



# NETTER'S Surgical Anatomy Review

P.R.N. 2nd Edition  
Robert B. Trelease

*F. Netter  
M.D.*

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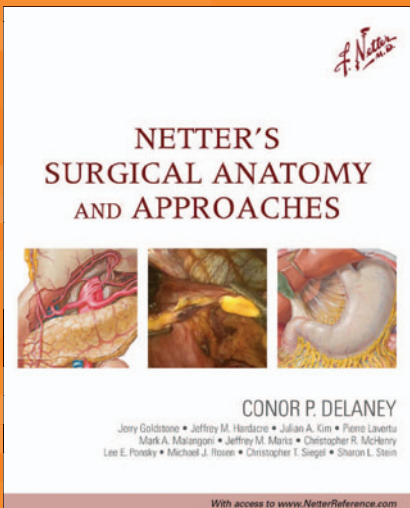
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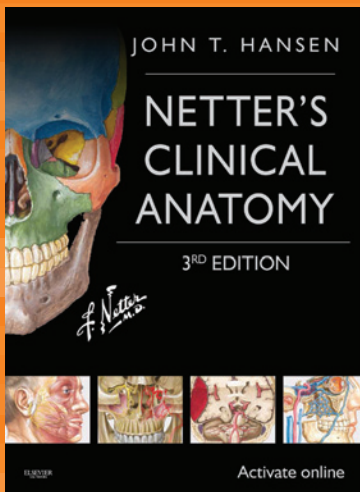
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ISBN: 978-1-4557-7008-3



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P.R.N. 2nd Edition

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NETTER'S SURGICAL ANATOMY REVIEW P.R.N. ISBN: 978-0-323-44727-0

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The Publisher

## Library of Congress Cataloging-in-Publication Data

Names: Trelease, Robert Bernard, author. | Netter, Frank H. (Frank Henry), 1906-1991, illustrator.

Title: Netter's surgical anatomy review P.R.N. / Robert B. Trelease ; illustrations by Frank H. Netter ; contributing illustrators, Carlos A.G. Machado, Kristen Wienandt Marzejon, Tiffany DeVanzo, John A. Craig.

Other titles: Netter's surgical anatomy review pro re nata | Surgical anatomy review PRN

Description: Second edition. | Philadelphia, PA : Elsevier, [2017] | Includes index.

Identifiers: LCCN 2015047555 | ISBN 9780323447270 (pbk.)

Subjects: | MESH: Surgical Procedures, Operative | Anatomy | Atlases

Classification: LCC QM531 | NLM WO 517 | DDC 611/.9--dc23 LC record available at <http://lccn.loc.gov/2015047555>

*Content Strategist:* Elyse O'Grady

*Content Development Specialist:* Marybeth Thiel

*Publishing Services Manager:* Patricia Tannian

*Project Manager:* Ted Rodgers

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***This book is dedicated to***

*My parents, Florence and Robert Trelease (Sr.),  
who always supported my pursuit of learning  
and science;*

*My wife, Barbara, and our daughters, Cristin  
and Heather, who have motivated all my work;*

*My students, who will put their anatomical  
knowledge to good use in caring for their  
patients.*

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## About the Author

**Robert B. Trelease, PhD**, is Professor in the Division of Integrative Anatomy, Department of Pathology and Laboratory Medicine, in the David Geffen School of Medicine (DGSOM) at UCLA. In 1996, Dr. Trelease became a founding member of and Faculty Advisor to the Instructional Design and Technology Unit (IDTU), part of the DGSOM Dean's Office established to develop online learning resources for medical education. IDTU currently provides and manages a broad range of web server- and mobile device-based educational resources for all 4 years of the medical school curriculum, as well as developing new multimedia teaching tools and course management applications. Dr. Trelease currently serves as Associate Director of IDTU, in addition to teaching medical gross anatomy, embryology, and neuroanatomy.

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# Preface

**Netter's Surgical Anatomy Review P.R.N.** is a just-in-time, point-of-contact review of anatomy for the most common of the surgically treated diseases and diagnoses encountered during medical student clerkships and general surgery residencies.

This second edition includes new chapters on Heart Diseases and Lungs and Respiratory Diseases, content requested by users of the first edition and its electronic versions. This extends the coverage of material from general surgery into thoracic surgery. There are also new updated Netter Figures contributed by Dr. Carlos Machado, Kristen Wienandt Marzejon, and Tiffany DaVanzo.

I thank the prior readers and institutional adopters for their confidence and support. In particular, special thanks go out to Dr. David Chen, Associate Professor of Clinical Surgery, and the medical students and residents of the David Geffen School of Medicine at UCLA (DGSOM) for their ongoing use of the Web-based version for surgical clerkships and in-service learning.

I am also grateful for the continuing support and good counsel of my Department Chair, Dr. Jonathan Braun, and feedback from former Senior Associate Dean of Medical Education, Dr. LuAnn Wilkerson, who originally suggested that I develop a PDA-based learning resource for surgical clerkships.

Great appreciation is due to my colleagues at DGSOM's Instructional Design and Technology Unit, directed by Dr. Anju Relan and including master developers Zhen Gu, Katherine Wigan, Sam Payne, and Jason Rock. Their continuing multimedia learning projects and dedicated support of the online medical school curriculum have provided many practical lessons on the complexities of development and what really works in educational technology.

Most of all, I thank my Editor, Elyse O'Grady, for her continuing dedication to the distribution and improvement of Netter's Surgical Anatomy Review P.R.N. I am especially grateful to Marybeth Thiel, original Development Editor, for providing continuing editorial review and oversight for second edition updates, including all the new artwork. Their expert team at Elsevier worked skillfully to produce the new, redesigned content that you are using.

ROBERT B. TRELEASE, PHD

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# Head and Neck



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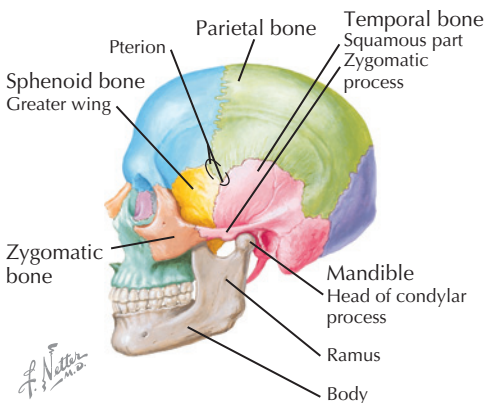
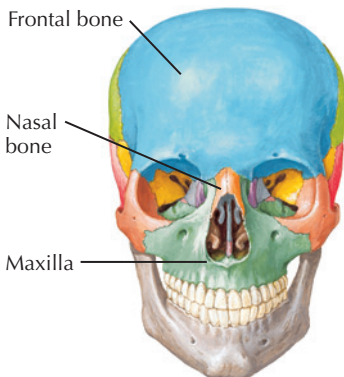


# 1 Skull and Face Fractures

## ANATOMY OF THE SKULL AND FACIAL SKELETON

### Skull and Facial Bones

- *Neurocranium* (cranial vault): frontal, ethmoid, sphenoid, temporal, parietal, occipital bones
- *Viscerocranium* (facial skeleton): maxilla, nasal, lacrimal, zygomatic, vomer, palatine, mandible bones
- *Base of skull*: occipital, sphenoid, temporal, palatine, maxilla bones
- Most of the bones of the skull are *flat* (type), with inner and outer “tables” (layers) of *compact (cortical) bone* surrounding trabecular bone and marrow space (*diploë*).
- *Emissary veins* connect *diploic spaces* with cerebral veins/sinuses (intracranial) and scalp and superficial veins: potential route for intracranial spread of infection.
- *Sutures*
  - Thin fibrous joints found only between skull and facial bones
  - Produced by intramembranous ossification
  - May be indented (e.g., coronal suture), planar, or squamous
- Most cranial and facial bones are pharyngeal arch derivatives.
- Occipital, sphenoid, and ethmoid bones develop from paraxial mesoderm, comparable to vertebrae.



Anterior and Lateral Aspects

## Scalp Layers

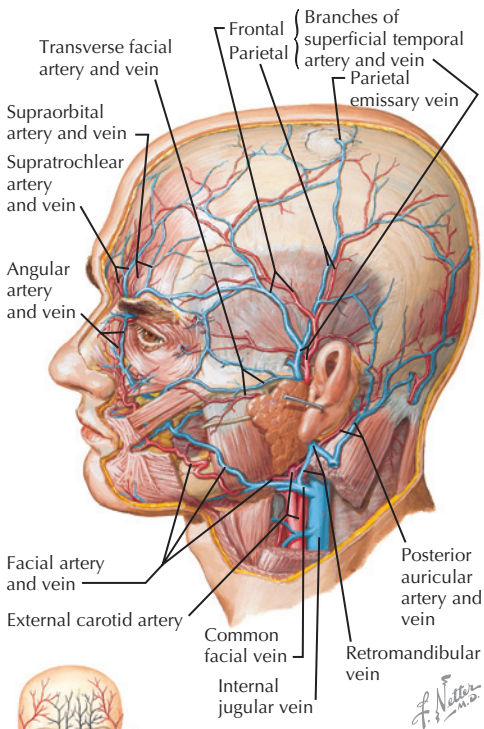
- Skin: thin (thicker in occipital region); well supplied with arteries, veins, lymphatic drainage
- Connective tissue: dense subcutaneous layer with rich neurovascular supply
- Aponeurosis of occipitofrontalis muscle, with lateral attachments of temporoparietalis and posterior auricular muscles (collectively the epicranium)
- Loose areolar tissue: allows aponeurosis movement; danger space for infections owing to emissary vein drainage into diploic spaces of cranium
- Pericranium: external periosteum, fibrously fused to sutures

## NEUROVASCULAR SUPPLY

### Arteries of Face and Cranium

#### *External Carotid (Proximal to Distal)*

- Lingual: to tongue and floor of mouth, may have common origin with facial
- Facial: superior, inferior labial, lateral nasal, angular branches; to anteromedial face
- Posterior auricular: posterior to ear and mastoid regions
- Occipital: lateral aspect of head behind ear
- Maxillary: deep auricular, anterior tympanic, deep temporal, middle meningeal, inferior alveolar, posterior alveolar, infraorbital branches; to deep face
- Transverse facial: lateral face, parallel to parotid duct
- Superficial temporal: anterior, lateral aspect of crania



Sources of arterial supply of face

Black: from internal carotid artery  
(via ophthalmic artery)

Red: from external carotid artery

## Superficial Arteries and Veins of Face and Scalp

### *Internal Carotid*

- Anterior cerebral
  - Ophthalmic artery: supraorbital, supratrochlear, anterior and posterior ethmoid branches
- Middle cerebral

### *Other*

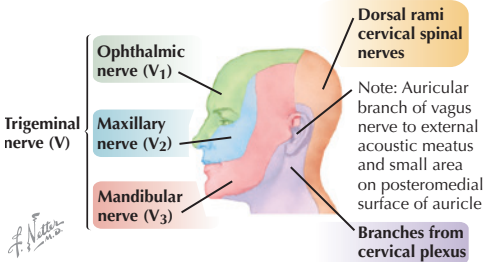
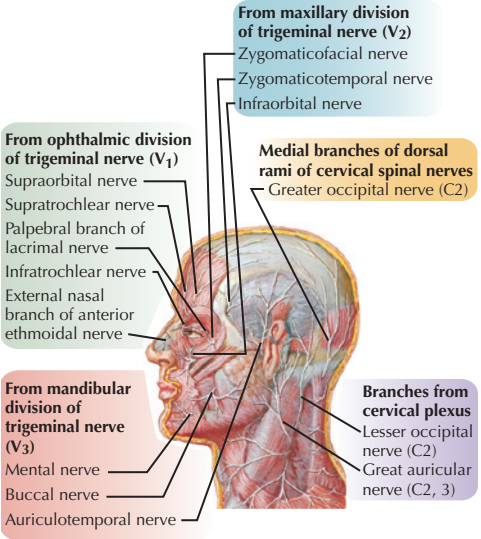
- Vertebral: basilar, pontine, posterior and inferior cerebellar, posterior cerebral, posterior communicating branches
- Facial: face richly perfused, with anastomoses across midline, anterior to posterior, and between intra- and extracranial branches
- Kiesselbach's area/plexus: anterior inferior nasal septal region, anastomoses between superior labial (facial), sphenopalatine, palatine (maxillary), and anterior ethmoid (anterior cerebral via ophthalmic) branches; frequent site of epistaxis

### **Venous Drainage**

#### *Internal Jugular Vein*

#### Common Facial Vein

- Tributaries
  - Facial: superior, inferior labial, deep facial, external nasal, angular ← orbital, inferior and superior palpebral
  - Submental
  - Retromandibular: superficial temporal, middle temporal, maxillary
- Pterygoid venous plexus of deep face connects with deep facial and maxillary veins and with cavernous sinus via connections through foramen ovale.
- Facial veins have no valves: potential route for spread of infection from face and deep venous



Cutaneous Nerves of Head and Neck

sinuses to intracranial sinuses (e.g., cavernous sinus via angular and orbital veins)

- Common facial connects to external jugular vein

### *External Jugular Vein*

- Drains posterior auricular

### **Innervation of the Head and Neck**

- Cranial nerve deficits may be associated with specific regional fractures, trauma
- Olfactory (I): special somatic sensory to superior nasal cavity; foramina: cribriform plate of ethmoid; intranasal CSF leakage, anosmia with ethmoid fracture
- Optic (II): foramen—optic canal (sphenoid)
- Oculomotor (III), trochlear (IV): motor to extraocular muscles, travel through cavernous sinus, superior orbital fissure (sphenoid bone), and orbit
- Trigeminal nerve (V): sensory to most of face and head, superficial and deep, including sinuses and supratentorial dura; motor to muscles of mastication, tensor palati, and tensor tympani
  - Ophthalmic division: foramen—superior orbital fissure (sphenoid bone)
  - Maxillary division: foramen rotundum (sphenoid bone)
  - Mandibular division: foramen ovale (sphenoid bone)
- Abducens (VI): runs along clivus and through cavernous sinus and superior orbital fissure to lateral rectus; clival fracture can cause lateral gaze paralysis
- Facial (VII)
  - Supplies muscles of facial expression and stapedius

- Carries visceromotor fibers to lacrimal and submandibular and sublingual salivary glands
- Taste afferents for anterior 2/3 of tongue
- Exits stylomastoid foramen (temporal bone)
- Acousticovestibular (vestibuloacoustic, auditory) (VIII): from cochlea and vestibular apparatus (labyrinth) in temporal bone; nerve enters internal acoustic meatus (temporal bone)
- Glossopharyngeal (IX): taste and common sensation from posterior third of tongue and tonsillar fossa; exits jugular foramen (between temporal and occipital bones)
- Vagus (X): motor to palate, pharynx and larynx, thoracoabdominal viscera; exits jugular foramen (between temporal and occipital bones)
- (Spinal) accessory (XI): motor to sternomastoid and trapezius muscles; exits jugular foramen (between temporal and occipital bones)
- Hypoglossal (XII): motor to tongue muscles except for palatoglossus (X); exits hypoglossal canal (anterior supracondylar occipital bone)
- Cervical nerves
  - No C1 dermatome exists.
  - C2 spinal nerve: sensory to skull, skin from vertex down, infratentorial dura, parotid (auriculotemporal nerve), and infratemporal skin
  - C3 spinal nerve: sensory to suboccipital region

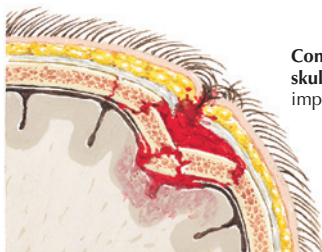
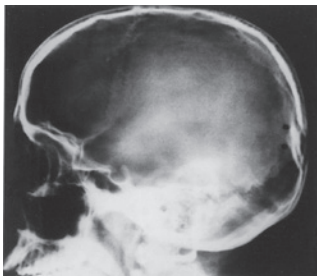
## CLINICAL CORRELATES

### Skull Fractures

#### *Classification*

- Linear: fracture line is distinct
- Comminuted: multiple fragments, may be depressed with compression of dura and brain (image)

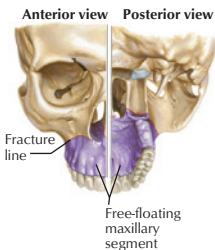




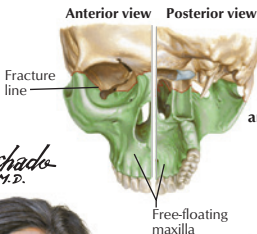
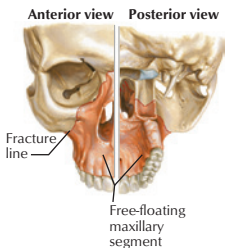
**Compound depressed skull fracture.** Note hair impacted into wound

Compound Depressed Skull Fractures

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

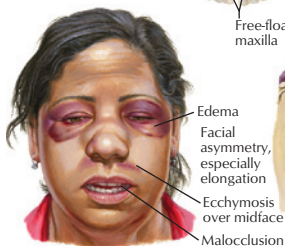


**Le Fort II fracture: fracture through maxillae, antra, nasal bones, and infraorbital rims**

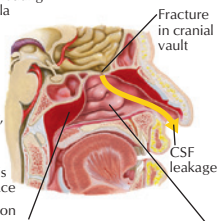


**Le Fort III fracture: fracture through zygomatic bones and orbits, separating facial bones from cranial vault**

*C. Machado*  
— M.D.



Craniofacial dysjunction in Le Fort III fracture distorts facial symmetry



Hematoma and massive edema may occlude nasal airway, necessitating tracheostomy

## Mid-face Fractures

- Basilar: in skull base
- Diastasis: fracture along a suture

### *Compound*

- A compound fracture is any fracture communicating with scalp laceration, sinuses, or middle ear.
- Depressed compound fractures require surgical treatment.

### *Middle Meningeal Artery*

- Underlies sphenoid, parietal, temporal bones
- May be lacerated with fractures at pterion, resulting in epidural hematoma

### Facial Fractures

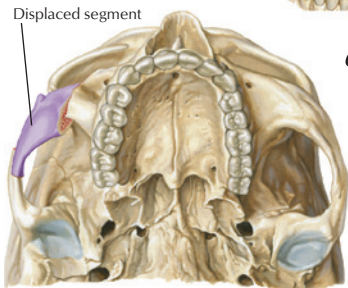
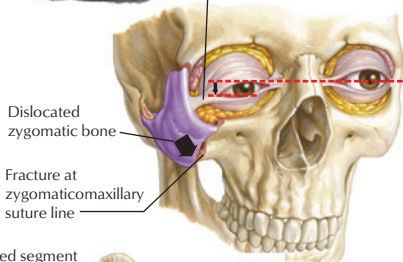
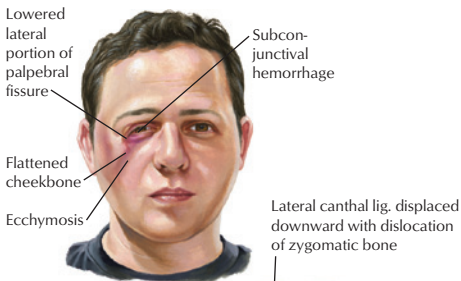
- Nasal fractures are most common (3rd most common fracture overall).
- Blowout fracture of orbit
  - Pressure of direct blunt trauma to eye fractures superior maxilla.
  - Entraps orbital fat, inferior rectus or inferior oblique in antrum
  - Impairs upward gaze

### Mid-face Fractures

- Consequence of high-energy impact with mid-face (e.g., motor vehicle accident)

### *Le Fort Classification*

- I: horizontal detachment of maxilla along nasal floor
- II: pyramidal fracture of maxilla, including nasal bones, antra, infraorbital rims, orbital floors



*C. Machado*  
— M.D.

Zygomatic Fractures

- III: pyramidal fractures as in II, with both zygomatic bones; may be accompanied by airway problems, nasolacrimal obstruction, CSF leakage

### Zygomatic Fractures

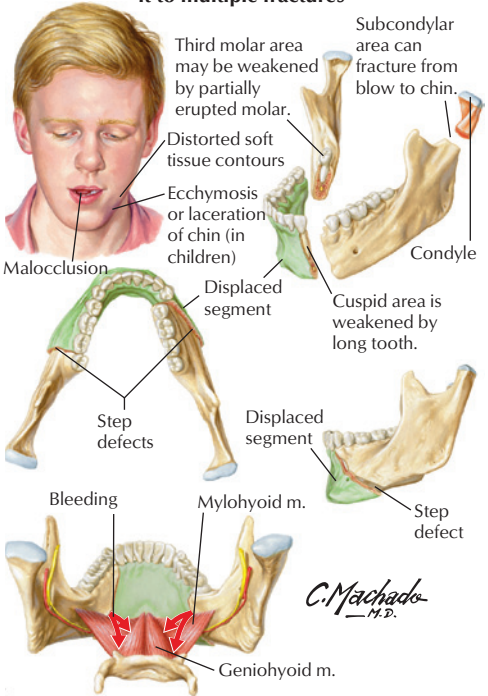
- Trauma to cheek can disrupt zygomatic articulations with frontal, maxilla, sphenoid, and temporal bones.
- Frontal and maxillary suture line fractures are common, with displacement inferiorly, medially, or posteriorly.
- Displacement of canthic ligament with lower margin of orbit may be associated with ipsilateral ocular and visual changes and diplopia.
- Hyphema (anterior chamber blood from hemorrhage) from associated eye impact

### Mandible Fractures

- Second most commonly fractured facial bone (after nasal)
- Multiple fractures are common (50%), favored by U shape and bilateral articulations
- Most common sites are cuspid (canine) and 3rd molar regions.
- Ecchymosis (blood leakage) is common in loose tissues of floor of mouth.

*See next page*

**Anatomy of mandible predisposes it to multiple fractures**



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

**Mandibular Fractures**

# 2

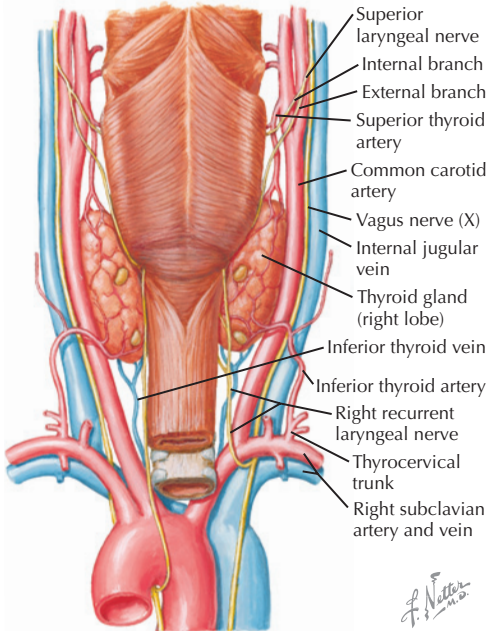
## Thyroid Diseases

### THYROID AND PARATHYROID ANATOMY

#### Thyroid

- Thyroid typically consists of right and left lobes, connected by a midline isthmus, with an ascending pyramidal lobe in about 50% of cases.
- Location
  - Immediately anterior and lateral to trachea, from about 5th cervical vertebra to 1st thoracic vertebra
  - Medial to internal jugular veins
  - Anterior to common carotid arteries
  - Deep to infrahyoid muscles: sternohyoid (medial), omohyoid, sternothyroid (lateral)
  - Infrahyoid muscles embedded in pretracheal fascia, deep to investing fascia of neck (superficial layer of deep fascia)
- Connective tissue (true) capsule is continuous with the septa dividing the stroma of the gland.
- Surgical (false) capsule lies external to the true capsule and is derived from the pretracheal fascia.
- Of the overlying strap muscles, the sternohyoid is most superficial, overlying the sternothyroid and thyrohyoid.
- Thyroid follicular (epithelial/principal) cells secrete thyroxine ( $T_4$ ) and triiodothyronine ( $T_3$ ), regulated by TSH receptors.

## Posterior view



Thyroid Gland and Pharynx: Posterior View



- Thyrotropin-releasing factor or hormone (TRF or TRH) from hypothalamus controls TSH release from pituitary.
- Parafollicular (C) cells secrete calcitonin.

## Parathyroids

- Superior parathyroid glands usually lie between the true capsule of the thyroid and its investing surgical (false) capsule fascia.
- Inferior parathyroid glands might lie between the true and false capsules, within the thyroid parenchyma, or on the outer surface of the surgical capsule.

## VESSELS AND LYMPHATICS

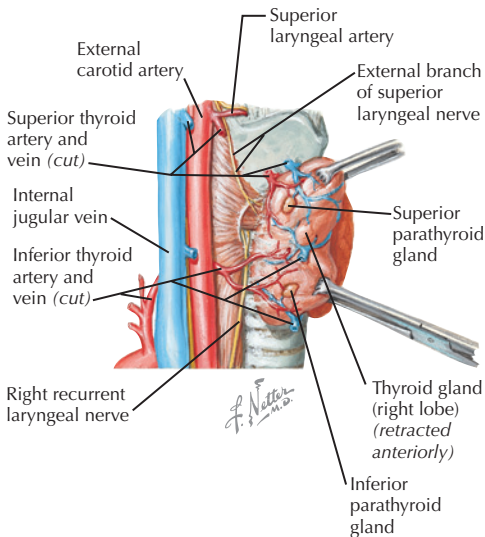
### Arterial Supply

- Superior thyroid arteries arise bilaterally from the external carotid arteries at, above, or below the bifurcation of the common carotid.
- Inferior thyroid arteries arise bilaterally from the thyrocervical trunks (branches of the subclavians) or occasionally directly from the subclavian arteries.
- Thyroid ima artery (1% of patients)
  - Variable, unpaired, anterior to trachea
  - Supplies isthmus
  - Can arise from brachiocephalic, right common carotid, or aortic arch: important consideration in tracheostomy

### Venous Drainage

- Thyroid vein plexus is in the substance of the gland and on its surface.
- Thyroid plexus is drained by 3 main pairs of veins.

## Right lateral view



## Blood Vessels and Parathyroid Glands

- Superior thyroid veins: accompany superior thyroid arteries
- Middle thyroid veins: occasionally double or absent, arise posterolaterally, drain independently
- Inferior thyroid veins: largest, drain inferiorly

## Lymphatic Drainage

- Vessels in interlobular connective tissue parallel the arterial supply
- Communicate with capsular network
- Drainage into prelaryngeal, pretracheal, and paratracheal nodes, then into superior and inferior deep cervical nodes
- Lateral drainage directly into inferior deep cervical nodes
- Some drainage into brachiocephalic nodes, trunks, or thoracic duct

## CLINICAL CORRELATES

### Thyroidectomy

- Partial or total removal of the thyroid may be indicated for refractory severe hyperthyroidism, Graves' disease, nodules, or cancer.
- Recurrent laryngeal nerves are at risk during surgery.

### Recurrent Laryngeal Nerve

- Nerve ascends from the thoracic outlet, in or near the tracheoesophageal groove.
- Course past the inferior thyroid artery is highly variable: it can pass anterior, between, or posterior to the artery's bifurcation into anterior and posterior branches.

### Thyroid Cancer

- Rare, but most common endocrine malignancy in the United States

#### *Types of Thyroid Cancer*

- Thyroid adenomas
- Follicular adenomas