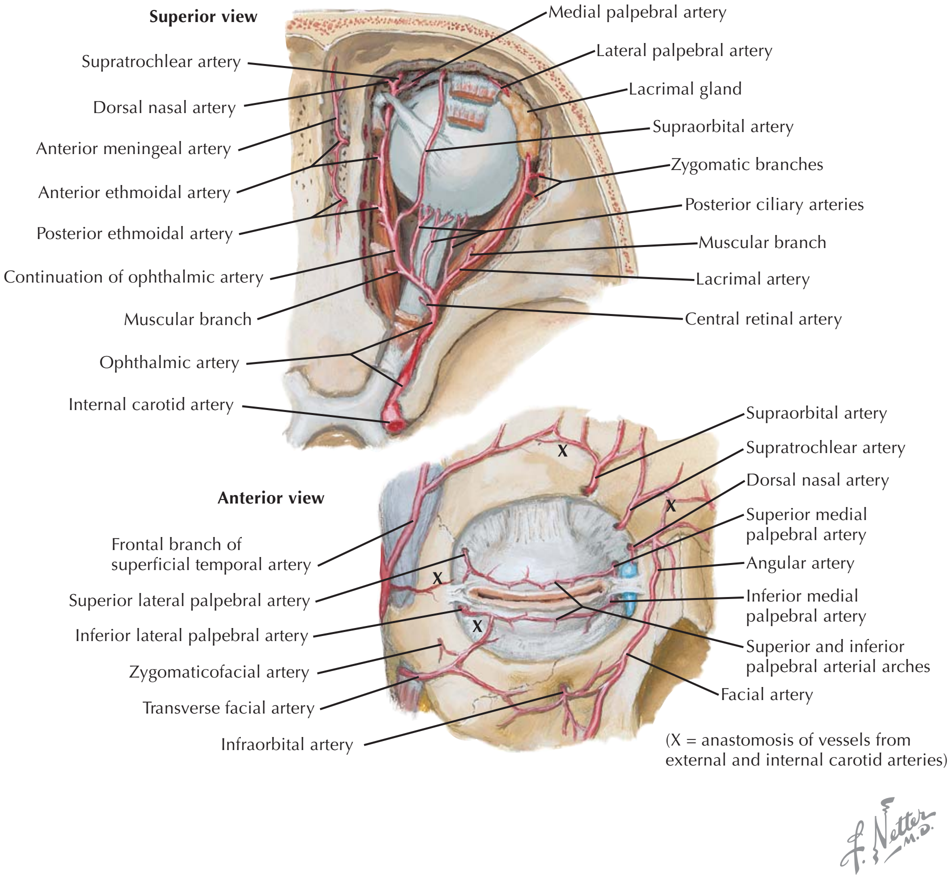
ARTERIAL SUPPLY		
Artery	**Source**	**Course**
Ophthalmic	Internal carotid a.	Enters the orbit through the optic foramen immediately inferior and lateral to the optic n. Crosses the optic n. to reach the medial part of the orbit While in the orbit, the artery gives rise to a series of arteries that supply the orbit and associated structures The terminal aa. of the ophthalmic a. anastomose along the scalp and face with the superficial temporal, facial, and infraorbital branches of the maxillary a.
Lacrimal	Ophthalmic a.	Arises near the optic foramen One of the ophthalmic's largest branches Follows the lacrimal n. along the superior border of the lateral rectus m. of the eye to reach and supply the lacrimal gland Gives rise to a series of terminal branches, such as the lateral palpebral, that supply the eyelids and conjunctiva Gives rise to a zygomatic branch that then gives rise to the zygomaticotemporal and zygomaticofacial aa. Supply those regions of the face
Supratrochlear		It exits the orbit at the medial angle accompanied by supratrochlear n. Ascends on the scalp, anastomosing with the supraorbital a. and supratrochlear a. from the opposite side

Contents of the Orbit

VASCULAR SUPPLY *CONTINUED*

ARTERIAL SUPPLY		
Artery	**Source**	**Course**
Supraorbital		Branches from the ophthalmic a. as it passes the optic n. Passes on the medial side of the levator palpebrae superioris and superior rectus mm. to join the supraorbital n. Passes through the supraorbital foramen (notch) and ascends superiorly along the scalp Anastomoses with the supratrochlear a. and superficial temporal a.
Anterior ethmoidal		Travels with the nerve through the anterior ethmoidal canal to supply the anterior and middle ethmoidal sinuses Continues to give rise to a meningeal branch and nasal branches that supply the lateral wall and septum of the nose Then gives rise to the terminal external nasal branch that supplies the external nose
Posterior ethmoidal		Travels through the posterior ethmoidal canal to supply the posterior ethmoidal sinus Gives rise to meningeal and nasal branches that anastomose with branches of the sphenopalatine
External nasal	A terminal branch of the anterior ethmoidal a.	Supplies the area along the external nose at the junction between the nasal bone and the lateral nasal cartilage
Medial palpebral (superior and inferior)	Ophthalmic a. of the internal carotid a.	Arise near the trochlea and exit the orbit to pass along the upper and lower eyelids These arteries anastomose with the other arteries supplying the face in the region
Dorsal nasal (Infratrochlear)	One of the ophthalmic a.'s terminal branches	Exits the orbit along the superomedial border along with the infratrochlear n. Supplies the area along the bridge of the nose
Muscular	Ophthalmic a. from the internal carotid a.	Supply the extraocular muscles of the orbit
Anterior ciliary	Muscular branches from the ophthalmic a.	Pass anteriorly to the anterior surface of the eye following the tendons of the extraocular muscles
Short posterior ciliary	Ophthalmic a. from the internal carotid a.	Usually 6 to 10 arise Travel anteriorly around the optic n. to enter the posterior portion of the eye
Long posterior ciliary		Usually 2 arise Travel anteriorly to enter the posterior portion of the eye near the optic n.
Central a. of the retina		Branches from the ophthalmic a. early on its entrance into the orbit Follows the optic n. and enters the nerve about halfway into the orbit Supplies the retina
Maxillary	1 of 2 terminal branches of the external carotid a.	Gives rise to a series of branches Only the infraorbital branch supplies the orbit
Infraorbital	Maxillary a.	Once the infraorbital exits the infraorbital foramen, the inferior palpebral a. supplies the lower eyelid Supplies some muscles along the floor of the orbit near the inferior orbital canal

VASCULAR SUPPLY *CONTINUED*



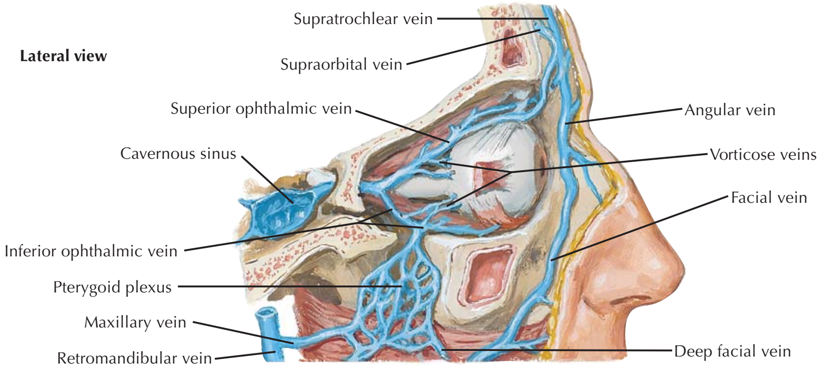
(X = anastomosis of vessels from external and internal carotid arteries)

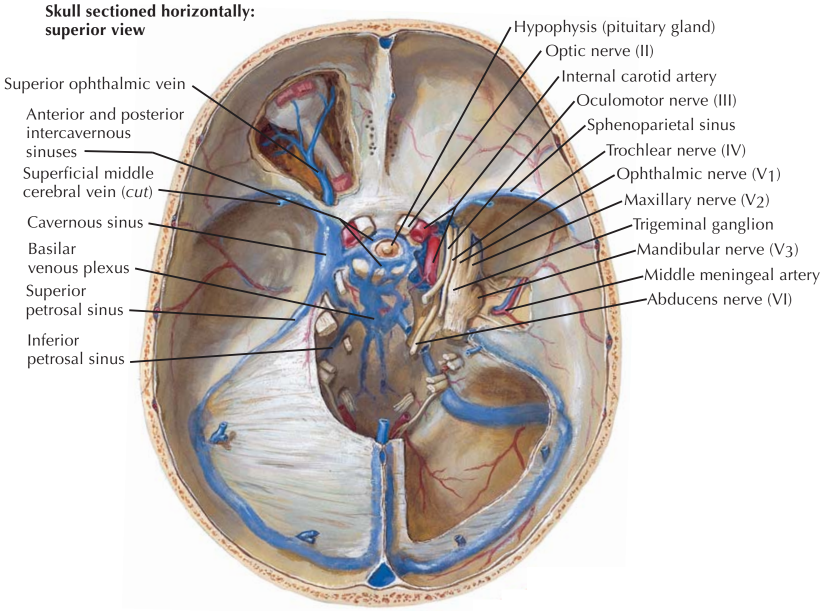
Contents of the Orbit

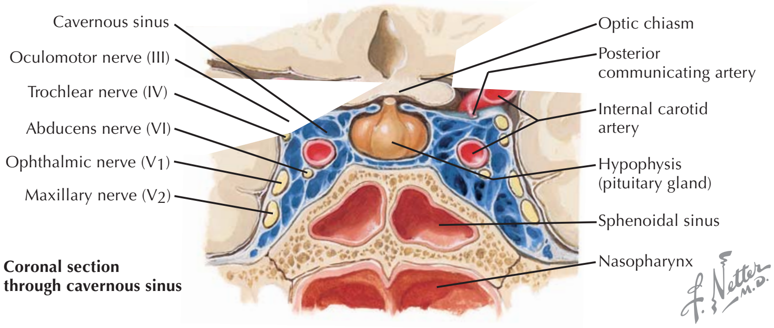
VASCULAR SUPPLY *CONTINUED*

VENOUS DRAINAGE	
Vein	**Course**
Superficial Veins	
Supraorbital	Begins on the forehead, where it communicates with the superficial temporal v. Passes inferiorly superficial to the frontalis m. and joins the supratrochlear v. at the medial angle of the orbit to form the angular v.
Supratrochlear	Begins on the forehead, where it communicates with the superficial temporal v. Passes inferiorly along the forehead, parallel with the vein of the opposite side At the medial angle of the orbit, the supratrochlear joins the supraorbital v. to form the angular v.
Angular	Forms from the confluence of the supraorbital and supratrochlear vv. along the medial part of the eye Travels along the lateral aspect of the nose to become the facial v.
Facial	Begins as the angular v. Passes inferiorly along the side of the nose, receiving the lateral nasal v. Continues posteroinferiorly across the angle of the mouth to the cheek receiving the superior and inferior labial vv. While passing toward the mandible, the deep facial v. connects the it to the pterygoid plexus In the submandibular triangle the facial v. joins the anterior branch of the retromandibular to form the common facial v. The facial v. has no valves that can allow blood to backflow
Deep Veins	
Cavernous sinus	A reticulated venous structure located on the lateral aspect of the body of the sphenoid bone Drain posteriorly into the superior and inferior petrosal sinuses Receives blood from the superior and inferior ophthalmic vv. Oculomotor and trochlear nn. and ophthalmic and maxillary divisions of the trigeminal n. lie along the lateral wall of the sinus Abducens n. and internal carotid a. lie in the sinus
Pterygoid plexus	An extensive network of veins that parallels the 2nd and 3rd parts of the maxillary a. Receives branches that correspond to the same branches of the maxillary a. Tributaries to the pterygoid plexus eventually converge to form a short maxillary v. Communicates with the cavernous sinus, pharyngeal venous plexus, facial v. via the deep facial v., and ophthalmic vv.
Communicating Veins	
Superior ophthalmic	Receives blood from the roof of the orbit and the scalp Travels posteriorly to communicate with the cavernous sinus
Inferior ophthalmic	Receives blood from the floor of the orbit Often splits into two branches One branch travels posteriorly with the infraorbital v. that passes through the inferior orbital fissure to communicate with the pterygoid plexus The other branch travels posteriorly to communicate directly with the superior ophthalmic v. in the superior orbital fissure, or it will pass through the fissure to communicate with the cavernous sinus
Infraorbital	Receives blood from the midface via the lower eyelid, lateral side of the nose, and the upper lip Eventually communicates with the pterygoid plexus of veins

VASCULAR SUPPLY *CONTINUED*


Lateral view


Skull sectioned horizontally: superior view

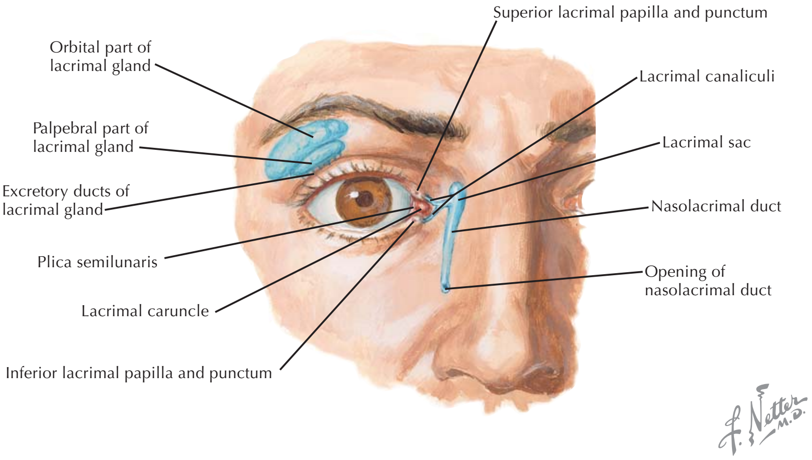

Coronal section through cavernous sinus

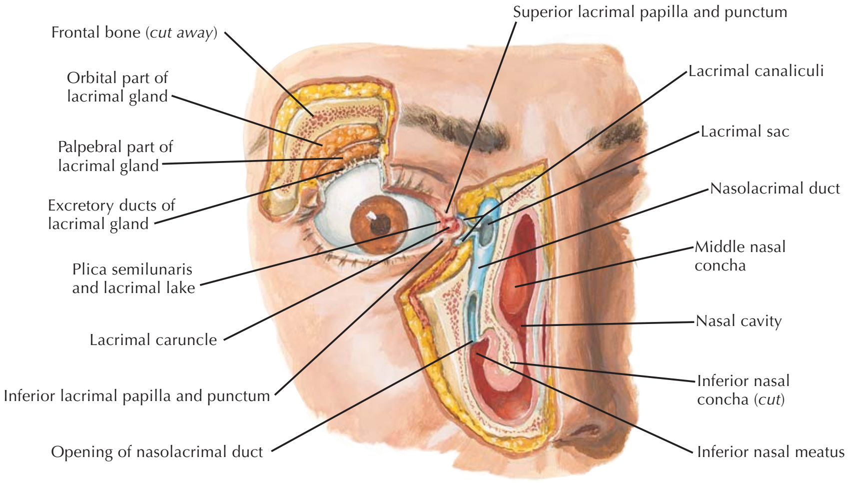
19

Contents of the Orbit

LACRIMAL APPARATUS

OVERVIEW	
Structure/Function	**Description**
Lacrimal apparatus	Composed of: • Lacrimal gland • Lacrimal canaliculi • Lacrimal sac • Nasolacrimal duct Secretes and drains all tears
Lacrimal gland	Located in the anterolateral part of the orbit Secretes serous fluid Divided into 2 parts by the lateral tendon of the levator palpebrae superioris m.
Tear formation and absorption	Tears coat the external surface of the eye to prevent drying, act as a lubricant, and contain bactericidal enzymes With blinking, tears are carried across the eye to collect near the medial canthus Tears enter through the lacrimal puncta into the lacrimal canaliculi Lacrimal canaliculi carry the tears to the lacrimal sac Lacrimal sac carries the tears inferiorly through the nasolacrimal duct, which terminates in the inferior meatus



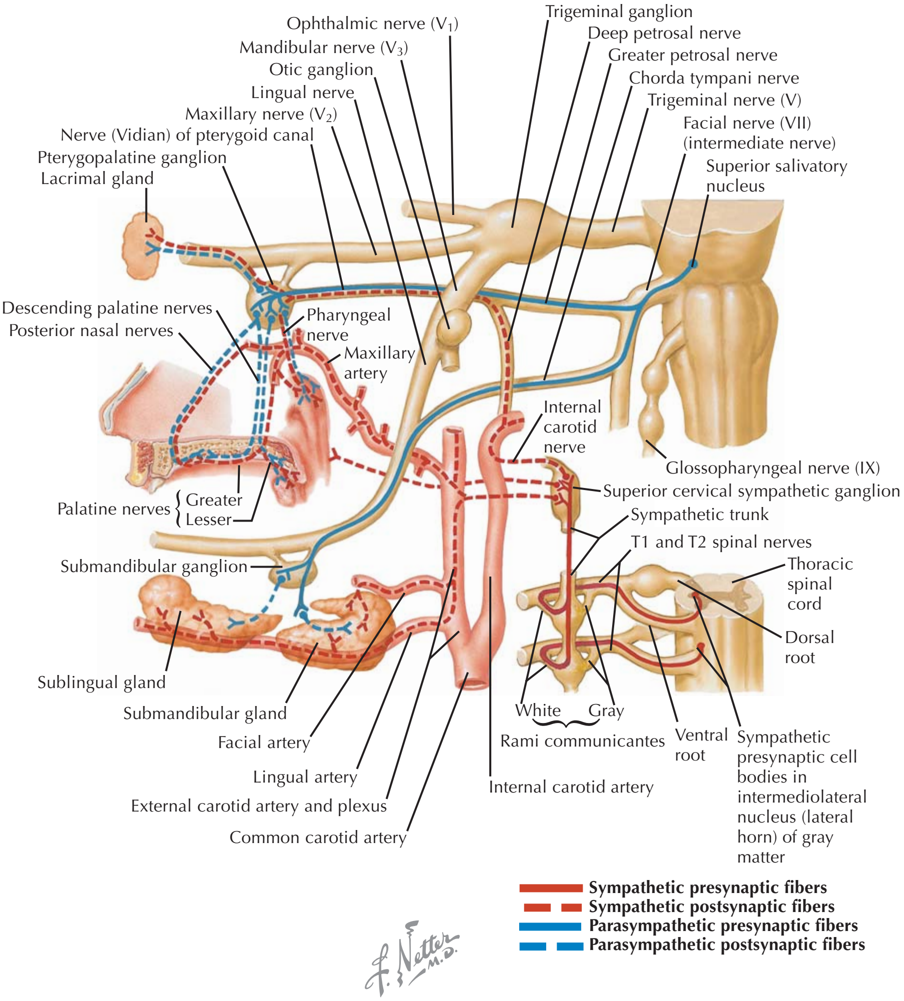


LACRIMAL APPARATUS *CONTINUED*

PARASYMPATHETICS OF THE LACRIMAL GLAND			
Type of Neuron	**Name of Cell Body**	**Characteristics of the Cell Body**	**Course of the Neuron**
Preganglionic neuron	Superior salivatory nucleus	A collection of nerve cell bodies located in the pons Travel through the nervus intermedius of the facial n. into the internal acoustic meatus In the facial canal, the facial n. gives rise to *2 parasympathetic branches:* ● Greater petrosal n. ● Chorda tympani n.	Lacrimal gland uses the greater petrosal n. **Greater Petrosal Nerve** Exits along the hiatus for the greater petrosal n. toward the foramen lacerum, where it joins the deep petrosal n. (sympathetics) to form the nerve of the pterygoid canal (vidian n.) Vidian n. passes through the pterygoid canal and enters the pterygopalatine fossa, where it joins with the pterygopalatine ganglion
Postganglionic neuron	Pterygopalatine ganglion	A collection of nerve cell bodies located in the pterygopalatine fossa Postganglionic parasympathetic fibers that arise in the pterygopalatine ganglion are distributed to the ophthalmic and maxillary divisions of the trigeminal n. to the: ● Lacrimal gland ● Nasal glands ● Palatine glands ● Pharyngeal glands	Lacrimal gland uses the ophthalmic and maxillary divisions **Ophthalmic and Maxillary Division Distribution** Postganglionic fibers travel along the zygomatic branch of the maxillary division for a short distance to enter the orbit A short communicating branch joins the lacrimal n. of the ophthalmic division of the trigeminal n. These fibers innervate: ● Lacrimal gland to cause the secretion of tears

Contents of the Orbit

LACRIMAL APPARATUS *CONTINUED*



19 Clinical Correlate

GLAUCOMA

Damage to the optic nerve often due to increased intraocular pressure

Open Angle Glaucoma

The most common form

Gradual and can result in gradual loss of vision

Intraocular pressure elevates due to insufficient drainage within the eye's canal system located in the angle of the anterior chamber of the anterior segment

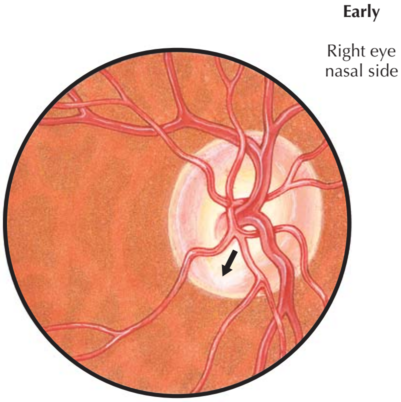
Various medications are successful in treating this form

Closed Angle Glaucoma

Result of an anatomic blockage of the canal system at the angle of the anterior chamber of the anterior segment

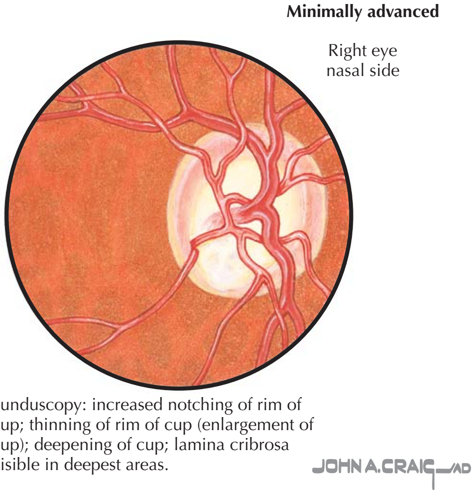
Example: When the iris opens the pupil very wide and blocks the angle, intraocular pressure rises quickly as a result of the possible abrupt blockage

Early



Funduscopy: notching of contour of physiologic cup in optic disc with slight focal pallor in area of notching; occurs almost invariably in superotemporal or inferotemporal (as shown) quadrants

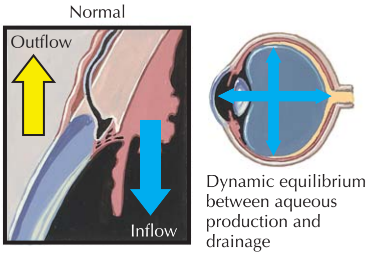
Minimally advanced



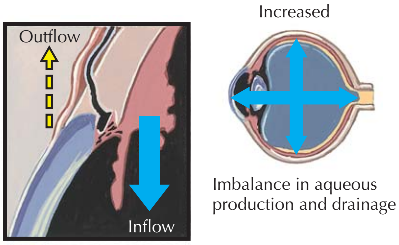
Funduscopy: increased notching of rim of cup; thinning of rim of cup (enlargement of cup); deepening of cup; lamina cribrosa visible in deepest areas.

Clinical Correlate

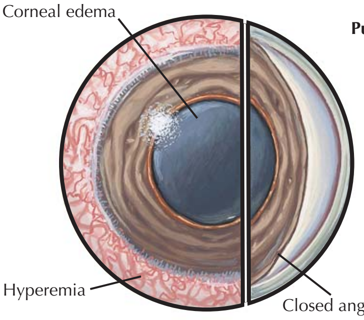
GLAUCOMA *CONTINUED*



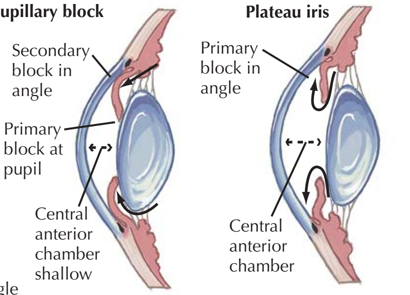
Dynamic equilibrium between aqueous production and drainage



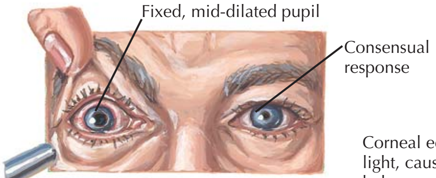
Imbalance in aqueous production and drainage



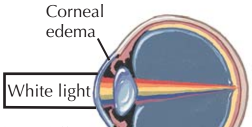
Acute angle closure results in marked increase in intraocular pressure with conjunctival hyperemia, corneal edema, and fixed mid-dilated pupil. Subacute and chronic forms may be asymptomatic.



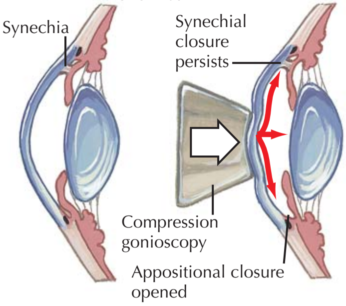
Angle closure may result from primary pupillary block with bulging iris or from less common plateau iris (primary occlusion at periphery of iris)



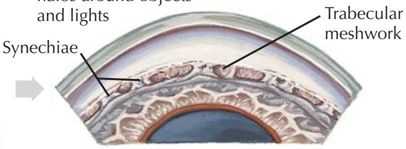
Inflamed eye with nonreactive, mid-dilated pupil typical of acute attack



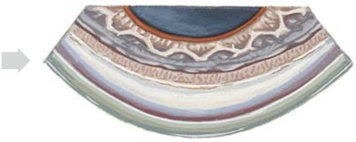
Corneal edema diffracts light, causing rainbow halos around objects and lights



Long-term angle closure may result in synechiae that can permanently close angle. Compression gonioscopy differentiates appositional closure from synechial closure



Synechial closure with peripheral anterior synechiae



Appositional closure opened by compression gonioscopy

Clinical Correlate

DIABETIC RETINOPATHY

Damage to the retina as a result of damage to the blood vessels in the retina due to diabetes

Can occur in all people with diabetes (types 1 and 2)

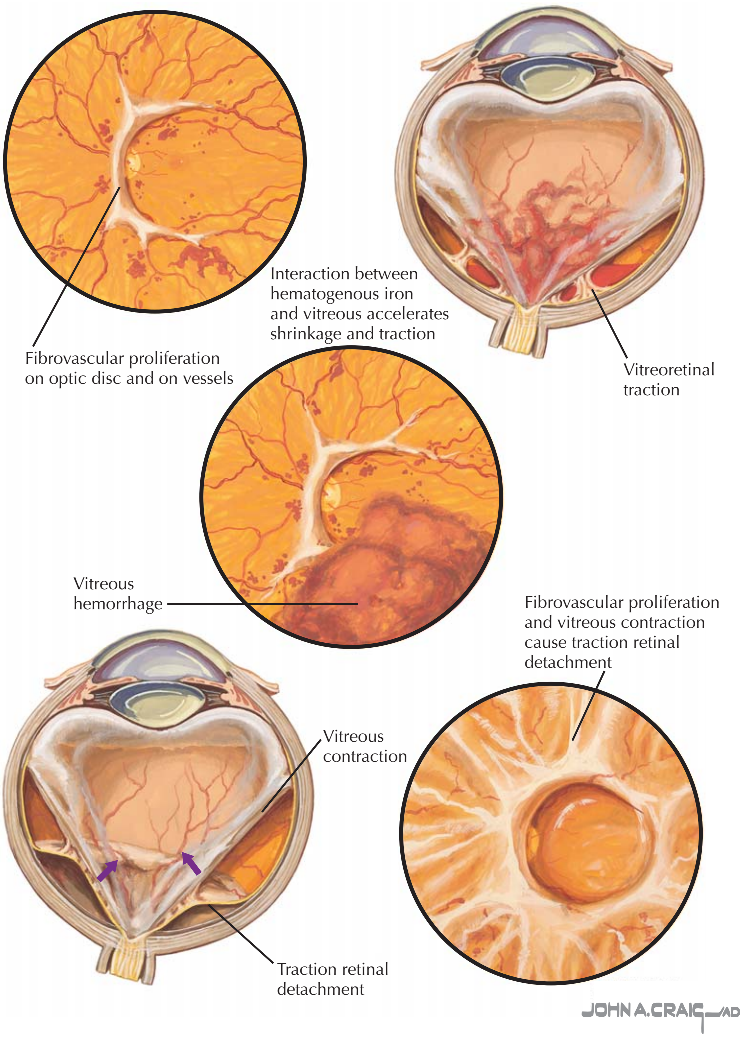
Pathophysiology

As the retinal blood vessels become damaged, they leak fluid into the eye

If the fluid accumulates around the macula lutea (contains the largest amount of cones for acute vision), macula edema occurs in which visual loss is noted

As the permeability of the vessels worsens, lipoprotein is deposited, leading to formation of hard exudates within the retina

As new blood vessels form, they are fragile and bleed, allowing blood to enter the eye, helping to cloud and destroy the retina



Clinical Correlate

AMETROPIAS

A series of refractive disorders of the eye that cause blurring of the image on the retina

Types

Myopia

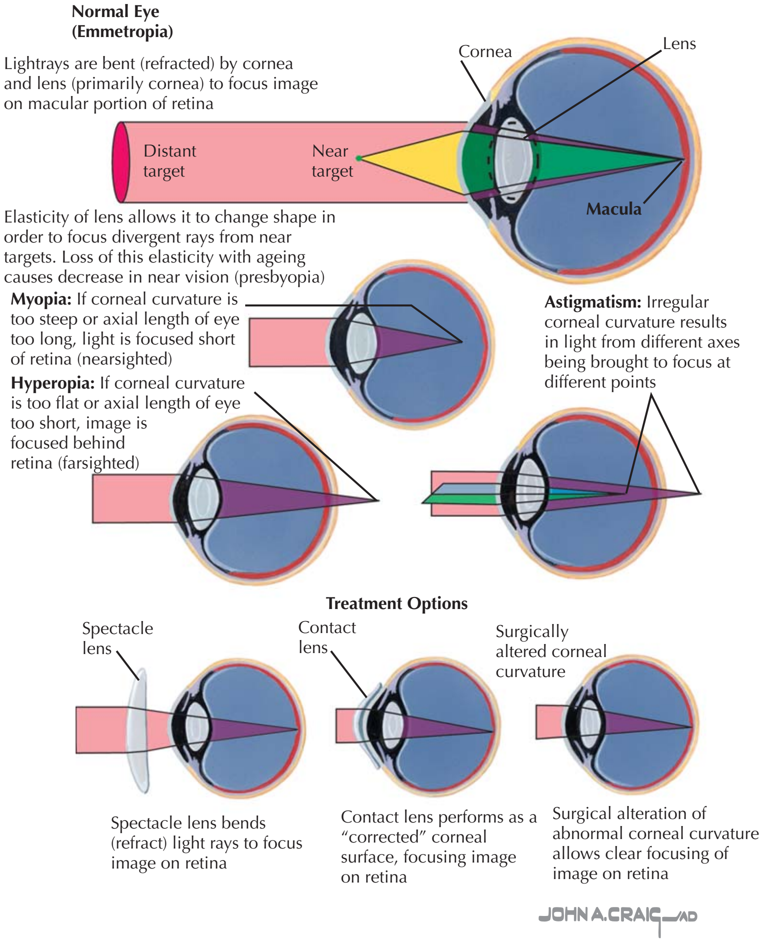
- Image is focused anterior to the retina
- Commonly referred to as nearsightedness

Hyperopia

- Image is focused posterior to the retina
- Commonly referred to as farsightedness

Astigmatism

- A nonspherical eye allows the parts of the image to focus at multiple locations, rather than in a single area



Myopia and Other Refractive Errors

Normal Eye (Emmetropia)

Lightrays are bent (refracted) by cornea and lens (primarily cornea) to focus image on macular portion of retina

Elasticity of lens allows it to change shape in order to focus divergent rays from near targets. Loss of this elasticity with ageing causes decrease in near vision (presbyopia)

Myopia: If corneal curvature is too steep or axial length of eye too long, light is focused short of retina (nearsighted)

Hyperopia: If corneal curvature is too flat or axial length of eye too short, image is focused behind retina (farsighted)

Astigmatism: Irregular corneal curvature results in light from different axes being brought to focus at different points

Treatment Options

Spectacle lens bends (refract) light rays to focus image on retina

Contact lens performs as a "corrected" corneal surface, focusing image on retina

Surgical alteration of abnormal corneal curvature allows clear focusing of image on retina

CHAPTER 20

AUTONOMICS OF THE HEAD AND NECK

20 Overview of the Autonomic Nervous System

GENERAL INFORMATION

The autonomic nervous system (ANS) has control over the function of many organ systems and tissues

Provides innervation to:
- Cardiac muscle
- Smooth muscle
- Glands

Also provides innervation to the organs of the immune system and metabolic organs (mainly through the sympathetics)

The hypothalamus exerts control over the ANS and helps the body maintain homeostasis

The ANS uses a 2-neuron chain system:
- Preganglionic neurons—the cell bodies are located in the central nervous system (CNS) (i.e., the brain and spinal cord), and their myelinated axons pass out to the autonomic ganglia
- Postganglionic neurons—the cell bodies are located in the autonomic ganglia, which are outside of the CNS, and their unmyelinated axons travel to the effector organ

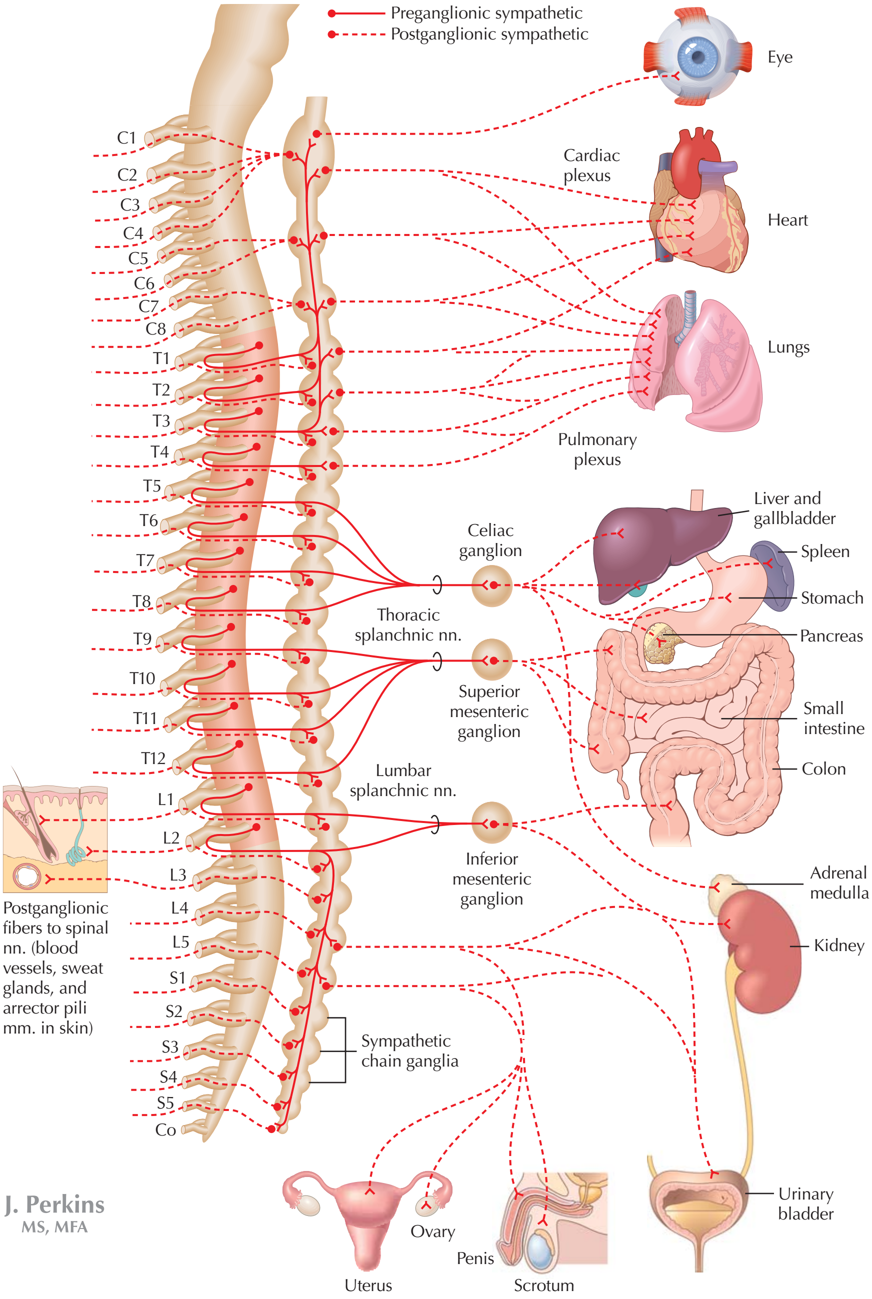
The ANS is divided into 2 parts:
- Parasympathetic—the portion responsible for preserving and restoring energy
- Sympathetic—the portion responsible for preparing the body for emergency situations

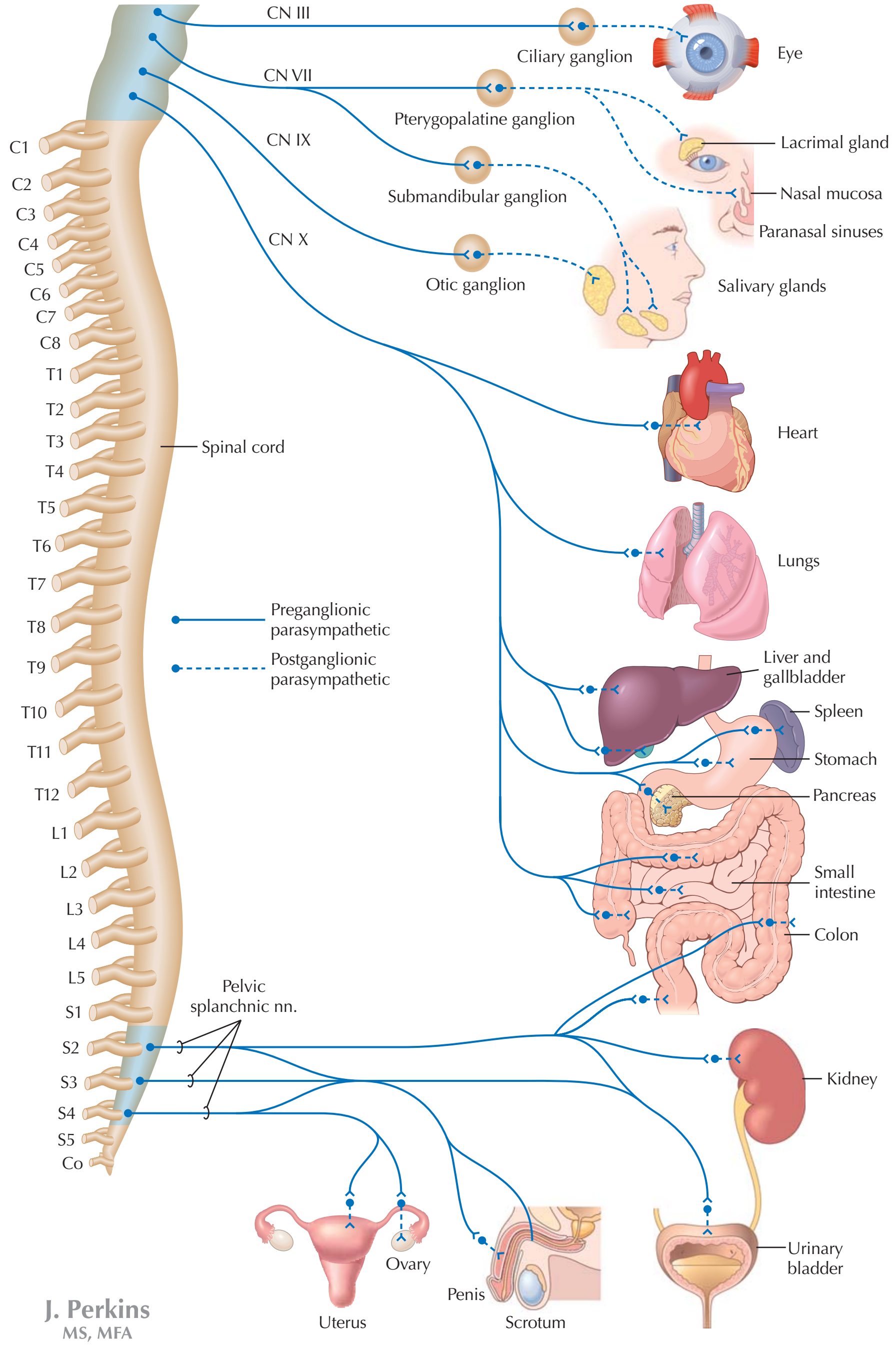
Organs typically receive dual innervation, which has an antagonistic action, although there are some notable exceptions, such as the arrector pili muscles (which are sympathetic only) and the male sexual response (erection is parasympathetic, ejaculation is sympathetic)

Acetylcholine and norepinephrine are the 2 major neurotransmitters used in synapses of the ANS

Overview of the Autonomic Nervous System

GENERAL INFORMATION *CONTINUED*




CN III
Ciliary ganglion
Eye
CN VII
Pterygopalatine ganglion
Lacrimal gland
CN IX
Submandibular ganglion
Nasal mucosa
Paranasal sinuses
CN X
Otic ganglion
Salivary glands
C1
C2
C3
C4
C5
C6
C7
C8
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T11
T12
L1
L2
L3
L4
L5
S1
S2
S3
S4
S5
Co
Spinal cord
Heart
Lungs
Preganglionic parasympathetic
Postganglionic parasympathetic
Liver and gallbladder
Spleen
Stomach
Pancreas
Small intestine
Colon
Pelvic splanchnic nn.
Kidney
Ovary
Uterus
Penis
Scrotum
Urinary bladder
J. Perkins
MS, MFA

Overview of the Autonomic Nervous System

DIVISIONS OF THE AUTONOMIC NERVOUS SYSTEM

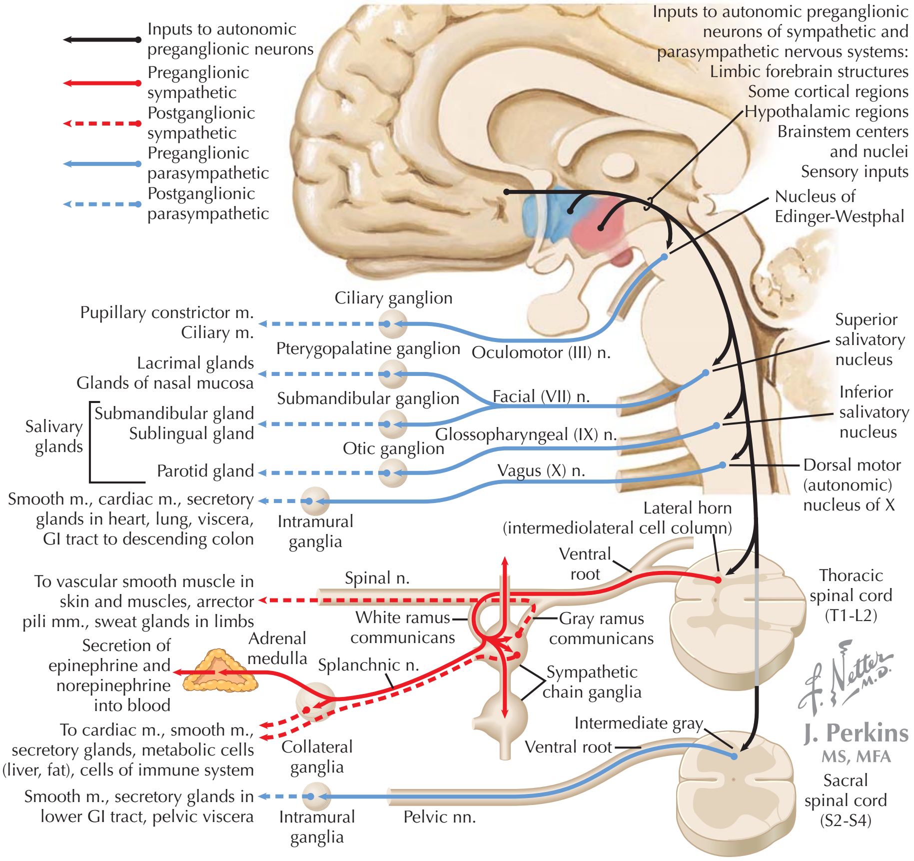
Parasympathetic	Sympathetic
Referred to as craniosacral fibers	Referred to as thoracolumbar fibers
Arise from: • Cranial nerves III, VII, IX, and X • Sacral fibers 2–4	Arise from: • Thoracic fibers 1 to 12 • Lumbar fibers 1 and 2
Preganglionic fibers are myelinated and travel from the CNS to their autonomic ganglia (located near their respective effector organ in the head and neck) utilizing acetylcholine as the neurotransmitter at the synapse with the nicotinic receptor	Preganglionic fibers are myelinated and travel from the CNS to their autonomic ganglia (located in the sympathetic chain for the head and neck) utilizing acetylcholine as the neurotransmitter at the synapse with the nicotinic receptor
Postganglionic fibers are unmyelinated and travel from the autonomic ganglia to the effector organ, utilizing acetylcholine as the neurotransmitter at the synapse with the muscarinic receptor	Postganglionic fibers are unmyelinated and travel from the autonomic ganglia to the effector organ, typically utilizing norepinephrine* as the neurotransmitter at the synapse with the α or β receptor

*Main exception to this is in the adrenal gland, where chromaffin cells secrete epinephrine and norepinephrine into the blood.

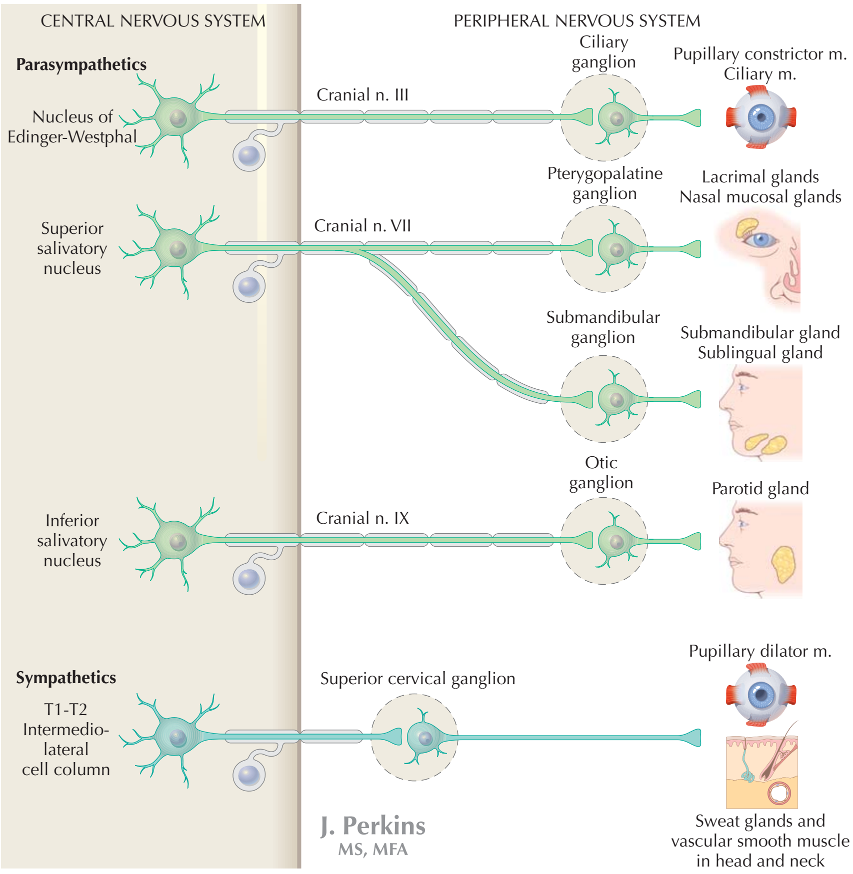
FUNCTIONS OF THE AUTONOMIC NERVOUS SYSTEM

Parasympathetic	Sympathetic
Responsible for preserving and restoring energy	Responsible for preparing the body for emergency situations
Discharges focally, not as a complete system	Discharges as a complete system
Activated in response to the specific body function that needs to be adjusted (peristalsis, pupillary accommodation)	Activated in response to stressful situations (helps to increase cardiac output, get blood to muscles, and decrease blood flow to the skin and viscera)

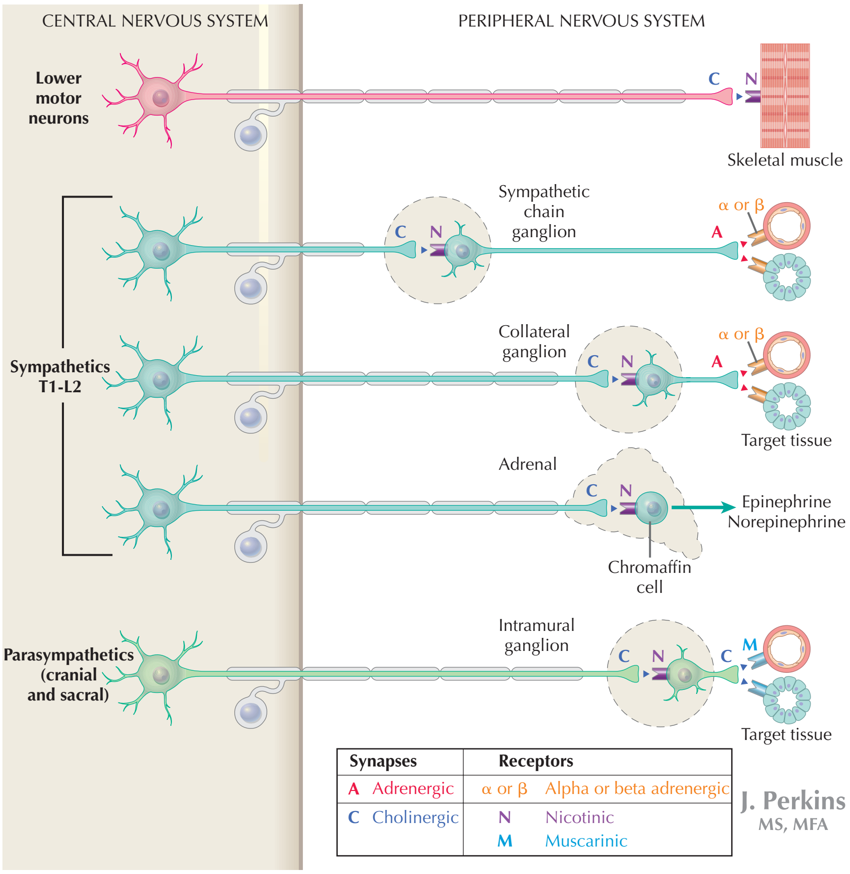
FUNCTIONS OF THE AUTONOMIC NERVOUS SYSTEM *CONTINUED*



FUNCTIONS OF THE AUTONOMIC NERVOUS SYSTEM *CONTINUED*



FUNCTIONS OF THE AUTONOMIC NERVOUS SYSTEM *CONTINUED*



Synapses	Receptors
A Adrenergic	α or β Alpha or beta adrenergic
C Cholinergic	N Nicotinic M Muscarinic

Sympathetics of the Head and Neck

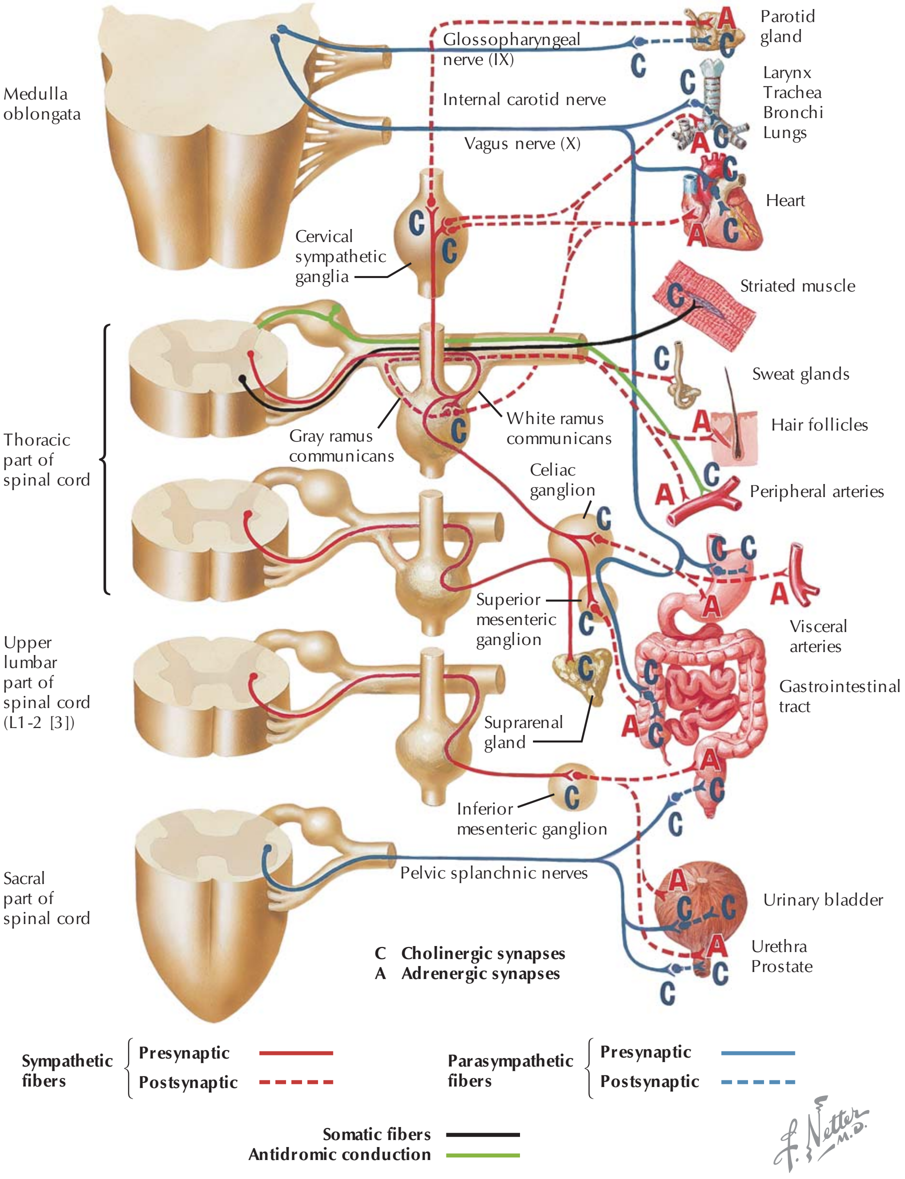
GENERAL ANATOMIC PATHWAY

Type of Neuron	Name of Cell Body	Characteristics of the Cell Body	Course of the Neuron
Preganglionic fibers	Intermediolateral horn nucleus	Collection of nerve cell bodies located in the lateral horn nucleus of the spinal cord between spinal segments T1 and T3 (and possibly T4)	Fibers arise from the intermediolateral horn nuclei from T1 to T3(4) Travel through the ventral root of the spinal cord to the spinal n. Enter the sympathetic chain via a white ramus communicantes Once in the sympathetic chain, the preganglionic fibers will ascend and synapse with postganglionic fibers in the various sympathetic chain ganglia A majority of the preganglionic fibers will synapse with postganglionic fibers in the superior cervical ganglion, located at the base of the skull
Postganglionic fibers	Superior cervical ganglion* (major part of head and neck)	Collection of nerve cell bodies located in the sympathetic chain The location of the nerve cell body for a majority of the postganglionic neurons is the superior cervical ganglion Others include the middle and inferior cervical ganglia	Postganglionic fibers arise in their respective sympathetic chain ganglia (e.g., superior cervical, middle cervical, inferior cervical nn.) Some of the postganglionic fibers that travel to the periphery (e.g., skin of the neck, blood vessels) will rejoin the spinal nerves in the cervical region via a gray ramus communicantes, to be distributed along the path of the peripheral nerves following the path with blood vessels A majority of the postganglionic fibers join the major blood vessels of the head (namely, the internal carotid a. and branches of the external carotid a.) to follow the vessel until reaching their final effector organ (e.g., dilator pupillae m. of the eye)

*Location of the cell body for the postganglionic is variable and depends on the course of this neuron.

20 Sympathetics of the Head and Neck

GENERAL ANATOMIC PATHWAY *CONTINUED*



Parasympathetic Pathways of the Head and Neck

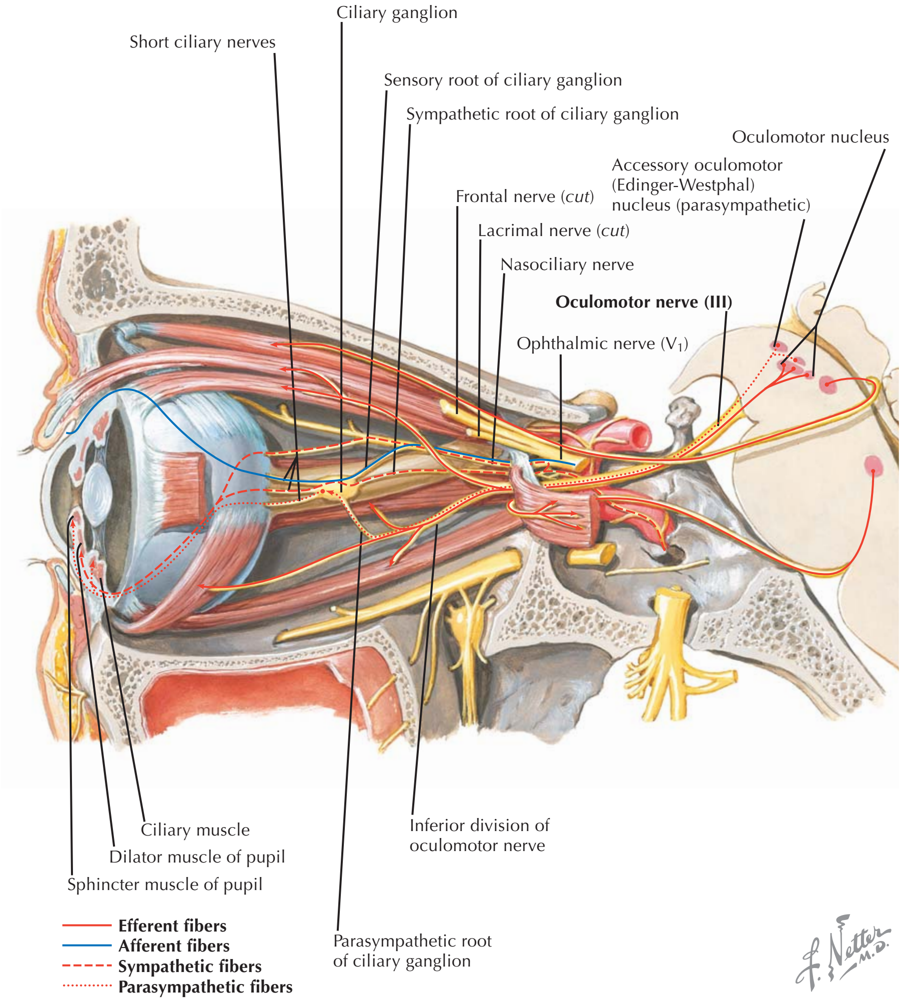
CRANIAL NERVE III WITH CORRESPONDING SYMPATHETICS

ANATOMIC PATHWAY FOR PARASYMPATHETICS OF THE EYE			
Type of Neuron	**Name of Cell Body**	**Characteristics of the Cell Body**	**Course of the Neuron**
Preganglionic neuron	Edinger-Westphal nucleus	A collection of nerve cell bodies located in the midbrain The Edinger-Westphal nucleus is found medial to the oculomotor nucleus and lateral to the cerebral aqueduct	Fibers arise from the Edinger-Westphal nucleus in the midbrain from the oculomotor n. Oculomotor n. passes anteriorly on the lateral wall of the cavernous sinus immediately superior to the trochlear n. Immediately before entering the orbit, the nerve divides into superior and inferior divisions of the oculomotor Both the superior and the inferior divisions of the oculomotor enter the orbit through the superior orbital fissure Preganglionic parasympathetic fibers travel in the inferior division A small parasympathetic root passes from the inferior division of the oculomotor to the ciliary ganglion carrying the preganglionic parasympathetic fibers
Postganglionic neuron	Ciliary ganglion	Located anterior to the optic foramen between the optic n. and the lateral rectus m. 3 roots connect to the ciliary ganglion: • Sensory root from the ophthalmic division of the trigeminal n., which carries general sensation fibers to the eye via the short ciliary n. • Parasympathetic root from the inferior division of the oculomotor n., carrying preganglionic parasympathetic fibers to the ganglion • Sympathetic root, which arises from the postganglionic sympathetic fibers that were carried by the internal carotid a. The short ciliary nn., usually numbering about 8 total, arise from the ciliary ganglion to enter the posterior portion of the eye Fibers from all 3 roots pass through the ciliary ganglion and short ciliary nn. to enter the eye Only the parasympathetic fibers synapse in the ciliary ganglion	Fibers arise in the ciliary ganglion following a synapse with the preganglionic parasympathetic fibers Travel through the short ciliary nn. to enter the eye's posterior portion Innervate the: • Sphincter pupillae m.—constricts the pupil • Ciliary m.—changes the shape of the lens during accommodation

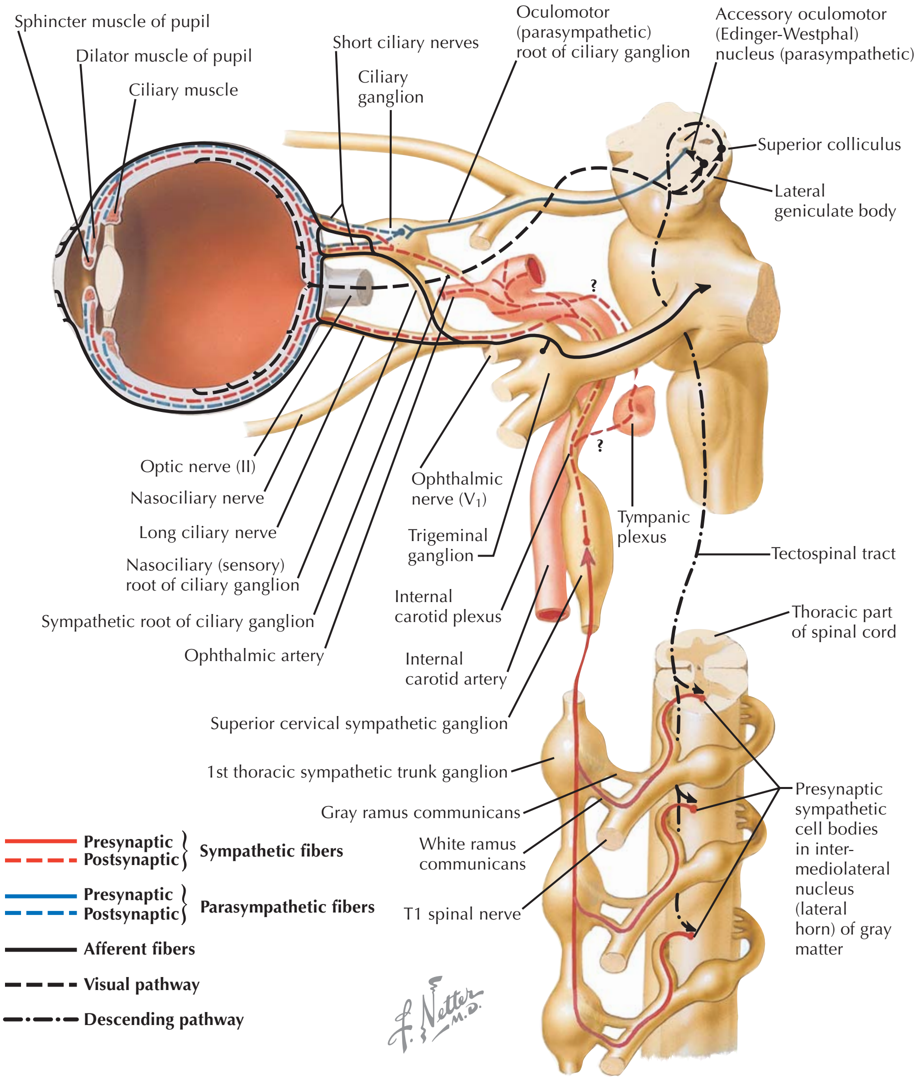
CRANIAL NERVE III WITH CORRESPONDING SYMPATHETICS *CONTINUED*

ANATOMIC PATHWAY FOR SYMPATHETICS OF THE EYE			
Type of Neuron	**Name of Cell Body**	**Characteristics of the Cell Body**	**Course of the Neuron**
Preganglionic neuron	Intermediolateral horn nucleus	Collection of nerve cell bodies located in the lateral horn nucleus of the spinal cord between spinal segments T1 and T3 (and possibly T4)	Fibers arise from the intermediolateral horn nuclei from T1 to T3(4) Travel through the ventral root of the spinal cord to the spinal n. Enter the sympathetic chain via a white ramus communicantes Once in the sympathetic chain, the preganglionic fibers for the eye will ascend and synapse with postganglionic fibers in the superior cervical ganglion
Postganglionic neuron	Superior cervical ganglion	Collection of nerve cell bodies located in the superior cervical ganglion, which is located at the base of the skull	Fibers arise in the superior cervical ganglion Postganglionic fibers will follow the internal carotid a. on the carotid plexus As the internal carotid nears the orbit, the postganglionic fibers branch and follow various structures that connect to the eye, such as the ophthalmic a. and its branches, and the long ciliary nn. that arise from the ophthalmic division of the trigeminal n. In the eye, the postganglionic fibers innervate the eye's dilator pupillae m.

CRANIAL NERVE III WITH CORRESPONDING SYMPATHETICS *CONTINUED*



CRANIAL NERVE III WITH CORRESPONDING SYMPATHETICS *CONTINUED*



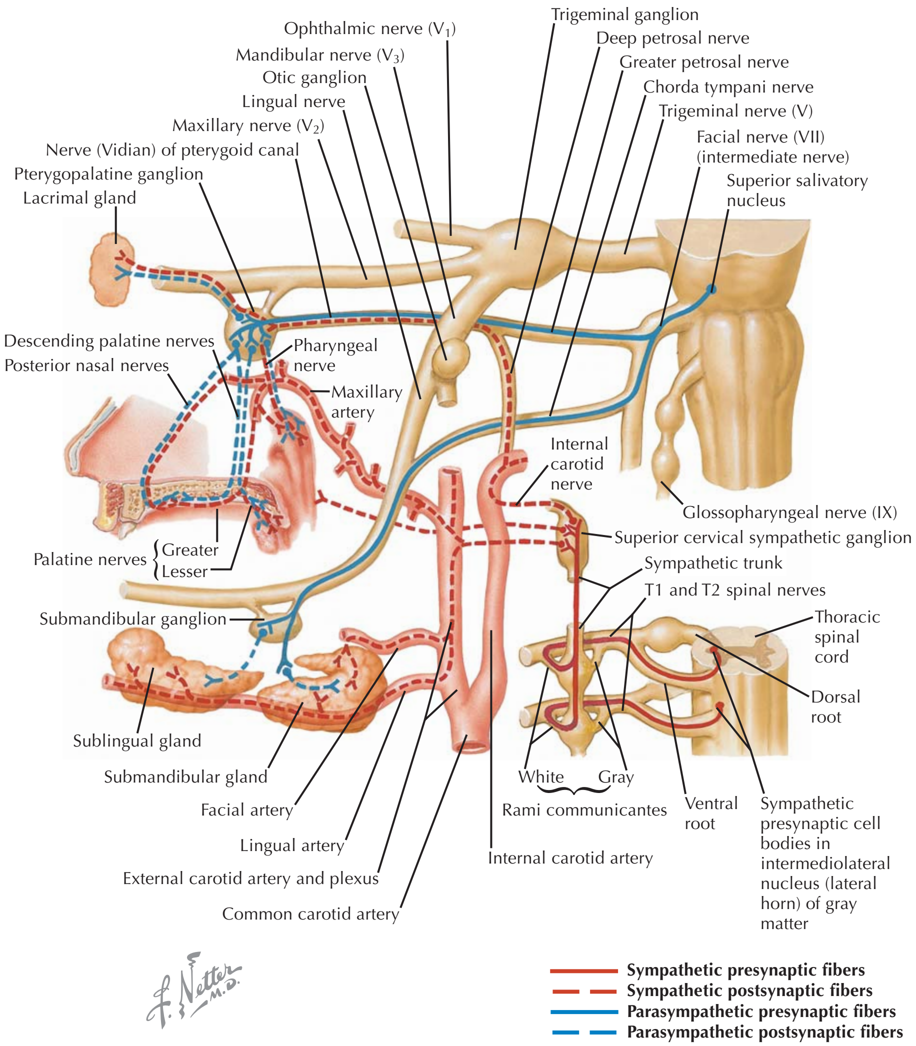
Parasympathetic Pathways of the Head and Neck

CRANIAL NERVE VII

ANATOMIC PATHWAY FOR PARASYMPATHETICS OF THE LACRIMAL, NASAL, PALATINE, PHARYNGEAL, SUBMANDIBULAR, AND SUBLINGUAL GLANDS

Type of Neuron	Name of Cell Body	Characteristics of the Cell Body	Course of the Neuron
Preganglionic neuron	Superior salivatory nucleus	A collection of nerve cell bodies located in the pons Travel through the nervus intermedius of the facial n. into the internal acoustic meatus In the facial canal, the facial n. gives rise to 2 parasympathetic branches: • Greater petrosal n. • Chorda tympani n.	**Greater Petrosal Nerve** • Exits along the hiatus for the greater petrosal n. toward the foramen lacerum, where it joins the deep petrosal n. (sympathetics) to form the nerve of the pterygoid canal (vidian n.) • Vidian n. passes through the pterygoid canal and enters the pterygopalatine fossa, where it joins with the pterygopalatine ganglion **Chorda Tympani Nerve** • Exits the petrotympanic fissure to enter the infratemporal fossa, where it joins the lingual n. • Preganglionic fibers travel with the lingual n. into the floor of the oral cavity, where it joins with the submandibular ganglion
Postganglionic neuron	Pterygopalatine ganglion	A collection of nerve cell bodies located in the pterygopalatine fossa Postganglionic parasympathetic fibers that arise in the pterygopalatine ganglion are distributed to the ophthalmic and maxillary divisions of the trigeminal n. to the: • Lacrimal gland • Nasal glands • Palatine glands • Pharyngeal glands	**Ophthalmic and Maxillary Division Distribution** Postganglionic fibers travel along the zygomatic branch of the maxillary division for a short distance to enter the orbit A short communicating branch joins the lacrimal n. of the ophthalmic division of the trigeminal n. These fibers innervate: • Lacrimal gland to cause the secretion of tears **Maxillary Division Distribution** Postganglionic fibers travel along the maxillary division of the trigeminal n. to be distributed along its branches that are located in the nasal cavity, oral cavity, and pharynx (e.g., nasopalatine, greater palatine) These fibers innervate: • Nasal glands • Palatine glands • Pharyngeal glands
	Submandibular ganglion	A collection of nerve cell bodies that is located in the oral cavity It is suspended from the lingual n. at the posterior border of the mylohyoid m. immediately superior to the deep portion of the submandibular gland	Postganglionic parasympathetic fibers arise in the submandibular ganglion and are distributed to the: • Submandibular gland • Sublingual gland

CRANIAL NERVE VII *CONTINUED*



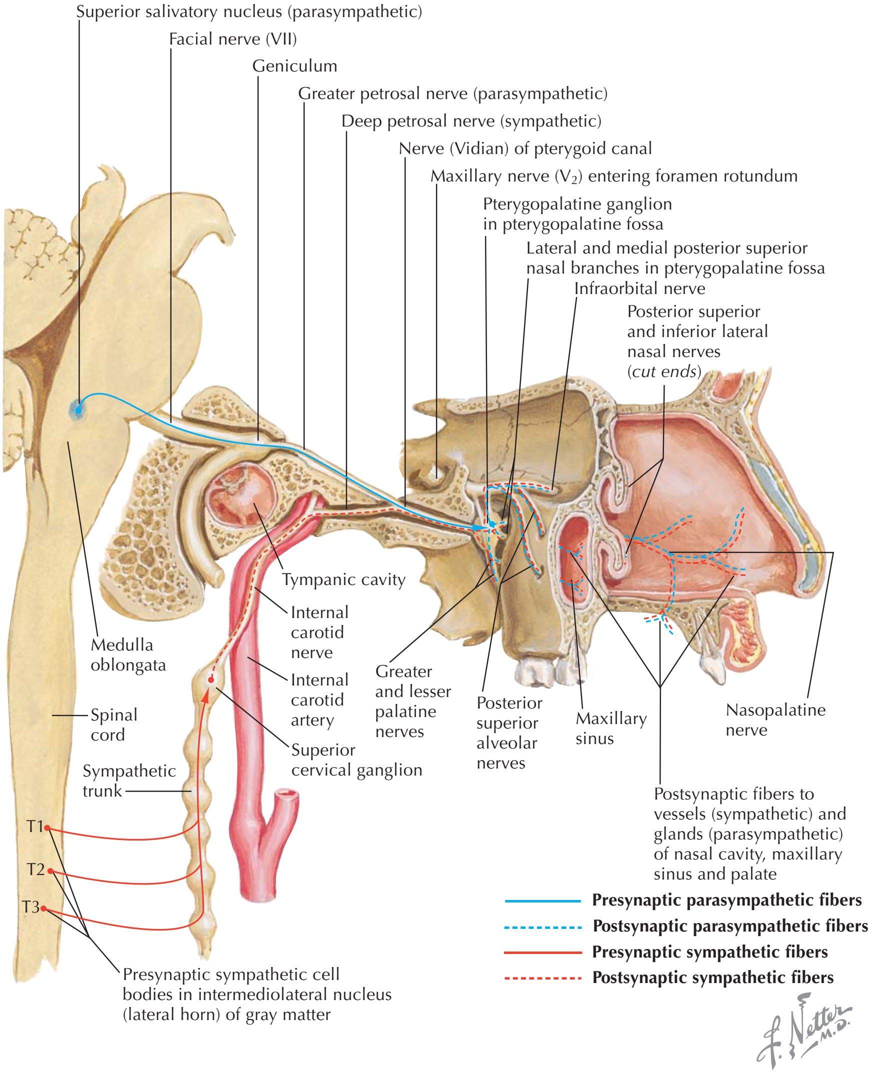
CRANIAL NERVE VII *CONTINUED*

ANATOMIC PATHWAY FOR SYMPATHETICS OF THE NASAL CAVITY, LACRIMAL GLAND, PALATE, AND SUBMANDIBULAR AND SUBLINGUAL GLANDS

Type of Neuron	Name of Cell Body	Characteristics of the Cell Body	Course of the Neuron
Preganglionic neuron	Intermediolateral horn nucleus	Collection of nerve cell bodies located in the lateral horn nucleus of the spinal cord between spinal segments T1 and T3 (and possibly T4)	Fibers arise from the intermediolateral horn nuclei from T1 to T3 (4) Travel through the ventral root of the spinal cord to the spinal nerve Enter the sympathetic chain via a white ramus communicantes Once in the sympathetic chain, the preganglionic fibers for the eye will ascend and synapse with postganglionic fibers in the superior cervical ganglion
Postganglionic neuron	Superior cervical ganglion	Collection of nerve cell bodies located in the superior cervical ganglion, which is located at the base of the skull Postganglionic sympathetic fibers follow the internal carotid or external carotid a. to pass near their respective effector organs: • Nasal cavity • Palate • Lacrimal gland • Submandibular gland • Sublingual gland	**Nasal Cavity and Palate** • Postganglionic sympathetic fibers follow both the *internal* and *external carotid* aa. • Postganglionic sympathetic fibers from the internal carotid branch in the region of the foramen lacerum to form the deep petrosal n. • The deep petrosal n. joins the greater petrosal n. (parasympathetics) to form the nerve of the pterygoid canal (vidian n.) • Postganglionic sympathetic fibers travel along the branches of the maxillary division of the trigeminal n. associated with the pterygopalatine ganglion to be distributed along its branches in the nasal cavity and palate • Postganglionic sympathetic fibers from the external carotid branch and follow the maxillary a. • These fibers travel along the branches of the maxillary a. to be distributed along the nasal cavity and palate **Lacrimal Gland** • Postganglionic sympathetic fibers follow the internal carotid a. • Postganglionic sympathetic fibers from the internal carotid branch off in the region of the foramen lacerum to form the deep petrosal nerve • The deep petrosal n. joins the greater petrosal n. (parasympathetics) to form the nerve of the pterygoid canal (vidian n.) • Postganglionic fibers travel along the zygomatic branch of the maxillary division for a short distance to enter the orbit • A short communicating branch joins the lacrimal n. of the ophthalmic division of the trigeminal n. • These fibers are distributed to the lacrimal gland **Submandibular and Sublingual Glands** • Postganglionic sympathetic fibers follow the external carotid a. • Postganglionic sympathetic fibers branch off the external carotid to follow the arteries that supply the submandibular and sublingual glands

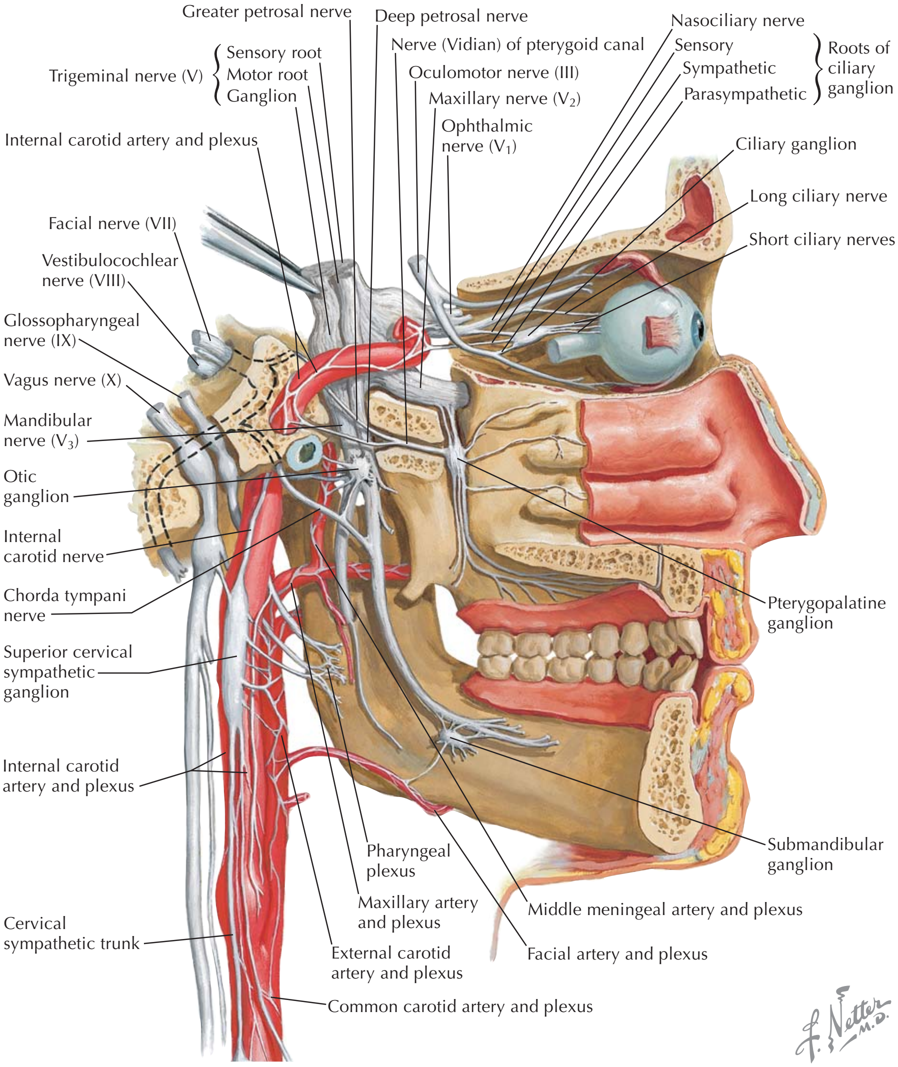
20 Parasympathetic Pathways of the Head and Neck

CRANIAL NERVE VII *CONTINUED*



Parasympathetic Pathways of the Head and Neck

CRANIAL NERVE VII *CONTINUED*

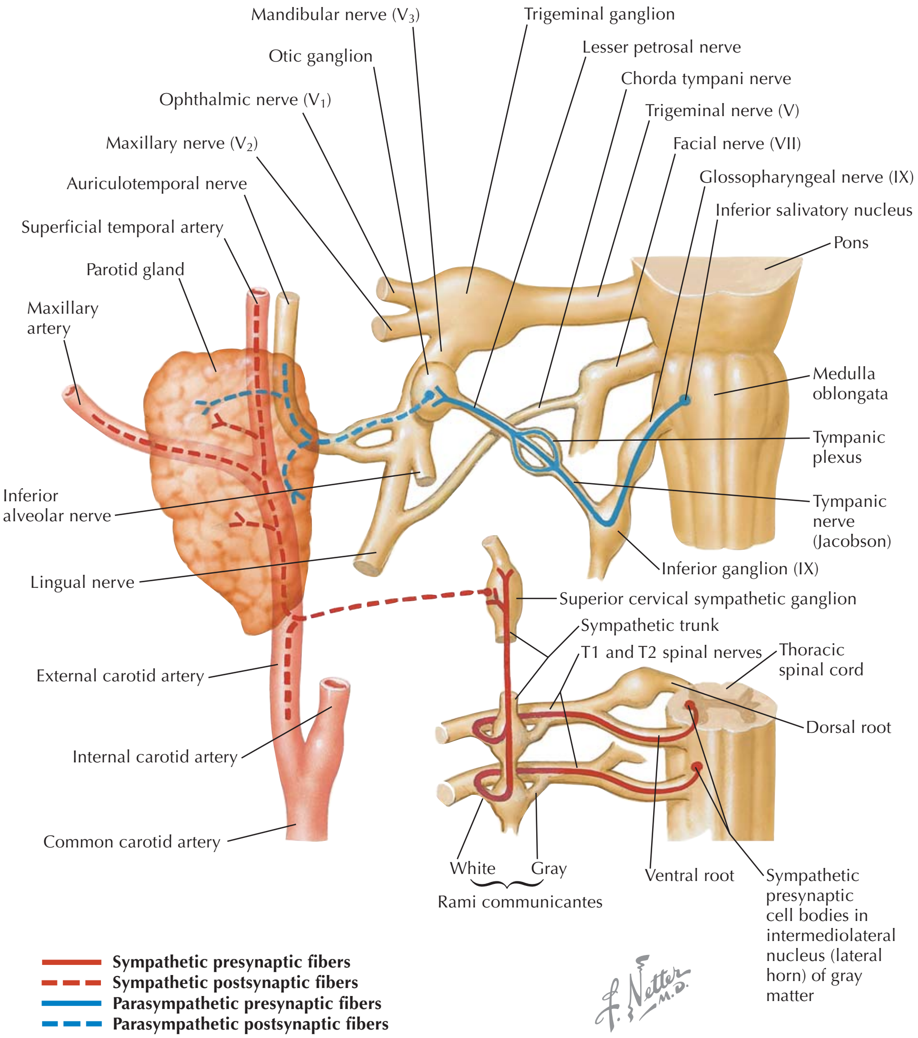


20 Parasympathetic Pathways of the Head and Neck

CRANIAL NERVE IX WITH CORRESPONDING SYMPATHETICS

ANATOMIC PATHWAY FOR PARASYMPATHETICS OF THE PAROTID GLAND			
Type of Neuron	**Name of Cell Body**	**Characteristics of the Cell Body**	**Course of the Neuron**
Preganglionic neuron	Inferior salivatory nucleus	A collection of nerve cell bodies located in the medulla	Preganglionic parasympathetic fibers arise from the inferior salivatory nucleus in the medulla Travel through the glossopharyngeal n. and exit the jugular foramen Gives rise to the tympanic branch of IX, which reenters the skull via the tympanic canaliculus The tympanic branch of IX forms the tympanic plexus along the promontory of the ear The plexus re-forms as the lesser petrosal n., which typically exits the foramen ovale to enter the infratemporal fossa Lesser petrosal n. joins the otic ganglion
Postganglionic neuron	Otic ganglion	A collection of nerve cell bodies located inferior to the foramen ovale medial to the mandibular division of the trigeminal n.	Postganglionic parasympathetic fibers arise in the otic ganglion These fibers travel to the auriculotemporal branch of the trigeminal n. Auriculotemporal n. travels to the parotid gland Postganglionic parasympathetic fibers innervate the: • Parotid gland

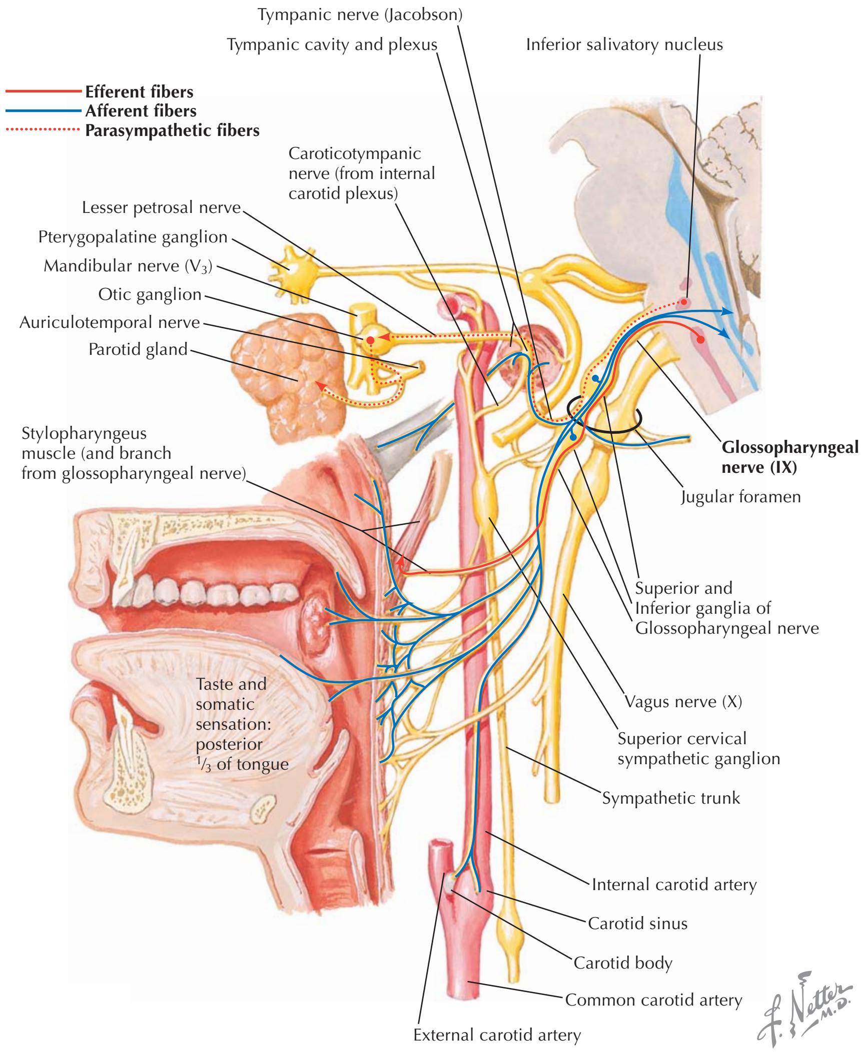
CRANIAL NERVE IX WITH CORRESPONDING SYMPATHETICS *CONTINUED*



CRANIAL NERVE IX WITH CORRESPONDING SYMPATHETICS *CONTINUED*

ANATOMIC PATHWAY FOR PARASYMPATHETICS OF THE EYE			
Type of Neuron	**Name of Cell Body**	**Characteristics of the Cell Body**	**Course of the Neuron**
Preganglionic neuron	Intermediolateral horn nucleus	Collection of nerve cell bodies located in the lateral horn nucleus of the spinal cord between spinal segments T1 and T3 (and possibly T4)	Fibers arise from the intermediolateral horn nuclei from T1 to T3 (4) Travel through the ventral root of the spinal cord to the spinal n. Enter the sympathetic chain via a white ramus communicantes Once in the sympathetic chain, the preganglionic fibers for the eye will ascend and synapse with postganglionic fibers in the superior cervical ganglion
Postganglionic neuron	Superior cervical ganglion	Collection of nerve cell bodies located in the superior cervical ganglion, which is located at the base of the skull	Fibers arise in the superior cervical ganglion Postganglionic fibers will follow the external carotid a. Branches from the external carotid a. follow the arteries that supply the parotid gland

CRANIAL NERVE IX WITH CORRESPONDING SYMPATHETICS *CONTINUED*



20 Parasympathetic Pathways of the Head and Neck

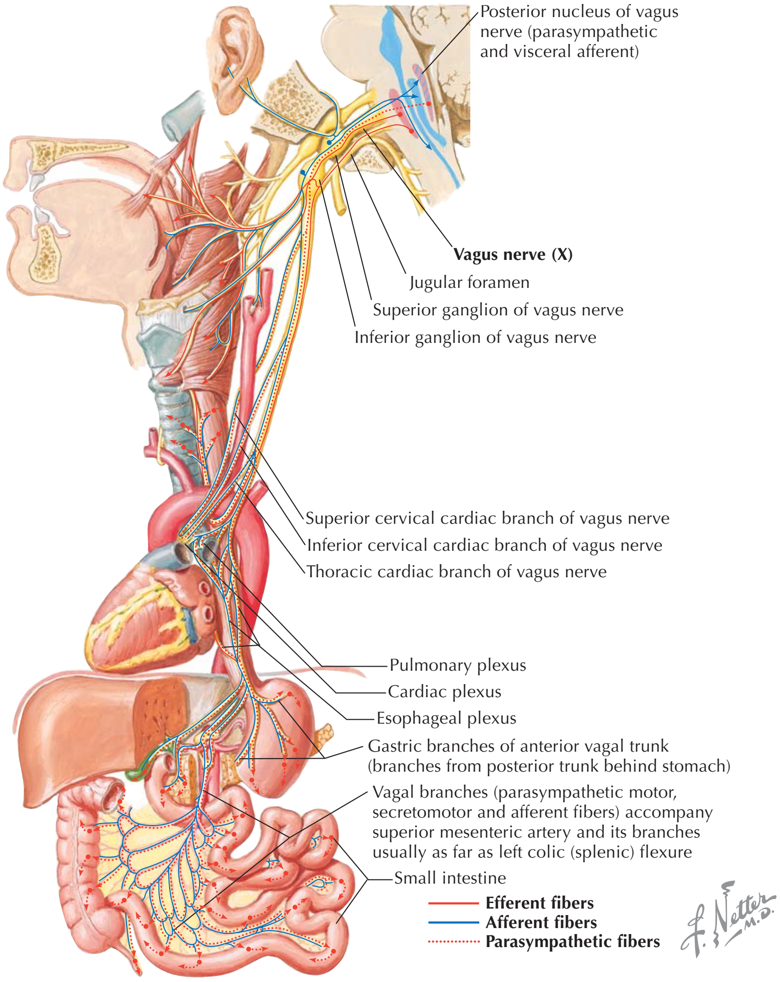
CRANIAL NERVE X

ANATOMIC PATHWAY FOR PARASYMPATHETICS OF THE VAGUS NERVE*			
Type of Neuron	**Name of Cell Body**	**Characteristics of the Cell Body**	**Course of the Neuron**
Preganglionic neuron	Dorsal motor nucleus	A collection of nerve cell bodies located in the medulla	Preganglionic fibers arise from the dorsal motor nucleus of the vagus in the medulla* Travel through the vagus n. and exit the jugular foramen Various branches connect to intramural ganglia in the thorax and abdomen
Postganglionic neuron	Intramural ganglion	A collection of nerve cell bodies located within the walls of the individual organ	Postganglionic fibers arise in the intramural ganglia These fibers travel to the various effector organs: • Cardiac muscle • Smooth muscle of vasculature • Glands

*The vagus n. arises in the brainstem but provides parasympathetic innervation to the thorax and greater part of the abdomen, rather than the head and neck. The sympathetics that follow the vagus n. to the thorax and greater part of the abdomen, as well as the sympathetics that follow the parasympathetic pelvic splanchnic nerves, arise from the various paravertebral and prevertebral ganglia associated with the sympathetic chain.

Parasympathetic Pathways of the Head and Neck

CRANIAL NERVE X *CONTINUED*



20 Clinical Correlate

HORNER'S SYNDROME

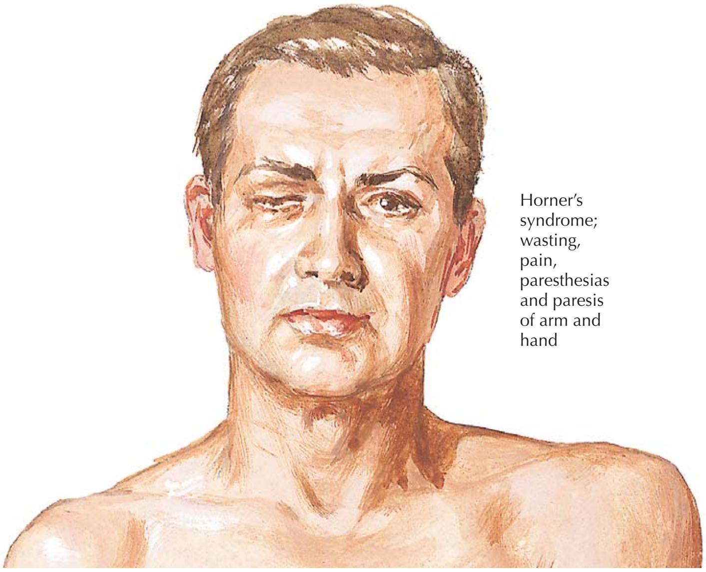
Results from injury or undue stimulus to the sympathetic nerves of the head and neck

Causes may include:
- Stroke
- Neck trauma
- Carotid artery injury
- Pancoast tumors
- Cluster headaches

Pharmacologic tests can help localize which part of the sympathetic pathway has been affected

Treatment depends on the cause (e.g., removal of a tumor)

Clinical manifestations include:
- Miosis (constriction of pupil)
- Ptosis (drooping of eyelid)
- Anhidrosis (decreased sweating)



Horner's syndrome; wasting, pain, paresthesias and paresis of arm and hand

CHAPTER 21

INTRAORAL INJECTIONS

21 Overview and Topographic Anatomy

GENERAL INFORMATION

Intraoral injections provide adequate pain control for various dental procedures

Many techniques have been developed

All require detailed understanding of head and neck anatomy to maximize proper administration and minimize complications

Injections should not be performed in areas of infection or inflammation

The application of topical anesthetic to the site of injection will help lessen the pain caused by the insertion of the needle

Classification

- Local injections (field blocks)
- Nerve blocks

Common Blocks

Mandibular:

- Inferior alveolar
- Long buccal
- Mental
- Gow-Gates
- Akinosi

Maxillary:

- Posterior superior alveolar
- Nasopalatine
- Greater palatine
- Infraorbital
- Maxillary division

Mandibular Injections

INNERVATION AND OSTEOLOGY LANDMARKS

Mandible: General Considerations and Landmarks

The strongest and largest facial bone

Composed of 2 pieces of thick cortical bone: a lingual plate and a buccal plate

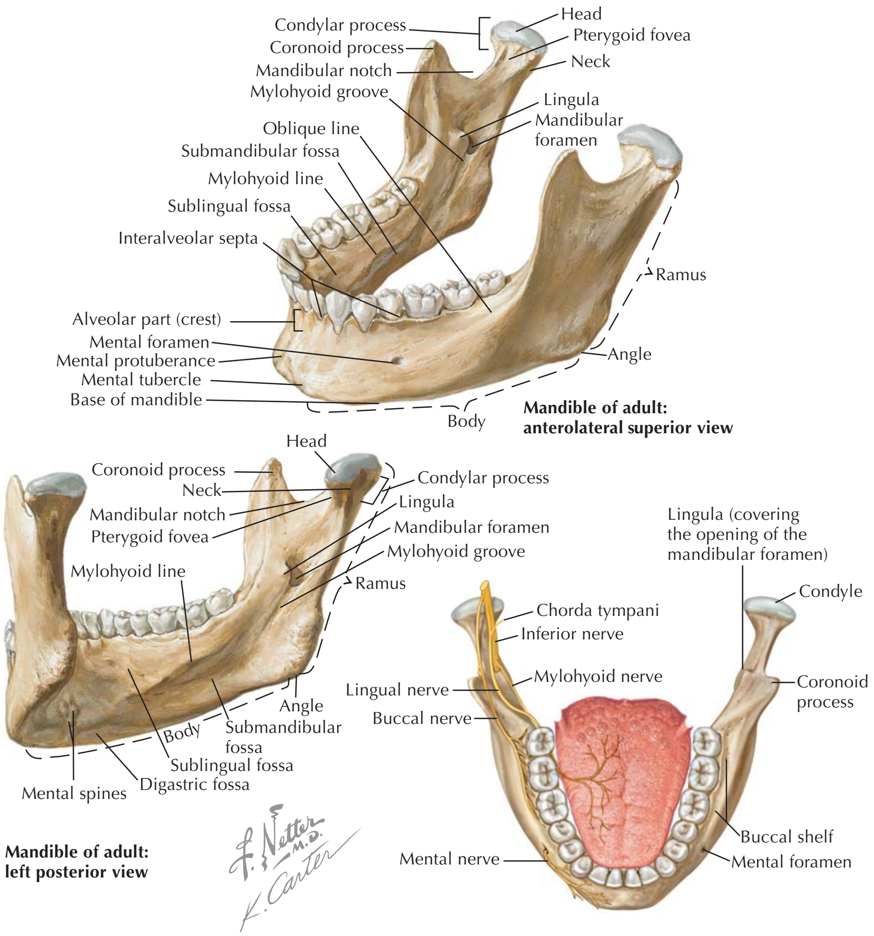
Teeth are contained in the horseshoe-shaped body

Ramus extends superiorly from the angle of the mandible

The coronoid notch is the concavity on the anterior portion of the ramus used to estimate the height of the mandibular foramen, which also is located at the height of the occlusal plane

Associated Nerves

- Inferior alveolar nerve enters the mandible at the mandibular foramen
- Lingual nerve enters the oral cavity passing against the lingual tuberosity
- Buccal nerve lies on the buccal shelf



Mandible of adult: anterolateral superior view

Mandible of adult: left posterior view

21 Mandibular Injections

INFERIOR ALVEOLAR NERVE BLOCK

OVERVIEW

Clinically acceptable mandibular anesthesia is more difficult to achieve than maxillary anesthesia because of the thickness of the cortical bone

Requires anesthetic deposition in the pterygomandibular space at the region of the mandibular foramen lateral to the sphenomandibular ligament

Requires proper needle penetration and correct needle angulation in the pterygomandibular space

Properly performed, it anesthetizes 2 nerves:

- Inferior alveolar nerve (and its branches—the incisive and mental nerves)
- Lingual nerve

Areas anesthetized:

- All mandibular teeth (inferior alveolar nerve)
- Epithelium of the anterior 2/3rds of the tongue (lingual nerve)
- All lingual gingiva and lingual mucosa (lingual nerve)
- All buccal gingiva and mucosa from the premolars to the midline (mental nerve)
- Skin of the lower lip (mental nerve)

GENERAL METHODOLOGY

Steps:

- Insert the needle into the mucosa between the deepest portion of the coronoid notch (which should represent the vertical height of the mandibular foramen) and just lateral to the pterygomandibular raphe
- Orient the needle from the contralateral premolars and advance it along the occlusal plane of the mandible
- The needle contacts the mandible after entering 20 to 25 mm (if bone is contacted immediately on penetration into the mucosa, then the temporal crest has been contacted; the needle should be reoriented to allow insertion to the proper depth)
- Withdraw the needle slightly and perform aspiration to determine whether the needle is in a blood vessel (inferior alveolar vessels)
- After a negative result on aspiration (no blood observed in the syringe), slowly inject the anesthetic into the pterygomandibular space
- If the result of aspiration is positive, readjust the needle position and perform aspiration again before injecting into the pterygomandibular space

CONSIDERATIONS

In *children,* the mandibular foramen is located closer to the posterior border of the mandible until more bone is added with age

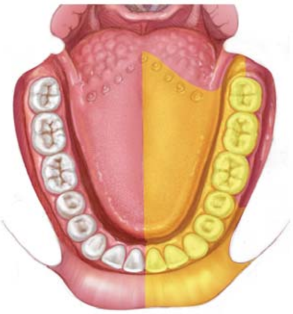
In *edentulous patients,* the alveolar bone is lost; thus, the deepest part of the coronoid notch is lower than normal, which could lead the clinician to aim the needle too low

In *class II patients,* the mandibular foramen is located superior to the deepest portion of the coronoid notch, which could lead the clinician to aim the needle too low

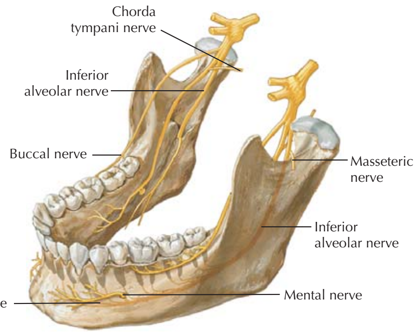
A transient, dental induced *Bell's palsy* can result if the needle is placed too far posteriorly in the parotid bed and anesthetic is introduced close to the facial nerve

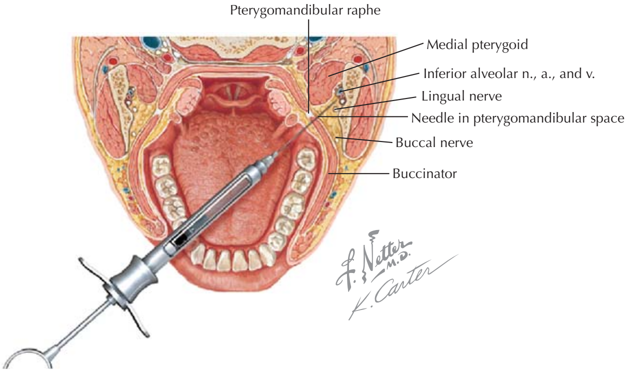
Mandibular Injections

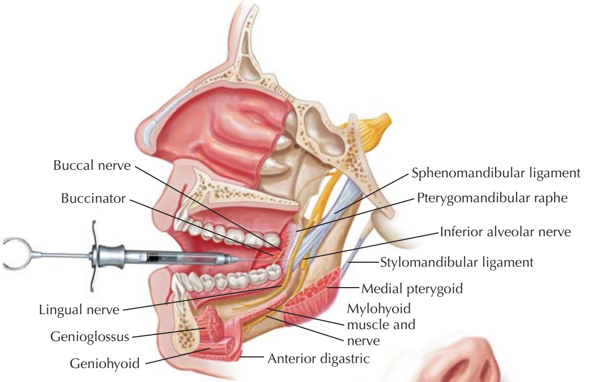
INFERIOR ALVEOLAR NERVE BLOCK *CONTINUED*

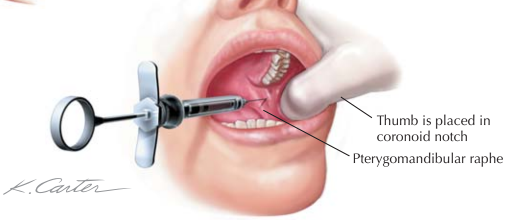


Area anesthetized by an inferior alveolar injection









21 Mandibular Injections

LONG BUCCAL NERVE BLOCK

OVERVIEW

A branch of the mandibular division of the trigeminal nerve, the long buccal nerve is not anesthetized in an inferior alveolar injection

This block anesthetizes all buccal gingiva opposite the mandibular molars, including the retromolar trigone

GENERAL METHODOLOGY

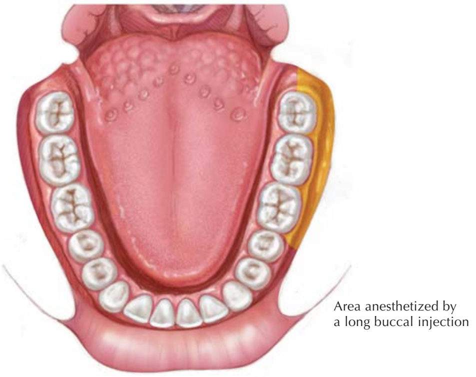
Steps:

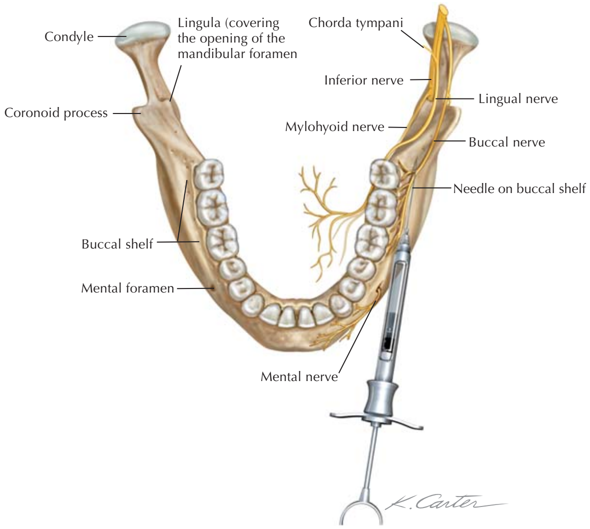
- Insert the needle into the mucosa posterior to the last molar in the mandibular arch on the buccal side (the needle will be inserted a very short distance—about 2 mm)
- Perform aspiration; after a negative result, inject the anesthetic

CONSIDERATIONS

A hematoma is rare with this block

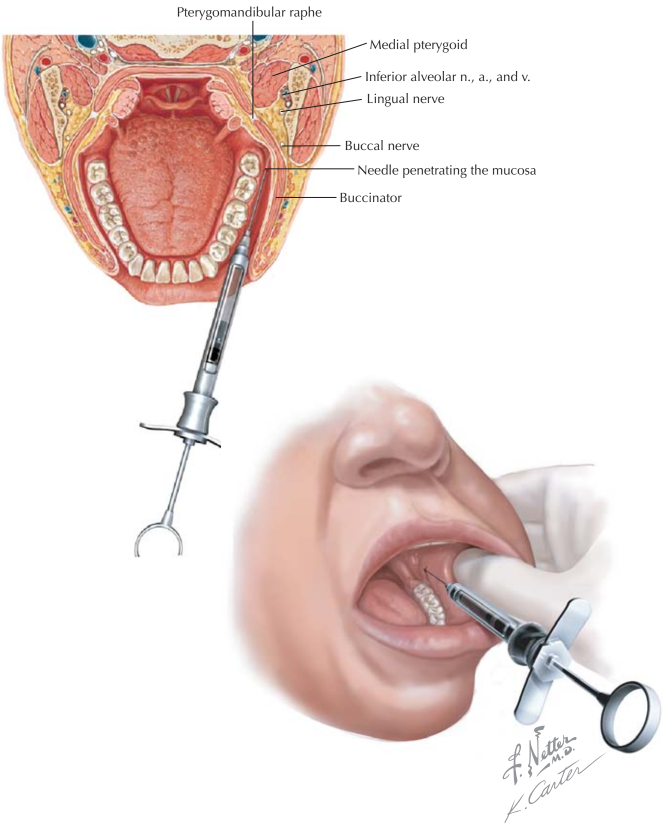
This injection seldom fails





Mandibular Injections

LONG BUCCAL NERVE BLOCK *CONTINUED*



MENTAL NERVE BLOCK

OVERVIEW

A branch of the inferior alveolar nerve within the mandibular canal

Areas anesthetized:
- All buccal gingiva and mucosa from the premolars to the midline (mental nerve)
- Skin of the lower lip (mental nerve)

GENERAL METHODOLOGY

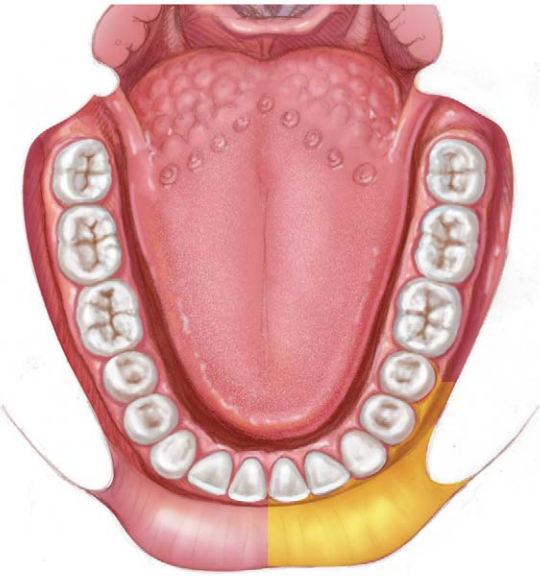
Steps:
- Locate the mental foramen via palpation
- Insert the needle into the mucosa at the mucobuccal fold at the location of the mental foramen (normally around the 2nd mandibular premolar) (the needle will be inserted a short distance in the direction of the mental foramen)
- Perform aspiration; after a negative result, slowly inject the anesthetic

CONSIDERATIONS

X-ray imaging can help the clinician locate the mental foramen if palpation does not do so

This block seldom fails

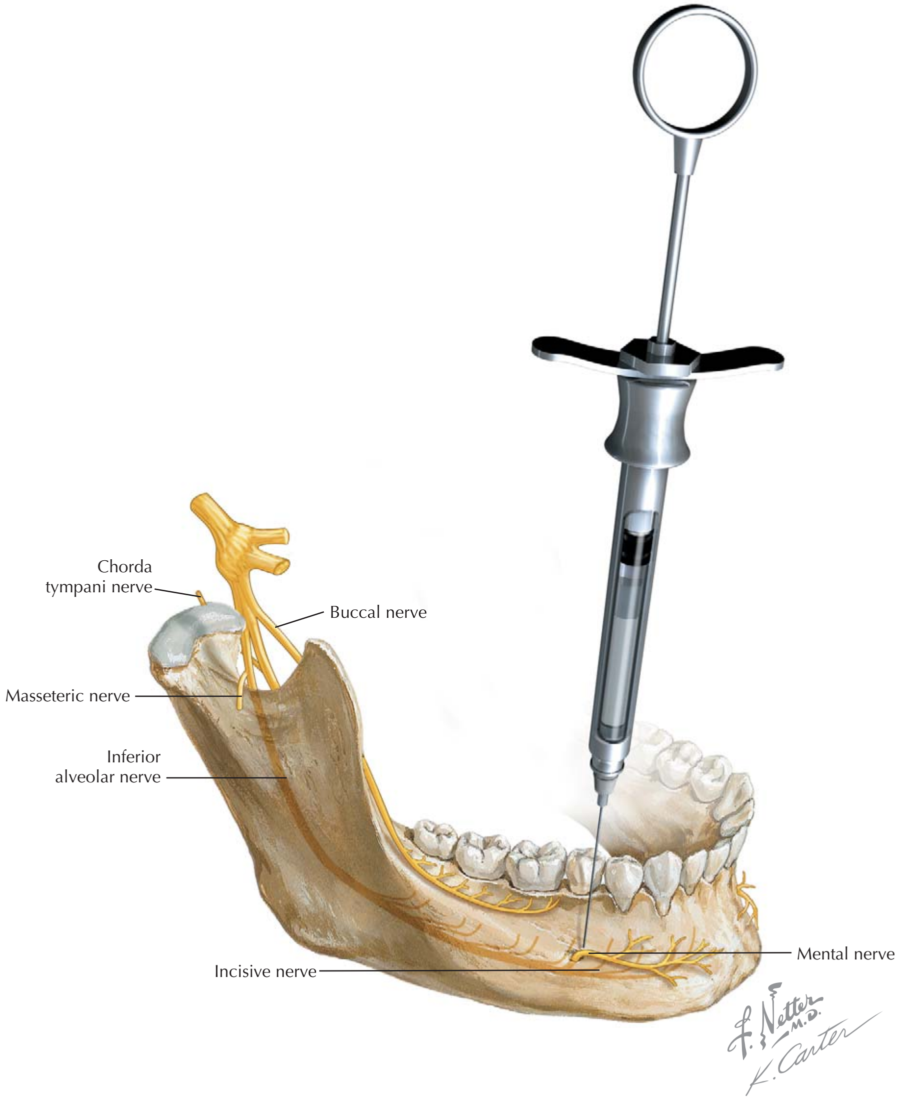
MENTAL NERVE BLOCK *CONTINUED*



Area anesthetized by a mental injection

Mental block

MENTAL NERVE BLOCK *CONTINUED*



21 Mandibular Injections

GOW-GATES BLOCK

OVERVIEW

A variation of the inferior alveolar nerve block, it anesthetizes the following nerves:
- Inferior alveolar nerve (and its branches, the mental and incisive nerves)
- Mylohyoid nerve
- Lingual nerve
- Long buccal nerve (often)
- Auriculotemporal nerve (often)

Low positive aspiration rate relative to that for the standard inferior alveolar nerve block injection

When the injection is properly administered, the needle contacts the neck of the mandibular condyle

Areas anesthetized:
- All mandibular teeth (inferior alveolar nerve)
- Epithelium of the anterior 2/3rds of the tongue (lingual nerve)
- All lingual gingiva and lingual mucosa (lingual nerve)
- All buccal gingiva and mucosa (long buccal and mental nerves)
- Skin of the lower lip (mental nerve)
- Skin along the temple, anterior to the ear, and posterior part of the cheek (auriculotemporal and buccal nerves)

GENERAL METHODOLOGY

Steps:
- The mouth is opened as wide as possible
- Insert the needle high into the mucosa at the level of the 2nd maxillary molar just distal to the mesiolingual cusp
- Use the intertragic notch as an extraoral landmark to help reach the neck of the mandibular condyle
- Advance the needle in a plane from the corner of the mouth to the intertragic notch from the contralateral premolars (this position varies in accordance with individual flare of the mandible) until it contacts the condylar neck
- Withdraw the needle slightly and perform aspiration to observe whether the needle is in a blood vessel
- After a negative result on aspiration, slowly inject the anesthetic
- Have the patient keep the mouth open for a few minutes after injection, to allow the anesthetic to diffuse around the nerves

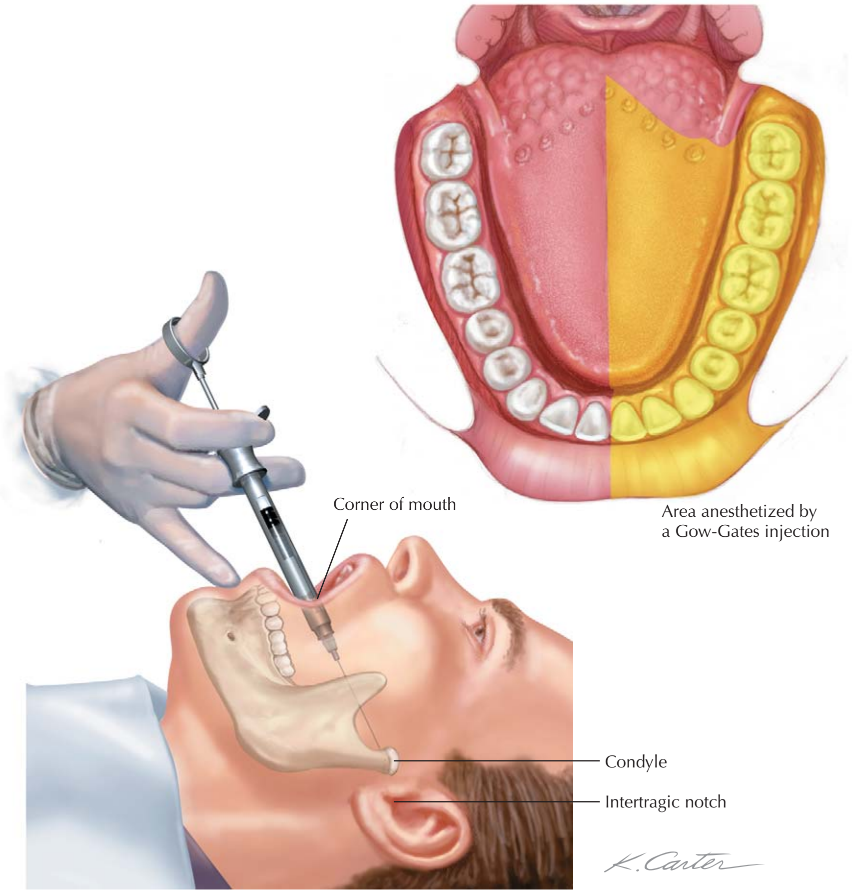
CONSIDERATIONS

Useful for multiple procedures on mandibular teeth and buccal soft tissue

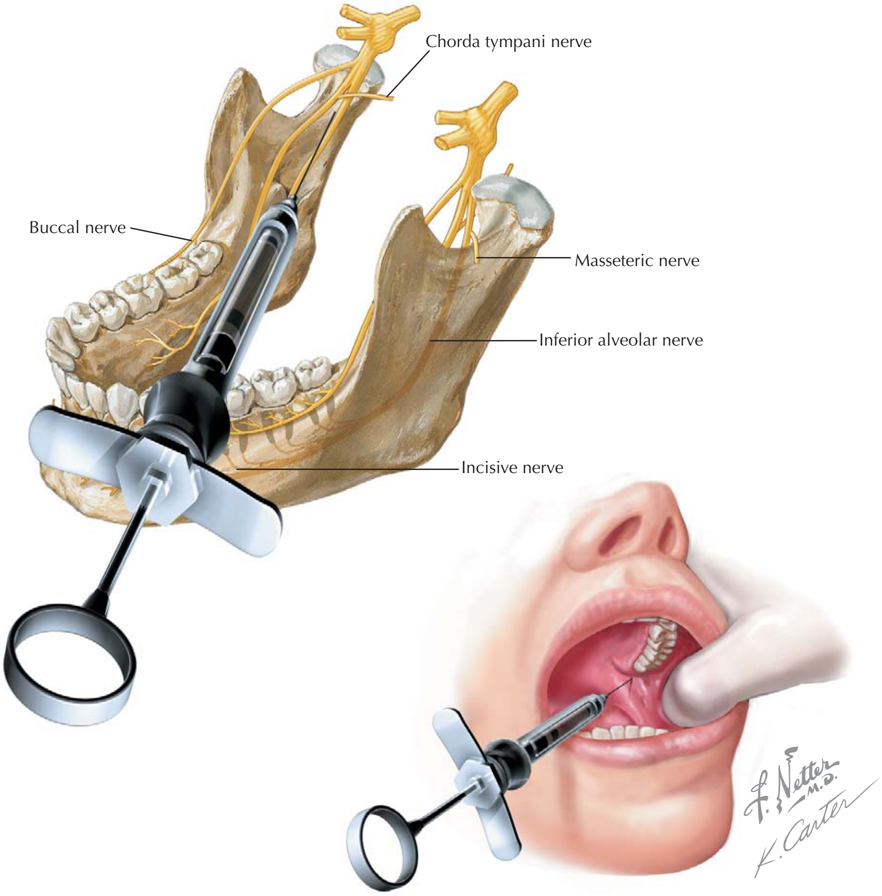
Few complications

Works well for a bifid inferior alveolar nerve

GOW-GATES BLOCK *CONTINUED*



GOW-GATES BLOCK *CONTINUED*



Mandibular Injections

AKINOSI BLOCK

OVERVIEW

A closed-mouth approach for the mandibular nerve block, it anesthetizes the following nerves:

- Inferior alveolar nerve (and its branches, the mental and incisive nerves)
- Mylohyoid nerve
- Lingual nerve

Useful when mandibular depression (opening) is limited, such as with trismus

Considered a “blind” injection

Areas anesthetized:

- All mandibular teeth (inferior alveolar nerve)
- Epithelium of the anterior 2/3rds of the tongue (lingual nerve)
- All lingual gingiva and lingual mucosa (lingual nerve)
- All buccal gingiva and mucosa from the premolars to the midline (mental nerve)
- Skin of the lower lip (mental nerve)

GENERAL METHODOLOGY

Steps:

- Have the patient close the mouth
- Insert the needle into the mucosa between the medial border of the mandibular ramus and the maxillary tuberosity at the level of the cervical margin of the maxillary molars
- Advance the needle parallel to the maxillary occlusal plane
- Once the needle is advanced approximately 23 to 25 mm, it should be located in the middle of the pterygomandibular space near the inferior alveolar and lingual nerves (*note:* no bone will be contacted)
- After a negative result on aspiration, slowly inject the anesthetic

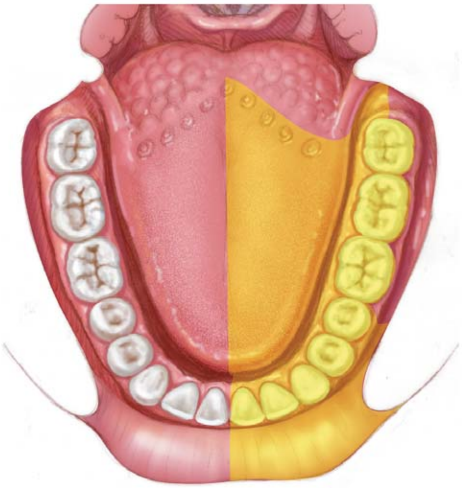
CONSIDERATIONS

Often used in patients with a *limited ability to open the mouth* and when intraoral landmarks for a standard inferior alveolar nerve block are difficult to view

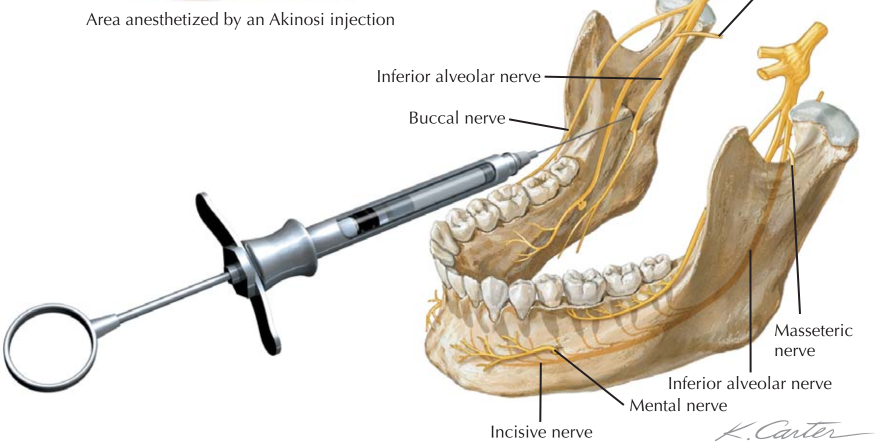
A transient, dental induced *Bell’s palsy* can result if the needle is placed too far posteriorly in the parotid bed and anesthetic is introduced close to the facial nerve

Good for patients with a *strong gag reflex* or macroglossia

AKINOSI BLOCK *CONTINUED*

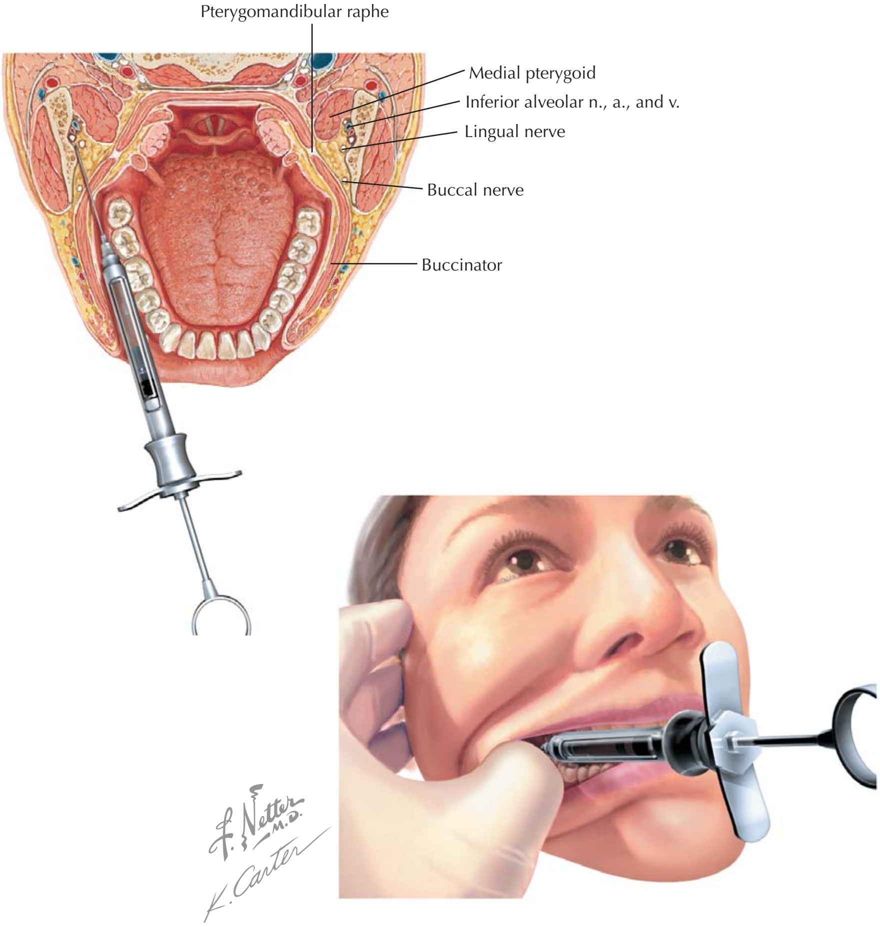


Area anesthetized by an Akinosi injection



Mandibular Injections

AKINOSI BLOCK *CONTINUED*



21 Maxillary Injections

INNERVATION AND OSTEOLOGY LANDMARKS

MAXILLA: GENERAL CONSIDERATIONS AND LANDMARKS

One of the largest facial bones

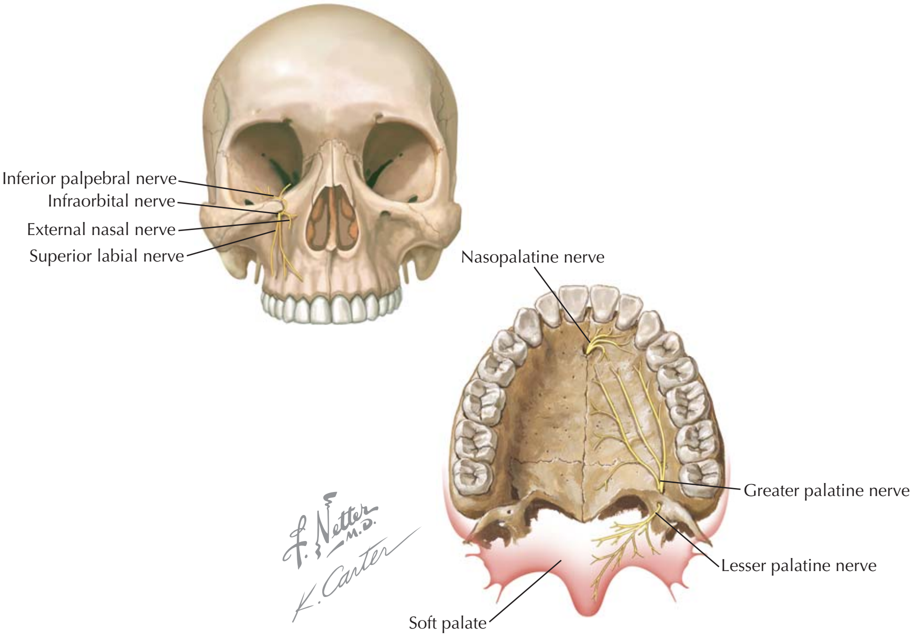
Porous bone, which aids in achieving anesthesia of the maxillary teeth

Teeth

- Contained in the alveolar bone
- Maxillary teeth are supplied by the anterior, middle, and posterior superior alveolar nerves (in some patients, the middle superior alveolar nerve may not be present)

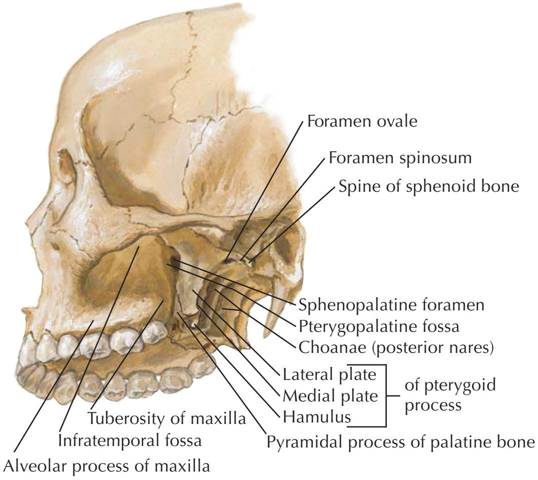
Hard Palate

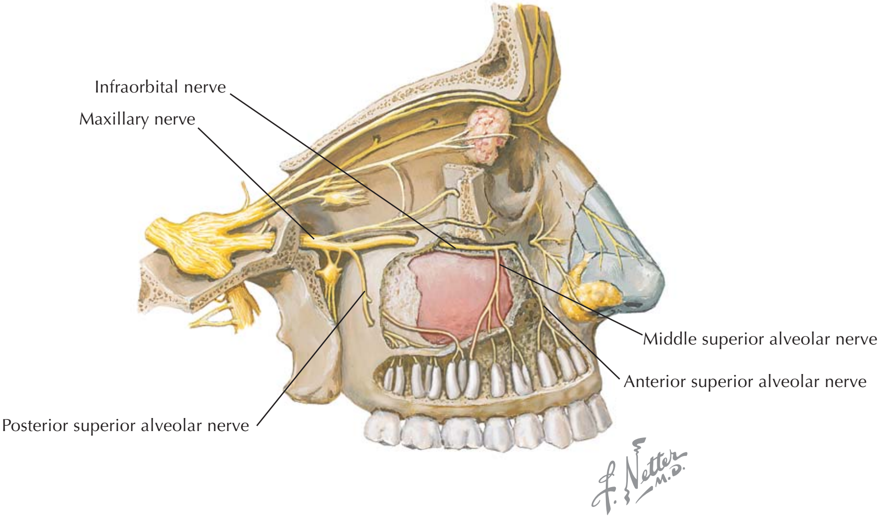
- Composed of the palatal process of the maxilla and the horizontal plate of the palatine
- Supplied by the nasopalatine and greater palatine nerves



Maxillary Injections

INNERVATION AND OSTEOLOGY LANDMARKS *CONTINUED*





21 Maxillary Injections

POSTERIOR SUPERIOR ALVEOLAR NERVE BLOCK

OVERVIEW

A frequently used block

The injection is in the infratemporal fossa

Areas anesthetized:
- All maxillary molars, with the possible exception of the mesiobuccal root of the 1st maxillary molar
- Buccal gingiva opposite the teeth

GENERAL METHODOLOGY

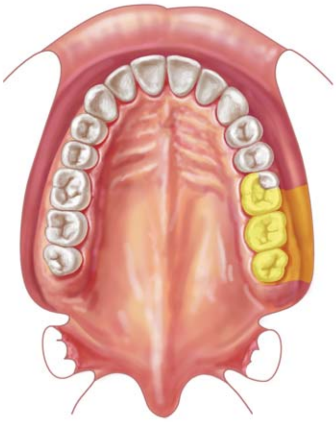
Steps:
- With the mouth open, the patient is instructed to deviate the mandible toward the same side as the injection, to produce more work space for the clinician
- Insert the needle into the mucosa at the mucobuccal fold just superior to the maxillary 2nd molar, between the medial border of the ramus of the mandible and the maxillary tuberosity
- In a single motion, the needle needs to be advanced approximately 15 mm in the following x-y-z plane at the same time, to reach the posterior superior alveolar nerve along the posterior surface of the maxilla:
  - Medially at a 45-degree angle to the maxillary occlusal plane
  - Superiorly at a 45-degree angle to the maxillary occlusal plane
  - Posteriorly at a 45-degree angle to the maxillary occlusal plane
- Perform aspiration due to the close proximity of the pterygoid plexus
- After a negative result on aspiration, slowly inject the anesthetic

CONSIDERATIONS

Significant potential for formation of a hematoma involving the pterygoid plexus

Short needles are preferred, to reduce the risk of hematoma

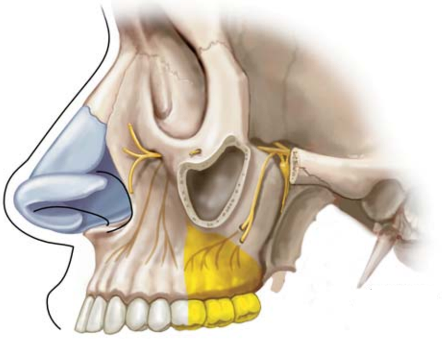
POSTERIOR SUPERIOR ALVEOLAR NERVE BLOCK *CONTINUED*



May not always anesthetize the mesiobuccal root of the 1st maxillary molar

Area anesthetized by a posterior superior alveolar injection

May not always anesthetize the mesiobuccal root of the 1st maxillary molar



Area anesthetized by a posterior superior alveolar injection

K Carter

POSTERIOR SUPERIOR ALVEOLAR NERVE BLOCK *CONTINUED*

Maxillary Injections

NASOPALATINE NERVE BLOCK

OVERVIEW

Considered the most painful of dental injections

Because of the sensitivity of the area, pressure anesthesia (e.g., using a cotton swab applicator) is helpful at the site of injection

Areas anesthetized:
- The area's palatal gingiva and mucosa from the maxillary canine on the right to the maxillary canine on the left side of the maxilla
- Both the right and left nasopalatine nerves, because they exit onto the hard palate in close proximity

Oral mucosa in this region is tightly adhered to the hard palate; thus deposition of anesthetic in the area has less space to diffuse

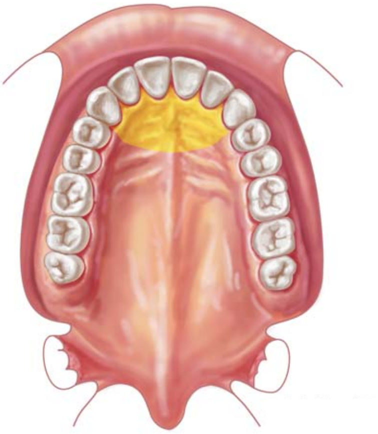
GENERAL METHODOLOGY

Steps:
- Use a cotton swab applicator to apply pressure to the injection site
- Insert the needle into the palatal mucosa lateral to the incisive papilla
- Deposit a small amount of anesthetic to help lessen the trauma; the vasoconstrictor norepinephrine then causes the area's soft tissue to blanch
- Advance the needle until it contacts the hard palate
- Withdraw the needle slightly and perform aspiration
- After a negative result on aspiration, very slowly inject the anesthetic

CONSIDERATIONS

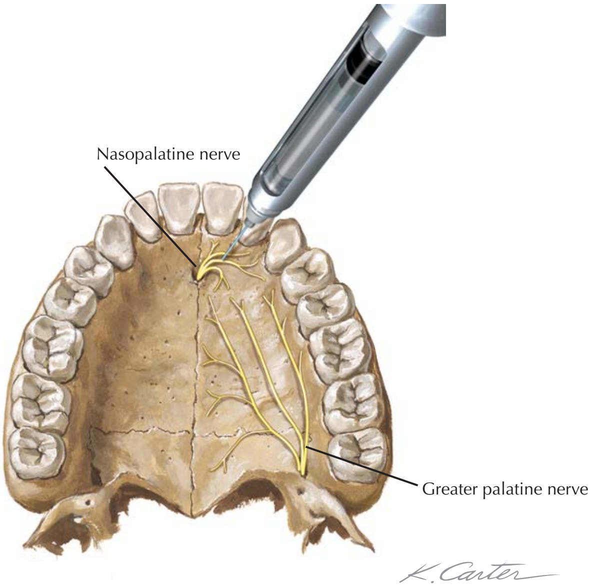
Pressure anesthesia is beneficial to help lessen the pain

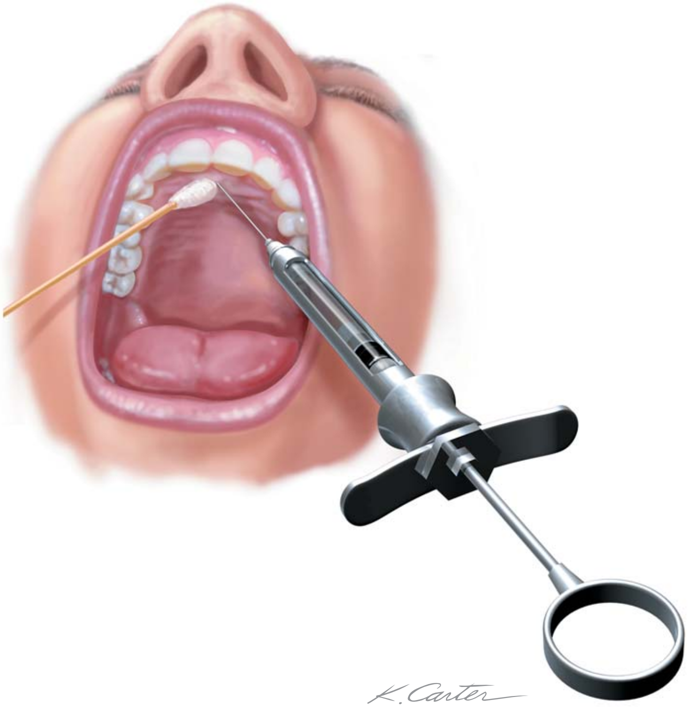
Because the tissue is so dense and is attached to the bone, this block requires a slow injection



Area anesthetized by a nasopalatine injection

NASOPALATINE NERVE BLOCK *CONTINUED*





Maxillary Injections

GREATER PALATINE NERVE BLOCK

OVERVIEW

Another commonly used block to anesthetize areas of the hard palate

Not as traumatic for the patient as the nasopalatine nerve block

Because of the sensitivity of the area, pressure anesthesia (e.g., using a cotton swab applicator) is helpful at the site of injection

Areas anesthetized:
- Palatal gingiva and mucosa in the area from the maxillary 1st premolar (anteriorly) to the posterior portion of the hard palate to the midline

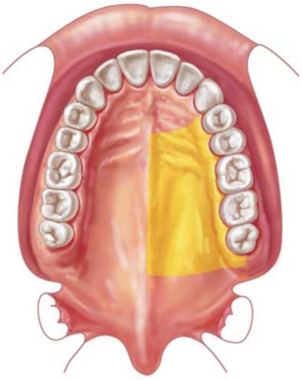
GENERAL METHODOLOGY

Steps:
- Locate the greater palatine foramen by using a cotton swab applicator to press down on the tissue in the region of the 1st maxillary molar, moving posteriorly until the swab dips into the tissue (usually posterior to the 2nd maxillary molar)
- Use a cotton swab applicator to apply pressure to the injection site
- Insert the needle and inject a small amount of anesthetic to lessen patient discomfort; the tissue of the area will begin to blanch from the effects of the anesthetic agent
- Advance the needle until it contacts the hard palate
- Withdraw the needle slightly and perform aspiration
- After a negative result on aspiration, slowly inject the anesthetic

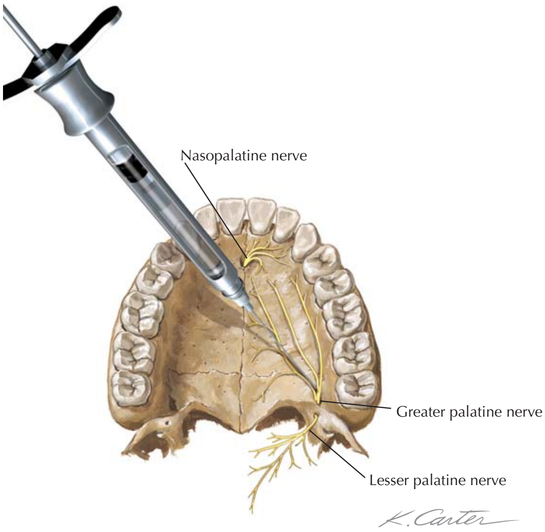
CONSIDERATIONS

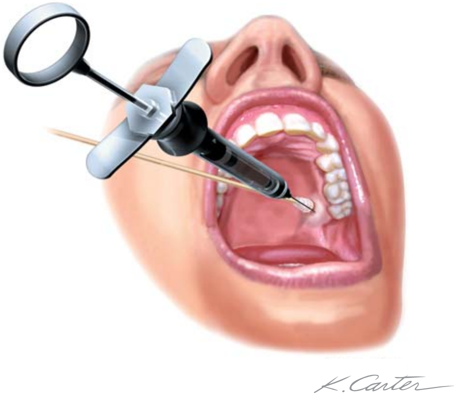
The clinician should be able to feel the needle contact bone; otherwise, the needle could be too posterior in the soft palate

GREATER PALATINE NERVE BLOCK *CONTINUED*



Area anesthetized by a greater palatine injection





MIDDLE SUPERIOR ALVEOLAR NERVE BLOCK

OVERVIEW

The middle superior alveolar nerve is reported to be present in about 30% of all people

Areas anesthetized:

- All maxillary premolars and possibly the mesiobuccal root of the 1st maxillary molar
- Buccal gingiva opposite the teeth

GENERAL METHODOLOGY

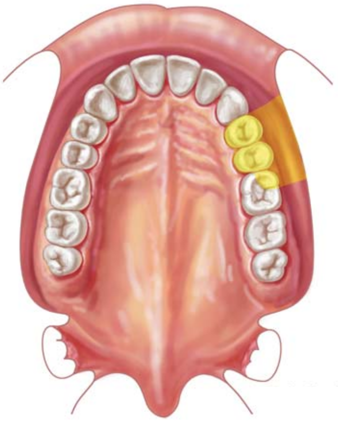
Steps:

- Insert the needle into the mucosa at the mucobuccal fold just superior to the area of the maxillary 2nd premolar
- Advance the needle until the tip is superior to the apex of the maxillary 2nd premolar for maximum anesthesia
- After a negative result on aspiration, slowly inject the anesthetic

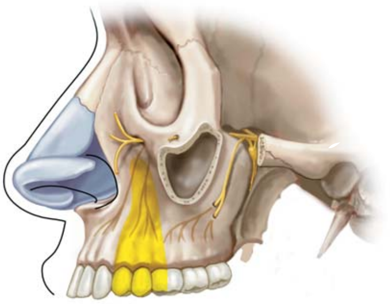
CONSIDERATIONS

Local infiltrations are a common substitute for this block

This area is somewhat avascular, and hematoma formation is rare



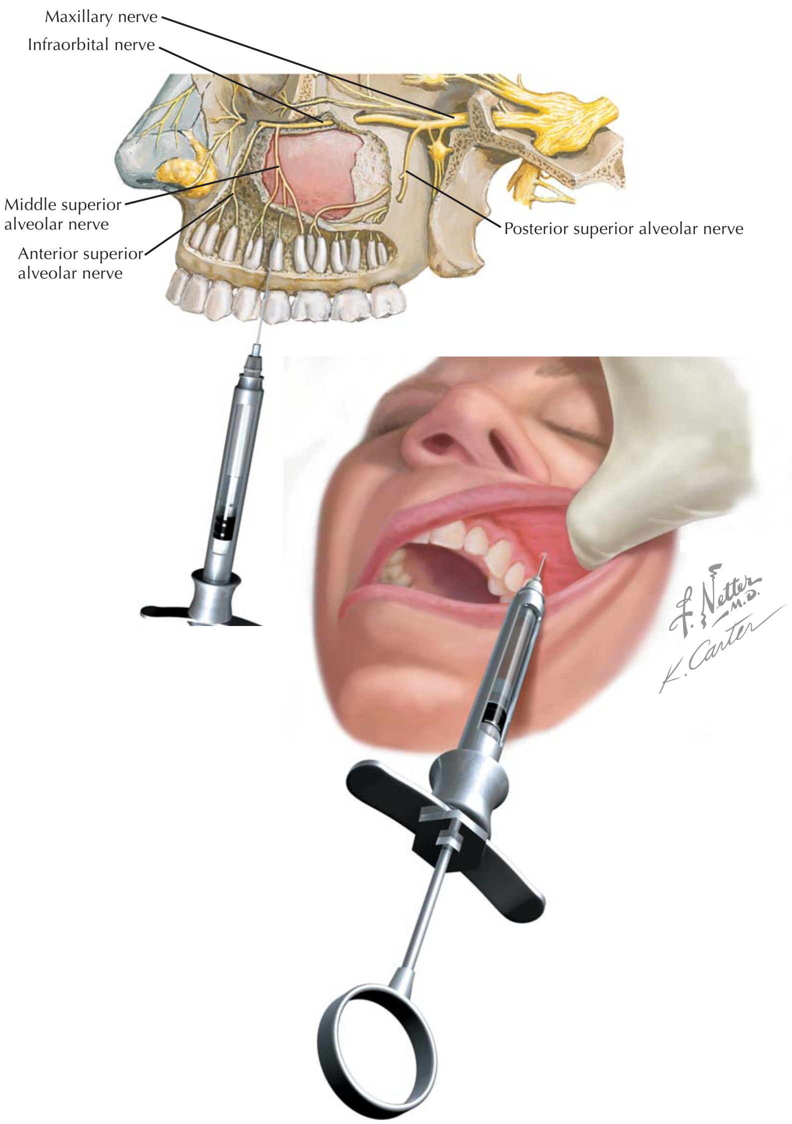
Area anesthetized by a middle superior alveolar injection



Area anesthetized by a middle superior alveolar injection

K. Carter

MIDDLE SUPERIOR ALVEOLAR NERVE BLOCK *CONTINUED*



Maxillary Injections

INFRAORBITAL/ANTERIOR SUPERIOR ALVEOLAR NERVE BLOCK

OVERVIEW

Less frequently used because of the risk of the clinician injuring the patient's eye

This block anesthetizes the following nerves:
- Anterior superior alveolar nerve
- Middle superior alveolar nerve
- Infraorbital nerve

Areas anesthetized:
- All maxillary teeth from the central incisor to the premolars, with the possible inclusion of the mesiobuccal root of the 1st maxillary molar
- Buccal gingiva opposite these teeth
- Lateral aspect of nose, lower eyelid, and upper lip

GENERAL METHODOLOGY

Steps:
- Locate the infraorbital foramen via palpation
- Insert the needle into the mucosa at the mucobuccal fold in the area superior to the 1st maxillary premolar
- Advance the needle parallel to the long axis of the tooth until it contacts the bone of the infraorbital foramen
- After a negative result on aspiration, slowly inject the anesthetic

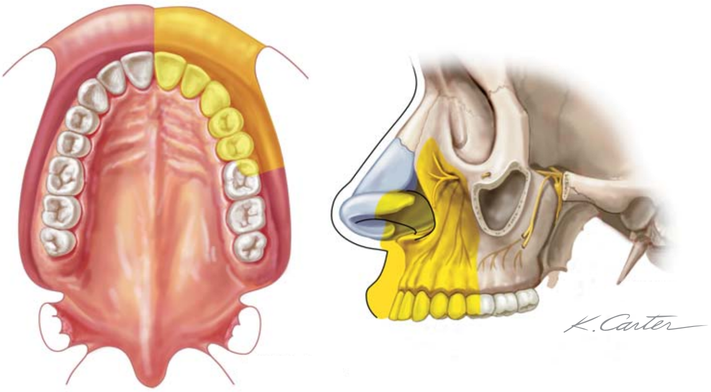
CONSIDERATIONS

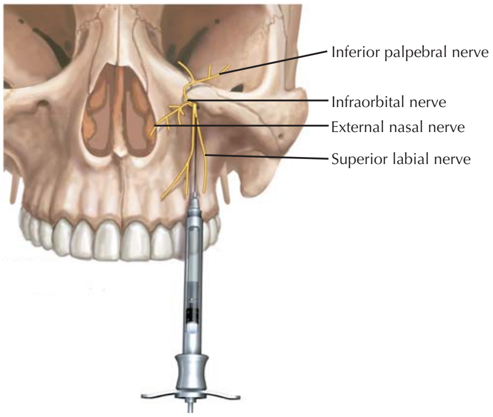
No significant potential for a hematoma

Useful when pulpal anesthesia cannot be achieved in a local infiltration because of dense bone or when anesthesia is required on multiple teeth that would need more than one injection

INFRAORBITAL/ANTERIOR SUPERIOR ALVEOLAR NERVE BLOCK *CONTINUED*

Area anesthetized by an anterior superior injection





Maxillary Injections

MAXILLARY DIVISION BLOCK

OVERVIEW

An excellent technique to achieve hemimaxillary anesthesia

Anesthetizes all of the branches of the maxillary division of the trigeminal nerve

Useful in extensive quadrant procedures and surgery

With blocking of the entire division, the following nerves are anesthetized:
- Posterior superior alveolar nerve
- Middle superior alveolar nerve
- Anterior superior alveolar nerve
- Nasopalatine nerve
- Greater palatine nerve
- Infraorbital nerve

Areas anesthetized:
- All maxillary teeth
- All buccal gingiva
- All palatal gingiva and mucosa
- Lateral aspect of nose, lower eyelid, and upper lip

GENERAL METHODOLOGY

Goal: to deposit the anesthetic in the pterygopalatine fossa using its eventual connection with the greater palatine foramen

Steps:
- Locate the greater palatine foramen by using a cotton swab applicator to press in the region of the 1st maxillary molar, moving posteriorly until the swab dips into the tissue (usually posterior to the 2nd maxillary molar)
- Use a cotton swab applicator to apply pressure to the injection site
- Insert the needle into the mucosa and inject a small amount of anesthetic to lessen patient discomfort; the tissue will begin to blanch as a result of effects of the anesthetic agent
- Insert the needle further and locate the greater palatine foramen with the needle
- Once the foramen is located, insert the needle and advance it approximately 28 to 30 mm; at this location, the needle should be in the pterygopalatine fossa
- During the passage, if any bony resistance is met, the needle may be rotated to aid insertion (*note:* under NO circumstances should the needle be forced)
- After a negative result on aspiration, slowly inject the anesthetic

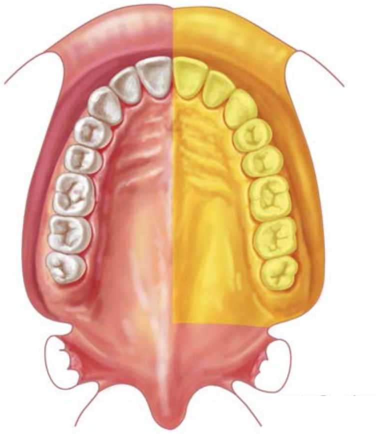
CONSIDERATIONS

The needle should NEVER be forced into the greater palatine foramen, because occasionally the canal is not vertical, so that forced entry will fracture the bone

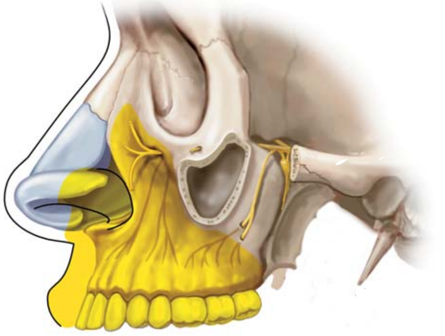
Because the orbit is located superior to the pterygopalatine fossa, if the needle is placed too far superiorly, the anesthetic can be deposited in this region, affecting the eye

Because the palatine vessels also are contents of the canal, care must be taken to prevent hematoma

MAXILLARY DIVISION BLOCK *CONTINUED*

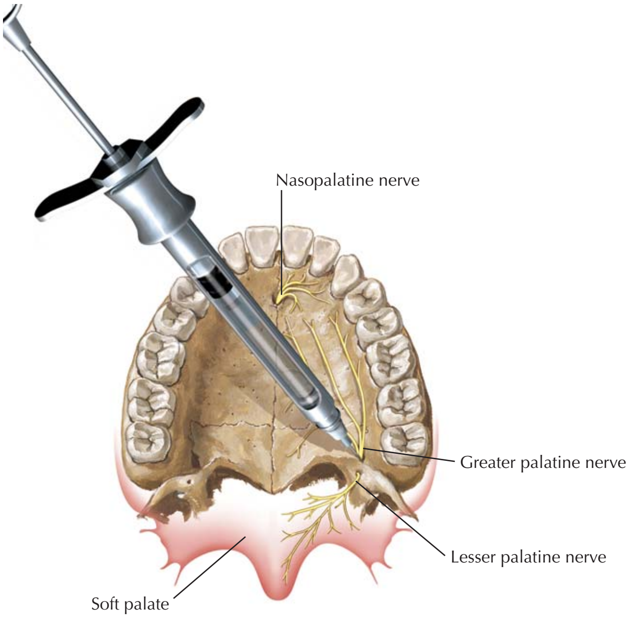


Area anesthetized by a maxillary division injection



Area anesthetized by a maxillary division injection

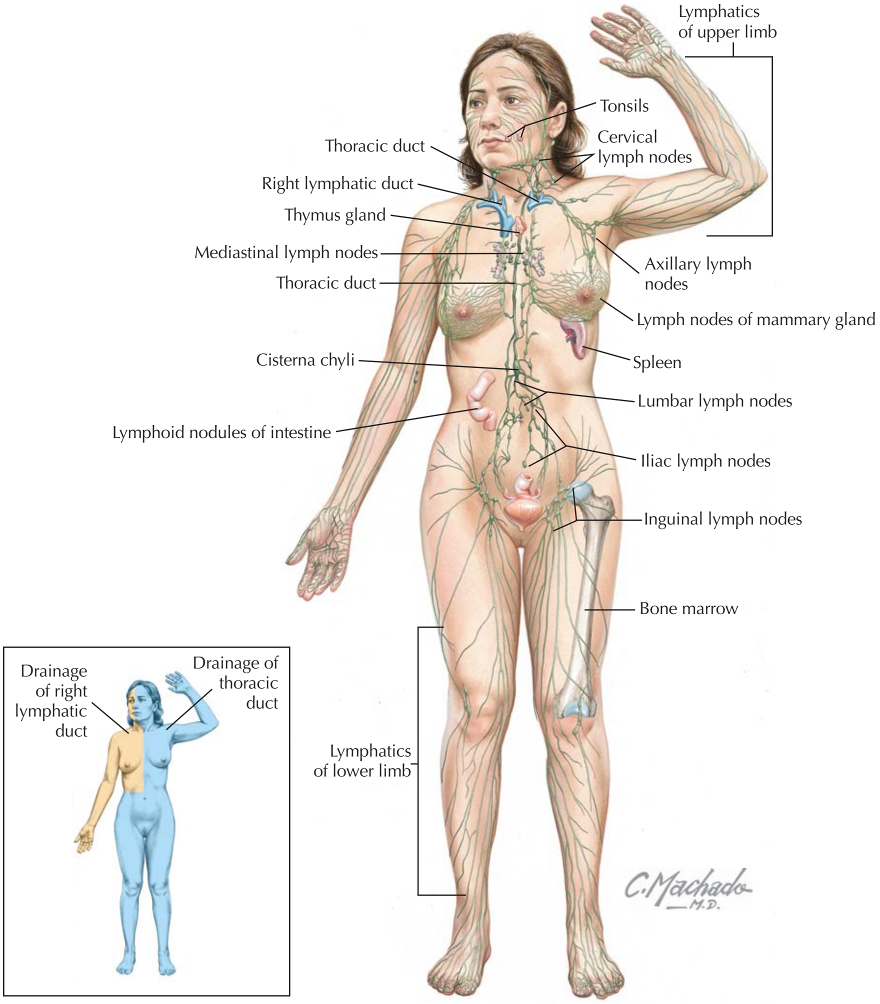
MAXILLARY DIVISION BLOCK *CONTINUED*



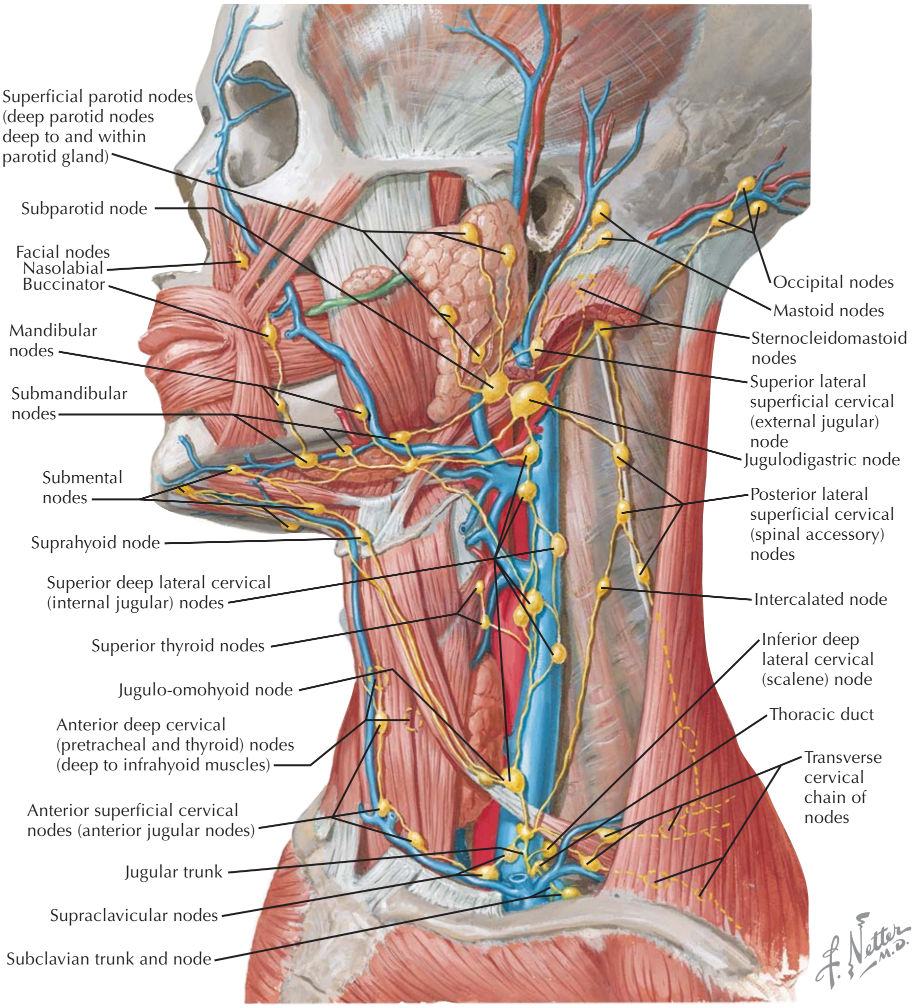
Appendix

Lymphatics

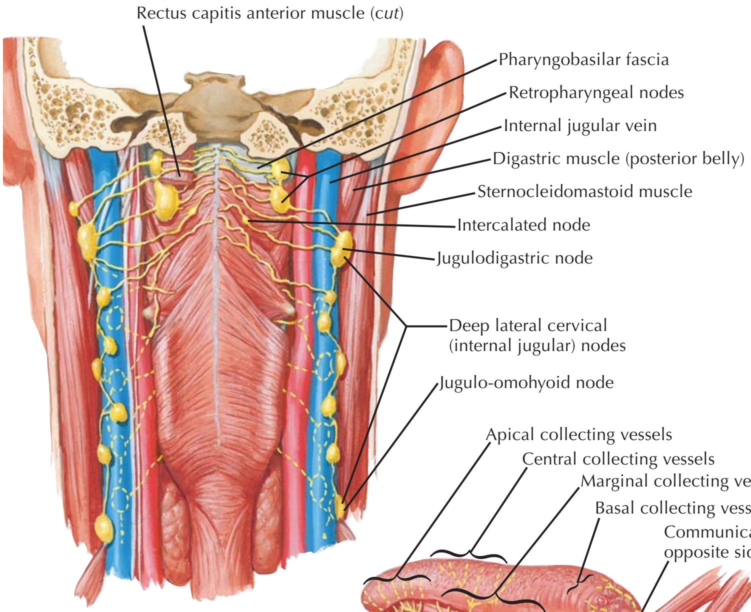
Lymphatics


Lymphatics of upper limb
Tonsils
Cervical lymph nodes
Thoracic duct
Right lymphatic duct
Thymus gland
Mediastinal lymph nodes
Thoracic duct
Axillary lymph nodes
Lymph nodes of mammary gland
Spleen
Cisterna chyli
Lumbar lymph nodes
Lymphoid nodules of intestine
Iliac lymph nodes
Inguinal lymph nodes
Bone marrow
Lymphatics of lower limb
Drainage of right lymphatic duct
Drainage of thoracic duct

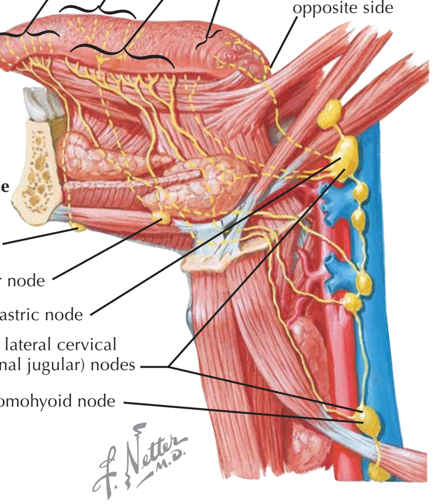
Lymphatics


Superficial parotid nodes (deep parotid nodes deep to and within parotid gland)
Subparotid node
Facial nodes
Nasolabial
Buccinator
Mandibular nodes
Submandibular nodes
Submental nodes
Suprahyoid node
Superior deep lateral cervical (internal jugular) nodes
Superior thyroid nodes
Jugulo-omohyoid node
Anterior deep cervical (pretracheal and thyroid) nodes (deep to infrahyoid muscles)
Anterior superficial cervical nodes (anterior jugular nodes)
Jugular trunk
Supraclavicular nodes
Subclavian trunk and node
Occipital nodes
Mastoid nodes
Sternocleidomastoid nodes
Superior lateral superficial cervical (external jugular) node
Jugulodigastric node
Posterior lateral superficial cervical (spinal accessory) nodes
Intercalated node
Inferior deep lateral cervical (scalene) node
Thoracic duct
Transverse cervical chain of nodes
F. Netter M.D.

Lymphatics



Lymphatic drainage of pharynx: posterior view



Lymphatic drainage of tongue

Index

Index

Index

Index

Index

Index

Index

Index

Index