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.
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
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

ACKNOWLEDGMENTS

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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 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.

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<td>19</td>
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</tbody>
</table>
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.
Overview

GENERAL INFORMATION CONTINUED

Cross section of embryo

- Notochord
- Paraxial column (segmenting into somites)
- Intermediate mesoderm
- Lateral plate mesoderm
- The intraembryonic coelom in the lateral plate is continuous with the coelom in the cardiogenic mesoderm
- The arrow passes through a temporary communication between the extraembryonic coelom and intraembryonic coelom

Vertebrate Body Plan after 4 Weeks

- Neural crest
- Embryonic endoderm forming gastrointestinal (gut) tube
- Somite
- Splanchnic mesoderm of lateral plate

- Connecting stalk
- Amnion (cut)
- Paraxial column
- Intermediate mesoderm
- Lateral plate
- Notochord
- Yolk sac
- Intermediate mesoderm: Nephrogenic ridge above somite
- Intermediate mesoderm (endoderm plus lateral plate mesoderm)
- Intermediate mesoderm (ectoderm plus lateral plate mesoderm)
- Somite sclerotome surrounds the neural tube and notochord to form vertebral column

- Left and right dorsal aorta
- Lateral plate is a thin mesodermal coating of the coelom
- Formation of ventral mesentery
- Amnion fusing with chorion
- Spinal nerve
- Dermatomyotome
- Aorta
- Dorsal mesentery
- Ventral mesentery
- Umbilical cord
- Amnion against chorion

- Yolk sac (stalk just out of the plane of section)
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

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

DERIVATIVES OF THE PHARYNGEAL ARCHES

1. **Embryo at 7 to 8 weeks**
   - **Cartilage primordia**
     - 1st pharyngeal arch territory
     - 2nd pharyngeal arch territory
     - 3rd pharyngeal arch territory
     - 4th pharyngeal arch territory

2. **DERIVATIVES OF THE PHARYNGEAL ARCHES**
   - 1st pharyngeal arch territory
     - Fissa
t     - Meckel's cartilage
     - Cartilage primordia

3. **Superficial muscles**
   - Occipitomandibularis (frontal belly)
   - Orbicularis oris
   - Procerus
   - Nasalis
   - Oculi
   - Nasalis

4. **Deep muscles**
   - Part of lateral pterygoid m.
   - Part of buccinator
   - Temporalis
   - Occipitofrontalis (frontal belly)
   - Zygomaticus
   - Masseter

5. **Pharyngeal Arches**
   - 1st pharyngeal arch territory
     - Malleus, incus, sphenomandibular ligament
   - 2nd pharyngeal arch territory
     - Stapes, styloid process, stylohyoid ligament, upper half of hyoid
   - 3rd pharyngeal arch territory
     - Thyroid and epiglottic cartilages of larynx
   - 4th pharyngeal arch territory
     - Cricoid, arytenoid, and corniculate cartilages of larynx

6. **Pharyngeal Arch Bones and Cartilage**

<table>
<thead>
<tr>
<th>Arch</th>
<th>Derivatives of Arch Cartilages</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Malleus, incus, sphenomandibular ligament</td>
</tr>
<tr>
<td>2</td>
<td>Stapes, styloid process, stylohyoid ligament, upper half of hyoid</td>
</tr>
<tr>
<td>3</td>
<td>Thyroid and epiglottic cartilages of larynx</td>
</tr>
<tr>
<td>4</td>
<td>Cricoid, arytenoid, and corniculate cartilages of larynx</td>
</tr>
</tbody>
</table>

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NETTER’S HEAD AND NECK ANATOMY FOR DENTISTRY
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**

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

**Sagittal section**

- Hypothalamus of brain
- Frontal prominence
- Nasal placode
- Stomodeum
- 1st pharyngeal arch
- Infundibulum (posterior lobe) Rathke’s pouch (anterior lobe) Pituitary gland
- 1st pharyngeal pouch
- Buccopharyngeal membrane (disintegrating)
- Pharynx
- Laryngotracheal ridge or groove
- Esophagus
- Lung bud
- Thyroid diverticulum
Pharyngeal Pouches, Membranes, and Clefts

**PHARYNGEAL POUCHES CONTINUED**
Pharyngeal Pouches, Membranes, and Clefts

PHARYNGEAL MEMBRANES

<table>
<thead>
<tr>
<th>Membrane</th>
<th>Location</th>
<th>Adult Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Between the 1st pharyngeal cleft and the 1st pharyngeal pouch</td>
<td>Tympanic membrane</td>
</tr>
<tr>
<td>2</td>
<td>Between the 2nd pharyngeal cleft and the 2nd pharyngeal pouch</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Between the 3rd pharyngeal cleft and the 3rd pharyngeal pouch</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Between the 4th pharyngeal cleft and the 4th pharyngeal pouch</td>
<td></td>
</tr>
</tbody>
</table>

PHARYNGEAL CLEFTS

<table>
<thead>
<tr>
<th>Cleft</th>
<th>Location</th>
<th>Adult Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A groove between the 1st and 2nd pharyngeal arches</td>
<td>External acoustic meatus</td>
</tr>
<tr>
<td>2</td>
<td>A groove between the 2nd and 3rd pharyngeal arches</td>
<td>Obliterated cervical sinus by the 2nd pharyngeal arch, which grows over the cleft</td>
</tr>
<tr>
<td>3</td>
<td>A groove between the 3rd and 4th pharyngeal arches</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>A groove between the 4th and 6th pharyngeal arches</td>
<td></td>
</tr>
</tbody>
</table>
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:
- Visceroocranium—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**

<table>
<thead>
<tr>
<th>Germ Layers</th>
<th>Origins</th>
<th>Adult Structure</th>
<th>Ossification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neural crest</td>
<td>1st pharyngeal arch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>● Maxillary process</td>
<td>Maxilla</td>
<td>Intramembranous</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Temporal bone</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Zygoma</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Palatine</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lacrimal</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vomer</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nasal</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Inferior nasal concha</td>
<td></td>
<td></td>
</tr>
<tr>
<td>● Mandibular process</td>
<td>Mandible</td>
<td>Intramembranous and endochondral</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sphenomandibular ligament</td>
<td>Not ossified</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Malleus</td>
<td>Endochondral</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Incus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2nd pharyngeal arch</td>
<td>Styloid process</td>
<td>Endochondral</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Stapes</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hyoid</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Stylohyoid ligament</td>
<td>Not ossified</td>
<td></td>
</tr>
</tbody>
</table>
Skull

**VISCEROCRANIUM CONTINUED**

**Chondrocranium at 9 weeks**
- Orbitosphenoid (orbital, or lesser, wing of future sphenoid bone) (vision)
- Crista galli
- Nasal capsule (olfaction)
- Meckel's cartilage
- Styloid process
- Hyoid cartilage
- Thyroid cartilage
- Cricoid cartilage
- Interparietal part of occipital bone
- Zygomatic bone
- Squamous part of temporal bone
- Chondrocranium

**Cartilaginous pharyngeal arch skeleton**
- Optic foramen
- Greater wing of future sphenoid bone
- Otic capsule (audition)
- Incus
- Malleus

**Membrane bones at 9 weeks**
- Frontal bone
- Nasal bone
- Maxilla
- Mandible
- Interparietal part of occipital bone
- Zygomatic bone
- Squamous part of temporal bone

**Membrane bones at 12 weeks**
- Frontal bone
- Nasal bone
- Lacrimal bone
- Maxilla
- Zygomatic bone
- Mandible
- Site of future anterior fonticulus (fontanelle)
- Site of future coronal suture
- Parietal bone
- Interparietal part of occipital bone
- Greater wing of sphenoid bone
- Chondrocranium
- Squamous part and zygomatic process of temporal bone
- Tympanic ring of temporal bone

**Pharyngeal arch mesenchyme for viscerocranium**
- Head mesenchyme for neurocranium
- Cartilage from pharyngeal arches for viscerocranium and neck cartilages
- Cartilage from somite sclerotomes and neural crest anteriorly for base of neurocranium

**Intramembranous ossification (both from neural crest)**

**Endochondral ossification**
**Skull**

### MEMBRANOUS NEUROCRANIUM

<table>
<thead>
<tr>
<th>Germ Layer</th>
<th>Portions of Neurocranium</th>
<th>Adult Structure</th>
<th>Ossification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neural crest</td>
<td>Main portion of the roof and lateral sides of the cranial vault</td>
<td>Frontal bone Squamous portion of the temporal bone</td>
<td>Intramembranous</td>
</tr>
<tr>
<td>Paraxial mesoderm</td>
<td>Prechordal Anterior to the sella turcica</td>
<td>Ethmoid Sphenoid</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chordal Posterior to the sella turcica</td>
<td>Petrous portion of the temporal bone Mastoid process of the temporal bone Occipital bone</td>
<td></td>
</tr>
</tbody>
</table>

### CARTILAGINOUS NEUROCRANIUM

<table>
<thead>
<tr>
<th>Germ Layer</th>
<th>Portions of Neurocranium</th>
<th>Adult Structure</th>
<th>Ossification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neural crest</td>
<td>Prechordal Anterior to the sella turcica</td>
<td>Ethmoid Sphenoid</td>
<td>Endochondral</td>
</tr>
<tr>
<td>Paraxial mesoderm</td>
<td>Chordal Posterior to the sella turcica</td>
<td>Petrous portion of the temporal bone Mastoid process of the temporal bone Occipital bone</td>
<td></td>
</tr>
</tbody>
</table>

**Skull of Newborn**

- **Lateral view**
  - Frontal bone
  - Sphenoidal fontanelle
  - Ethmoid bone
  - Orbital plate
  - Lacrimal bone
  - Nasal bone
  - Maxilla
  - Zygomatic bone
  - Palatine bone

- **Superior view**
  - Frontal bone
  - Parietal bone
  - Occipital bone

- **Parietal bone**
  - Tuberc (fronmine)
  - Squamous suture
  - Posterior fontanelle
  - Lambda (lambdoid) sutures
  - Occipital bone
  - Mastoid fontanelle

- **Temporal bone**
  - Squamous part
  - Petroseous fissure
  - Petrous part (mastoid process absent)
  - Tympanic part (bony external acoustic meatus absent)
  - Oval (vestibular) window
  - Round (cochlear) window
  - Styloid process
  - Mandibular fossa
  - Zygomatic process

- **Sphenoid Bone**
  - Greater wing
  - Lateral plate of pterygoid process
  - Hamulus of medial plate of pterygoid process

- **Mastoid process of the temporal bone**
  - Squamous part
  - Petroseous fissure
  - Petrous part (mastoid process absent)
  - Tympanic part (bony external acoustic meatus absent)
  - Oval (vestibular) window
  - Round (cochlear) window
  - Styloid process
  - Mandibular fossa
  - Zygomatic process

- **Anterior fontanelle**
- **Coronal suture**
- **Sagittal suture**
- **Posterior fontanelle**
- **Lambdoid suture**
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

<table>
<thead>
<tr>
<th>ADULT STRUCTURES OF THE FACE</th>
<th>Structure(s) Develop(s) from</th>
</tr>
</thead>
</table>
| Upper lip | Maxillary prominence  
Medial nasal prominence |
| Lower lip | Mandibular prominence |
| Lacrimal sac | 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 6 to 7 weeks

- Left eye
- Nasolacrimal groove
- Maxillary process
- Opening of left nasal sac (future naris)
- Cardiac prominence
- Oral opening

Ventral view at 6 to 7 weeks

- Opening of right nasal sac (future naris)
- Maxillary process of 1st arch
- Right eye
- 1st pharyngeal arch
- 1st pharyngeal cleft (future external acoustic meatus)
- 2nd pharyngeal arch
- 3rd and 4th pharyngeal arches in cervical sinus
- 1st pharyngeal arch
- Nasolacrimal groove
- Oral opening
- Nodules that merge to form auricle of ear
- 3rd and 4th pharyngeal arches in cervical sinus (sites of future laryngeal cartilages)

Ventral view at 7 to 8 weeks

- Site of nasolacrimal groove (fusion of lateral nasal and maxillary processes)
- Site of fusion of medial nasal and maxillary processes (site of cleft lip)
- Auricle of ear
- Philtrum upper lip (fusion of medial nasal processes)

Lateral view at 7 to 8 weeks

- Auricle of ear
- Lateral nasal process
- Medial nasal process
- Philtrum

Lateral view at 8 to 10 weeks

- Fused eyelids
- Philtrum of upper lip
- Auricle of ear
**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**

- Right olfactory bulb
- Ocular muscles
- Eyeball
- Maxilla
- Right lateral palatine process of secondary palate
- Meckel’s cartilage
- Submandibular salivary gland
- Hyoid cartilage
- Thyroid cartilage

**Frontal (coronal) section at 8 to 10 weeks**

- Septal cartilage
- Superior concha and meatus
- Ethmoid cartilage
- Eyeball
- Lens
- Middle concha and meatus
- Right nasal cavity
- Inferior concha and meatus
- Enamel organs of deciduous molar teeth
- Meckel’s cartilage
- Submandibular salivary gland
- Hyoid cartilage
- Infrahyoid muscles

**DEVELOPMENT OF THE HEAD AND NECK**
Roof of stomodeum (inferior view; 6 to 7 weeks)

- Frontal area
- Medial nasal process
- Lateral nasal process
- Nasolacrimal groove
- Definitive nasal septum
- Maxillary process of 1st arch
- Lateral palatine process (secondary palate)
- Opening of Rathke’s pouch

Palate formation (inferior view; 7 to 8 weeks)

- Left naris
- Site of fusion of medial nasal and maxillary processes (cleft lip site)
- Primitive posterior naris or choana (former site of oronasal membrane)
- Left lateral palatine process
- Site of evagination of Rathke’s pouch

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

- Left naris
- Upper lip
- Gingiva (gum)
- Palatine raphé (cleft palate site)
- Palatoglossal arch
- Palatopharyngeal arch
- Uvula

Broken lines border area formed from medial nasal processes and primary palate

Medical palate process (primary palate contribution to definitive palate)

Lateral palatine process (secondary palate contribution to definitive palate)

Arrow emerging from choana (posterior naris of right nasal cavity)
Tongue

GENERAL INFORMATION

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

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)
**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
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.
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
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)
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
Clinical Correlate

CLEFT LIP AND PALATE CONTINUED

Unilateral cleft lip—partial

Partial cleft of palate

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

Complete cleft of secondary palate and unilateral cleft of primary palate

Bilateral cleft lip
## Overview

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<th>Page</th>
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</thead>
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<td>Major Foramina and Fissures</td>
<td>54</td>
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<td>Cervical Vertebrae</td>
<td>59</td>
</tr>
<tr>
<td>Clinical Correlates</td>
<td>64</td>
</tr>
</tbody>
</table>
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
ARTICULATIONS

<table>
<thead>
<tr>
<th>Bone</th>
<th>Single</th>
<th>Paired</th>
<th>Articulates with</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frontal</td>
<td>X</td>
<td></td>
<td>Parietal, sphenoid, zygomatic, maxilla, ethmoid, nasal, lacrimal</td>
</tr>
<tr>
<td>Parietal</td>
<td></td>
<td>X</td>
<td>Frontal, parietal, temporal, occipital, sphenoid</td>
</tr>
<tr>
<td>Temporal</td>
<td></td>
<td>X</td>
<td>Parietal, occipital, sphenoid, zygomatic, mandible</td>
</tr>
<tr>
<td>Occipital</td>
<td></td>
<td>X</td>
<td>Parietal, temporal, sphenoid, and atlas (C1)</td>
</tr>
<tr>
<td>Sphenoid</td>
<td></td>
<td>X</td>
<td>Frontal, parietal, temporal, occipital, zygomatic, maxilla, ethmoid, palatine, vomer</td>
</tr>
<tr>
<td>Zygomatic</td>
<td></td>
<td>X</td>
<td>Frontal, temporal, maxilla</td>
</tr>
<tr>
<td>Maxilla</td>
<td></td>
<td>X</td>
<td>Frontal, sphenoid, zygomatic, maxilla, ethmoid, palatine, vomer, nasal, lacrimal, inferior nasal concha</td>
</tr>
<tr>
<td>Ethmoid</td>
<td></td>
<td>X</td>
<td>Frontal, sphenoid, maxilla, palatine, vomer, nasal, lacrimal, inferior nasal concha</td>
</tr>
<tr>
<td>Palatine</td>
<td></td>
<td>X</td>
<td>Sphenoid, maxilla, ethmoid, palatine, vomer, inferior nasal concha</td>
</tr>
<tr>
<td>Vomer</td>
<td></td>
<td>X</td>
<td>Sphenoid, maxilla, ethmoid, palatine</td>
</tr>
<tr>
<td>Nasal</td>
<td></td>
<td>X</td>
<td>Frontal, maxilla, nasal</td>
</tr>
<tr>
<td>Lacrimal</td>
<td></td>
<td>X</td>
<td>Frontal, maxilla, ethmoid</td>
</tr>
<tr>
<td>Inferior nasal concha</td>
<td></td>
<td>X</td>
<td>Maxilla, ethmoid, palatine, lacrimal</td>
</tr>
<tr>
<td>Mandible</td>
<td></td>
<td>X</td>
<td>Temporal</td>
</tr>
</tbody>
</table>
### Bones of the Skull

#### FRONTAL BONE

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Parts</th>
<th>Ossification</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contains the frontal paranasal sinuses</td>
<td>Squamous portion</td>
<td>For all 3 parts: Intramembranous</td>
<td>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</td>
</tr>
<tr>
<td>Has two primary centers that ossify along the frontal suture (metopic) in the 2nd year</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Helps form the foramen cecum, which allows passage of an emissary vein that connects to the superior sagittal sinus There is 1 frontal bone</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Orbital portion**
- **Nasal portion**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Parts</th>
<th>Ossification</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Forms the roof of the orbit and floor of the anterior cranial fossa</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>------------------------------------------------------------------------------------------------------------------------------------------</td>
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<td></td>
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</tbody>
</table>

- **Orbital portion**
- **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

---

![Diagram of the skull](image-url)

- **Parietal bone**
- **Temporal fossa**
- **Coronal suture**
- **Ethmoid bone**
- **Lacrimal bone**
- **Nasal bone**
- **Sphenoid bone**
- **Zygomatic bone**
- **Maxilla**
- **Mandible**

---

- **Frontal bone**
- **Supraorbital notch (foramen)**
- **Glabella**
- **Orbital surface**
- **Nasal bone**
- **Lacrimal bone**
- **Zygomatic bone**
- **Maxilla**
- **Vomer**

---

**Foramen cecum**

- **Occipital bone**
- **Crista galli**
- **Cribiform plate**

---

**Groove for superior sagittal sinus**

---

**Frontal crest**

---

**Groove for anterior meningeal vessels**

---

**Foramen cecum**

---

**Superior surface of orbital part**

---

**Ethmoid bone**

---

**Cribiform plate**

---

**Inferior nasal concha**

---

**Vomer**

---

**Coronal suture**

---

**Parietal bone**

---

**Temporal fossa**

---

**Superior temporal line**

---

**Inferior temporal line**

---

**Temporal bone**
## Bones of the Skull

### Parietal Bone

**Characteristics**
- Forms the majority of the cranial vault
- Provides for the attachment of the temporals muscle
- The four corners of the parietal are not ossified at birth and give rise to the fontanelles
- There are 2 parietal bones

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Parts</th>
<th>Ossification</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Forms the majority of the cranial vault</strong></td>
<td><strong>Has 4 angles:</strong></td>
<td><strong>Intramembranous</strong></td>
<td><strong>Relatively square, forming the roof and sides of the cranial vault</strong></td>
</tr>
<tr>
<td><strong>Provides for the attachment of the temporals muscle</strong></td>
<td><strong>Parietal—located at lambd</strong></td>
<td></td>
<td><strong>Endocranial surface is filled with grooves made by branches of the middle meningeal a.</strong></td>
</tr>
<tr>
<td><strong>The four corners of the parietal are not ossified at birth and give rise to the fontanelles</strong></td>
<td><strong>Sphenoid—located at pterion</strong></td>
<td></td>
<td><strong>Sigmoid sulcus is a groove caused by the beginning of the transverse sinus, located at the mastoid angle</strong></td>
</tr>
<tr>
<td><strong>There are 2 parietal bones</strong></td>
<td><strong>Occipital—located at asterion</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Diagram:**
- **Superior view**
- **Inferior view**
- **Occipital bone**
- **Parietal bone**
- **Temporal bone**
- **Sphenoid bone**
- **Frontal bone**
- **Coronal suture**
- **Bregma**
- **Parietal bone**
- **Sagittal suture**
- **Parietal foramen**
- **Lambda**
- **Lambdoid suture**
- **Sagittal sinus**
- **Temporals**
- **Mastoid**
- **Vomer**
- **Maxilla**
- **Ethmoid bone**
- **Cribriform plate**
- **Nasal bone**
- **Perpendicular plate**
- **Inferior nasal concha**
- **Palatine bone**
### Bones of the Skull

#### OCCIPITAL BONE

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

**OCCIPITAL BONE CONTINUED**
# TEMPOREAL BONE

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Parts</th>
<th>Ossification</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>The paired temporal bones:</td>
<td>Squamous part</td>
<td>Intramembranous</td>
<td>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</td>
</tr>
<tr>
<td>Help form the base and the lateral walls of the skull</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>House the auditory and vestibular apparatuses</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contain mastoid air cells</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Each bone has 8 centers of ossification that give rise to the 3 major centers observed before birth</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>There are 2 temporal bones</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Petrous part</td>
<td>Endochondral</td>
<td>Forms the solid portion of bone The auditory and vestibular apparatuses are located within the petrous part Helps separate the temporal and 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 Petrotymanpic 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</td>
</tr>
<tr>
<td></td>
<td>Tympanic part</td>
<td>Intramembranous</td>
<td>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</td>
</tr>
<tr>
<td></td>
<td>Styloid process</td>
<td>Endochondral</td>
<td>A projection from the temporal bone The stylomastoid foramen lies posterior to this process</td>
</tr>
</tbody>
</table>

---

*32 NETTER’S HEAD AND NECK ANATOMY FOR DENTISTRY*
Bones of the Skull

TEMPORAL BONE CONTINUED

- Parietal bone
- Sphenoid bone
- Frontal bone
- Ethmoid bone
- Lacrimal bone
- Nasal bone
- Zygomatic bone
- Temporal bone
- Squamous part
- Articular process
- External acoustic meatus
- Mastoid process
- Lambdoid suture
- Occipital bone
- Mandible
- Temporal bone
- Squamous part
- Petrous part
- Groove for lesser petrosal n.
- Groove for greater petrosal n.
- Trigeminal impression
- Acute eminence
- Groove for superior petrosal sinus
- Groove for sigmoid sinus
- Maxilla
- Zygomatic bone
- Palatine bone
- Vomer
- Foramen lacerum
- Temporal bone
- Squamous part
- Groove for middle meningeal artery
- Groove for greater petrosal nerve
- Internal acoustic meatus
- Styloid process
- Temporal bone
- Sigmoid process
- Groove for the lesser petrosal nerve
- Opening to the auditory tube
- Middle Meningeal grooves
- Groove for the greater petrosal nerve
- Styloid process
- Temporal bone portion of the foramen lacerum
- Sigmoid sulcus
- Groove for the greater petrosal nerve
- Middle Meningeal grooves
## Bones of the Skull
### SPHENOID BONE

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

SPHENOID BONE CONTINUED
Bones of the Skull

**LACRIMAL BONE**

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

**NASAL BONE**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Parts</th>
<th>Ossification</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inferior portion forms the</td>
<td></td>
<td>Intramembranous</td>
<td>Articulates with the nasal bone of the opposite side, the nasal portion</td>
</tr>
<tr>
<td>superior margin of the nasal</td>
<td></td>
<td></td>
<td>of the frontal bone, the frontal process of the maxilla, and the</td>
</tr>
<tr>
<td>aperture</td>
<td></td>
<td></td>
<td>perpendicular plate of the ethmoid</td>
</tr>
<tr>
<td>Forms the bridge of the nose</td>
<td></td>
<td></td>
<td>Inferior portion of the nasal bones attaches with the lateral nasal</td>
</tr>
<tr>
<td>There are 2 nasal bones</td>
<td></td>
<td></td>
<td>cartilages and septal cartilage</td>
</tr>
</tbody>
</table>
Bones of the Skull

**ZYGOMATIC BONE (ZYGOMA)**

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

- Sphenoid bone
  - Greater wing
- Frontal bone
  - Supraorbital notch (foramen)
  - Glabella
  - Ethmoid bone
  - Orbital plate
- Lacrimal bone
  - Fossa for lacrimal sac
  - Nasal bone
- Maxilla
  - Incisive fossa
- Palatine process
  - Incisive fossa
- Median palatine suture
- Zygomatic process
- Zygomatic bone
- Frontal bone
  - Palatine bone
  - Vomer
- Sphenoid bone
- Zygomatic bone
- Temporal bone
- Occipital bone
- Nasal bone
- Lacrimal bone
- Zygomatic bone
- Frontal process
- Orbital surface
- Temporal process
- Zygomaticofacial foramen
- Maxillary process
- Mandible

OSTEOLOGY 37
## Bones of the Skull

### ETHMOID BONE

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Part</th>
<th>Ossification</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>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</td>
<td>Perpendicular plate</td>
<td>Endochondral</td>
<td>A flat plate that descends from the cribriform plate to form part of the nasal septum Articulates with the vomer inferiorly</td>
</tr>
<tr>
<td></td>
<td>Cribriform plate</td>
<td></td>
<td>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</td>
</tr>
<tr>
<td></td>
<td>Ethmoid labyrinth</td>
<td></td>
<td>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</td>
</tr>
</tbody>
</table>
Bones of the Skull

**ETHMOID BONE CONTINUED**

- Frontal bone
- Nasal bone
- Lacrimal bone
- Zygomatic bone
- Maxilla
- Sphenoid bone
- Ethmoid bone
- Orbital plate
- Perpendicular plate
- Middle nasal concha
- Inferior nasal concha
- Vomer
- Middle nasal concha (cut away)
- Superior nasal concha (cut away)
- Openings of posterior ethmoidal cells
- Opening of middle ethmoidal cells
- Openings into maxillary sinus
- Ethmoidal process of inferior nasal concha
- Semilunar hiatus with opening
- Uncinate process
- Inferior nasal concha (cut away)
- Opening of nasolacrimal canal
- Ethmoidal bulla
- Sphenoethmoidal recess
- Maxilla
- Palatine bone
- Frontal bone
- Nasal bone
- Superior nasal concha
- Highest nasal concha
- Maxilla
- Palatine bone
# Bones of the Skull

## VOMER

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Part</th>
<th>Ossification</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shaped like a &quot;plough&quot;</td>
<td>Intramembranous</td>
<td>Articulates with the</td>
<td></td>
</tr>
<tr>
<td>Forms the posterior inferior part of the nasal septum</td>
<td></td>
<td>perpendicular plate</td>
<td></td>
</tr>
<tr>
<td>There is 1 vomer bone</td>
<td></td>
<td>of the ethmoid, maxilla,</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>palatine, and sphenoid</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>bones and septal</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>cartilage</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Posterior border does</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>not articulate with</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>any other bone</td>
<td></td>
</tr>
</tbody>
</table>

**Diagram:**

- Parietal bone
- Temporal bone
- Frontal bone
- Sphenoid bone
- Ethmoid bone
- Cribriform plate
- Perpendicular plate
- Nasal bone
- Inferior nasal concha
- Maxilla
- Palatine bone
- Crista galli
- Vomerine groove for nasopalatine n. and vessels
- Maxilla
- Frontal bone
- Ethmoid bone
- Perpendicular plate
- Sphenoid bone
- Palatine bone
Bones of the Skull

**INFERIOR NASAL CONCHA**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Part</th>
<th>Ossification</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is described as a curved bone that forms part of the lateral wall of the nasal cavity. There are 2 inferior nasal conchae.</td>
<td>Perpendicular plate</td>
<td>Intramembranous</td>
<td>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.</td>
</tr>
</tbody>
</table>

**PALATINE BONE**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Part</th>
<th>Ossification</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forms part of the nasal cavity and the hard palate. It is L-shaped. There are 2 palatine bones.</td>
<td>Perpendicular plate</td>
<td>Intramembranous</td>
<td>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.</td>
</tr>
<tr>
<td></td>
<td>Horizontal plate</td>
<td></td>
<td>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.</td>
</tr>
<tr>
<td></td>
<td>Pyramidal process</td>
<td></td>
<td>Extends posteriorly and inferiorly from the junction of the perpendicular and horizontal plates of the palatine. Lesser palatine foramina are located here.</td>
</tr>
</tbody>
</table>
Bones of the Skull

INFERIOR NASAL CONCHA CONTINUED
Bones of the Skull

**MAXILLA**

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

MAXILLA CONTINUED

- Frontal bone
- Nasal bone
- Lacrimal bone
- Zygomatic bone
- Maxilla
- Zygomatic process
- Orbital surface
- Infracocular foramen
- Frontal process
- Alveolar process
- Anterior nasal spine
- Maxilla
- Zygomatic process
- Orbital surface
- Infracocular foramen
- Frontal process
- Alveolar process
- Anterior nasal spine
- Incisive fossa
- Palatine process of maxilla
- Horizontal plate of palatine bone
- Greater and lesser palatine foramina

Upper permanent teeth:
- Central incisors
- Lateral incisors
- Canines
- 1st premolars
- 2nd premolars
- 1st molars
- 2nd molars
- 3rd molars

- Incisive fossa
- Palatine process of maxilla
- Horizontal plate of palatine bone
- Greater and lesser palatine foramina

Upper permanent teeth:
- Central incisors
- Lateral incisors
- Canines
- 1st premolars
- 2nd premolars
- 1st molars
- 2nd molars
- 3rd molars
Bones of the Skull

MAXILLA CONTINUED
### Bones of the Skull

#### MANDIBLE

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Part</th>
<th>Ossification</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forms the lower jaw</td>
<td>Body</td>
<td>Intramembranous</td>
<td>Mental foramen lies on the anterior part of the lateral surface of the body</td>
</tr>
<tr>
<td>Described as horseshoe shaped</td>
<td></td>
<td>(ossifies around Meckel’s cartilage)</td>
<td>External oblique line is observed on the lateral side of the mandible</td>
</tr>
<tr>
<td>All muscles of mastication attach to the mandible</td>
<td></td>
<td></td>
<td>On the medial side of the body lies the mylohyoid line</td>
</tr>
<tr>
<td>There is 1 mandible</td>
<td></td>
<td></td>
<td>Mylohyoid line helps divide a sublingual from a submandibular fossa</td>
</tr>
<tr>
<td></td>
<td>Ramus</td>
<td></td>
<td>Posterior border of the mylohyoid line provides for attachment of the pterygomandibular raphe</td>
</tr>
<tr>
<td></td>
<td>Coronoid process</td>
<td>The anterioiremost superior extension of each ramus</td>
<td>Superior part divides into a coronoid process anteriorly and a condylar process posteriorly, separated by a mandibular notch</td>
</tr>
<tr>
<td></td>
<td>Condylar process</td>
<td>Articulates with the temporal bone in the temporomandibular joint</td>
<td>Has a neck that forms a condyle superiorly</td>
</tr>
<tr>
<td></td>
<td>Alveolar process</td>
<td>Extends superiorly from the body</td>
<td>Created by a thick buccal and a thin lingual plate of bone</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Created by a thick buccal and a thin lingual plate of bone</td>
<td>The part of the mandible that supports the mandibular teeth</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Contains 5 primary and 8 permanent teeth</td>
<td>Each side of the mandible contains 5 primary and 8 permanent teeth</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Alveolar bone is resorbed when a tooth is lost</td>
<td>Alveolar bone is resorbed when a tooth is lost</td>
</tr>
</tbody>
</table>
Bones of the Skull

MANDIBLE CONTINUED
Views and Sutures

**NORMA FRONTALIS**

<table>
<thead>
<tr>
<th>Bones</th>
<th>Frontal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nasal</td>
</tr>
<tr>
<td></td>
<td>Maxilla</td>
</tr>
<tr>
<td></td>
<td>Zygomatic</td>
</tr>
<tr>
<td></td>
<td>Mandible</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sutures</th>
<th>Frontonasal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frontozygomatic</td>
</tr>
<tr>
<td></td>
<td>Zygomaticomaxillary</td>
</tr>
<tr>
<td></td>
<td>Metopic</td>
</tr>
</tbody>
</table>

![Image of human skull with labeled bones and sutures]
# Views and Sutures

## NORMA VERTICALIS

| Bones               | FrONTAL
|---------------------|------------------|
|                     | PARIETAL
|                     | OCCIPITAL

| Sutures             | CORONAL
|---------------------|------------------|
|                     | SAGITTAL
|                     | LAMBDOIDAL

---

**Superior view**

- Frontal bone
- Coronal suture
- Bregma
- Parietal bone
- Sagittal suture
- Lambda
- Lambdoid suture
- Occipital bone

---

**Superior view**

- Frontal bone
- Anterior fontanelle
- Coronal suture
- Parietal bone
- Sagittal suture
- Posterior fontanelle
- Lambdoid suture
- Occipital bone
Views and Sutures

**NORMA OCCIPITALIS**

<table>
<thead>
<tr>
<th>Bones</th>
<th>Parietal Occipital</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sutures</td>
<td>Sagittal Lambdoidal</td>
</tr>
</tbody>
</table>

- Sagittal suture
- Parietal bone
- Lambda
- Lambdoid suture
- Occipital bone
- Temporal bone
# 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               |  

![Diagram of skull with labeled bones and sutures](image)
Views and Sutures

**NORMA BASALIS**

<table>
<thead>
<tr>
<th>Bones</th>
<th>Palatine process of maxilla</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Occipital</td>
</tr>
<tr>
<td></td>
<td>Temporal</td>
</tr>
<tr>
<td></td>
<td>Horizontal plate of the palatine</td>
</tr>
<tr>
<td></td>
<td>Greater wing of the sphenoid</td>
</tr>
<tr>
<td></td>
<td>Vomer</td>
</tr>
<tr>
<td></td>
<td>Medial pterygoid plate</td>
</tr>
<tr>
<td></td>
<td>Lateral pterygoid plate</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sutures</th>
<th>Intermaxillary</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Transverse palatine</td>
</tr>
<tr>
<td></td>
<td>Petro-occipital</td>
</tr>
<tr>
<td></td>
<td>Spheno-occipital</td>
</tr>
<tr>
<td></td>
<td>Petrosquamous</td>
</tr>
<tr>
<td></td>
<td>Petrotypanic</td>
</tr>
<tr>
<td></td>
<td>Squamotympanic</td>
</tr>
</tbody>
</table>

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

SUPERIOR VIEW OF THE CRANIAL BASE CONTINUED

- Foramen cecum
- Nasal slit
- Anterior ethmoidal foramen
- Foramina of cribriform plate
- Posterior ethmoidal foramen
- Optic canal
- Superior orbital fissure
- Foramen rotundum
- Foramen ovale
- Foramen spinosum
- Sphenoid emissary foramen (Vesalius) (inconstant)
- Foramen lacerum
- Carotid canal for
  - Internal carotid artery
  - Internal carotid nerve plexus
- Hiatus for
  - Lesser petrosal nerve
  - Greater petrosal nerve
- Internal acoustic meatus
- External opening of vestibular aqueduct
- Mastoid foramen (inconstant)
- Jugular foramen
- Condylar canal (inconstant)
- Hypoglossal canal
- Foramen magnum
## Major Foramina and Fissures

### INFERIOR VIEW OF THE CRANIAL BASE

<table>
<thead>
<tr>
<th>Foramen/Fissure</th>
<th>Located in or Formed by</th>
<th>Structures Passing through</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incisive foramen</td>
<td>Maxilla (palatine process)</td>
<td>Nasopalatine n., sphenopalatine a.</td>
</tr>
<tr>
<td>Greater palatine foramen</td>
<td>Palatine</td>
<td>Greater palatine n. and vessels</td>
</tr>
<tr>
<td>Lesser palatine foramina</td>
<td>Palatine</td>
<td>Lesser palatine n. and vessels</td>
</tr>
<tr>
<td>Foramen ovale</td>
<td>Sphenoid</td>
<td>Mandibular division of the trigeminal n., accessory meningeal a., lesser petrosal n., emissary v.</td>
</tr>
<tr>
<td>Foramen spinosum</td>
<td>Sphenoid</td>
<td>Middle meningeal vessels and meningeal branch of the mandibular division of the trigeminal n.</td>
</tr>
<tr>
<td>Foramen lacerum</td>
<td>Articulation of the sphenoid (greater wing and body), temporal (petrous portion), and occipital (basilar portion) bones</td>
<td>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)</td>
</tr>
<tr>
<td>Opening for auditory tube</td>
<td>Temporal and sphenoid</td>
<td>Cartilaginous portion of the auditory tube</td>
</tr>
<tr>
<td>Carotid canal</td>
<td>Temporal (petrous portion)</td>
<td>Internal carotid a., internal carotid n. plexus (sympathetics)</td>
</tr>
<tr>
<td>Tympamic canaliculus</td>
<td>Temporal</td>
<td>Tympanic branch of the glossopharyngeal n.</td>
</tr>
<tr>
<td>Jugular foramen</td>
<td>Temporal (petrous portion) and occipital</td>
<td>Glossopharyngeal n., vagus n., spinal accessory n., inferior petrosal sinus, sigmoid sinus, posterior meningeal a.</td>
</tr>
<tr>
<td>Mastoid canaliculus</td>
<td>Temporal (within the jugular fossa)</td>
<td>Auricular branch of the vagus n.</td>
</tr>
<tr>
<td>Petrotypanic fissure</td>
<td>Temporal</td>
<td>Chorda tympani n.</td>
</tr>
<tr>
<td>Stylomastoid foramen</td>
<td></td>
<td>Facial n., stylomastoid a.</td>
</tr>
<tr>
<td>Tymanomastoid fissure</td>
<td></td>
<td>Auricular branch of the vagus n.</td>
</tr>
<tr>
<td>Hypoglossal canal</td>
<td>Occipital</td>
<td>Hypoglossal n.</td>
</tr>
<tr>
<td>Condylar canal</td>
<td></td>
<td>Emissary v., meningeal branches of ascending pharyngeal a.</td>
</tr>
<tr>
<td>Foramen magnum</td>
<td></td>
<td>Medulla oblongata, vertebral arteries, spinal roots of the spinal accessory n.</td>
</tr>
</tbody>
</table>
Major Foramina and Fissures

INFERIOR VIEW OF THE CRANIAL BASE CONTINUED
## Major Foramina and Fissures

### ANTERIOR VIEW

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

![Diagram of the head and neck anatomy with major foramina and fissures labeled.](image-url)
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**

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

**GENERAL INFORMATION CONTINUED**
Cervical Vertebrae

### MAJOR EXTERNAL LIGAMENTS

<table>
<thead>
<tr>
<th>Ligament(s)/Membrane(s)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior longitudinal ligament</td>
<td>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.</td>
</tr>
<tr>
<td>Ligamenta flava</td>
<td>Attached to the anterior surfaces of the lamina within the vertebral foramen extending from the axis to the first sacral vertebra</td>
</tr>
<tr>
<td>Ligamentum nuchae</td>
<td>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</td>
</tr>
<tr>
<td>Anterior atlanto-occipital membrane</td>
<td>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</td>
</tr>
<tr>
<td>Posterior atlanto-occipital membrane</td>
<td>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</td>
</tr>
</tbody>
</table>
### MAJOR INTERNAL LIGAMENTS

<table>
<thead>
<tr>
<th>Ligament(s)/Membrane(s)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Deep Ligaments/Membranes</strong></td>
<td></td>
</tr>
<tr>
<td>Alar ligament</td>
<td>Extends from the dens to the medial portions of the occipital condyles Also known as “check ligaments” because they limit skull rotation</td>
</tr>
<tr>
<td>Apical ligament of the dens</td>
<td>Extends from the dens to the anterior margin of the foramen magnum</td>
</tr>
<tr>
<td>Cruciate ligament</td>
<td></td>
</tr>
<tr>
<td>● <em>Superior longitudinal band</em></td>
<td>Part of the transverse lig. of the atlas, which extends superiorly to attach to the basilar portion of the occipital bone</td>
</tr>
<tr>
<td>● <em>Transverse ligament of atlas</em></td>
<td>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</td>
</tr>
<tr>
<td>● <em>Inferior longitudinal band</em></td>
<td>Part of the transverse lig. of the atlas that extends inferiorly, attaching to the posterior body of the axis</td>
</tr>
<tr>
<td><strong>Superficial Ligaments/Membranes</strong></td>
<td></td>
</tr>
<tr>
<td>Tectorial membrane</td>
<td>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.</td>
</tr>
<tr>
<td>Posterior longitudinal ligament</td>
<td>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</td>
</tr>
</tbody>
</table>
Cervical Vertebrae

MAJOR INTERNAL LIGAMENTS CONTINUED
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

![Image of an anatomical diagram showing various fractures and clinical manifestations of zygomatic fractures.]
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
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.
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
Fractures of cervical vertebrae

**Type I. Fracture of tip**

**Type II. Fracture of base or neck**

**Type III. Fracture extends into body of axis**

Jefferson fracture of atlas (C1)
Each arch may be broken in one or more places

Hangman’s fracture
Fracture through neural arch of axis (C2), between superior and inferior articular facets
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)
**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.
Central Nervous System

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

Computed 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

Computed 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
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
Central Nervous System

SPINAL CORD CONTINUED

Sections through spinal cord at various levels

C5  T2  T8

L1  L3  S1  S3
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

- Oculomotor (III) n.
- Facial (VII) n.
- Glossopharyngeal (IX) n.
- Medulla oblongata
- Vagus (X) n.
- C1 - C8
- T1 - T12
- S1 - S5
- Coccyx

- Sympathetic fibers
  - preganglionic
  - postganglionic

- Parasympathetic fibers
  - preganglionic
  - postganglionic

- Intracranial vessels
- Eye
- Lacrimal gland
- Root of tongue
- Tonsils
- Sublingual and submandibular glands
- Peripheral cranial
  blood vessels
- Larynx
- Trachea
- Bronchi and lungs
- Heart
- Stomach
- Liver
- Gallbladder
- Bile ducts
- Pancreas
- Adrenal glands
- Brown fat
- Kidneys
- Intestines
- Lymphoid organs
- Distal colon
- Bladder
- External genitalia

- Shown for only 1 segment
- Brown fat
- Lymphoid organs
- Gray and white rami communicantes
- Sympathetic trunk
- Inf. hypogastric (pelvic) plexus
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  VII: Facial nerve
II: Optic nerve  VIII: Vestibulocochlear nerve
III: Oculomotor nerve  IX: Glossopharyngeal nerve
IV: Trochlear nerve  X: Vagus nerve
V: Trigeminal nerve  XI: Spinal accessory nerve
VI: Abducens 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.*
### Cranial Nerves

#### CRANIAL NERVE I: OLFATORY NERVE

<table>
<thead>
<tr>
<th>Functional Column</th>
<th>Origin of Fibers</th>
<th>Termination of Fibers</th>
<th>Summary</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>SVA</td>
<td>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.</td>
<td>The secondary fibers continue to synapse in the olfactory areas:  - Lateral olfactory area  - Anterior olfactory nucleus  - Intermediate olfactory area  - Medial olfactory area</td>
<td>The SVA fibers are responsible for the sense of smell.</td>
<td>Tumors of the olfactory lobe can affect the olfactory system.</td>
</tr>
</tbody>
</table>

**Olfactory bulb cells: schema**

- Efferent fibers to olfactory bulbs
- Afferent fibers from bulb to central connections and contralateral bulb
- Granule cell (excited by and inhibiting to mitral and tufted cells)
- Mitral cell
- Recurrent process
- Tufted cell
- Periglomerular cell
- Glomerulus
- Olfactory nerve fibers

**Subcallosal (parolfactory) area**
- Septal area and nuclei
- Fibers from fibers to olfactory bulb
- Anterior commissure
- Medial olfactory stria

**Olfactory tract**
- Olfactory trigone and olfactory tubercle
- Lateral olfactory stria
- Lateral olfactory tract nucleus
- Anterior perforated substance
- Amygdaloid body (phantom)
- Piriform lobe

**Hippocampal limbus**
- Uncus
- Dentate gyrus
- Parahippocampal gyrus
Distribution of olfactory epithelium (blue area)

Lateral nasal wall

Olfactory bulb

Cribiform plate of ethmoid bone

Septum

Schema of section through olfactory mucosa

- Cribiform plate
- Schwann cell
- Olfactory gland
- Unmyelinated olfactory axons
- Basement membrane
- Sustentacular cells
- Endoplasmic reticulum
- Nucleus
- Olfactory cells
- Dendrites
- Terminal bars (desmosomes)
- Olfactory rod (vesicle)
- Villi
- Cilia
- Mucus
**Cranial Nerves**

**CRANIAL NERVE II: OPTIC NERVE**

<table>
<thead>
<tr>
<th>Functional Column</th>
<th>Origin of Fibers</th>
<th>Termination of Fibers</th>
<th>Summary</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSA</td>
<td>Begins in the retina with the receptors of rods and cones that synapse on bipolar cells which synapse with ganglion cells</td>
<td>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</td>
<td>The SSA fibers are responsible for vision</td>
<td>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</td>
</tr>
</tbody>
</table>

Central darker circle represents macular zone. Lightest shades represent monocular fields. Each quadrant is a different color.
Cranial Nerves

CRANIAL NERVE II: OPTIC NERVE CONTINUED
### Cranial Nerves

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

<table>
<thead>
<tr>
<th><strong>OCULOMOTOR NERVE</strong></th>
<th><strong>TROCHLEAR NERVE</strong></th>
<th><strong>ABDUCENS NERVE</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Functional Column</strong></td>
<td><strong>Origin of Fibers</strong></td>
<td><strong>Termination of Fibers</strong></td>
</tr>
<tr>
<td>GSE</td>
<td>Begins in the oculomotor nucleus</td>
<td>Innervates the superior rectus, inferior rectus, medial rectus, inferior oblique, and levator palpebrae superioris mm.</td>
</tr>
</tbody>
</table>

**References:**
- Netter's Head and Neck Anatomy for Dentistry
- Cranial Nerves III, IV, and VI: Oculomotor, and Trochlear, Abducens Nerves.
Cranial Nerves

CRANIAL NERVES III, IV, AND VI: OCULOMOTOR, AND TROCHLEAR, ABDUCENS NERVES CONTINUED
## Cranial Nerves

### CRANIAL NERVE V: TRIGEMINAL NERVE

<table>
<thead>
<tr>
<th>Functional Column</th>
<th>Origin of Fibers</th>
<th>Termination of Fibers</th>
<th>Summary</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSA</td>
<td>Afferent fibers begin in the various receptors (nociceptors, mechanoreceptors, proprioceptors) of the skin and deep tissues of the head</td>
<td>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</td>
<td>GSA fibers are responsible for providing sensory innervation to the major part of the head GSA fibers utilize the trigeminotatalamic lemniscus to carry their sensory impulses to consciousness</td>
<td>Provides sensory innervation through 3 main divisions: - Ophthalmic - Maxillary - Mandibular The nerve cell bodies for the primary fibers are located in the trigeminal ganglion</td>
</tr>
<tr>
<td>SVE</td>
<td>Begins in the motor nucleus of the trigeminal</td>
<td>Innervates the muscles of mastication: - Masseter - Temporalis - Medial pterygoid - Lateral pterygoid Also innervates: - Mylohyoid - Anterior digastric - Tensor tympani - Tensor veli palatini</td>
<td>The SVE fibers are responsible for innervating the muscles of the 1st pharyngeal arch</td>
<td></td>
</tr>
</tbody>
</table>

![Diagram of cranial nerves](image_url)
OPHTHALMIC DIVISION OF THE TRIGEMINAL NERVE

The ophthalmic division (V1), being a branch of the trigeminal nerve, 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 nerves, but superior to the maxillary division of the trigeminal nerve.
- Immediately before entering the orbit, through the superior orbital fissure, it divides into 3 major branches:
  - Lacrimal
  - Frontal
  - Nasociliary

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lacrimal</td>
<td>1 of the 3 major branches of the ophthalmic division of the trigeminal nerve.</td>
<td>Smallest branch of the ophthalmic division of the trigeminal nerve. 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 artery. Before reaching the lacrimal gland, it communicates with the zygomatic branch of the maxillary division of the trigeminal nerve 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.</td>
</tr>
</tbody>
</table>
### Cranial Nerve V: Trigeminal Nerve

#### Continued

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frontal</td>
<td>Frontal n.</td>
<td>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.</td>
</tr>
<tr>
<td>Supraorbital</td>
<td>Frontal n.</td>
<td>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</td>
</tr>
<tr>
<td>Supratrochlear</td>
<td>Frontal n.</td>
<td>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</td>
</tr>
<tr>
<td>Nasociliary</td>
<td>1 of the 3 major branches of the ophthalmic division of the trigeminal n.</td>
<td>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</td>
</tr>
<tr>
<td>Sensory root of the ciliary ganglion</td>
<td>Nasociliary n.</td>
<td>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.</td>
</tr>
<tr>
<td>Short ciliary</td>
<td>Ciliary ganglion</td>
<td>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</td>
</tr>
<tr>
<td>Long ciliary</td>
<td>Nasociliary n.</td>
<td>Has 2 to 4 branches that travel anteriorly to enter the posterior part of the sclera of the eye</td>
</tr>
<tr>
<td>Posterior ethmoid</td>
<td>Nasociliary n.</td>
<td>Travels deep to the superior oblique m. to pass through the posterior ethmoid foramen Supplies the sphenoid sinus and the posterior ethmoid sinus</td>
</tr>
<tr>
<td>Anterior ethmoid</td>
<td>Nasociliary n.</td>
<td>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</td>
</tr>
<tr>
<td>External nasal</td>
<td>A terminal branch of the anterior ethmoid n.</td>
<td>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</td>
</tr>
<tr>
<td>Internal nasal</td>
<td></td>
<td>Supplies the skin on the internal surface of the vestibule</td>
</tr>
<tr>
<td>Infratrochlear</td>
<td>Nasociliary n.</td>
<td>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</td>
</tr>
</tbody>
</table>
Cranial Nerves

CRANIAL NERVE V: TRIGEMINAL NERVE CONTINUED

Superior view

Supratrochlear n.
Supraorbital n.
Levator palpebrae superioris m.
Superior rectus m.
Lacrimal gland
Lacrimal n.
Supratrochlear n.
Medial branch
Lateral branch
Levator palpebrae superioris m.
Mandibular n. (V3)
Lesser petrosal n.
Greater petrosal n.
Trigeminal (semilunar) ganglion

Infratrochlear n.
Nasociliary n.
Trochlear n. (IV)
Oculomotor n. (III)
Abducens n. (VI)

Internal carotid a.
and n. plexus
Optic n. (II)
Posterior ethmoidal n.
Superior branch of oculomotor n. (III) (cut)
Nasociliary n.
Internal carotid plexus
Trochlear n. (IV) (cut)
Oculomotor n. (III)
Abducens n. (VI)

Long ciliary nn.
Short ciliary nn.
Lacrimal n.
Ciliary ganglion
Parasympathetic root of ciliary ganglion (from inferior branch of oculomotor n.)
Long ciliary nn.
Short ciliary nn.
Lacrimal n.
Ciliary ganglion
Parasympathetic root of ciliary ganglion (from inferior branch of oculomotor n.)
Sympathetic root of ciliary ganglion (from internal carotid plexus)
Sensory root of ciliary ganglion (from nasociliary n.)
Branches to inferior and medial rectus mm.
Abducens n. (VI)
Superior branch of oculomotor n. (III)
Meningeal branch
of mandibular n.
Greater petrosal n.
Medial branch
Lateral branch
Frontal n.
Maxillary n. (V2)
Mandibular n. (V3)
Lesser petrosal n.
Greater petrosal n.
Trigeminal (semilunar) ganglion

Supratrochlear n. (cut)
Supraorbital n. branches (cut)
Infratrochlear n.
Anterior ethmoidal n.
Optic n. (II)
Posterior ethmoidal n.
Superior branch of oculomotor n. (III) (cut)
Nasociliary n.
Internal carotid plexus
Trochlear n. (IV) (cut)
Oculomotor n. (III)
Abducens n. (VI)

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

Supratrochlear n.
Supraorbital n.
Infraorbital n.
Nasociliary n.
Superior branch of oculomotor n. (III) (cut)
Optic n. (II)
Infratrochlear n.
External carotid a.
Infratrochlear n.
Infraorbital a. and n.
Nasalis m. (transverse part)
Infraorbital a. and n.

Optic n. (II)
Posterior ethmoidal n.
Superior branch of oculomotor n. (III) (cut)
Nasociliary n.
Internal carotid plexus
Trochlear n. (IV) (cut)
Oculomotor n. (III)
Abducens n. (VI)

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

Supratrochlear n.
Supraorbital n.
Infraorbital n.
Nasociliary n.
Superior branch of oculomotor n. (III) (cut)
Optic n. (II)
Infratrochlear n.
External carotid a.
Infratrochlear n.
Infraorbital a. and n.
Nasalis m. (transverse part)
Infraorbital a. and n.

Optic n. (II)
Posterior ethmoidal n.
Superior branch of oculomotor n. (III) (cut)
Nasociliary n.
Internal carotid plexus
Trochlear n. (IV) (cut)
Oculomotor n. (III)
Abducens n. (VI)

Infratrochlear n.
**Cranial Nerves**

**CRANIAL NERVE V: TRIGEMINAL NERVE** CONTINUED

### MAXILLARY DIVISION OF THE TRIGEMINAL NERVE

The maxillary division (V₂), 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

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meningeal</td>
<td>A small meningeal branch is given off within the middle cranial fossa</td>
</tr>
<tr>
<td></td>
<td>The nerve supplies the meninges</td>
</tr>
</tbody>
</table>

#### BRANCHES WITHIN THE PTERYGOPALATINE FOSSA

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posterior superior alveolar</td>
<td>Passes through the pterygomaxillary fissure to enter the infratemporal fossa.</td>
</tr>
<tr>
<td></td>
<td>In the infratemporal fossa, it passes on the posterior surface of the maxilla along the region of the maxillary tuberosity.</td>
</tr>
<tr>
<td></td>
<td>Gives rise to a gingival branch that innervates the buccal gingiva alongside the maxillary molars.</td>
</tr>
<tr>
<td></td>
<td>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.</td>
</tr>
<tr>
<td>Zygomatic</td>
<td>Passes through the inferior orbital fissure to enter the orbit.</td>
</tr>
<tr>
<td></td>
<td>Passes on the lateral wall of the orbit and branches into the zygomaticotemporal and zygomaticofacial branches.</td>
</tr>
<tr>
<td></td>
<td>A communicating branch from it joins the lacrimal n. from the ophthalmic division of the trigeminal n. to carry autonomic to the lacrimal gland.</td>
</tr>
<tr>
<td>Ganglionic branches</td>
<td>Usually 1 or 2 ganglionic branches that connect the maxillary division of the trigeminal n. to the pterygopalatine ganglion.</td>
</tr>
<tr>
<td></td>
<td>Contain sensory fibers that pass through the pterygopalatine ganglion (without synapsing) to be distributed with the nerves that arise from the pterygopalatine ganglion.</td>
</tr>
<tr>
<td></td>
<td>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).</td>
</tr>
<tr>
<td>Infraorbital</td>
<td>Considered the continuation of the maxillary division of the trigeminal n.</td>
</tr>
<tr>
<td></td>
<td>Passes through the inferior orbital fissure to enter the orbit.</td>
</tr>
<tr>
<td></td>
<td>Passes anteriorly through the infraorbital groove and infraorbital canal and exits onto the face via the infraorbital foramen.</td>
</tr>
</tbody>
</table>

#### BRANCHES ASSOCIATED WITH THE PTERYGOPALATINE GANGLION

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pharyngeal</td>
<td>Passes through the pharyngeal canal to enter and supply the nasopharynx.</td>
</tr>
<tr>
<td>Posterior superior nasal</td>
<td>A branch of the maxillary division of the trigeminal n.</td>
</tr>
<tr>
<td></td>
<td>Arises from the pterygopalatine ganglion in the pterygopalatine fossa.</td>
</tr>
<tr>
<td></td>
<td>Passes through the sphenopalatine foramen to enter the nasal cavity and branches into the:</td>
</tr>
<tr>
<td></td>
<td>● Posterior medial superior nasal n.</td>
</tr>
<tr>
<td></td>
<td>● Posterior lateral superior nasal n.</td>
</tr>
<tr>
<td>Posterior lateral superior nasal</td>
<td>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.</td>
</tr>
<tr>
<td>Posterior medial superior nasal</td>
<td>Arises from the posterior superior nasal n. from the maxillary division of the trigeminal n.</td>
</tr>
<tr>
<td></td>
<td>This nerve supplies the posterior portion of the nasal septum.</td>
</tr>
<tr>
<td>Greater palatine</td>
<td>Passes through the palatine canal to enter the hard palate via the greater palatine foramen.</td>
</tr>
<tr>
<td></td>
<td>Supplies the palatal gingiva and mucosa from the area in the premolar region to the posterior border of the hard palate to the midline.</td>
</tr>
</tbody>
</table>
### Cranial Nerves

**Cranial Nerve V: Trigeminal Nerve Continued**

#### Branches Associated with the Pterygopalatine Ganglion

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posterior inferior nasal branch of the greater palatine</td>
<td>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</td>
</tr>
<tr>
<td>Lesser palatine</td>
<td>Passes through the palatine canal to enter and supply the soft palate via the lesser palatine foramen</td>
</tr>
<tr>
<td>Nasopalatine</td>
<td>Branches from the pterygopalatine ganglion in the pterygopalatine fossa Passes through the sphenopalatine foramen to enter the nasal cavity, 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</td>
</tr>
</tbody>
</table>

#### Branches Within the Infraorbital Canal

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Middle superior alveolar</td>
<td>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</td>
</tr>
<tr>
<td>Anterior superior alveolar</td>
<td>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</td>
</tr>
</tbody>
</table>

#### Branches After Infraorbital Nerve Emerges From the Infraorbital Foramen

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior labial branch of the infraorbital</td>
<td>Supplies the skin of the upper lip</td>
</tr>
<tr>
<td>Nasal branch of the infraorbital</td>
<td>Supplies the ala of the nose</td>
</tr>
<tr>
<td>Inferior palpebral branch of the infraorbital</td>
<td>Supplies the skin of the lower eyelid</td>
</tr>
</tbody>
</table>
Cranial Nerves

**CRANIAL NERVE V: TRIGEMINAL NERVE** CONTINUED

- Ciliary ganglion
- Lacrimal n.
- Nasociliary n.
- Frontal n.
- Ophthalmic n. (V1)
- Trigeminal (semilunar) ganglion
- Trigeminal n. (V)
- Meningeal branch
- Foramen rotundum
- Foramen ovale
- Mandibular n. (V3)
- Maxillary nerve (V2)
- Zygomatic n.
- Nerve (vidian) of pterygoid canal
- Pterygopalatine ganglion
- Greater and lesser palatine nn.
- Ganglionic branches to pterygopalatine ganglion
- Lacrimal gland
- Zygomaticotemporal n.
- Zygomaticofacial n.
- Infraorbital n.
- Anterior superior alveolar n.
- Nasal branch
- Mucous membrane of maxillary sinus
- Middle superior alveolar n.
- Dental and gingival branches
- Superior dental plexus
- Infraorbital nerve entering infraorbital canal
- Posterior superior alveolar n.
- Medial wall of nasal cavity (nasal septum)
- Sphenopalatine foramen (dissected away)
- Pterygopalatine ganglion
- Nerve (Vidian) of pterygoid canal
- Posterior superior lateral nasal branch of maxillary nerve (V2)
- Posterior inferior lateral nasal branch of greater palatine nerve (V2)
- Lesser palatine nerves (V2)
- Greater palatine nerve (V3)
- Lateral wall of nasal cavity
- Nasopalatine nerve (V3)
Cranial Nerves

CRANIAL NERVE V: TRIGEMINAL NERVE CONTINUED

### MANDIBULAR DIVISION OF THE TRIGEMINAL NERVE

<table>
<thead>
<tr>
<th>Description</th>
<th>Source</th>
<th>Course</th>
<th>Anterior</th>
<th>Posterior</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mandibular division (V3)</td>
<td>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</td>
<td>Immediately gives rise to a meningeal branch and then divides into anterior and posterior divisions</td>
<td>Smaller; mainly motor, with 1 sensory branch (buccal); Masseteric; Anterior and posterior deep temporal; Medial pterygoid; Lateral pterygoid; Buccal</td>
<td>Larger; mainly sensory, with 1 motor branch (nerve to the mylohyoid): Auriculotemporal; Lingual; Inferior alveolar; Mylohyoid nerve</td>
</tr>
</tbody>
</table>

### ANTERIOR DIVISION OF THE MANDIBULAR NERVE

<table>
<thead>
<tr>
<th>Branch</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Masseteric</td>
<td>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</td>
</tr>
<tr>
<td>Anterior and posterior deep temporal</td>
<td>Pass superior to the lateral pterygoid m. between the skull and the temporalis m. while passing deep to the muscle to innervate it</td>
</tr>
<tr>
<td>Medial pterygoid</td>
<td>Enters the deep surface of the muscle</td>
</tr>
<tr>
<td>Lateral pterygoid</td>
<td>Passes into the deep surface of the muscle</td>
</tr>
<tr>
<td>Buccal</td>
<td>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</td>
</tr>
</tbody>
</table>

### POSTERIOR DIVISION OF THE MANDIBULAR NERVE

<table>
<thead>
<tr>
<th>Branch</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auriculotemporal</td>
<td>Normally arises by 2 roots, between which the middle meningeal a. passes Runs posteriory 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</td>
</tr>
<tr>
<td>Lingual</td>
<td>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</td>
</tr>
<tr>
<td>Inferior alveolar</td>
<td>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</td>
</tr>
<tr>
<td>Mylohyoid</td>
<td>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.</td>
</tr>
</tbody>
</table>
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 nucleus)

<table>
<thead>
<tr>
<th>Types of Fibers</th>
<th>Trigeminal Sensory Nucleus</th>
<th>Ascending Pathway</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain and temperature Light touch</td>
<td>Spinal (descending) nucleus</td>
<td>Ventral trigeminothalamic tract</td>
</tr>
<tr>
<td>Discriminative touch Pressure</td>
<td>Principal (main) sensory nucleus</td>
<td>Ventral trigeminothalamic tract (Dorsal trigeminothalamic tract subserves discriminative touch and pressure)</td>
</tr>
<tr>
<td>Proprioception</td>
<td>Mesencephalic nucleus</td>
<td>Projects to motor nucleus of V to control the jaw jerk reflex and force of bite</td>
</tr>
</tbody>
</table>
## MAJOR ASCENDING PATHWAYS OF THE TRIGEMINAL NERVE

<table>
<thead>
<tr>
<th>Types of Neurons</th>
<th>Path of Pain and Temperature</th>
<th>Path of Light Touch</th>
<th>Path of Discriminative Touch and Pressure</th>
</tr>
</thead>
</table>
| 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 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 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 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. |
| 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 Nerves

CRANIAL NERVE V: TRIGEMINAL NERVE  CONTINUED
## Cranial Nerves

### CRANIAL NERVE VII: FACIAL NERVE

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

CRANIAL NERVE VII: FACIAL NERVE CONTINUED
### Cranial Nerves

#### CRANIAL NERVE VIII: VESTIBULOCOCHLEAR NERVE

<table>
<thead>
<tr>
<th>Functional Column</th>
<th>Origin of Fibers</th>
<th>Termination of Fibers</th>
<th>Summary</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSA</td>
<td>Organ of Corti</td>
<td>Cochlear and vestibular nuclei</td>
<td>SSA fibers travel from the various vestibulocochlear receptors to their respective nuclei in the brainstem</td>
<td>Vestibulocochlear and facial nn. both enter the internal acoustic meatus and can be affected by tumors in the region</td>
</tr>
</tbody>
</table>

**Membranous labyrinth within bony labyrinth** (path of sound waves)

- **Scala vestibuli**
- **Cochlear duct** (scala media)
- **Scala tympani**

**Section through turn of cochlea**

- **Efferent n. fibers**
- **Afferent n. fibers**
- **Spiral ganglion**

**Spiral organ of Corti**

- **Hair cells**
- **Rods and tunnel of Corti**
- **Spiral ganglion**

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

CRANIAL NERVE VIII: VESTIBULOCOCHLEAR NERVE CONTINUED
## Cranial Nerves

### CRANIAL NERVE IX: GLOS SOPHARYNGEAL NERVE

<table>
<thead>
<tr>
<th>Functional Column</th>
<th>Origin of Fibers</th>
<th>Termination of Fibers</th>
<th>Summary</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSA</td>
<td>Afferent fibers begin in the various receptors of the skin of the external ear and the posterior 1/3 of the tongue</td>
<td>Pain and temperature fibers terminate in the spinal nucleus of V</td>
<td>GSA fibers are responsible for providing sensory innervation to a small portion of the external ear and posterior 1/3 of the tongue</td>
<td>Nerve cell bodies for the primary fibers are located in the superior ganglion of IX</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SVA</td>
<td>Afferent fibers begin in the taste receptors of the posterior 1/3 of the tongue</td>
<td>Primary afferent fibers travel in the tractus solitarius and terminate in the nucleus solitarius</td>
<td>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</td>
<td>Nerve cell bodies for the primary fibers are located in the inferior ganglion of IX</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GVA</td>
<td>Afferent fibers begin in the various receptors of the mucous membranes of the nasopharynx, oropharynx, middle ear, carotid body, and carotid sinus</td>
<td>Primary afferent fibers travel in the tractus solitarius and terminate in the nucleus solitarius</td>
<td>GVA fibers utilize the same pathway as for the SVA fibers</td>
<td>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</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GVE</td>
<td>Preganglionic parasympathetic fibers begin in the inferior salivatory nucleus</td>
<td>Postganglionic parasympathetic fibers innervate the parotid gland</td>
<td>The GVE fibers are responsible for providing the parasympathetic innervation to the parotid gland</td>
<td>GVE fibers utilize 1 ganglion: Otic</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SVE</td>
<td>Begins in the nucleus ambiguus</td>
<td>Innervates the stylopharyngeus m.</td>
<td>SVE fibers are responsible for innervating the muscles of the 3rd pharyngeal arch</td>
<td>Stylopharyngeus is the only muscle innervated by the glossopharyngeal n.</td>
</tr>
</tbody>
</table>
### Cranial Nerves

#### CRANIAL NERVE X: VAGUS NERVE

<table>
<thead>
<tr>
<th>Functional Column</th>
<th>Origin of Fibers</th>
<th>Termination of Fibers</th>
<th>Summary</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GSA</strong> Afferent fibers begin in the various receptors on a small part of the skin of the external ear</td>
<td>Pain and temperature fibers terminate in the spinal nucleus of V</td>
<td>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</td>
<td>The nerve cell bodies for the primary fibers are located in the superior ganglion of X</td>
<td></td>
</tr>
<tr>
<td><strong>SVA</strong> Afferent fibers begin in the taste receptors of the epiglottic region and are scattered on the palate</td>
<td>Primary afferent fibers travel in the tractus solitarius and terminate in the nucleus solitarius</td>
<td>The SVA fibers are responsible for carrying the taste fibers from the epiglottic region and are scattered on the palate</td>
<td>The nerve cell bodies for the primary fibers are located in the inferior ganglion of X</td>
<td></td>
</tr>
<tr>
<td><strong>GVA</strong> Afferent fibers begin in the various receptors of the mucous membranes of the laryngopharynx, larynx, thorax, and abdomen</td>
<td>Primary afferent fibers travel in the tractus solitarius and terminate in the nucleus solitarius</td>
<td>The GVA fibers utilize the same pathway as for the SVA fibers</td>
<td>The nerve cell bodies for the primary fibers are located in the inferior ganglion of X</td>
<td></td>
</tr>
<tr>
<td><strong>GVE</strong> Preganglionic parasympathetic fibers begin in the dorsal motor nucleus of the trigeminal nerve</td>
<td>Postganglionic parasympathetic fibers innervate the thoracic and abdominal viscera</td>
<td>The GVE fibers are responsible for providing the parasympathetic innervation to the thoracic and abdominal viscera</td>
<td>The GVE fibers utilize: ● Intramural ganglia</td>
<td></td>
</tr>
<tr>
<td><strong>SVE</strong> Begins in the nucleus ambiguus</td>
<td>Innervates the muscles of the pharynx (via the pharyngeal plexus) and the larynx</td>
<td>The SVE fibers are responsible for innervating the muscles of the 4th pharyngeal arch</td>
<td>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</td>
<td></td>
</tr>
</tbody>
</table>
BASIC NEUROANATOMY AND CRANIAL NERVES

CRANIAL NERVE XI: SPINAL ACCESSORY NERVE

<table>
<thead>
<tr>
<th>Functional Column</th>
<th>Origin of Fibers</th>
<th>Termination of Fibers</th>
<th>Summary</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>SVE</td>
<td>Cranial part: Begins in the nucleus ambiguus</td>
<td>Cranial part: Innervates the muscles of the pharynx (via the pharyngeal plexus) Spinal part: Innervates the trapezius and sternocleidomastoid mm.</td>
<td>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</td>
<td>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.</td>
</tr>
</tbody>
</table>

*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.*
CRANIAL NERVE XII: HYPOGLOSSAL NERVE

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

**Diagram:**
- Hypoglossal n. (XII) (in hypoglossal canal)
- Hypoglossal nucleus
- Intrinsic mm. of tongue
- Superior longitudinal
- Transverse and vertical
- Inferior longitudinal
- Genioglossus m.
- Geniohyoid m.
- Hyoglossus m.
- Thyrohyoid m.
- Omohyoid m. (superior belly)
- Sternohyoid m.
- Sternothyroid m.
- Omohyoid m. (inferior belly)
- Inferior ganglion of vagus n.
- Ventral rami of C1, 2, 3 form ansa cervicalis of cervical plexus
- Superior cervical sympathetic ganglion
- Superior root of ansa cervicalis
- Internal carotid a.
- Inferior root of ansa cervicalis
- Ansa cervicalis
- Internal jugular v.
- Common carotid a.

**Legend:**
- Efferent fibers
- Afferent fibers
Clinical Correlate

CEREBRAL ANEURYSMS CAUSING OPHTHALMOPLE gia

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.

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

<table>
<thead>
<tr>
<th>Lesion proximal to sternocleidomastoid (SCM) innervation</th>
<th>Weakness of SCM</th>
<th>Weakness of trapezius</th>
<th>Weakness turning head to opposite side</th>
<th>Drooping of shoulder and mid-scapular winging; weakness in shoulder elevation and arm abduction above horizontal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesion in posterior triangle of neck (distal to SCM innervation)</td>
<td>Weakness of trapezius</td>
<td>Weakness of trapezius</td>
<td>Weakness of trapezius</td>
<td>Weakness of trapezius</td>
</tr>
</tbody>
</table>

Clinical presentation varies with location of damage.

- **CN-XI damage**
  - Mild shoulder droop
  - Mild scapular winging
  - Normal

- **Arms at side**
  - Normal
  - Marked scapular winging

- **Arms in abduction**
  - 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.

Subtle weakness of the tongue may be tested by asking the patient to press the tongue against the 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).

Lesions of the hypoglossal nerve or its nucleus result in ipsilateral deficit when hypoglossal nerve or its nucleus is damaged. Atrophy and fasciculation of the tongue are noted on evaluation.
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
Overview and Topographic Anatomy

GENERAL INFORMATION CONTINUED
Overview and Topographic Anatomy

GENERAL INFORMATION CONTINUED

- Temporal bone
- Sphenoid bone
- Condylar process of mandible
- Coronoid process of mandible
- Lateral pterygoid plate (broken line)
- Pterygomandibular raphe (broken line)
- Mandible
  - Ramus
  - Angle
  - Body
- Stylohyoid ligament
- Hyoid bone
- Spine of sphenoid bone
- Foramen spinosum
- Foramen ovale
- Epiglottis
- Thyroid cartilage
- Cricoid cartilage
- Trachea
- Sphenopalatine foramen
- Choanae (posterior nares)
- Lateral plate
- Medial plate
- Hamulus
- Pyramidal process of palatine bone
- Pterygomaxillary fissure leading into pterygopalatine fossa
- Tuberosity of maxilla
- Infratemporal fossa
- Alveolar process of maxilla
- Atlas (C1)
- Styloid process
- Axis (C2)
- Mastoid process
- External acoustic meatus
- C3 vertebra
- C7 vertebra
- T1 vertebra
- 1st rib
- Sphenopalatine foramen
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: suprathyroid and infrathyroid regions.

The suprathyroid region contains 4 muscles:
- Mylohyoid
- Digastric
- Stylohyoid
- Geniohyoid

The infrathyroid 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

---

<table>
<thead>
<tr>
<th>CONTENTS OF THE SUBMANDIBULAR TRIANGLE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Arteries</strong></td>
</tr>
<tr>
<td>Facial</td>
</tr>
<tr>
<td>Submental</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
Anterior Triangle

**SUBMANDIBULAR TRIANGLE CONTINUED**

Lateral, slightly inferior view

- Hyoglossus muscle
- Mylohyoid muscle
- Fibrous loop for intermediate digastric tendon
- Digastric muscle (anterior belly)
- Median raphe between mylohyoid muscles
- Mastoid process
- Styloid process
- Digastric muscle (posterior belly)
- Stylohyoid muscle
- Greater horn
- Lesser horn
- Body
- Hyoid bone
- Thyrohyoid muscle
- Omohyoid muscle
- Sternohyoid muscle
- Parotid gland
- Posterior auricular v.
- Posterior retromandibular v.
- Facial a.
- Hypoglossal n.
- Lingual a.
- External jugular v.
- Common facial v.
- Internal laryngeal n. and superior laryngeal vv.
- External carotid a.
- Retromandibular v.
- Anterior retromandibular v.
- Facial a. and v.
- Submental a. and v.
- Anterior digastric m.
- External jugular v.
- Nerve to the mylohyoid
- Mylohyoid m.
- Nerve to the thyrohyoid
- Anterior jugular v.
Anterior Triangle

**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

---

**CONTENT OF THE CAROTID TRIANGLE**

<table>
<thead>
<tr>
<th>Arteries</th>
<th>Veins</th>
<th>Nerves</th>
<th>Structures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common carotid (with carotid body)</td>
<td>Internal jugular</td>
<td>Vagus</td>
<td>Larynx (small portion)</td>
</tr>
<tr>
<td>• Internal carotid (with carotid sinus)</td>
<td>Common facial</td>
<td>• External laryngeal</td>
<td>Thyroid (small portion)</td>
</tr>
<tr>
<td>• External carotid</td>
<td>Lingual</td>
<td>• Internal laryngeal</td>
<td></td>
</tr>
<tr>
<td>• Superior thyroid (with superior laryngeal branch)</td>
<td>Superior thyroid</td>
<td>• Spinal accessory (small portion)</td>
<td></td>
</tr>
<tr>
<td>• Lingual</td>
<td>Middle thyroid</td>
<td>Hypoglossal</td>
<td></td>
</tr>
<tr>
<td>• Facial</td>
<td></td>
<td>Ansa cervicalis (superior limb)</td>
<td></td>
</tr>
<tr>
<td>• Ascending pharyngeal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Occipital</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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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

<table>
<thead>
<tr>
<th>CONTENTS OF THE MUSCULAR TRIANGLE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Artery</strong></td>
</tr>
<tr>
<td>Superior thyroid</td>
</tr>
<tr>
<td>Anterior jugular</td>
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</tr>
</tbody>
</table>
Anterior Triangle

MUSCULAR TRIANGLE CONTINUED

- Hyoid bone
- Thyrohyoid membrane
- Thyrohyoid muscle
- Thyroid cartilage
- Omohyoid muscle (superior belly)
- Sternohyoid muscle
- Median cricothyroid ligament
- Cricoid cartilage
- Sternohyoid and omohyoid muscles (cut)
- Thyrohyoid muscle
- Oblique line of thyroid cartilage
- Cricothyroid muscle
- Sternothyroid muscle
- Omohyoid muscle (superior belly) (cut)
- Thyroid gland
- Sternothyroid muscle (cut)

- Thyrohyoid membrane
- Ansa cervicalis
- Superior root
- Inferior root
- Common carotid artery
- Internal jugular vein
- Middle thyroid vein
- Inferior thyroid veins
- Inferior thyroid artery
- Thyrocervical trunk
- Subclavian artery and vein
- Vagus nerve (X)
- Right recurrent laryngeal nerve
- Vagus nerve (X)
- 1st rib (cut)
- Left recurrent laryngeal nerve

- Superior laryngeal nerve
  - Internal branch
  - External branch
- Thyroid cartilage (lamina)
- Median cricothyroid ligament
- Cricothyroid muscles
- Cricoid cartilage
- Pyramidal lobe (often absent or small)
- Right lobe
- Left lobe
- Isthmus
- Pretracheal lymph nodes
- Vagus nerve (X)
- Right recurrent laryngeal nerve
- Left recurrent laryngeal nerve

THE NECK 123
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

<table>
<thead>
<tr>
<th>Artery</th>
<th>Vein</th>
<th>Nerve</th>
<th>Structures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior jugular</td>
<td>Submental lymph nodes</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>CONTENTS OF THE POSTERIOR TRIANGLE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Arteries</strong></td>
</tr>
<tr>
<td>3rd part of the subclavian</td>
</tr>
<tr>
<td>Occipital</td>
</tr>
<tr>
<td>Suprascapular</td>
</tr>
<tr>
<td>Transverse cervical</td>
</tr>
<tr>
<td>Dorsal scapular (usually)</td>
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<td></td>
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</tbody>
</table>

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

- Superior root
- Inferior root

Vagus nerve (X)

Vertebral artery

Thyrocervical trunk

Subclavian artery and vein

Great auricular nerve

Lesser occipital nerve

Sternocleidomastoid muscle (cut, turned up)

C2 spinal nerve (ventral ramus)

Accessory nerve (XI)

C3 spinal nerve (ventral ramus)

Levator scapulae muscle

Middle scalene muscle

Anterior scalene muscle

C5 spinal nerve (ventral ramus)

Transverse cervical artery

Phrenic nerve

Omohyoid muscle (inferior belly) (cut)

Brachial plexus

Dorsal scapular artery

Suprascapular artery

Anterior retromandibular v.

Retromandibular v.

Posterior retromandibular v.

Posterior auricular v.

Lesser occipital n.

Great auricular n.

External jugular v.

Facial v.

Common facial v.

Tranverse cervical nn.

Subclavicular nn.
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**

<table>
<thead>
<tr>
<th>Artery</th>
<th>Vein</th>
<th>Nerves</th>
<th>Structures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertebral</td>
<td>Vertebral</td>
<td>Greater occipital Suboccipital</td>
<td>Muscles:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rectus capitis posterior major</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rectus capitis posterior minor</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Obliquus capitis superior</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Obliquus capitis inferior</td>
</tr>
</tbody>
</table>
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
Visceral Contents

**THYROID GLAND, PARATHYROID GLANDS, LARYNX CONTINUED**

![Diagram of the neck showing the neck and thoracic anatomy, including the thyroid gland, parathyroid glands, and major blood vessels.](image)

**Right lateral view**

- External carotid artery
- Superior laryngeal artery
- Superior thyroid artery (cist)
- Inferior pharyngeal constrictor muscle
- Common carotid artery
- Internal jugular vein
- Inferior thyroid artery
- Recurrent laryngeal nerve
- Esophagus

- Internal branch of superior laryngeal nerve
- External branch of superior laryngeal nerve
- Superior parathyroid gland
- Thyroid gland (right lobe) (retracted anteriorly)
- Inferior parathyroid gland

**Key Structures**

- External carotid artery
- Internal carotid artery
- Superior thyroid artery and vein
- Superior laryngeal artery
- Ansa cervicalis
- Common carotid artery
- Internal jugular vein
- Middle thyroid vein
- Inferior thyroid veins
- Inferior thyroid artery
- Transverse cervical artery
- Suprascapular artery
- Thyrocervical trunk
- Subclavian artery and vein
- Pyramidal lobe (often absent or small)

**Thyroid gland**

- Right lobe
- Left lobe
- Isthmus

**Additional Structures**

- Phrenic nerve
- Anterior scalene muscle
- Vagus nerve (X)

**Visceral Contents**

- THYROID GLAND, PARATHYROID GLANDS, LARYNX CONTINUED
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.

<table>
<thead>
<tr>
<th>Arteries</th>
<th>Veins</th>
<th>Nerves</th>
<th>Structures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common carotid</td>
<td>Internal jugular</td>
<td>Vagus</td>
<td>Trachea</td>
</tr>
<tr>
<td>Subclavian</td>
<td>Subclavian</td>
<td>Recurrent laryngeal</td>
<td>Esophagus</td>
</tr>
<tr>
<td>Vertebral</td>
<td>Brachiocephalic</td>
<td>Phrenic</td>
<td>Thoracic duct</td>
</tr>
<tr>
<td>Transverse cervical</td>
<td>Inferior thyroid</td>
<td>Sympathetic trunk</td>
<td>Right lymphatic duct</td>
</tr>
</tbody>
</table>
Right anterior dissection

- Internal jugular vein
- Common carotid artery
- Phrenic nerve
- Inferior thyroid artery
- Transverse cervical artery
- Suprascapular artery
- Thyrocervical trunk
- Subclavian artery and vein

- Thyroid gland (reflected)
- Middle cervical sympathetic ganglion
- Vagus nerve (X)
- Vertebral artery
- Common carotid artery

- Thyroid gland
  - Pyramidal lobe (often absent or small)
  - Right lobe
  - Left lobe
  - Isthmus
- Pretracheal lymph nodes
- Phrenic nerve
- Anterior scalene muscle
- Vagus nerve (X)
- External jugular vein
- Anterior jugular vein
- 1st rib (cut)
- Left recurrent laryngeal nerve
- Right recurrent laryngeal nerve
- Brachiocephalic trunk
- Brachiocephalic veins
**MAJOR BORDERS OF THE TRIANGLES**

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Actions</th>
<th>Nerve Supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trapezius</td>
<td>External occipital protuberance Superior nuchal line Ligamentum nuchae</td>
<td>Spine of the scapula Acromion Lateral 1/3 of the clavicle</td>
<td>Elevate the scapula Retract the scapula</td>
<td>Spinal accessory n. also receives some branches from C3 and C4, thought to be proprioceptive</td>
</tr>
<tr>
<td>Omohyoid muscle</td>
<td>(superior belly)</td>
<td>Sternohyoid and omohyoid muscles (cut)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sternohyoid</td>
<td></td>
<td>Thyrohyoid muscle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digastric</td>
<td>Mastoid process</td>
<td>Digastric fossa of the mandible</td>
<td>Elevates hyoid Helps depress and retract the</td>
<td>Facial n. (posterior belly) Trigeminal n. (anterior belly)</td>
</tr>
<tr>
<td>Omohyoid muscle</td>
<td>Superior border of the scapula</td>
<td>Body of the hyoid</td>
<td>Depresses the hyoid Helps depress the larynx</td>
<td>Ansa cervicalis</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MUSCLES THAT SUBDIVIDE THE TRIANGLES**

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

**Diagram:**
- Hyoid bone
- Digastric muscle (anterior belly)
- Mylohyoid muscle
- Digastric muscle (posterior belly)
- Omohyoid muscle (superior belly)
- Sternothyroid muscle
- Omohyoid muscle (superior belly) (cut)
- Thyrohyoid muscle
- Sternothyroid muscle
- Omohyoid muscle (inferior belly)
Muscles

SUPRAHYOID MUSCLES

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

INFRAHYOID MUSCLES

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

Posterosuperior view

**Muscles:**
- **Mylohyoid muscle**
- **Geniohyoid muscle**
- **Hyoid bone:**
  - Lesser horn
  - Body
  - Greater horn
- **Hyoglossus muscle (cut)**
- **Superior mental spine for origin of genioglossus muscle**
### PREVERTEBRAL MUSCLES

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

**PREVERTEBRAL MUSCLES CONTINUED**

- Longus capitis muscle
- Posterior tubercle of transverse process of axis (C2)
- Longus colli muscle
- Scalene muscles (Anterior, Middle, Posterior)
- Phrenic nerve
- Brachial plexus
- Basilar part of occipital bone
- Rectus capitis anterior muscle
- Rectus capitis lateralis muscle
- Transverse process of atlas (C1)
- Anterior tubercles of transverse process of C3 vertebra
- Slips of origin of anterior scalene muscle (cut)
- Slips of origin of posterior scalene muscle
- Middle tubercles of transverse process of C3 vertebra
- Posterior tubercles of transverse process of C7 vertebra
- 1st rib
- Anterior scalene muscle (cut)
## Muscles

### SUBOCcipital Triangle Muscles

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Actions</th>
<th>Nerve Supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obliquus capitis superior</td>
<td>Transverse process of the atlas</td>
<td>Occipital bone</td>
<td>Extends head</td>
<td>Suboccipital n. (dorsal rami of C1)</td>
</tr>
<tr>
<td>Obliquus capitis inferior</td>
<td>Spinal process of the axis</td>
<td>Transverse process of the atlas</td>
<td>Rotates head to ipsilateral side</td>
<td>Suboccipital n. (dorsal rami of C1)</td>
</tr>
<tr>
<td>Rectus capitis posterior major</td>
<td>Posterio arch of the atlas</td>
<td>Inferior nuchal line (lateral portion) of the occipital bone</td>
<td>Extends head</td>
<td>Suboccipital n. (dorsal rami of C1)</td>
</tr>
<tr>
<td>Rectus capitis posterior minor</td>
<td>Posterio arch of the atlas</td>
<td>Inferior nuchal line (medial portion) of the occipital bone</td>
<td>Extends head</td>
<td>Suboccipital n. (dorsal rami of C1)</td>
</tr>
</tbody>
</table>
Vascular Supply of the Neck

ARTERIAL SUPPLY

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

SUBCLAVIAN
- Thyrocervical
- Costocervical
- Vertebra
d- 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)

<table>
<thead>
<tr>
<th>Artery</th>
<th>Source</th>
<th>Comments</th>
</tr>
</thead>
</table>
| 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.  
  - Supracervical—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 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. |
Vascular Supply of the Neck

**ARTERIAL SUPPLY CONTINUED**

**Right anterior dissection**

- Phrenic nerve
- Anterior scalene muscle
- Inferior thyroid artery
- Transverse cervical artery
- Suprascapular artery
- Dorsal scapular artery
- Costocervical trunk
- Thyrocervical trunk
- Subclavian artery and vein

**Right lateral schematic view**

- Vertebral artery
- Deep cervical artery (ascending to anastomose with descending branch of occipital artery)
- Costocervical trunk
- Supreme intercostal artery
- 1st posterior intercostal artery

- Vagus nerve (X)
- Vertebral artery
- Common carotid artery
- Recurrent laryngeal nerve
- Brachiocephalic trunk
- Internal jugular vein (cut)

- External carotid artery
- Internal carotid artery
- Ascending cervical artery
- Inferior thyroid artery
- Transverse cervical artery
- Common carotid artery
- Thyrocervical trunk
- Suprascapular artery

- Subclavian artery (1st part medial to, 2nd part posterior to, 3rd part lateral to anterior scalene muscle)
- Internal thoracic artery
## Vascular Supply of the Neck

### CAROTID VASCULAR SUPPLY OF THE NECK

<table>
<thead>
<tr>
<th>Artery</th>
<th>Source Description</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common carotid</td>
<td>Right common carotid a. is a branch of the brachiocephalic a.; left common carotid a. is a direct branch of the aorta</td>
<td>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 glosopharyngeal n.</td>
</tr>
<tr>
<td>Internal carotid</td>
<td>The 2 branches of the common carotid a. arise at the superior border of the thyroid cartilage at C3</td>
<td>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 glosopharyngeal n.</td>
</tr>
<tr>
<td>External carotid</td>
<td></td>
<td>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</td>
</tr>
<tr>
<td>Superior thyroid</td>
<td>The first branch of the external carotid a.; arises in the carotid triangle</td>
<td>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</td>
</tr>
<tr>
<td>Lingual</td>
<td>External carotid a.; arises within the carotid triangle</td>
<td>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</td>
</tr>
<tr>
<td>Facial</td>
<td>External carotid a. in the carotid triangle of the neck</td>
<td>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</td>
</tr>
<tr>
<td>Ascending pharyngeal</td>
<td>Posterior portion of the external carotid a. near the bifurcation of the common carotid a.</td>
<td>The smallest branch of the external carotid Ascends superiority 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.</td>
</tr>
<tr>
<td>Occipital</td>
<td>External carotid a. in the carotid triangle of the neck</td>
<td>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.</td>
</tr>
</tbody>
</table>
Vascular Supply of the Neck

ARTERIAL SUPPLY CONTINUED

Parotid space (bed; right lateral dissection)

- Facial nerve (VII) (cut)
- Sternocleidomastoid muscle (cut)
- Digastric muscle (posterior belly) (cut)
- Occipital artery and sternocleidomastoid branch
- Accessory nerve (XI)
- Ansa cervicalis
  - Superior root
  - Inferior root
- Vagus nerve (X)
- Ascending pharyngeal artery
- Carotid branch of glossopharyngeal nerve (IX) and carotid body
- Internal carotid artery
- Internal jugular vein
- Transverse facial artery
- Facial artery
- Lingual artery
- Superior laryngeal artery
- Superior thyroid artery
- External carotid artery
- Common carotid artery
- Maxillary artery
- External carotid artery
- Posterior auricular artery
- Facial artery
- Lingual artery
- Ascending pharyngeal artery
- Superior thyroid artery
- Omohyoid muscle (phantom)
# Vascular Supply of the Neck

## Venous Drainage

Highly variable with inconsistent drainage

## Veins of the Neck

<table>
<thead>
<tr>
<th>Vein</th>
<th>Comments</th>
</tr>
</thead>
</table>
| **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 v. pass from the pharyngeal plexus of v. 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. |
Vascular Supply of the Neck

VENOUS DRAINAGE CONTINUED
Vascular Supply of the Neck

VENOUS DRAINAGE CONTINUED

Facial artery and vein
Retromandibular vein
Internal jugular vein
External jugular vein
Anterior jugular vein
Communicating vein
Anterior division of retromandibular vein
Common facial vein
Superior thyroid artery and vein
Internal jugular vein
Transverse cervical and suprascapular vein
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.**

Arous 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.
Glossopharyngeal nerve (IX) and tonsillar branch
Hypoglossal nerve (XII)
Carotid nerve (IX) and carotid body
Nerve to thyrohyoid muscle (C1)
Internal and external branches of superior laryngeal nerve (X)
Ansa cervicalis (Superior root (C1, 2, 3) Inferior root)
Nerves to superior and inferior bellies of omohyoid, sternohyoid and sternothyroid muscles (ansa cervicalis)
Recurrent laryngeal nerve (X)
Sympathetic trunk and middle cervical ganglion
Accessory nerve (XI) (cut)
C1 spinal nerve (ventral ramus) (cut)
C2 spinal nerve (ventral ramus) (cut)
Pharyngeal plexus composed of branches from glossopharyngeal (IX), vagus (X) and cranial part of (XI)
Vagus nerve (X) and superior cervical cardiac branch
C4 spinal nerve (ventral ramus) (cut)
Phrenic nerve (C3, 4, 5)
Brachial plexus (cut)
Nerve Supply of the Neck

CRANIAL NERVES OF THE NECK CONTINUED
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

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Source</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesser occipital</td>
<td>Cervical plexus by contributions from the ventral ramus of C2</td>
<td>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</td>
</tr>
<tr>
<td>Great auricular</td>
<td>Cervical plexus formed by contributions of ventral rami C2 and C3</td>
<td>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</td>
</tr>
<tr>
<td>Transverse cervical</td>
<td></td>
<td>Passes posterior to the sternocleidomastoid m. at Erb’s point Ascends 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</td>
</tr>
<tr>
<td>Supraclavicular</td>
<td>Cervical plexus formed by contributions of ventral rami C3 and C4</td>
<td>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.</td>
</tr>
</tbody>
</table>

DORSAL RAMI

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Source</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greater occipital</td>
<td>Dorsal ramus of C2</td>
<td>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</td>
</tr>
<tr>
<td>3rd occipital</td>
<td>Branch of the dorsal ramus of C3 deep to the trapezius m.</td>
<td>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</td>
</tr>
<tr>
<td>Dorsal ramus of C4</td>
<td>Dorsal ramus of C4 deep to the trapezius m.</td>
<td>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</td>
</tr>
<tr>
<td>Dorsal ramus of C5</td>
<td>Dorsal ramus of C5 deep to the trapezius m.</td>
<td>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</td>
</tr>
</tbody>
</table>
Nerve Supply of the Neck

SENSORY INNERVATION OF THE NECK CONTINUED

From ophthalmic division of trigeminal nerve (V1)

Auricular branch of vagus nerve (X)

Greater occipital nerve (C2)

3rd occipital nerve (C3)

From 4th, 5th, 6th and 7th nerves in succession below

Medial branches of dorsal rami of cervical spinal nerves

Lesser occipital nerve (C2)

Great auricular nerve (C2, 3)

Transverse cervical nerve (C2, 3)

Supraclavicular nerves (C3, 4)

From maxillary division of trigeminal nerve (V2)

Branches from cervical plexus

From mandibular division of trigeminal nerve (V3)

Dorsal rami of cervical spinal nerves

Note: Auricular branch of vagus nerve to external acoustic meatus and small area on posteromedial surface of auricle

Branches from cervical plexus
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

<table>
<thead>
<tr>
<th>Source</th>
<th>Comments</th>
</tr>
</thead>
</table>
| 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

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Source</th>
<th>Comments</th>
</tr>
</thead>
</table>
| Lesser occipital | Cervical plexus by contributions from the ventral ramus of C2 | Passes posterior to the sternocleidomastoid m. at Erb’s point  
  - 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

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)
Thyrohyoid muscle
Superior root of ansa cervicalis
Inferior root of ansa cervicalis
Transverse cervical nerve
Sternothyroid muscle
Sternocleidomastoid muscle (cut)
Omniohyoid muscle (superior belly)
Sternocleidomastoid muscle (cut)
Omniohyoid muscle (inferior belly)
Ansa cervicalis
Sternocleidomastoid muscle (cut)
Omniohyoid muscle (inferior belly)
Supraclavicular nerves (medial, intermediate and lateral)

- Efferent fibers
- Afferent fibers
- Proprioceptive fibers

Cervical plexus: schema

(S = gray ramus from superior cervical sympathetic ganglion)

To geniohyoid muscle
To thyrohyoid muscle
Communication to vagus nerve
Transverse cervical nerves
To omohyoid muscle (superior belly)
Ansa cervicalis
Superior root
Inferior root
To sternothyroid muscle
To sternohyoid muscle
To omohyoid muscle (inferior belly)
To omohyoid muscle (superior belly)
To sternothyroid muscle
To sternomastoid muscle
To omohyoid muscle (inferior belly)
To rectus capitis lateralis, longus capitis and rectus capitis anterior muscles
To rectus capitis and longus colli muscles
To longus capitis and longus colli muscles
To scalene and levator scapulae muscles

Phrenic nerve

THE NECK 151
## Nerve Supply of the Neck

### VENTRAL RAMI NERVES OF THE NECK

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Source</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phrenic</td>
<td>Arises from the ventral rami of C3 to C5</td>
<td>Passes inferiorly along the anterior surface of the anterior scalene m. Eventually passes through the thorax to innervate the diaphragm.</td>
</tr>
</tbody>
</table>
| 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. Ventrail rami of C5 and C6 unite to form the upper trunk. Ventrail ramus of C7 continues as the middle 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. |

---

**Diagram:**

- **Great auricular nerve**
- **Lesser occipital nerve**
- **Hypoglossal nerve (XII)**
- **Ansas cervicalis:** Superior root, Inferior root
- **C2 spinal nerve (ventral ramus)**
- **Accessory nerve (XI)**
- **C3 spinal nerve (ventral ramus)**
- **C5 spinal nerve (ventral ramus)**
- **Phrenic nerve**
- **Brachial plexus**

---

**Text (Diagram):**

- **Great auricular nerve**
- **Lesser occipital nerve**
- **Hypoglossal nerve (XII)**
- **Ansas cervicalis:** Superior root, Inferior root
- **C2 spinal nerve (ventral ramus)**
- **Accessory nerve (XI)**
- **C3 spinal nerve (ventral ramus)**
- **C5 spinal nerve (ventral ramus)**
- **Phrenic nerve**
- **Brachial plexus**
Nerve Supply of the Neck

**SYMPATHTICS IN THE NECK**

Sympathetic trunk extends into the neck from the thorax.

- 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
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.
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

**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
- Hypertension (frequently)
- Menorrhagia (amenorrhea may occur late in disease)

**Symptoms**

- Hair dry, brittle
- Edema of face and eyelids
- Sensation of coldness
- Diminished perspiration
- Skin coarse, dry, scalding, cold (follicular keratosis), yellowish (carotenemia)
- Pulse slow
- Ascites
- Weakness
- Reflexes, prolonged recovery
- Lethargy, memory impairment, slow cerebration (psychoses may occur)
- Thick tongue, slow speech
- Deep, coarse voice
- Heart enlarged, poor heart sounds, precordial pain (occasional)
- Hypertension (frequently)
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.
<table>
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<tr>
<th>Topic</th>
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<td>Overview of Muscles of Facial Expression</td>
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<td>Vascular Supply of the Face</td>
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<td>Nerve Supply of the Face</td>
<td>184</td>
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<tr>
<td>Clinical Correlates</td>
<td>192</td>
</tr>
</tbody>
</table>
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
## Overview of the Scalp

### GENERAL INFORMATION

<table>
<thead>
<tr>
<th>Layer</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skin</td>
<td>Thickest layer of the scalp</td>
</tr>
<tr>
<td>Connective tissue</td>
<td>Heavily vascularized</td>
</tr>
<tr>
<td>Aponeurosis</td>
<td>Also called galea aponeurosis</td>
</tr>
<tr>
<td>Loose areolar connective tissue</td>
<td>Thin and mobile</td>
</tr>
<tr>
<td>Pericranium</td>
<td>Covers the outer surface of the cranium</td>
</tr>
</tbody>
</table>

![Diagram of the Scalp](image-url)
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

<table>
<thead>
<tr>
<th>Artery</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supratrochlear</td>
<td>Ophthalmic a. from the internal carotid a.</td>
<td>Exits the orbit at the medial angle accompanied by supratrochlear n. Anastomoses with the contralateral supraorbital and supratrochlear aa.</td>
</tr>
<tr>
<td>Supraorbital</td>
<td>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 supratrochlear n. Passes through the supraorbital foramen (notch) and ascends superiorly along the scalp Anastomoses with the supratrochlear and superficial temporal aa.</td>
<td></td>
</tr>
<tr>
<td>Superficial temporal</td>
<td>1 of 2 external carotid a. terminal branches</td>
<td>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</td>
</tr>
<tr>
<td>Posterior auricular</td>
<td>External carotid a.</td>
<td>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.</td>
</tr>
<tr>
<td>Occipital</td>
<td>Branches along the inferior margin of the posterior belly of the digastic 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.</td>
<td></td>
</tr>
</tbody>
</table>

**VENOUS DRAINAGE**

<table>
<thead>
<tr>
<th>Vein</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supratrochlear</td>
<td>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.</td>
</tr>
<tr>
<td>Supraorbital</td>
<td>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.</td>
</tr>
<tr>
<td>Superficial temporal</td>
<td>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.</td>
</tr>
<tr>
<td>Posterior auricular</td>
<td>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.</td>
</tr>
<tr>
<td>Occipital</td>
<td>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.</td>
</tr>
</tbody>
</table>
**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.

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supratrochlear</td>
<td>Arises from the ophthalmic division of the trigeminal n.; 1 of the 2 terminal branches of the frontal n. in the orbit</td>
<td>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.</td>
</tr>
<tr>
<td>Supraorbital</td>
<td>Passes between the levator palpebrae superioris m. and periorbita of the orbit</td>
<td>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.</td>
</tr>
<tr>
<td>Zygomaticotemporal</td>
<td>Maxillary division of the trigeminal n.</td>
<td>Arises from the zygomatic n. in the pterygopalatine fossa, and passes through the inferior orbital fissure to enter 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.</td>
</tr>
<tr>
<td>Auriculotemporal</td>
<td>Mandibular division of the trigeminal n.</td>
<td>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.</td>
</tr>
<tr>
<td>Lesser occipital</td>
<td>Arises from the cervical plexus from the ventral ramus of C2</td>
<td>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.</td>
</tr>
<tr>
<td>Greater occipital</td>
<td>Dorsal ramus of C2</td>
<td>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.</td>
</tr>
<tr>
<td>3rd occipital</td>
<td>Dorsal ramus of C3</td>
<td>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.</td>
</tr>
</tbody>
</table>
Nerve Supply of the Scalp

Sensory Distribution Continued

- Epicranial aponeurosis (galea aponeurotica)
- Occipital belly (occipitalis) of occipitofrontalis muscle
- Greater occipital nerve (dorsal ramus of C2 spinal nerve)
- Occipital artery
- Posterior auricular artery
- Great auricular nerve (cervical plexus C2, 3)
- Lesser occipital nerve (cervical plexus C2, 3)
- 3rd (least) occipital nerve (dorsal ramus of C3 spinal nerve)
- Zygomaticotemporal nerve
  - From ophthalmic division of trigeminal nerve (V1)
  - Supraorbital nerve
  - Supratrochlear nerve
- Medial branches of dorsal rami of cervical spinal nerves
- Greater occipital nerve (C2)
- 3rd occipital nerve (C3)
- Branches from cervical plexus
- Auriculotemporal nerve
  - From mandibular division of trigeminal nerve (V3)
  - Greater occipital nerve (C2)
  - 3rd occipital nerve (C3)
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**

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Actions</th>
<th>Nerve</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orbicularis oris</td>
<td>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.</td>
<td>Skin along the mouth</td>
<td>Closes mouth Protrusion of lips Pursing of lips</td>
<td>Facial (buccal and mandibular branches)</td>
<td>Sphincter of the mouth Muscle fibers encircle the mouth</td>
</tr>
<tr>
<td>Depressor anguli oris</td>
<td>Mandible along area near the external oblique line</td>
<td>Angle of the mouth Some fibers blend and provide origin for the orbicularis oris m. Fibers overlap those of the depressor labii inferioris m.</td>
<td>Depresses the corners of the mouth Antagonizes levator anguli oris m.</td>
<td></td>
<td>Antagonizes levator anguli oris m.</td>
</tr>
<tr>
<td>Levator anguli oris</td>
<td>Canine fossa of the maxilla (inferior to the infraorbital foramen)</td>
<td>Angle of the mouth Some fibers blend and provide origin for the orbicularis oris m.</td>
<td>Elevates the angle of the mouth</td>
<td>Facial (zygomatic and buccal branches)</td>
<td>In an infraorbital injection, the needle lies between the levator anguli oris and levator labii superioris mm.</td>
</tr>
<tr>
<td>Zygomaticus major</td>
<td>Zygomatic bone (anterior to the zygomaticotemporal suture)</td>
<td></td>
<td>Moves the angle of the mouth superiorly and laterally</td>
<td></td>
<td>Commonly called the “laughing muscle” owing to its action</td>
</tr>
<tr>
<td>Zygomaticus minor</td>
<td>Zygomatic bone (anterior to the zygomaticus major)</td>
<td>Lateral upper lip</td>
<td>Helps elevate the upper lip</td>
<td></td>
<td>Inserts between the levator labii superioris and zygomaticus major mm.</td>
</tr>
</tbody>
</table>
## Overview of Muscles of Facial Expression

### ORAL GROUP

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

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168 NETTER'S HEAD AND NECK ANATOMY FOR DENTISTRY
Overview of Muscles of Facial Expression

SCALP AND MUSCLES OF FACIAL EXPRESSION 169
Overview of Muscles of Facial Expression

**ORAL GROUP CONTINUED**
## Overview of Muscles of Facial Expression

### NASAL GROUP

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

### ORBITAL GROUP

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

---

SCALP AND MUSCLES OF FACIAL EXPRESSION 171
Overview of Muscles of Facial Expression

**NASAL GROUP CONTINUED**

- Procerus muscle
- Corrugator supercili muscle
- Orbital part of orbicularis oculi muscle
- Palpebral part of orbicularis oculi muscle
- Transverse part of nasalis muscle
- Alar part of nasalis muscle
- Depressor septi nasi muscle
Overview of Muscles of Facial Expression

**NASAL GROUP CONTINUED**

- Frontal belly (frontalis) of epicranius muscle
- Procerus muscle
- Orbicularis oculi muscle
  - Orbital part
  - Palpebral part
- Nasalis muscle
  - Transverse part
  - Alar part
- Depressor septi nasi muscle
- Corrugator supercilii muscle (frontalis and orbicularis oculi, partially cut away)
Overview of Muscles of Facial Expression

### AURICULAR GROUP

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

### SCALP GROUP (OCCIPITOFRONTALIS)

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

### NECK GROUP

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Actions</th>
<th>Nerve</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Platysma</td>
<td>Fascia of upper part of the pectoralis major m. and deltoid</td>
<td>Inferior border of the mandible Some fibers blend with the skin of the neck and lower face</td>
<td>Wrinkles the skin of the neck</td>
<td>Facial n.: cervical branch</td>
<td>The external jugular lies deep to the platysma m.</td>
</tr>
</tbody>
</table>
Overview of Muscles of Facial Expression

**AURICULAR GROUP CONTINUED**

- Auricularis anterior muscle
- Auricularis superior muscle
- Auricularis posterior muscle
- Frontal belly (frontalis) of epicranius muscle
- Occipital belly (occipitalis) of epicranius muscle
- Platysma muscle
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.
## Vascular Supply of the Face

### Arterial Supply

**External Carotid Artery and Its Branches in the Face**

<table>
<thead>
<tr>
<th>Artery</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facial</td>
<td>External carotid a</td>
<td>Arises in the carotid triangle of the neck.&lt;br&gt;Passes superiorly immediately deep to the posterior belly of the digastric m. and the stylohyoid mm.&lt;br&gt;Passes along the submandibular gland, giving rise to the submental a. that helps supply the gland.&lt;br&gt;Passes superiorly over the body of the mandible at the masseter m.&lt;br&gt;Continues anterosuperiorly across the cheek to the angle of the mouth, giving rise to the superior and inferior labial aa.&lt;br&gt;Passes superiorly along the side of the nose, giving rise to the lateral nasal a.&lt;br&gt;Continues on the side of the nose as the angular a. to terminate along the medial aspect of the eye. Tortuous.</td>
</tr>
<tr>
<td>Superior labial</td>
<td>Facial a.</td>
<td>Supplies the upper lip。&lt;br&gt;Gives rise to the septal branch that travels to the nasal septum.</td>
</tr>
<tr>
<td>Inferior labial</td>
<td></td>
<td>Supplies the lower lip.</td>
</tr>
<tr>
<td>Lateral nasal</td>
<td></td>
<td>Supplies the ala and nose.</td>
</tr>
<tr>
<td>Angular</td>
<td></td>
<td>The facial a.'s terminal branch. Passes superiorly to terminate at the medial angle of the orbit.</td>
</tr>
<tr>
<td>Superficial temporal</td>
<td>External carotid a</td>
<td>1 of the 2 terminal branches of the external carotid a. Arises posterior to the neck of the mandible and travels superiorly as a continuation of the external carotid a. Joined by the auriculotemporal n.</td>
</tr>
<tr>
<td>Transverse facial</td>
<td>Superficial temporal a.</td>
<td>Passes transversely before it exits the parotid gland. Passes immediately superior to the parotid duct across the masseter m. and face.</td>
</tr>
<tr>
<td>Maxillary</td>
<td>External carotid a</td>
<td>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.</td>
</tr>
<tr>
<td>Infraorbital</td>
<td>Maxillary a.</td>
<td>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)</td>
</tr>
<tr>
<td>Buccal</td>
<td></td>
<td>A branch of the 2nd part of the maxillary a. 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.</td>
</tr>
<tr>
<td>Mental</td>
<td></td>
<td>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.</td>
</tr>
</tbody>
</table>
Vascular Supply of the Face

ARTERIAL SUPPLY CONTINUED
### Vascular Supply of the Face

#### Arterial Supply

<table>
<thead>
<tr>
<th>Artery</th>
<th>Course</th>
</tr>
</thead>
</table>
| Ophthalmic          | A branch of the internal carotid<br>Enters the orbit through the optic foramen immediately inferior and lateral to the optic n.<br>Crosses the optic n. to reach the medial part of the orbit<br><em>Within the orbit, besides the orbital branches, it gives rise to 5 major branches that supply the face:</em><br>  
  ● Supratrochlear  
  ● Supraorbital  
  ● Lacrimal  
  ● Anterior ethmoid  
  ● Dorsal nasal |
| Supratrochlear      | Exits the orbit at the medial angle accompanied by supratrochlear n.<br>Ascends on the scalp, anastomosing with the supraorbital and supratrochlear aa. from the opposite side |
| Supraorbital        | Arises as the ophthalmic passes the optic n.<br>Passes on the medial side of the levator palpebrae superioris and superior rectus mm. to join the supraorbital n.<br>Passes through the supraorbital foramen (notch) and ascends superiorly along the scalp<br>Anastomoses with the supratrochlear and superficial temporal aa. |
| Lacrimal            | Arises near the optic foramen<br>One of the largest branches of the ophthalmic a.<br>Follows the lacrimal n. along the superior border of the lateral rectus m. of the eye to reach and supply the lacrimal gland<br>Gives rise to a series of terminal branches that pass to the eyelids and conjunctivae<br>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.<br>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.<br>Exits the orbit along the superomedial border along with the infratrochlear n.<br>Supplies the area along the bridge of the nose |
Vascular Supply of the Face

ARTERIAL SUPPLY CONTINUED

Anterior view

- Supraorbital artery
- Supratrochlear artery
- Dorsal nasal artery
- Angular artery
- External nasal artery
- Nasalis muscle (transverse part)
- Infraorbital artery and nerve
- Lateral nasal artery
- Transverse facial artery
- Facial artery

(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

<table>
<thead>
<tr>
<th>Vein</th>
<th>Course</th>
</tr>
</thead>
</table>
| 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 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 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                                                   |

![Vascular Supply of the Face Diagram](image-url)
### Communicating Veins

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

### Deep Veins

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

VENOUS DRAINAGE CONTINUED
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 (V₁, V₂, V₃)
Some sensory branches are from the cervical plexus
Nerve Supply of the Face

GENERAL INFORMATION CONTINUED

Facial nerve (VII)
- Temporal branches
- Zygomatic branches
- Buccal branches
- Marginal mandibular branch
TRIGEMINAL NERVE: OPHTHALMIC DIVISION

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ophthalmic division</td>
<td>Trigeminal n. in the middle cranial fossa</td>
<td>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</td>
</tr>
<tr>
<td>Supratrochlear</td>
<td>From the ophthalmic division; the 2 terminal branches of the frontal n. in the orbit</td>
<td>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</td>
</tr>
<tr>
<td>Supraorbital</td>
<td></td>
<td>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</td>
</tr>
<tr>
<td>Lacrimal</td>
<td>The smallest branch of the ophthalmic division</td>
<td>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</td>
</tr>
<tr>
<td>Infratrochlear</td>
<td>One of the terminal branches of the nasociliary</td>
<td>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</td>
</tr>
<tr>
<td>External nasal</td>
<td>Arises from the anterior ethmoid n. (from the nasociliary n.)</td>
<td>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</td>
</tr>
</tbody>
</table>

TRIGEMINAL NERVE: MAXILLARY DIVISION

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maxillary division</td>
<td>Trigeminal n. in the middle cranial fossa</td>
<td>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.</td>
</tr>
<tr>
<td>Zygomaticotemporal</td>
<td>Zygomatic branch of the maxillary division</td>
<td>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 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. Continues along the skin of the side of the scalp</td>
</tr>
</tbody>
</table>
### Nerve Supply of the Face

**SENSORY INNERVATION CONTINUED**

#### TRIGEMINAL NERVE: MAXILLARY DIVISION

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zygomaticofacial</td>
<td>Zygomatic branch of the maxillary division</td>
<td>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.</td>
</tr>
</tbody>
</table>
| 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) |

---

![Diagram of the head showing nerve supply and foramina](image-url)
Nerve Supply of the Face

SENSORY INNERVATION CONTINUED

<table>
<thead>
<tr>
<th>TRIGEMINAL NERVE: MANDIBULAR DIVISION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nerve</td>
</tr>
<tr>
<td>-------</td>
</tr>
</tbody>
</table>
| 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.) |

- Auriculo-temporal | 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 superiority 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

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Great auricular</td>
<td>Arises from the cervical plexus formed by</td>
<td>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.</td>
</tr>
<tr>
<td>Transverse cervical</td>
<td>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.</td>
<td></td>
</tr>
</tbody>
</table>
Nerve Supply of the Face

MOTOR INNERVATION

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facial</td>
<td>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 m. 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.</td>
</tr>
<tr>
<td>Temporal</td>
<td>Exits the superior portion of the parotid gland from the temporofacial trunk. Crosses the zygomatic arch along the temporal fossa to innervate the forehead.</td>
</tr>
<tr>
<td>Zygomatic</td>
<td>The zygomatic branches from the temporofacial trunk pass across the zygomatic bone to the lateral angle of the orbit. Innervates muscles in the region.</td>
</tr>
<tr>
<td>Buccal</td>
<td>Branches arise from both the temporofacial and the cervicofacial trunks. Innervates muscles of the cheek.</td>
</tr>
<tr>
<td>Mandibular</td>
<td>Branches arise from the cervicofacial trunk and pass anteriorly. Innervates muscles of the lower lip and chin.</td>
</tr>
<tr>
<td>Cervical</td>
<td>Branches arise from the cervicofacial trunk and pass anteriorly and inferiorly to innervate the platysma m.</td>
</tr>
</tbody>
</table>
Clinical Correlate

**TRIGEMINAL NEURALGIA**

Also called tic douloureux

Usually affects the maxillary (V₂) or mandibular (V₃) division of the trigeminal nerve; rarely affects the ophthalmic division (V₁)

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
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 V₁
- Cranial nerve V₂
- Cranial nerve VI

Common clinical manifestations include:
- Ophthalmoplegia with diminished pupillary light reflexes
- Venous congestion leading to periorbital edema
- Exophthalmos
Clinical Correlate

CAVERNOUS SINUS SYNDROME CONTINUED

Involvement of cranial nerves (III, IV, V, and VI) results in ophthalmoplegia and facial analgesia.

Network of valveless veins allows migration of septic thrombi from sinus or orbit sites to cavernous sinus.

Communication between cavernous sinuses results in bilateral disease.
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
Overview and Topographic Anatomy

GENERAL INFORMATION

Parotid gland: totally serous
# Recess of the Parotid Bed

## Borders and Structures

<table>
<thead>
<tr>
<th>Borders</th>
<th>Structures</th>
</tr>
</thead>
</table>
| 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.
### Contents of the Parotid Bed

#### MAJOR STRUCTURES

<table>
<thead>
<tr>
<th>Structure</th>
<th>Features</th>
</tr>
</thead>
</table>
| Parotid gland | 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  
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
Contents of the Parotid Bed

**VASCULAR SUPPLY**

**ARTERIAL SUPPLY**

<table>
<thead>
<tr>
<th>Artery</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>External carotid</td>
<td>The bifurcation of the common carotid a. at vertebral level C3</td>
<td>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.</td>
</tr>
<tr>
<td>Posterior auricular</td>
<td>External carotid a. within the parotid gland</td>
<td>Passes superiorly between the mastoid process and cartilage of the ear.</td>
</tr>
<tr>
<td>Maxillary</td>
<td>The 2 terminal branches of the external carotid a.</td>
<td>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.</td>
</tr>
<tr>
<td>Superficial temporal</td>
<td></td>
<td>Begins posterior to the neck of the mandible and travels superiorly as a continuation of the external carotid. Joined by the auriculotemporal n.</td>
</tr>
<tr>
<td>Transverse facial</td>
<td>Superficial temporal a. before it exits the parotid gland</td>
<td>Passes transversely to exit the gland. Passes immediately superior to the parotid duct across the masseter m. and face.</td>
</tr>
</tbody>
</table>
### VENOUS DRAINAGE

<table>
<thead>
<tr>
<th>Vein</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superficial temporal</td>
<td>Descends posterior to the zygomatic root of the temporal bone alongside the auricolotemporal n. to enter the parotid gland. Unites with the maxillary v. to form the retromandibular v.</td>
</tr>
<tr>
<td>Transverse facial</td>
<td>Travels posteriorly to enter the parotid gland and join the superficial temporal v.</td>
</tr>
<tr>
<td>Maxillary</td>
<td>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.</td>
</tr>
<tr>
<td>Retromandibular</td>
<td>Arises from the joining of the superficial temporal and maxillary v. 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.</td>
</tr>
<tr>
<td>Posterior auricular</td>
<td>Arises from a plexus of veins created by the occipital and superficial temporal v. Descends posterior to the auricle to unite with the posterior division of the retromandibular v. to form the external jugular v.</td>
</tr>
</tbody>
</table>
Contents of the Parotid Bed

VASCULAR SUPPLY CONTINUED

- Transverse facial artery and vein
- Posterior auricular artery and vein
- Retromandibular vein (anterior and posterior branches)
- External carotid artery
- Maxillary veins
- Superficial temporal vein and artery
- Frontal
- Parietal
- Branches of superficial temporal artery and vein
- Posterior auricular artery and vein
- Retromandibular vein
- External carotid artery
Contents of the Parotid Bed

**NERVE SUPPLY**

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auriculotemporal</td>
<td>Mandibular division of the trigeminal n.</td>
<td>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.</td>
</tr>
<tr>
<td>Great auricular</td>
<td>The cervical plexus formed by contributions of C2 and C3 ventral rami</td>
<td>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.</td>
</tr>
</tbody>
</table>

**SENSORY NERVES OF THE PAROTID**

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Great auricular</td>
<td>The cervical plexus formed by contributions of C2 and C3 ventral rami</td>
<td>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.</td>
</tr>
</tbody>
</table>
Contents of the Parotid Bed

**NERVE SUPPLY CONTINUED**
## Contents of the Parotid Bed

### NERVE SUPPLY CONTINUED

<table>
<thead>
<tr>
<th>Type of Neuron</th>
<th>Name of Cell Body</th>
<th>Characteristics of the Cell Body</th>
<th>Course of the Neuron</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preganglionic neuron</td>
<td>Inferior salivary nucleus</td>
<td>A collection of nerve cell bodies located in the medulla</td>
<td>Preganglionic parasympathetic fibers arise from the inferior salivary 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 canalculus. Tymanic 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.</td>
</tr>
</tbody>
</table>

| 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. |

<table>
<thead>
<tr>
<th>Type of Neuron</th>
<th>Name of Cell Body</th>
<th>Characteristics of the Cell Body</th>
<th>Course of the Neuron</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preganglionic neuron</td>
<td>Intermediolateral horn nucleus</td>
<td>Collection of nerve cell bodies located in the lateral horn nucleus of the spinal cord between spinal segments T1 and T3 (and possibly T4)</td>
<td>Arise from the intermediolateral horn nuclei from T1 and T3(4). Enter the sympathetic chain via white rami communicantes. In the sympathetic chain, the preganglionic fibers for the eye will ascend and synapse with postganglionic fibers in the superior cervical ganglion.</td>
</tr>
</tbody>
</table>

| 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. |
 Contents of the Parotid Bed

NERVE SUPPLY CONTINUED
Contents of the Parotid Bed

NERVE SUPPLY CONTINUED

Lateral view

- Foramen ovale
- Foramen spinosum
- Middle meningeal artery
- Auriculotemporal nerve
- Facial nerve (VII)
- Chorda tympani nerve
- Lingual nerve
- Inferior alveolar nerve (cut)
- Nerve to mylohyoid
- Inferior alveolar nerve (cut)
- Digastric muscle (anterior belly)
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
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 due to paralysis of buccinator muscle).

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 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.
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).
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
Clinical Correlate

**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
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.

![Image of mouth and tongue with annotations]
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
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overview and Topographic Anatomy</td>
<td>220</td>
</tr>
<tr>
<td>Borders of the Temporal Fossa</td>
<td>221</td>
</tr>
<tr>
<td>Contents of the Temporal Fossa</td>
<td>222</td>
</tr>
<tr>
<td>Borders of the Infratemporal Fossa</td>
<td>228</td>
</tr>
<tr>
<td>Contents of the Infratemporal Fossa</td>
<td>230</td>
</tr>
</tbody>
</table>
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**

<table>
<thead>
<tr>
<th>Border</th>
<th>Structures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior</td>
<td>Superior temporal line of the skull</td>
</tr>
<tr>
<td>Inferior</td>
<td>Zygomatic arch</td>
</tr>
<tr>
<td>Anterior</td>
<td>Frontal process of the zygoma</td>
</tr>
<tr>
<td></td>
<td>Zygomatic process of the frontal bone</td>
</tr>
<tr>
<td>Posterior</td>
<td>Superior temporal line of the skull</td>
</tr>
<tr>
<td>Floor</td>
<td>Frontal, greater wing of the sphenoid</td>
</tr>
<tr>
<td></td>
<td>Parietal and squamous part of the temporal bones (including the pterion)</td>
</tr>
</tbody>
</table>

**Diagram**

- **Sphenoid bone**
  - Greater wing
- **Frontal bone**
  - Zygomatic process
- **Zygomatic bone**
  - Frontal process
  - Zygomatic arch
- **Temporal bone**
  - Superior temporal line
  - Inferior temporal line
  - Squamous part
- **Parietal bone**
  - Superior temporal line
  - Inferior temporal line
  - Coronal suture
  - Pterion
## Contents of the Temporal Fossa

### VASCULAR SUPPLY

<table>
<thead>
<tr>
<th>Artery</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
</table>
| Superficial temporal 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.  
Emerged from the superior part of the parotid gland  
Immediately posterior to the temporomandibular joint and anterior to the external auditory meatus  
Passed 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 | Passed 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. |

222 NETTER’S HEAD AND NECK ANATOMY FOR DENTISTRY
Contents of the Temporal Fossa

VASCULAR SUPPLY CONTINUED
## Contents of the Temporal Fossa

### Vascular Supply

#### Venous Drainage

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

VASCULAR SUPPLY CONTINUED

- Middle temporal artery and vein
- Parietal emissary vein
- Branches of superficial temporal artery and vein
**Contents of the Temporal Fossa**

**NERVE SUPPLY**

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mandibular division of the trigeminal</td>
<td>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</td>
<td>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.)</td>
</tr>
<tr>
<td>Anterior and posterior deep temporal</td>
<td>Arise from the anterior part of the mandibular division of the trigeminal n.</td>
<td>Pass superior to the lateral pterygoid m. between the skull and the temporalis m. while passing deep to the muscle to innervate it</td>
</tr>
<tr>
<td>Auriculotemporal</td>
<td>Arises from the posterior part of the mandibular division of the trigeminal n.</td>
<td>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</td>
</tr>
<tr>
<td>Temporal branches of the facial</td>
<td>Motor branches that arise in the substance of the parotid gland</td>
<td>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.</td>
</tr>
</tbody>
</table>

**Diagram:**

- Temporal branches
- Zygomatic branches
- Parotid duct
- Buccal branches
- Marginal mandibular branch
- Cervical branch
- Parotid gland
- Posterior auricular nerve
- Main trunk of facial nerve emerging from stylomastoid foramen
- Nerve to posterior belly of digastric muscle and to stylohyoid muscle
Contents of the Temporal Fossa

NERVE SUPPLY CONTINUED
Borders of the Infratemporal Fossa

OVERVIEW

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

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
Contents of the Infratemporal Fossa

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)

<table>
<thead>
<tr>
<th>Artery</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st part (mandibular part)</td>
<td>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</td>
</tr>
<tr>
<td>Deep auricular</td>
<td>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</td>
</tr>
<tr>
<td>Anterior tympanic</td>
<td>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.</td>
</tr>
<tr>
<td>Middle meningeal</td>
<td>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</td>
</tr>
<tr>
<td>Accessory meningeal</td>
<td>Arises from the maxillary or middle meningeal Enters the skull through the foramen ovale to supply the trigeminal ganglion and dura mater</td>
</tr>
<tr>
<td>Inferior alveolar</td>
<td>Descends inferiorly following the inferior alveolar n. to enter the mandibular foramen</td>
</tr>
</tbody>
</table>

MAXILLARY ARTERY: 2ND PART (PTERYGOID PART)

<table>
<thead>
<tr>
<th>Artery</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>2nd part (pterygoid part)</td>
<td>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</td>
</tr>
<tr>
<td>Anterior and posterior deep temporal</td>
<td>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.</td>
</tr>
<tr>
<td>Masseteric</td>
<td>Small; passes laterally through the mandibular notch to supply the deep surface of the masseter m.</td>
</tr>
<tr>
<td>Pterygoid</td>
<td>An irregular number of arteries supplying the pterygoid mm.</td>
</tr>
<tr>
<td>Buccal</td>
<td>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</td>
</tr>
</tbody>
</table>
Contents of the Infratemporal Fossa

**VASCULAR SUPPLY CONTINUED**

<table>
<thead>
<tr>
<th>MAXILLARY ARTERY: 3RD PART (PTERYGOPALATINE PART)</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>3rd part (pterygopalatine part)</td>
<td>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).</td>
</tr>
<tr>
<td>Posterior superior alveolar</td>
<td>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.</td>
</tr>
</tbody>
</table>

**Image Description:**
- **Posterior superior alveolar artery**
- **Buccal artery**
- **Pterygoid arteries**
- **Masseteric artery**
- **Inferior alveolar artery**
- **Anterior**
- **Deep temporal arteries and nerves**
- **Accessory meningeal artery**
- **Middle meningeal artery**
- **Anterior tympanic artery**
- **Deep auricular artery**
- **Lateral pterygoid artery and muscle**
- **Posterior superior alveolar arteries**
- **Buccal artery and nerve**
- **Medial pterygoid artery and muscle**
- **Pterygomandibular raphe**
Contents of the Infratemporal Fossa

VASCULAR SUPPLY CONTINUED

Anterior tympanic a.
Maxillary a.
Deep auricular a.

Exterior carotid a.
Posterior auricular a.
Contents of the Infratemporal Fossa

**VASCULAR SUPPLY CONTINUED**

<table>
<thead>
<tr>
<th>Vein</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pterygoid plexus</td>
<td>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 v.</td>
</tr>
</tbody>
</table>

Lateral view

- Supratrochlear vein
- Supraorbital vein
- Superior ophthalmic vein
- Angular vein
- Cavernous sinus
- Facial vein
- Inferior ophthalmic vein
- Pterygoid plexus
- Maxillary vein
- Retromandibular vein
- Deep facial vein
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

<table>
<thead>
<tr>
<th>Branch</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Masseteric</td>
<td>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</td>
</tr>
<tr>
<td>Anterior and posterior deep temporal</td>
<td>Pass superior to the lateral pterygoid m. between the skull and the temporalis m. while passing deep to the muscle to innervate it</td>
</tr>
<tr>
<td>Medial pterygoid</td>
<td>Enters the deep surface of the muscle</td>
</tr>
<tr>
<td>Lateral pterygoid</td>
<td>Passes into the deep surface of the muscle. Often arises from the buccal n.</td>
</tr>
<tr>
<td>Buccal</td>
<td>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</td>
</tr>
</tbody>
</table>

POSTERIOR DIVISION OF THE MANDIBULAR NERVE

<table>
<thead>
<tr>
<th>Branch</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auriculotemporal</td>
<td>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</td>
</tr>
<tr>
<td>Lingual</td>
<td>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</td>
</tr>
</tbody>
</table>
Contents of the Infratemporal Fossa

NERVOUS STRUCTURES CONTINUED

<table>
<thead>
<tr>
<th>POSTERIOR DIVISION OF THE MANDIBULAR NERVE CONTINUED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Branch</td>
</tr>
<tr>
<td>--------</td>
</tr>
<tr>
<td>Inferior alveolar</td>
</tr>
</tbody>
</table>

| 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. |

<table>
<thead>
<tr>
<th>MAXILLARY NERVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Branch</td>
</tr>
<tr>
<td>--------</td>
</tr>
<tr>
<td>Posterior superior alveolar</td>
</tr>
</tbody>
</table>

---

[Diagram showing the nervous structures of the head and face, including the maxillary and mandibular nerves, and their branches.]
Contents of the Infratemporal Fossa

NERVOUS STRUCTURES CONTINUED
**NERVOUS STRUCTURES CONTINUED**

### CHORDA TYMPANI, LESSER PETROSAL NERVE, AND OTIC GANGLION

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chorda tympani</td>
<td>Branch from the facial n. in the tympanic cavity</td>
<td>Carries the preganglionic parasympathetic fibers to the submandibular ganglion and taste fibers to the anterior 2/3 of the tongue. It 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.</td>
</tr>
<tr>
<td>Lesser petrosal</td>
<td>Tympanic plexus along the promontory of the ear re-forms as the lesser petrosal n.</td>
<td>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. It joins the otic ganglion.</td>
</tr>
</tbody>
</table>

### Nerve Cell Body

<table>
<thead>
<tr>
<th>Nerve Cell Body</th>
<th>Characteristics of the Cell Body</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Otic ganglion</td>
<td>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.</td>
<td>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.</td>
</tr>
</tbody>
</table>

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

NERVOUS STRUCTURES CONTINUED
ANATOMIC PATHWAY FOR PARASYMPATHETICS OF THE PAROTID GLAND

<table>
<thead>
<tr>
<th>Type of Neuron</th>
<th>Name of Cell Body</th>
<th>Characteristics of the Cell Body</th>
<th>Course of the Neuron</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preganglionic neuron</td>
<td>Inferior salivary nucleus</td>
<td>A collection of nerve cell bodies located in the medulla</td>
<td>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 canalculus. 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.</td>
</tr>
<tr>
<td>Postganglionic neuron</td>
<td>Otic ganglion</td>
<td>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.</td>
<td>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</td>
</tr>
</tbody>
</table>
Contents of the Infratemporal Fossa

NERVOUS STRUCTURES CONTINUED
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<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overview and Topographic Anatomy</td>
<td>242</td>
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<tr>
<td>Muscles of Mastication</td>
<td>244</td>
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<td>Vascular Supply</td>
<td>247</td>
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<tr>
<td>Nerve Supply</td>
<td>251</td>
</tr>
<tr>
<td>Clinical Correlate</td>
<td>253</td>
</tr>
</tbody>
</table>
**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

---

**Image Description**

- Foramen spinosum
- Spine of sphenoid bone
- Foramen ovale
- Foramen spinosum
- Spine of sphenoid bone
- Foramen ovale
- Tuberosity of maxilla
- Infratemporal fossa
- Alveolar process of maxilla
- Sphenopalatine foramen
- Pterygopalatine fossa
- Choanae (posterior nares)
- Lateral plate
- Medial plate
- Hamulus
- Pyramidal process of palatine bone
Overview and Topographic Anatomy

GENERAL INFORMATION CONTINUED

MUSCLES OF MASTICATION 243
## Muscles of Mastication

### OVERVIEW

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

OVERVIEW CONTINUED
Muscles of Mastication

OVERVIEW CONTINUED
### Vascular Supply

#### ARTERIAL SUPPLY

<table>
<thead>
<tr>
<th>Artery</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maxillary</td>
<td>Larger of the 2 terminal branches of the external carotid a. (superficial temporal a. is the other terminal branch)</td>
<td>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</td>
</tr>
<tr>
<td>2nd part: (pterygoid part)</td>
<td>External carotid a.</td>
<td>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</td>
</tr>
<tr>
<td></td>
<td></td>
<td>● Anterior and posterior deep temporal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pterygoid (2nd part of the maxillary a.)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>● Masseteric</td>
</tr>
<tr>
<td></td>
<td></td>
<td>● Pterygoid</td>
</tr>
<tr>
<td></td>
<td></td>
<td>● Buccal</td>
</tr>
<tr>
<td>Middle temporal</td>
<td>Superficial temporal a. after it passes superior to the root of the zygomatic arch</td>
<td>Passes deep into the temporalis fascia and temporalis m. Anastomoses with the anterior and posterior deep temporal vessels</td>
</tr>
<tr>
<td>Transverse facial</td>
<td>Superficial temporal a. before it exits the parotid gland</td>
<td>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</td>
</tr>
</tbody>
</table>
Vascular Supply

ARTERIAL SUPPLY CONTINUED
Vascular Supply

**ARTERIAL SUPPLY CONTINUED**

- Middle temporal artery and vein
- Transverse facial artery and vein
- Facial artery and vein
**Vascular Supply**

**VENOUS DRAINAGE**

<table>
<thead>
<tr>
<th>Vein</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pterygoid plexus</td>
<td>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 v.</td>
</tr>
<tr>
<td>Middle temporal</td>
<td>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</td>
</tr>
<tr>
<td>Transverse facial</td>
<td>Travels posteriorly to enter the parotid gland and join the superficial temporal v.</td>
</tr>
<tr>
<td>Anterior and posterior deep temporal</td>
<td>Join the pterygoid plexus of veins Also communicate with the middle temporal v.</td>
</tr>
<tr>
<td>Masseteric</td>
<td>Join the pterygoid plexus of veins</td>
</tr>
<tr>
<td>Pterygoid</td>
<td></td>
</tr>
<tr>
<td>Buccal</td>
<td></td>
</tr>
</tbody>
</table>
## Nerve Supply

### MOTOR BRANCHES OF THE TRIGEMINAL NERVE

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mandibular division of the trigeminal</td>
<td>Largest of the 3 divisions of the trigeminal n.</td>
<td>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.).</td>
</tr>
<tr>
<td></td>
<td>Created by a large sensory and a small motor root that unite just after passing through the foramen ovale to enter the infratemporal fossa.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anterior and posterior deep temporal</td>
<td>The anterior part of the mandibular division of the trigeminal n.</td>
<td>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.</td>
</tr>
<tr>
<td></td>
<td>The anterior deep temporal n. sometimes arises from the buccal n.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Masseteric</td>
<td>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.</td>
<td>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.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medial pterygoid</td>
<td>Arises from the undivided trunk created by the large sensory and the small motor root of the mandibular division of the trigeminal n.</td>
<td>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.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lateral pterygoid</td>
<td>Arises from the anterior part of the mandibular division of the trigeminal n., but sometimes arises as a branch from the buccal n.</td>
<td>These branches, 1 for each muscular head, enter the deep surface of the lateral pterygoid m. to innervate it.</td>
</tr>
</tbody>
</table>
Nerve Supply

MOTOR BRANCHES OF THE TRIGEMINAL NERVE CONTINUED
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
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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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.
## Anatomy

### ANATOMIC FEATURES

<table>
<thead>
<tr>
<th>Feature</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Squamous portion of the temporal bone</td>
<td>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.</td>
</tr>
<tr>
<td>Mandibular condyles</td>
<td>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.</td>
</tr>
<tr>
<td>Articular disc</td>
<td>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.</td>
</tr>
</tbody>
</table>
### Bilaminar zone (posterior attachment complex)

- **Feature**: Bilaminar zone (posterior attachment complex)
- **Comments**: 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.
**ANATOMIC FEATURES CONTINUED**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ligaments</strong></td>
<td><em>Inner horizontal part</em>—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</td>
</tr>
</tbody>
</table>
| **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 |
### Vascular Supply

**ARTERIAL SUPPLY**

<table>
<thead>
<tr>
<th>Artery</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superficial temporal branch</td>
<td>Terminal branch of the external carotid a.</td>
<td>Begins in the parotid gland and initially is located posterior to the mandible, where it provides small branches to the TMJ</td>
</tr>
<tr>
<td>Deep auricular</td>
<td>Maxillary a.</td>
<td>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</td>
</tr>
<tr>
<td>Anterior tympanic</td>
<td></td>
<td>Arising in the same area as that of the deep auricular a. Passes superiorly behind the TMJ to enter the tympanic cavity through the petrotypanic fissure, where it gives branches to the TMJ</td>
</tr>
</tbody>
</table>

---

**Diagram:**

- Middle meningeal a.
- Deep temporal aa.
- Masseteric a.
- Inferior alveolar a. and lingual branch
- Mylohyoid branch of inferior alveolar a.
- Transverse facial a. (cut)
- Superficial temporal a.
- Maxillary a.
- Posterior auricular a.
- Ascending pharyngeal a.
- Ascending palatine a.
- Tonsillar a.
- Facial a.
- External carotid a.

**Annotations:**

- Joint capsule
- Lateral TMJ lig.
- TMJ branch from superior temporal a.
- Exterior carotid a.
- Inferior alveolar a.
- Anterior tympanic a.
Vascular Supply

**VENOUS DRAINAGE**

<table>
<thead>
<tr>
<th>Vein</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superficial temporal</td>
<td>Receives some branches from the TMJ Then joins the maxillary v. to form the retromandibular v.</td>
</tr>
<tr>
<td>Maxillary</td>
<td>Receives some branches from the TMJ Joins the superficial temporal v. to form the retromandibular v.</td>
</tr>
</tbody>
</table>

---

**Diagram:**
- Pterygoid plexus
- Deep facial v.
- Maxillary v.
- Superficial temporal v. and a.
- Transverse facial v. (cut)
- Posterior auricular v.
- Retromandibular vein
- Posterior retromandibular vein
- External jugular v. (cut)
- Inferior alveolar v. and a.
- Common facial vein
Nerve Supply

**SENSORY INNERVATION**

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Source</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auriculotemporal</td>
<td>Mandibular division of the trigeminal n.</td>
<td>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.</td>
</tr>
<tr>
<td>Masseteric</td>
<td>Anterior division of the mandibular division of the trigeminal n.</td>
<td>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.</td>
</tr>
<tr>
<td>Posterior deep temporal</td>
<td></td>
<td>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</td>
</tr>
</tbody>
</table>

**Medial view**

- Mandibular n. and otic ganglion
- Middle meningeal a.
- Joint capsule
- Auriculotemporal n.
- Inferior alveolar n.
- Maxillary a.
- Lingual n.
- Sphenomandibular lig.
- Stylomandibular lig.
- Mylohyoid branch of inferior alveolar a. and mylohyoid n.
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
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](image1)
![Open position](image2)
![Anterior dislocation](image3)

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

ARTHРИTIS AND ANKYLOSIS CONTINUEД

Unilateral ankylosis

Ankylosis

Ankylosis

Ankylosis

Osteoarthritis
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

<table>
<thead>
<tr>
<th>Border</th>
<th>Structures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior wall</td>
<td>Infratemporal surface of the maxilla</td>
</tr>
<tr>
<td>Posterior wall</td>
<td>Pterygoid process of the sphenoid</td>
</tr>
<tr>
<td>Medial wall</td>
<td>Perpendicular plate of the palatine</td>
</tr>
<tr>
<td>Lateral wall</td>
<td>None (open to the pterygomaxillary fissure)</td>
</tr>
<tr>
<td>Superior wall</td>
<td>Inferior surface of the sphenoid and the orbital plate of the palatine bone</td>
</tr>
<tr>
<td>Inferior wall</td>
<td>Pyramidal process of the palatine</td>
</tr>
</tbody>
</table>

### OPENINGS

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

Infratemporal fossa exposed by removal of zygomatic arch and mandible*

*Superficially, mastoid process forms posterior boundary

Borders and Openings

Superior orbital fissure
Optic foramen
Cut edge of zygoma to view into the pterygopalatine fossa
Foramen rotundum
Cut edge of zygomatic arch
Styloid process
Maxillary sinus (posterior portion)
Sphenoidal sinus
Pterygoid canal
Pharyngeal canal
Nasal cavity
Sphenopalatine foramen

Pterygopalatine fossa
Sphenopalatine foramen

Inferior orbital fissure

Sphenopalatine foramen

270 NETTER’S HEAD AND NECK ANATOMY FOR DENTISTRY
**PTERYGOPALATINE FOSSA**

**OPENINGS CONTINUED**

- Sphenopalatine foramen communicating with the nasal cavity
- Inferior orbital fissure
- Pharyngeal canal communicating with the nasopharynx
- Foramen rotundum communicating with the middle cranial fossa
- Pterygomaxillary fissure communicating with the infratemporal fossa
- Palatine canal communicating with the oral cavity

**Borders and Openings**

**Posterior – Red border**
- Pterygoid canal
- Foramen rotundum communicating with the middle cranial fossa
- Pterygomaxillary fissure communicating with the infratemporal fossa

**Superior**
- Inferior orbital fissure

**Medial**
- Sphenopalatine foramen communicating with the nasal cavity
- Pharyngeal canal communicating with the nasopharynx

**Lateral**
- Palatine canal communicating with the oral cavity

**Inferior**
- Maxillary division
- Posterior superior alveolar nerve
- Maxillary artery
- Nerve and artery of the pterygoid canal
- Descending palatine artery
- Greater palatine artery
- Lesser palatine artery

**Infraorbital artery**
- Infraorbital nerve
- Zyomatic nerve
- Posterior superior nasal nerve
- Sphenopalatine artery and nasopalatine nerve
- Pharyngeal artery and nerve
- Greater palatine nerve

**Lesser palatine nerve**
- Maxillary division
- Pterygopalatine ganglion

**Notes:**
- Wien
### Contents of the Pterygopalatine Fossa

#### VASCULAR SUPPLY

<table>
<thead>
<tr>
<th>Artery (3rd part)</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maxillary (3rd part)</td>
<td>External carotid a.</td>
<td>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).</td>
</tr>
<tr>
<td>Infraorbital</td>
<td>The continuation of the 3rd part of the maxillary a.</td>
<td>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.</td>
</tr>
<tr>
<td>Descending palatine</td>
<td>3rd part of the maxillary a.</td>
<td>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. Lesser palatine a. supplies the soft palate and palatine tonsil.</td>
</tr>
<tr>
<td>Artery of the pterygoid canal</td>
<td></td>
<td>Passes posteriorly into the pterygoid canal, accompanying the nerve of the pterygoid canal (vidian n.) Helps supply the auditory tube and sphenoid sinus.</td>
</tr>
<tr>
<td>Pharyngeal</td>
<td></td>
<td>Passes posteromedially into the pharyngeal canal Helps supply the auditory tube and nasopharynx.</td>
</tr>
<tr>
<td>Sphenopalatine</td>
<td></td>
<td>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.</td>
</tr>
</tbody>
</table>
Contents of the Pterygopalatine Fossa

**VASCULAR SUPPLY CONTINUED**

- Medial wall of nasal cavity (nasal septum)
- Lateral wall of nasal cavity
- Maxillary artery
- External carotid artery
- Sphenopalatine foramen
- Sphenopalatine artery
- Infraorbital artery
- Sphenopalatine foramen
- Artery of pterygoid canal
- Superior orbital fissure
- Optic nerve passing thru optic foramen
- Zygomatic nerve
- Infraorbital nerve
- Maxillary artery
- Posterior superior alveolar nerve
- Descending palatine artery
- Lesser palatine artery and nerve
- Sphenoid sinus
- Nerve and artery of the pterygoid canal
- Pharyngeal artery and nerve
- Sphenopalatine artery and nasopalatine nerve
- Posterior superior nasal nerve
- Posterior inferior nasal nerve arising from the greater palatine nerve
- Greater palatine artery and nerve (located posterior to the maxillary sinus)
## Contents of the Pterygopalatine Fossa

### Vascular Supply (continued)

<table>
<thead>
<tr>
<th>Vein</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Posterior superior alveolar</strong></td>
<td>Receives blood from the posterior teeth and soft tissue</td>
</tr>
<tr>
<td><strong>Pharyngeal</strong></td>
<td>Receives blood from the nasopharynx</td>
</tr>
<tr>
<td><strong>Descending palatine</strong></td>
<td>Receives blood from the hard and soft palate</td>
</tr>
<tr>
<td><strong>Infraorbital</strong></td>
<td>Receives blood from the midface via the lower eyelid, lateral side of the nose, and the upper lip</td>
</tr>
<tr>
<td><strong>Sphenopalatine</strong></td>
<td>Receives blood from the nasal cavity and the nasal septum</td>
</tr>
<tr>
<td><strong>Vein of the pterygoid canal</strong></td>
<td>Receives blood from the foramen lacerum region and the sphenoid sinus</td>
</tr>
<tr>
<td><strong>Inferior ophthalmic</strong></td>
<td>Receives blood from the floor of the orbit</td>
</tr>
<tr>
<td></td>
<td>Branches into 2 parts</td>
</tr>
<tr>
<td></td>
<td>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</td>
</tr>
<tr>
<td></td>
<td>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</td>
</tr>
<tr>
<td><strong>Pterygoid plexus</strong></td>
<td>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.</td>
</tr>
</tbody>
</table>

**Venous Drainage**

<table>
<thead>
<tr>
<th>Vein</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Superior ophthalmic vein</strong></td>
<td>Receives blood from the superior ophthalmic vein</td>
</tr>
<tr>
<td><strong>Nasofrontal vein</strong></td>
<td>Receives blood from the nasofrontal vein</td>
</tr>
<tr>
<td><strong>Facial vein</strong></td>
<td>Receives blood from the facial vein</td>
</tr>
<tr>
<td><strong>Vorticose veins</strong></td>
<td>Receives blood from the vorticose veins</td>
</tr>
<tr>
<td><strong>Deep facial vein</strong></td>
<td>Receives blood from the deep facial vein</td>
</tr>
<tr>
<td><strong>Supratrochlear vein</strong></td>
<td>Receives blood from the supratrochlear vein</td>
</tr>
<tr>
<td><strong>Supraorbital vein</strong></td>
<td>Receives blood from the supraorbital vein</td>
</tr>
<tr>
<td><strong>Angular vein</strong></td>
<td>Receives blood from the angular vein</td>
</tr>
<tr>
<td><strong>Cavernous sinus</strong></td>
<td>Receives blood from the cavernous sinus</td>
</tr>
<tr>
<td><strong>Inferior ophthalmic vein</strong></td>
<td>Receives blood from the inferior ophthalmic vein</td>
</tr>
<tr>
<td><strong>Pterygoid plexus</strong></td>
<td>Receives blood from the pterygoid plexus</td>
</tr>
<tr>
<td><strong>Maxillary vein</strong></td>
<td>Receives blood from the maxillary vein</td>
</tr>
<tr>
<td><strong>Retromandibular vein</strong></td>
<td>Receives blood from the retromandibular vein</td>
</tr>
</tbody>
</table>

![Lateral view of the head and neck](image-url)
# Contents of the Pterygopalatine Fossa

## Nerve Supply

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maxillary division of the trigeminal n.</td>
<td>Trigeminal n.</td>
<td>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.</td>
</tr>
<tr>
<td>Posterior superior alveolar</td>
<td>Maxillary division of the trigeminal n. in pterygopalatine fossa</td>
<td>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</td>
</tr>
<tr>
<td>Zygomatic</td>
<td></td>
<td>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 autonomic to the lacrimal gland</td>
</tr>
<tr>
<td>Ganglionic branches</td>
<td></td>
<td>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)</td>
</tr>
<tr>
<td>Infraorbital</td>
<td>Considered the continuation of the maxillary division of the trigeminal n.</td>
<td>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)</td>
</tr>
</tbody>
</table>
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.

<table>
<thead>
<tr>
<th>Branch</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
</table>
| 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 |
Contents of the Pterygopalatine Fossa

NERVE SUPPLY CONTINUED

- Maxillary n.
- Pterygopalatine ganglion and branches
- Nerve of pterygoid canal
- Greater petrosal n.
- Deep petrosal n.
- Pharyngeal branch
- Nasopalatine n. (passing to septum)
- Lesser (minor) palatine nerves (V2)
- Greater palatine nerve (V3)
- Nasal septum
- Nasopalatine n.
- Lateral wall of nasal cavity
- Medial wall of nasal cavity (nasal septum)
- Sphenopalatine foramen (dissected away)
- Nasopalatine nerve (V2)

- Greater and lesser palatine nerves (V2)
- Nasopalatine n.
- Lateral wall of nasal cavity

- Maxillary n.
- Pterygopalatine ganglion and branches
- Nerve of pterygoid canal
- Greater petrosal n.
- Deep petrosal n.
- Pharyngeal branch
- Nasopalatine n. (passing to septum)
- Lesser (minor) palatine nerves (V2)
- Greater (major) palatine nerves (V2)

- Nasopalatine n.
- Nasal septum
## Contents of the Pterygopalatine Fossa

### NERVE SUPPLY

#### AUTONOMICS TRAVERSING THE PTERYGOPALATINE FOSSA

<table>
<thead>
<tr>
<th>Type of Neuron</th>
<th>Name of Cell Body</th>
<th>Characteristics of the Cell Body</th>
<th>Course of the Neuron</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preganglionic neuron</td>
<td>Superior salivatory nucleus</td>
<td>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.</td>
<td>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.</td>
</tr>
<tr>
<td>Postganglionic neuron</td>
<td>Pterygopalatine ganglion</td>
<td>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</td>
<td>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</td>
</tr>
</tbody>
</table>
Contents of the Pterygopalatine Fossa

NERVE SUPPLY CONTINUED

- Sympathetic presynaptic fibers
- Sympathetic postsynaptic fibers
- Parasympathetic presynaptic fibers
- Parasympathetic postsynaptic fibers

Sympathetic presynaptic fibers
Sympathetic postsynaptic fibers
Parasympathetic presynaptic fibers
Parasympathetic postsynaptic fibers
## Contents of the Pterygopalatine Fossa

**NERVE SUPPLY CONTINUED**

<table>
<thead>
<tr>
<th>Type of Neuron</th>
<th>Name of Cell Body</th>
<th>Characteristics of the Cell Body</th>
<th>Course of the Neuron</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Preganglionic neuron</strong></td>
<td>Intermediolateral horn nucleus</td>
<td>Collection of nerve cell bodies located in the lateral horn nucleus of the spinal cord between spinal segments T1 and T3 (and possibly T4)</td>
<td>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</td>
</tr>
<tr>
<td><strong>Postganglionic neuron</strong></td>
<td>Superior cervical ganglion</td>
<td>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)</td>
<td><strong>Nasal Cavity and Palate</strong> 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</td>
</tr>
</tbody>
</table>

### 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.
Contents of the Pterygopalatine Fossa

NERVE SUPPLY CONTINUED

<table>
<thead>
<tr>
<th>Type of Neuron</th>
<th>Name of Cell Body</th>
<th>Characteristics of the Cell Body</th>
<th>Course of the Neuron</th>
</tr>
</thead>
<tbody>
<tr>
<td>Postganglionic neuron</td>
<td>Greater petrosal nerve (parasympathetic)</td>
<td></td>
<td>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</td>
</tr>
</tbody>
</table>
**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
Overview and Topographic Anatomy

GENERAL INFORMATION CONTINUED

Coronal section
- Cerebral falk
- Brain
- Nasal cavities
- Nasal septum
- Middle nasal concha
- Middle nasal meatus
- Maxillary sinus
- Inferior nasal meatus
- Inferior nasal concha
- Hard palate
- Oral cavity

Olfactory bulbs
- Frontal sinus
- Orbital fat
- Ethmoidal cells
- Opening of maxillary sinus
- Infraorbital
  - Zygomatic
  - Alveolar
- Recesses of maxillary sinus
- Buccinator muscle
- Alveolar process of maxilla
- Body of tongue
- Sublingual gland
- Mandible (body)

Horizontal section
- Eyeball
- Ethmoidal cells
- Orbital fat and muscles
- Sphenoidal sinuses
- Optic chiasm
- Nasal cavities
- Nasal septum
- Medial wall of orbit
- Optic nerve (II)
- Brain
**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.
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
ARTERIAL SUPPLY

<table>
<thead>
<tr>
<th>Artery</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
</table>
| 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 (infracrochlear) | 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

#### Arterial Supply

<table>
<thead>
<tr>
<th>Artery</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maxillary</td>
<td>1 of 2 terminal branches of the external carotid a.</td>
<td>Gives rise to a series of branches; only 1 provides blood supply to the nose: nasal branch of the infraorbital a.</td>
</tr>
<tr>
<td>Nasal branch of the infraorbital</td>
<td>Infraorbital, the continuation of the 3rd part of the maxillary a.</td>
<td>Arises with the inferior palpebral branch and the superior labial branch. Supplies the lateral aspect of the nose.</td>
</tr>
<tr>
<td>Facial</td>
<td>External carotid a. in the carotid triangle of the neck</td>
<td>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.</td>
</tr>
<tr>
<td>Septal</td>
<td>Superior labial a.</td>
<td>Supplies the septum.</td>
</tr>
<tr>
<td>Alar</td>
<td>Superior labial a. off the facial a.</td>
<td>Supplies the ala of the nose.</td>
</tr>
<tr>
<td>Lateral nasal</td>
<td>Facial a.</td>
<td>Supplies the ala and dorsal surface of the nose.</td>
</tr>
</tbody>
</table>

#### Diagram

[Diagram of the vascular supply of the nose, showing various branches and connections.]

**Labels:**
- Anterior lateral nasal branch of the anterior ethmoidal artery
- Alar branches of the lateral nasal branch (of facial artery)
- Lateral wall of nasal cavity
- Posterior lateral nasal branches of the sphenopalatine artery
- Sphenopalatine artery
- Anterior septal branch
- Posterior septal branch of the sphenopalatine artery
- Maxillary artery
- External carotid artery
- Lesser palatine foramen and artery
- Greater palatine foramen and artery
- Nasal septal branch of superior labial branch (of facial artery)
### VASCULAR SUPPLY OF THE NOSE

**VENOUS DRAINAGE**

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

![Diagram of nasal veins and arteries](image)
NERVE SUPPLY OF THE NOSE

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

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ophthalmic division</td>
<td>Trigeminal n.</td>
<td>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</td>
</tr>
<tr>
<td>External nasal</td>
<td>Terminal branches of the anterior ethmoid nerve from the ophthalmic division of the trigeminal n.</td>
<td>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</td>
</tr>
<tr>
<td>Internal nasal</td>
<td></td>
<td>Supplies the skin on the internal surface of the vestibule</td>
</tr>
<tr>
<td>Infratrochlear</td>
<td>One of the terminal branches of the nasociliary branch of the ophthalmic division of the trigeminal n.</td>
<td>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</td>
</tr>
<tr>
<td>Maxillary division</td>
<td>Trigeminal n.</td>
<td>Travels along the lateral wall of the cavernous sinus Passes from the middle cranial fossa via the foramen rotundum 4 branches: Infraorbital—this is the continuation of the maxillary division. Posterior superior alveolar. Zygomatic. Ganglionic.</td>
</tr>
<tr>
<td>Infraorbital</td>
<td>The continuation of the 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 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).</td>
</tr>
<tr>
<td>Nasal branch of the</td>
<td>Infraorbital n.</td>
<td>Supplies the ala of the nose</td>
</tr>
<tr>
<td>infraorbital</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Efferent fibers
Afferent fibers
Proprioceptive fibers
Parasympathetic fibers
Sympathetic fibers

Ophthalmic nerve (V1)
Anterior ethmoidal nerve
Infratrochlear nerve
Internal nasal branches and External nasal branches of anterior ethmoidal nerve
Maxillary nerve (V2)
Mandibular nerve (V3)

Trigeminal (semilunar) ganglion
Trigeminal nerve (V)

Nose NERVE SUPPLY OF THE NOSE CONTINUED

Infratrochlear nerve (from nasociliary nerve)
Nasal branch of infraorbital n.
Infraorbital nerve
External nasal branch of anterior ethmoidal nerve
Ophthalmic nerve (V1)
Nose

NERVE SUPPLY OF THE NOSE CONTINUED

Lateral internal nasal
External nasal branches of anterior ethmoidal nerve (V1)
Internal nasal branches of infraorbital nerve (V2)

Olfactory nerves (I)
Nasopalatine nerve (V2)
Pterygopalatine ganglion

Medial internal nasal branches of anterior ethmoidal nerve (V1)

Posterior inferior lateral nasal branch of greater palatine nerve (V2)
Lesser palatine nerves (V2)
Greater palatine nerve (V2)

Lateral wall of nasal cavity
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

<table>
<thead>
<tr>
<th>Border</th>
<th>Structures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior</td>
<td>Frontal sinus, sphenoid sinus, anterior cranial fossa with frontal lobe of the brain</td>
</tr>
<tr>
<td>Inferior</td>
<td>Palate, oral cavity</td>
</tr>
<tr>
<td>Medial</td>
<td>Other half of nasal cavity</td>
</tr>
<tr>
<td>Lateral</td>
<td>Maxillary sinus, ethmoid sinuses, orbit, and pterygopalatine fossa</td>
</tr>
</tbody>
</table>

BOUNDARIES

<table>
<thead>
<tr>
<th>Border</th>
<th>Structures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior</td>
<td>Nasal, frontal, cribiform plate of the ethmoid, body of the sphenoid</td>
</tr>
<tr>
<td>Inferior</td>
<td>Palatine process of the maxilla, horizontal plate of the palatine</td>
</tr>
<tr>
<td>Anterior</td>
<td>External nose</td>
</tr>
<tr>
<td>Posterior</td>
<td>Choanae</td>
</tr>
</tbody>
</table>

[Diagram of the nasal cavity with labeled structures]
Nasal Cavity

BOUNDARIES AND RELATIONS OF THE NASAL CAVITY CONTINUED

Sinus of frontal bone
Nasal bone
Lateral process of septal nasal cartilage
Major alar cartilage
Alar fibrofatty tissue
Maxilla
Frontal process
Anterior nasal spine
Incisive canal
Palatine process
Alveolar process
Inferior nasal concha
Lacrimal bone
Ethmoid bone
Middle nasal concha
Uncinate process
Cribriform plate
Superior nasal concha
Highest nasal concha
Sphenopalatine recess
Sphenopalatine foramen
Ethmoidal bulla
Sphenoid bone
Frontal sinus
Opening of middle ethmoidal cells
Superior nasal concha (cut away)
Infratubal canal leading to frontonasal canal
Semilunar hiatus with openings of anterior ethmoidal cells
Uncinate process
Inferior nasal concha (cut away)
Opening of nasolacrimal canal
Opening of posterior ethmoidal cells
Openings of sphenoidal sinus
Openings into maxillary sinus
Sphenopalatine foramen
Ethmoidal process of inferior nasal concha
Lesser palatine foramen
Greater palatine foramen
Nasal Cavity

CONCHAE OF THE NASAL CAVITY

<table>
<thead>
<tr>
<th>Concha</th>
<th>Regions Drained</th>
<th>Location</th>
<th>Structures Drained</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior</td>
<td>Sphenoethmoidal recess</td>
<td>Superior to the superior meatus</td>
<td>Sphenoidal sinus</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Superior meatus</td>
<td></td>
</tr>
<tr>
<td>Middle</td>
<td>Middle meatus</td>
<td>Inferior to the middle meatus</td>
<td>Anterior ethmoidal sinus</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Middle ethmoidal sinus</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Maxillary sinus</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Frontal sinus</td>
</tr>
<tr>
<td>Inferior</td>
<td>Inferior meatus</td>
<td>Inferior to the inferior meatus</td>
<td>Nasolacrimal duct</td>
</tr>
</tbody>
</table>

![Diagram of nasal cavity showing conchae and their related structures.](image)
Nasal Cavity

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.

<table>
<thead>
<tr>
<th>Artery</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ophthalmic</td>
<td>Internal carotid a.</td>
<td>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.</td>
</tr>
<tr>
<td>Anterior ethmoid</td>
<td>Ophthalmic a.</td>
<td>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.</td>
</tr>
<tr>
<td>Posterior ethmoid</td>
<td>Ophthalmic a.</td>
<td>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.</td>
</tr>
<tr>
<td>Maxillary</td>
<td>1 of 2 terminal branches of the external carotid a.</td>
<td>Gives rise to a series of branches; 2 provide blood supply to the nasal cavity: Sphenopalatine. Greater palatine.</td>
</tr>
<tr>
<td>Sphenopalatine</td>
<td>3rd part of the maxillary a.</td>
<td>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.</td>
</tr>
<tr>
<td>Greater palatine</td>
<td>A branch of the descending palatine, arising from the 3rd part of the maxillary a.</td>
<td>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.</td>
</tr>
</tbody>
</table>
### Vascular Supply of the Nasal Cavity (Continued)

#### Arterial Supply

<table>
<thead>
<tr>
<th>Artery</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facial</td>
<td>External carotid a., in the carotid triangle of the neck</td>
<td>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.</td>
</tr>
<tr>
<td>Superior labial</td>
<td>Facial</td>
<td>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.</td>
</tr>
</tbody>
</table>

**Superior view**

- Supratrochlear artery
- Dorsal nasal artery
- Anterior meningeal artery
- Anterior ethmoidal artery
- Posterior ethmoidal artery
- Ophthalmic artery
- Internal carotid artery
- Supraorbital artery
- Posterior ciliary arteries
- Lacrimal artery
- Central retinal artery
Nasal Cavity

VASCULAR SUPPLY OF THE NASAL CAVITY CONTINUED

- Supraorbital artery
- Supratrochlear artery
- Ophthalmic artery
- Dorsal nasal artery
- Angular artery
- Infraorbital artery
- Superior alveolar arteries
- Facial artery
- Sphenopalatine artery
- Posterior lateral nasal branch
- Posterior superior alveolar artery
- Sphenopalatine artery
- Posterior septal branches
- Descending palatine artery in pterygopalatine fossa
- Left and right greater palatine arteries
- Left and right lesser palatine arteries
VASCULAR SUPPLY OF THE NASAL CAVITY

CONTINUED

<table>
<thead>
<tr>
<th>Vein</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emissary</td>
<td>Vein from the cavernous plexus in the nasal cavity passes through the foramen cecum to drain into the superior sagittal sinus</td>
</tr>
<tr>
<td>Sphenopalatine</td>
<td>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</td>
</tr>
<tr>
<td>Ethmoidal branches</td>
<td>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.</td>
</tr>
</tbody>
</table>

Anterior ethmoidal vein connecting to septum and plexus
Posterior ethmoidal veins connecting to septum and plexus
Sphenopalatine vein
Pterygoid plexus
Retromandibular vein
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
Nasal Cavity

NERVE SUPPLY OF THE NASAL CAVITY CONTINUED
Nasal Cavity

NERVE SUPPLY OF THE NASAL CAVITY CONTINUED

### SENSORY INNERVATION

**Olfaction**

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.

### GENERAL SENSATION

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
</table>
| Ophthalmic division of the trigeminal | Trigeminal n. | 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

| Anterior ethmoid | Nasociliary n. on the medial wall of the orbit | 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 |
|---------------------------------|-----------------------------------------------|------------------------------------------------------------------------|
| Maxillary division of the trigeminal | Trigeminal n. | 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 |
| Infraorbital | 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
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) |
| 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 |
| Posterior inferior nasal branch of the greater palatine | 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 |
**GENERAL SENSATION**

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
</table>
| **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 posterolateral nasal 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                        |

---

**Diagram**

- Lateral internal nasal
- External nasal branches of anterior ethmoidal nerve (V1)
- Internal nasal branches of infraorbital nerve (V2)
- Nasal branch of anterior superior alveolar nerve (V2)
- Lateral wall of nasal cavity
- Olfactory nerves (I)
- Pterygopalatine ganglion
- Sphenopalatine foramen (dissected away)
- Nasopalatine nerve (V2)
- Medial internal nasal branches of anterior ethmoidal nerve (V1)
- Posterior superior lateral nasal branch of greater palatine nerve (V2)
- Greater and lesser palatine nerves (V2)
- Posterior inferior lateral nasal branch of greater palatine nerve (V2)
- Lesser palatine nerves (V2)
- Greater palatine nerve (V2)
Nasal Cavity

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

<table>
<thead>
<tr>
<th>Type of Neuron</th>
<th>Name of Cell Body</th>
<th>Characteristics of the Cell Body</th>
<th>Course of the Neuron</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preganglionic neuron</td>
<td>Superior salivary nucleus</td>
<td>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: 1. Greater petrosal n. 2. Chorda tympani n.</td>
<td>Greater Petrosal Nerve</td>
</tr>
<tr>
<td>Postganglionic neuron</td>
<td>Pterygopalatine ganglion</td>
<td>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: 1. Lacrimal gland 2. Nasal glands 3. Palatine glands 4. Pharyngeal glands</td>
<td>Maxillary Division Distribution</td>
</tr>
</tbody>
</table>

### Autonomics: Anatomic Pathway for Parasympathetics of the Nasal Cavity

**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.

### Autonomics: Anatomic Pathway for Sympathetics of the Nasal Cavity

**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:

1. Nasal glands
2. Palatine glands
3. Pharyngeal glands
## NERVE SUPPLY OF THE NASAL CAVITY

### AUTONOMICS: ANATOMIC PATHWAY FOR SYMPATHETICS OF THE NASAL CAVITY

<table>
<thead>
<tr>
<th>Type of Neuron</th>
<th>Name of Cell Body</th>
<th>Characteristics of the Cell Body</th>
<th>Course of the Neuron</th>
</tr>
</thead>
</table>
| 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

Greater petrosal nerve

Sensory root
Motor root
Ganglion

Mandibular nerve (V3)

Deep petrosal nerve
Nerve (Vidian) of pterygoid canal

Maxillary nerve (V2)
Ophthalmic nerve (V1)

Posterior superior and inferior lateral nasal nerves

Internal carotid nerve

Superior cervical sympathetic ganglion

Internal carotid artery and plexus

Cervical sympathetic trunk

Facial artery and plexus

Pterygopalatine ganglion

Greater and lesser palatine nerves
NERVE SUPPLY OF THE NASAL CAVITY

- Superior salivatory nucleus (parasympathetic)
- Facial nerve (VII)
- Geniculum
- Greater petrosal nerve (parasympathetic)
- Deep petrosal nerve (sympathetic)
- Nerve (Vidian) of pterygoid canal
- Maxillary nerve (V₂) entering foramen rotundum
- Pterygopalatine ganglion in pterygopalatine fossa
- Lateral and medial posterior superior nasal branches in pterygopalatine fossa
- Infraorbital nerve
- Posterior superior and inferior lateral nasal nerves (cut ends)
- Tympanic cavity
- Internal carotid nerve
- Internal carotid artery
- Superior cervical ganglion
- Greater and lesser palatine nerves
- Posterior superior and inferior lateral nasal nerves
- Nasopalatine nerve
- Presynaptic sympathetic cell bodies in intermediolateral nucleus (lateral horn) of gray matter
- Postsynaptic parasympathetic fibers
- Postsynaptic parasympathetic fibers
- Presynaptic sympathetic fibers
- Postsynaptic sympathetic fibers
- Medulla oblongata
- Spinal cord
- Sympathetic trunk
- T1
- T2
- T3
- Postsynaptic fibers to vessels (sympathetic) and glands (parasympathetic) of nasal cavity, maxillary sinus and palate

NOSE AND NASAL CAVITY 311
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**

**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

**Silver nitrate stick**

Kiesselbach’s plexus on septum

Suction

**2 or 3 petrolatum gauze packs placed vertically side by side**

- **A. Intraorbital nerve and artery**
- **B. View through operating microscope**
- **C. Sphenopalatine artery clipped and divided**
- **Sphenopalatine artery entering sphenopalatine foramen to divide into posterior lateral nasal and posterior septal nasal arteries**
- **Pterygopalatine ganglion (sphenopalatine)**
- **Nerve of pterygoid canal (vidian nerve)**
- **Palatine nerves and arteries**

**Clinical Correlate**

**EPISTAXIS**

**CONTINUED**

**Cauterization of Anterior Nasal Bleeding**

Kiesselbach’s plexus

Silver nitrate stick

**Placement of Anterior Pack**

2 or 3 petrolatum gauze packs placed vertically side by side

**2.5”**

**NOSE AND NASAL CAVITY 313**
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

---

**Figures**

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
Endoscopic view of nasal polyp protruding from middle meatus

Nasal septum
Middle turbinate
Polyp

Nasal and sinus polyps common in allergic rhinitis

Nasal polyps most often bilateral in allergic sinusitis
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
Overview and Topographic Anatomy

GENERAL INFORMATION CONTINUED

FEATURES OF THE PARANASAL SINUSES

<table>
<thead>
<tr>
<th>Sinus</th>
<th>Location</th>
<th>Comment</th>
<th>Artery</th>
<th>Nerve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frontal</td>
<td>Within frontal bone</td>
<td>Flattened triangular shape</td>
<td>Ophthalmic branches</td>
<td>Ophthalmic division of the trigeminal n.</td>
</tr>
<tr>
<td>Maxillary</td>
<td>Within maxillary bone</td>
<td>Pyramidal shape,</td>
<td>Maxillary branches</td>
<td>Maxillary division of the trigeminal n.</td>
</tr>
<tr>
<td>Ethmoid</td>
<td>Within ethmoid bone</td>
<td>3 to 18 irregularly shaped</td>
<td>Ophthalmic and</td>
<td>Ophthalmic and maxillary divisions</td>
</tr>
<tr>
<td>Sphenoid</td>
<td>Within sphenoid bone</td>
<td>Cuboid shape</td>
<td>maxillary branches</td>
<td>of the trigeminal n.</td>
</tr>
</tbody>
</table>
Overview and Topographic Anatomy

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

<table>
<thead>
<tr>
<th>Region Drained</th>
<th>Location</th>
<th>Structure(s) Drained</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sphenoethmoidal recess</td>
<td>Superior to the superior concha</td>
<td>Sphenoid sinus</td>
</tr>
<tr>
<td>Superior meatus</td>
<td>Inferior to the superior concha</td>
<td>Posterior ethmoid sinus</td>
</tr>
<tr>
<td>Middle meatus</td>
<td>Inferior to the middle concha</td>
<td>Anterior ethmoid sinus Middle ethmoid sinus Maxillary sinus Frontal sinus</td>
</tr>
<tr>
<td>Inferior meatus</td>
<td>Inferior to the inferior concha</td>
<td>Nasolacrimal duct</td>
</tr>
</tbody>
</table>
**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

![FrontalSinus](image-url)
## Articular Supply

<table>
<thead>
<tr>
<th>Artery</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior ethmoid</td>
<td>Ophthalmic a. (from the internal carotid a.)</td>
<td>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.</td>
</tr>
<tr>
<td>Supraorbital</td>
<td>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.</td>
<td></td>
</tr>
<tr>
<td>Supratrochlear</td>
<td>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.</td>
<td></td>
</tr>
</tbody>
</table>

[Diagram of Articular Supply]

---

**Frontal Sinus**

---

**ARTERIAL SUPPLY**

---

**PARANASAL SINUSES** 323
Frontal Sinus

NERVE SUPPLY

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supraorbital</td>
<td>Ophthalmic division of the trigeminal n.</td>
<td>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.</td>
</tr>
<tr>
<td>Supratrochlear</td>
<td></td>
<td>Once the supratrochlear a. joins it, the nerve continues to pass anteriorly toward the trochlear n. There it often supplies the frontal sinus.</td>
</tr>
</tbody>
</table>
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
Ethmoid Sinus

**GENERAL INFORMATION CONTINUED**

**Horizontal section**
- Nasal cavity
- Ethmoidal cells
- Periorbita
- Medial rectus muscle and fascial sheath
- Optic nerve (II) and outer sheath
- Sphenoidal sinus

**Frontal section**
- Lacrimal gland
- Periorbita
- Ethmoidal cell
- Retrobulbar fat (orbital fat body)
- Infraorbital nerve (V2)
Ethmoid Sinus

**ARTERIAL SUPPLY**

<table>
<thead>
<tr>
<th>Artery</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior ethmoid</td>
<td>Ophthalmic a. (from the internal carotid)</td>
<td>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.</td>
</tr>
<tr>
<td>Posterior ethmoid</td>
<td></td>
<td>Passes through the posterior ethmoid foramen to enter the canal. There it supplies the posterior ethmoid air cells and sphenoid sinus.</td>
</tr>
<tr>
<td>Posterior lateral nasal branches</td>
<td>Sphenopalatine a. (from the maxillary a. from the external carotid a.)</td>
<td>Anastomose with the ethmoidal arteries to help supply the ethmoid air cells and sphenoid sinus.</td>
</tr>
</tbody>
</table>
**Ethmoid Sinus**

### NERVE SUPPLY

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior ethmoid</td>
<td>Nasociliary n. on the medial wall of the orbit (from the ophthalmic division of the trigeminal n.)</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 and middle ethmoid air cells.</td>
</tr>
<tr>
<td>Posterior ethmoid</td>
<td>Posterior ethmoid ganglion in the pterygopalatine fossa (from the maxillary division of the trigeminal n.)</td>
<td>Enters the posterior ethmoid foramen to supply the posterior ethmoid air cell. Also innervates the sphenoid sinus at this location.</td>
</tr>
<tr>
<td>Posterior lateral superior nasal</td>
<td>Pterygopalatine ganglion in the pterygopalatine fossa (from the maxillary division of the trigeminal n.)</td>
<td>Pass through the sphenopalatine foramen to enter the nasal cavity. Branches supply the posterior ethmoid air cells at this location.</td>
</tr>
<tr>
<td>Posterior lateral inferior nasal</td>
<td>Greater palatine n. as it descends through the palatine canal (from the maxillary division of the trigeminal n.)</td>
<td>May send branches to the ethmoid air cells.</td>
</tr>
</tbody>
</table>

![Diagram of Ethmoid Sinus](image)
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
Maxillary Sinus

GENERAL INFORMATION CONTINUED

ARTERIAL SUPPLY

<table>
<thead>
<tr>
<th>Artery</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior superior alveolar</td>
<td>Maxillary a. from the external carotid a.</td>
<td>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</td>
</tr>
<tr>
<td>Middle superior alveolar</td>
<td></td>
<td>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</td>
</tr>
<tr>
<td>Posterior superior alveolar</td>
<td></td>
<td>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</td>
</tr>
</tbody>
</table>

Facial artery
Mental branch of inferior alveolar artery
Submental artery

Ophthalmic artery
Angular artery
Inferior alveolar artery
Superior alveolar arteries
Posterior
Middle
Anterior

Maxillary artery
Superficial temporal artery
Facial nerve
Sphenomandibular ligament

External carotid artery
Facial artery
Lingual artery
# Maxillary Sinus

## Nerve Supply

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posterior superior alveolar nerve</td>
<td>Infraorbital n. which is the continuation of the maxillary division of the trigeminal n.</td>
<td>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.</td>
</tr>
<tr>
<td>Middle superior alveolar nerve</td>
<td>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.</td>
<td></td>
</tr>
<tr>
<td>Anterior superior alveolar nerve</td>
<td>Arises in the pterygopalatine fossa</td>
<td>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.</td>
</tr>
</tbody>
</table>

![Diagram of the maxillary sinus and its nerve supply](image)

- Ophthalmic nerve (V₁)
- Trigeminal (semilunar) ganglion
- Trigeminal nerve (V)
- Infraorbital nerve
- Mandibular nerve (V₃)
- Maxillary nerve (V₂)
- Pterygopalatine ganglion
- Infraorbital nerve entering infraorbital canal
- Middle superior alveolar nerve
- Anterior superior alveolar nerve
- Maxillary division of the trigeminal n.
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, V₁, V₂, and VI
- **Anterior:** nasal cavity

**Location of Ostium**

Sphenoethmoidal recess

**Coronal section through cavernous sinus**
Sphenoid Sinus

ARTERIAL SUPPLY

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

Branch of posterior ethmoidal a. supplying the sphenoidal sinus

Branch of posterior lateral nasal a. supplying the sphenoidal sinus

Sphenopalatine a.

Posterior lateral nasal a.
## Sphenoid Sinus

### NERVE SUPPLY

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posterior ethmoid</td>
<td>Ophthalmic division of the trigeminal n.</td>
<td>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.</td>
</tr>
<tr>
<td>Orbital branch from the pterygopalatine ganglion</td>
<td>Maxillary division of the trigeminal n.</td>
<td>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.</td>
</tr>
</tbody>
</table>

![Diagram of nerve supply to the sphenoid sinus](https://via.placeholder.com/150)
Imaging of the Paranasal Sinuses

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

*Root of third maxillary molar protruding into sinus
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
Clinical Correlate

**SINUSITIS CONTINUED**

- **Structural abnormalities**
  - Allergy
  - Infection
  - Inflammation

- **Mucosal congestion**
  - Obstruction of ostiomeatal complex or sinus ostia

- **Obstruction of outflow tract**
  - Decreases mucociliary clearance, resulting in pooling of secretions

- **Anoxia in sinus**
  - Increases mucosal hypoxia, edema, and fluid leakage

- **Inflamed mucous membrane**
  - Bacterial infection of stagnant secretions causes acute sinusitis

- **Resolution of obstruction and infection**
  - Antibiotics, drainage

- **Chronic sinusitis**
  - Decreases oxygen in sinus

**PARANASAL SINUSES 337**
POTENTIAL SPREAD OF INFECTION VIA THE PARANASAL SINUSES

Direct extension
Venous spread
Arterial spread

Routes of spread of sinus infection to orbit

Pituitary gland
Oculomotor n. (III)
Trochlear n. (IV)
Abducens n. (VI)
Trigeminal n. (V)

Cross section of cavernous sinus

Anterior spread (Pott puffy tumor)
Posterior spread (epidural abscess)
Posterior spread (subdural abscess)

Cerebral and dural abscesses

Routes of intracranial spread of frontal sinusitis

Venous spread

Frontal lobe abscess

Osteomyelitis
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
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
Clinical Correlate

**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**

![Diagram of Functional Endoscopic Sinus Surgery](image)
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overview and Topographic Anatomy</td>
<td>344</td>
</tr>
<tr>
<td>External Anatomy</td>
<td>345</td>
</tr>
<tr>
<td>Boundaries of the Oral Cavity</td>
<td>350</td>
</tr>
<tr>
<td>Teeth</td>
<td>359</td>
</tr>
<tr>
<td>Vascular Supply of the Oral Cavity</td>
<td>372</td>
</tr>
<tr>
<td>Nerve Supply of the Oral Cavity</td>
<td>378</td>
</tr>
<tr>
<td>Salivary Glands</td>
<td>386</td>
</tr>
<tr>
<td>Clinical Correlates</td>
<td>392</td>
</tr>
</tbody>
</table>
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**

<table>
<thead>
<tr>
<th>Structure</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lips</td>
<td>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.</td>
</tr>
<tr>
<td>Cheek</td>
<td>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.</td>
</tr>
</tbody>
</table>
## Vascular Supply of the Lips and Cheek

<table>
<thead>
<tr>
<th>Artery</th>
<th>Source</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior labial branch of the facial</td>
<td>Facial a. off the external carotid a.</td>
<td>Supplies the structures associated with the upper lip. Provides rise to the septal branch that travels to the nasal septum</td>
</tr>
<tr>
<td>Superior labial branch of the infraorbital</td>
<td>Infraorbital a. off the maxillary a.</td>
<td>A continuation of the 3rd part of the maxillary a. Along with the inferior palpebral branch and the nasal branch.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Accompanied by the nerve and vein of the same name. Helps supply the upper lip.</td>
</tr>
<tr>
<td>Inferior labial branch of the facial</td>
<td>Facial a. off the external carotid a.</td>
<td>Supplies the structures associated with the lower lip.</td>
</tr>
<tr>
<td>Mental</td>
<td>Inferior alveolar a.</td>
<td>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</td>
</tr>
<tr>
<td>Buccal</td>
<td>Maxillary a.</td>
<td>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</td>
</tr>
</tbody>
</table>
**External Anatomy**

**VAScular Supply of the Lips and Cheek CONTINUED**

<table>
<thead>
<tr>
<th>Vein</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior labial branch of the facial</td>
<td>Drains the upper lip and joins the facial v.</td>
</tr>
<tr>
<td>Inferior labial branch of the facial</td>
<td>Drains the lower lip and joins the facial v.</td>
</tr>
<tr>
<td>Mental</td>
<td>Drains the chin and lower lip and joins the pterygoid plexus of veins</td>
</tr>
<tr>
<td>Buccal</td>
<td>Drains the cheek and joins the pterygoid plexus of veins</td>
</tr>
</tbody>
</table>
**External Anatomy**

**NERVE SUPPLY**

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buccal branch of the facial</td>
<td>Facial n.</td>
<td>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.</td>
</tr>
<tr>
<td>Mandibular branch of the facial</td>
<td></td>
<td>Arises from the cervicofacial trunk and passes anteriorly, supplying the muscles of the lower lip and chin, including the orbicularis oris m.</td>
</tr>
</tbody>
</table>

**MOTOR INNERVATION**

All muscles of facial expression are innervated by the facial n.

- Temporal branches
- Zygomatic branches
- Parotid duct
- Buccal branches
- Marginal mandibular branch
- Cervical branch
- Posterior auricular nerve
- Parotid gland
- Nerve to posterior belly of digastric muscle and to stylohyoid muscle
- Main trunk of facial nerve emerging from stylomastoid foramen

NETTER'S HEAD AND NECK ANATOMY FOR DENTISTRY
All sensory innervation to the skin of this region is supplied by the trigeminal n.

### SENSORY INNERVATION

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior labial branch of the infraorbital</td>
<td>Infraorbital n. (a continuation of the maxillary division of the trigeminal n.)</td>
<td>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</td>
</tr>
<tr>
<td>Mental</td>
<td>Inferior alveolar n.</td>
<td>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</td>
</tr>
<tr>
<td>Buccal branch of the mandibular division of the trigeminal</td>
<td>Mandibular division of the trigeminal n.</td>
<td>Passes anteriorly between the 2 heads of the lateral pterygoid m. Descends inferiorly along the lower part of the temporalis m. to emerge 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</td>
</tr>
</tbody>
</table>
Boundary of the Oral Cavity

**GENERAL INFORMATION**

<table>
<thead>
<tr>
<th>Boundary</th>
<th>Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior</td>
<td>The roof is the hard palate</td>
</tr>
<tr>
<td>Posterosuperior</td>
<td>Soft palate</td>
</tr>
<tr>
<td>Lateral</td>
<td>Cheeks</td>
</tr>
<tr>
<td>Inferior</td>
<td>The floor is located along the lingual border of the mandible forming a horseshoe-shaped region</td>
</tr>
</tbody>
</table>

**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 on 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 palatine glands.
Boundaries of the Oral Cavity

SUPERIOR BORDER: HARD PALATE CONTINUED

Incisive papilla
Transverse palatine folds
Palatine raphe
Palatine process of maxilla
Palatine glands
Horizontal plate of palatine bone
Palatine aponeurosis (from tensor veli palatini muscle)
Uvular muscle
Molar minor salivary glands
Palatopharyngeus muscle
Palatine tonsil

Incisive fossa
Greater palatine artery and nerve
Greater palatine foramen
Lesser palatine artery and nerves
Lesser palatine foramen
Tendon of tensor veli palatini muscle
Pterygoid hamulus
Interdigitating fibers of levator veli palatini muscle
Buccinator muscle
Pterygomandibular raphe
Superior pharyngeal constrictor muscle
Palatoglossus muscle

Incisive fossa
Central incisors
Lateral incisors
Canines
1st premolars
2nd premolars
1st molars
2nd molars
3rd molars
Greater and lesser palatine foramina

Anterior view

Upper permanent teeth
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.
### Boundaries of the Oral Cavity

**POSTEROSUPERIOR BORDER: SOFT PALATE  CONTINUED**

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

POSTEROSUPERIOR BORDER: SOFT PALATE

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

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

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

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

Posterior view
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

### INFERIOR BORDER: FLOOR OF THE ORAL CAVITY

<table>
<thead>
<tr>
<th>Structure</th>
<th>Comments</th>
</tr>
</thead>
</table>
| 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**

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Actions</th>
<th>Nerve Supply</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mylohyoid</td>
<td>Mylohyoid line of the mandible</td>
<td>Symphysis of the mylohyoid</td>
<td>Raises the floor of the oral cavity</td>
<td>Mylohyoid n. from the inferior alveolar branch of the mandibular division of the trigeminal n.</td>
<td>Forms the sling of the oral cavity</td>
</tr>
<tr>
<td>Geniohyoid</td>
<td>Inferior genial tubercle</td>
<td>Body of the hyoid bone</td>
<td>Elevates the hyoid bone</td>
<td>C1 ventral ramus, which follows the hypoglossal n.</td>
<td>Superior to the mylohyoid m.</td>
</tr>
</tbody>
</table>

---

**Posterosuperior view**

- Lingual nerve
- Sublingual gland
- Inferior alveolar nerve and artery
- Mylohyoid nerve and artery
- Submandibular gland and duct
- Mylohyoid muscle
- Geniohyoid muscle
- Hyoid bone

- Lesser horn
- Body
- Greater horn

- Hyoglossus muscle (cut)
- Superior mental spine for origin of genioglossus muscle

**Frontal section behind 1st molar tooth (anterior view)**

- Buccinator muscle
- Muscles of facial expression
- Genioglossus muscle
- Sublingual salivary gland
- Submandibular duct

- Lingual nerve
- Nerve to mylohyoid

- Lingual artery
- Facial artery
- Hypoglossal nerve (XII)

- Mylohyoid muscle
- Facial vein

- Hyoid bone
Boundaries of the Oral Cavity

INFERIOR BORDER: FLOOR OF THE ORAL CAVITY CONTINUED

- Frenulum of upper lip
- Lingual minor salivary gland
- Deep lingual artery and veins and lingual nerve
- Fimbriated fold
- Submandibular duct
- Sublingual gland
- Frenulum of tongue
- Sublingual fold with openings of sublingual ducts
- Sublingual caruncle with opening of submandibular duct
- Frenulum of lower lip
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 $I_2 \overline{C}_1 \overline{M}_2$, 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 $I_2 \overline{C}_1 \overline{P}_2 \overline{M}_3$, 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

<table>
<thead>
<tr>
<th>Surface</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labial</td>
<td>The surface of the anterior teeth that is closest to the lip</td>
</tr>
<tr>
<td>Buccal</td>
<td>The surface of the posterior teeth that is closest to the cheek</td>
</tr>
<tr>
<td>Facial</td>
<td>Used as a synonym for labial or buccal</td>
</tr>
<tr>
<td>Lingual</td>
<td>Opposite the tongue in the mandibular arch and opposite the hard palate of the maxillary arch</td>
</tr>
<tr>
<td>Mesial</td>
<td>Closest to the midline of the dental arch</td>
</tr>
<tr>
<td>Distal</td>
<td>Farthest from the midline of the dental arch</td>
</tr>
<tr>
<td>Occlusal</td>
<td>Used for chewing in posterior teeth</td>
</tr>
<tr>
<td>Incisal</td>
<td>The cutting edge of anterior teeth</td>
</tr>
</tbody>
</table>
**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**

<table>
<thead>
<tr>
<th>Structure</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cervical line</td>
<td>The anatomic demarcation between the crown and the root. It often is termed the cementoenamel junction (CEJ).</td>
</tr>
<tr>
<td>Enamel</td>
<td>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.</td>
</tr>
<tr>
<td>Cementum</td>
<td>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.</td>
</tr>
<tr>
<td>Dentin</td>
<td>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.</td>
</tr>
<tr>
<td>Cusp</td>
<td>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.</td>
</tr>
<tr>
<td>Pulp cavity</td>
<td>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.</td>
</tr>
<tr>
<td>Cingulum</td>
<td>A convex elevation that is located on the lingual surface of the crowns of anterior teeth just incisal to the CEJ.</td>
</tr>
</tbody>
</table>
# Teeth

## TYPES OF TEETH IN THE PERMANENT DENTITION

<table>
<thead>
<tr>
<th>Tooth</th>
<th>Crown</th>
<th>Surfaces</th>
<th>Root(s)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MAXILLARY INCISORS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Central incisor</td>
<td>The widest of all of the anterior teeth, nearly as wide as it is long Cingulum: well-developed</td>
<td>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</td>
<td>1 conical root that is triangular in cross section</td>
<td>Incisors are cutting teeth</td>
</tr>
<tr>
<td>Lateral incisor</td>
<td>More narrow than the central incisor in a mesial-to-distal measurement</td>
<td>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</td>
<td>One conical root that is oval in cross section</td>
<td></td>
</tr>
</tbody>
</table>

| **MAXILLARY CANINE** |         |                                                                          |                          |                                                                          |
| 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 |
Teeth

TYPES OF TEETH IN THE PERMANENT DENTITION CONTINUED

Maxillary central incisor (right side)

Maxillary lateral incisor (right side)
Teeth

**TYPES OF TEETH IN THE PERMANENT DENTITION CONTINUED**

<table>
<thead>
<tr>
<th>Tooth</th>
<th>Crown</th>
<th>Surfaces</th>
<th>Root(s)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st premolar</td>
<td>Shorter than the anterior teeth Wider in a facial-lingual dimension than in a mesial-distal dimension</td>
<td>Has a lingual and a facial cusp&lt;br&gt;&lt;br&gt;<strong>Facial surface:</strong> convex&lt;br&gt;<strong>Facial cusp:</strong> long and similar in appearance to the cusp of the canine&lt;br&gt;<strong>Lingual cusp:</strong> shorter than the facial cusp and positioned mesial of the mesial distal midline&lt;br&gt;Displays a mesial marginal developmental groove</td>
<td>Usually 2 roots—a facial and a lingual root</td>
<td>Often referred to as bicuspids, teeth, but a more accepted designation would be premolar teeth&lt;br&gt;Prehensile tooth</td>
</tr>
<tr>
<td>2nd premolar</td>
<td>Not as angular in shape as the 1st premolar</td>
<td><strong>Facial surface:</strong> convex&lt;br&gt;Has a lingual and a facial cusp&lt;br&gt;● <strong>Facial cusp:</strong> not as sharp as the facial cusp of the 1st premolar&lt;br&gt;● <strong>Lingual cusp:</strong> nearly equal in size and similar in shape to the facial cusp</td>
<td>Usually 1 root</td>
<td>Occlusal surface contains supplemental grooves, which gives it a wrinkled appearance&lt;br&gt;Supplements the molars in function</td>
</tr>
</tbody>
</table>
Teeth

TYPES OF TEETH IN THE PERMANENT DENTITION CONTINUED

Occlusal view

Maxillary 1st premolar (right side)

Buccal view

Lingual view

Occlusal view

Maxillary 2nd premolar (right side)

Buccal view

Lingual view
### Teeth

**Types of Teeth in the Permanent Dentition**

<table>
<thead>
<tr>
<th>MAXILLARY MOLARS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tooth</td>
</tr>
<tr>
<td>---</td>
</tr>
</tbody>
</table>
| **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**

<table>
<thead>
<tr>
<th>MANDIBULAR CANINE</th>
<th>Tooth</th>
<th>Crown</th>
<th>Surfaces</th>
<th>Root(s)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canine</td>
<td>Longer than the maxillary canine</td>
<td><em>Cingulum:</em> not as prominent as on the maxillary canine</td>
<td><em>Incisal edge:</em> rounded into a cusp</td>
<td>1 long and conical root</td>
<td>Also called cuspids. Smaller and more symmetrical than the maxillary canine</td>
</tr>
</tbody>
</table>

*Canine* is longer than the maxillary canine. *Cingulum* is not as prominent as on the maxillary canine. *Incisal edge* is rounded into a cusp. *Mamelons* are not usually located on canine teeth. *Mesial surface of crown and root* is relatively straight, without much convexity.
## Teeth

### TYPES OF TEETH IN THE PERMANENT DENTITION  CONTINUED

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

**Mandibular Incisors**

![Incisal view](image1.png)

![Labial view](image2.png)

![Lingual view](image3.png)

*Mandibular central incisor (right side)*

![Incisal view](image4.png)

![Labial view](image5.png)

![Lingual view](image6.png)

*Mandibular lateral incisor (right side)*
Mandibular canines (right side)

### MANDIBULAR PREMOLARS

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

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

TYPES OF TEETH IN THE PERMANENT DENTITION CONTINUED

- Mandibular 1st molar (right side)
- Mandibular 2nd molar (right side)
- Mandibular 3rd molar (right side)
### Vascular Supply of the Oral Cavity

#### Arterial Supply

**Arterial Supply of the Palate**

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

**ARTERIAL SUPPLY CONTINUED**

- Sphenopalatine artery
- Infraorbital artery
- Posterior superior alveolar artery
- Artery of pterygoid canal
- Pharyngeal artery
- Sphenopalatine foramen
- Accessory meningeal artery
- Middle meningeal artery
- Auriculo-temporal nerve
- Superficial temporal artery
- Ascending pharyngeal artery
- Tonsillar branches
- Tonsillar artery
- External carotid artery
- Facial artery
- Descending palatine artery in pterygo-palatine fossa
- Anastomosis in incisive canal
- Left and right greater palatine arteries
- Left and right lesser palatine arteries
- Maxillary artery
- Ascending pharyngeal artery
- Ascending palatine artery
- Facial artery
- Lingual artery
- Ascending pharyngeal artery
### Vascular Supply of the Oral Cavity

**ARTERIAL SUPPLY CONTINUED**

<table>
<thead>
<tr>
<th>Artery</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facial</td>
<td>External carotid a.</td>
<td>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.</td>
</tr>
<tr>
<td>Ascending palatine</td>
<td>Facial a.</td>
<td>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.</td>
</tr>
<tr>
<td>Submental</td>
<td>Facial a.</td>
<td>Arises in the submandibular triangle of the neck. Supplies the submandibular gland and surrounding muscles</td>
</tr>
<tr>
<td>Lingual</td>
<td>External carotid a.</td>
<td>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.</td>
</tr>
</tbody>
</table>
### Vascular Supply of the Oral Cavity

**ARTERIAL SUPPLY** CONTINUED

#### ARTERIAL SUPPLY OF THE MAXILLARY AND MANDIBULAR TEETH

<table>
<thead>
<tr>
<th>Artery</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maxillary</td>
<td>External carotid a.</td>
<td>Gives rise to 3 branches that form a plexus to supply the maxillary arch:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Anterior superior alveolar</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Middle superior alveolar</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Posterior superior alveolar</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gives rise to 1 branch that supplies the mandibular arch:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Inferior alveolar</td>
</tr>
</tbody>
</table>

#### MAXILLARY TEETH

<table>
<thead>
<tr>
<th>Anterior superior alveolar</th>
<th>Infraorbital a. (of the maxillary a.)</th>
<th>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.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Middle superior alveolar</td>
<td>Infraorbital a.</td>
<td>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.</td>
</tr>
<tr>
<td>Posterior superior alveolar</td>
<td>3rd part of the maxillary a.</td>
<td>Arises before the maxillary a. enters the pterygopalatine fossa. Enters the infratemporal surface of the maxilla to supply the maxillary sinus, premolars, and molars.</td>
</tr>
</tbody>
</table>

#### MANDIBULAR TEETH

<table>
<thead>
<tr>
<th>Inferior alveolar</th>
<th>3rd part of the maxillary a.</th>
<th>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.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mental</td>
<td>Inferior alveolar a.</td>
<td>Supplies the labial gingiva of the anterior teeth.</td>
</tr>
<tr>
<td>Incisive</td>
<td>Inferior alveolar a.</td>
<td>Supplies the anterior teeth.</td>
</tr>
</tbody>
</table>
Vascular Supply of the Oral Cavity

**ARTERIAL SUPPLY CONTINUED**

![Diagram of vascular supply of the oral cavity]

**VENOUS DRAINAGE OF THE ORAL CAVITY**

<table>
<thead>
<tr>
<th>Vein</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greater palatine</td>
<td>Connect to the pterygoid plexus</td>
</tr>
<tr>
<td>Lesser palatine</td>
<td></td>
</tr>
<tr>
<td>Sphenopalatine</td>
<td></td>
</tr>
<tr>
<td>Lingual</td>
<td>Receives tributaries from the deep lingual v. on the ventral surface,</td>
</tr>
<tr>
<td></td>
<td>and dorsal lingual v. from the dorsal surface of the tongue</td>
</tr>
<tr>
<td></td>
<td>Passes with the lingual a., deep to the hyoglossus m., and ends in the</td>
</tr>
<tr>
<td></td>
<td>internal jugular v.</td>
</tr>
<tr>
<td></td>
<td>The vena comitans nervi hypoglossi, or accompanying vein of the hypoglo</td>
</tr>
<tr>
<td></td>
<td>ssi 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.</td>
</tr>
<tr>
<td>Submental</td>
<td>Anastomoses with the branches of the lingual v. and the inferior alveolar v.</td>
</tr>
<tr>
<td></td>
<td>Parallels the submental a. on the superficial surface of the mylohyoid m.</td>
</tr>
<tr>
<td></td>
<td>Ends in the facial v.</td>
</tr>
<tr>
<td>Pharyngeal plexus</td>
<td>Located along the lateral pterygoid m.</td>
</tr>
<tr>
<td></td>
<td>Most of the vessels in the infratemporal fossa and oral cavity drain into the pterygoid plexus</td>
</tr>
<tr>
<td></td>
<td>Connected to the cavernous sinus, the pterygoid plexus of veins, and the facial v. Valvesless</td>
</tr>
<tr>
<td></td>
<td>Eventually drains into the maxillary v.</td>
</tr>
</tbody>
</table>

**VENOUS DRAINAGE OF THE TEETH**

<table>
<thead>
<tr>
<th>Vein</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior superior alveolar</td>
<td>Drain onto the pterygoid plexus of veins</td>
</tr>
<tr>
<td>Middle superior alveolar</td>
<td></td>
</tr>
<tr>
<td>Posterior superior alveolar</td>
<td></td>
</tr>
<tr>
<td>Inferior alveolar</td>
<td></td>
</tr>
</tbody>
</table>
Vascular Supply of the Oral Cavity

VENOUS DRAINAGE OF THE ORAL CAVITY CONTINUED

- Emissary vein (Vesalius) communicating with cavernous sinus
- Posterior superior alveolar veins
- Palatine vein
- Maxillary veins
- Facial vein
- Submental vein
- Inferior alveolar vein and artery
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

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
</table>
| 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 |
Nerve Supply of the Oral Cavity

**SENSORY INNERVATION OF THE MANDIBULAR TEETH**

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mandibular</td>
<td>Trigeminal n.</td>
<td>This division has motor function in addition to sensory function</td>
</tr>
<tr>
<td></td>
<td></td>
<td>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</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Immediately gives rise to a meningeal branch and divides into an anterior and a posterior division</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Anterior division is smaller and mainly motor, with 1 sensory branch (buccal):</td>
</tr>
<tr>
<td></td>
<td></td>
<td>● Masseteric</td>
</tr>
<tr>
<td></td>
<td></td>
<td>● Anterior and posterior deep temporal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>● Medial pterygoid</td>
</tr>
<tr>
<td></td>
<td></td>
<td>● Lateral pterygoid</td>
</tr>
<tr>
<td></td>
<td></td>
<td>● Buccal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Posterior division is larger and mainly sensory, with 1 motor branch (mylohyoid):</td>
</tr>
<tr>
<td></td>
<td></td>
<td>● Auriculotemporal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>● Lingual</td>
</tr>
<tr>
<td></td>
<td></td>
<td>● Inferior alveolar</td>
</tr>
<tr>
<td></td>
<td></td>
<td>● Mylohyoid</td>
</tr>
<tr>
<td>Inferior alveolar</td>
<td>The largest branch of the mandibular division</td>
<td>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)</td>
</tr>
<tr>
<td>Mental</td>
<td>Inferior alveolar n.</td>
<td>Supplies the chin, lip, and facial gingiva and mucosa from the 2nd premolar anteriorly</td>
</tr>
<tr>
<td>Incisive</td>
<td></td>
<td>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.)</td>
</tr>
</tbody>
</table>
Nerve Supply of the Oral Cavity

SENSORY INNERVATION OF THE MANDIBULAR TEETH CONTINUED
### Nerve Supply of the Oral Cavity

#### FLOOR OF THE ORAL CAVITY

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lingual</td>
<td>Mandibular division of the trigeminal n.</td>
<td>Lies inferior to the lateral pterygoid and medial n. 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</td>
</tr>
<tr>
<td>Glossopharyngeal</td>
<td>Medulla oblongata</td>
<td>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</td>
</tr>
<tr>
<td>Internal laryngeal</td>
<td>Superior laryngeal branch of the vagus n.</td>
<td>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</td>
</tr>
</tbody>
</table>
Nerve Supply of the Oral Cavity

FLOOR OF THE ORAL CAVITY CONTINUED

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

Trigeminal nerve (V)
Glossopharyngeal nerve (IX)
Vagus nerve (X)
Facial nerve (VII)

Glossopharyngeal (IX)
Via pharyngeal plexus
Via tonsillar branches
Taste plus general sensation via lingual branches

Vagus (X)
Via internal branch of superior laryngeal nerve

Facial (VII) (intermediate nerve)
Taste via chorda tympani and lingual nerve

Trigeminal (V) (mandibular V3)
Via lingual nerve
## Nerve Supply of the Oral Cavity

### PALATE

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
</table>
| 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**

- **Maxillary nerve (V2)** (sphenopalatine foramen dissected away)
- **Pterygopalatine ganglion**
- **Greater petrosal nerve**
- **Nerve (Vidian) of pterygoid canal**
- **Nasopalatine nerve (V2) passing to septum (cut)**
- **Lateral wall of nasal cavity**
- **Palatine nerves (V2)**: Greater, Lesser
- **Olfactory nerves (I)**
- **Nasopalatine nerve (V2)**
- **Nasal septum**
- **Trigeminal nerve (V)**
- **Glossopharyngeal nerve (IX)**
- **Vagus nerve (X)**
- **Facial nerve (VII)**

**Trigeminal nerve (V) (maxillary V2)**
- Via superior alveolar nerves
- Via pterygopalatine ganglion and nasopalatine and greater and lesser palatine nerves

**Glossopharyngeal (IX)**
- Via pharyngeal plexus
- Via tonsillar branches
- Taste plus general sensation via lingual branches

**Vagus (X)**
- Via internal branch of superior laryngeal nerve

**Facial (VII) (intermediate nerve)**
- Via greater petrosal nerve, pterygopalatine ganglion and greater and lesser palatine nerves
**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
### FEATURES OF THE MAJOR SALIVARY GLANDS

<table>
<thead>
<tr>
<th>Gland</th>
<th>Duct</th>
<th>Comment</th>
<th>Autonomic Innervation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parotid</td>
<td>Parotid duct (Stensen’s duct)</td>
<td>The largest salivary gland</td>
<td>Glossopharyngeal n.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>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</td>
<td></td>
</tr>
<tr>
<td>Submandibular</td>
<td>Submandibular duct (Wharton’s duct)</td>
<td>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 n. 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</td>
<td>Facial n.</td>
</tr>
<tr>
<td>Sublingual</td>
<td>Numerous small ducts opening along the sublingual fold</td>
<td>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</td>
<td></td>
</tr>
</tbody>
</table>
Salivary Glands

GENERAL INFORMATION CONTINUED

Food particles progressively reduced in size and mixed with saliva. Tongue aids in mixing process.

Saliva entering mouth

Incisor teeth (cutting action)

Bicuspid and molar teeth (grinding action)

Sublingual gland

Submandibular gland

Parotid gland

Aromatic substances released from food

From teeth and palate

To muscles of mastication

From back of tongue

Afferents “report” on character of food and progress of mastication,

Proprioceptive fibers “report” on pressure

AUTONOMICS OF THE SALIVARY GLANDS

<table>
<thead>
<tr>
<th>Type of Neuron</th>
<th>Name of Cell Body</th>
<th>Characteristics of the Cell Body</th>
<th>Course of the Neuron</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preganglionic neuron</td>
<td>Inferior salivatory nucleus</td>
<td>A collection of nerve cell bodies located in the medulla</td>
<td>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.</td>
</tr>
<tr>
<td>Postganglionic neuron</td>
<td>Otic ganglion</td>
<td>A collection of nerve cell bodies located inferior to the foramen ovale, medial to the mandibular division of the trigeminal</td>
<td>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</td>
</tr>
</tbody>
</table>
Salivary Glands

AUTONOMICS OF THE SALIVARY GLANDS CONTINUED

- Mandibular nerve (V3)
- Trigeminal ganglion
- Lesser petrosal nerve
- Chorda tympani nerve
- Trigeminal nerve (V)
- Facial nerve (VII)
- Glossopharyngeal nerve (IX)
- Inferior salivatory nucleus
- Pons
- Otic ganglion
- Ophthalmic nerve (V1)
- Maxillary nerve (V2)
- Auriculotemporal nerve
- Superficial temporal artery
- Maxillary artery
- Inferior alveolar nerve
- Lingual nerve
- External carotid artery
- Internal carotid artery
- Common carotid artery
- Medulla oblongata
- Tympanic plexus
- Sympathetic presynaptic fibers
- Sympathetic postsynaptic fibers
- Parasympathetic presynaptic fibers
- Parasympathetic postsynaptic fibers

- Sympathetic presynaptic fibers
- Sympathetic postsynaptic fibers
- Parasympathetic presynaptic fibers
- Parasympathetic postsynaptic fibers

- Superior cervical sympathetic ganglion
- Sympathetic trunk
- T1 and T2 spinal nerves
- Thoracic spinal cord
- Dorsal root
- Sympathetic presynaptic cell bodies in intermediolateral nucleus (lateral horn) of gray matter
### PARASYMPATHETICS OF THE SUBMANDIBULAR, SUBLINGUAL, AND MINOR SALIVARY GLANDS

<table>
<thead>
<tr>
<th>Type of Neuron</th>
<th>Name of Cell Body</th>
<th>Characteristics of the Cell Body</th>
<th>Course of the Neuron</th>
</tr>
</thead>
</table>
| 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  
  - Preganglionic 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 |
Salivary Glands

AUTONOMICS OF THE SALIVARY GLANDS CONTINUED

Sympathetic presynaptic fibers
Sympathetic postsynaptic fibers
Parasympathetic presynaptic fibers
Parasympathetic postsynaptic fibers
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.
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

**MUOCOELE**

_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
**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)
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overview and Topographic Anatomy</td>
<td>400</td>
</tr>
<tr>
<td>Gross Anatomy</td>
<td>402</td>
</tr>
<tr>
<td>Muscles</td>
<td>405</td>
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<tr>
<td>Nerve Supply</td>
<td>408</td>
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<tr>
<td>Vascular Supply</td>
<td>414</td>
</tr>
<tr>
<td>Clinical Correlates</td>
<td>417</td>
</tr>
</tbody>
</table>
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
Overview and Topographic Anatomy

GENERAL INFORMATION CONTINUED

Fissured tongue

Hairy tongue

Geographic tongue
### Oral portion
- **Description**: Occupies tongue’s anterior 2/3
- **Comments**: Covered with keratinized stratified squamous epithelium

### Pharyngeal portion
- **Description**: Occupies tongue’s posterior 1/3
- **Comments**: Covered with nonkeratinized stratified squamous epithelium

### Sulcus terminalis
- **Description**: A V-shaped groove immediately posterior to the circumvallate papillae
- **Comments**: Demarcates junction between the oral and pharyngeal portions

### Foramen cecum
- **Description**: The initial developmental site for the thyroid gland
- **Comments**: Located at the angle of the V

### Midline septum
- **Description**: Fibrous
- **Comments**: Divides tongue into halves

### Lingual tonsils
- **Description**: Large nodules of lymphatic tissue
- **Comments**: Cover the pharyngeal surface of the tongue

### Types of papillae on the tongue’s oral portion

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filiform</td>
<td>Most numerous but lack taste buds</td>
<td></td>
</tr>
<tr>
<td>Fungiform</td>
<td>Scattered throughout the dorsum of the tongue</td>
<td></td>
</tr>
<tr>
<td>Foliate</td>
<td>Fairly rudimentary in humans</td>
<td></td>
</tr>
<tr>
<td>Circumvallate</td>
<td>Have taste buds</td>
<td>Lie in a row immediately anterior to the sulcus terminalis</td>
</tr>
</tbody>
</table>

### Glossoepiglottic folds
- **Description**: Mucous membranes
- **Comments**: Connect the posterior portion of the pharyngeal part of the tongue with the epiglottis of the larynx

### Palatoglossal arches
- **Description**: Pass from the soft palate to the lateral aspects of the tongue
- **Comments**: Also known as the anterior pillar of the fauces

### Glands
- **Description**: Mucous and serous
- **Comments**: Numerous
Gross Anatomy

**DORSAL SURFACE CONTINUED**

- Epiglottis
- Median glossoepiglottic fold
- Lateral glossoepiglottic fold
- Vallecula
- Palatopharyngeal arch and muscle (cut)
- Palatine tonsil (cut)
- Palatoglossal arch and muscle (cut)
- Foramen cecum
- Terminal sulcus
- Valuate papillae
- Foliate papillae
- Filiform papillae
- Fungiform papilla
- Midline groove (median sulcus)

**VENTRAL SURFACE**

<table>
<thead>
<tr>
<th>Structure</th>
<th>Description</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epithelium</td>
<td>Nonkeratinized stratified squamous</td>
<td>Covers ventral surface</td>
</tr>
<tr>
<td>Lingual frenulum</td>
<td>A midline fold</td>
<td>Connects the ventral surface of the tongue to the floor of the oral cavity</td>
</tr>
<tr>
<td>Sublingual papilla</td>
<td>A swelling on both sides of the lingual frenulum at the tongue base</td>
<td>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</td>
</tr>
<tr>
<td>Plica fimbriata</td>
<td>Fimbriated folds</td>
<td>Lateral to the lingual frenulum</td>
</tr>
<tr>
<td>Deep lingual veins</td>
<td>(See table on Venous Drainage later on)</td>
<td>Can be observed through the mucosa between the plica fimbriata and the lingual frenulum</td>
</tr>
</tbody>
</table>
Frenulum of lower lip
Fimbriated fold
Submandibular duct
Sublingual gland
Frenulum of tongue
Frenulum of upper lip
Lingual minor salivary gland
Deep lingual artery and veins and lingual nerve
Fimbriated fold
Submandibular duct
Sublingual gland
Frenulum of tongue
Sublingual fold with openings of sublingual ducts
Sublingual caruncle with opening of submandibular duct
Frenulum of lower lip
## EXTRINSIC TONGUE MUSCLES

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Actions</th>
<th>Nerve</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genioglos-</td>
<td>Superior genial tubercle of the mandible</td>
<td>Fibers fan into the tongue substance</td>
<td>Protracts</td>
<td>Hypoglossal n.</td>
<td>The lingual a. is located between the genioglossus and hyoglossus mm.</td>
</tr>
<tr>
<td>sus</td>
<td></td>
<td>Some fibers insert into the body of the hyoid</td>
<td>Depresses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hyoglos-</td>
<td>Greater and lesser cornu and body of the hyoid</td>
<td>Side of the tongue where fibers mix with the styloglossus m.</td>
<td>Depresses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>sus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Styloglos-</td>
<td>Tip of styloid process</td>
<td>Side of the tongue where fibers mix with the hyoglossus m.</td>
<td>Retracts</td>
<td></td>
<td>Smallest of the extrinsic tongue muscles</td>
</tr>
<tr>
<td>sus</td>
<td></td>
<td></td>
<td>Elevates</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Palatoglos-</td>
<td>Palatine aponeurosis</td>
<td>Side of the tongue where fibers mix with the intrinsic muscle</td>
<td>Elevates</td>
<td>Pharyngeal plexus (motor portion from the vagus n. and cranial part of the accessory n.)</td>
<td>Grouped as either an extrinsic tongue muscle or a muscle of the soft palate</td>
</tr>
<tr>
<td>sus</td>
<td></td>
<td></td>
<td>Narrows the oropharyngeal isthmus for deglutition</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Notes
- **Genioglossus**
  - Muscle Origin: Superior genial tubercle of the mandible
  - Actions: Fibers fan into the tongue substance, Some fibers insert into the body of the hyoid
  - Nerve: Hypoglossal n.
  - Comment: The lingual a. is located between the genioglossus and hyoglossus mm.

- **Hyoglossus**
  - Muscle Origin: Greater and lesser cornu and body of the hyoid
  - Actions: Depresses
  - Nerve: Hypoglossal n.
  - Comment: The lingual n., hypoglossal n., and submandibular duct are located on the lateral surface of the hyoglossus m.

- **Styloglossus**
  - Muscle Origin: Tip of styloid process
  - Actions: Retracts
  - Nerve: Hypoglossal n.
  - Comment: Smallest of the extrinsic tongue muscles

- **Palatoglossus**
  - Muscle Origin: Palatine aponeurosis
  - Actions: Elevates, Narrows the oropharyngeal isthmus for deglutition
  - Nerve: Pharyngeal plexus (motor portion from the vagus n. and cranial part of the accessory n.)
  - Comment: Grouped as either an extrinsic tongue muscle or a muscle of the soft palate
### Muscles

#### EXTRINSIC TONGUE MUSCLES CONTINUED

![Diagram of extrinsic tongue muscles](image)

#### INTRINSIC TONGUE MUSCLES

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Actions</th>
<th>Nerve</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior longitudinal</td>
<td>Median fibrous septum Submucous layer near epiglottis</td>
<td>Submucosa along edges of the tongue</td>
<td>Shortens Curls the tongue's apex upward</td>
<td>Hypoglossal n.</td>
<td>Located immediately deep to the mucus membrane of the tongue's dorsal surface</td>
</tr>
<tr>
<td>Inferior longitudinal</td>
<td>Root of the tongue Body of the hyoid</td>
<td>Submucosa at the apex of the tongue</td>
<td>Shortens Curls the tongue's apex downward</td>
<td></td>
<td>Runs the length of the tongue between the hyoglossus and genioglossus mm.</td>
</tr>
<tr>
<td>Transverse</td>
<td>Median fibrous septum</td>
<td>Fibrous tissue in the submucosa of the sides of the tongue</td>
<td>Narrows Lengthens</td>
<td></td>
<td>Runs the width of the tongue</td>
</tr>
<tr>
<td>Vertical</td>
<td>Submucosa of upper layer of tongue</td>
<td>Submucosa of lower layer of tongue</td>
<td>Broadens Flattens</td>
<td></td>
<td>Runs from the superior to the inferior tongue surface</td>
</tr>
</tbody>
</table>
Superior longitudinal muscle
Vertical and transverse muscles
Inferior longitudinal muscle
Styloglossus muscle
Buccinator muscle
Muscles of facial expression
Hyoglossus muscle
Genioglossus muscle
Mandibular canal, inferior alveolar artery, vein, and nerve
Lingual nerve
Nerve to mylohyoid
Vena comitans of hypoglossal nerve (to lingual vein)
Lingual artery
Hypoglossal nerve (XII)
Submandibular salivary gland
Mylohyoid muscle

Frontal section behind 1st molar tooth (anterior view) demonstrating beds of sublingual and submandibular glands
### Types of Sensory Nerve Supply

<table>
<thead>
<tr>
<th>Type</th>
<th>Function</th>
<th>Nerves</th>
</tr>
</thead>
<tbody>
<tr>
<td>General somatic afferent (GSA)</td>
<td>Pain, temperature, discriminative touch</td>
<td>Trigeminal (via lingual), glossopharyngeal, and vagus (via internal laryngeal), to innervate the epithelium and mucosa</td>
</tr>
<tr>
<td>Special visceral afferent (SVA)</td>
<td>Taste</td>
<td>Facial (via chorda tympani), glossopharyngeal, and vagus (via internal laryngeal), to innervate the taste buds</td>
</tr>
</tbody>
</table>

---

**Figure:**

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

**TONGUE**

- **Trigeminal nerve (V)**
  - Via lingual nerve
  - Supplies GSA fibers to the epithelium and papillae of the tongue's anterior 2/3, mucosa along the floor of the oral cavity (linguovallar ridge), and gingiva on the lingual aspect of the mandibular teeth

- **Facial nerve (VII)**
  - Via chorda tympani and lingual nerve

- **Glossopharyngeal nerve (IX)**
  - Via pharyngeal plexus
  - Via tonsillar branches
  - Taste plus general sensation via lingual branches

- **Vagus nerve (X)**
  - Via internal branch of superior laryngeal nerve

**GENERAL SENSORY INNERVATION**

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
</table>
| 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 (linguovallar ridge), and gingiva on the lingual aspect of the mandibular teeth |
### Nerve Supply

**SENSORY INNERVATION CONTINUED**

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

---

![Image of the head and neck anatomy with labeled nerves](image-url)
## SPECIAL SENSORY INNERVATION

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chorda tympani</td>
<td>Facial n. in the tympanic cavity</td>
<td>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.</td>
</tr>
<tr>
<td>Glossopharyngeal</td>
<td>Arises as a cranial nerve from the medulla oblongata</td>
<td>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.</td>
</tr>
<tr>
<td>Internal laryngeal</td>
<td>Superior laryngeal branch of the vagus n.</td>
<td>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.</td>
</tr>
</tbody>
</table>
### MOTOR INNERVATION

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypoglossal</td>
<td>Arises as a series of rootlets from the medulla oblongata and passes through the hypoglossal canal</td>
<td>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</td>
</tr>
<tr>
<td>Pharyngeal plexus</td>
<td>The motor part of the pharyngeal plexus arises from the pharyngeal branch of the vagus n. and the cranial part of the accessory n.</td>
<td>In the tongue, it innervates the palatoglossus m.</td>
</tr>
<tr>
<td>Pharyngeal branch of the vagus</td>
<td>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.</td>
<td>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.)</td>
</tr>
<tr>
<td>Cranial part of the spinal accessory n.</td>
<td>Emerges as 4 or 5 branches just inferior to the vagus n.’s roots</td>
<td>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</td>
</tr>
</tbody>
</table>
Nerve Supply

Intrinsic muscles of tongue

Superior longitudinal
Transverse and vertical
Inferior longitudinal

Styloglossus muscle

Inferior ganglion of vagus nerve

Hypoglossal nucleus

Hypoglossal nerve (XII) (in hypoglossal canal)

Meningeal branch

Occipital condyle

Inferior root of ansa cervicalis

Superior root of ansa cervicalis

Superior cervical sympathetic ganglion

Ventral rami of C1, 2, 3 form ansa cervicalis of cervical plexus

Sternothyroid muscle

Sternohyoid muscle

Omohyoid muscle (superior belly)

Thyrohyoid muscle

Genioglossus muscle

Geniohyoid muscle

Hyoglossus muscle

Omohyoid muscle (inferior belly)

Common carotid artery

Internal carotid artery

Internal jugular vein

Ventral rami of C1, 2, 3 form ansa cervicalis of cervical plexus

Superior cervical sympathetic ganglion

Inferior ganglion of vagus nerve

Hypoglossal nucleus

Meningeal branch

Occipital condyle

Inferior root of ansa cervicalis

Superior root of ansa cervicalis

Superior cervical sympathetic ganglion

Ventral rami of C1, 2, 3 form ansa cervicalis of cervical plexus

Sternothyroid muscle

Sternohyoid muscle

Omohyoid muscle (superior belly)

Thyrohyoid muscle

Genioglossus muscle

Geniohyoid muscle

Hyoglossus muscle

Omohyoid muscle (inferior belly)
**Vascular Supply**

**ARTERIAL SUPPLY**

<table>
<thead>
<tr>
<th>Artery</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lingual</td>
<td>External carotid a. within the carotid triangle</td>
<td>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 suprathyroid 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.</td>
</tr>
<tr>
<td>Submental</td>
<td>A branch of the facial a. from the external carotid a.</td>
<td>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</td>
</tr>
</tbody>
</table>

**Diagram:**
- Submandibular ganglion
- Deep lingual artery and venae comitantes
- Artery to frenulum
- Submandibular duct
- Sublingual artery and vein
- Geniohyoid muscle
- Hyoid bone
- Hypoglossal nerve
- Lingual nerve
- Superior pharyngeal constrictor muscle
- Styloglossus muscle
- Palatoglossus muscle
- Palatopharyngeus muscle
- Hyoglossus muscle (cut)
- Lingual artery
- External carotid artery
- Internal jugular vein
- Facial vein
- Common trunk for facial, retromandibular and lingual veins
- Lingual vein
- Suprathyroid artery
- Dorsal lingual artery and vein
- Vena comitans of hypoglossal nerve
Vascular Supply

**ARTERIAL SUPPLY CONTINUED**
### Vascular Supply

#### VENOUS DRAINAGE

<table>
<thead>
<tr>
<th>Vein</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lingual</td>
<td>Receives tributaries from the deep lingual v. on the ventral surface, and dorsal lingual v. 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.</td>
</tr>
<tr>
<td>Submental</td>
<td>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.</td>
</tr>
</tbody>
</table>

![Anatomical Diagram](image_url)
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)
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

Subtle weakness of tongue may be tested by asking patient to press tongue against cheek (shown) or against a tongue depressor.
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 the base of the tongue.
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.
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
Overview and Topographic Anatomy

GENERAL INFORMATION CONTINUED

PHARYNX

- Styloid process
- Digastric muscle (posterior belly)
- Stylohyoid muscle
- Stylopharyngeus muscle
- Accessory muscle bundle from petrous part of temporal bone
- Medial pterygoid muscle
- Pharyngobasilar fascia
- Pharyngeal raphe
- Superior pharyngeus constrictor muscle
- Middle pharyngeal constrictor muscle
- Epiglottis
- Inferior pharyngeal constrictor muscle
- Cuneiform tubercle
- Corniculate tubercle (Transverse and oblique arytenoid muscles)
- Posterior cricoarytenoid muscle
- Cricopharyngeal muscle (part of inferior pharyngeal constrictor)
- Longitudinal esophageal muscle
- Basilar part of occipital bone
- Pharyngeal tubercle
- Pharyngeal tonsil
- Cartilaginous part of pharyngotympanic (auditory) tube
- Pharyngobasilar fascia
- Choana
- Levator veli palatini muscle
- Superior pharyngeal constrictor muscle
- Salpingopharyngeus muscle
- Uvula
- Palatopharyngeus muscle
- Middle pharyngeal constrictor muscle
- Stylopharyngeus muscle
- Pharyngoepiglottic fold
- Aryepiglottic fold
- Interior pharyngeal constrictor muscle (cut edge)
- Longitudinal pharyngeal muscles
- Superior horn of thyroid cartilage
- Thyrohyoid membrane
- Minimal branch of superior laryngeal nerve
- Pharyngeal aponeurosis
- Cricopharyngeal muscle (part of inferior pharyngeal constrictor)
- Posterior border of thyroid cartilage
- Cricoid attachment of longitudinal esophageal muscle
- Circular esophageal muscle
### NASOPHARYNX

<table>
<thead>
<tr>
<th>Boundaries</th>
<th>Major Anatomic Features</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof—fornix</td>
<td>Ostium of the auditory tube opens into the nasopharynx</td>
<td>Has a respiratory function</td>
</tr>
<tr>
<td>Floor—soft palate</td>
<td>Torus tubarius is an elevation formed by the base of the cartilaginous portion of the</td>
<td>The auditory tube connects the middle ear with the nasopharynx and helps</td>
</tr>
<tr>
<td>Anterior—choanae of the</td>
<td>auditory tube, which lies superior to the ostium of the tube</td>
<td>equalize air pressure on both sides of the tympanic membrane</td>
</tr>
<tr>
<td>nasal cavity</td>
<td>Salpingopharyngeal fold is mucous membrane that lies over the salpingopharyngeus m.,</td>
<td>The cartilaginous portion of the auditory tube normally is closed,</td>
</tr>
<tr>
<td>Posterior—mucosa covering</td>
<td>connecting the torus tubarius to the lateral wall of the pharynx</td>
<td>except during deglutition and yawning</td>
</tr>
<tr>
<td>superior constrictor</td>
<td>Pharyngeal recess is located posterior to the salpingopharyngeal fold and contains the</td>
<td>The auditory tube allows spread of infections between the middle ear and</td>
</tr>
<tr>
<td>Lateral—mucosa covering</td>
<td>pharyngeal tonsils (adenoids)</td>
<td>the nasopharynx</td>
</tr>
<tr>
<td>superior</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### OROPHARYNX

<table>
<thead>
<tr>
<th>Boundaries</th>
<th>Major Anatomic Features</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior—nasopharynx</td>
<td>Palatine tonsils are located in the oropharynx between the palatoglossal and palatopharyngeal folds</td>
<td>Has a respiratory and a digestive function</td>
</tr>
<tr>
<td>Inferior—posterior 1/3 of</td>
<td>Epiglottic vallecula—the depression immediately posterior to the root of the tongue</td>
<td></td>
</tr>
<tr>
<td>the tongue</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anterior—palatoglossal fold</td>
<td></td>
<td></td>
</tr>
<tr>
<td>of the oral cavity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Posterior—mucosa covering</td>
<td></td>
<td></td>
</tr>
<tr>
<td>the superior and middle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>constrictor mm.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lateral—mucosa covering</td>
<td></td>
<td></td>
</tr>
<tr>
<td>the superior and middle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>constrictors</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### LARYNGOPHARYNX

<table>
<thead>
<tr>
<th>Boundaries</th>
<th>Major Anatomic Features</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior—oropharynx</td>
<td>Piriﬁrm recess is a small depression located on the lateral wall of the</td>
<td>Communicates with the larynx</td>
</tr>
<tr>
<td>Anterior—larynx and epiglottis</td>
<td>laryngopharyngeal cavity on either side of the entrance to the larynx</td>
<td></td>
</tr>
<tr>
<td>Posterior—mucosa covering</td>
<td></td>
<td>The piriﬁrm recess is a potential location for objects to become lodged</td>
</tr>
<tr>
<td>middle and inferior</td>
<td></td>
<td></td>
</tr>
<tr>
<td>constrictor mm.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lateral—mucosa covering</td>
<td></td>
<td></td>
</tr>
<tr>
<td>middle and inferior</td>
<td></td>
<td></td>
</tr>
<tr>
<td>constrictors</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Parts of the Pharynx

**LARYNGOPHARYNX CONTINUED**

- Choanae
- Base of skull (basilar part of occipital bone)
- Nasopharynx
- Oropharynx
- Laryngopharynx
- Nasal septum
- Torus tubarius
- Pharyngeal opening of pharyngotympanic (auditory) tube
- Pharyngeal recess
- Parotid gland
- Torus levatorius (fold caused by levator veli palatini muscle)
- Salpingopharyngeal fold
- Soft palate
- Uvula
- Palatine tonsil
- Root of tongue
- Palatopharyngeal arch
- Prominence caused by greater horn of hyoid bone
- Epiglottis
- Laryngeal inlet (aditus)
- Prominence caused by superior horn of thyroid cartilage
- Aryepiglottic fold
- Piriform fossa
- Fold over internal branch of superior laryngeal nerve
- Trachea
Muscles

**OVERVIEW**

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Actions</th>
<th>Nerve Supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior constrictor</td>
<td>Pterygoid hamulus</td>
<td>Pharyngeal tubercle</td>
<td>Constricts the upper portion of the pharynx</td>
<td>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.)</td>
</tr>
<tr>
<td></td>
<td>Pterygomandibular raphe</td>
<td>Pharyngeal raphe</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Retromolar trigone of mandible</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Side of tongue</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Middle constrictor</td>
<td>Stylohyoid lig.</td>
<td>Pharyngeal raphe</td>
<td>Constricts the middle portion of the pharynx</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lesser cornu of hyoid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Greater cornu of hyoid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inferior constrictor</td>
<td>Oblique line of thyroid cartilage</td>
<td></td>
<td>Constricts the lower portion of the pharynx</td>
<td>Pharyngeal plexus</td>
</tr>
<tr>
<td></td>
<td>Side of cricoid cartilage</td>
<td></td>
<td></td>
<td>External laryngeal n. of the vagus</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Recurrent laryngeal n. of the vagus</td>
</tr>
<tr>
<td>Palatopharyngeus</td>
<td>Posterior border of hard palate Palatine aponeurosis</td>
<td>Posterior border of the lamina of the thyroid cartilage</td>
<td>Elevates pharynx Helps close the nasopharynx</td>
<td>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.)</td>
</tr>
<tr>
<td>Salpingopharyngeus</td>
<td>Cartilage of auditory tube</td>
<td></td>
<td>Elevates the upper and lateral portions of the pharynx</td>
<td></td>
</tr>
<tr>
<td>Stylopharyngeus</td>
<td>Medial aspect of base of styloid process</td>
<td></td>
<td>Elevates pharynx</td>
<td>Glossopharyngeal n.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Expands the sides of the pharynx</td>
<td></td>
</tr>
</tbody>
</table>
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.

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

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

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

OVERVIEW CONTINUED

- Pharyngobasilar fascia
- Tensor veli palatini muscle
- Levator veli palatini muscle
- Lateral pterygoid plate
- Pterygoid hamulus
- Buccinator muscle (cut)
- Pterygomandibular raphe
- Buccinator crest of mandible
- Oblique line of mandible
- Digastric muscle (anterior belly) (cut)
- Mylohyoid muscle
- Hyoid bone
- Stylohyoid muscle (cut)
- Thyroid cartilage
- Median cricothyroid ligament
- Cricothyroid muscle
- Cricoid cartilage
- Digastric muscle (posterior belly) (cut)
- Stylohyoid muscle
- Styloglossus muscle
- Stylopharyngeus muscle
- Middle pharyngeal constrictor muscle
- Hyoglossus muscle
- Greater horn of hyoid bone
- Stylohyoid ligament
- Thyroid cartilage
- Thyrohyoid membrane
- Inferior pharyngeal constrictor muscle
- Tendinous arch
- Zone of sparse muscle fibers
- Cricopharyngeus muscle (part of inferior pharyngeal constrictor)
Muscles

OVERVIEW CONTINUED
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.

<table>
<thead>
<tr>
<th>Location</th>
<th>Anatomic Structures That Pass Through</th>
</tr>
</thead>
</table>
| 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

<table>
<thead>
<tr>
<th>Artery</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
</table>
| 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 |
Vascular Supply

**ARTERIAL SUPPLY CONTINUED**

- External carotid artery
- Internal carotid artery
- Facial artery
- Lingual artery
- Superior thyroid artery
- Superior laryngeal artery
- Common carotid artery
- Internal jugular vein
- Superior parathyroid gland
- Inferior parathyroid gland
- Inferior thyroid artery
- Right recurrent laryngeal nerve
- Transverse cervical artery
- Suprascapular artery
- Thyrocervical trunk
- Superior pharyngeal constrictor muscle
- Middle pharyngeal constrictor muscle
- Internal pharyngeal constrictor muscle
- Pharyngeal raphe
- Inferior thyroid vein
- Trachea
- Internal thoracic artery and vein
- Ventral artery
- Left recurrent laryngeal nerve
- Left vagus nerve (X)
- Right vagus nerve (X)
**Vascular Supply**

**VENOUS DRAINAGE**

<table>
<thead>
<tr>
<th>Vein</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pharyngeal plexus</td>
<td>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.</td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Function</th>
<th>Course</th>
<th>Sensory</th>
<th>Motor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pharyngeal branch of the glossopharyngeal</td>
<td>The major branch of the glossopharyngeal n. that contributes to the pharyngeal plexus. Mainly sensory, but has motor function.</td>
<td>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.</td>
<td>Sensory branches contributing to the plexus perforate the pharyngeal muscles and supply its mucous membranes (mainly oropharynx region).</td>
<td>Aids the pharyngeal branch of the vagus n. and cranial part of the spinal accessory n.</td>
</tr>
<tr>
<td>Pharyngeal branch of the vagus</td>
<td>The major branch of the vagus n. that contributes to the pharyngeal plexus. Mainly motor, but has sensory function.</td>
<td>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.).</td>
<td>Sensory branches contributing to the plexus perforate the pharyngeal muscles and supply the remainder of the pharyngeal mucous membranes.</td>
<td>Superior constrictor, middle constrictor, inferior constrictor, palatopharyngeus, salpingopharyngeus mm.</td>
</tr>
</tbody>
</table>
### Nerve Supply

#### PHARYNGEAL Plexus CONTINUED

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Function</th>
<th>Course</th>
<th>Sensory</th>
<th>Motor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cranial part of the spinal accessory</td>
<td>Contributes with the pharyngeal branch of the vagus to supply the major portion of the motor innervation of the muscles of the pharynx</td>
<td>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.</td>
<td>Aids the pharyngeal branch of the vagus n.</td>
<td></td>
</tr>
</tbody>
</table>

#### OTHER INNERVATION OF THE PHARYNX

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Function</th>
<th>Course</th>
<th>Sensory</th>
<th>Motor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recurrent laryngeal branch of the vagus</td>
<td>A small contributor to the motor innervation of the muscles of the pharynx Provides significant innervation to the larynx</td>
<td>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</td>
<td></td>
<td>Part of the inferior constrictor</td>
</tr>
<tr>
<td>Pharyngeal</td>
<td>A small sensory nerve</td>
<td>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</td>
<td>Supplies sensory fibers to the nasopharynx and the auditory tube</td>
<td></td>
</tr>
</tbody>
</table>
Nerve Supply

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.
Clinical Correlate

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 close 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 layers 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 aditus.

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 pushes 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 layers 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.
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
Cartilages

**GENERAL INFORMATION**

<table>
<thead>
<tr>
<th>Cartilage</th>
<th>Cartilage Type</th>
<th>Paired</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thyroid</td>
<td>Hyaline</td>
<td>No</td>
<td>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</td>
</tr>
<tr>
<td>Cricoid</td>
<td></td>
<td></td>
<td>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</td>
</tr>
<tr>
<td>Arytenoid</td>
<td>Yes</td>
<td></td>
<td>Forms framework of the true vocal cord</td>
</tr>
<tr>
<td>Epiglottis</td>
<td>Elastic</td>
<td>No</td>
<td>Helps prevent foreign bodies from entering the larynx</td>
</tr>
<tr>
<td>Corniculate (minor)</td>
<td></td>
<td>Yes</td>
<td>Minor cartilages that lie in the aryepiglottic fold</td>
</tr>
<tr>
<td>Cuneiform (minor)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Cartilage Locations**

- Thyroid cartilage lamina
- Corniculate cartilage
- Arytenoid cartilage
- Superior horn of thyroid cartilage
- Inferior horn of thyroid cartilage
- Vocal process
- Vocal ligament
- Median cricothyroid ligament
- Hyoepiglottic ligament
- Thyroepiglottic ligament
- Thyroid cartilage lamina
- Hyoid bone
- Hyoid bone
- Thyrohyoid membrane
- Thyrohyoid membrane
- Cuneiform (minor)
- Cuneiform (minor)
- Anteroinferior view
- Anterosuperior view
- Medial view, median (sagittal) section
- Posterior view
- Anterior view

---

**Netter's Head and Neck Anatomy for Dentistry**

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## Cartilages

### Thyroid Cartilage

<table>
<thead>
<tr>
<th>Anatomic Feature</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 lateral laminae</td>
<td>2 plates that meet at an acute angle in the anterior midline</td>
</tr>
<tr>
<td>Laryngeal prominence</td>
<td>Also known as the Adam’s apple</td>
</tr>
<tr>
<td></td>
<td>Formed by the fusion of the 2 lateral lamina</td>
</tr>
<tr>
<td></td>
<td>Larger in males than in females</td>
</tr>
<tr>
<td>Thyroid notch</td>
<td>Superior portion of the laryngeal prominence, which forms a V shape</td>
</tr>
<tr>
<td>Superior tubercle</td>
<td>Superior border of the oblique line</td>
</tr>
<tr>
<td>Oblique line</td>
<td>Attachment for sternothyroid, thyrohyoid, and inferior constrictor mm.</td>
</tr>
<tr>
<td></td>
<td>(extrinsic muscles of the larynx)</td>
</tr>
<tr>
<td>Inferior tubercle</td>
<td>Inferior border of the oblique line</td>
</tr>
<tr>
<td>Superior horn</td>
<td>Provides lateralmost attachment for the thyrohyoid membrane</td>
</tr>
<tr>
<td>Inferior horn</td>
<td>Articulates with the cricoid to form the cricothyroid joint</td>
</tr>
</tbody>
</table>

![Anterior view](image1.png)  
![Posterior view](image2.png)  
![Right lateral view](image3.png)
**Cartilages**

**CRICOID CARTILAGE**

<table>
<thead>
<tr>
<th>Anatomic Feature</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arch (anteriorly)</td>
<td>1 cm long\nNarrow</td>
</tr>
<tr>
<td>Lamina (posteriorly)</td>
<td>2 to 3 cm long</td>
</tr>
<tr>
<td>Superior border (on the lamina)</td>
<td>Articulates with the arytenoid cartilage to form the cricoarytenoid joint</td>
</tr>
<tr>
<td>Inferior border (on the lamina)</td>
<td>Articulates with the inferior cornu of the thyroid cartilage to form the cricothyroid joint</td>
</tr>
</tbody>
</table>

![Diagram of Cricoid Cartilage with annotations](image-url)

**Anterior view**
- Median cricothyroid ligament
- Inferior horn of thyroid cartilage
- Cricoid cartilage

**Right lateral view**
- Cricothyroid ligament
- Cricoid cartilage
- Cricothyroid joint

**Anterosuperior view**
- Lamina
- Arch
- Muscular process
- Vocal process
- Arytenoid cartilage
- Corniculate cartilage
- Cricoid cartilage
## Arytenoid Cartilage

<table>
<thead>
<tr>
<th>Anatomic Feature</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 processes:</td>
<td></td>
</tr>
<tr>
<td>● Muscular (lateral)</td>
<td>Base articulates with cricoid to form the cricoarytenoid joint</td>
</tr>
<tr>
<td>● Vocal (anterior)</td>
<td>Vocal process gives rise to true vocal cord</td>
</tr>
<tr>
<td>● Apex (superior)</td>
<td></td>
</tr>
</tbody>
</table>

**Posterior view**

- Corniculate cartilage
- Arytenoid cartilage
- Vocal ligament

**Anterosuperior view**

- Corniculate cartilage
- Arytenoid cartilage
- Muscular process
- Vocal process
- Vocal ligament

**Medial view, median (sagittal) section**

- Corniculate cartilage
- Apex
- Muscular process
- Vocal process
- Arytenoid cartilage
**Cartilages**

**EPIGLOTTIS**

<table>
<thead>
<tr>
<th>Anatomic Feature</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epiglottic tubercle</td>
<td>Pear-shaped</td>
</tr>
</tbody>
</table>
Cartilages

**MINOR CARTILAGES**

<table>
<thead>
<tr>
<th>Cartilage</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corniculate</td>
<td>Lies on the apex of the arytenoid cartilage</td>
</tr>
<tr>
<td></td>
<td>Helps support the aryepiglottic fold</td>
</tr>
<tr>
<td>Cuneiform</td>
<td>Lies superior to the corniculate cartilage</td>
</tr>
<tr>
<td></td>
<td>Helps support the aryepiglottic fold</td>
</tr>
</tbody>
</table>

- **Posterior view**
  - Cuneiform cartilage
  - Corniculate cartilage
  - Arytenoid cartilage

- **Anterosuperior view**
  - Cuneiform cartilage
  - Corniculate cartilage
  - Arytenoid cartilage

- **Medial view, median (sagittal) section**
  - Cuneiform cartilage
  - Corniculate cartilage
### Membranes and Ligaments

#### MAJOR EXTRINSIC LIGAMENTS

<table>
<thead>
<tr>
<th>Ligament(s)</th>
<th>Location</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 lateral thyrohyoid ligaments</td>
<td>Thyroid cartilage to hyoid bone</td>
<td>The thyrohyoid membrane allows passage of the internal laryngeal n. and</td>
</tr>
<tr>
<td>1 median thyrohyoid ligament</td>
<td></td>
<td>superior laryngeal vessels</td>
</tr>
<tr>
<td>Thyrohyoid membrane</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median cricothyroid ligament</td>
<td>Cricoid cartilage to thyroid cartilage</td>
<td>Primary site for establishing an emergency airway</td>
</tr>
<tr>
<td>Cricotracheal ligament</td>
<td>Cricoid cartilage to trachea</td>
<td>Attaches the cricoid cartilage to the first tracheal ring May be used in</td>
</tr>
<tr>
<td></td>
<td></td>
<td>establishing an emergency airway</td>
</tr>
</tbody>
</table>

#### MAJOR INTRINSIC LIGAMENTS

<table>
<thead>
<tr>
<th>Ligament</th>
<th>Location</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vocal ligament</td>
<td>Arytenoid (vocal) to thyroid cartilage</td>
<td>Help form true vocal cord</td>
</tr>
<tr>
<td>Conus elasticus</td>
<td>Superior—thyroid, vocal lig., arytenoid (vocal)</td>
<td>Inferior—upper border of cricoid</td>
</tr>
<tr>
<td>Quadrangular membrane</td>
<td>Arytenoid to epiglottis</td>
<td>Help form false vocal cord</td>
</tr>
<tr>
<td>Vestibular ligament</td>
<td>Free edge of quadrangular membrane</td>
<td></td>
</tr>
</tbody>
</table>
## Muscles

### OVERVIEW

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Action(s)</th>
<th>Nerve Supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cricothyroid</td>
<td>Arch of cricoid</td>
<td>Lamina and inferior cornu of thyroid</td>
<td>Increases tension on vocal ligaments</td>
<td>External laryngeal n.</td>
</tr>
<tr>
<td>Thyroarytenoid</td>
<td>Angle of thyroid cartilage</td>
<td>Arytenoid (vocal process)</td>
<td>Decreases tension on vocal ligaments</td>
<td>Recurrent laryngeal n.</td>
</tr>
<tr>
<td>Posterior cricoarytenoid</td>
<td>Lamina of cricoid</td>
<td>Arytenoid (muscular process)</td>
<td>Opens rima glottidis</td>
<td></td>
</tr>
<tr>
<td>Lateral cricoarytenoid</td>
<td>Arch of cricoid (lateral portion)</td>
<td>Opposite arytenoid (muscular process)</td>
<td>Closes rima glottidis</td>
<td></td>
</tr>
<tr>
<td>Transverse arytenoid</td>
<td>Arytenoid (muscular process)</td>
<td>Opposite arytenoid (muscular process)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oblique arytenoid</td>
<td>Opposite arytenoid (apex)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aryepiglotticus</td>
<td>Arytenoid (apex)</td>
<td>Epiglottis</td>
<td>Helps close laryngopharyngeal opening</td>
<td></td>
</tr>
<tr>
<td>Thyroepiglotticus</td>
<td>Thyroid lamina</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### SUMMARY OF MUSCLE ACTIONS

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Action</th>
<th>Muscle</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posterior cricoarytenoid</td>
<td>Opens the rima glottidis</td>
<td>Cricothyroid</td>
<td>Increasing tension</td>
</tr>
<tr>
<td>Transverse arytenoids</td>
<td>Closes the rima glottidis</td>
<td>Thyroarytenoid</td>
<td>Decreasing tension</td>
</tr>
</tbody>
</table>

**Muscles**

**OVERVIEW CONTINUED**

**Cricothyroid joint**

(Cricket point)

**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**

<table>
<thead>
<tr>
<th>Artery</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior laryngeal</td>
<td>Superior thyroid a., which arises from the external carotid a.</td>
<td>Passes through the thyrohyoid membrane with the internal laryngeal n. to enter the deep surface of the larynx</td>
</tr>
<tr>
<td>Inferior laryngeal</td>
<td>Inferior thyroid a., which arises from the thyrocervical trunk</td>
<td>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.</td>
</tr>
</tbody>
</table>

![Diagram of the vascular supply to the larynx](image)
### Vascular Supply

#### VENOUS DRAINAGE

<table>
<thead>
<tr>
<th>Vein</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior laryngeal</td>
<td>Begins in the deep surface of the superior part of the larynx&lt;br&gt;Passes with the superior laryngeal a. and the internal laryngeal n.&lt;br&gt;Passes through the thyrohyoid membrane to lie on the superficial surface of the larynx&lt;br&gt;Drains into the superior thyroid v., which drains into the internal jugular v.</td>
</tr>
<tr>
<td>Inferior laryngeal</td>
<td>Arises within the deep surface of the inferior part of the larynx&lt;br&gt;Passes with the inferior laryngeal a. and the recurrent laryngeal n.&lt;br&gt;Passes inferiorly deep to the inferior constrictor to exit the larynx&lt;br&gt;Drains into the inferior thyroid v., which drains into the brachiocephalic v.</td>
</tr>
</tbody>
</table>
## Nerve Supply

### MOTOR AND SENSORY BRANCHES FROM THE VAGUS NERVE

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Type</th>
<th>Sensory Target</th>
<th>Muscles Innervated</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal laryngeal</td>
<td>Sensory</td>
<td>Membranes above the false vocal folds</td>
<td>Branch of superior laryngeal nerve from the vagus</td>
<td></td>
</tr>
<tr>
<td>Recurrent laryngeal</td>
<td>Sensory and motor</td>
<td>Membranes below the false vocal folds</td>
<td>Thyroarytenoid Posterior cricoarytenoid Lateral cricoarytenoid Transverse arytenoid Oblique arytenoid Aryepiglotticus Thyroepiglotticus</td>
<td>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</td>
</tr>
<tr>
<td>External laryngeal</td>
<td>Motor</td>
<td>Cricothyroid</td>
<td>Branch of superior laryngeal nerve from the vagus</td>
<td></td>
</tr>
</tbody>
</table>

![Diagram of the larynx](image)
Nerve Supply

MOTOR AND SENSORY BRANCHES FROM THE VAGUS NERVE CONTINUED

Superior laryngeal nerve

Internal branch

External branch

Inferior pharyngeal constrictor muscle

Cricothyroid muscle

Cricopharyngeus muscle (part of inferior pharyngeal constrictor)

Recurrent laryngeal nerve

Right lateral view: thyroid cartilage lamina removed

Internal branch of superior laryngeal nerve

Sensory branches to larynx

Anterior and posterior branches of inferior laryngeal nerve

Recurrent laryngeal nerve
Clinical Correlate

**EMERGENCY AIRWAY: CRICOXYTROTOMY**

*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
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

- Sella turcica
- Frontal sinus
- Sphenoidal sinus
- Nasopharynx
- Oral cavity
- Palatine tonsil
- Oropharynx
- Epiglottis
- Mandible
- Hyoid bone
- Laryngopharynx
- Thyroid cartilage
- Cricoid cartilage
- Trachea
- Esophagus
- Esophageal muscles
- Thyroid gland
- Investing layer of (deep) cervical fascia
- Pretracheal fascia
- Suprasternal space
- Manubrium of sternum
- Pharyngeal opening of pharyngotympanic (auditory) tube
**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.
### SUPERFICIAL LAYER OF DEEP CERVICAL FASCIA

<table>
<thead>
<tr>
<th>Layer</th>
<th>Location</th>
<th>Attachment</th>
<th>Comments</th>
</tr>
</thead>
</table>
| Superficial layer of deep cervical fascia (also known as the investing layer of deep cervical fascia) | Immediately deep to the superficial fascia | Anterior—chin, hyoid, sternum
Posterior—spinal process of cervical vertebra and the ligamentum nuchae | 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 |
| | Encircles the neck completely | 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 | |
| | When the layer approaches the sternocleidomastoid and the trapezius mm., it splits to lie on the superficial and deep surfaces | Inferior—sternum (splitting into anterior and posterior parts), clavicle, acromion of the scapula | |

### MIDDLE LAYER OF DEEP CERVICAL FASCIA

<table>
<thead>
<tr>
<th>Layer</th>
<th>Location</th>
<th>Attachment</th>
<th>Comments</th>
</tr>
</thead>
</table>
| 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

<table>
<thead>
<tr>
<th>Layer</th>
<th>Location</th>
<th>Attachment</th>
<th>Comments</th>
</tr>
</thead>
</table>
| 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 |
## Fascia of the Neck

### DEEP FASCIA CONTINUED

<table>
<thead>
<tr>
<th>Layer</th>
<th>Location</th>
<th>Attachment</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carotid sheath</td>
<td>In the neck between the investing layer, pretracheal layer, and the prevertebral layer</td>
<td>Superior—base of skull inferior—merges with connective tissue around arch of the aorta</td>
<td>Contains the internal or common carotid a., internal jugular v., and vagus n.</td>
</tr>
</tbody>
</table>

![Diagram of the neck fascia](image_url)

- Masseter muscle
- Parotid gland
- Platysma muscle (cut away)
- Mastoid process
- Hyoid bone
- Carotid sheath
- Fascia of infrahyoid muscles and cut edge
- Thyroid cartilage
- Investing layer of (deep) cervical fascia and cut edge
- Cricoid cartilage
- Pretracheal layer of (deep) cervical fascia over thyroid gland and trachea

- Digastric muscle (anterior belly)
- Mylohyoid muscle
- Submandibular gland
- Fibrous loop for intermediate digastric tendon
- Stylohyoid muscle
- Digastric muscle (posterior belly)
- External carotid artery
- Internal jugular vein
- Thyrohyoid muscle
- Omohyoid muscle (superior belly)
- Sternohyoid muscle
- Sternothyroid muscle
- Scolene muscles
- Trapezius muscle
- Deltoid muscle
- Clavicle
- Omohyoid muscle (inferior belly)
- Pectoralis major muscle
- Sternocleidomastoid muscle

- Suprasternal space
- Manubrium of sternum
- Jugular notch
- Clavicular head
- Sternal head
- Sternocleidomastoid muscle
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
# Fascial Spaces

## Suprahyoid Fascial Spaces

<table>
<thead>
<tr>
<th>Space</th>
<th>Location</th>
<th>Comments and Potential for Infection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Submandibular</td>
<td>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</td>
<td>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: <em>Sublingual space</em> <em>Submaxillary space</em></td>
</tr>
<tr>
<td>Sublingual</td>
<td>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.</td>
<td>Contains the: <em>Hypoglossal n.</em> <em>Lingual n.</em> <em>Sublingual gland</em> <em>Deep part of the submandibular gland</em> <em>Submandibular duct</em> Continuous with the submaxillary space along the posterior free border on the mylohyoid m.</td>
</tr>
<tr>
<td>Submaxillary</td>
<td>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 digastic m. and the mandible</td>
<td>Contains the: <em>Submandibular gland</em> <em>Anterior digastic m.</em> 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.</td>
</tr>
<tr>
<td>Lateral pharyngeal</td>
<td>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.</td>
<td>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.</td>
</tr>
<tr>
<td>Masticator</td>
<td>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.</td>
<td>Contains the: <em>Masseter m.</em> <em>Medial pterygoid m.</em> <em>Lateral pterygoid m.</em> <em>Lower portion (insertion) of the temporalis m.</em> <em>Contents of the pterygomandibular space</em> Continuous with the temporal space.</td>
</tr>
<tr>
<td>Temporal</td>
<td>Formed when the superficial layer of deep cervical fascia encloses the temporalis m.</td>
<td>Can be further subdivided into a superficial and a deep space. Continuous with the masticator space.</td>
</tr>
</tbody>
</table>
Fascial Spaces

**SUPRAHYOID FASCIAL SPACES CONTINUED**

<table>
<thead>
<tr>
<th>Space</th>
<th>Location</th>
<th>Comments and Potential for Infection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peritonsillar</td>
<td>Anterior—palatoglossal fold Posterior—palatopharyngeal fold Medial—palatine tonsil capsule Lateral—superior constrictor m.</td>
<td>Located within the wall of the pharynx Infections of the peritonsillar space may extend into the lateral pharyngeal space</td>
</tr>
<tr>
<td>Parotid gland [space]</td>
<td>Formed when the superficial layer of deep cervical fascia encloses the parotid gland as a capsule</td>
<td>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</td>
</tr>
<tr>
<td>Submandibular gland [space]</td>
<td>Formed when the superficial layer of deep cervical fascia encloses the submandibular gland as a capsule</td>
<td>The inner layer of the capsule is weaker, and infections of this space tend to break through the fascia to this side</td>
</tr>
</tbody>
</table>

---

**Diagram:**

- Temporalis
- Lateral pterygoid
- Masseter
- Medial pterygoid
- Ramus of mandible
- Lateral pharynx
- Superficial layer of deep cervical fascia surrounding maseter, lower portion of the temporalis, ramus of the mandible, and medial pterygoid forming the masticator space
- Mylohyoid
- Submandibular gland
- Buccopharyngeal fascia
- Superior constrictor
- Peritonsilar space
- Superficial layer of deep cervical fascia
- Middle constrictor
- Inferior constrictor
# Fascial Spaces

## Infrahyoid Fascial Spaces

<table>
<thead>
<tr>
<th>Space</th>
<th>Location</th>
<th>Comments and Potential for Infection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretracheal (anterior visceral)</td>
<td>Superior—inferior larynx</td>
<td>Usually infections spread to the pretracheal space only by puncturing the esophagus anteriorly or by a perforation in the retropharyngeal space</td>
</tr>
</tbody>
</table>

## Fascial Spaces Traversing the Length of the Neck

<table>
<thead>
<tr>
<th>Space</th>
<th>Location</th>
<th>Comments and Potential for Infection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superficial</td>
<td>Between the superficial fascia and the superficial layer of deep cervical fascia Surrounds the platysma m.</td>
<td>Infections are superficial and often observed early Continuous with the face</td>
</tr>
<tr>
<td>Retropharyngeal</td>
<td>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</td>
<td>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</td>
</tr>
<tr>
<td>“Danger space”</td>
<td>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</td>
<td>Via the superior mediastinum, it allows infection to spread into the thorax</td>
</tr>
<tr>
<td>Prevertebral</td>
<td>Between the prevertebral fascia and the vertebral column</td>
<td>Closed off superiorly, laterally, and inferiorly, so spread of infections in this space is not common</td>
</tr>
<tr>
<td>Carotid sheath</td>
<td>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</td>
<td>Infections from visceral spaces may enter and pass within the carotid sheath</td>
</tr>
</tbody>
</table>
Fascial Spaces

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
Clinical Correlate

**ABSCESSES CONTINUED**

Dento alveolar abscess

Periodontal infection related to:
- A. Subgingival calculus
- B. Overhanging filling margin
- C. Poor contact and “tipping” of tooth

Pericoronal abscess about partially erupted 3rd molar
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 glossopharyngeal 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
Overview and Topographic Anatomy

GENERAL INFORMATION CONTINUED
## Structures and Boundaries

### STRUCTURES OF THE EXTERNAL EAR

<table>
<thead>
<tr>
<th>Structure</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Auricle</strong></td>
<td>An irregularly-shaped structure made of elastic cartilage and skin</td>
</tr>
<tr>
<td></td>
<td>Superior portion has a skeleton of elastic cartilage</td>
</tr>
<tr>
<td></td>
<td>Inferior portion, the lobule, has no cartilage</td>
</tr>
<tr>
<td></td>
<td><strong>Helix:</strong> the outermost curved rim of the auricle, continues anteriorly</td>
</tr>
<tr>
<td></td>
<td>to blend with the head at the crus helix</td>
</tr>
<tr>
<td></td>
<td><strong>Antihelix:</strong> the portion of cartilage that follows along the helix from</td>
</tr>
<tr>
<td></td>
<td>the inside</td>
</tr>
<tr>
<td></td>
<td><strong>Scaphoid fossa:</strong> the depressed area between the helix and antihelix</td>
</tr>
<tr>
<td></td>
<td><strong>Concha:</strong> demarcated by the antihelix, it is the depressed area that</td>
</tr>
<tr>
<td></td>
<td>leads to the external acoustic meatus</td>
</tr>
<tr>
<td></td>
<td><strong>Tragus:</strong> extends from the face into the concha</td>
</tr>
<tr>
<td></td>
<td><strong>Antitragus:</strong> extends from the inferior portion of the antihelix into</td>
</tr>
<tr>
<td></td>
<td>the concha and is separated from the tragus by the intertragic notch</td>
</tr>
<tr>
<td><strong>External acoustic meatus</strong></td>
<td>The passageway connecting the concha of the auricle to the tympanic</td>
</tr>
<tr>
<td></td>
<td>membrane</td>
</tr>
<tr>
<td></td>
<td>Covered by skin rich in sebaceous and cerumen-secreting glands</td>
</tr>
<tr>
<td></td>
<td>About 2.5 cm in length</td>
</tr>
<tr>
<td></td>
<td><strong>Lateral 1/3:</strong> cartilaginous, extends into the temporal bone</td>
</tr>
<tr>
<td></td>
<td><strong>Medial 2/3:</strong> osseous, formed by the tympanic, squamous, and petrous</td>
</tr>
<tr>
<td></td>
<td>portions of the temporal bone</td>
</tr>
<tr>
<td><strong>Tympanic membrane</strong></td>
<td>The most medial portion of the external ear that separates it from the</td>
</tr>
<tr>
<td></td>
<td>middle ear</td>
</tr>
<tr>
<td></td>
<td>Lies in a groove on the tympanic part of the temporal bone</td>
</tr>
<tr>
<td></td>
<td>A thin, semitransparent, 3-layered membrane:</td>
</tr>
<tr>
<td></td>
<td>● <strong>External layer:</strong> derived from skin; composed of stratified squamous</td>
</tr>
<tr>
<td></td>
<td>epithelium</td>
</tr>
<tr>
<td></td>
<td>● <strong>Middle layer:</strong> fibrous, with fibers attaching to the malleus</td>
</tr>
<tr>
<td></td>
<td>● <strong>Inner layer:</strong> continuous with the mucous membrane of the middle ear</td>
</tr>
<tr>
<td></td>
<td>cavity; composed of columnar epithelium with cilia</td>
</tr>
<tr>
<td></td>
<td>Anterior and posterior malleolar folds lie on the superior portion of the</td>
</tr>
<tr>
<td></td>
<td>tympanic membrane</td>
</tr>
<tr>
<td></td>
<td>Tense and loose portions are called the pars tensa and pars flaccida,</td>
</tr>
<tr>
<td></td>
<td>respectively</td>
</tr>
</tbody>
</table>
Structures and Boundaries

**STRUCTURES OF THE EXTERNAL EAR** CONTINUED

- Helix
- Crura of antihelix
- Auricular tubercle
- Scapha
- Antihelix
- Concha of auricle
- Lobule of auricle
- Tragus
- Intertragic notch
- Antitragus
- Triangle fossa
- Crus of helix
- Right auricle
- Long limb of incus
- Posterior malleal fold
- Pars flaccida
- Anterior malleal fold
- Lateral process of malleus
- Pars tensa
- Handle of malleus
- Right tympanic membrane (eardrum) viewed through speculum
- Umbo
- Cone of light
- Epitympanic recess
- Malleus incus
- Stapes
- Tensor tympani muscle
- Cartilaginous Osseous
- External acoustic meatus
- Tympanic membrane
- Coronal oblique section of external acoustic meatus and middle ear
- Tympanic cavity
- Pharyngotympanic (auditory) tube
- Levator veli palatini muscle
BOUNDARIES OF THE MIDDLE EAR

<table>
<thead>
<tr>
<th>Boundary</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof</td>
<td>Made by the tegmen tympani, separating the middle ear from the temporal lobe of the middle cranial fossa</td>
</tr>
<tr>
<td>Floor</td>
<td>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</td>
</tr>
<tr>
<td>Anterior wall</td>
<td><em>Auditory tube</em>: 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</td>
</tr>
<tr>
<td></td>
<td>Lesser petrosal n. exits the middle ear through the anterior wall</td>
</tr>
<tr>
<td></td>
<td>Postganglionic sympathetic nerve fibers from the internal carotid a. pass through the anterior wall to enter the middle ear</td>
</tr>
<tr>
<td>Posterior wall</td>
<td><em>Facial canal</em>: passes superoinferiorly immediately posterior to the middle ear until it terminates at the stylomastoid foramen</td>
</tr>
<tr>
<td></td>
<td><em>Mastoid antrum</em>: located in the superior portion of the posterior wall near the junction with the roof of the middle ear</td>
</tr>
<tr>
<td></td>
<td><em>Pyramid</em>: a hollow projection from the posterior wall; contains the tendon of the stapedius m.</td>
</tr>
<tr>
<td></td>
<td>Posterior cranial fossa and sigmoid sinus are located posterior to the posterior wall</td>
</tr>
<tr>
<td>Medial wall</td>
<td>The medial wall separates the middle ear from the inner ear</td>
</tr>
<tr>
<td></td>
<td><em>Promontory</em>: a large protuberance created by the cochlea of the inner ear</td>
</tr>
<tr>
<td></td>
<td>In the superior portion of the medial wall is a protuberance formed by the lateral semicircular canal</td>
</tr>
<tr>
<td></td>
<td>Inferior to the lateral semicircular canal on the opposite side of the medial wall is the horizontal portion of the facial canal</td>
</tr>
<tr>
<td></td>
<td>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</td>
</tr>
<tr>
<td></td>
<td>Tendon of the tensor tympani m. enters the middle ear through the medial wall</td>
</tr>
<tr>
<td>Lateral wall</td>
<td>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</td>
</tr>
<tr>
<td></td>
<td><em>Epitympanic recess</em>: the region superior to the tympanic membrane that houses portions of the malleus and incus</td>
</tr>
<tr>
<td></td>
<td>Chorda tympani n. lies along the tympanic membrane and malleus until exiting the petrotympanic fissure</td>
</tr>
</tbody>
</table>
Lateral wall of tympanic cavity: medial (internal) view

- Head of malleus
- Epitympanic recess
- Anterior process of malleus
- Chorda tympani nerve
- Anterior malleal fold
- Tensor tympani muscle
- Handle of malleus
- Pharyngotympanic (auditory) tube
- Internal carotid artery

Medial wall of tympanic cavity: lateral view

- Prominence of lateral semicircular canal
- Prominence of facial canal
- Geniculum of facial nerve
- Greater petrosal nerve
- Tensor tympani muscle (tendon cut)
- Pharyngotympanic (auditory) tube
- Levator veli palatini muscle
- Promontory with tympanic nerve (Jacobson) and plexus under mucosa
- Internal carotid artery

BOUNDARIES OF THE MIDDLE EAR CONTINUED
Structures and Boundaries

BOUNDARIES OF THE MIDDLE EAR CONTINUED

- View into tympanic cavity after removal of tympanic membrane
- Auditory ossicles
- Articular surface for incus
- Malleus: lateral view
- Stapes: superolateral view
- Incus: lateral view
- Malleus
- Incus
- Stapes
- Ossicles articulated: medial view

- Chorda tympani nerve
- Stapes in oval (vestibular) window
- Tendon of tensor tympani muscle
- Promontory
- Handle of malleus
- Fossa of round (cochlear) window
- Articular surface for malleus
- Neck
- Handle
- Lateral process
- Posterior limb
- Head
- Anterior process
- Body
- Long limb
- Base
- Articular surface for malleus
- Malleus
- Incus
- Stapes
- Lenticular process of incus
## STRUCTURES OF THE INNER EAR

<table>
<thead>
<tr>
<th>Structure</th>
<th>Description</th>
</tr>
</thead>
</table>
| 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 endolympathic 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 reuniens  
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 endolympathic 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 and Boundaries

STRUCTURES OF THE INNER EAR CONTINUED
A. Membranous labyrinth within bony labyrinth (path of sound waves)

B. Section through turn of cochlea

C. 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.
# Muscles

## OVERVIEW

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Actions</th>
<th>Nerve Supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensor tympani</td>
<td>Bony canal at auditory tube, Cartilaginous part of auditory tube, Greater wing of the sphenoid</td>
<td>Handle of the malleus</td>
<td>Tenses the tympanic membrane and helps dampen sound vibrations</td>
<td>Mandibular division of the trigeminal n.</td>
</tr>
<tr>
<td>Stapedius</td>
<td>Pyramid on posterior wall of the tympanic cavity</td>
<td>Neck of the stapes</td>
<td>Dampens excessive sound vibrations</td>
<td>Stapedius branch of the facial n.</td>
</tr>
</tbody>
</table>

**Medial wall of tympanic cavity: lateral view**

- Prominence of lateral semicircular canal
- Prominence of facial canal
- Geniculum of facial nerve
- Greater petrosal nerve
- Tensor tympani muscle (tendon cut)
- Pharyngotympanic (auditory) tube
- Levator veli palatini muscle
- Promontory with tympanic nerve (Jacobson) and plexus under mucosa
- Internal carotid artery
- Base of stapes in fossa of oval (vestibular) window
- Limbs of stapes
- Pyramidal eminence
- Chorda tympani nerve (cut)
- Mastoid cells
- Tendon of stapedius muscle
- Fossa of round (cochlear) window
- Facial nerve (VII) in stylomastoid foramen
- Mastoid antrum
- Tympanic cells
- Jugular fossa
- Fossa of round (cochlear) window
- Internal carotid artery

**Figure:** Medial wall of tympanic cavity: lateral view.
# Nerve Supply

## Sensory Innervation of the External Ear

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Great auricular</td>
<td>Cervical plexus, formed by contributions of C2 and C3 ventral rami</td>
<td>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.</td>
</tr>
<tr>
<td>Lesser occipital</td>
<td>Cervical plexus, formed by contributions from C2 ventral ramus</td>
<td>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.</td>
</tr>
<tr>
<td>Auriculotemporal</td>
<td>Posterior part of the mandibular division of the trigeminal n.</td>
<td>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. 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.</td>
</tr>
<tr>
<td>Auricular branch of the vagus</td>
<td>Superior ganglion of the vagus n.</td>
<td>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 canalculus 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.</td>
</tr>
<tr>
<td>Tympanic branch of glossopharyngeal</td>
<td>Branches from the inferior ganglion of the vagus n. located in the petrous portion of the temporal bone</td>
<td>Passes superiorly through the tympanic canalculus 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 parasym pathetic 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.).</td>
</tr>
</tbody>
</table>
Nerve Supply

SENSORY INNERVATION OF THE EXTERNAL EAR CONTINUED
Nerve Supply

SENSORY INNERVATION OF THE EXTERNAL EAR CONTINUED

- Hypoglossal nerve (XII)
- Great auricular nerve
- Lesser occipital nerve
- Transverse cervical nerve
- Supraclavicular nerves (medial, intermediate, and lateral)
- Ansa cervicalis
- Phrenic nerve

- Efferent fibers
- Afferent fibers
- Proprioceptive fibers
Nerve Supply

SENSORY INNERVATION OF THE EXTERNAL EAR CONTINUED

Glossopharyngeal nerve (IX)
Auricular branch of vagus nerve
Pharyngotympanic (auditory) tube

Vagus nerve (X)
Jugular foramen
Superior ganglion of vagus nerve
Inferior ganglion of vagus nerve

- **Efferent fibers**
- **Afferent fibers**
- **Parasympathetic fibers**
SENSORY INNERVATION OF THE MIDDLE EAR

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typanic plexus</td>
<td>Formed by the:</td>
<td>Tympanic branch of the glossopharyngeal n. passes</td>
</tr>
<tr>
<td></td>
<td>● Tympanic branch of the glossopharyngeal n.</td>
<td>superiorly through the tympanic canaliculus to enter the middle ear</td>
</tr>
<tr>
<td></td>
<td>(arises from the inferior ganglion</td>
<td>In the middle ear, it divides into branches that form the tympanic</td>
</tr>
<tr>
<td></td>
<td>located in the petrous portion of the</td>
<td>plexus</td>
</tr>
<tr>
<td></td>
<td>temporal bone)</td>
<td>Caroticotympanic nn. join the tympanic branch of the glossopharyngeal</td>
</tr>
<tr>
<td></td>
<td>● Caroticotympanic nn.</td>
<td>n.</td>
</tr>
<tr>
<td></td>
<td>(arise from the carotid plexus on the</td>
<td>Tympanic plexus gives rise to:</td>
</tr>
<tr>
<td></td>
<td>internal carotid a.)</td>
<td>● Preganglionic parasympathetic fibers to the parotid gland</td>
</tr>
<tr>
<td></td>
<td></td>
<td>● Postganglionic sympathetic fibers to the parotid gland</td>
</tr>
<tr>
<td></td>
<td></td>
<td>● Sensory fibers to the middle ear cavity, including the tympanic</td>
</tr>
<tr>
<td></td>
<td></td>
<td>membrane and auditory tube (mainly from the tympanic branch of the</td>
</tr>
<tr>
<td></td>
<td></td>
<td>glossopharyngeal)</td>
</tr>
<tr>
<td>Facial</td>
<td>Cranial n. VII has multiple motor and</td>
<td>Nervus intermedius and motor portions—enter the internal acoustic</td>
</tr>
<tr>
<td></td>
<td>sensory functions</td>
<td>meatus of the temporal bone</td>
</tr>
<tr>
<td></td>
<td>Created by:</td>
<td>Facial n. then passes through the facial canal until it exits the</td>
</tr>
<tr>
<td></td>
<td>● Nervus intermedius,</td>
<td>stylomastoid foramen, initially traveling horizontally along the</td>
</tr>
<tr>
<td></td>
<td>which contains the</td>
<td>outside of the medial wall of the middle ear; then it</td>
</tr>
<tr>
<td></td>
<td>sensory fibers and the</td>
<td>bends posteriorly and inferiorly to the middle ear</td>
</tr>
<tr>
<td></td>
<td>parasympathetic fibers</td>
<td>Where the nerve changes direction is in the geniculate ganglion; here</td>
</tr>
<tr>
<td></td>
<td>● Motor portion that</td>
<td>the greater petrosal n. is given off to travel</td>
</tr>
<tr>
<td></td>
<td>innervates the muscles</td>
<td>anteriorly toward the pterygopalatine fossa</td>
</tr>
<tr>
<td></td>
<td>derived from the 2nd</td>
<td>Within the facial canal, the nerve gives rise to the nerve to the</td>
</tr>
<tr>
<td></td>
<td>pharyngeal arch</td>
<td>stapedius m. and the chorda tympani n.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chorda tympani passes anteriorly along the tympanic membrane and the</td>
</tr>
<tr>
<td></td>
<td></td>
<td>malleus until it exits via the petrotympanic fissure</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chorda tympani carries preganglionic parasympathetic fibers to the</td>
</tr>
<tr>
<td></td>
<td></td>
<td>submandibular ganglion of the oral cavity, and taste fibers to the</td>
</tr>
<tr>
<td></td>
<td></td>
<td>anterior 2/3 of the tongue</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Stapedius n. innervates the stapedius m.</td>
</tr>
</tbody>
</table>

Medial view
**Nerve Supply**

**SENSORY INNERVATION OF THE INNER EAR**

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vestibulocochlear</td>
<td>Also called cranial n. VIII, it emerges between the pons and the medulla oblongata</td>
<td>Enters the internal acoustic meatus with the facial n. Within the internal acoustic meatus, it divides into vestibular branches and the cochlear branch</td>
</tr>
</tbody>
</table>
| 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 |

---

**Diagram:**

- **Afferent fibers**
- Geniculum of facial nerve (site of geniculate ganglion)
- Greater petrosal nerve
- Cochlear (spiral) ganglion
- Vestibular nerve
- Cochlear nerve
- Motor root of facial nerve and intermediate nerve
- Vestibulocochlear nerve (VIII)
- Medulla oblongata (cross section)
- Internal acoustic meatus
- Anterior and posterior cochlear nuclei
- Inferior cerebellar peduncle (to cerebellum)
- Vestibular ganglion
- Medial and lateral superior and inferior vestibular nuclei (diagrammatic)
- Ampulla of lateral semicircular duct
- Ampulla of superior semicircular duct
- Ampulla of posterior semicircular duct
- Utricle
- Saccule
- Inferior division of vestibular nerve
- Superior division of vestibular nerve
- Facial canal
- Tympanic cavity
- Chorda tympani nerve
- Head of malleus
- Incus

---

**Ear 491**
# Vascular Supply

## Arterial Supply of the External Ear

<table>
<thead>
<tr>
<th>Artery</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superficial temporal</td>
<td>A terminal branch of the external carotid a that arises within the parotid gland</td>
<td>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.</td>
</tr>
<tr>
<td>Posterior auricular</td>
<td>External carotid a. within the parotid gland</td>
<td>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.</td>
</tr>
<tr>
<td>Deep auricular</td>
<td>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.</td>
<td>Lies in the parotid gland, posterior to the temporomandibular joint. Passes into the external acoustic meatus to supply it; then supplies the outer surface of the tympanic membrane.</td>
</tr>
<tr>
<td>Anterior tympanic</td>
<td>A branch of the maxillary a. (1 of the terminal branches of the external carotid a.)</td>
<td>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.</td>
</tr>
</tbody>
</table>

![Diagram of the vascular supply of the external ear](image)
Vascular Supply

**ARTERIAL SUPPLY OF THE EXTERNAL EAR CONTINUED**

Anterior tympanic a.
Maxillary a.
Deep auricular a.
Exterior carotid a.
Posterior auricular a.
## Vascular Supply

### ARTERIAL SUPPLY OF THE MIDDLE EAR

<table>
<thead>
<tr>
<th>Artery</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posterior and the auricular</td>
<td>External carotid a. within the parotid gland</td>
<td>Passes superiorly between the mastoid process cartilage of the ear</td>
</tr>
<tr>
<td></td>
<td></td>
<td>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</td>
</tr>
<tr>
<td>Anterior tympanic</td>
<td>Maxillary a. (1 of the terminal branches of the external carotid a.)</td>
<td>Given off in the same area as for the deep auricular a.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Passes superiorly immediately posterior to the temporomandibular joint</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Enters the tympanic cavity through the petrotypanic fissure</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Aids in supplying the outer surface of the tympanic membrane and the anterior portion of the tympanic cavity</td>
</tr>
<tr>
<td>Inferior tympanic</td>
<td>Ascending pharyngeal a. of the external carotid a.</td>
<td>Ascends deep to the other branches of the external carotid a. and more superiorly to the stylopharyngeus m.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Passes into the middle ear through the petrous portion of the temporal bone</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Helps supply the medial wall of the tympanic cavity</td>
</tr>
<tr>
<td>Superior tympanic</td>
<td>Middle meningeal a. of the maxillary a.</td>
<td>Arises from the middle meningeal a. immediately after passing through the foramen spinosum within the middle cranial fossa</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Passes in the canal of the tensor tympani m. to help supply the tensor tympani and its bony canal</td>
</tr>
<tr>
<td>Caroticotympanic branch of the internal carotid</td>
<td>Internal carotid a.</td>
<td>Passes into the tympanic cavity through an aperture in the carotid canal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Helps supply the middle ear</td>
</tr>
</tbody>
</table>
Vascular Supply

ARTERIAL SUPPLY OF THE MIDDLE EAR CONTINUED

Superior branch of anterior tympanic
Anterior tympanic
Mallear branch from the anterior tympanic
Incudal branch from the anterior tympanic
Stylomastoid branch of the posterior auricular
Superior branch of anterior tympanic
Deep auricular branch
Vessels observed following removal of mucosa

Superior tympanic
Caroticotympanic
Inferior tympanic
**Vascular Supply**

### ARTERIAL SUPPLY OF THE INNER EAR

<table>
<thead>
<tr>
<th>Artery</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labyrinthine</td>
<td>Basilar a., which gives rise to the circle of Willis</td>
<td>Passes through the internal acoustic meatus, where it further divides into cochlear and vestibular branches that supply the cochlear and vestibular structures</td>
</tr>
<tr>
<td>Posterior auricular</td>
<td>External carotid a. within the parotid gland</td>
<td>Passes superiorly between the mastoid process and cartilage of the ear. Anastomoses with the superficial temporal and the occipital aas. 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 aas, 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</td>
</tr>
</tbody>
</table>

---

**Diagram:**

- Superficial temporal artery
- Digastric muscle (phantom)
- Occipital artery
- Transverse facial artery
- Maxillary artery
- Posterior auricular artery
- Facial artery
- Lingual artery
- Ascending pharyngeal artery
- Superior thyroid artery and superior laryngeal artery
- Omohyoid muscle (phantom)
- Thyrocervical trunk
- External carotid branches: schema
**Vascular Supply**

**ARTERIAL SUPPLY OF THE INNER EAR**  
CONTINUED

- Vestibulocochlear artery
- Common cochlear artery
- Anterior vestibular artery
- Posterior vestibular artery
- Labyrinthine artery

**VENOUS DRAINAGE OF THE EXTERNAL EAR**

<table>
<thead>
<tr>
<th>Vein</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superficial temporal</td>
<td>Descends posterior to the zygomatic root of the temporal bone alongside the auriculotemporal n. to enter the substance of the parotid gland. Along its path, receives tributaries from the auricle.</td>
</tr>
<tr>
<td>Posterior auricular</td>
<td>Arises from a plexus of veins created by the occipital and superficial temporal v. 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.</td>
</tr>
<tr>
<td>Maxillary</td>
<td>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.</td>
</tr>
<tr>
<td>Pterygoid plexus</td>
<td>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.</td>
</tr>
<tr>
<td>Transverse sinus</td>
<td>One of the deep venous sinuses that helps drain the brain. Aids in receiving blood from the tympanic membrane.</td>
</tr>
</tbody>
</table>
VENOUS DRAINAGE OF THE MIDDLE EAR

<table>
<thead>
<tr>
<th>Pterygoid plexus</th>
<th>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</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior petrosal sinus</td>
<td>One 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</td>
</tr>
</tbody>
</table>

VENOUS DRAINAGE OF THE INNER EAR

<table>
<thead>
<tr>
<th>Labyrinthine</th>
<th>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</th>
</tr>
</thead>
</table>
Vascular Supply

VENOUS DRAINAGE OF THE INNER EAR CONTINUED

- Pterygoid plexus
- Maxillary vein
- Superficial temporal vein and artery
- Posterior auricular vein
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

![Otoscopic view demonstrating clinical appearance of otitis externa](image)

In otitis externa, inflammation, edema, and discharge are limited to external auditory canal and its walls

![Diagram of the external ear](image)

- Marked inflammation and edema of walls of external auditory canal narrows canal lumen
- Tympanic membrane (eardrum)
- Malleus
- Incus
- Footplate of stapes in oval window
- Vestibular n.
- Internal acoustic meatus
- Cochlear n.
- Semicircular canals
- Facial n.
- Eustachian tube
- Round window
- Middle ear
- External acoustic meatus (ear canal)
- Auricle (pinna)
- Cochlea
- Scala tympani
- Cochlear duct
- Scala vestibuli

- Crura of stapes
- Malleus
- Incus
- Footplate of stapes in oval window
- Vestibular n.
- Internal acoustic meatus
- Cochlear n.
- Semicircular canals
- Facial n.
- Eustachian tube
- Round window
- Middle ear
- External acoustic meatus (ear canal)
- Auricle (pinna)
- Cochlea
- Scala tympani
- Cochlear duct
- Scala vestibuli

In otitis externa, inflammation, edema, and discharge are limited to external auditory canal and its walls
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
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

Overview and Topographic Anatomy of the Orbit

Osteology of the Orbit

Contents of the Orbit

Clinical Correlates
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
- Trochlear nerve
- Ophthalmic division of the trigeminal nerve
- Abducens nerve
- Ophthalmic artery and branches
- Superior and inferior ophthalmic veins
- Lacrimal apparatus
- Much fatty tissue
Overview and Topographic Anatomy of the Orbit

**GENERAL INFORMATION CONTINUED**

**Horizontal section**
- Zonular fibers (suspensory ligament of lens)
- Scleral venous sinus (Schlemm's canal)
- Ciliary body and ciliary muscle
- Ciliary part of retina
- Optic (visual) part of retina
- Cornea
- Anterior chamber
- Posterior chamber
- Ciliary processes
- Bulbar conjunctiva
- Ora serrata
- Optic nerve (II)
- Lamina cribrosa of sclera
- Central retinal artery and vein
- Vitreous body
- Hyaloid canal
- Fovea centralis in macula (lutea)
- Outer sheath of optic nerve
- Subarachnoid space
- Sclera
- Fascial sheath of eyeball (Tenon's capsule)
- Choroid
Osteology of the Orbit

OPENINGS IN THE ORBIT

<table>
<thead>
<tr>
<th>Opening</th>
<th>Bony Boundaries</th>
<th>Structures Passing through Opening</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optic foramen</td>
<td>Lesser wing of the sphenoid</td>
<td>Optic n.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ophthalmic a.</td>
</tr>
<tr>
<td>Superior orbital fissure</td>
<td>Greater wing of the sphenoid</td>
<td>Lacrimal branch of the trigeminal n.’s ophthalmic division</td>
</tr>
<tr>
<td></td>
<td>Lesser wing of the sphenoid</td>
<td>Frontal branch of the trigeminal n.’s ophthalmic division</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nasociliary branch of the trigeminal n.’s ophthalmic division</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Oculomotor n.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Trochlear n.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Abducens n.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Superior ophthalmic v.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inferior ophthalmic v.</td>
</tr>
<tr>
<td>Inferior orbital fissure</td>
<td>Greater wing of the sphenoid</td>
<td>Infraorbital n. and vessels</td>
</tr>
<tr>
<td></td>
<td>Maxilla</td>
<td>Zygomatic n. Branch of inferior ophthalmic v. that connects to the pterygoid plexus</td>
</tr>
<tr>
<td>Supraorbital foramen</td>
<td>Frontal</td>
<td>Supraorbital n. and vessels</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Supratrochlear n. and vessels</td>
</tr>
<tr>
<td>Infraorbital groove and</td>
<td>Maxilla</td>
<td>Infraorbital n. and vessels</td>
</tr>
<tr>
<td>canal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zygomatic foramen (1 or</td>
<td>Zygomatic</td>
<td>Branches of the zygomatic</td>
</tr>
<tr>
<td>2 openings)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nasolacrimal canal</td>
<td>Lacrimal</td>
<td>Nasolacrimal duct</td>
</tr>
<tr>
<td>Anterior ethmoidal</td>
<td>Ethmoid</td>
<td>Anterior ethmoidal n. and vessels</td>
</tr>
<tr>
<td>foramen</td>
<td>Frontal</td>
<td></td>
</tr>
<tr>
<td>Posterior ethmoidal</td>
<td>Ethmoid</td>
<td>Posterior ethmoidal n. and vessels</td>
</tr>
<tr>
<td>foramen</td>
<td>Frontal</td>
<td></td>
</tr>
</tbody>
</table>

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     |
Osteology of the Orbit

WALLS OF THE ORBIT CONTINUED

Right orbit: frontal and slightly lateral view

Muscle attachments and nerves and vessels entering orbit

- Superior orbital fissure
- Lacrimal nerve (V₁)
- Frontal nerve (V₁)
- Trochlear nerve (IV)
- Superior ophthalmic vein
- Lateral rectus muscle
- Superior branch of oculomotor nerve (III)
- Inferior orbital fissure
- Abducens nerve (VI)
- Levator palpebrae superioris muscle
- Superior oblique muscle
- Superior rectus muscle
- Medial rectus muscle
- Optic nerve (II)
- Ophthalmic artery
- In optic canal
- Inferior rectus muscle
- Nasociliary nerve (V₁)
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 mmHg

**Posterior Segment:**
- Filled with vitreous fluid
- Called the vitreous cavity
Contents of the Orbit

EYE CONTINUED
Contents of the Orbit

**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
Contents of the Orbit

**EYE CONTINUED**

- Sclera
- Choroid
- Optic part of retina
- Ora serrata
- Orbiculus ciliaris of ciliary body covered by ciliary part of retina
- Ciliary processes
- Zonular fibers
- Lens
- Anterior chamber
- Iris
- Posterior chamber
- Ciliary body
- Ciliary process
- Orbiculus ciliaris of ciliary body covered by ciliary part of retina
- Optic part of retina
- Zonular fibers
- Iris
- Ciliary processes
- Lens

**Eyeball sectioned in frontal plane:** anterior segment viewed from behind

**Horizontal section**

Enlargement of segment outlined in top illustration (semischematic)
### ASSOCIATED EXTRINSIC MUSCLE OF THE ORBIT

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Actions</th>
<th>Nerve</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Levator palpebrae superioris</td>
<td>Roof of the orbit</td>
<td>Skin of the upper eyelid</td>
<td>Raises the superior eyelid</td>
<td>Superior division of the oculomotor</td>
<td>Sympathetic fibers to the smooth muscle. Lesions of the sympathetic fibers will lead to ptosis, or drooping of the upper eyelid</td>
</tr>
</tbody>
</table>

### EXTRINSIC MUSCLES OF THE EYE

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Actions on Eye</th>
<th>Nerve</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior rectus</td>
<td>Common tendinous ring on sphenoid</td>
<td>Superior sclera</td>
<td>Elevation Intorsion</td>
<td>Superior division of the oculomotor</td>
<td>A check ligament attaches it to the levator palpebrae superioris m. to help elevate the upper eyelid</td>
</tr>
<tr>
<td>Inferior rectus</td>
<td>Inferior sclera</td>
<td>Inferior sclera</td>
<td>Depression Adduction Extorsion</td>
<td>Inferior division of the oculomotor</td>
<td>A check ligament attaches it to the inferior tarsal plate to help depress the lower eyelid</td>
</tr>
<tr>
<td>Medial rectus</td>
<td>Medial sclera</td>
<td>Medial sclera</td>
<td>Adduction</td>
<td></td>
<td>The most medial of the extraocular muscles</td>
</tr>
<tr>
<td>Lateral rectus</td>
<td>Lateral sclera</td>
<td>Lateral sclera</td>
<td>Abduction</td>
<td>Abducens</td>
<td>Impaired in abducens n. palsy</td>
</tr>
<tr>
<td>Superior oblique</td>
<td>Body of the sphenoid</td>
<td>Superior portion of the posterolateral sclera</td>
<td>Depression Abduction Extorsion</td>
<td>Trochlear</td>
<td>Tendon passes through the trochlea, a fibrocartilaginous pulley</td>
</tr>
<tr>
<td>Inferior oblique</td>
<td>Maxilla (lateral to the lacrimal groove)</td>
<td>Inferior portion of the posterolateral sclera</td>
<td>Elevation Abduction Extorsion</td>
<td>Inferior division of the oculomotor</td>
<td>Only extraocular muscle that attaches to the maxilla</td>
</tr>
</tbody>
</table>
Contents of the Orbit

**MUSCLES CONTINUED**

Innervation and action of extrinsic eye muscles:

- **Superior oblique muscle**
- **Trochlear nerve (IV)**
- **Oculomotor nerve (III)**
- **Abducens nerve (VI)**

Note: Arrows indicate direction of eye movement produced by each muscle.
**NERVE SUPPLY**

<table>
<thead>
<tr>
<th>Orbital Innervation</th>
<th>ORBITAL INNERVATION</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sensory</strong></td>
<td>2 Major Types</td>
<td>Vision (special somatic afferent) via the optic n. General sensation (general somatic afferent) via the ophthalmic (and some maxillary) division of the trigeminal n.</td>
</tr>
<tr>
<td><strong>Motor</strong></td>
<td>2 Major Types</td>
<td>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</td>
</tr>
<tr>
<td><strong>Cranial nn.</strong></td>
<td>5 cranial nerves provide innervation to the orbit: ● Optic—vision ● Oculomotor—extraocular motor and autonomies to the intrinsic muscles of the eye ● Trochlear—extraocular motor ● Trigeminal—general sensation ● Abducens—extraocular motor</td>
<td></td>
</tr>
</tbody>
</table>
Contents of the Orbit

**NERVE SUPPLY CONTINUED**
Contents of the Orbit

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 nerve enters the sclera, and posteriorly, where it merges with the periosteum lining the orbit at the optic foramen. Central artery of the retina enters the optic nerve posterior to the bulb of the eye.

Course

Axons from the ganglionic cells of the retina comprise the optic nerve and come together at the optic disc. They leave the eye and travel as the optic nerve posteriorly and medially through the orbit. Posteriorly, the optic nerve passes through the optic foramen to enter the cranial cavity. The two optic nerves 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

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lacrimal</td>
<td>Ophthalmic division of the trigeminal n.</td>
<td>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.</td>
</tr>
<tr>
<td>Frontal</td>
<td></td>
<td>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 periorbitum 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.</td>
</tr>
<tr>
<td>Supraorbital</td>
<td>Frontal n.; the 2 terminal branches of the frontal n. in the orbit</td>
<td>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.</td>
</tr>
<tr>
<td>Supratrochlear</td>
<td></td>
<td>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.</td>
</tr>
<tr>
<td>Nasociliary</td>
<td>Ophthalmic division of the trigeminal n.</td>
<td>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.</td>
</tr>
<tr>
<td>Sensory root of the ciliary ganglion</td>
<td>Nasociliary n.</td>
<td>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.</td>
</tr>
<tr>
<td>Long ciliary</td>
<td></td>
<td>There are 2 to 4 branches that travel anteriorly to enter the posterior part of the sclera of the eye.</td>
</tr>
</tbody>
</table>
Contents of the Orbit

**NERVE SUPPLY CONTINUED**

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posterior ethmoidal</td>
<td>Nasociliary n.</td>
<td>Travels deep to the superior oblique m. to pass through the posterior ethmoidal foramen. Supplies the sphenoid sinus and the posterior ethmoidal sinus.</td>
</tr>
<tr>
<td>Anterior ethmoidal</td>
<td></td>
<td>Arises on the medial wall of the orbit. Enters the anterior ethmoidal foramen and travels through the canal to enter the anterior cranial fossa. Provides the anterior and middle ethmoidal sinuses before entering and supplying the nasal cavity. Terminates as the external nasal n. on the face.</td>
</tr>
<tr>
<td>Infratrochlear</td>
<td></td>
<td>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.</td>
</tr>
</tbody>
</table>

**Superior view**

- Supratrochlear nerve
- Infratrochlear nerve
- Nasociliary nerve
- Trochlear nerve (IV)
- Ophthalmic nerve (V₁)
- Optic nerve (II)
- Oculomotor nerve (III)
- Trochlear nerve (IV)
- Abducent nerve (VI)

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

- Supratrochlear nerve (*cut*)
- Supraorbital nerve branches (*cut*)
- Infratrochlear nerve
- Anterior ethmoidal nerve
- Optic nerve (II)
- Posterior ethmoidal nerve
- Superior branch of oculomotor nerve (III) (*cut*)
- Nasociliary nerve
- Internal carotid plexus
- Trochlear nerve (IV) (*cut*)
- Oculomotor nerve (III)
- Abducent nerve (VI)

**Long ciliary nerves**

- Short ciliary nerves
- Lacrimal nerve
- Ciliary ganglion
- Parasympathetic root of ciliary ganglion (from inferior branch of oculomotor nerve)
- Sympathetic root of ciliary ganglion (from internal carotid plexus)
- Sensory root of ciliary ganglion (from nasociliary nerve)
- Branches to inferior and medial rectus muscles
- Abducent nerve (VI)
- Inferior branch of oculomotor nerve (III)
- Lacrimal nerve
- Frontal nerve (*cut*)
- Ophthalmic nerve (V₁)
Contents of the Orbit

**NERVE SUPPLY CONTINUED**

### GENERAL SENSATION

<table>
<thead>
<tr>
<th>Maxillary Division of the Trigeminal Nerve</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Travels along the lateral wall of the cavernous sinus</strong></td>
</tr>
<tr>
<td><strong>Before exiting the middle cranial fossa, it gives off a meningeal branch that innervates the dura mater</strong></td>
</tr>
<tr>
<td><strong>Passes from the middle cranial fossa into the pterygopalatine fossa via the foramen rotundum</strong></td>
</tr>
<tr>
<td><strong>Within the pterygopalatine fossa, it gives rise to 4 branches:</strong></td>
</tr>
<tr>
<td>- posterior superior alveolar n., zygomatic n., ganglionic branches, and the infraorbital n.</td>
</tr>
<tr>
<td><strong>The zygomatic and infraorbital continue within the orbit</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Zygomatic</strong></td>
<td>Maxillary division of the trigeminal n.</td>
<td>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.</td>
</tr>
<tr>
<td><strong>Infraorbital</strong></td>
<td></td>
<td>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:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Inferior palpebral—supplies the skin of the lower eyelid and conjunctiva</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Nasal—supplies the ala of the nose</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Superior labial—supplies the skin of the upper lip</td>
</tr>
</tbody>
</table>

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![Diagram of the orbital nerve supply](chart.png)
### Contents of the Orbit

**NERVE SUPPLY CONTINUED**

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oculomotor (cranial n. III)</td>
<td>Ventral surface of the midbrain</td>
<td>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.</td>
</tr>
<tr>
<td>Superior division of the oculomotor</td>
<td>Oculomotor</td>
<td>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.</td>
</tr>
</tbody>
</table>
| 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

Long ciliary nerve
Short ciliary nerves
Superior oblique muscle
Levator palpebrae superiors muscle
Ciliary ganglion
Sensory root of ciliary ganglion
Sympathetic root of ciliary ganglion
Superior division of oculomotor nerve
Frontal nerve (cut)
Lacrimal nerve (cut)
Nasociliary nerve
Trochlear nerve (IV)
Oculomotor nerve (III)
Ophthalmic nerve (V1)
Infraorbital nerve
Zygomatic nerve (cut)
Inferior oblique muscle
Ciliary muscle
Dilator muscle of pupil
Sphincter muscle of pupil
Efferent fibers
Afferent fibers
Sympathetic fibers
Parasympathetic fibers
Abducens nerve (VI)
Mandibular nerve (V3)
Maxillary nerve (V2)
Internal carotid artery and nerve plexus
Lateral rectus muscle and abducens nerve (turned back)
### Parasympathetics of the Eye

<table>
<thead>
<tr>
<th>Type of Neuron</th>
<th>Location of Cell Body</th>
<th>Characteristics of the Cell Body</th>
<th>Course of the Neuron</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preganglionic neuron</td>
<td>Edinger-Westphal nucleus</td>
<td>A collection of nerve cell bodies located in the midbrain</td>
<td>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.</td>
</tr>
<tr>
<td>Postganglionic neuron</td>
<td>Ciliary ganglion</td>
<td>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.</td>
<td>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.</td>
</tr>
</tbody>
</table>
Contents of the Orbit

NERVE SUPPLY CONTINUED
## Contents of the Orbit

### Nerve Supply

<table>
<thead>
<tr>
<th>Type of Neuron</th>
<th>Name of Cell Body</th>
<th>Characteristics of the Cell Body</th>
<th>Course of the Neuron</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preganglionic neuron</td>
<td>Intermediolateral horn nucleus</td>
<td>Collection of nerve cell bodies located in the lateral horn nucleus of the spinal cord between spinal segments T1 and T3 (and possibly T4)</td>
<td>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</td>
</tr>
<tr>
<td>Postganglionic neuron</td>
<td>Superior cervical ganglion</td>
<td>Collection of nerve cell bodies located in the superior cervical ganglion, which is located at the base of the skull</td>
<td>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.</td>
</tr>
</tbody>
</table>

### Vascular Supply

<table>
<thead>
<tr>
<th>Artery</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ophthalmic</td>
<td>Internal carotid a.</td>
<td>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.</td>
</tr>
<tr>
<td>Lacrimal</td>
<td>Ophthalmic a.</td>
<td>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</td>
</tr>
<tr>
<td>Supratrochlear</td>
<td></td>
<td>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</td>
</tr>
</tbody>
</table>
## Contents of the Orbit

### VASCULAR SUPPLY CONTINUED

<table>
<thead>
<tr>
<th>Artery</th>
<th>Source</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supraorbital</td>
<td>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.</td>
<td></td>
</tr>
<tr>
<td>Anterior ethmoidal</td>
<td>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.</td>
<td></td>
</tr>
<tr>
<td>Posterior ethmoidal</td>
<td>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.</td>
<td></td>
</tr>
<tr>
<td>External nasal</td>
<td>A terminal branch of the anterior ethmoidal a.</td>
<td>Supplies the area along the external nose at the junction between the nasal bone and the lateral nasal cartilage.</td>
</tr>
<tr>
<td>Medial palpebral (superior and inferior)</td>
<td>Ophthalmic a. of the internal carotid a.</td>
<td>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.</td>
</tr>
<tr>
<td>Dorsal nasal (Infratrochlear)</td>
<td>One of the terminal branches of the ophthalmic a.'s terminal branches</td>
<td>Exits the orbit along the superomedial border along with the infratrochlear n. Supplies the area along the bridge of the nose.</td>
</tr>
<tr>
<td>Muscular</td>
<td>Ophthalmic a. from the internal carotid a.</td>
<td>Supply the extraocular muscles of the orbit.</td>
</tr>
<tr>
<td>Anterior ciliary</td>
<td>Muscular branches from the ophthalmic a.</td>
<td>Pass anteriorly to the anterior surface of the eye following the tendons of the extraocular muscles.</td>
</tr>
<tr>
<td>Short posterior ciliary</td>
<td>Ophthalmic a. from the internal carotid a.</td>
<td>Usually 6 to 10 arise. Travel anteriorly around the optic n. to enter the posterior portion of the eye.</td>
</tr>
<tr>
<td>Long posterior ciliary</td>
<td>Usually 2 arise. Travel anteriorly to enter the posterior portion of the eye near the optic n.</td>
<td></td>
</tr>
<tr>
<td>Central a. of the retina</td>
<td>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.</td>
<td></td>
</tr>
<tr>
<td>Maxillary</td>
<td>1 of 2 terminal branches of the external carotid a.</td>
<td>Gives rise to a series of branches. Only the infraorbital branch supplies the orbit.</td>
</tr>
<tr>
<td>Infraorbital</td>
<td>Maxillary a.</td>
<td>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.</td>
</tr>
</tbody>
</table>
Contents of the Orbit

VASCULAR SUPPLY  CONTINUED

Superior view
- Supratrochlear artery
- Dorsal nasal artery
- Anterior meningeal artery
- Anterior ethmoidal artery
- Posterior ethmoidal artery
- Continuation of ophthalmic artery
- Muscular branch
- Ophthalmic artery
- Internal carotid artery
- Medial palpebral artery
- Lateral palpebral artery
- Lacrimal gland
- Supraorbital artery
- Zygomatic branches
- Posterior ciliary arteries
- Muscular branch
- Lacrimal artery
- Central retinal artery

Anterior view
- Frontal branch of superficial temporal artery
- Superior lateral palpebral artery
- Inferior lateral palpebral artery
- Zygomaticofacial artery
- Transverse facial artery
- Infratrochlear artery
- Supraorbital artery
- Supratrochlear artery
- Dorsal nasal artery
- Superior medial palpebral artery
- Angular artery
- Inferior medial palpebral artery
- Superior and inferior palpebral arterial arches
- Facial artery

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

**VASCULAR SUPPLY CONTINUED**

### VENOUS DRAINAGE

<table>
<thead>
<tr>
<th>Vein</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Superficial Veins</strong></td>
<td></td>
</tr>
<tr>
<td>Supraorbital</td>
<td>Begins on the forehead, where it communicates with the superficial temporal v. at the medial angle of the orbit to form the angular v.</td>
</tr>
<tr>
<td>Supratrochlear</td>
<td>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.</td>
</tr>
<tr>
<td>Angular</td>
<td>Forms from the confluence of the supraorbital and supratrochlear v. along the medial part of the eye. Travels along the lateral aspect of the nose to become the facial v.</td>
</tr>
<tr>
<td>Facial</td>
<td>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</td>
</tr>
<tr>
<td><strong>Deep Veins</strong></td>
<td></td>
</tr>
<tr>
<td>Cavernous sinus</td>
<td>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</td>
</tr>
<tr>
<td>Pterygoid plexus</td>
<td>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 v.</td>
</tr>
<tr>
<td><strong>Communicating Veins</strong></td>
<td></td>
</tr>
<tr>
<td>Superior ophthalmic</td>
<td>Receives blood from the roof of the orbit and the scalp. Travels posteriorly to communicate with the cavernous sinus</td>
</tr>
<tr>
<td>Inferior ophthalmic</td>
<td>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</td>
</tr>
<tr>
<td>Infraorbital</td>
<td>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</td>
</tr>
</tbody>
</table>
Contents of the Orbit

**VASCULAR SUPPLY** CONTINUED

[Lateral view diagram]
- Supratrochlear vein
- Supraorbital vein
- Superior ophthalmic vein
- Cavernous sinus
- Inferior ophthalmic vein
- Pterygoid plexus
- Maxillary vein
- Angular vein
- Vorticose veins
- Facial vein
- Deep facial vein

[Skull sectioned horizontally: superior view]
- Superior ophthalmic vein
- Anterior and posterior intercavernous sinuses
- Superior pterygoid plexus
- Superior petrosal sinus
- Inferior petrosal sinus
- Cavernous sinus
- Hypophysis (pituitary gland)
- Optic nerve (II)
- Internal carotid artery
- Oculomotor nerve (III)
- Sphenoparietal sinus
- Trochlear nerve (IV)
- Ophthalmic nerve (V1)
- Maxillary nerve (V2)
- Trigeminal ganglion
- Mandibular nerve (V3)
- Middle meningeal artery
- Abducens nerve (VI)
- Basilar venous plexus
- Superior and posterior intercavernous sinuses
- Superficial middle cerebral vein (cut)
- Internal carotid artery
- Hypophysis (pituitary gland)
- Optic chiasm
- Posterior communicating artery
- Internal carotid artery
- Hypophysis (pituitary gland)
- Sphenoidal sinus
- Nasopharynx
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LACRIMAL APPARATUS

OVERVIEW

<table>
<thead>
<tr>
<th>Structure/Function</th>
<th>Description</th>
</tr>
</thead>
</table>
| 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 |
### Contents of the Orbit

**Lacrimal Apparatus Continued**

#### Parasympathetics of the Lacrimal Gland

<table>
<thead>
<tr>
<th>Type of Neuron</th>
<th>Name of Cell Body</th>
<th>Characteristics of the Cell Body</th>
<th>Course of the Neuron</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preganglionic neuron</td>
<td>Superior salivatory nucleus</td>
<td>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.</td>
<td>Lacrimal gland uses the greater petrosal n. <strong>Greater Petrosal Nerve</strong> 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</td>
</tr>
<tr>
<td>Postganglionic neuron</td>
<td>Pterygopalatine ganglion</td>
<td>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</td>
<td>Lacrimal gland uses the ophthalmic and maxillary divisions <strong>Ophthalmic and Maxillary Division Distribution</strong> 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</td>
</tr>
</tbody>
</table>

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.

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.
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
Dynamic equilibrium between aqueous production and drainage

Imbalance in aqueous production and drainage

Corneal edema
Hyperemia
Closed angle

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.

Inflamed eye with nonreactive, mid-dilated pupil typical of acute attack
Synechia
Synechial closure persists
Compression gonioscopy
Appositional closure opened

Long-term angle closure may result in synechiae that can permanently close angle. Compression gonioscopy differentiates appositional closure from synechial closure

Primary block at pupil
Central anterior chamber shallow

Secondary block in angle

Pupillary block

Plateau iris

Angle closure may result from primary pupillary block with bulging iris or from less common plateau iris (primary occlusion at periphery of iris)

Consensual response

Corneal edema diffracts light, causing rainbow halos around objects and lights

Synechiae
Synechial closure with peripheral anterior synechiae

Appositional closure opened by compression gonioscopy
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**

- 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
- Surgically altered corneal curvature allows clear focusing of image on retina
Overview of the Autonomic Nervous System

Sympathetics of the Head and Neck

Parasympathetic Pathways of the Head and Neck

Clinical Correlate
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
Overview of the Autonomic Nervous System

DIVISIONS OF THE AUTONOMIC NERVOUS SYSTEM

<table>
<thead>
<tr>
<th>Parasympathetic</th>
<th>Sympathetic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Referred to as craniosacral fibers</td>
<td>Referred to as thoracolumbar fibers</td>
</tr>
<tr>
<td>Arise from:</td>
<td>Arise from:</td>
</tr>
<tr>
<td>• Cranial nerves III, VII, IX, and X</td>
<td>• Thoracic fibers 1 to 12</td>
</tr>
<tr>
<td>• Sacral fibers 2–4</td>
<td>• Lumbar fibers 1 and 2</td>
</tr>
<tr>
<td>Preganglionic fibers are myelinated and travel from</td>
<td>Preganglionic fibers are myelinated and travel</td>
</tr>
<tr>
<td>the CNS to their autonomic ganglia</td>
<td>from the CNS to their autonomic ganglia</td>
</tr>
<tr>
<td>(located near their respective effector organ in</td>
<td>(located in the sympathetic chain for the head</td>
</tr>
<tr>
<td>the head and neck) utilizing acetylcholine as the</td>
<td>and neck) utilizing acetylcholine as the</td>
</tr>
<tr>
<td>neurotransmitter at the synapse with the nicotinic</td>
<td>neurotransmitter at the synapse with the</td>
</tr>
<tr>
<td>receptor</td>
<td>nicotinic receptor</td>
</tr>
<tr>
<td>Postganglionic fibers are unmyelinated and travel</td>
<td>Postganglionic fibers are unmyelinated and</td>
</tr>
<tr>
<td>from the autonomic ganglia to the effector organ,</td>
<td>travel from the autonomic ganglia to the</td>
</tr>
<tr>
<td>utilizing acetylcholine as the neurotransmitter at</td>
<td>effector organ, typically utilizing norepinephrine* as the</td>
</tr>
<tr>
<td>the synapse with the muscarinic receptor</td>
<td>neurotransmitter at the synapse with the</td>
</tr>
<tr>
<td></td>
<td>nicotinic receptor</td>
</tr>
</tbody>
</table>

*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

<table>
<thead>
<tr>
<th>Parasympathetic</th>
<th>Sympathetic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Responsible for preserving and restoring energy</td>
<td>Responsible for preparing the body for emergency situations</td>
</tr>
<tr>
<td>Discharges focally, not as a complete system</td>
<td>Discharges as a complete system</td>
</tr>
<tr>
<td>Activated in response to the specific body function</td>
<td>Activated in response to stressful situations</td>
</tr>
<tr>
<td>that needs to be adjusted (peristalsis, pupillary</td>
<td>(helps to increase cardiac output, get blood to</td>
</tr>
<tr>
<td>accommodation)</td>
<td>muscles, and decrease blood flow to the skin and</td>
</tr>
<tr>
<td></td>
<td>viscera)</td>
</tr>
</tbody>
</table>
Overview of the Autonomic Nervous System

FUNCTIONS OF THE AUTONOMIC NERVOUS SYSTEM CONTINUED
Overview of the Autonomic Nervous System

FUNCTIONS OF THE AUTONOMIC NERVOUS SYSTEM CONTINUED

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Central Nervous System

**Parasympathetics**
- Nucleus of Edinger-Westphal
- Superior salivatory nucleus
- Inferior salivatory nucleus

**Sympathetics**
- T1-T2 Intermedio-lateral cell column

Peripheral Nervous System

- Cranial n. III
- Cranial n. VII
- Cranial n. IX

- Superior cervical ganglion

- Pterygopalatine ganglion
- Submandibular ganglion
- Otic ganglion

- Ciliary ganglion

- Pupillary constrictor m.
- Pupillary dilator m.

- Lacrimal glands
- Nasal mucosal glands
- Submandibular gland
- Sublingual gland
- Parotid gland

- Sweaty glands and vascular smooth muscle in head and neck

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*J. Perkins*  
MS, MFA
Overview of the Autonomic Nervous System

FUNCTIONS OF THE AUTONOMIC NERVOUS SYSTEM CONTINUED

<table>
<thead>
<tr>
<th>Synapses</th>
<th>Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Adrenergic</td>
<td>α or β Alpha or beta adrenergic</td>
</tr>
<tr>
<td>C Cholinergic</td>
<td>N Nicotinic</td>
</tr>
<tr>
<td></td>
<td>M Muscarinic</td>
</tr>
</tbody>
</table>

J. Perkins
MS, MFA
### General Anatonic Pathway

<table>
<thead>
<tr>
<th>Type of Neuron</th>
<th>Name of Cell Body</th>
<th>Characteristics of the Cell Body</th>
<th>Course of the Neuron</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preganglionic fibers</td>
<td>Intermediolateral horn nucleus</td>
<td>Collection of nerve cell bodies located in the lateral horn nucleus of the spinal cord between spinal segments T1 and T3 (and possibly T4)</td>
<td>Fibers arise from the intermediolateral horn nuclei from T1 to T3 (and possibly T4) 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</td>
</tr>
<tr>
<td>Postganglionic fibers</td>
<td>Superior cervical ganglion* (major part of head and neck)</td>
<td>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</td>
<td>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)</td>
</tr>
</tbody>
</table>

*Location of the cell body for the postganglionic is variable and depends on the course of this neuron.
Sympathetics of the Head and Neck

**GENERAL ANATOMIC PATHWAY CONTINUED**
### Parasympathetic Pathways of the Head and Neck

**Cranial Nerve III With Corresponding Sympathetics**

<table>
<thead>
<tr>
<th>Type of Neuron</th>
<th>Name of Neuron</th>
<th>Characteristics of the Cell Body</th>
<th>Course of the Neuron</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preganglionic neuron</td>
<td>Edinger-Westphal nucleus</td>
<td>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.</td>
<td>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 n. 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.</td>
</tr>
<tr>
<td>Postganglionic neuron</td>
<td>Ciliary ganglion</td>
<td>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.</td>
<td>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.</td>
</tr>
</tbody>
</table>

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**Anatomic Pathway for Parasympathetics of the Eye**

<table>
<thead>
<tr>
<th>Type of Neuron</th>
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<th>Course of the Neuron</th>
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<td>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 n. 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.</td>
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<td>Ciliary ganglion</td>
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<td>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.</td>
</tr>
</tbody>
</table>
### ANATOMIC PATHWAY FOR SYMPATHETICS OF THE EYE

<table>
<thead>
<tr>
<th>Type of Neuron</th>
<th>Name of Cell Body</th>
<th>Characteristics of the Cell Body</th>
<th>Course of the Neuron</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preganglionic neuron</td>
<td>Intermediolateral horn nucleus</td>
<td>Collection of nerve cell bodies located in the lateral horn nucleus of the spinal cord between spinal segments T1 and T3 (and possibly T4)</td>
<td>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</td>
</tr>
</tbody>
</table>

| 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. |
Short ciliary nerves

Ciliary ganglion

Sensory root of ciliary ganglion

Sympathetic root of ciliary ganglion

Frontal nerve (cut)

Lacrimal nerve (cut)

Nasociliary nerve

Nasociliary nerve

Ciliary muscle

Dilator muscle of pupil

Sphincter muscle of pupil

Oculomotor nucleus

Accessory oculomotor nucleus (Edinger-Westphal)

Nucleus (parasympathetic)

Oculomotor nerve (III)

Ophthalmic nerve (V1)

Inferior division of oculomotor nerve

Parasympathetic root of ciliary ganglion

Efferent fibers

Afferent fibers

Sympathetic fibers

Parasympathetic fibers

Parasympathetic Pathways of the Head and Neck

CRANIAL NERVE III WITH CORRESPONDING SYMPATHETICS CONTINUED
Parasympathetic Pathways of the Head and Neck

CRANIAL NERVE III WITH CORRESPONDING SYMPATHETICS CONTINUED

- Sphincter muscle of pupil
- Dilator muscle of pupil
- Ciliary muscle
- Short ciliary nerves
- Ciliary ganglion
- Oculomotor (parasympathetic) root of ciliary ganglion
- Accessory oculomotor (Edinger-Westphal) nucleus (parasympathetic)
- Superior colliculus
- Lateral geniculate body
- Optic nerve (II)
- Nasociliary nerve
- Long ciliary nerve
- Nasociliary (sensory) root of ciliary ganglion
- Sympathetic root of ciliary ganglion
- Ophthalmic artery
- Ophthalmic (sensorimotor) nerve (V1)
- Trigeminal ganglion
- Internal carotid plexus
- Internal carotid artery
- Thoracic part of spinal cord
- Presynaptic sympathetic cell bodies in intermediodorsal nucleus (lateral horn) of gray matter
- Tectospinal tract
- Gray ramus communicans
- White ramus communicans.
- T1 spinal nerve

Legend:
- Presynaptic
- Postsynaptic
- Sympathetic fibers
- Parasympathetic fibers
- Afferent fibers
- Visual pathway
- Descending pathway
### Parasympathetic Pathways of the Head and Neck

**CRANIAL NERVE VII**

#### ANATOMIC PATHWAY FOR PARASYMPATHETICS OF THE LACRIMAL, NASAL, PALATINE, PHARYNGEAL, SUBMANDIBULAR, AND SUBLINGUAL GLANDS

<table>
<thead>
<tr>
<th>Type of Neuron</th>
<th>Name of Cell Body</th>
<th>Characteristics of the Cell Body</th>
<th>Course of the Neuron</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preganglionic neuron</td>
<td>Superior salivatory nucleus</td>
<td>A collection of nerve cell bodies located in the pons</td>
<td><strong>Greater Petrosal Nerve</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Travel through the nervus intermedius of the facial n. into the internal acoustic meatus</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>In the facial canal, the facial n. gives rise to 2 parasympathetic branches:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Greater petrosal n.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Chorda tympani n.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>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.).</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Vidian n. passes through the pterygoid canal and enters the pterygopalatine fossa, where it joins with the pterygopalatine ganglion.</em></td>
<td></td>
</tr>
<tr>
<td>Postganglionic neuron</td>
<td>Pterygopalatine ganglion</td>
<td>A collection of nerve cell bodies located in the pterygopalatine fossa</td>
<td><strong>Ophthalmic and Maxillary Division Distribution</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Postganglionic parasympathetic fibers that arise in the pterygopalatine ganglion are distributed to the ophthalmic and maxillary divisions of the trigeminal n. to the:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Lacrimal gland</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Nasal glands</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Palatine glands</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Pharyngeal glands</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Postganglionic fibers travel along the zygomatic branch of the maxillary division for a short distance to enter the orbit.</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>A short communicating branch joins the lacrimal n. of the ophthalmic division of the trigeminal n.</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>These fibers innervate:</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Lacrimal gland to cause the secretion of tears</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Maxillary Division Distribution</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>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)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>These fibers innervate:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Nasal glands</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Palatine glands</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Pharyngeal glands</td>
<td></td>
</tr>
<tr>
<td>Submandibular gland</td>
<td></td>
<td>A collection of nerve cell bodies that is located in the oral cavity</td>
<td><strong>Postganglionic parasympathetic fibers arise in the submandibular ganglion and are distributed to the:</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>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</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Submandibular gland</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Sublingual gland</em></td>
<td></td>
</tr>
</tbody>
</table>
Parasympathetic Pathways of the Head and Neck

CRANIAL NERVE VII CONTINUED
### Parasympathetic Pathways of the Head and Neck

#### CRANIAL NERVE VII CONTINUED

#### ANATOMIC PATHWAY FOR SYMPATHETICS OF THE NASAL CAVITY, LACRIMAL GLAND, PALATE, AND SUBMANDIBULAR AND SUBLINGUAL GLANDS

<table>
<thead>
<tr>
<th>Type of Neuron</th>
<th>Name of Cell Body</th>
<th>Characteristics of the Cell Body</th>
<th>Course of the Neuron</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preganglionic neuron</td>
<td>Intermediolateral horn nucleus</td>
<td>Collection of nerve cell bodies located in the lateral horn nucleus of the spinal cord between spinal segments T1 and T3 (and possibly T4)</td>
<td>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</td>
</tr>
<tr>
<td>Postganglionic neuron</td>
<td>Superior cervical ganglion</td>
<td>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</td>
<td>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</td>
</tr>
</tbody>
</table>
Superior salivatory nucleus (parasympathetic)
Facial nerve (VII)
Geniculum
Greater petrosal nerve (parasympathetic)
Deep petrosal nerve (sympathetic)
Nerve (Vidian) of pterygoid canal
Maxillary nerve (V2) entering foramen rotundum
Pterygopalatine ganglion in pterygopalatine fossa
Lateral and medial posterior superior nasal branches in pterygopalatine fossa
Infraorbital nerve
Posterior superior and interior lateral nasal nerves (cut ends)

Tympanic cavity
Internal carotid nerve
Internal carotid artery
Superior cervical ganglion
Greater and lesser palatine nerves
Posterior superior alveolar nerves
Maxillary sinus
Nasopalatine nerve
Postganglionic sympathetic fibers to vessels (sympathetic) and glands (parasympathetic) of nasal cavity, maxillary sinus and palate

Presynaptic sympathetic cell bodies in intermediolateral nucleus (lateral horn) of gray matter

Presynaptic parasympathetic fibers
Postsynaptic parasympathetic fibers
Presynaptic sympathetic fibers
Postsynaptic sympathetic fibers
Parasympathetic Pathways of the Head and Neck

CRANIAL NERVE VII CONTINUED
## ANATOMIC PATHWAY FOR PARASYMPATHETICS OF THE PAROTID GLAND

<table>
<thead>
<tr>
<th>Type of Neuron</th>
<th>Name of Cell Body</th>
<th>Characteristics of the Cell Body</th>
<th>Course of the Neuron</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preganglionic neuron</td>
<td>Inferior salivatory nucleus</td>
<td>A collection of nerve cell bodies located in the medulla</td>
<td>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.</td>
</tr>
</tbody>
</table>

| 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 |
Parasympathetic Pathways of the Head and Neck

CRANIAL NERVE IX WITH CORRESPONDING SYMPATHETICS CONTINUED
**Parasympathetic Pathways of the Head and Neck**

**ANATOMIC PATHWAY FOR PARASYMPATHTICS OF THE EYE**

<table>
<thead>
<tr>
<th>Type of Neuron</th>
<th>Name of Cell Body</th>
<th>Characteristics of the Cell Body</th>
<th>Course of the Neuron</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preganglionic neuron</td>
<td>Intermediolateral horn nucleus</td>
<td>Collection of nerve cell bodies located in the lateral horn nucleus of the spinal cord between spinal segments T1 and T3 (and possibly T4)</td>
<td>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</td>
</tr>
<tr>
<td>Postganglionic neuron</td>
<td>Superior cervical ganglion</td>
<td>Collection of nerve cell bodies located in the superior cervical ganglion, which is located at the base of the skull</td>
<td>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</td>
</tr>
</tbody>
</table>
Parasympathetic Pathways of the Head and Neck

CRANIAL NERVE IX WITH CORRESPONDING SYMPATHETICS CONTINUED
## CRANIAL NERVE X

### ANATOMIC PATHWAY FOR PARASYMPATHETICS OF THE VAGUS NERVE*

<table>
<thead>
<tr>
<th>Type of Neuron</th>
<th>Name of Cell Body</th>
<th>Characteristics of the Cell Body</th>
<th>Course of the Neuron</th>
</tr>
</thead>
</table>
| 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
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)
Overview and Topographic Anatomy

Mandibular Injections

Maxillary Injections
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

**INNERRVATION AND OSTELOGY 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
## 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

Area anesthetized by an inferior alveolar injection

Area anesthetized by an inferior alveolar injection

Area anesthetized by an inferior alveolar injection
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
Mandibular Injections

MENTAL NERVE BLOCK CONTINUED

- Inferior alveolar nerve
- Masseteric nerve
- Incisive nerve
- Buccal nerve
- Chorda tympani nerve
- Mental nerve

INTRAORAL INJECTIONS 571
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
Mandibular Injections

GOW-GATES BLOCK CONTINUED

Corner of mouth

Area anesthetized by a Gow-Gates injection

Condyle

Intertragic notch
Mandibular Injections

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
Mandibular Injections

AKINOSI BLOCK CONTINUED

Area anesthetized by an Akinosi injection

- Inferior alveolar nerve
- Masseteric nerve
- Incisive nerve
- Mental nerve
- Buccal nerve
- Chorda tympani nerve
Mandibular Injections

AKINOSI BLOCK CONTINUED

- Pterygomandibular raphe
- Medial pterygoid
- Inferior alveolar n., a., and v.
- Lingual nerve
- Buccal nerve
- Buccinator
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*

- Infraorbital nerve
- Maxillary nerve
- Posterior superior alveolar nerve
- Middle superior alveolar nerve
- Anterior superior alveolar nerve
- Foramen ovale
- Foramen spinosum
- Spine of sphenoid bone
- Sphenopalatine foramen
- Pterygopalatine fossa
- Choanae (posterior nares)
- Lateral plate
- Medial plate
- Hamulus
- process
- Tuberosity of maxilla
- Infratemporal fossa
- Alveolar process of maxilla
- Spine of sphenoid bone
- Foramen spinosum
## 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
Maxillary Injections

POSTERIOR SUPERIOR ALVEOLAR NERVE BLOCK CONTINUED

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

May not always anesthetize the mesiobuccal root of the 1st maxillary molar
Maxillary Injections

POSTERIOR SUPERIOR ALVEOLAR NERVE BLOCK  CONTINUED
Maxillary Injections

**NASOPALATINE NERVE BLOCK**

<table>
<thead>
<tr>
<th>OVERVIEW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Considered the most painful of dental injections</td>
</tr>
<tr>
<td>Because of the sensitivity of the area, pressure anesthesia (e.g., using a cotton swab applicator) is helpful at the site of injection</td>
</tr>
</tbody>
</table>

**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

<table>
<thead>
<tr>
<th>GENERAL METHODOLOGY</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Steps:</strong></td>
</tr>
<tr>
<td>- Use a cotton swab applicator to apply pressure to the injection site</td>
</tr>
<tr>
<td>- Insert the needle into the palatal mucosa lateral to the incisive papilla</td>
</tr>
<tr>
<td>- Deposit a small amount of anesthetic to help lessen the trauma; the vasoconstrictor norepinephrine then causes the area’s soft tissue to blanch</td>
</tr>
<tr>
<td>- Advance the needle until it contacts the hard palate</td>
</tr>
<tr>
<td>- Withdraw the needle slightly and perform aspiration</td>
</tr>
<tr>
<td>- After a negative result on aspiration, very slowly inject the anesthetic</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CONSIDERATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure anesthesia is beneficial to help lessen the pain</td>
</tr>
<tr>
<td>Because the tissue is so dense and is attached to the bone, this block requires a slow injection</td>
</tr>
</tbody>
</table>

Area anesthetized by a nasopalatine injection
Maxillary Injections

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:
1. 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)
2. Use a cotton swab applicator to apply pressure to the injection site
3. 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
4. Advance the needle until it contacts the hard palate
5. Withdraw the needle slightly and perform aspiration
6. 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
Maxillary Injections

GREATER PALATINE NERVE BLOCK CONTINUED

Area anesthetized by a greater palatine injection

Nasopalatine nerve

Greater palatine nerve

Lesser palatine nerve
Maxillary Injections

**MIDDLE SUPERIOR ALVEOLAR NERVE BLOCK**

<table>
<thead>
<tr>
<th>OVERVIEW</th>
</tr>
</thead>
<tbody>
<tr>
<td>The middle superior alveolar nerve is reported to be present in about 30% of all people.</td>
</tr>
</tbody>
</table>

**Areas anesthetized:**
- All maxillary premolars and possibly the mesiobuccal root of the 1st maxillary molar
- Buccal gingiva opposite the teeth

<table>
<thead>
<tr>
<th>GENERAL METHODOLOGY</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Steps:</strong></td>
</tr>
<tr>
<td>- Insert the needle into the mucosa at the mucobuccal fold just superior to the area of the maxillary 2nd premolar</td>
</tr>
<tr>
<td>- Advance the needle until the tip is superior to the apex of the maxillary 2nd premolar for maximum anesthesia</td>
</tr>
<tr>
<td>- After a negative result on aspiration, slowly inject the anesthetic</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CONSIDERATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local infiltrations are a common substitute for this block</td>
</tr>
<tr>
<td>This area is somewhat avascular, and hematoma formation is rare</td>
</tr>
</tbody>
</table>

Area anesthetized by a middle superior alveolar injection

Area anesthetized by a middle superior alveolar injection
Maxillary Injections

MIDDLE SUPERIOR ALVEOLAR NERVE BLOCK CONTINUED

Infraorbital nerve
Maxillary nerve
Middle superior alveolar nerve
Anterior superior alveolar nerve
Posterior superior alveolar nerve
Maxillary Injections

**INFRAORBITAL/ANTERIOR SUPERIOR ALVEOLAR NERVE BLOCK**

<table>
<thead>
<tr>
<th>OVERVIEW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less frequently used because of the risk of the clinician injuring the patient’s eye</td>
</tr>
<tr>
<td>This block anesthetizes the following nerves:</td>
</tr>
<tr>
<td>- Anterior superior alveolar nerve</td>
</tr>
<tr>
<td>- Middle superior alveolar nerve</td>
</tr>
<tr>
<td>- Infraorbital nerve</td>
</tr>
</tbody>
</table>

**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

<table>
<thead>
<tr>
<th>GENERAL METHODOLOGY</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Steps:</strong></td>
</tr>
<tr>
<td>- Locate the infraorbital foramen via palpation</td>
</tr>
<tr>
<td>- Insert the needle into the mucosa at the mucobuccal fold in the area superior to the 1st maxillary premolar</td>
</tr>
<tr>
<td>- Advance the needle parallel to the long axis of the tooth until it contacts the bone of the infraorbital foramen</td>
</tr>
<tr>
<td>- After a negative result on aspiration, slowly inject the anesthetic</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CONSIDERATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>No significant potential for a hematoma</td>
</tr>
<tr>
<td>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</td>
</tr>
</tbody>
</table>
Maxillary Injections

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 30mm; 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 Injections

MAXILLARY DIVISION BLOCK  CONTINUED

Area anesthetized by a maxillary division injection

Area anesthetized by a maxillary division injection
Maxillary Injections

MAXILLARY DIVISION BLOCK CONTINUED

- Nasopalatine nerve
- Greater palatine nerve
- Lesser palatine nerve
- Soft palate
Appendix
Lymphatics
Lymphatics

Lymphatics of upper limb
- Tonsils
- Cervical lymph nodes
- Axillary lymph nodes
- Lymph nodes of mammary gland
- Spleen
- Iliac lymph nodes
- Inguinal lymph nodes
- Bone marrow

Lymphatics of lower limb
- Mediastinal lymph nodes
- Cisterna chyli
- Lymphoid nodules of intestine
- Lumbar lymph nodes
- Thoracic duct
- Thymus gland
- Right lymphatic duct

Drainage of right lymphatic duct
Drainage of thoracic duct

Lymphatics of lower limb
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
Lymphatics

Lymphatic drainage of pharynx: posterior view

Lymphatic drainage of tongue

Rectus capitis anterior muscle (cut)

Pharyngobasilar fascia
Retropharyngeal nodes
Internal jugular vein
Digastric muscle (posterior belly)
Sternocleidomastoid muscle
Intercalated node
Jugulodigastric node
Deep lateral cervical (internal jugular) nodes
Jugulo-omohyoid node
Apical collecting vessels
Central collecting vessels
Marginal collecting vessels
Basal collecting vessels
Communication to opposite side
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Submandibular node
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Lymphatic drainage of pharynx:
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