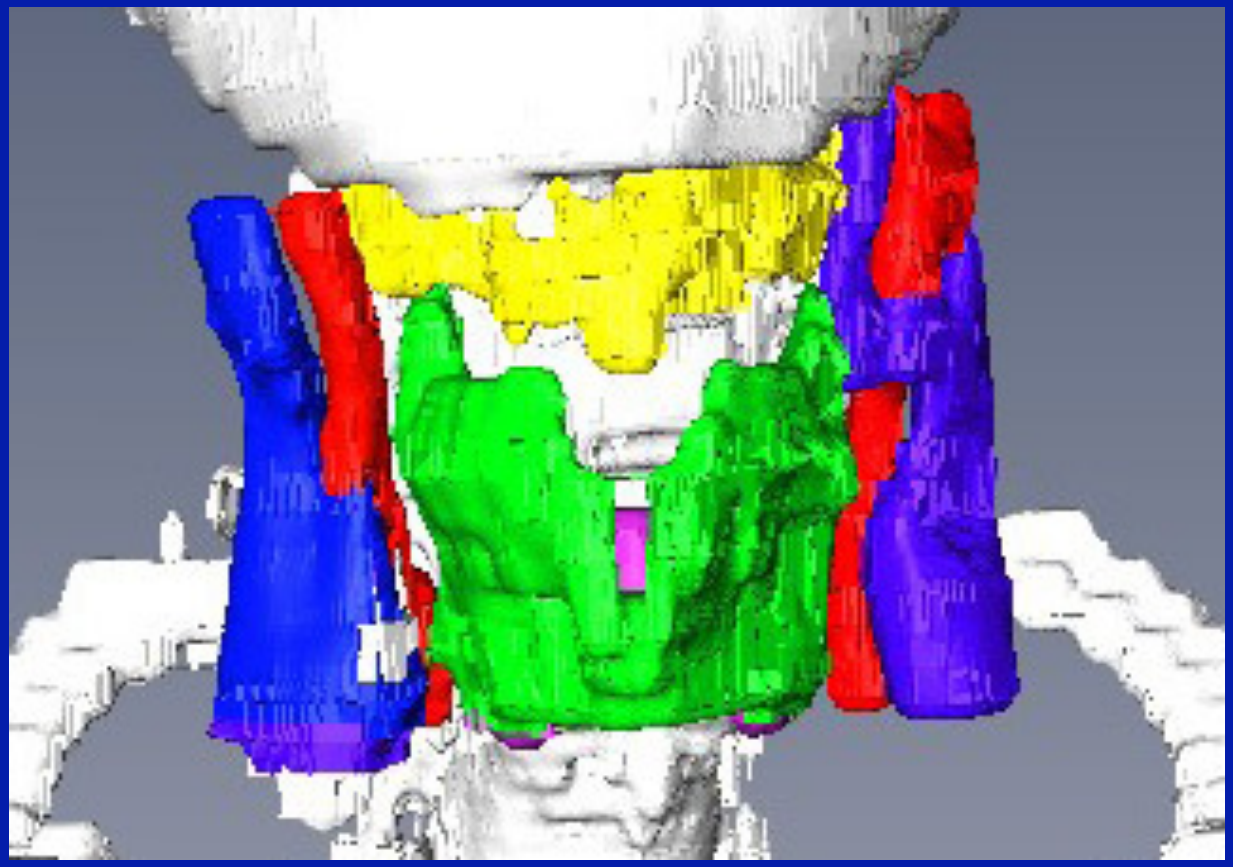
The Larynx



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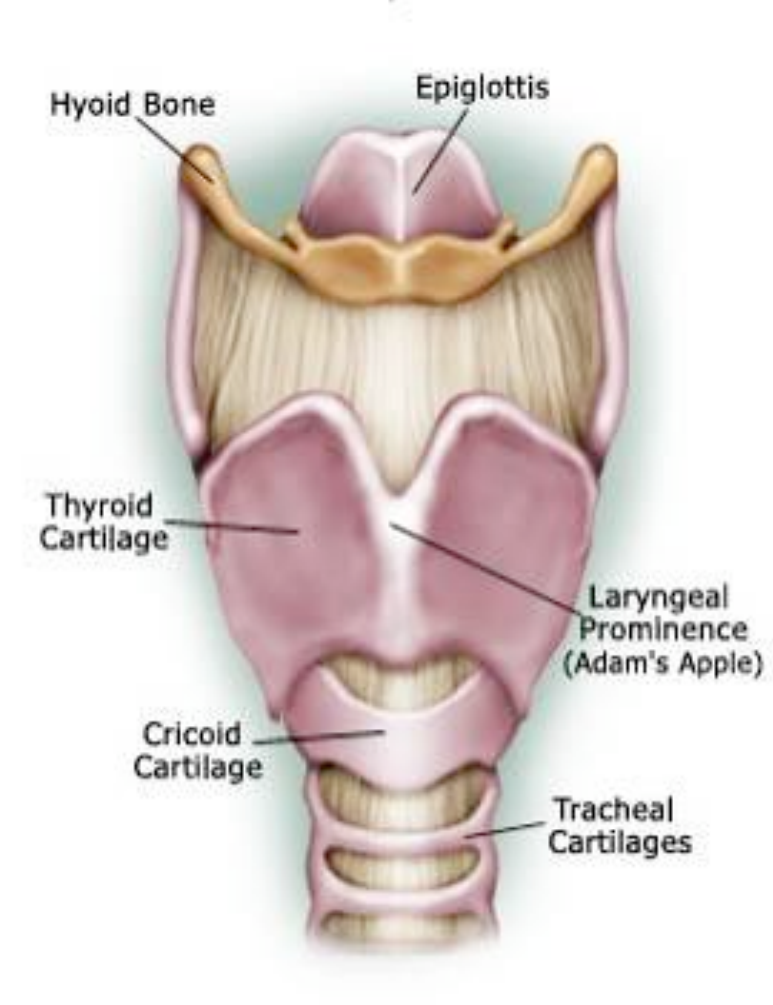
Functions

- To produce voice
- To protect the airway, especially during swallowing
- To keep the airway patent

Anatomy

- The larynx is located at the point where the respiratory and digestive tracts separate.
- The entrance to the larynx, or laryngeal inlet, is in the anterior wall of the laryngopharynx.
- Internally, the wall of the larynx is modified to form the vocal cords.

Anatomy

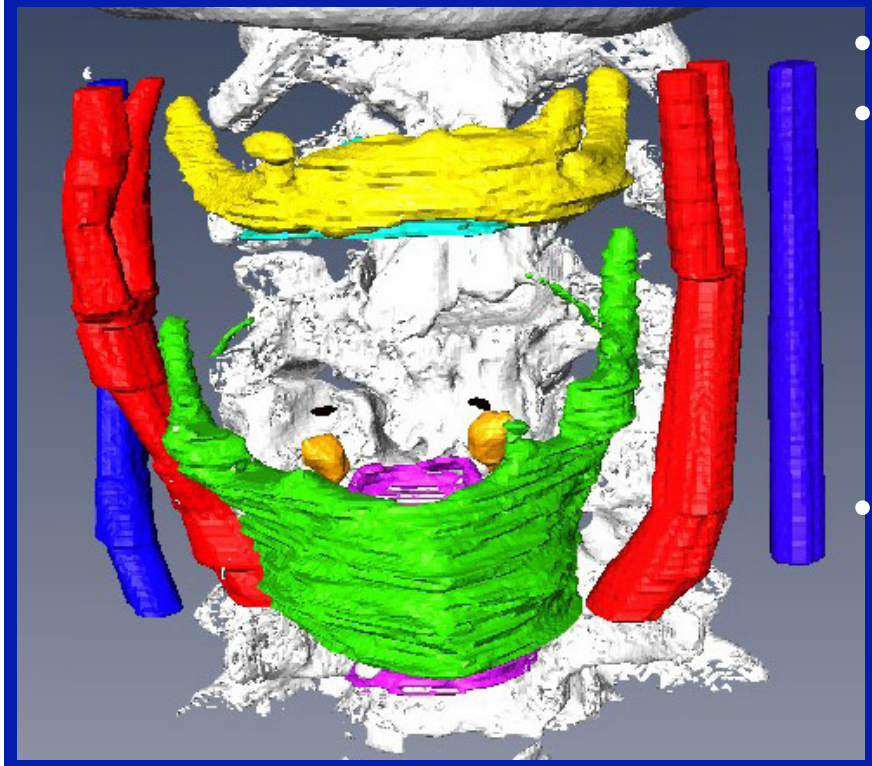


- The larynx lies in the mid-line of the neck, deep to the strap muscles and partly covered by the thyroid gland.
- At roughly the C vertebral level, the larynx is continuous with the trachea.

Subdivisions

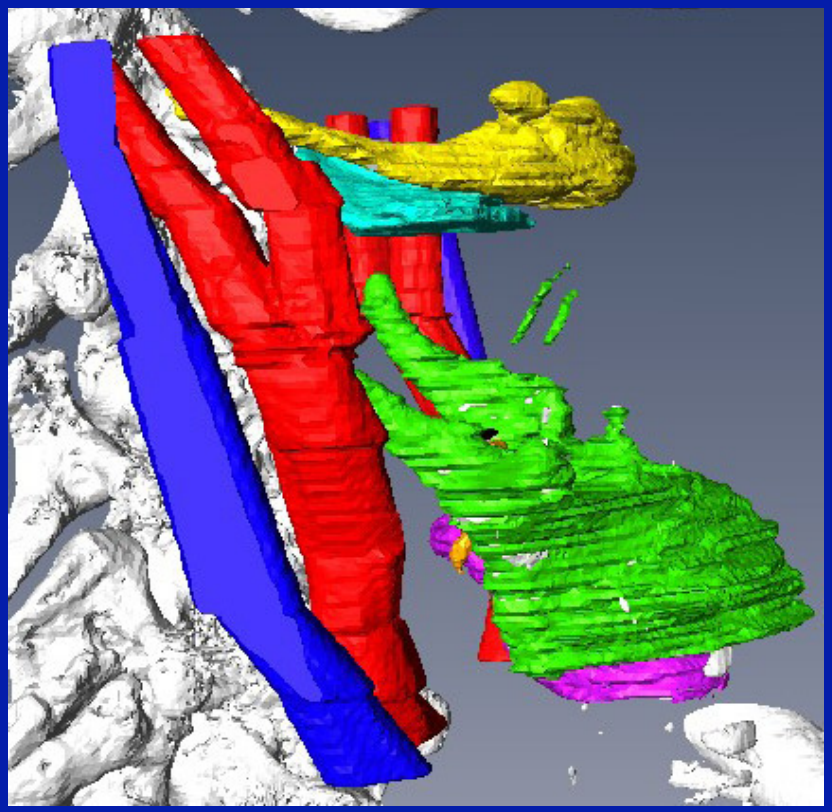
- Vertically, the larynx is divided into 3 regions:
- 1. **Supraglottis** – Includes the epiglottis, aryepiglottic folds, false vocal folds, arytenoids, and ventricle
- 2. **Glottis** – true vocal folds
- 3. **Subglottis** –below the true vocal folds to the inferior border of the cricoid cartilage

Cartilages



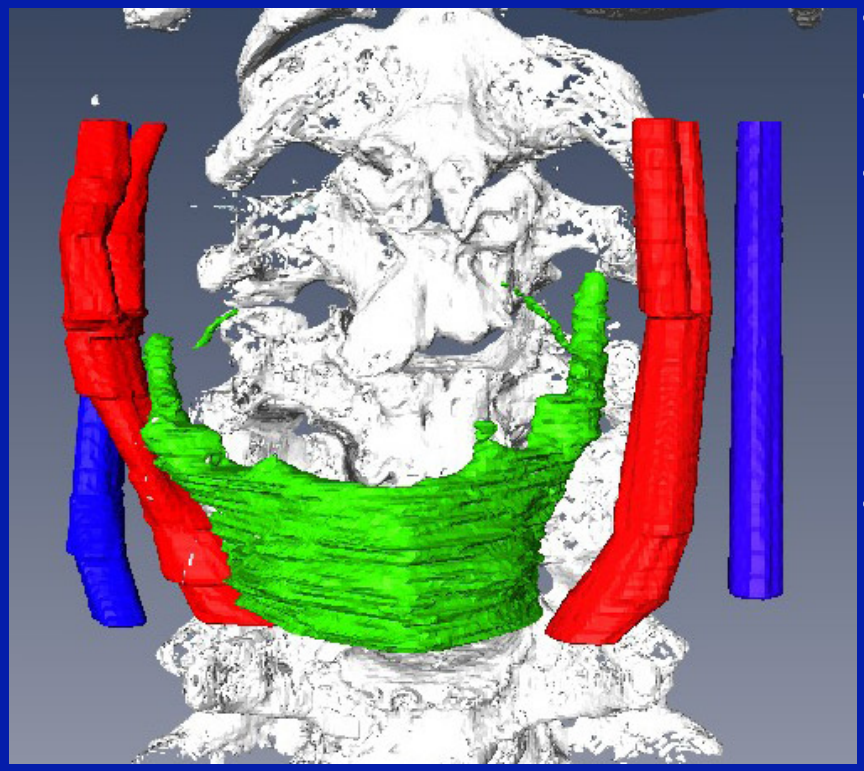
- Total of 9 cartilages
- 3 single cartilages
  - Thyroid Cartilage (green)
  - Cricoid (purple)
  - Epiglottis (light blue)
- 3 paired cartilages
  - Arytenoids (orange)
  - Corniculates & Cuneiforms (black)

Cartilages



- The hyoid bone (yellow) and the cartilages are collectively referred to as the visceral skeleton of the neck.

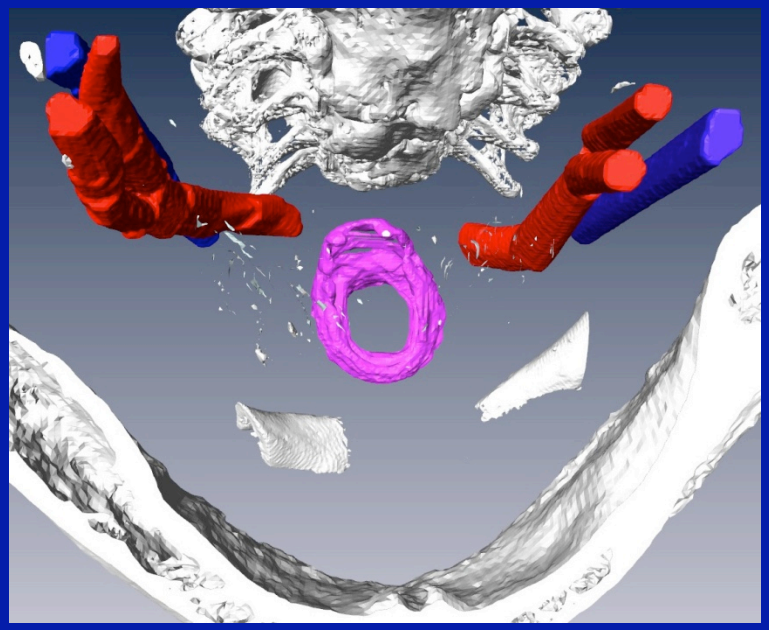
Thyroid Cartilage



<- Cartilages

- Thyroid = shield-like
- The largest cartilage
- The two laminae meet anteriorly at the superior thyroid notch (Adam's apple).
- The inferior horns articulate with the cricoid cartilage at the cricothyroid joints.
- The thyroid cartilage suspended from the hyoid bone by the thyrohyoid membrane.

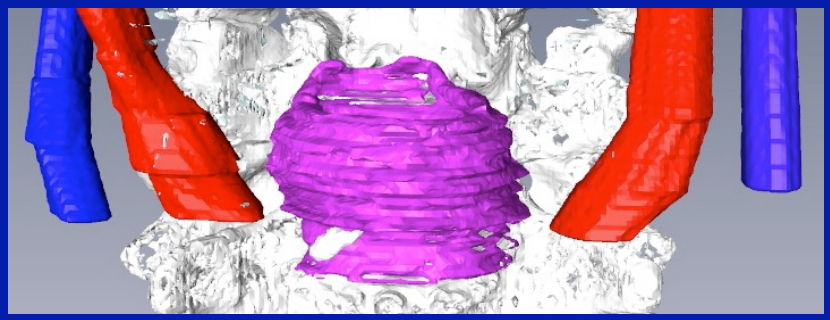
Cricoid



<- Cartilages

- Cricoid = ring-shaped
- The only complete ring of cartilage in the respiratory tract.
- Cricoid pressure is applied to the esophagus during intubation to prevent gastric contents from refluxing into the airway.

Cricoid



- Anteriorly - a narrow arch.
- Posteriorly - enlarges to form the lamina.
- The cricoid lamina articulates with the inferior horns of the thyroid cartilage at the crico-thyroid joints.

<- Cartilages

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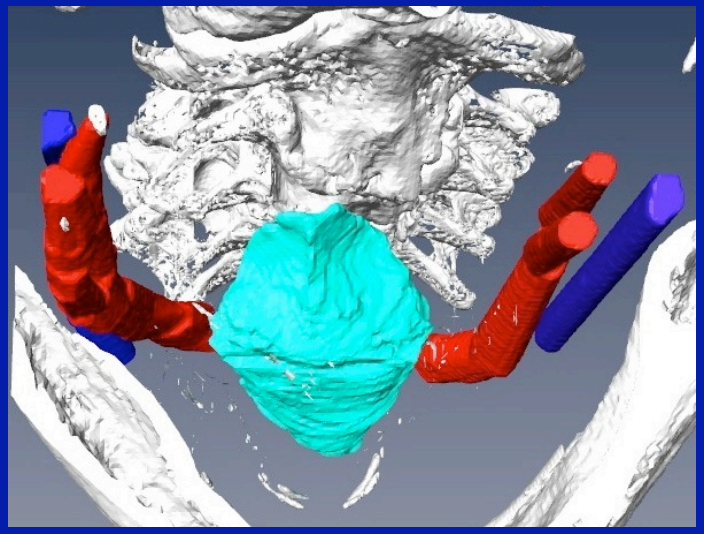
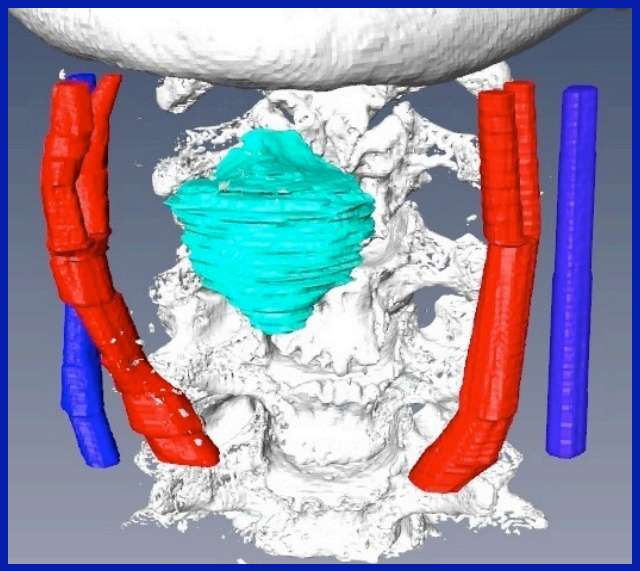
Epiglottis

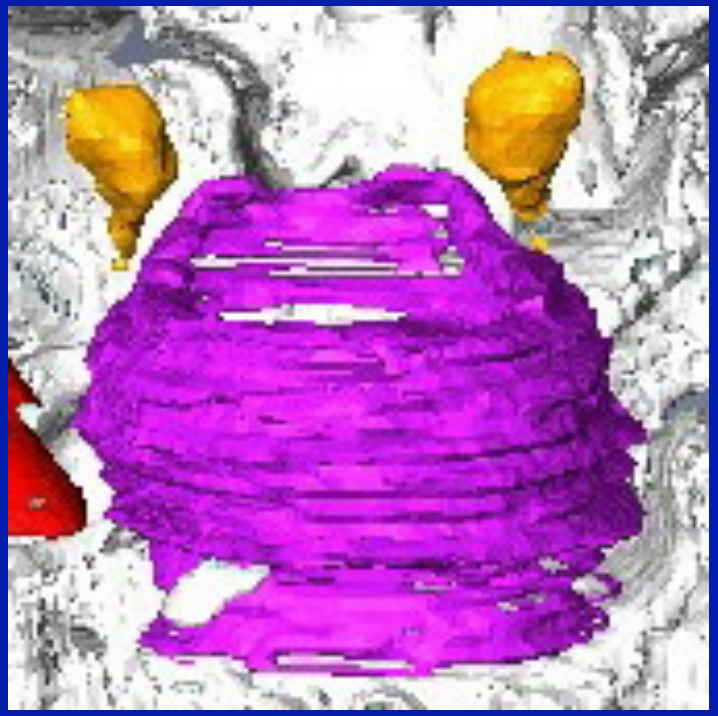




- Guards the entrance of the larynx. It folds posteriorly over the opening of the larynx during swallowing.
- Leaf-shaped, flexible, elastic cartilage.
- It attaches to the back of the thyroid cartilage via the thyroepiglottic ligament.
- Unlike the other cartilages, the epiglottis remains unossified.

<- Cartilages

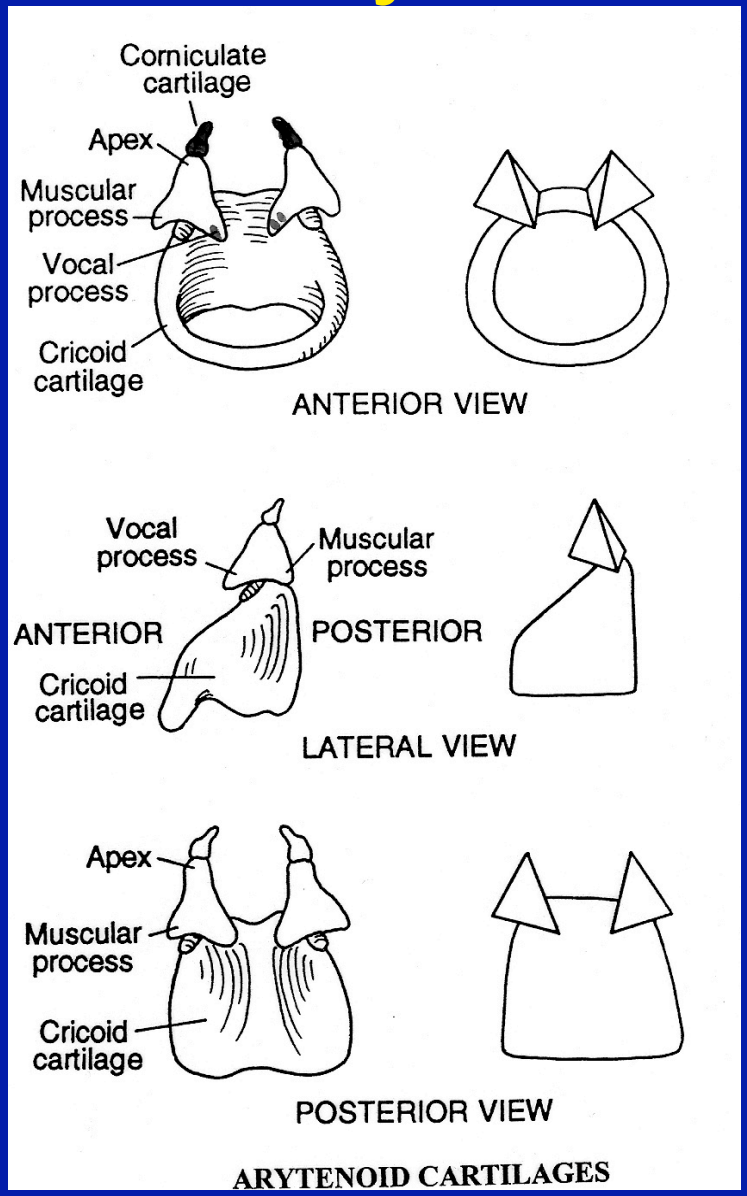
Arytenoids



- Paired and pyramidal in shape.
- The base rests on the upper surface of the cricoid and forms the crico-arytenoid joint.

<- Cartilages

Arytenoids



- Postero-laterally - muscular process
- Anteriorly - vocal process provides attachment for the vocal cords.
- Superiorly - apex

<- Cartilages

Corniculates & Cuneiforms

- These small cartilages are both in the posteri part of the aryepiglottic folds
- The corniculates attach to the apices of the arytenoid cartilages
- The cuneiforms (not shown) do not directly attach to any cartilages

<- Cartilages

Vocal Cords

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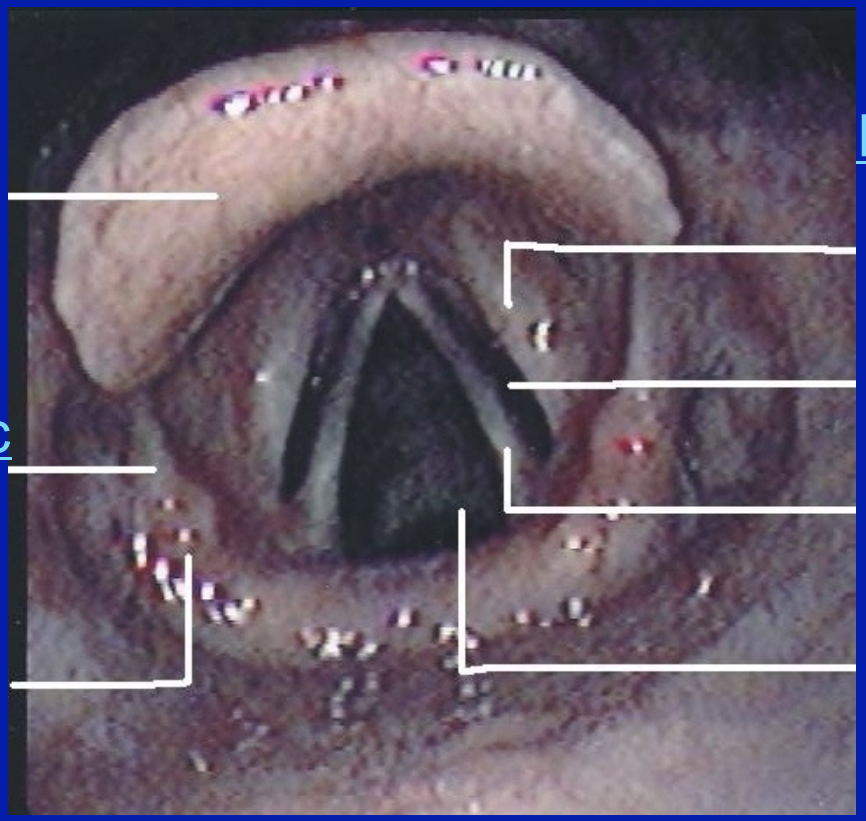

True Vocal Cords

- Vocal folds (true vocal cords) control sound production (tone). Each vocal fold includes:
  - Vocal ligament – elastic tissue that is the thickened medial free edge of the lateral cricothyroid ligament (conus elasticus)
  - Vocalis muscle – fibres that form the most medial part of the thyroarytenoid muscle

<- Photo

False Vocal Cords

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- Vestibular folds (false vocal cords) extend between the thyroid and arytenoids.
  - Have little to no part in voice production
  - Serve a protective function
- Vestibular folds are the mucous membrane covering the lower border of the quadrangular membrane

<- Photo

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Ventricle

- Between the true vocal cords and false vocal cords, on each side, is a lateral depression, lined by mucous membrane, known as the ***ventricle*** of the larynx.

<- Photo

Glottis

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- **Glottis** (rima glottidis) - the opening between the two true vocal cords (or vocal folds).

<- Photo

Larynx – Sagittal View

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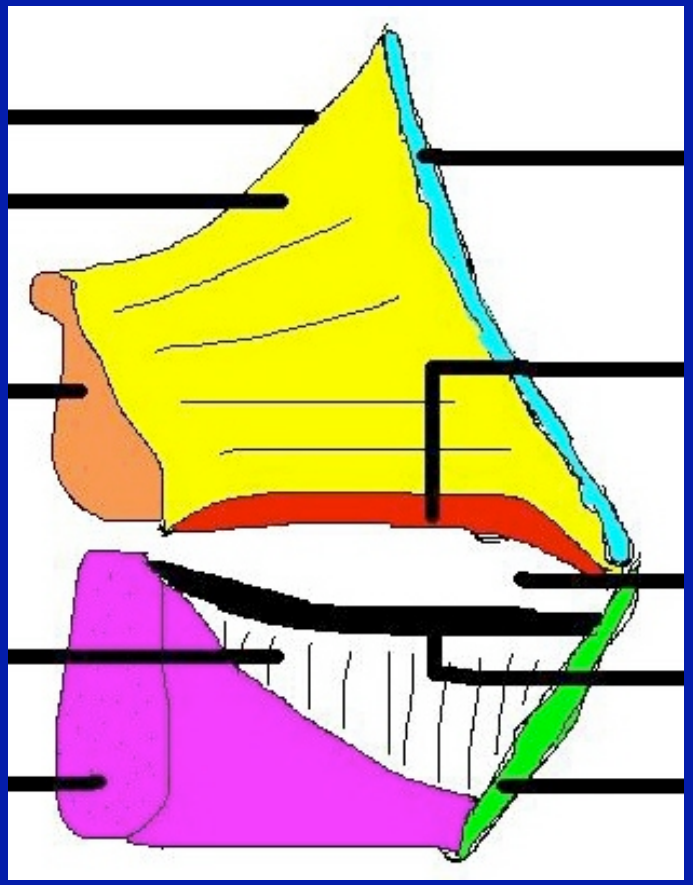
Aryepiglottic Fold

Quadrangular Membrane

Arytenoids

Conus Elasticus

Cricoid



Epiglottis

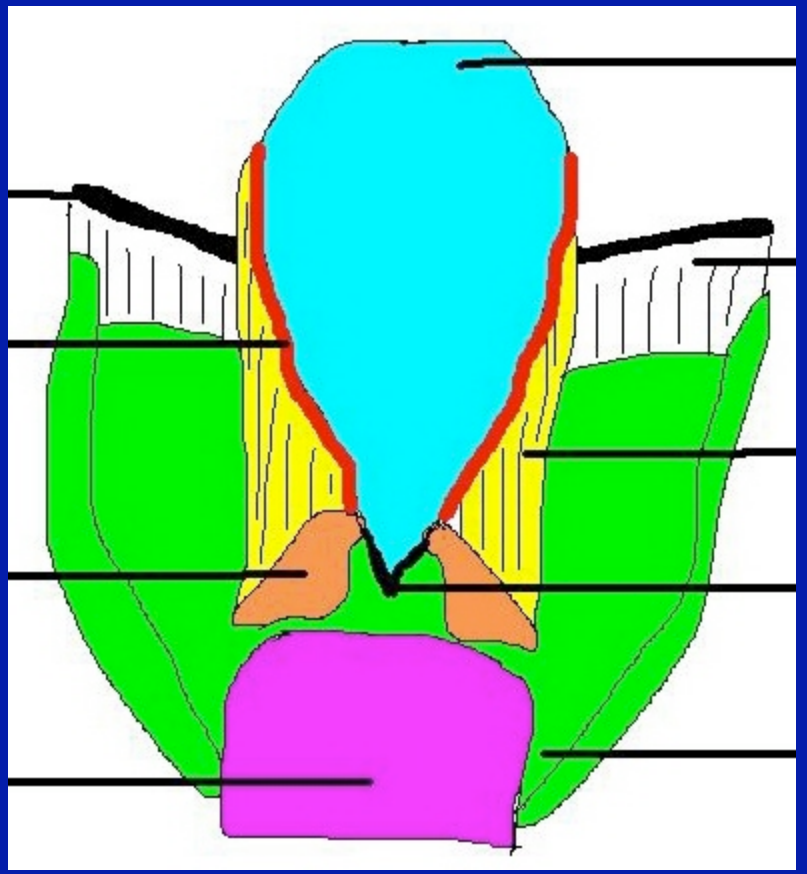
False Vocal Cords

Ventricle

True Vocal Cords

Thyroid Cartilage

Larynx – Posterior View



<- Photo

Quandrangular Membrane (In more detail)

- The quadrangular membrane is a sheet of fibrous connective tissue that extends from the arytenoids to the epiglottis.
- The upper border, covered by mucous membrane, is the ***aryepiglottic fold***.
- The lower border is the ***vestibular ligament***.
- The latter, together with its covering of mucous membrane, is the ***vestibular fold***, or ***false vocal chord***.

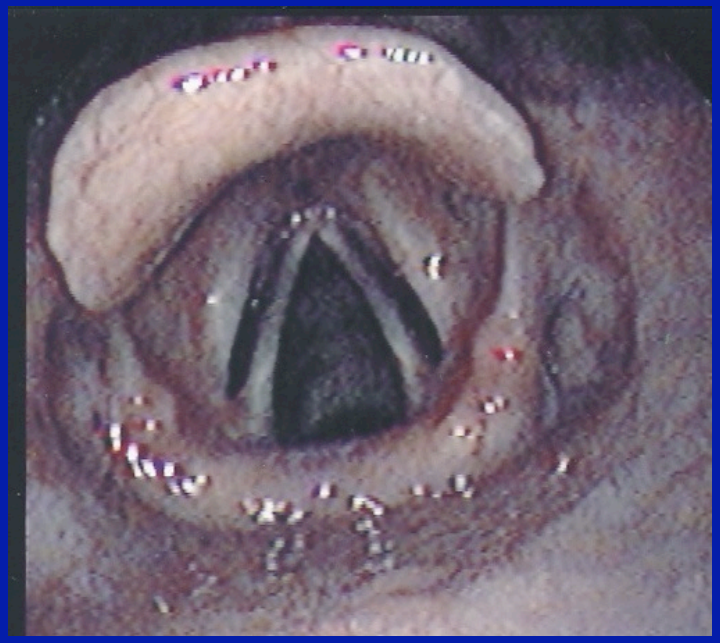
<- Diagram

Conus Elasticus (In more detail)

- The ***conus elasticus*** attaches to the upper surface of the cricoid arch.
- Its upper border is the ***vocal ligament*** which extends between the vocal process of the arytenoid cartilage and the thyroid lamina.
- The vocal ligament, covered with mucous membrane, is the ***vocal fold*** or ***true vocal chord***.
- The membrane between the thyroid cartilage and cricoid is the cricothyroid membrane. 

<- Diagram

Vocal Cords



Abducted Adducted

Vocal Cord Abduction & Adduction

- The vocal cords are abducted during breathing
- The vocal cords are tightly adducted in straining efforts and before a cough or sneeze.
- Voice production is the result of the escape of small amounts of air between the adducted vocal cords.

<- Photos

Phonation Physiology

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- Special Cases

- Power source – Lungs & Diaphragm
- Pitch & quality – Larynx
- Articulation – Lips and Tongue

<- Photos

Muscles

- The muscles of the larynx are classified as extrinsic or intrinsic
- Extrinsic laryngeal muscles
  - Move the larynx as a whole
  - Depress or elevate the hyoid bone & larynx
  - Infrahyoid strap muscles (omohyoid, sternohyoid, sternothyroid, thyrohyoid)– depressors
  - Palato-pharyngeus & stylopharyngeus muscles – elevators
- Intrinsic laryngeal muscles
  - Move parts of the larynx
  - Control the length/tension and movements of the vocal folds and may help in the closure of the laryngeal inlet

Extrinsic Muscles

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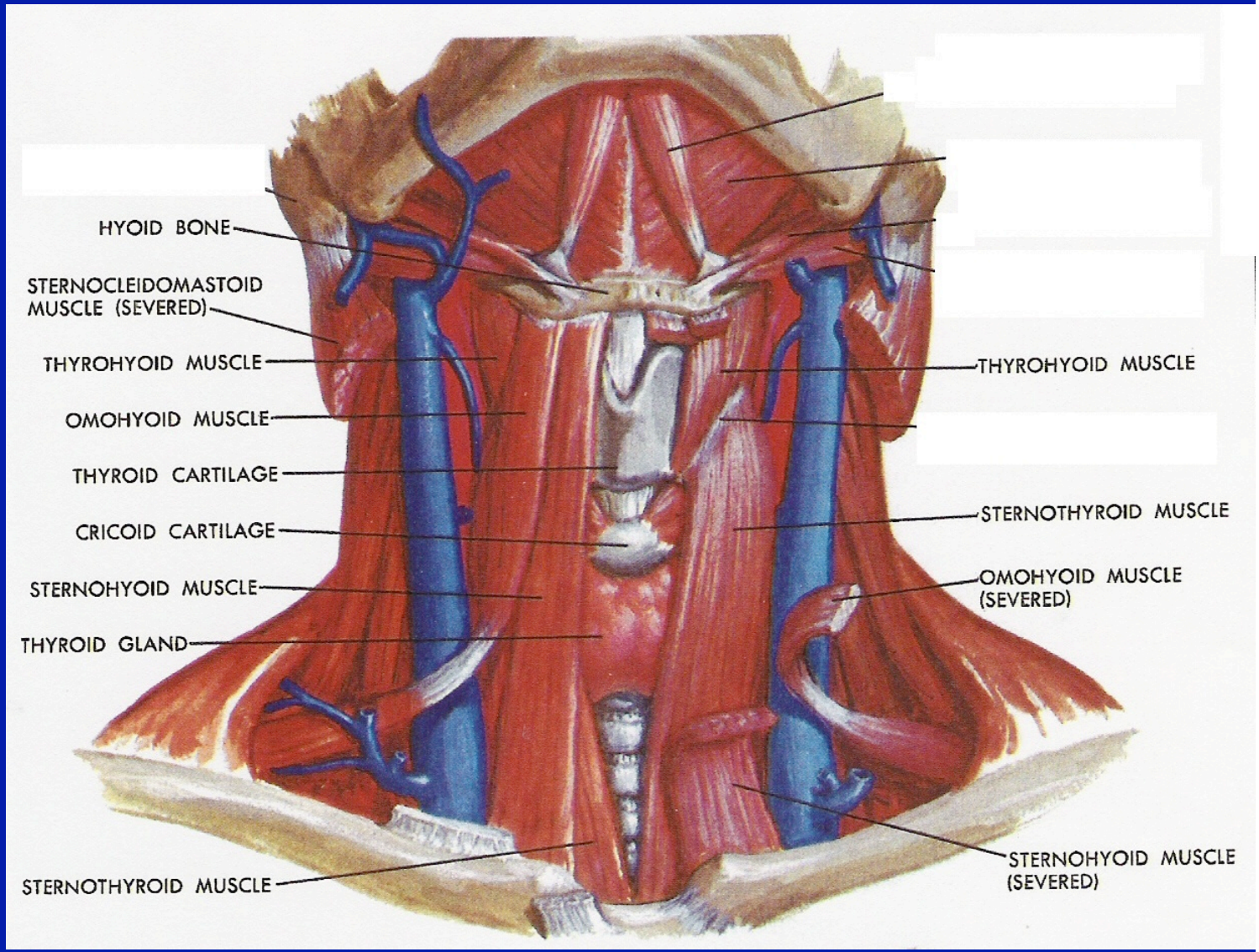
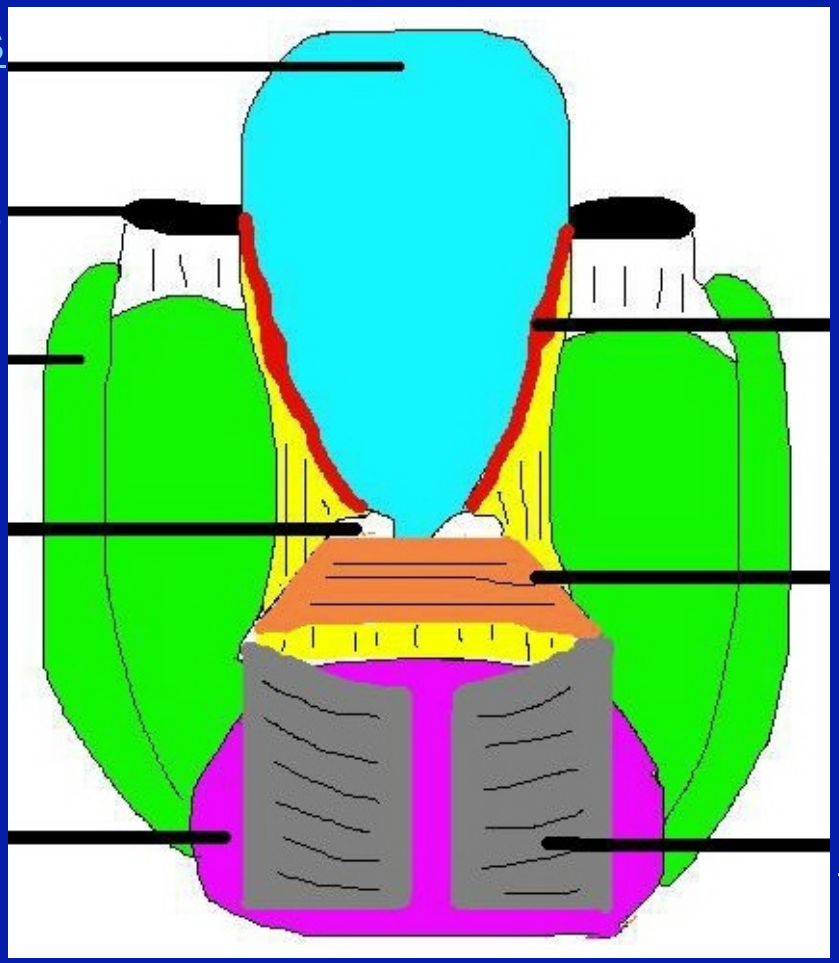
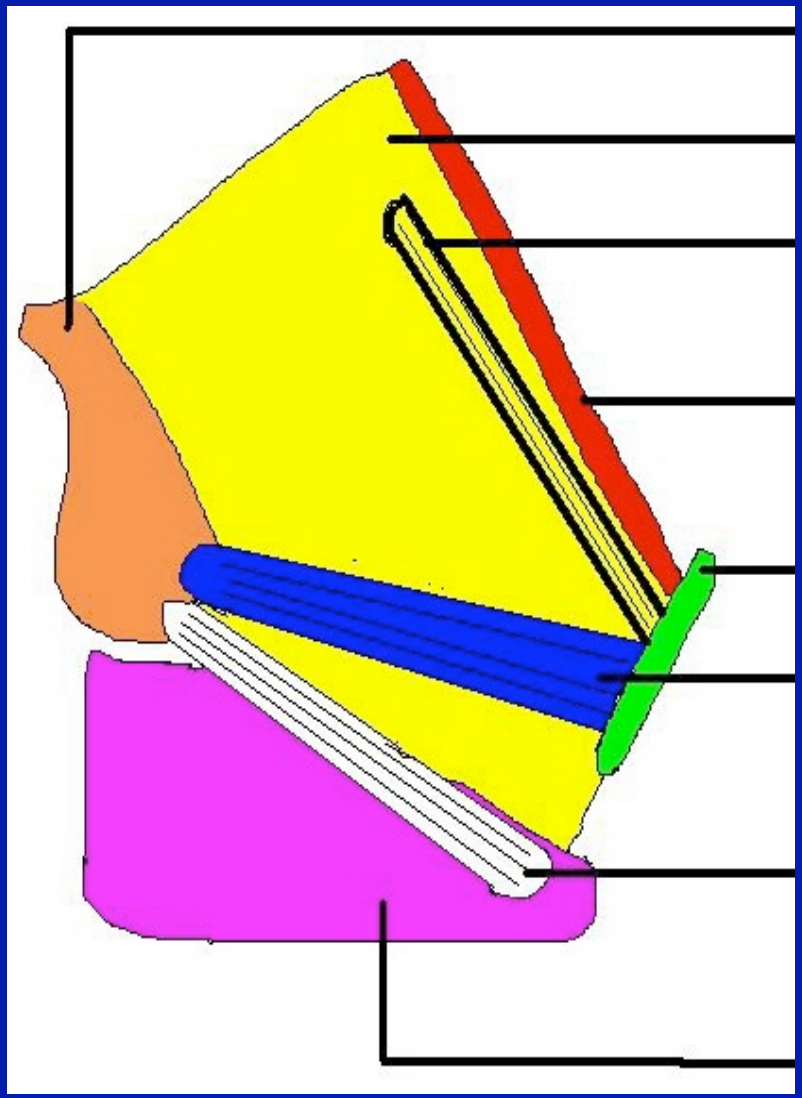


Intrinsic Muscles – Posterior View



Intrinsic Muscles
Lateral View from Inside



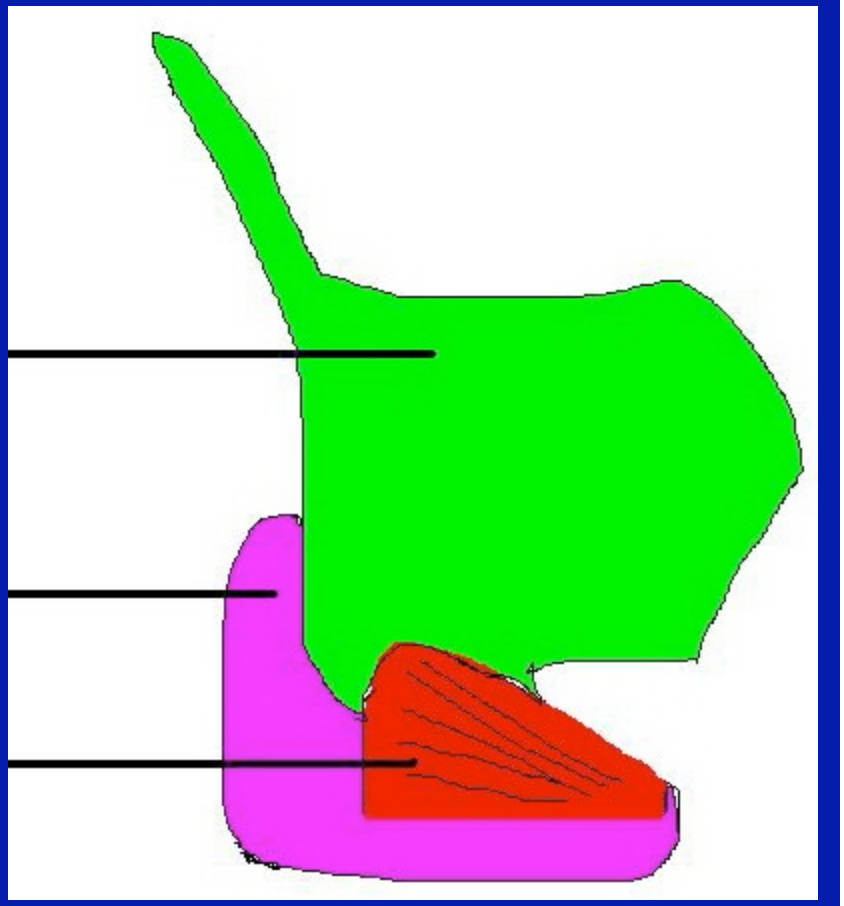
- Arytenoids
- Quadrangular Membrane
- Thyroepiglottic Muscle
- Aryepiglottic Fold
- Thyroid Cartilage
- Thyroarytenoid Muscle
- Lateral Cricoarytenoid Muscle
- Cricoid

Intrinsic Muscles
Lateral View from Inside

Thyroid Cartilage

Cricoid

Cricothyroid Muscle



Posterior Cricoarytenoid Muscle

<- Diagram

- From the posterior surface of the lamina of the cricoid, its fibres converge to insert into the muscular process of the arytenoid.
- The two posterior cricoarytenoid muscles abduct the vocal chords by both rotating and separating the two arytenoid cartilages.

Interarytenoid muscle

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Special Cases

- Consists of transverse and oblique fibres which pass between the two arytenoid cartilages.
- They adduct the vocal chords by drawing the two arytenoid cartilages together.

<- Diagram

Aryepiglottic muscle

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Special Cases

- This muscle is an extension of the oblique interarytenoid muscle along the aryepiglottic fold to the epiglottis.
- It aids in pulling down the epiglottis over the laryngeal inlet during swallowing.

<- Diagram

Lateral Cricoarytenoid Muscle

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Special Cases

- Originates from the upper margin of the cricoid arch and inserts into the muscular process of the arytenoid.
- It adducts the vocal chord by rotating the arytenoid cartilage, so that the vocal process swings towards the mid-line.

<- Diagram

Cricothyroid Muscle

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- Passes from the arch of the cricoid to the inferior margin and inferior horn of the thyroid cartilage.
- It acts on the cricothyroid joint, causing an increase in the length, and/or tension of the vocal chords.
- This movement is opposed by the thyroarytenoid muscle.

<- Diagram

Thyroarytenoid Muscle

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Special Cases

- Passes between the arytenoid and thyroid cartilages, on the lateral side of the vocal ligament.
- It contracts to shorten the vocal chord and/or decrease its tension.
- This movement is opposed by the cricothyroid muscle.

<- Diagram

Thyroepiglottic Muscle

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Special Cases

- Some detached fibres of the thyroarytenoid may extend up to the epiglottis as the **thyroepiglottic muscle**.
- This muscle aids in depressing the epiglottis and closing off the larynx during swallowing.

<- Diagram

Nerves

- The larynx is innervated by branches of the vagus nerve (CN X).
- Sensory
  - For the laryngopharynx, the *internal laryngeal branch of the superior laryngeal nerve* supplies sensation above the vocal chords (supraglottis/glottis) and the *recurrent laryngeal nerve* supplies sensation below the vocal chords (subglottis).
- Motor
  - All intrinsic muscles are supplied by the *recurrent laryngeal nerve*, except for the cricothyroid which is supplied by the *external laryngeal nerve*. The cricothyroid muscle tenses the vocal folds.

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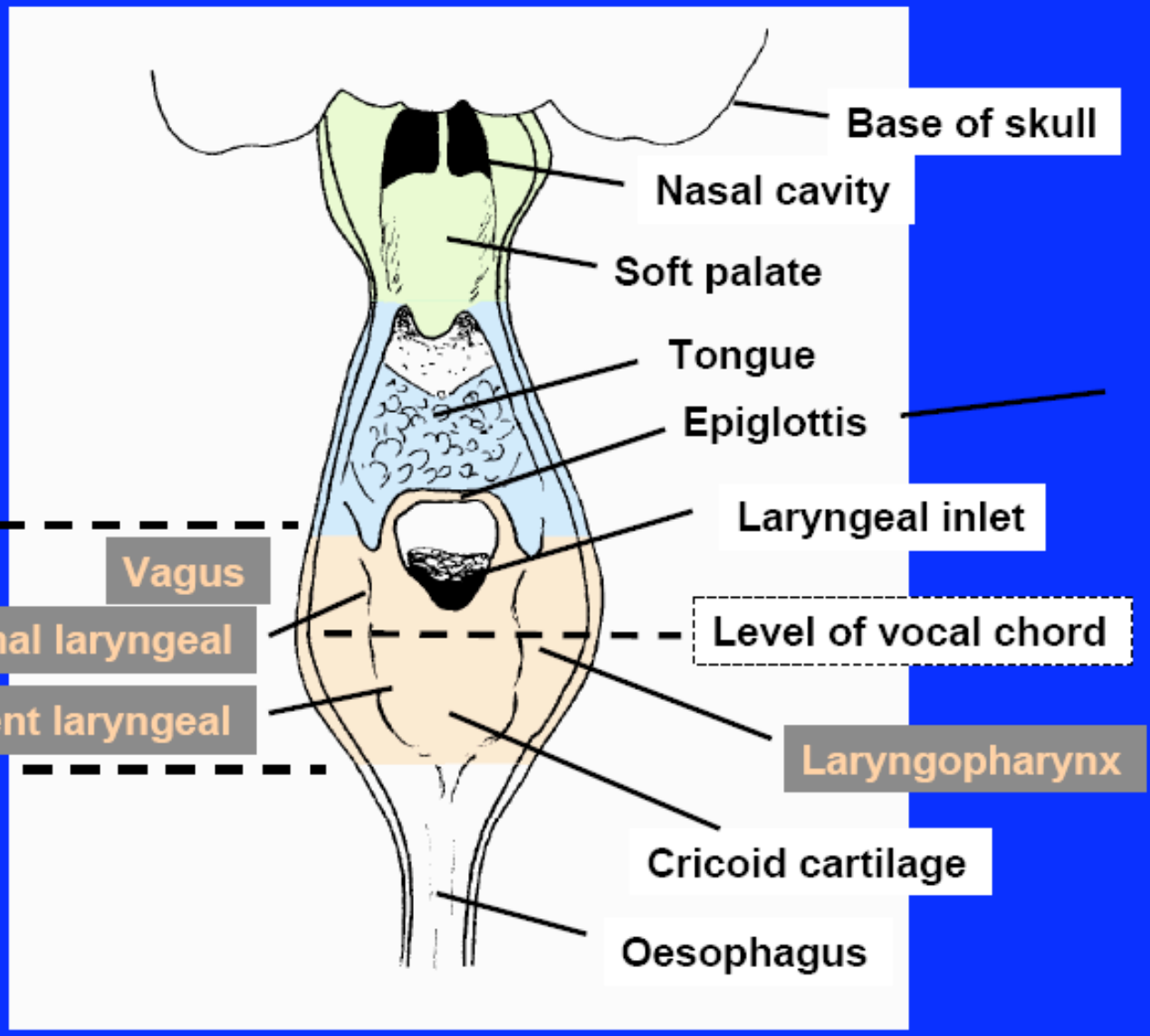
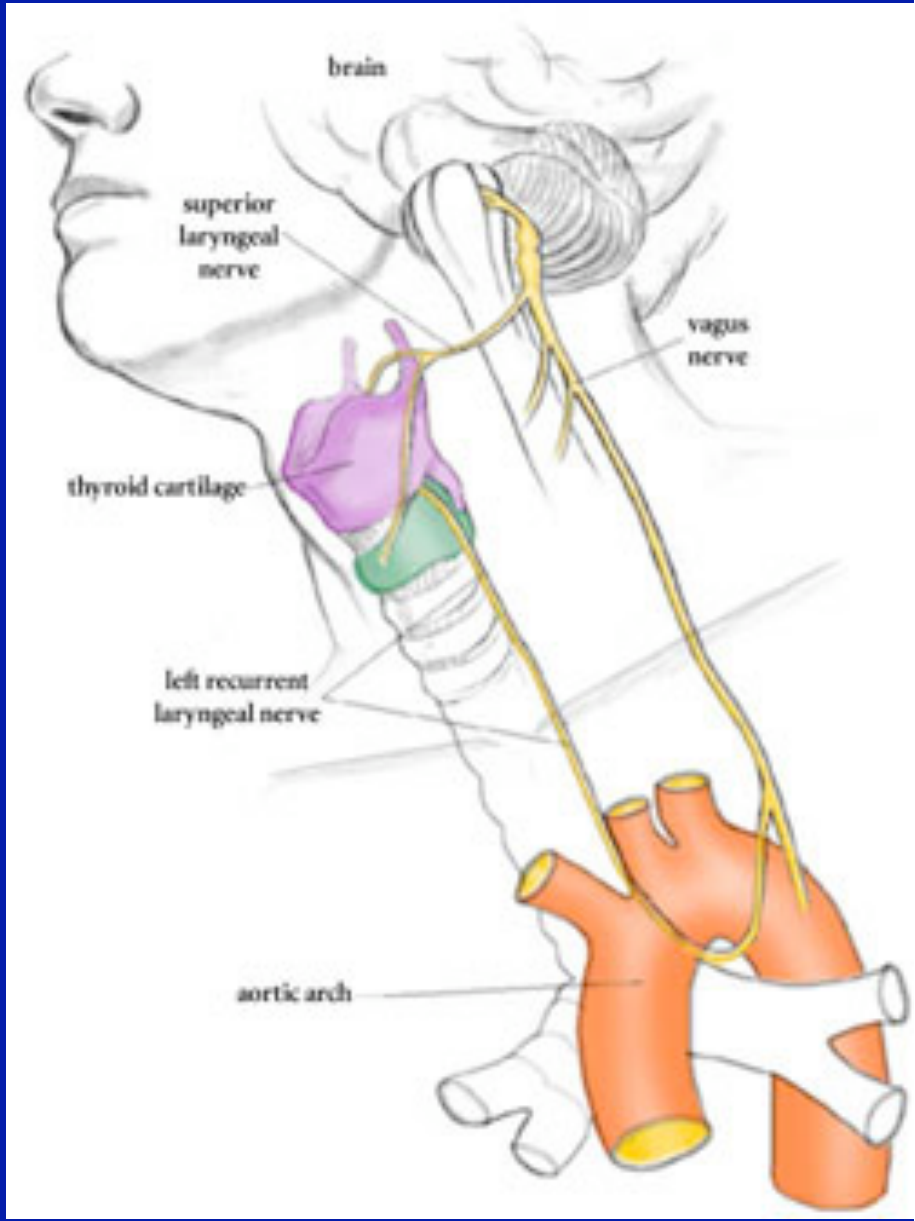
LARYNX – SENSORY NERVES

POSTERIOR VIEW



Recurrent Laryngeal Nerve

- LEFT
  - Loops around aortic arch
- RIGHT
  - Loops around subclavian artery



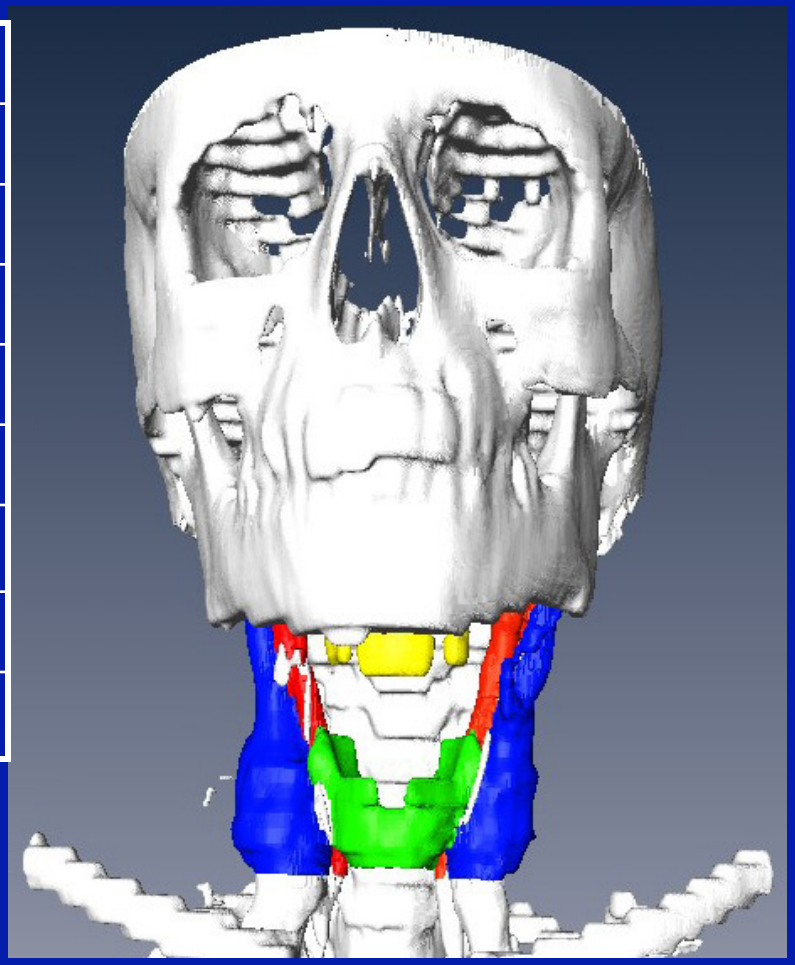
Vessels

- Arteries
  - ***Superior*** and ***inferior laryngeal arteries*** (from the superior and inferior thyroid arteries) accompany the internal and recurrent laryngeal nerves, respectively.
- Vein
  - Venous drainage is by corresponding veins.

Special Cases

- Child's Larynx
- Laryngeal Carcinoma
- Tracheostomy
- Epiglottitis
- Cricothyrotomy
- Spasmodic Dysphonia

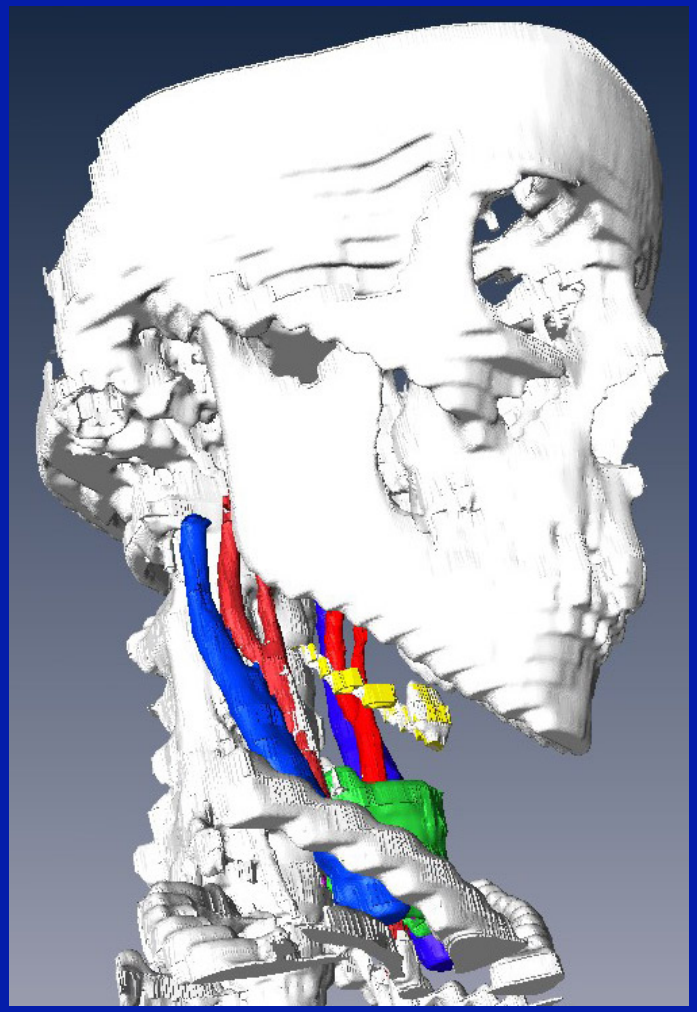
Child's Larynx



There are several differences between an adult and child's larynx and airway:

- More anterior and cephalad larynx
- Short trachea and neck. Beware of right mainstem bronchus intubation
- Proportionally larger head and tongue

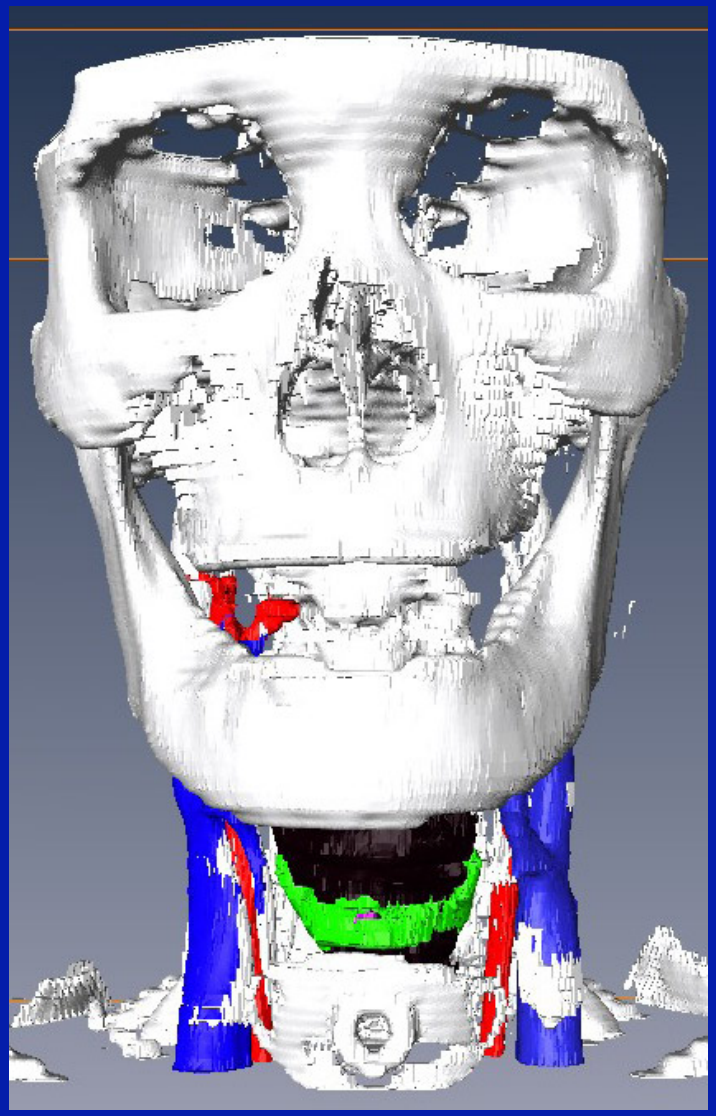
Child's Larynx



Narrowest point in the pediatric airway is the cricoid cartilage, while in the adults, it is the vocal cords. Use an uncuffed tube to intubate children.

Long, floppy epiglottis, "U shaped". Use a straight blade for intubation

Laryngeal Carcinoma



This laryngeal carcinoma, shown in black, is obstructing the airway. A tracheostomy was done to secure the patient's airway

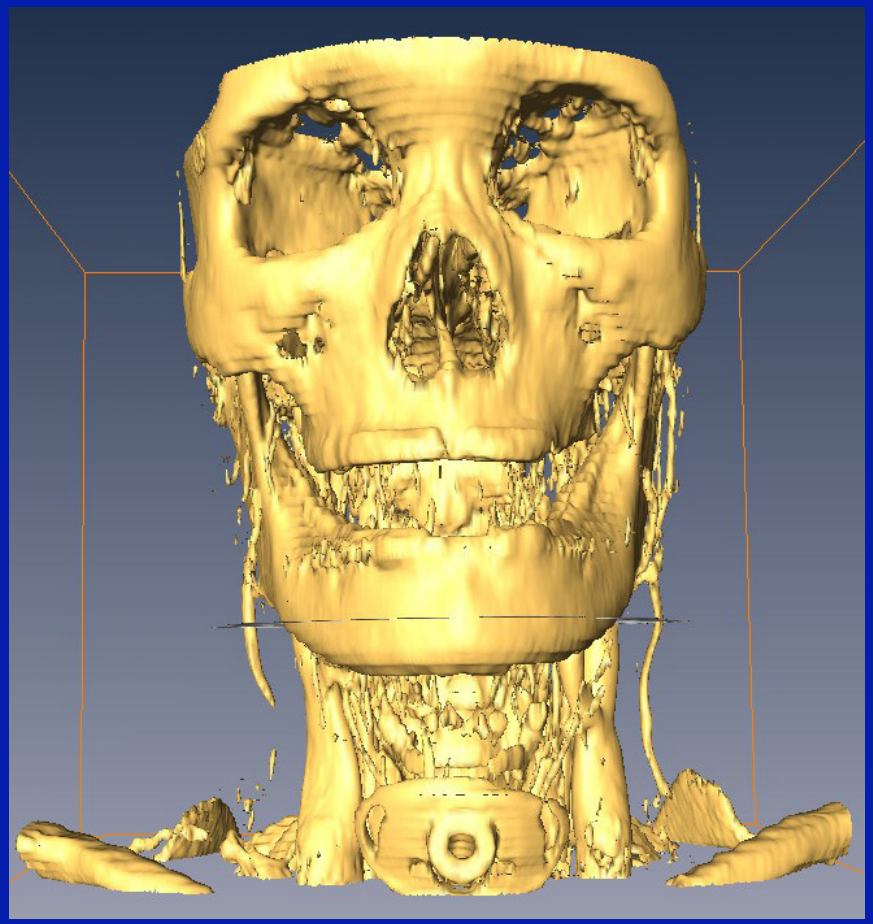
Laryngeal Carcinoma

- The most common head & neck cancer
- 5% of all malignancies diagnosed annually
- 20,000 new cases in US annually
- Mean age: 60-62 years
- Predisposing factors: smoking & alcohol
- Most are squamous cell carcinomas (>95%)

Laryngeal Carcinoma

- Presenting symptoms: hoarseness, dysphagia, odynophagia, sore throat, referred otalgia, globus sensation, weight loss, and neck mass.
- Laryngeal tumors arise in the glottis (67%), supraglottis (31%), and subglottis (2%)
- Early cancers (T1/T2) are treated with single-modality treatment (surgery or radiation), while late cancers (T3/T4) are treated with multimodality treatment (surgery with postoperative radiation or organ preserving therapy)

Tracheostomy



A tracheostomy is an opening is made into the anterior wall of the trachea to establish an airway

Indications for Tracheostomy

- Upper airway obstruction
  - Due to burns or corrosive injury, laryngeal dysfunction, foreign bodies, infections, inflammatory conditions, neoplasms, OSA
- Inability of patient to manage secretions
  - Due to aspiration or excessive bronchopulmonary secretions
- Prolonged intubation
- Facilitation of ventilation support
- Inability to intubate
- Adjunct to major head & neck surgery
- Adjunct to management of major head & neck trauma

Tracheostomy

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Airway Obstruction

Tracheostomy

http://www.nlm.nih.gov/medlineplus/ency/presentations/100043_4.htm

Epiglottitis

- Acute inflammation of the epiglottis and the supraglottic structures surrounding it
- Can be a severe, life-threatening disease of the upper airway
- *Haemophilus influenzae* was the predominant organism.
  - *Hib* vaccine has decreased the incidence of epiglottitis
- Age: 1-6 years old

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Epiglottitis

- Clinical triad of the 3 Ds:
  - Drooling
  - Dysphagia
  - respiratory Distress
- Rapid onset of fever and sore throat
- Patient anxious and toxic looking

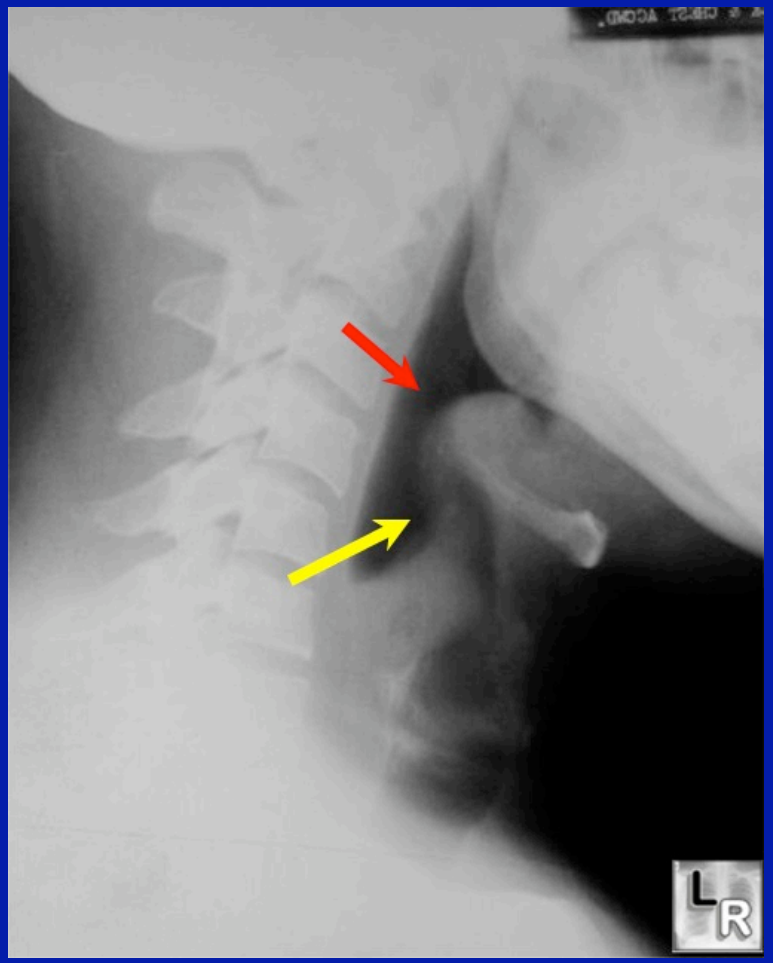
Epiglottitis

- “Hot potato" muffled voice
  - supraglottic
- May have inspiratory stridor
  - Inspiratory – supraglottic or glottic
  - Biphasic – subglottic
  - Expiratory – distal tracheobronchial tree
- “Sniffing position" with their nose pointed superiorly, head forward, sitting erect to maintain an adequate airway.
- Cough is rare

Epiglottitis

- Secure the AIRWAY first before any tests
  - ENT/Anesthesia consults
  - May need to intubate in the OR
- Do not agitate the child in any way
  - e.g. iv, tests
- Administer humidified oxygen
- iv Antibiotics to cover causative agents X 7-10 d

Epiglottitis



- After the airway is secure, lateral neck radiographs may show an enlarged epiglottis called the thumb sign

Cricothyrotomy

- Emergency incision through the skin and cricothyroid membrane to secure a patient's airway during certain emergency situations
- Easier and faster than a tracheostomy
- Only used when oral or nasal intubation is not possible
- A cricothyrotomy is a temporary airway, while a tracheostomy is a definitive airway

Cricothyrotomy

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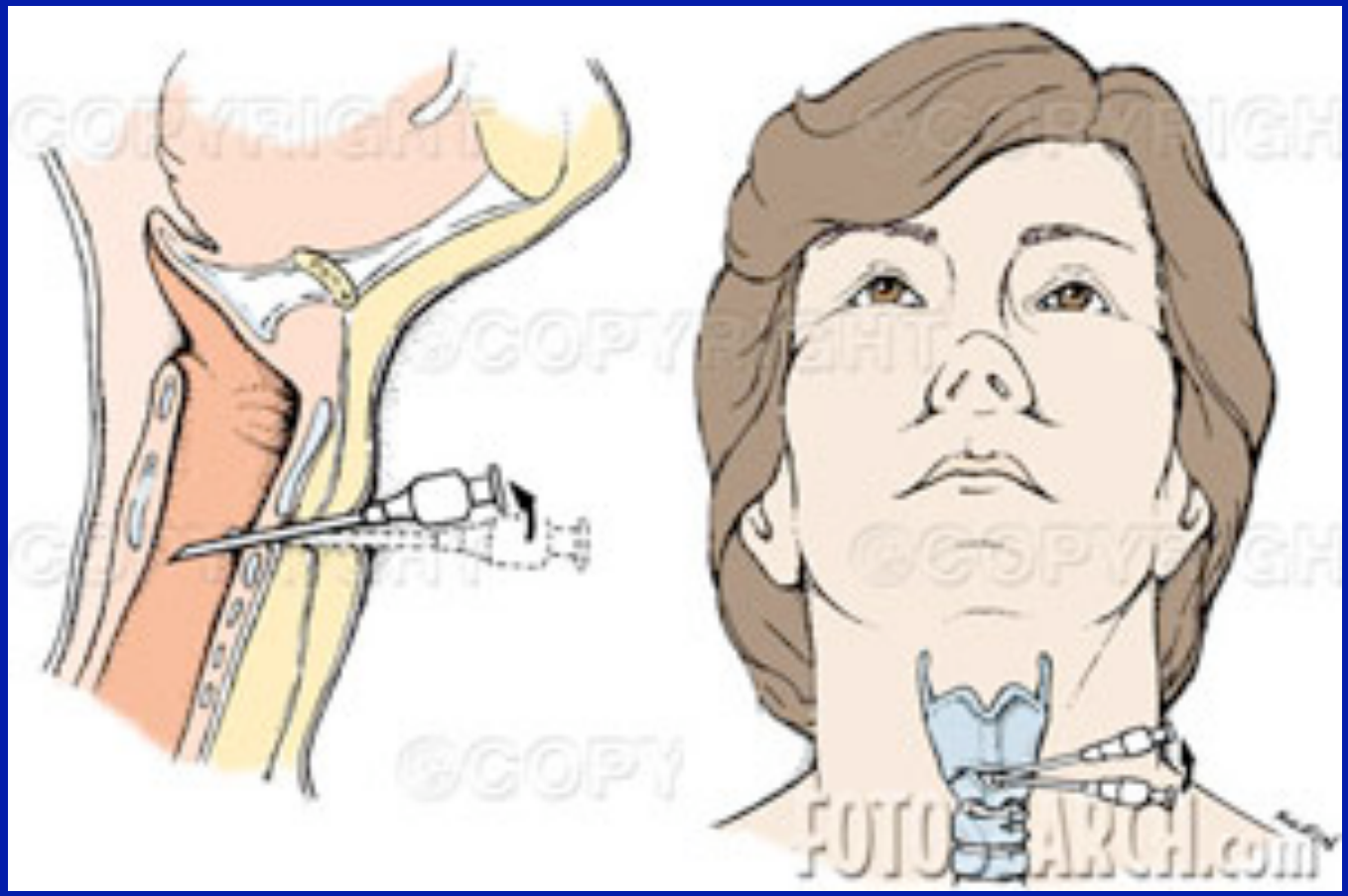

http://www.fotosearch.com/comp/LIF/LIF141/NU304004.jpg

Adductor Spasmodic Dysphonia

- Sudden involuntary muscle movements or spasms cause the vocal cords to slam together and stiffen.
- Speech may be choppy and sound similar to stuttering. The voice is commonly described as strained or strangled and full of effort.

Abductor Spasmodic Dysphonia

- Sudden involuntary muscle movements or spasms cause the vocal folds to open.
- The vocal folds can not vibrate when they are open.
- The open position of the vocal folds also allows air to escape from the lungs during speech.
- The voices sounds weak, quiet and breathy or whispery.

Spasmodic Dysphonia

- With both abductor and adductor spasmodic dysphonia, the spasms are often absent during activities such as laughing or singing
- Stress often makes the spasms worse
- There is no cure
- The most effective treatment for reducing symptoms is injections of very small amounts of botulinum toxin (Botox) directly into the affected muscles of the larynx

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