Upper Air Ways

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Anatomy of the upper respiratory tract:

Reference books:

- **Oxford handbook of Medical Sciences (2011), pp: 362-370.**
- **Kaplan (2021), pp: 35-53, 207-207-224.**

Objective of the Lecture:

By the end of the lecture the student will be able to:

A1- Describe the normal anatomy of the nasal cavity.

A2 -Describe the normal anatomy of the paranasal air sinuses.

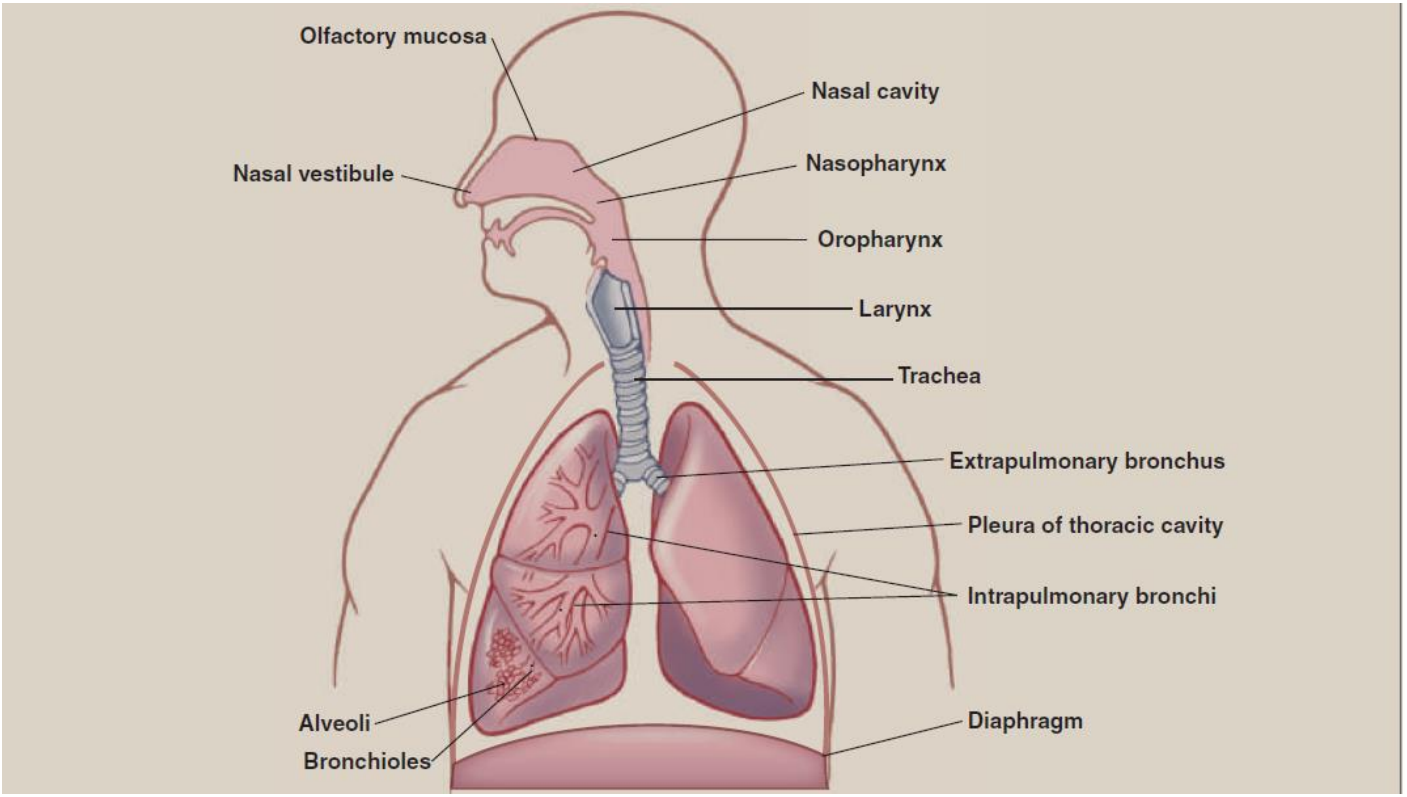
A3- Describe the normal anatomy of the nasopharynx and associated openings.

A4-Describe the normal anatomy of the larynx including cartilages, ligaments, muscles, blood supply and innervation.

A5-Describe the normal anatomy of the trachea including level, shape, muscles, blood supply and innervation.

The pulmonary system consists of:

1. Nasal cavities
2. Pharynx
3. Larynx
4. Trachea
5. Bronchi
6. Bronchioles
7. Alveoli
8. Lungs



As well as the thoracic cavity with muscles, nerves, vasculature, pleural membranes, diaphragm

Upper Airways

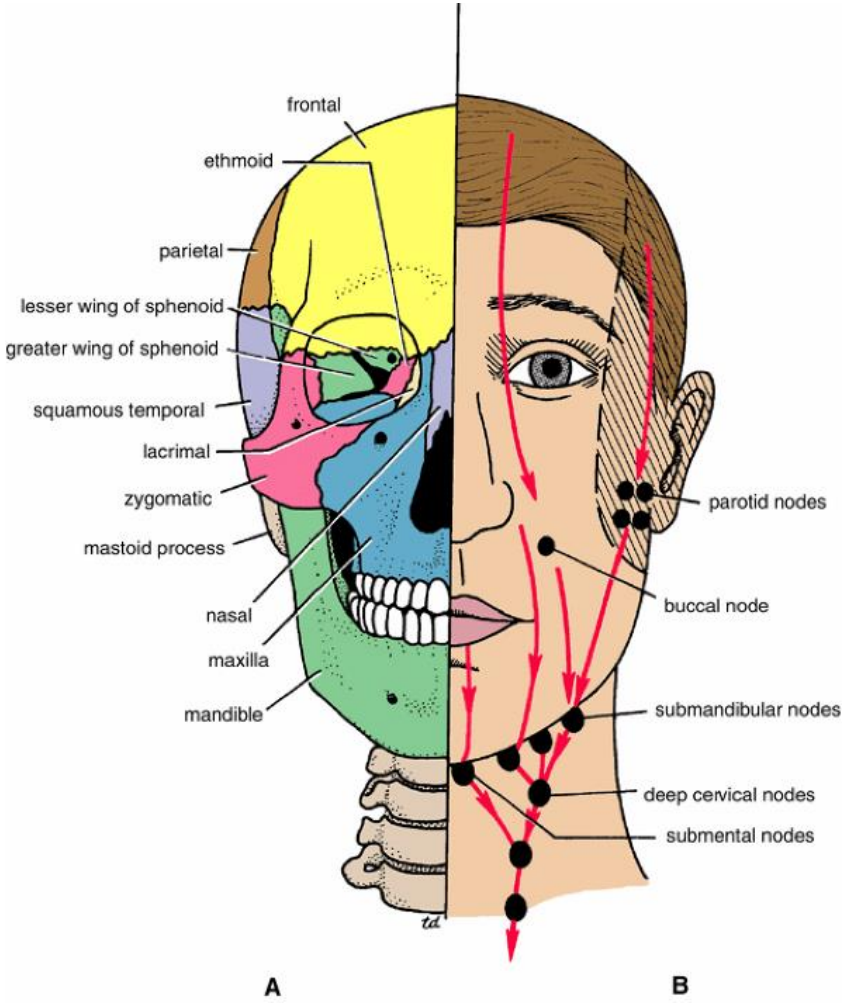
- Comprise those parts of respiratory tract above trachea.
- However, same term is referred to all airways which conduct inspired gases from atmosphere to terminal bronchioles, where gas exchange starts.
- Upper airways are lined by respiratory epithelium; pseudostratified and ciliated.
- Frequent goblet cells secrete mucus, which absorbs smaller inhaled particles not excluded by the nose
- Continuous beating motion of cilia prevents these particles from entering lungs by shifting mucus upwards and out of respiratory tract where swallowed or expectorated (mucociliary escalator).
- This is important defense against entry of foreign, potentially pathogenic, particles.

Nose

Plays important role in:

1. **Sense of smell**
2. **Moistens inhaled air**
3. **Warms inhaled air**
4. **Prevents particulate matter from entering the airways.**

- **Air enters the nose through anterior nares (nostrils), passing anterior nasal hairs (vibrissae).**
- **These trap and prevent inhalation of larger foreign particles.**
- **Epithelial lining changes shortly after entering the nose from keratinized to respiratory epithelium**



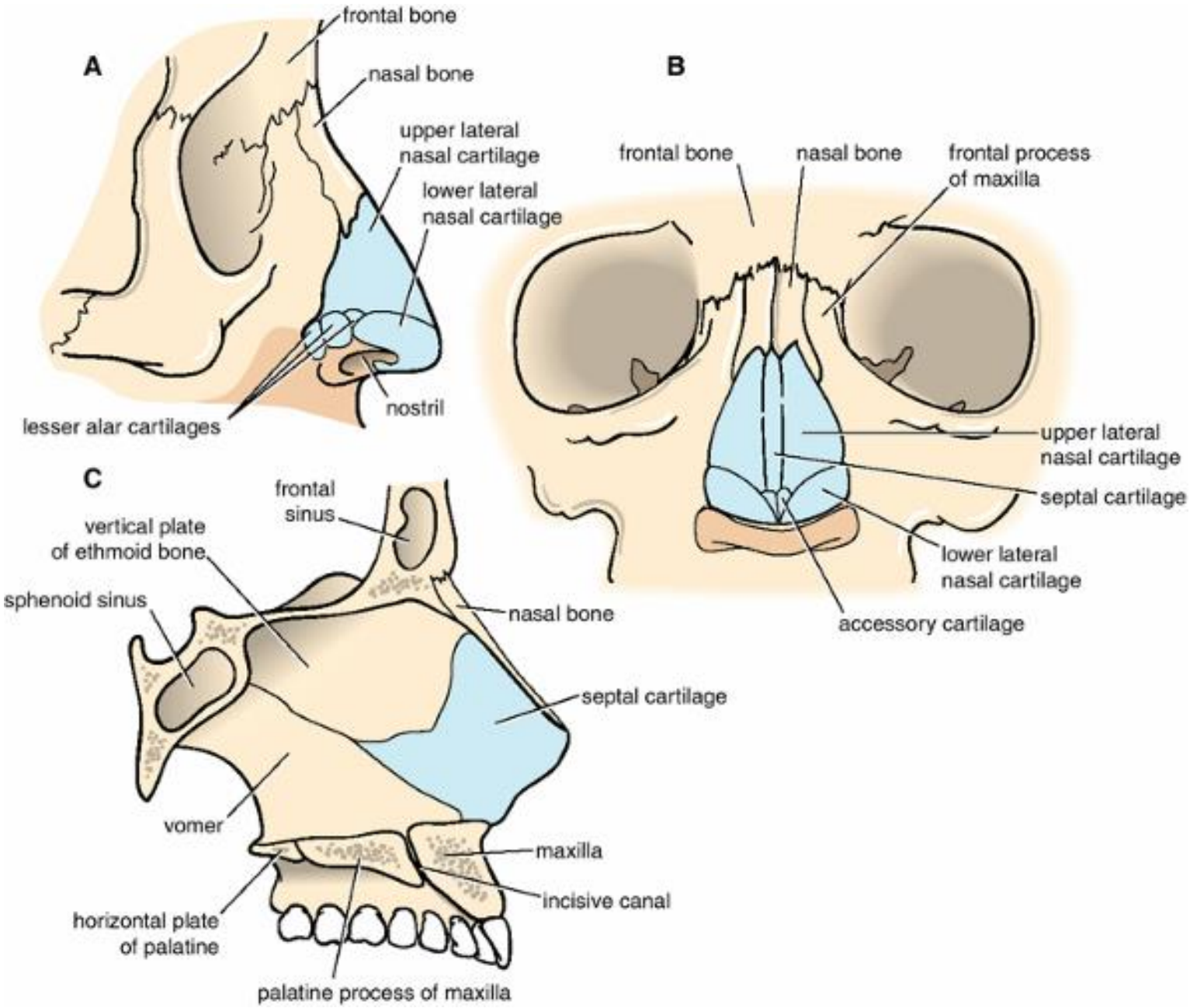
Nose (Cont.)

Nasal septum:

Formed from:

1. Vertical plate of ethmoid bone of skull
2. Septal cartilage
3. Vomer

- Separates nasal airway into left and right halves



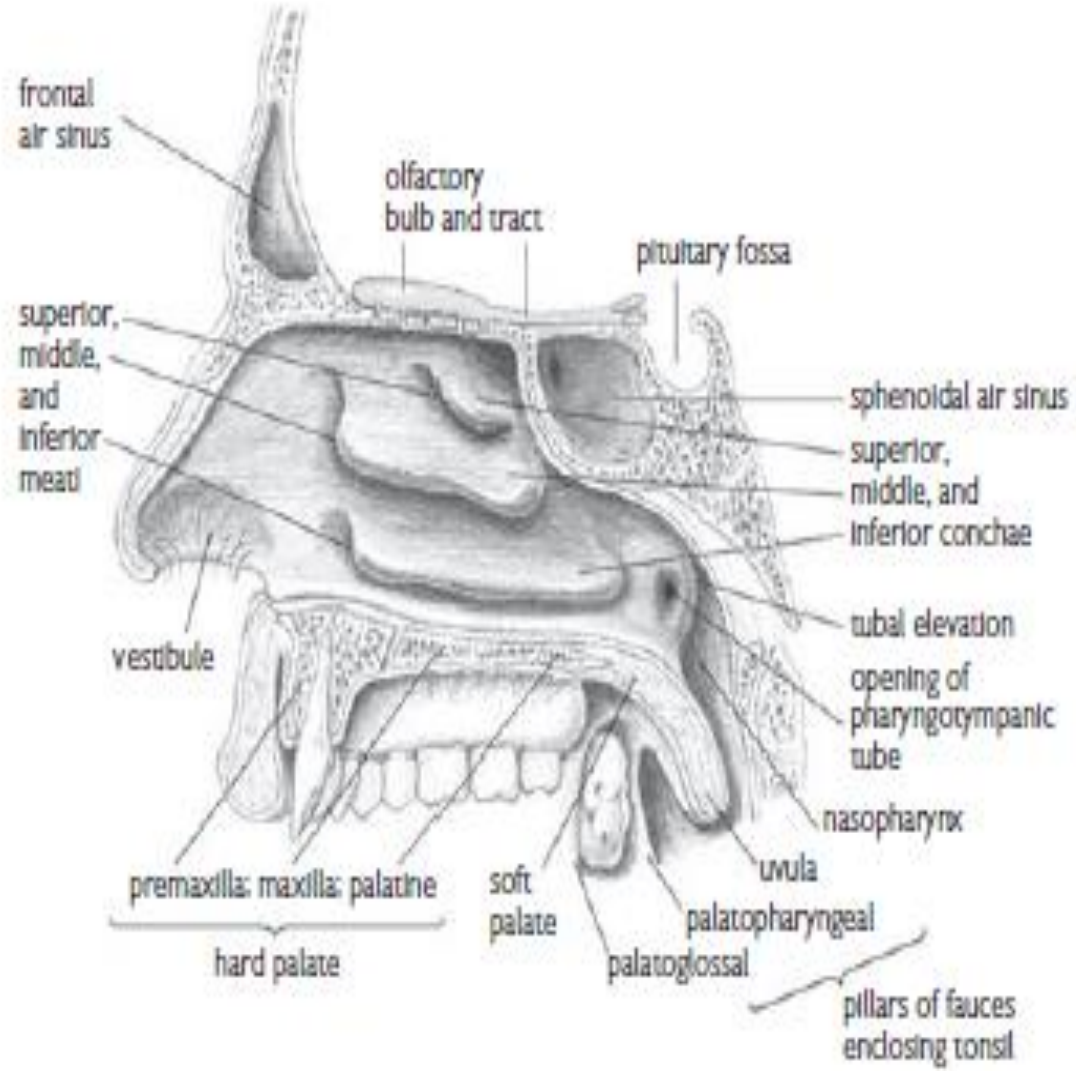
Conchae:

- 3 conchae on each side: inferior, middle, and superior concha
- Swirl-like bony structures
- Found on lateral aspect of each side of nasal airway

Function of conchae:

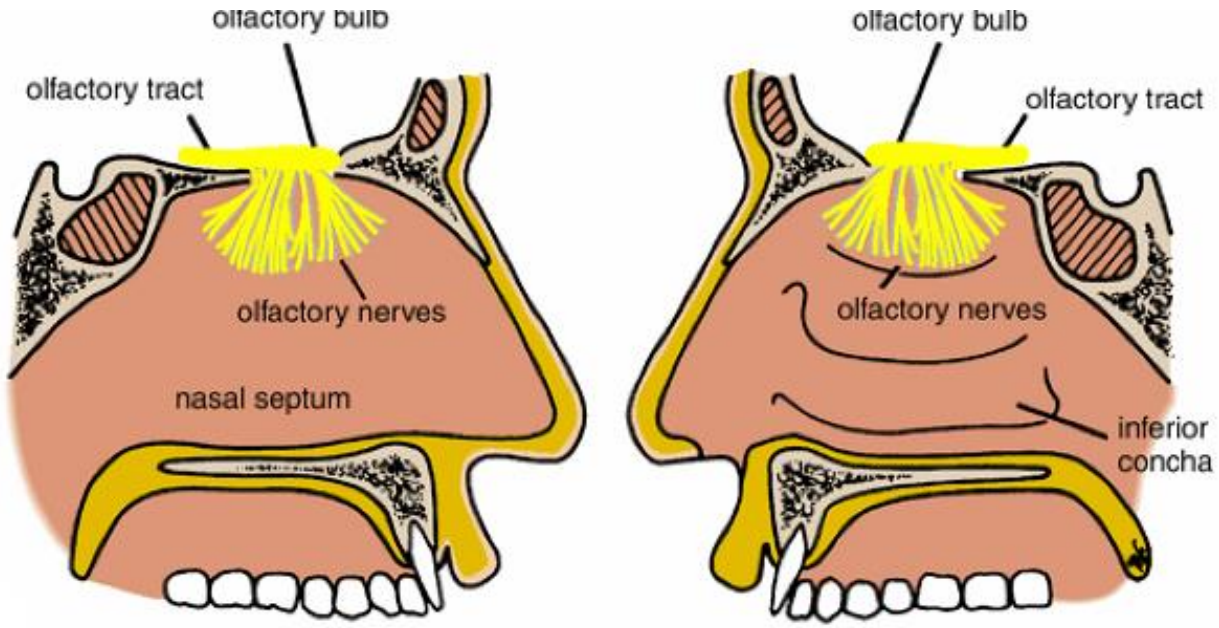
1. Moisten passing air
2. Warm passing air

by increasing surface area of nasal passage.



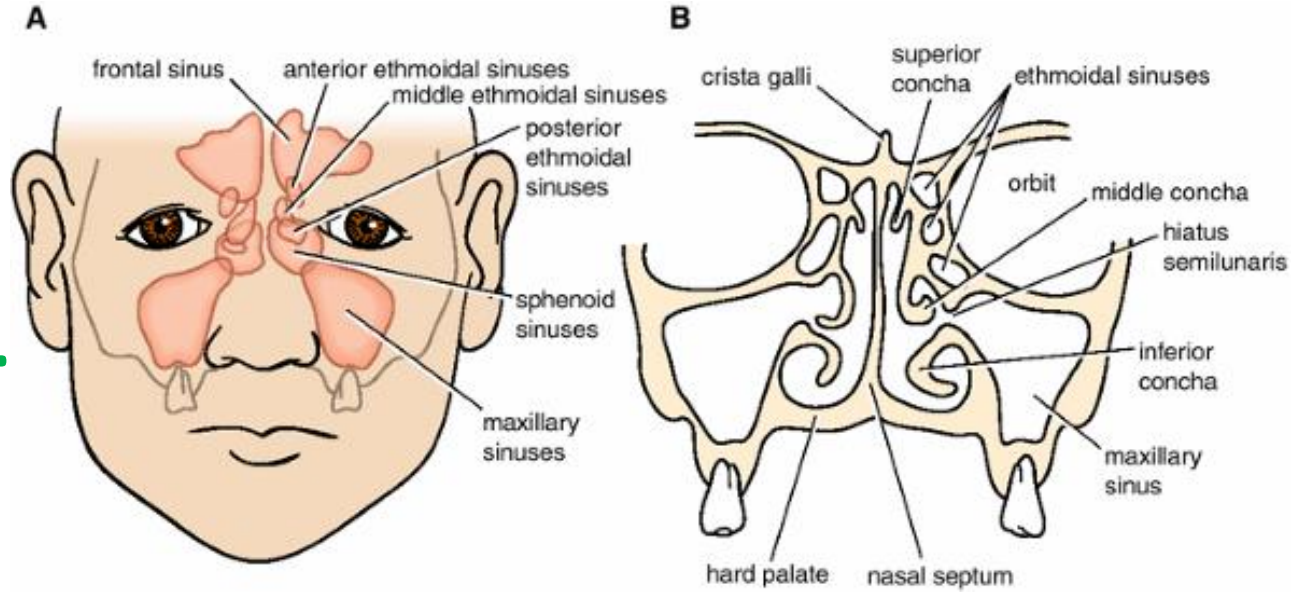
• Nose (Cont.)

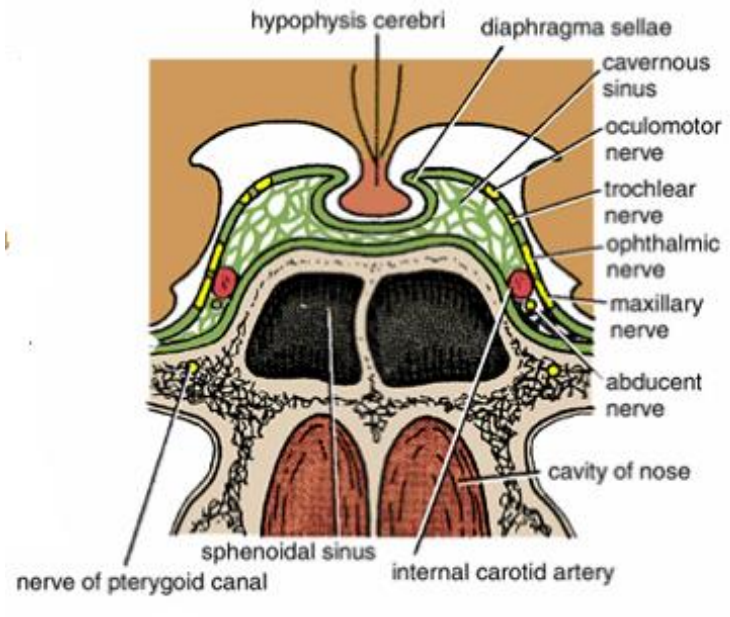
- Olfactory epithelium: found in upper regions of nasal airway above superior conchae and specialized for detection of smell.
- Olfactory nerves, hair-like projections that line roof and lateral walls of nose where olfactory epithelium is found, possess receptors that bind specific odorants as air circulates past them.
- Inhaled air exits nose through its posterior openings— right and left choanae (posterior nares)—to enter nasopharynx (area lying behind nasal passage and above soft palate).



Paranasal sinuses

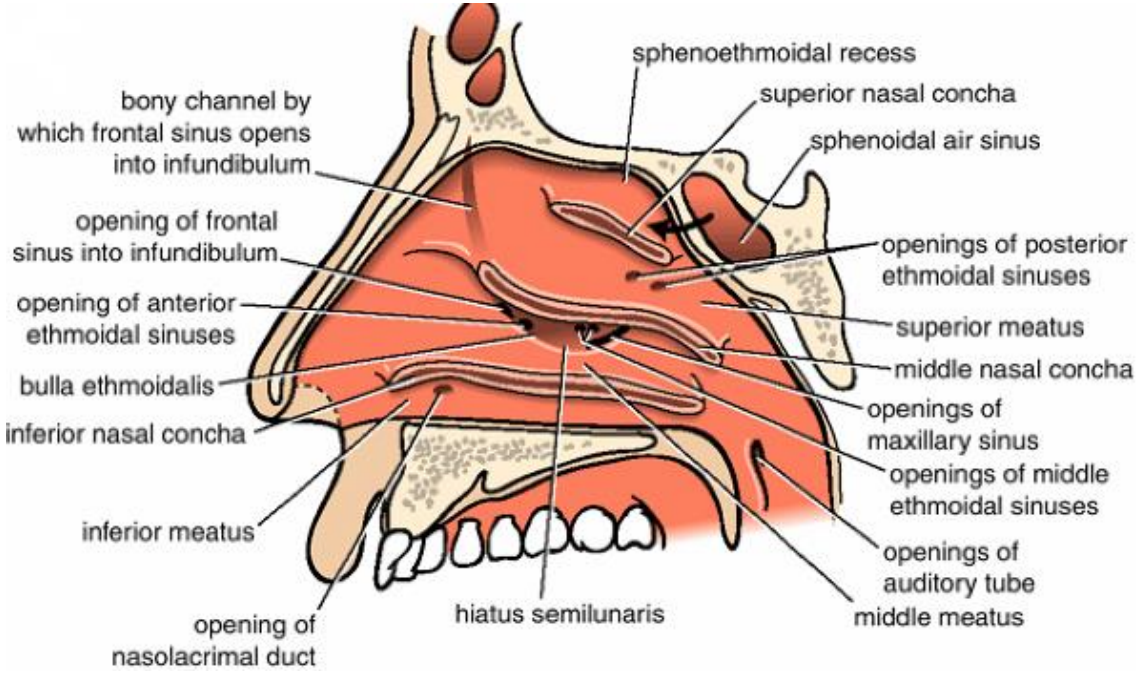
- Hollow, air-filled bony cavities that surround the nose.
- Four pairs: maxillary, frontal, ethmoidal, and sphenoidal sinuses.
- Lined with respiratory epithelium and produce mucus that drains into nasal cavity via ostia (cavities or holes below each concha; meati).
- There is a meatus associated with each concha, and spheno-ethmoidal recess above superior concha.





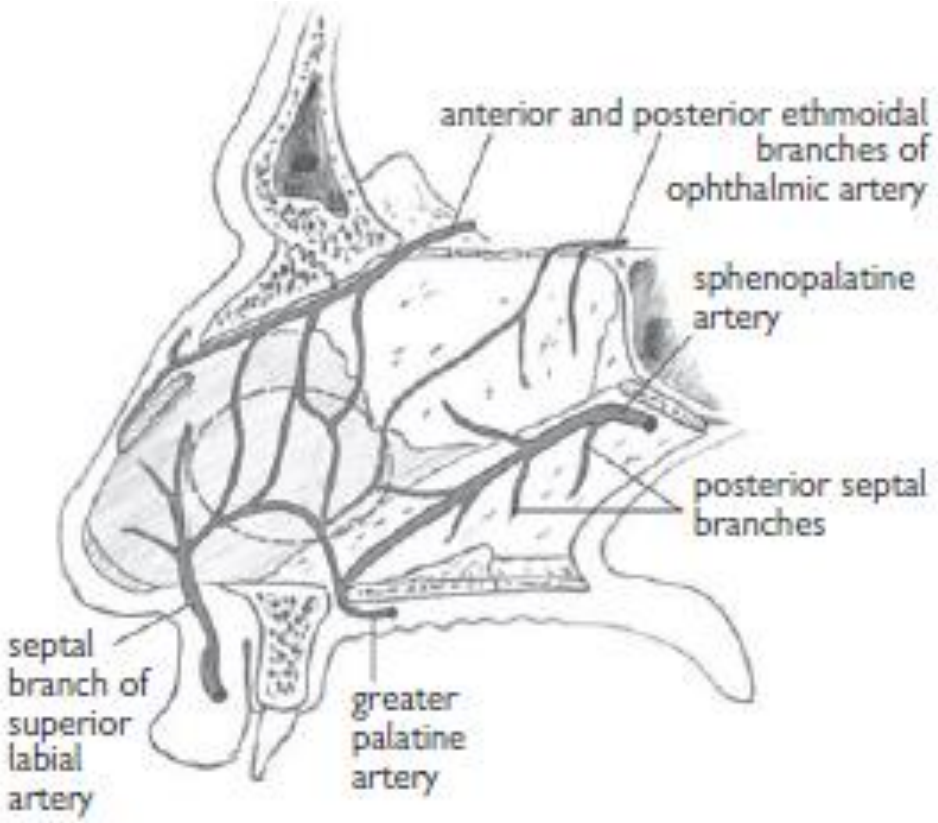
Paranasal sinuses (Cont.)

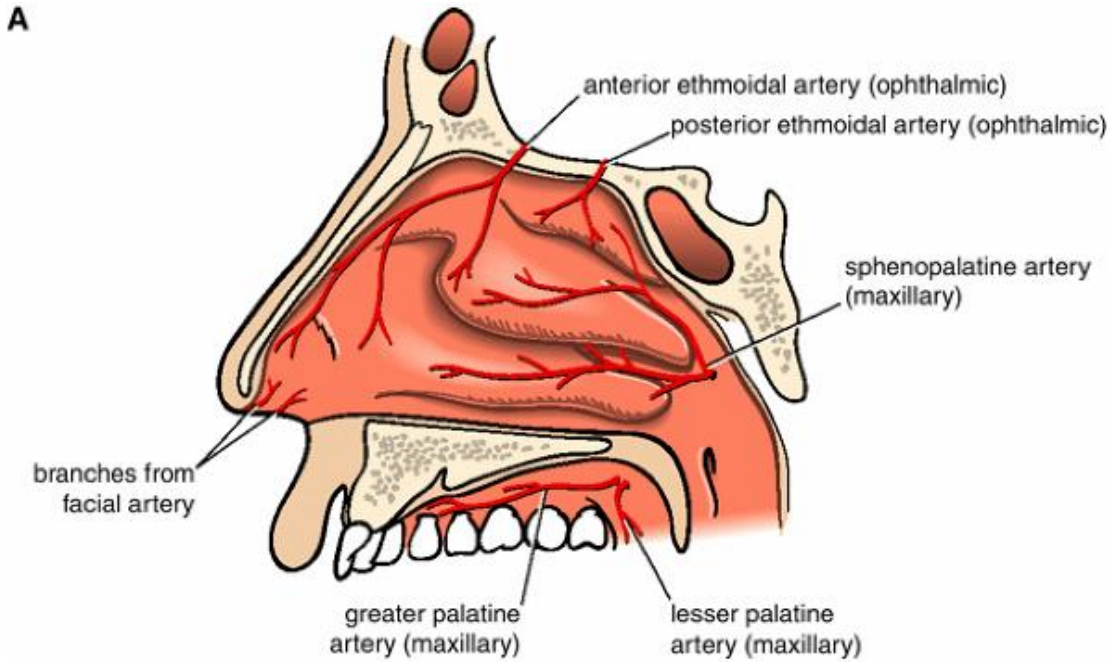
- Spheno-ethmoidal recess drains sphenoidal sinuses.
- Superior meatus drains the posterior ethmoidal sinuses.
- Middle meatus drains rest of ethmoidal sinuses (middle and anterior) and all of maxillary and frontal sinuses.
- Inferior meatus receives drainage from naso-lacrimal duct.
- This duct drains tears from medial angle of the eye into nose.

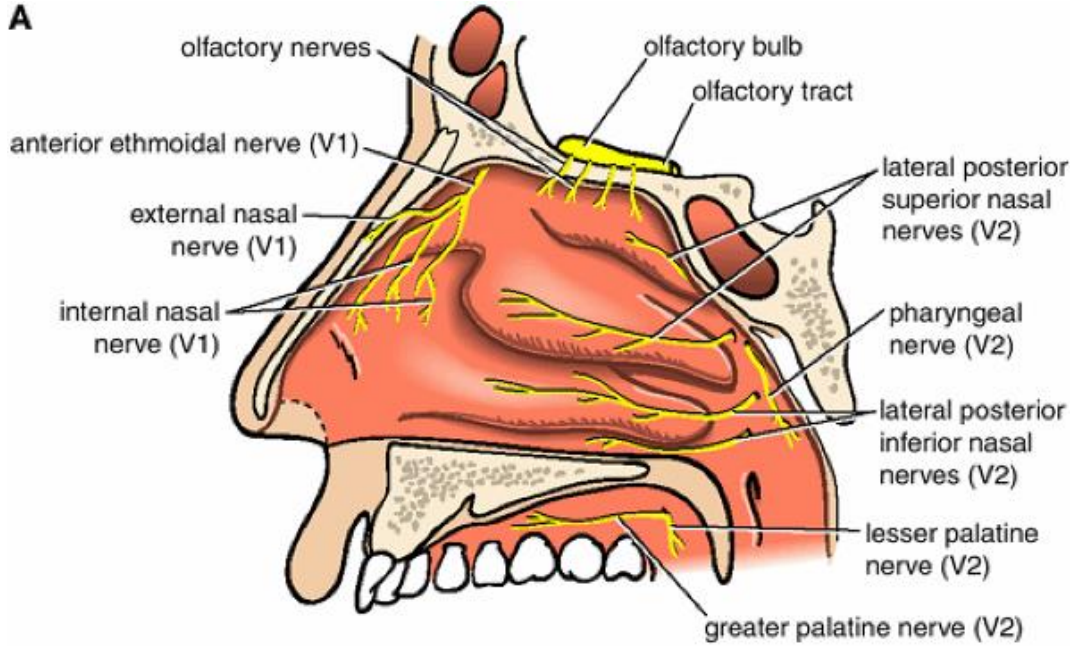


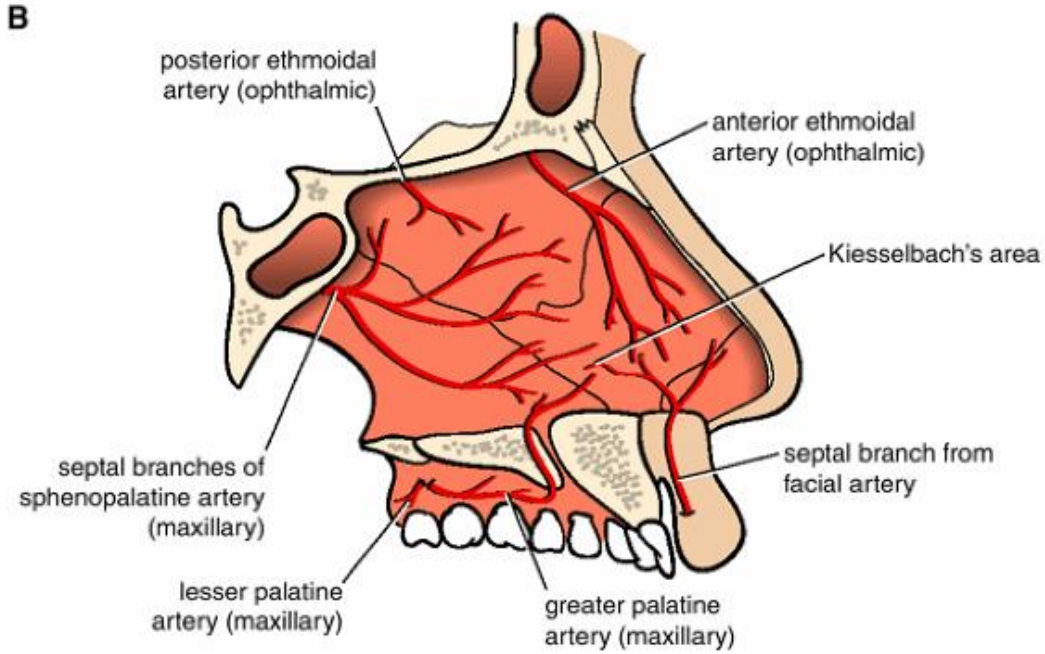
Blood supply to the nose

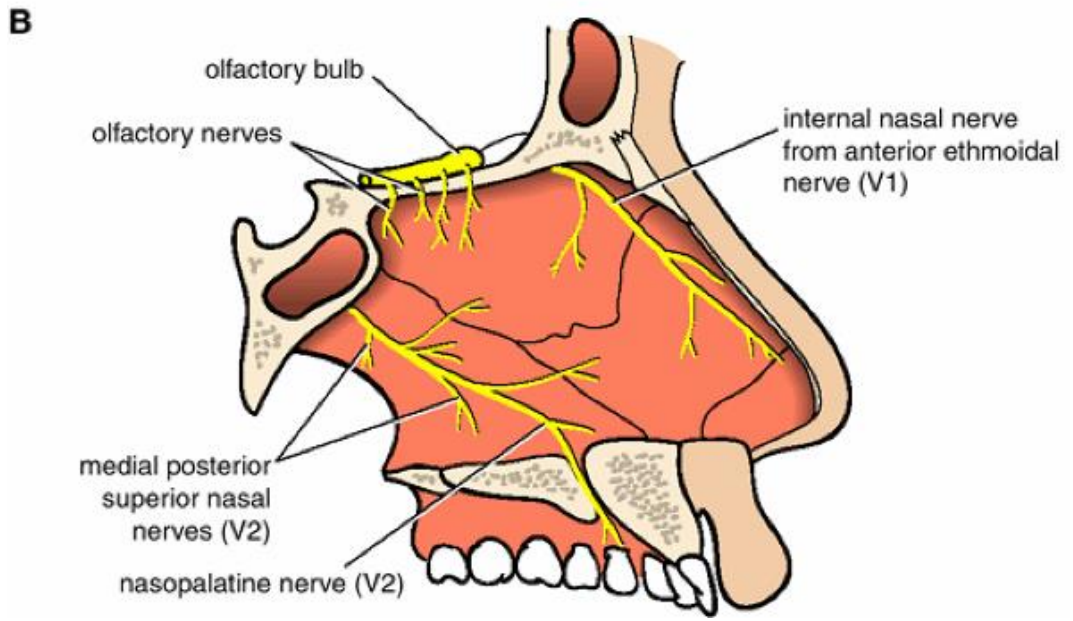
- **The nose is supplied by several different arteries which anastomose at Little's area in anterior part of nasal septum.**
- **Roof, anterior, and lateral walls are supplied by *anterior and posterior ethmoidal arteries*, whilst meati, septum, and conchae are supplied by *sphenopalatine arteries, superior labial artery, and a branch of greater palatine artery.***

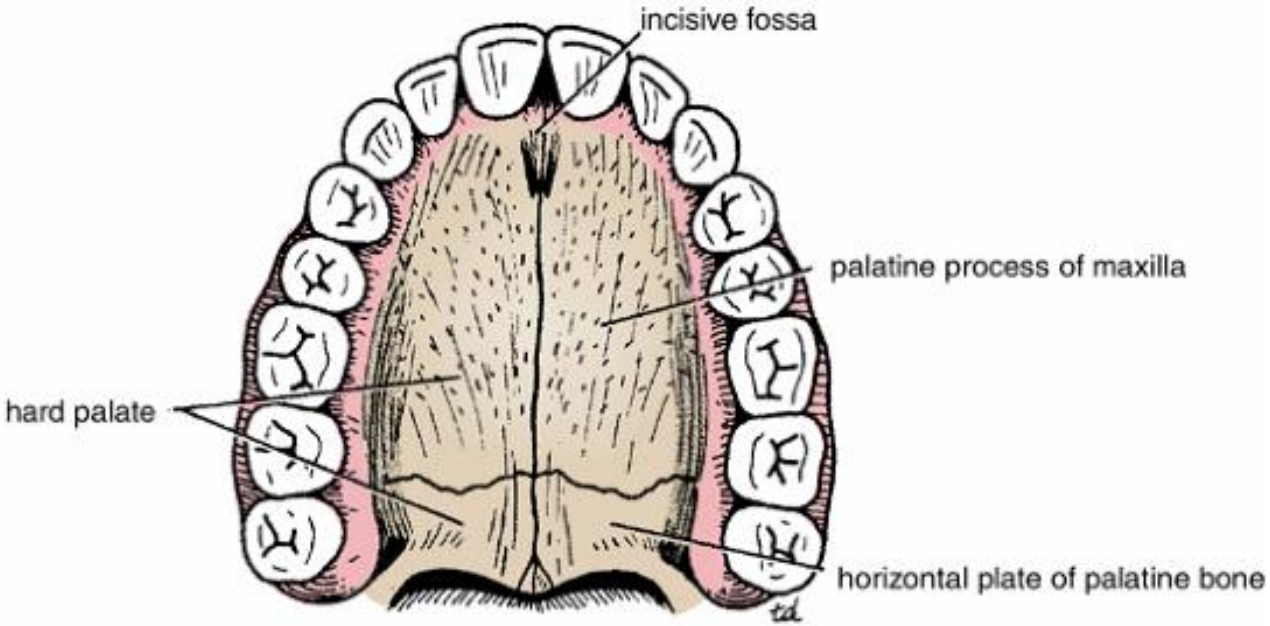


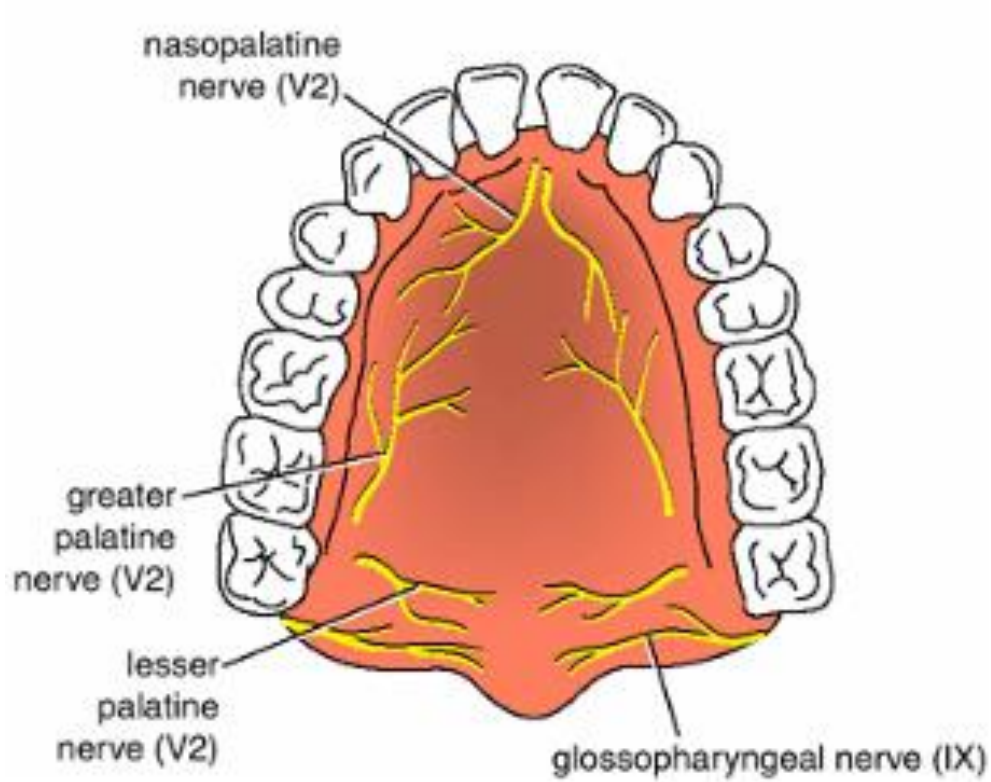

A
anterior ethmoidal artery (ophthalmic)
posterior ethmoidal artery (ophthalmic)
sphenopalatine artery (maxillary)
branches from facial artery
greater palatine artery (maxillary)
lesser palatine artery (maxillary)


A
olfactory nerves
olfactory bulb
olfactory tract
anterior ethmoidal nerve (V1)
external nasal nerve (V1)
internal nasal nerve (V1)
lateral posterior superior nasal nerves (V2)
pharyngeal nerve (V2)
lateral posterior inferior nasal nerves (V2)
lesser palatine nerve (V2)
greater palatine nerve (V2)


B
posterior ethmoidal artery (ophthalmic)
anterior ethmoidal artery (ophthalmic)
Kiesselbach's area
septal branches of sphenopalatine artery (maxillary)
septal branch from facial artery
lesser palatine artery (maxillary)
greater palatine artery (maxillary)


B
olfactory bulb
olfactory nerves
internal nasal nerve from anterior ethmoidal nerve (V1)
medial posterior superior nasal nerves (V2)
nasopalatine nerve (V2)

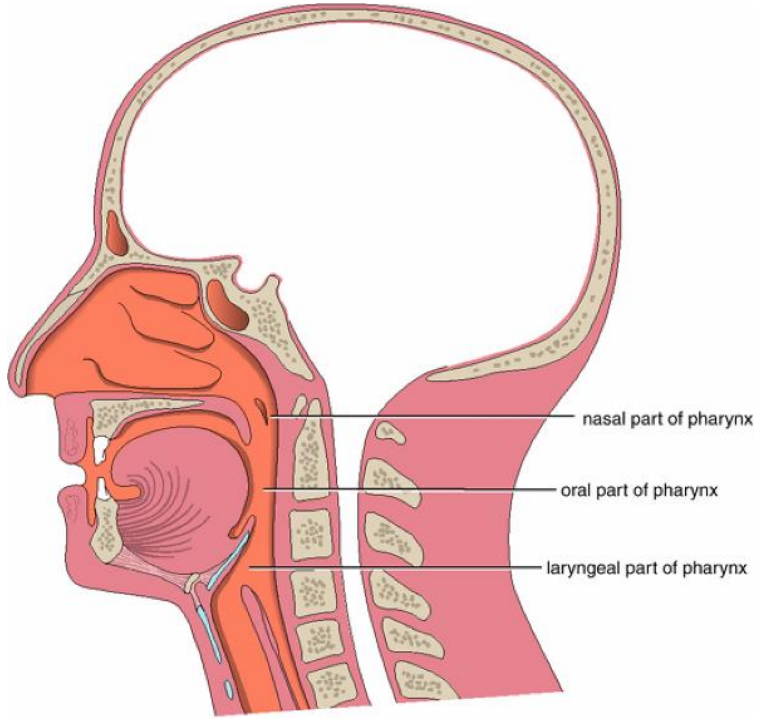

incisive fossa
palatine process of maxilla
hard palate
horizontal plate of palatine bone

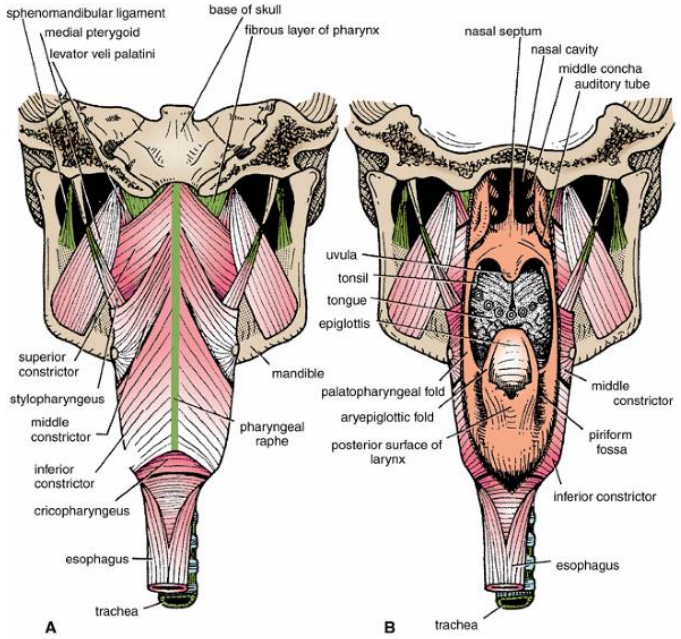

nasopalatine nerve (V2)
greater palatine nerve (V2)
lesser palatine nerve (V2)
glossopharyngeal nerve (IX)

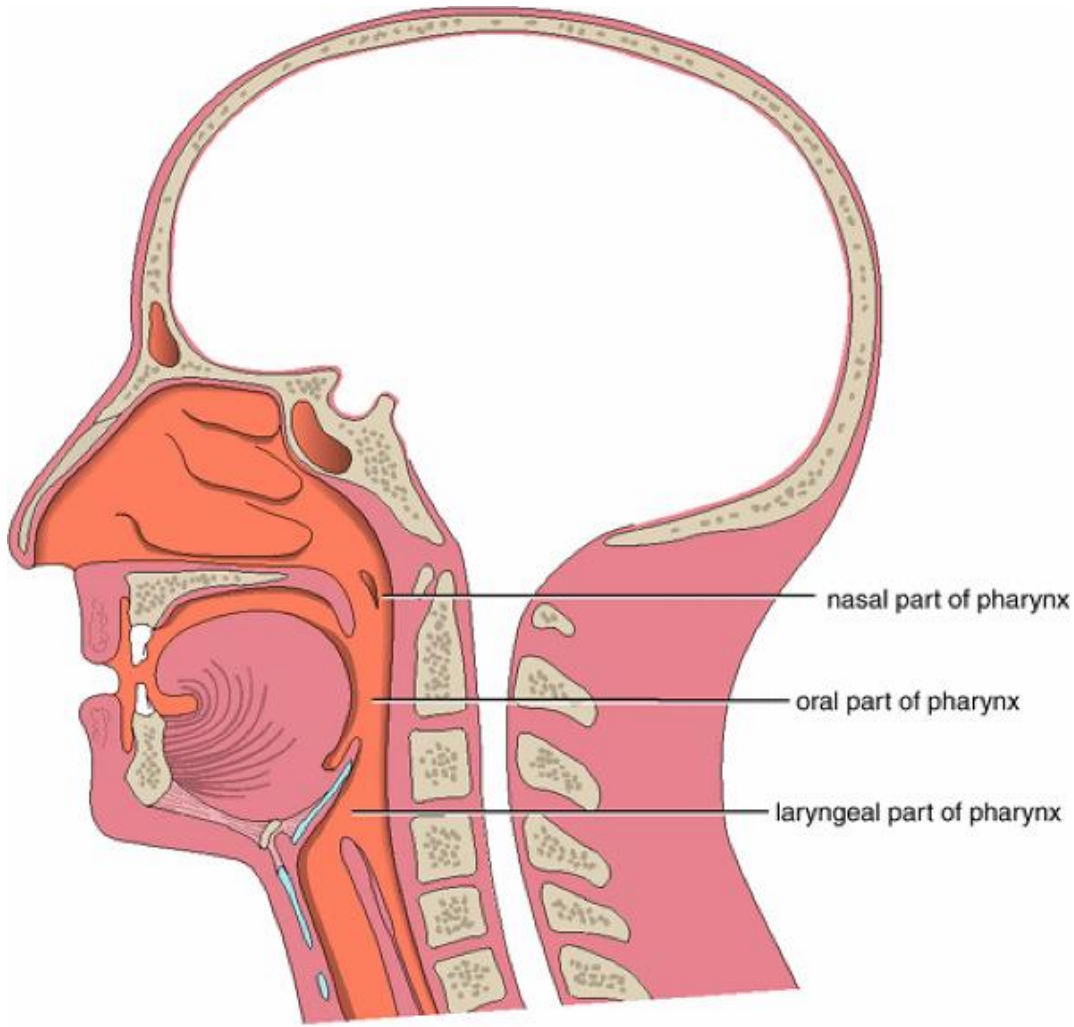
Pharynx

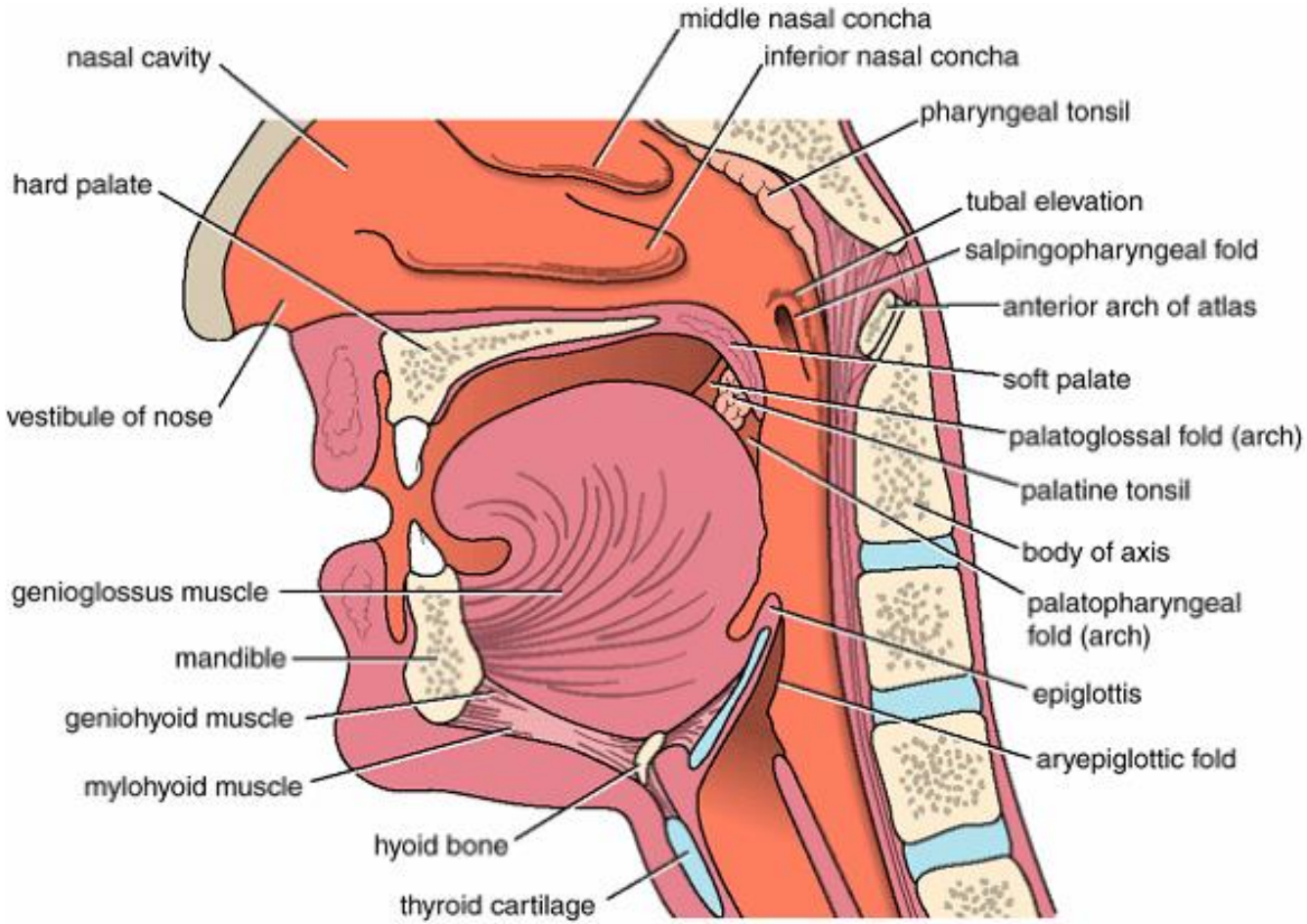
Pharynx

- Muscular tube that extends from oesophagus (C 6) to base of skull.
- Anteriorly, pharynx opens into back of nose, mouth, and larynx.
- Pathway of food and air to oesophagus and larynx respectively.
- Comprised of three muscles:
- Superior, middle, and inferior pharyngeal constrictor muscles.
- Fan-like structures that stack one inside the other and interdigitate.
- Attached to side walls of 3 orifices into which pharynx opens anteriorly.
- All 3 muscles attach to median raphe (fusion of the muscles) as they fan out and attach to posterior wall of pharynx.

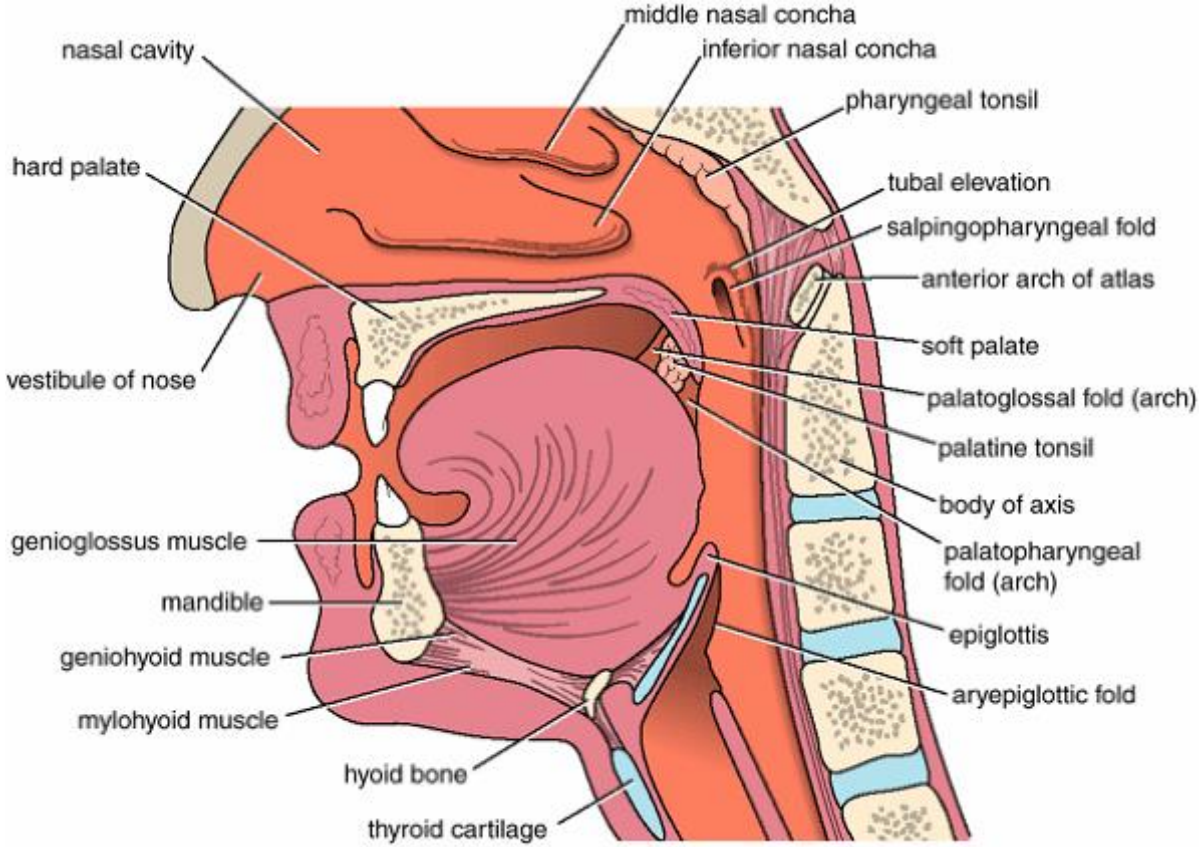





nasal part of pharynx
oral part of pharynx
laryngeal part of pharynx

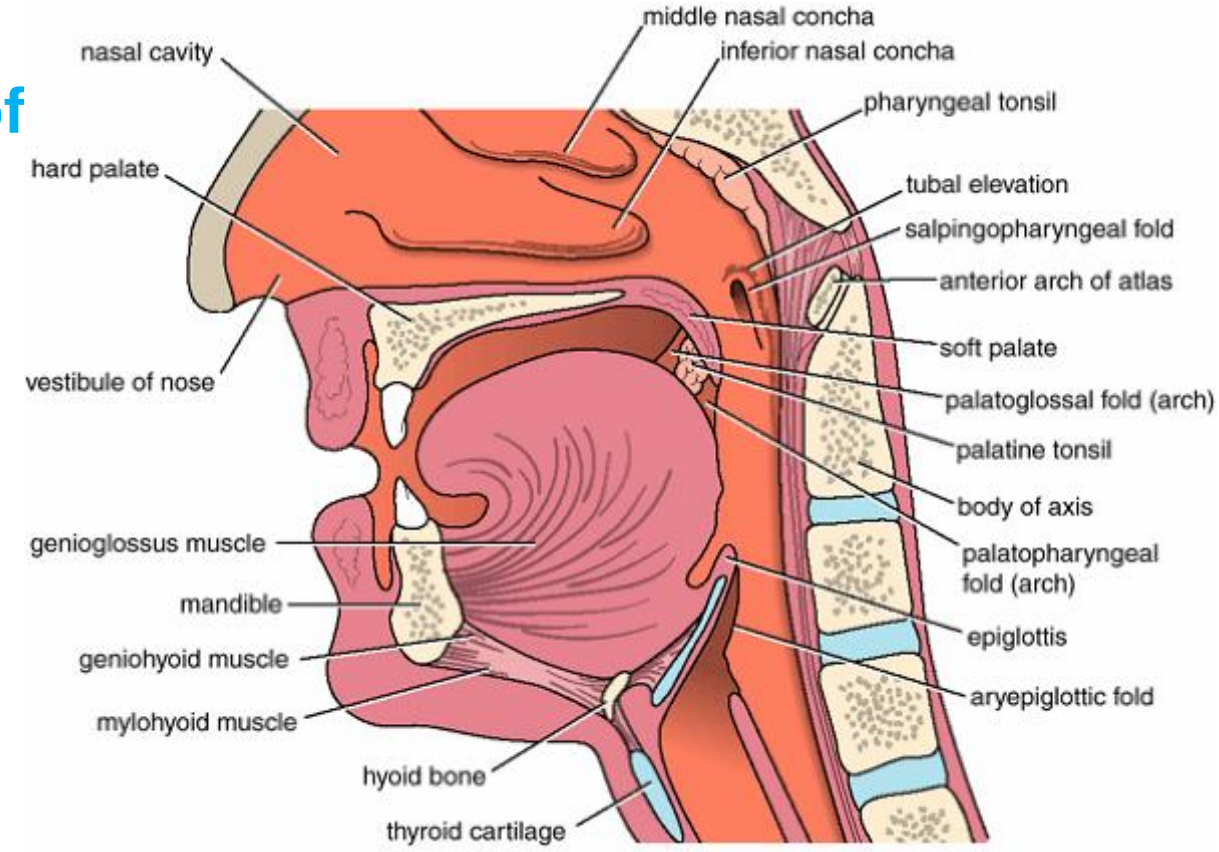

middle nasal concha
nasal cavity
inferior nasal concha
pharyngeal tonsil
hard palate
tubal elevation
salpingopharyngeal fold
anterior arch of atlas
soft palate
vestibule of nose
palatoglossal fold (arch)
palatine tonsil
body of axis
genioglossus muscle
palatopharyngeal fold (arch)
mandible
epiglottis
geniohyoid muscle
aryepiglottic fold
mylohyoid muscle
hyoid bone
thyroid cartilage

- **Nasopharynx:** area behind the nose and above soft palate, and plays an important role in respiration.
- It is protected from regurgitation of food during swallowing by soft palate rising upwards and closing it from rest of pharynx.
- **Pharyngeal tonsil:** (collection of lymphoid tissue; adenoids) is found in posterior wall and roof of the nasopharynx.
- **Eustachian tube:** conduit with middle ear, enters at level of floor of the nose on lateral walls.
- This explains common concurrence of throat and middle ear infections.



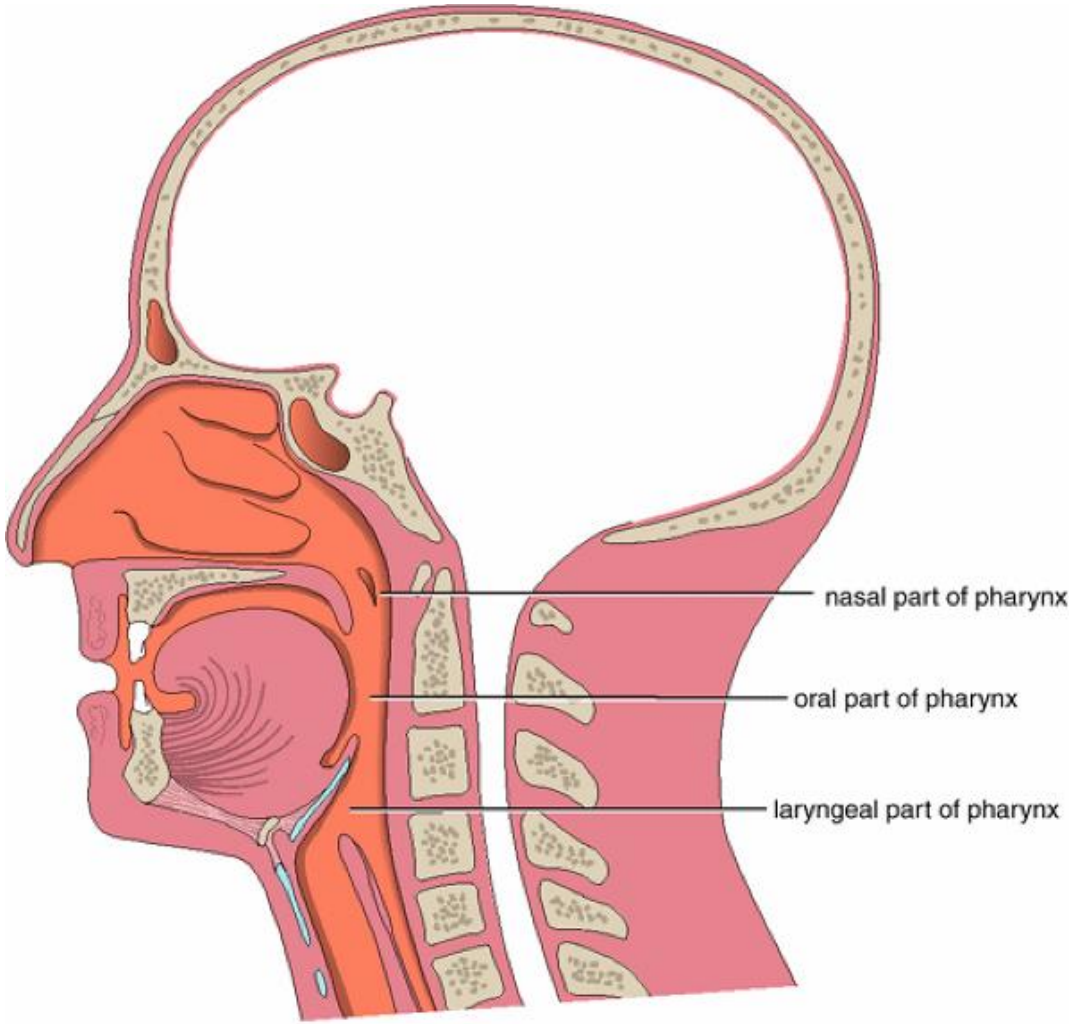
Oropharynx:

- Area behind mouth, between soft palate and hyoid bone, and is important in digestion and as part of immune response.
- Receives food boluses during deglutition (swallowing) and is part of conduit between mouth, laryngeopharynx and oesophagus.
- Involuntarily contracts on receiving food, squeezing the bolus into laryngopharynx and into oesophagus.
- Contains palatine tonsils, between palatoglossal and palatopharyngeal arches at back of throat.



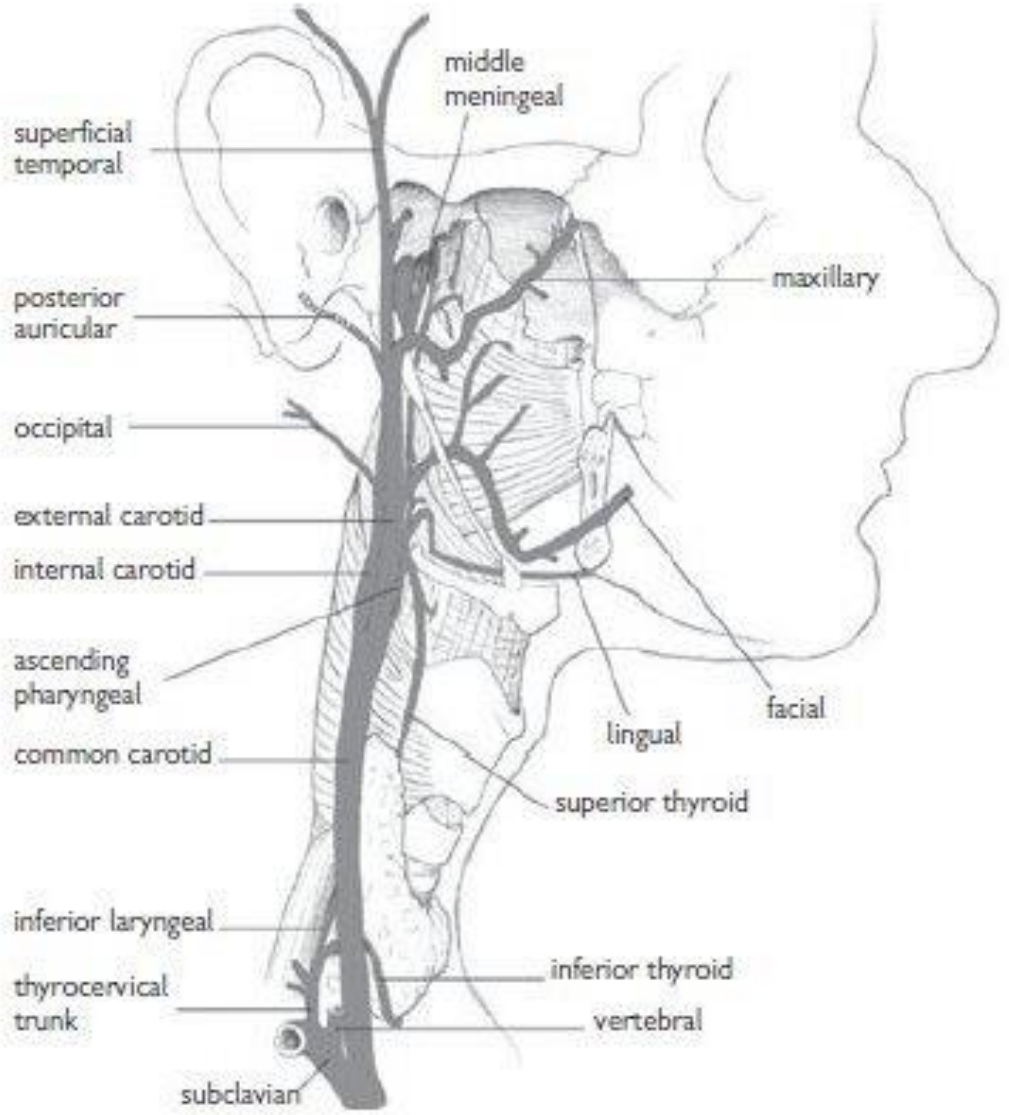
Laryngopharynx:

- Area behind larynx, from epiglottis; C 3 to C5, terminating at start of oesophagus C 6.
- A continuous lymphoid ring is formed by palatine tonsils, Waldeyer's ring (lymphoid tissue on dorsum of tongue), and adenoids (pharyngeal tonsil).
- Together, they act as one of first lines of defense in immune system.



Blood supply and innervation of the pharynx

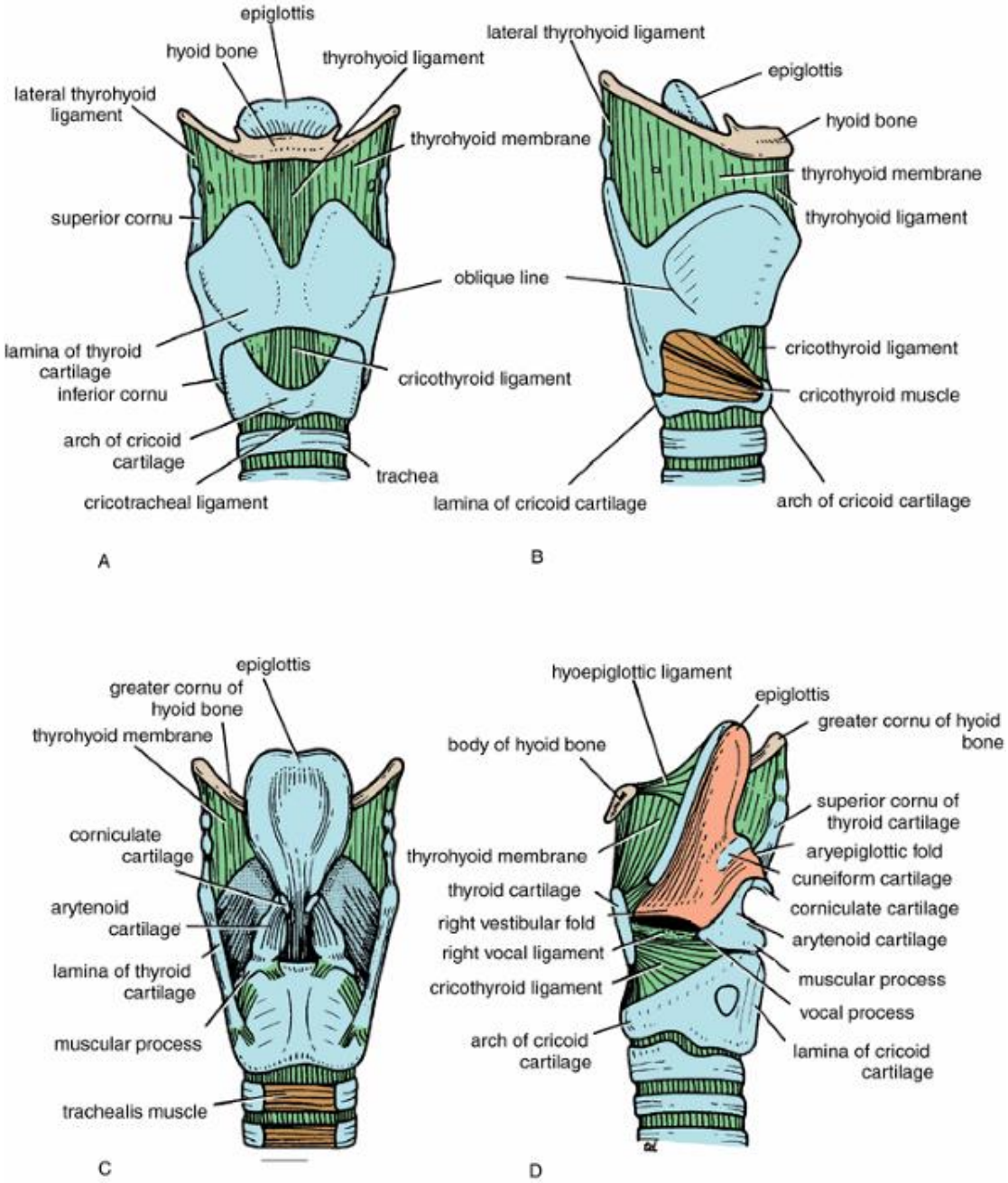
- **Pharynx is supplied by branches from *external carotid (*Ascending pharyngeal, tonsillar branches of facial , lingual, maxillary *and* superior thyroid arteries).**
- **Pharyngeal venous plexus drains into internal jugular vein.**
- **Sensory innervation of pharynx is via cranial nerve IX (via pharyngeal branches) and cranial nerve V (via maxillary division), which supplies nasopharynx.**
- **Motor innervation is by cranial nerve X (via pharyngeal branches).**



Larynx

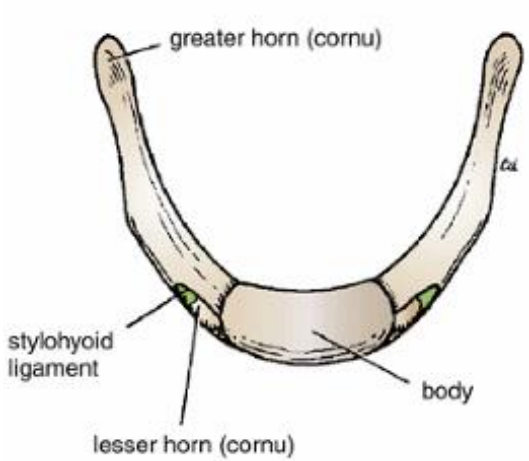
Larynx

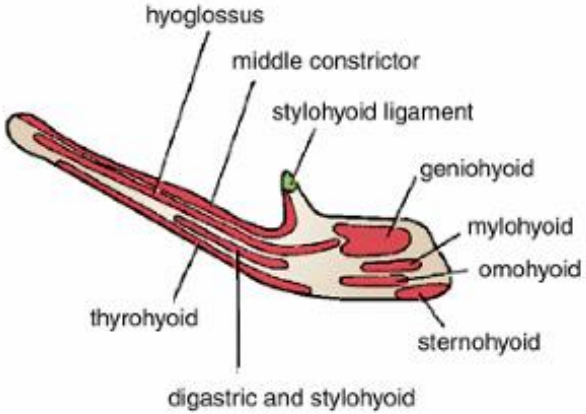
- **Tube that conveys air to the lungs from the pharynx.**
- **Plays an important role in producing speech and sound, allows for ventilation, and protects the trachea and bronchial tree during swallowing.**
- **Comprised of a framework of *<u>nine</u>* cartilages, bound together by ligaments and muscles, and contains vocal cords which are responsible for vocalization.**

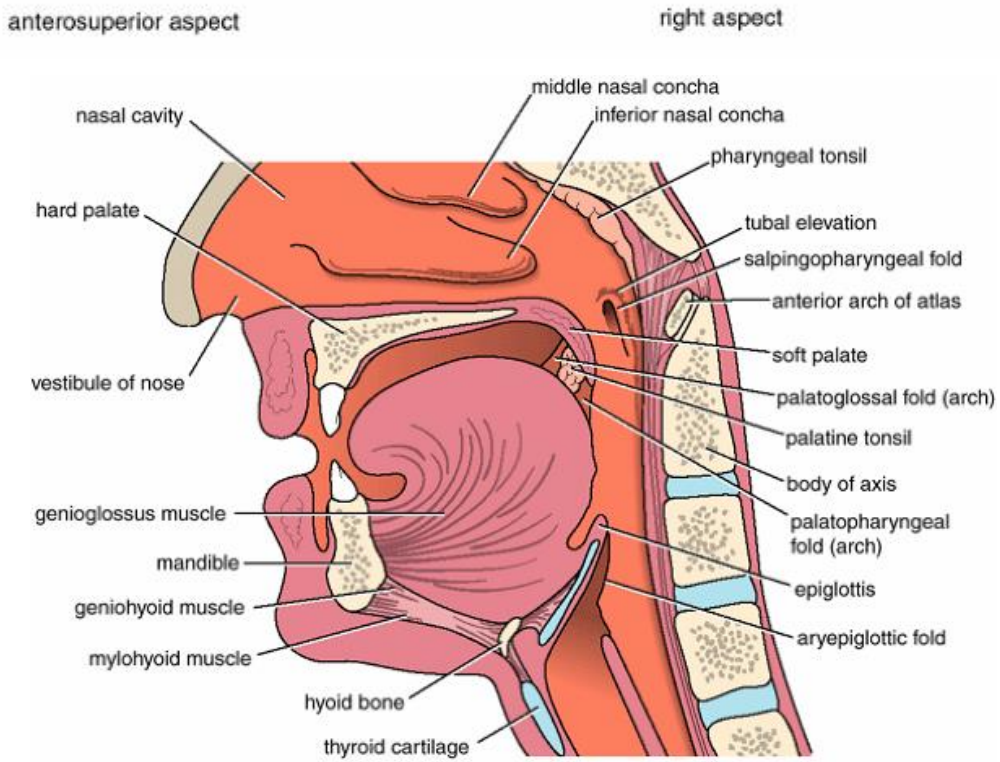


Hyoid Bone:

- U-shaped within neck is framework by which larynx is attached to other structures within neck, including pharynx, mandible, and tongue.
- Hyoid bone lies at level of cervical vertebrae 3 and 4.
- Larynx is attached to hyoid bone by thyrohyoid muscle and membrane.

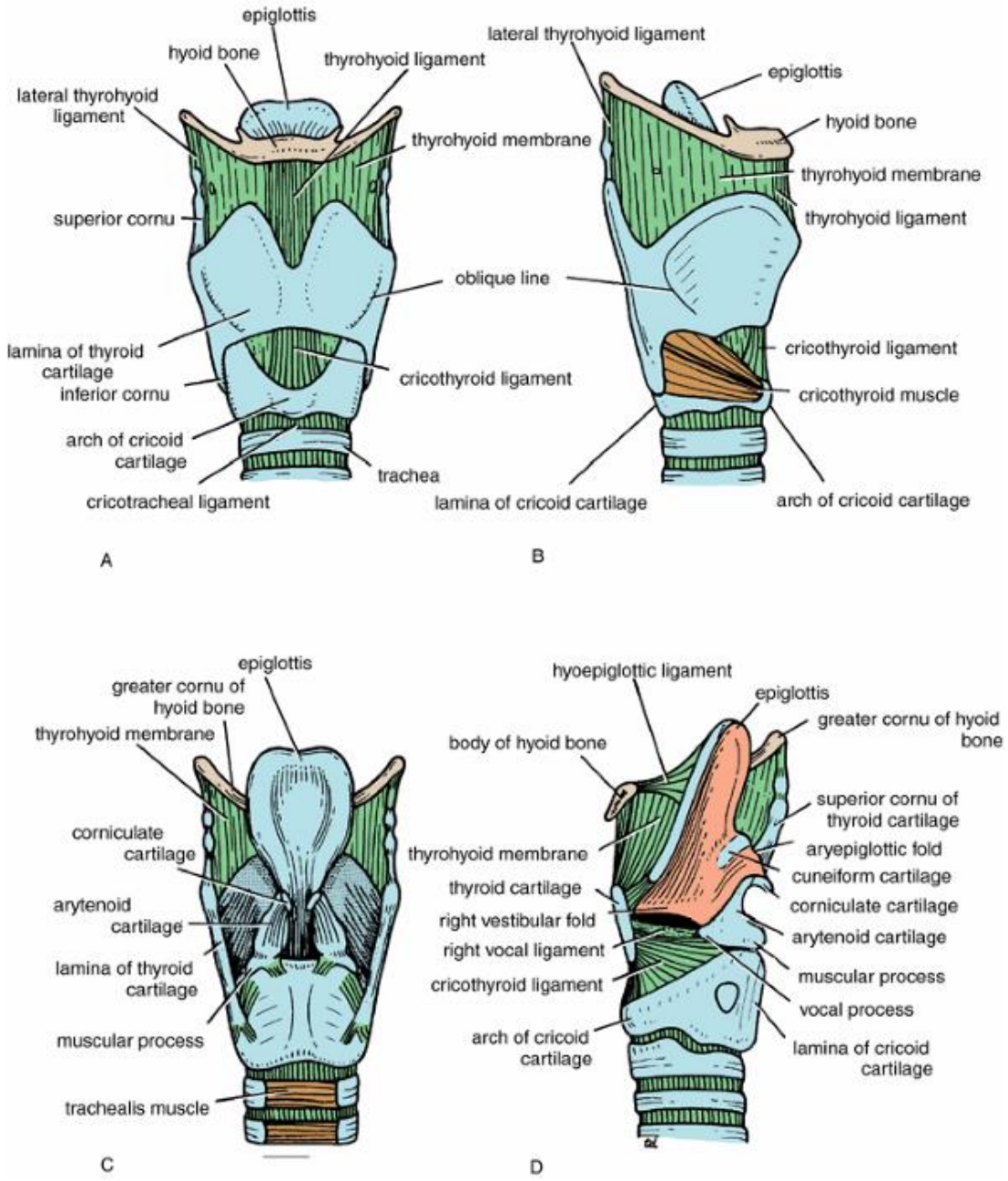






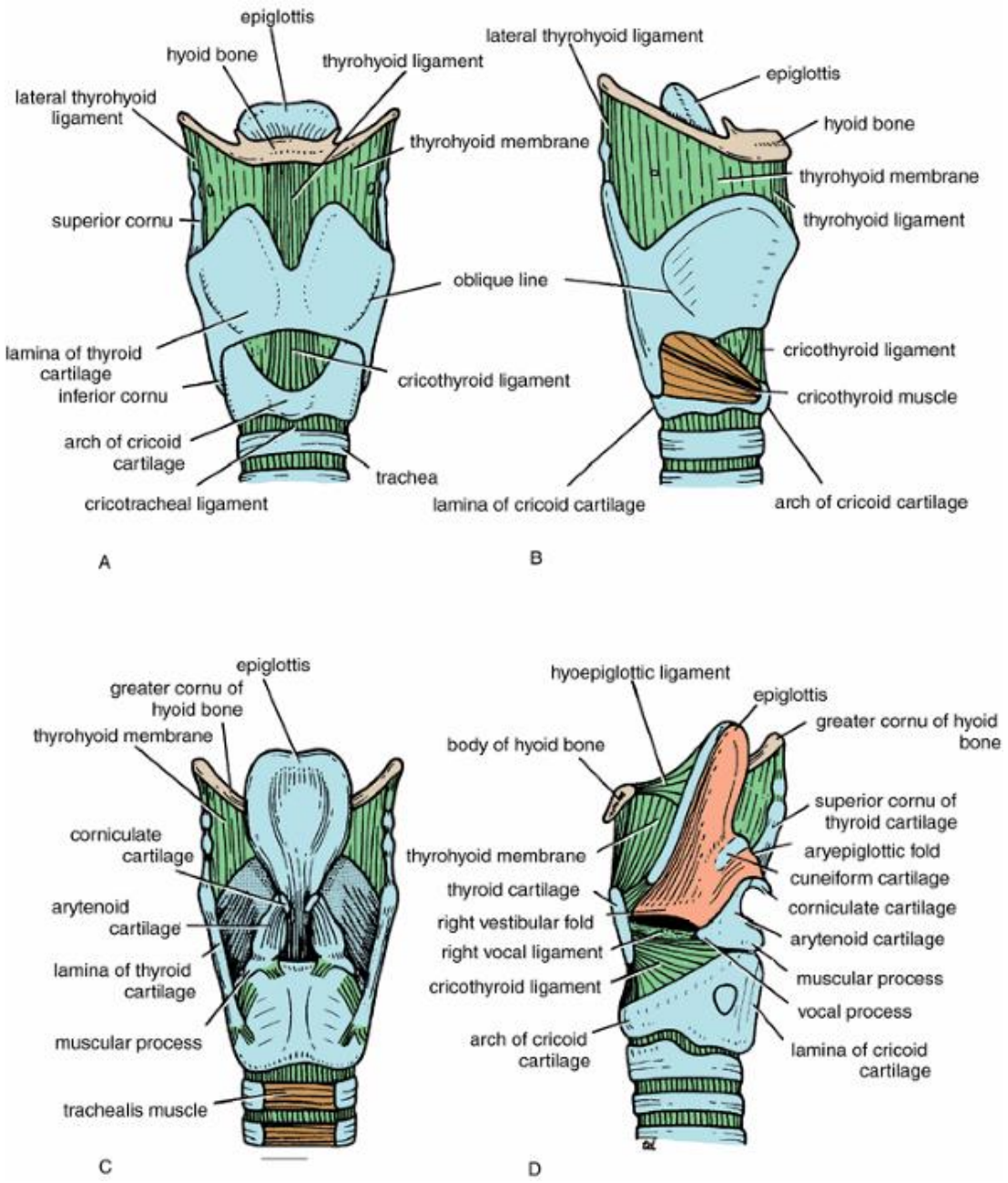
Epiglottis:

- Elastic flap of cartilage, which lies behind tongue and forms entrance to larynx.
- Attaches to hyoid bone (in front) and posteriorly to back of thyroid cartilage.
- Laterally, epiglottis is attached to the pyramid-shaped arytenoid cartilages by aryepiglottic folds which form opening of larynx.



Thyroid cartilage:

- V-shaped and, in men, forms the prominence in the neck called ‘Adam’s apple’.
- Attached to hyoid bone by thyrohyoid membrane.

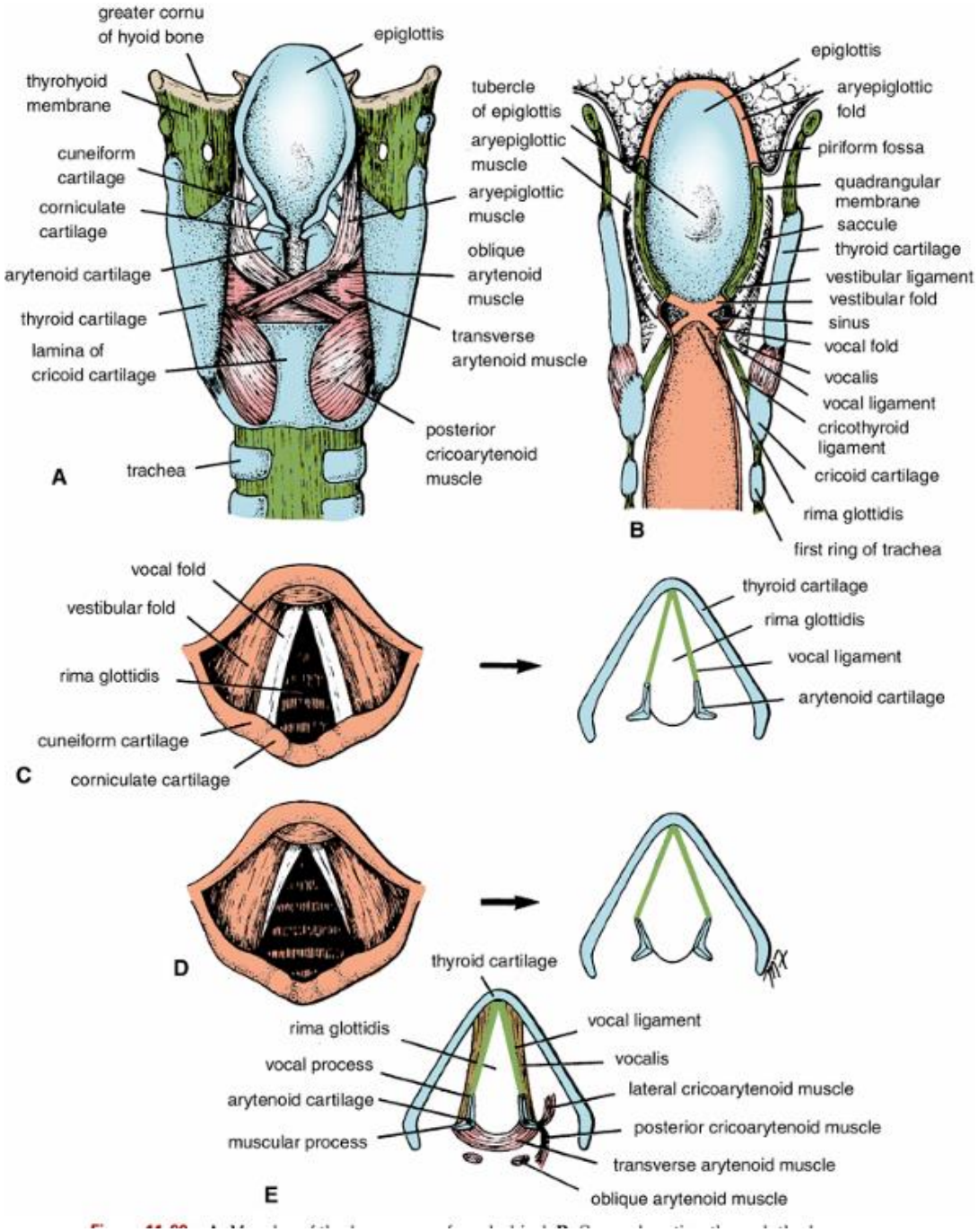


Cricoid cartilage:

- Only complete ring of cartilage in respiratory system and is signet ring-shaped.
- Widest part of the ring faces posteriorly and, either side of it, sit arytenoid cartilages.

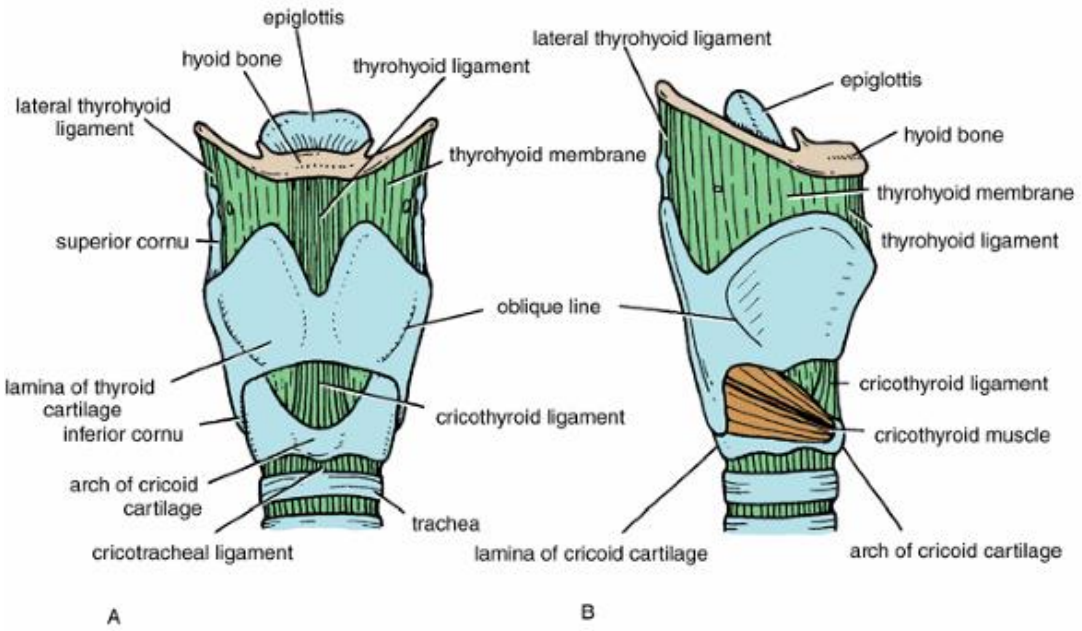
Corniculate and cuneiform cartilages:

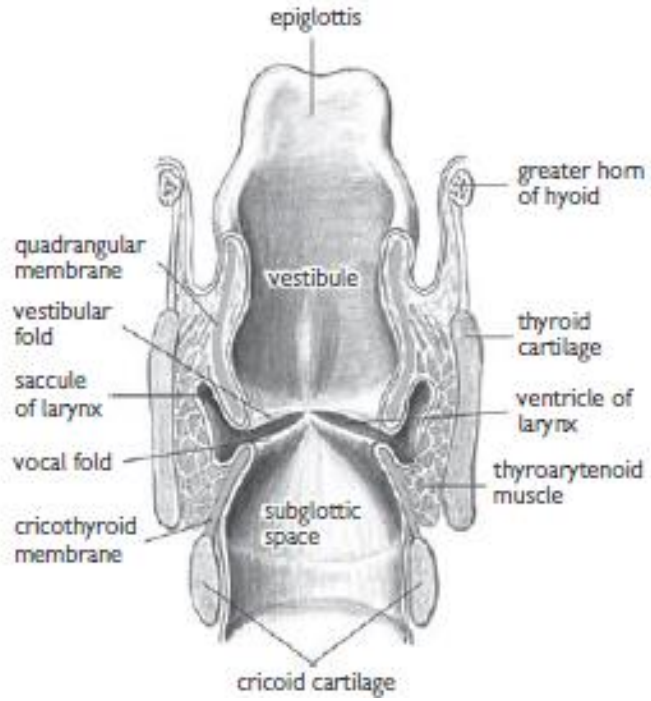
- Small, paired cartilages which support aryepiglottic folds and are found within them.

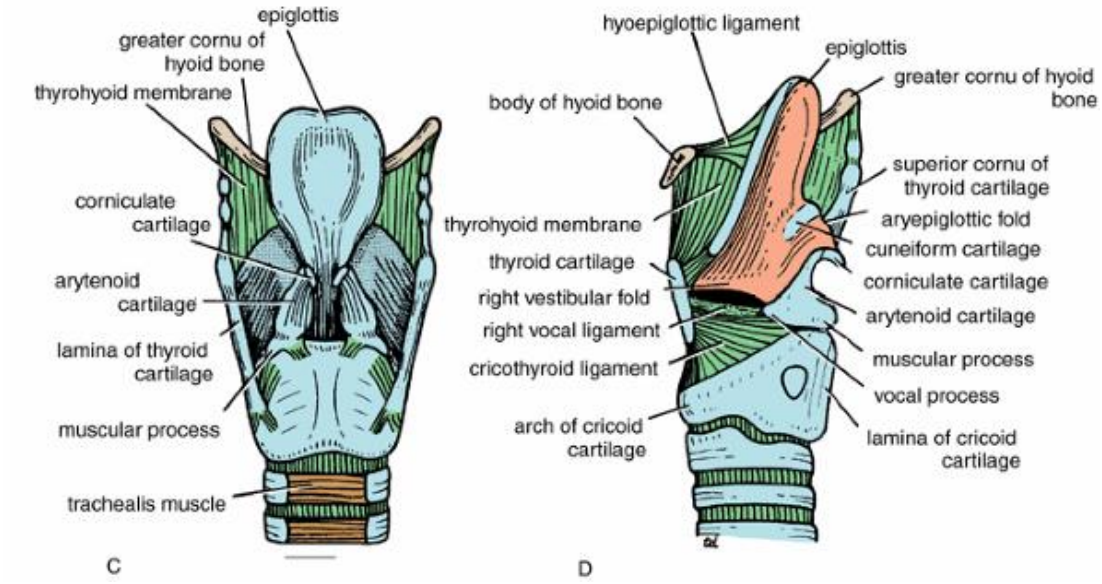


Cricothyroid membrane (cricovocal membrane):

- Runs on posterior surface of thyroid cartilage, behind vocal processes of arytenoids, connecting thyroid, cricoid, and arytenoid cartilages.
- Thickened between thyroid and cricoid and, anteriorly, it becomes cricothyroid ligament.
- Easily palpable since it is subcutaneous and, in emergency, can be pierced to provide an airway during laryngeal obstruction.







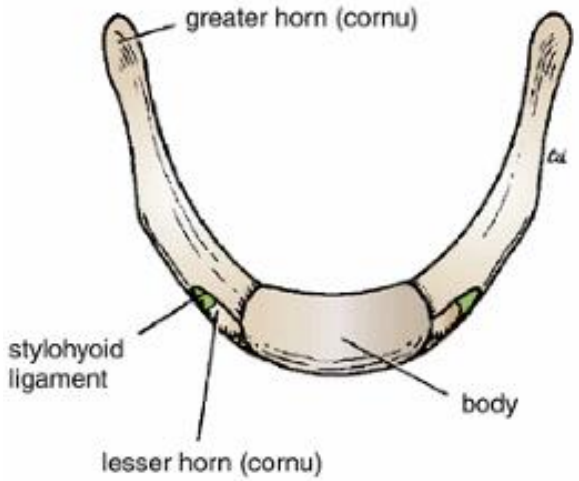
Laryngeal muscles:

- Divided into intrinsic and extrinsic muscles

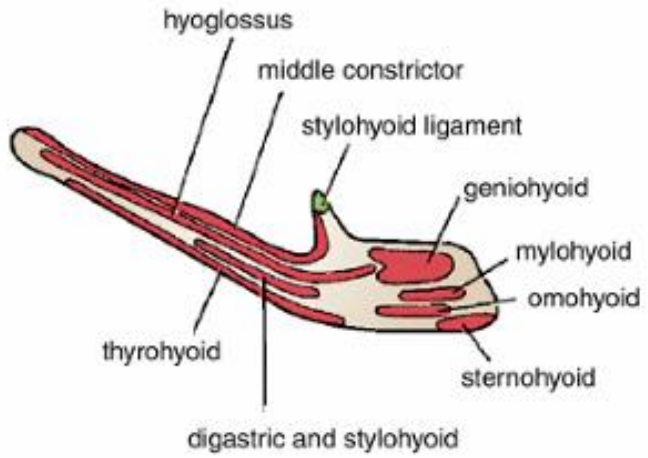
Extrinsic muscles consist of infra- and supra-hyoid muscles and stylopharyngeus.

Infra-hyoid muscles:

1. Sternohyoid
2. Omohyoid
3. Thyrohyoid
4. Sternothyroid



anterosuperior aspect

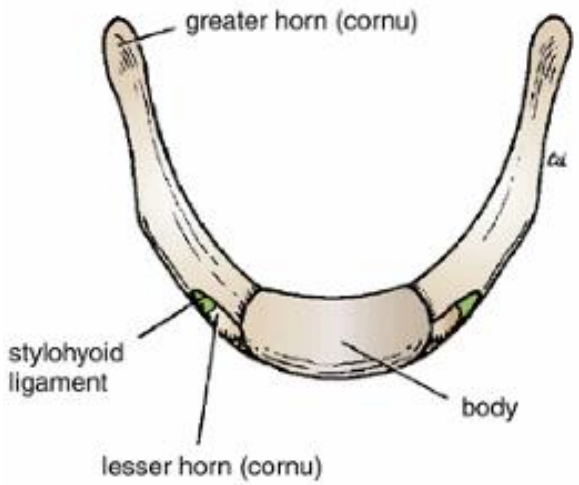


right aspect

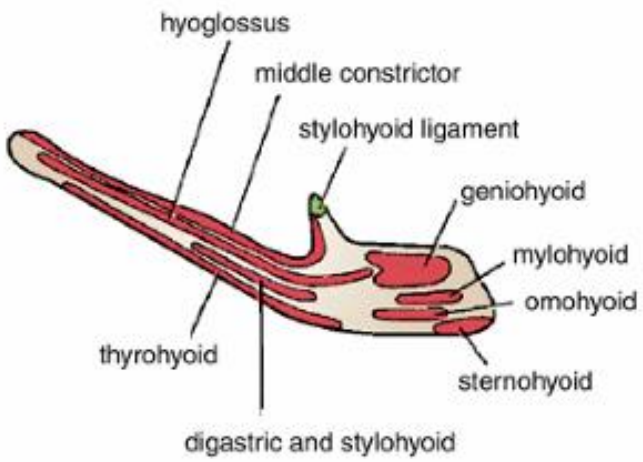
- Responsible for depressing larynx and hyoid bone

Supra-hyoid muscles:

1. Digastric
2. Stylohyoid
3. Mylohyoid
4. Geniohyoid



anterosuperior aspect



right aspect

- Together with stylopharyngeus, elevate larynx and hyoid bone

Intrinsic muscles of the larynx include:

1. **Thyroarytenoid,**
2. **Posterior cricoarytenoid**
3. **Lateral cricoarytenoid**
4. **Interarytenoid**
5. **Aryepiglottic**
6. **Cricothyroid**

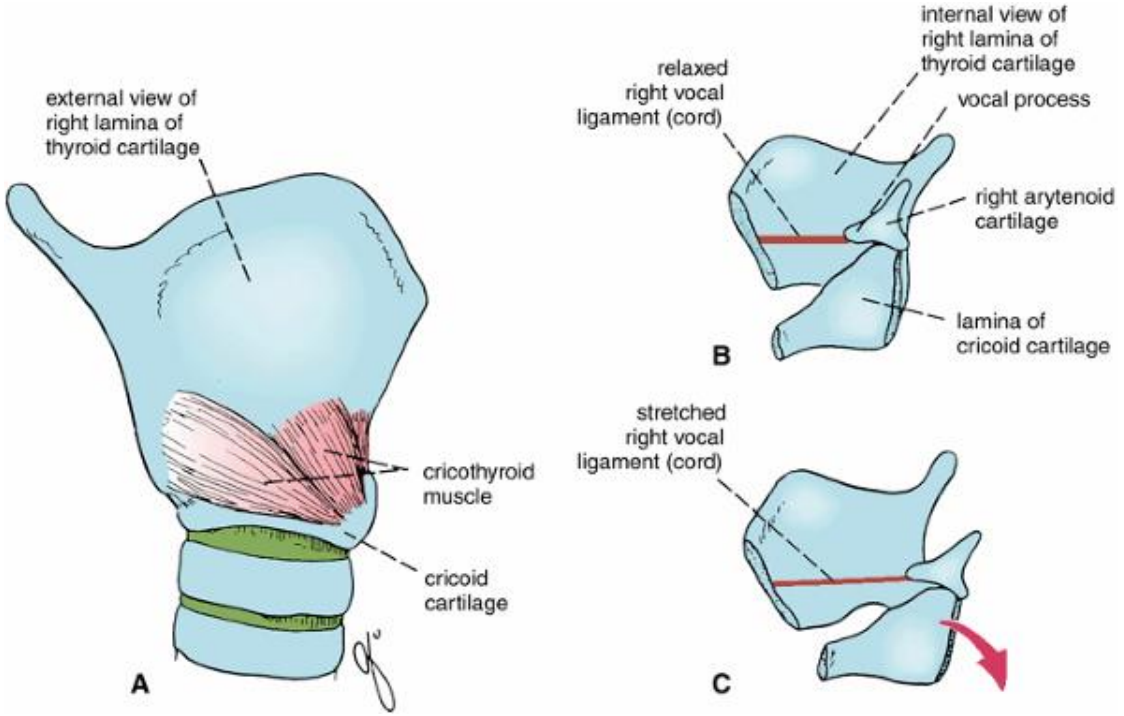
- **Control movements within larynx; tension on vocal cords**
- **All intrinsic muscles are supplied by *recurrent laryngeal nerve* and have common sphincter action, since they form encircling sheet except cricothyroid muscle which is supplied by *external laryngeal nerve.***

They have different attachments which are evident in their names:

- **Thyroarytenoid relaxes the vocal cords**
- ***Posterior cricoarytenoid abducts the vocal cords***
- **Lateral cricoarytenoids adduct the vocal cords**
- **Interarytenoids and aryepiglottic muscle close the larynx during swallowing by forming a sphincter.**

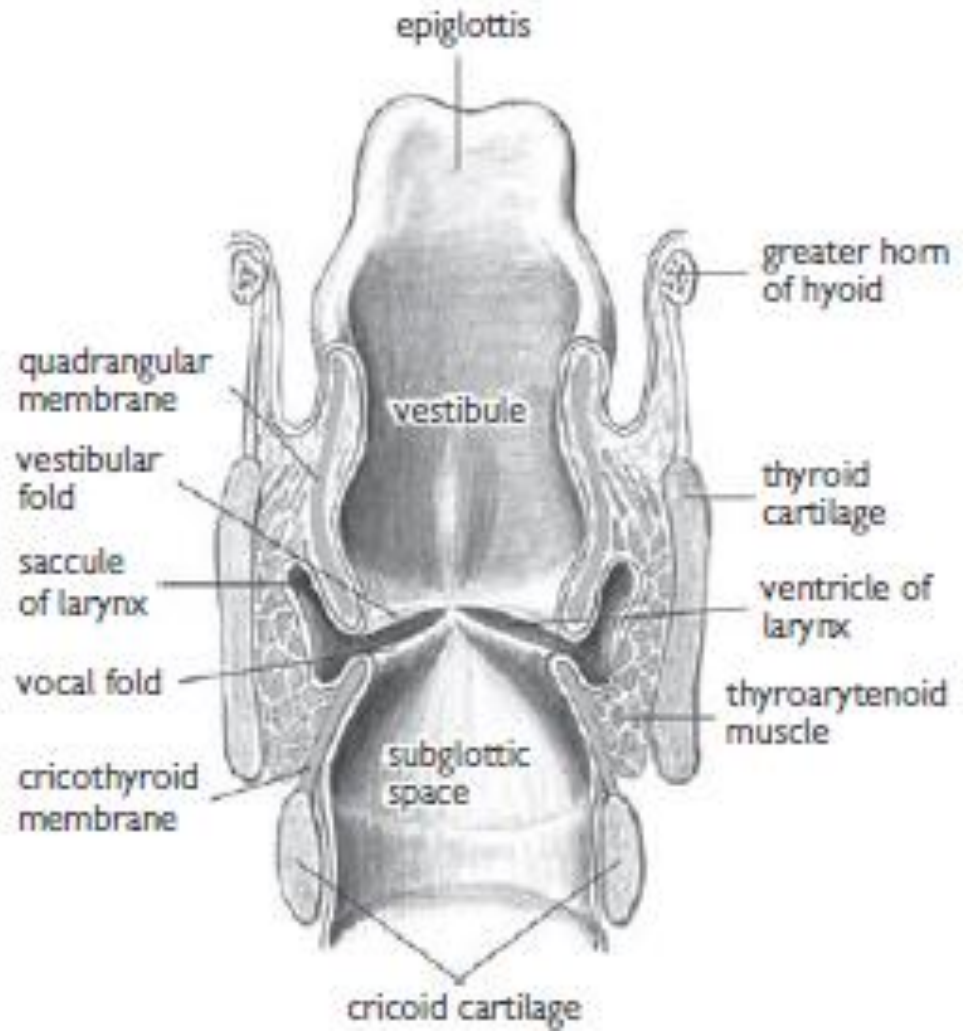
Cricothyroid:

- **The only exterior muscle and tightens vocal cords by tilting cricoid cartilage.**



Vocal cords:

- 2 different folds of mucosa to form triangular-shaped membrane on either side of opening between them; rima glottidis.
- Shape of this area is constantly changing with vocalization.
- Have pearly white avascular appearance, as there is no submucosa between them; only consist of tightly fused mucosa
- Superior vestibular fold forms false vocal cord; inferior vestibular fold forms true vocal cord.
- True cords are important for vocalization, while false cords have purely protective role.

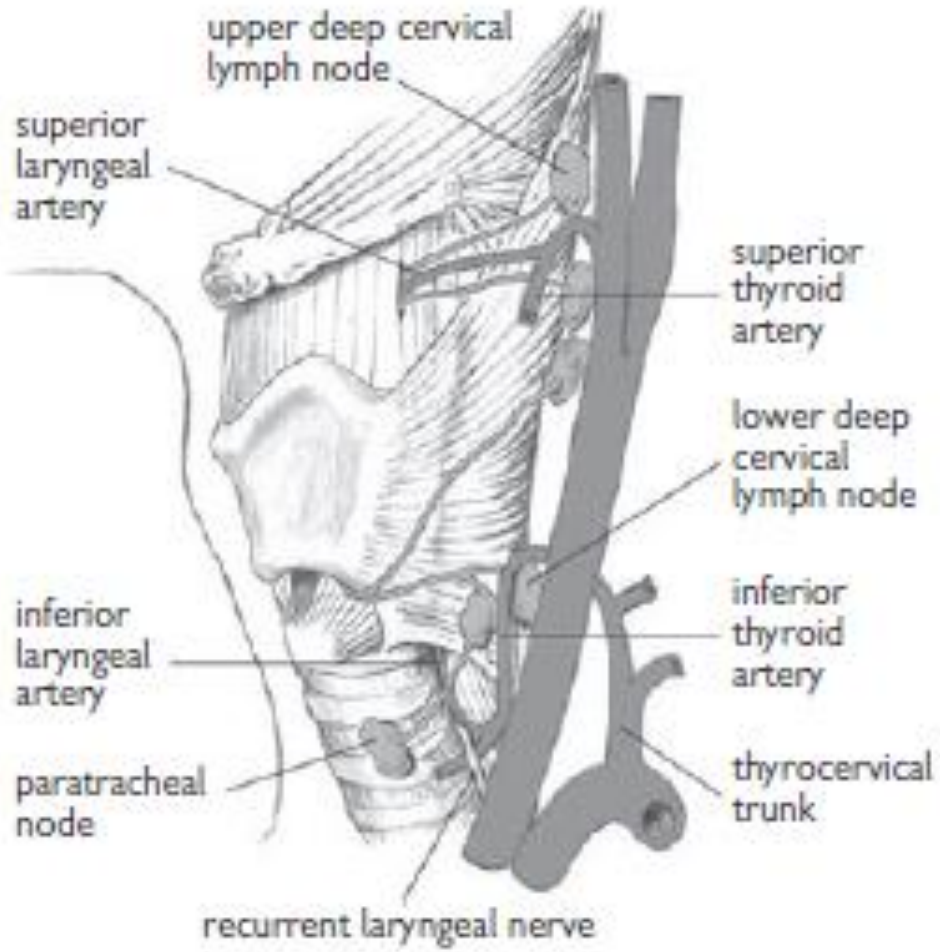


Larynx is divided into three areas by the vocal cords:

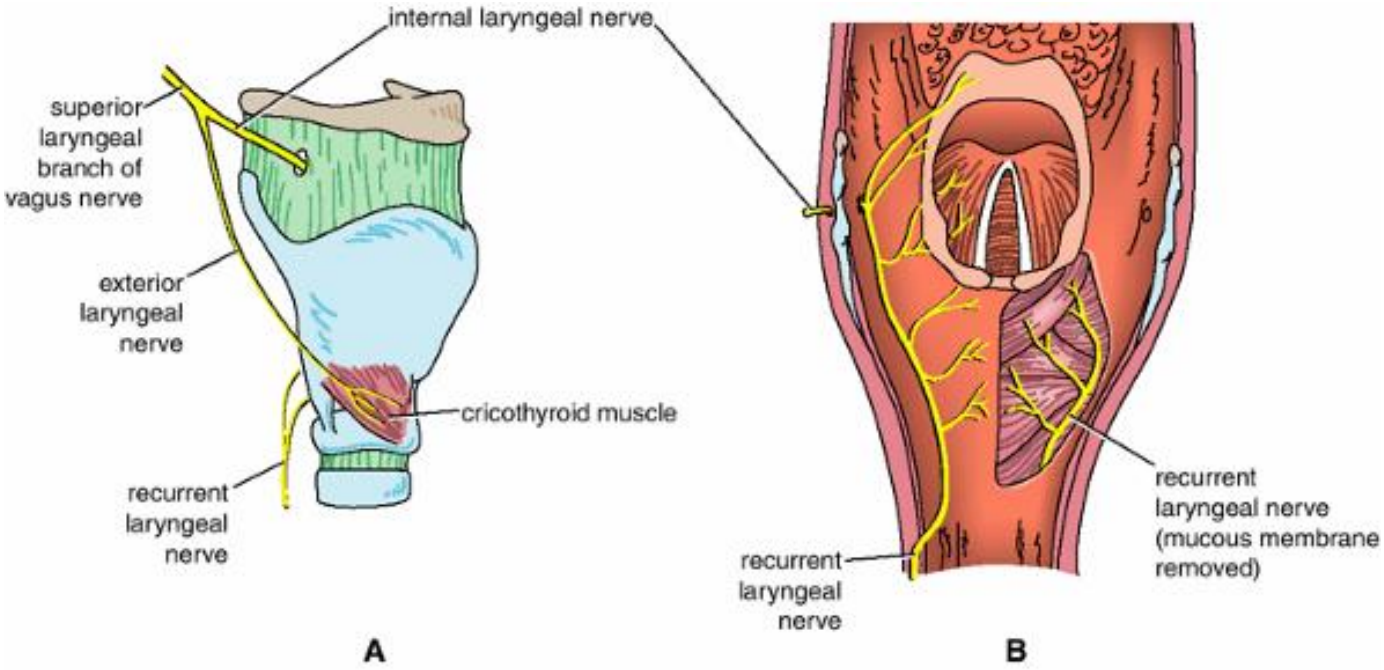
1. Supraglottic compartment (above vocal cords)
2. Glottic compartment (between 2 types of vocal cords)
3. Subglottic compartment (below true cords; at start of trachea).

Nerve, blood, and lymphatic supply of the larynx:

- Sensory innervation, blood supply, and lymphatic drainage are different above and below vocal cords.
- Superior laryngeal branch from superior thyroid artery supplies structures above the cords, while inferior laryngeal branch from inferior thyroid artery supplies structures below cords.
- Lymphatic drainage below the cords is to lower group of deep cervical nodes; upper group of deep cervical nodes drain structures above the cords.

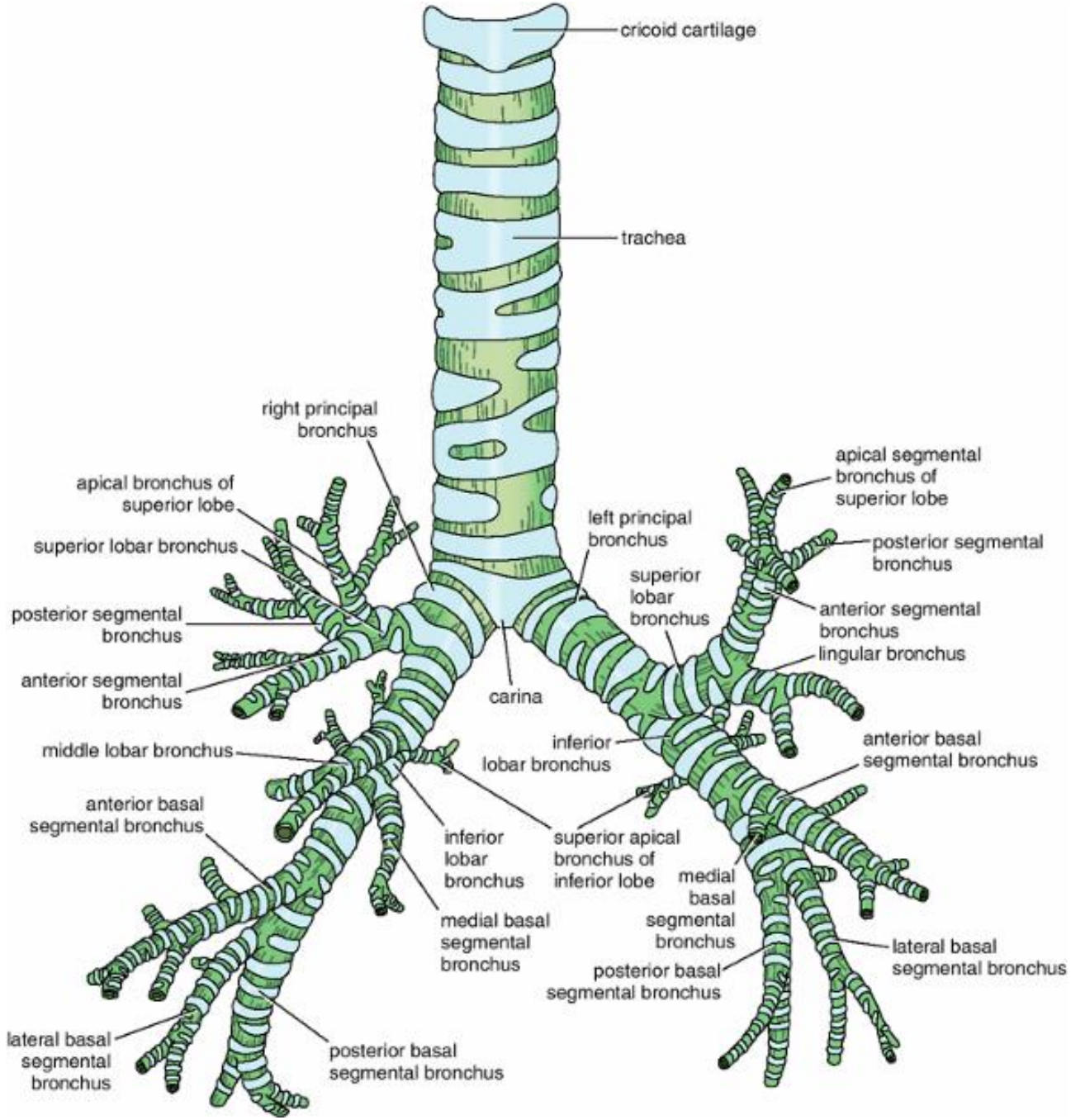


- **Superior laryngeal nerve provides sensory innervation for laryngeal structures above vocal cords and the recurrent laryngeal nerve below.**



Trachea

- Starts below cricoid cartilage, at level of C6.
- Length 10 cm
- Has c-shaped cartilaginous rings, with a fibrous muscular band (trachealis) over the cartilage-deficient area posteriorly.
- Lined with respiratory epithelium, which acts as an escalator, wafting particulate matter in the mucus upwards, away from lower airways.



Nerve, blood, and lymphatic supply of the trachea

- **Parasympathetic innervation is from vagus nerve and recurrent laryngeal nerve, while sympathetic innervation is from sympathetic trunk.**

- **Inferior thyroid artery supplies the trachea.**

- **Postero-inferior deep cervical nodes drain the trachea.**

THANK YOU