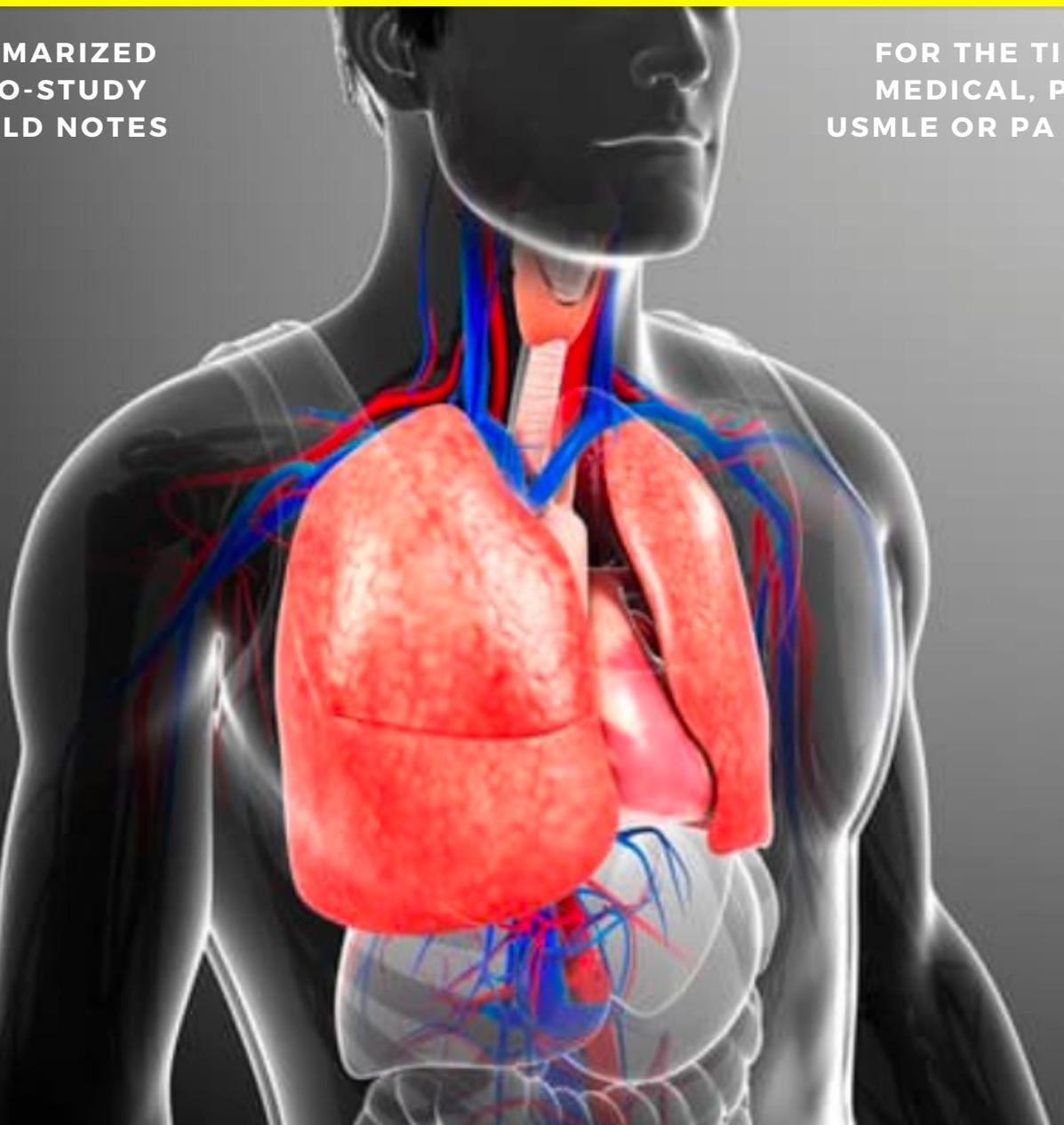


# ANATOMY, PHYSIOLOGY & PATHOLOGY NOTES OF THE **RESPIRATORY** SYSTEM

## FOURTH EDITION

PRE-SUMMARIZED  
READY-TO-STUDY  
HIGH-YIELD NOTES

FOR THE TIME-POOR  
MEDICAL, PRE-MED,  
USMLE OR PA STUDENT



PDF



192 PAGES

## A Message From Our Team

Studying medicine or any health-related degree can be stressful; believe us, we know from experience! The human body is an incredibly complex organism, and finding a way to streamline your learning is crucial to succeeding in your exams and future profession. Our goal from the outset has been to create the greatest educational resource for the next generation of medical students, and to make them as affordable as possible.

In this fourth edition of our notes we have made a number of text corrections, formatting updates, and figure updates which we feel will enhance your study experience. We have also endeavoured to use only open-source images and/or provide attribution where possible.

**If you are new to us, here are a few things to help get the most out of your notes:**

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## Table Of Contents:

**What's included:** Ready-to-study anatomy, physiology and pathology notes of the respiratory system presented in succinct, intuitive and richly illustrated downloadable PDF documents. Once downloaded, you may choose to either print and bind them, or make annotations digitally on your iPad or tablet PC.

### Anatomy & Physiology Notes:

- ANATOMY OF THE THORAX
- ANATOMY OF THE AIRWAYS
- AIRWAY MUCOSAL LININGS
- ALVEOLAR GAS EXCHANGE & GAS TRANSPORT
- THE PHYSIOLOGY OF BREATHING
- HEMOGLOBIN / HAEMOGLOBIN
- BODY ACID-BASE BALANCE
- CONTROL OF BREATHING
- FOETAL LUNG DEVELOPMENT & TRANSITION TO EXTRAUTERINE LIFE

### Pathology Notes:

- HYPERBARIC & HYPOBARIC CONDITIONS
- AIRWAY HYPERSENSITIVITY & ASTHMA
- UPPER RESPIRATORY TRACT INFECTIONS (URTI'S)
  - COMMON COLD (ACUTE RHINITIS)
  - PHARYNGITIS (SORE THROAT)
  - (EPSTEIN BARR VIRUS) – INFECTIOUS MONONUCLEOSIS (GLANDULAR FEVER)
  - DIPHTHERIA
  - SCARLET FEVER ("STRAWBERRY TONGUE")
  - ACUTE LARYNGITIS
  - CHRONIC LARYNGITIS
  - ACUTE TONSILLITIS
  - ACUTE LARYNGOTRACHEOBRONCHITIS (CROUP)
  - ACUTE EPIGLOTTITIS
  - PERTUSSIS - WHOOPING COUGH:
  - MEASLES VIRUS
  - MUMPS VIRUS
  - RUBELLA VIRUS
  - ACUTE OTITIS MEDIA (AOM)
  - ACUTE SUPPURATIVE SINUSITIS (<4wks)
  - CHRONIC SINUSITIS (>3MTHS)
  - Q-FEVER
- LOWER RESPIRATORY TRACT INFECTIONS
  - BRONCHITIS (ACUTE)
  - BRONCHIECTASIS:
  - PNEUMONIAS
  - BRONCHIOLITIS
- GLOBAL RESPIRATORY VIRUSES
  - SEASONAL FLU (INFLUENZA A & B)
  - BIRD FLU (H5N1)
  - SWINE FLU (H1N1)
  - SARS & COVID – SEVERE ACUTE RESPIRATORY SYNDROME

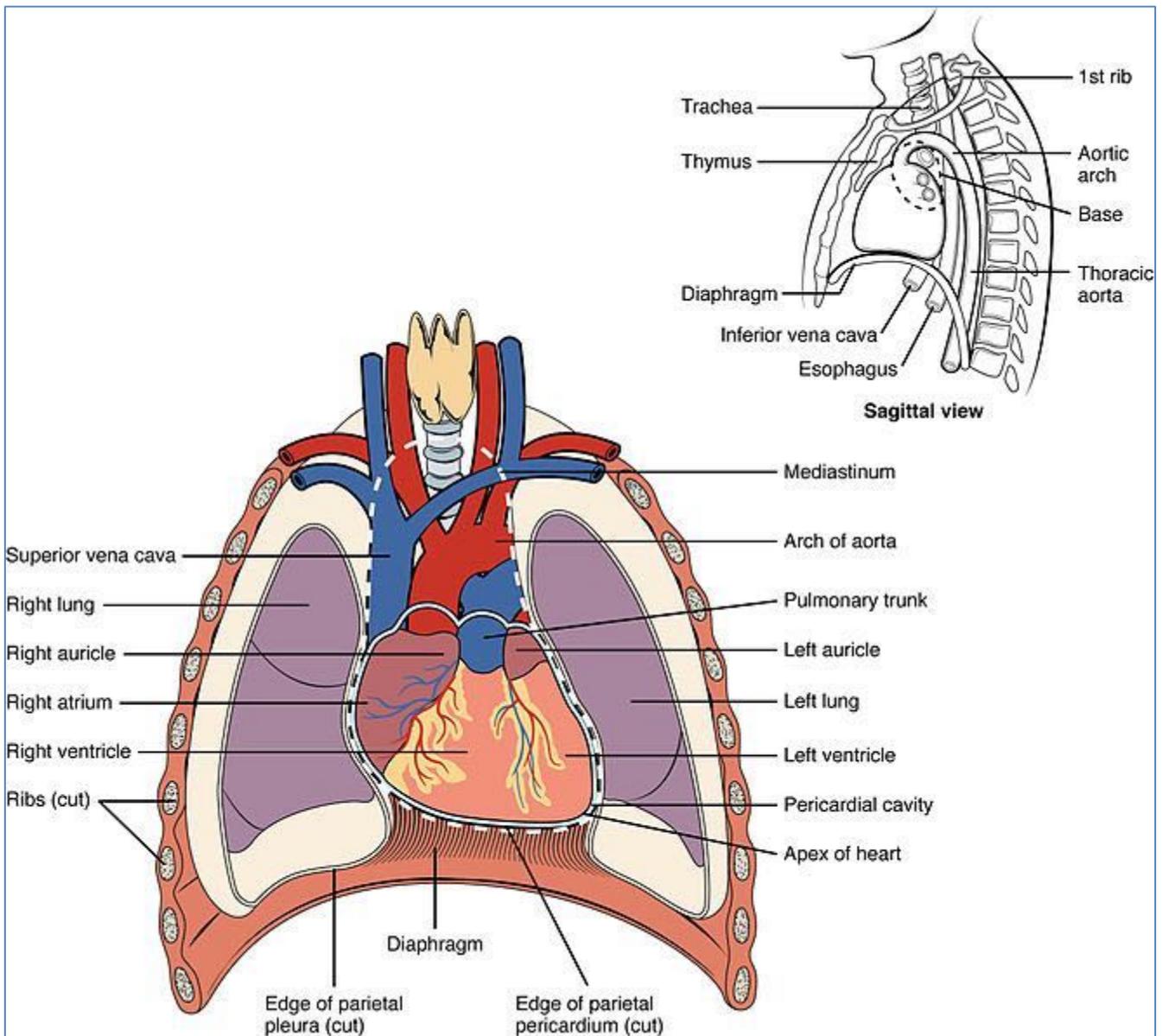
- OBSTRUCTIVE & RESTRICTIVE LUNG DISORDERS
  - CHRONIC OBSTRUCTIVE PULMONARY DISEASE
  - CHRONIC BRONCHITIS
  - EMPHYSEMA
  - IDIOPATHIC PULMONARY FIBROSIS (IPF)
  - SARCOIDOSIS
  - PNEUMOCONIOSES
  - CYSTIC FIBROSIS (CF)
  - PNEUMOTHORAX
- HEAD AND NECK PATHOLOGIES
  - SIALADENITIS (PAROTITIS):
  - SIALOLITHIASIS (SALIVARY GLAND CALCULI)
  - PLEOMORPHIC ADENOMA
  - WARTHIN'S TUMOUR
  - ORAL SQUAMOUS CELL CARCINOMA
  - NASAL POLYPS (Inflammatory)
  - NASOPHARYNGEAL CARCINOMA
  - LARYNGEAL TUMOURS
- LUNG CANCERS
  - BRONCHOGENIC LUNG CANCERS
  - MESOTHELIOMA
- HYPOXIA AND HYPERCAPNIA

**ANATOMY OF THE THORAX**

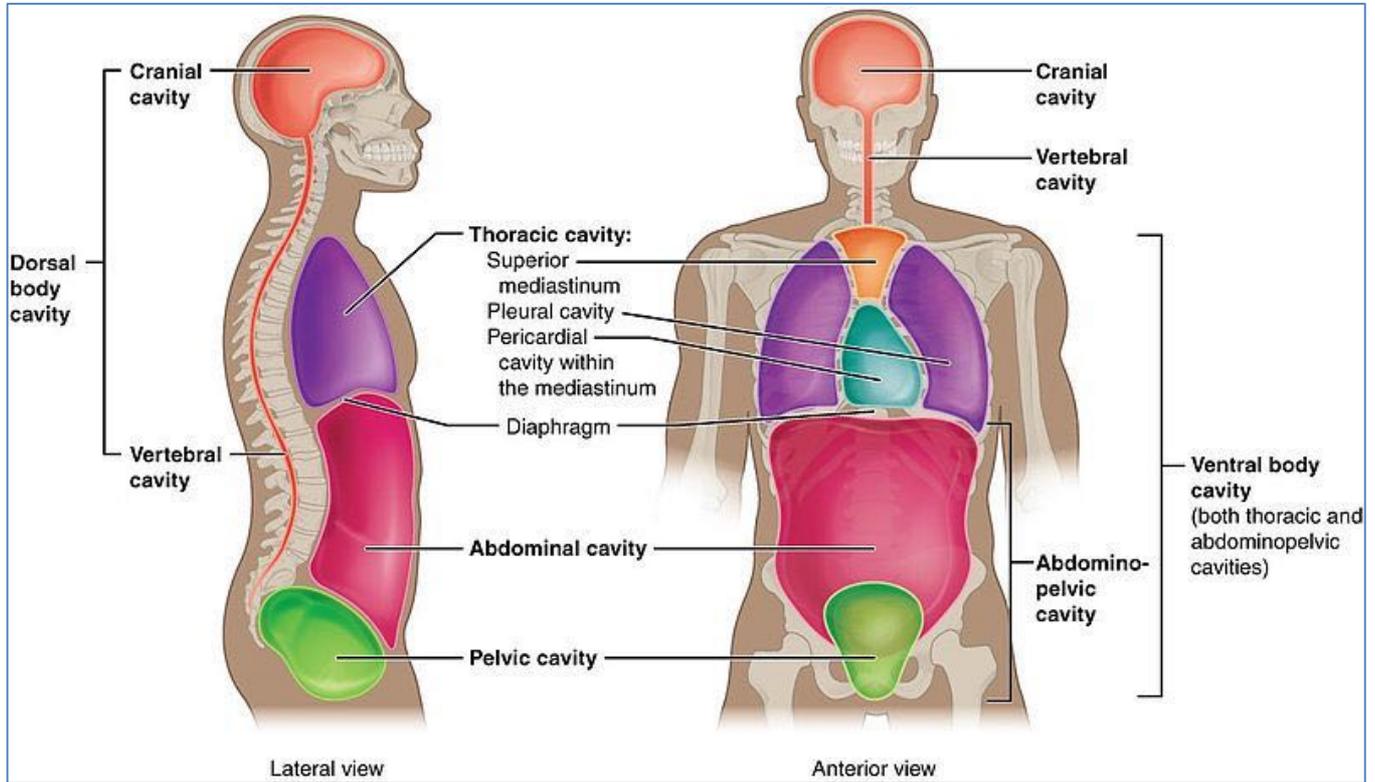
## ANATOMY OF THE THORAX

### Thoracic Overview:

- **3 Parts:**
  - Thoracic Cage (skeletal components)
  - Thoracic Wall (muscular components)
  - Thoracic Cavity (internal area)
- **3 Internal Compartments:**
  - **Central Mediastinum**
    - Containing the Heart/oesophagus/trachea/nerves/vessels
  - **Left Pleural Cavity**
    - Containing the L-Lung
  - **Right Pleural Cavity**
    - Containing the R-Lung



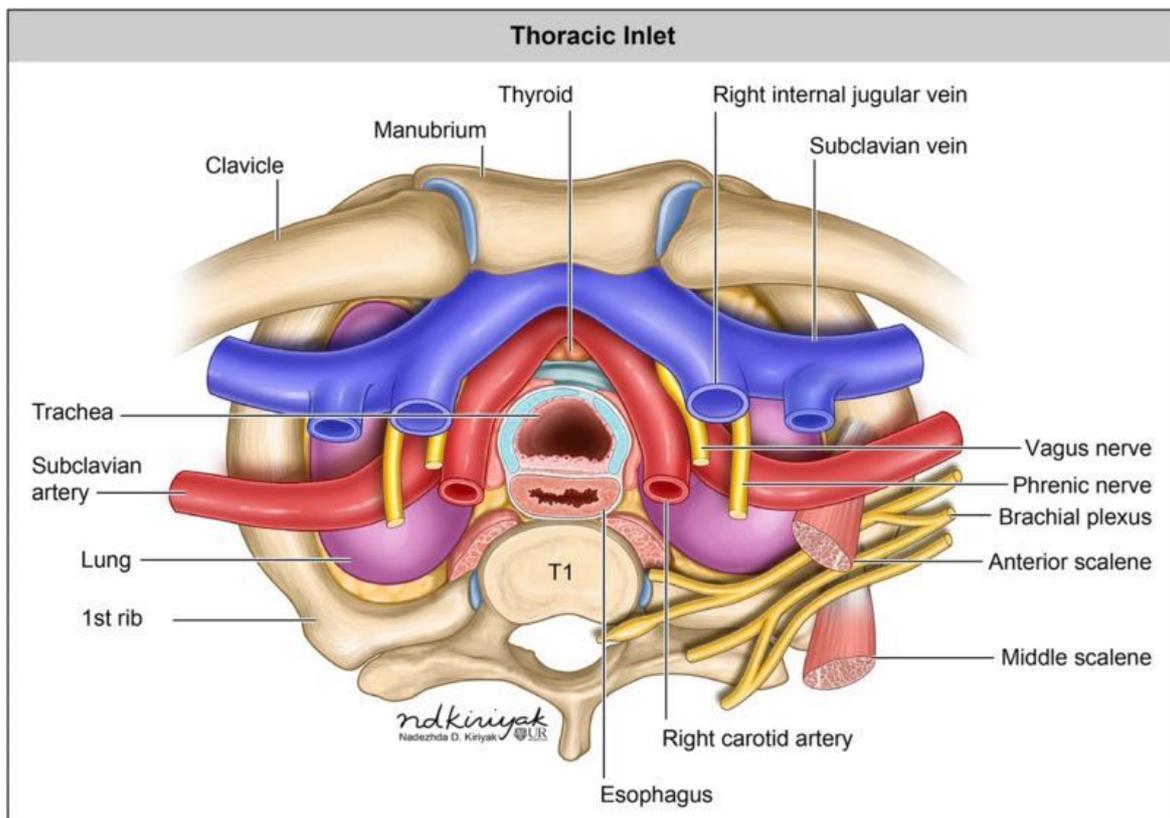
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### Relationship of thorax to Other Regions:

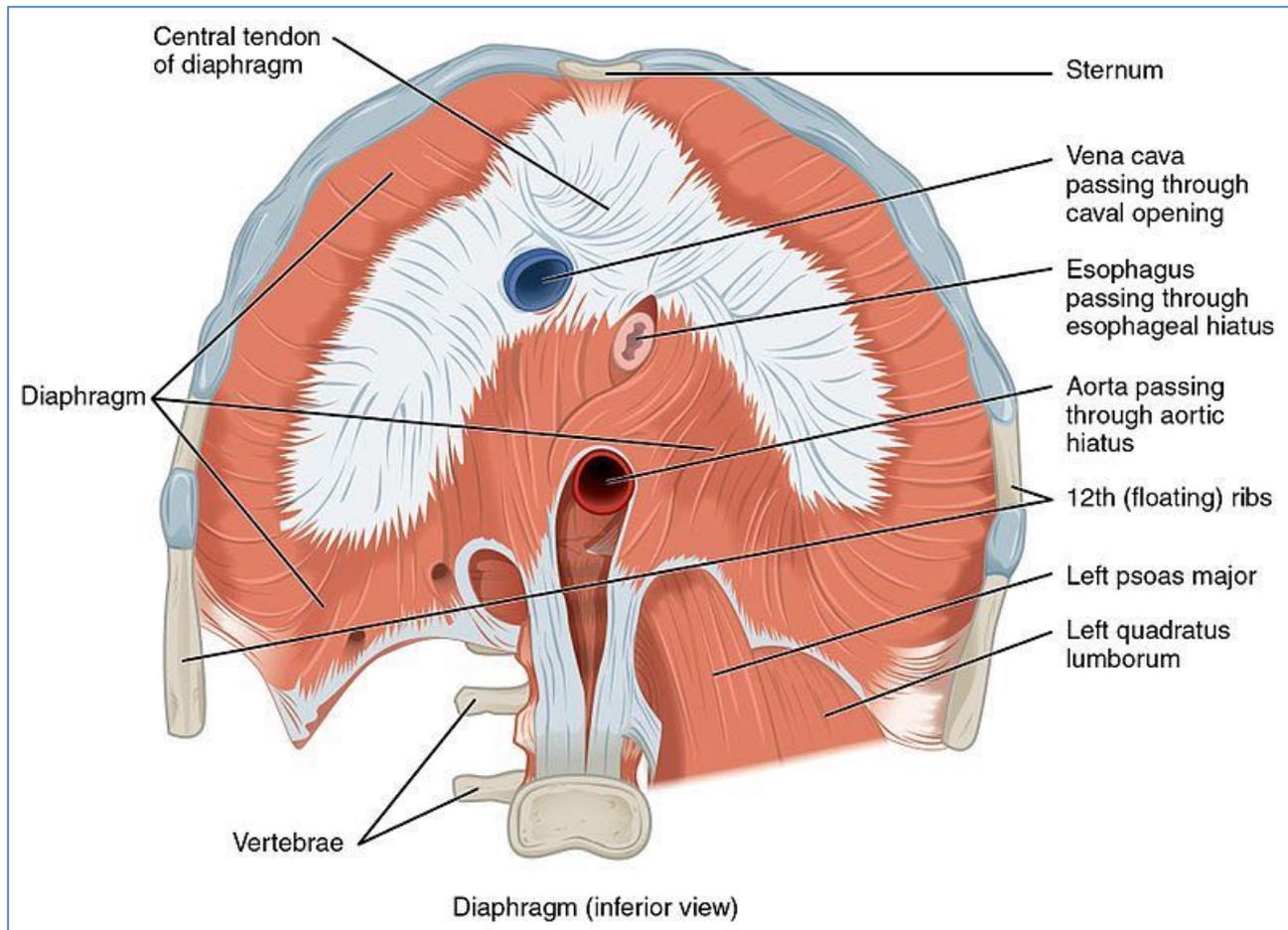
- **Neck:**
  - Trachea
  - Oesophagus
  - Major Nerves & Vessels



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- **Abdomen:**

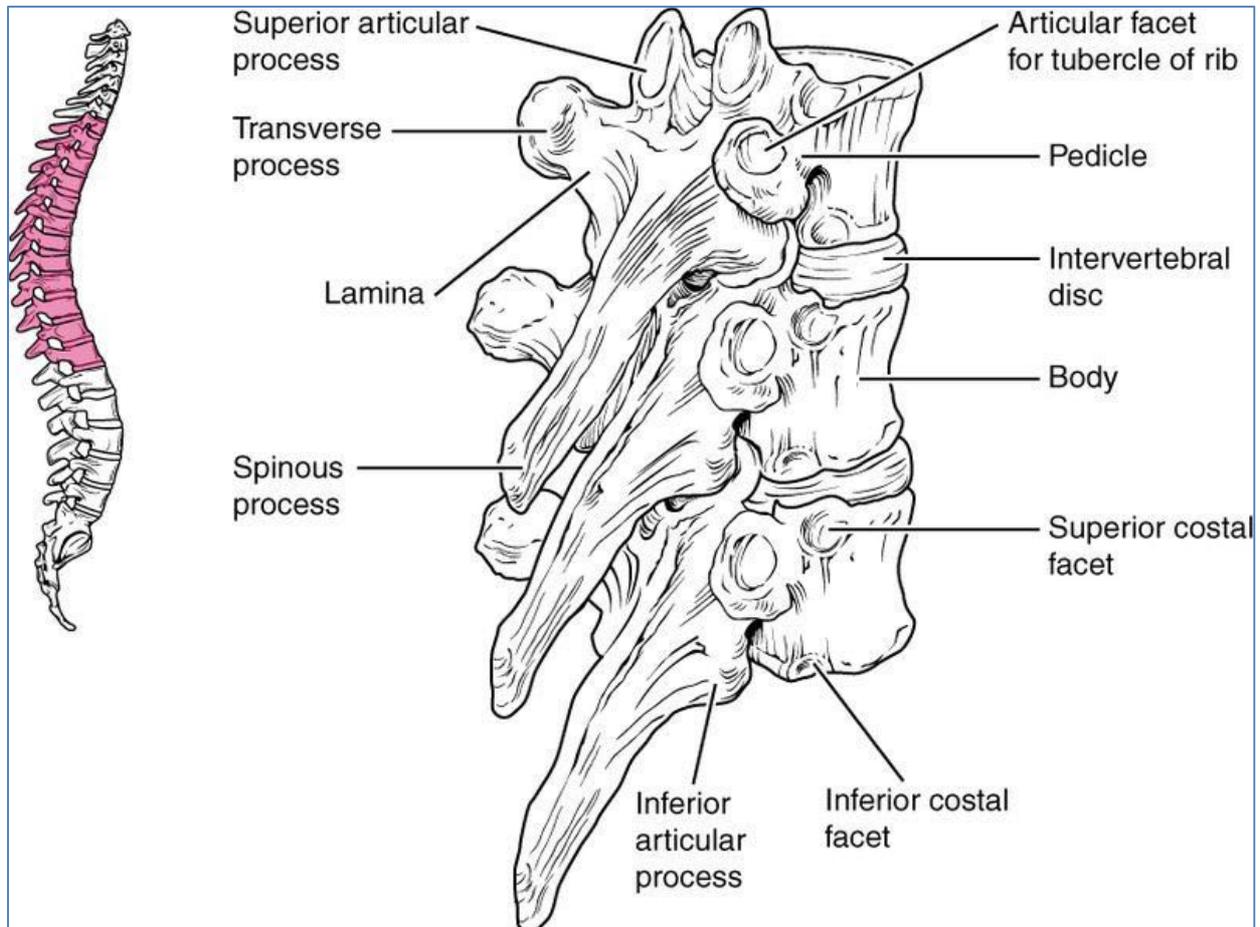
- Inferior Vena Cava
- Oesophagus
- Aorta



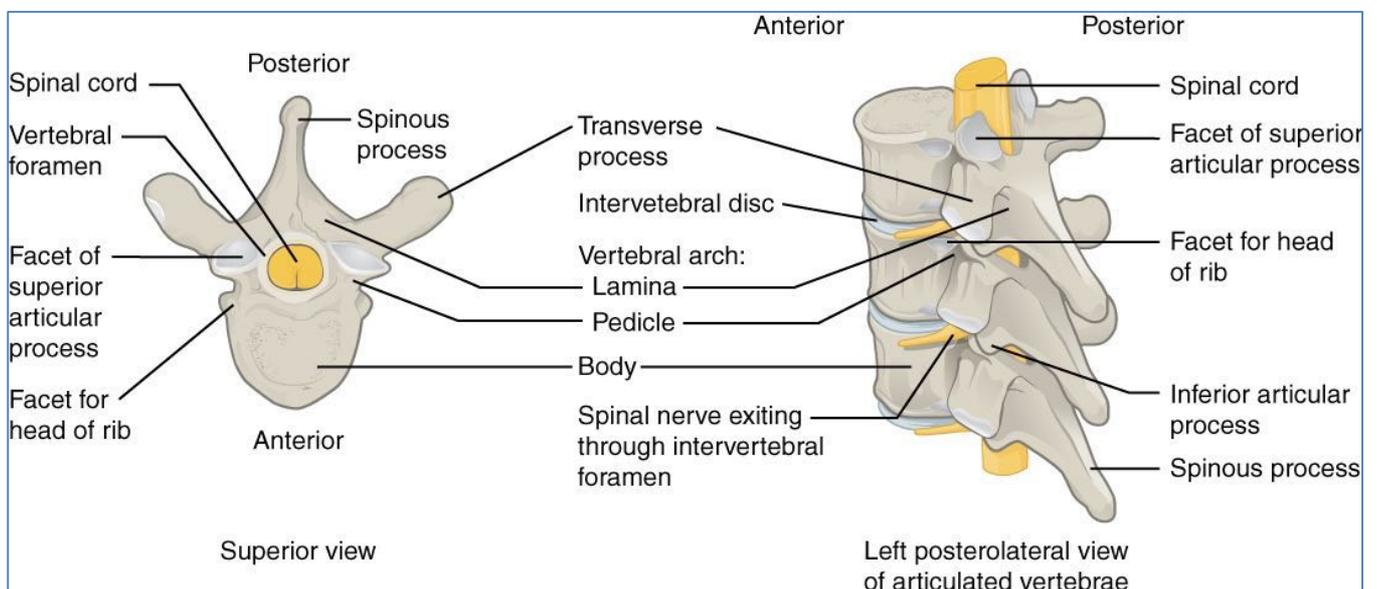
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## Thoracic Skeleton:

- **12 Thoracic Vertebrae:**
  - T1 - T12
  - **Distinguishing Features:**
    - **Heart-Shaped Body** (for extra weight-bearing)
    - **Inferiorly Projecting Spine** (Allows a degree of mobility that would otherwise not be possible due to ribs)
    - **Large Transverse Processes** (To support articulations with ribs)
    - **Costal Demifacets** (small articulation points) for articulation with the ribs.



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- **Sternum:**

- **3 Parts:**

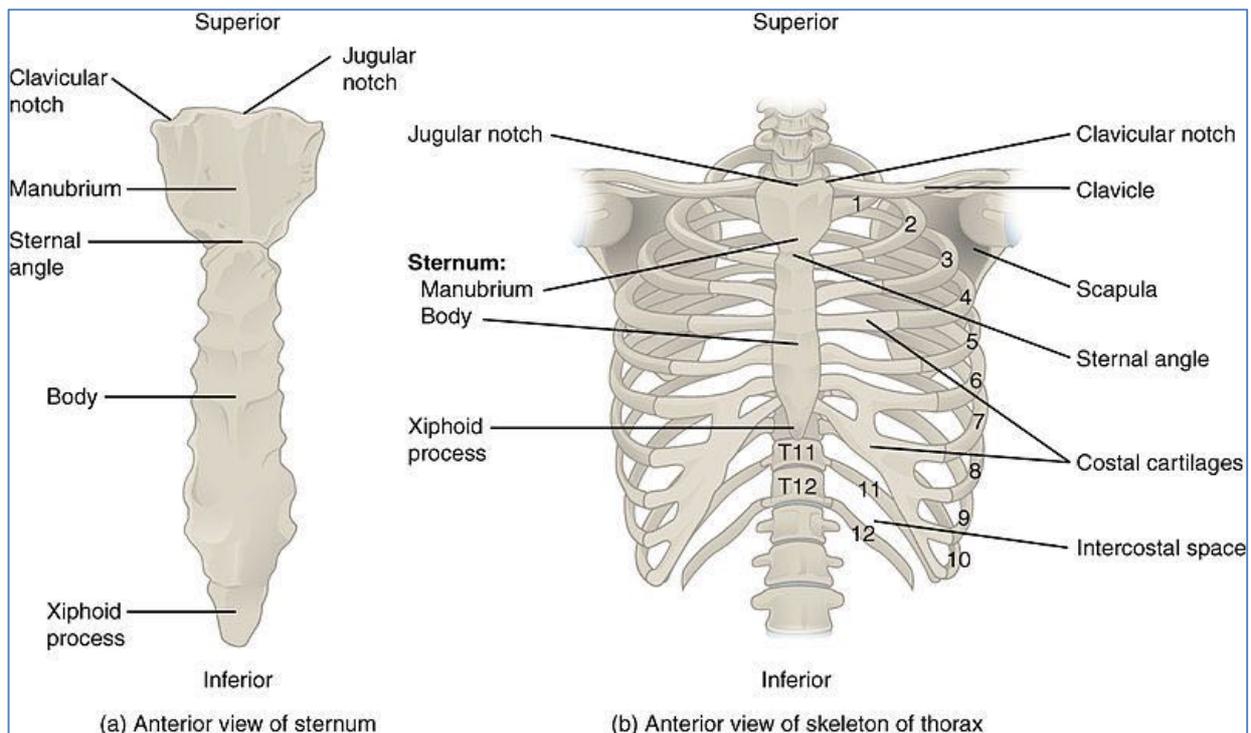
- Manubrium
    - Body of Sternum
    - Xiphoid Process

- **Sternal Angle:**

- Between the Manubrium & the Body
    - Important **Landmark for:**
      - Bifurcation of Trachea
      - Aortic Crest
      - T-4 Vertebrae
      - 2<sup>nd</sup> Rib

- **Articulations:**

- **Ribs 1-7:** Via **Sternocostal Joints** (Synovial Joints)
    - **Ribs 8-10:** Have **Interchondral Joints** between the costal cartilages (i.e. Indirect articulation with sternum.)

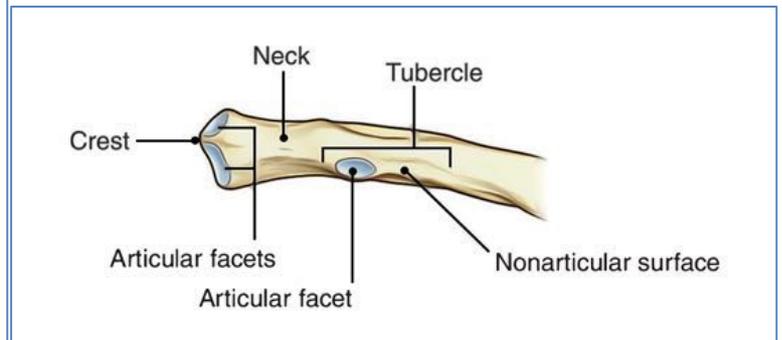
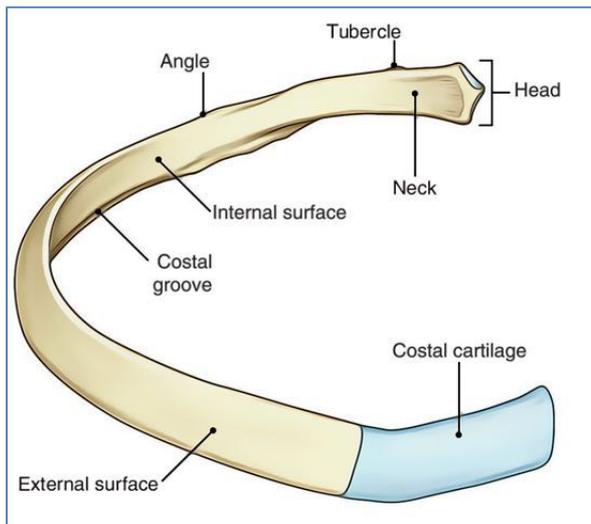


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- **Note:** all bones of the Thoracic Cage are interconnected by articulations (cartilaginous & synovial), each offering a small amount of movement. However, despite limited movement of individual joints, their combined movements make the Thoracic Cage remarkably mobile.

- **12 Pairs of Ribs:**

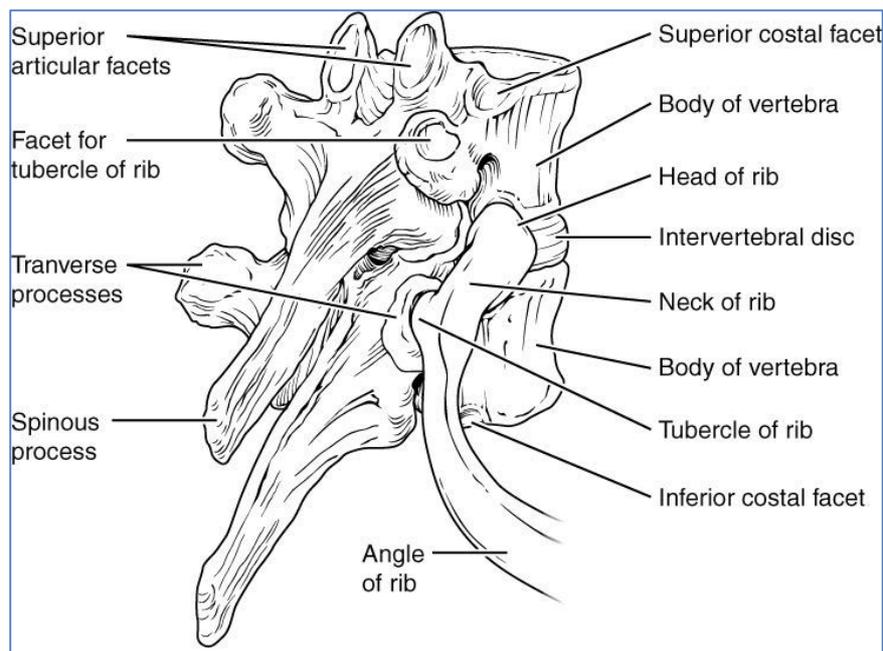
- 1-7 = 'True' Ribs (attach directly to sternum)
- 8-12 = 'False' Ribs (don't attach directly to the sternum)
  - Ribs 11 & 12 are 'Floating' Ribs (insert into abdominal muscles & connective tissue.)
- **Distinguishing Features:**
  - **Posterior End:**
    - has a **head, neck & tubercle** (for attachment of ligaments & to vertebrae)
  - **Curved shaft:**
    - Generally thin & flat
    - Oriented Vertically
    - Has a subcostal groove running on the inside of its inferior aspect.
  - **SubCostal Groove:**
    - Houses the **Intercostals Nerve, Artery & Vein**
  - **Anterior End:**
    - Sits more inferior than the posterior end.
    - Attach to sternum via **Costal Cartilage** – forms a *cartilaginous joint*



Source: Unattributable.

- **Typical Articulations:**

- Between **Head & Vertebrae** of the *same number*
- Between **Head & Vertebrae above**
- Between the **Tubercle & the Transverse Process** of the **Vertebrae** of the *same number*



- **Atypical Ribs:**

- Ribs 1, 2, 10, 11 & 12.

- Why atypical?:

- **Rib 1:**

- Oriented horizontally (rather than vertically)
      - Much shorter
      - Articulates *only* with the *body* of T1.
      - Scalene Tubercle – attachment point of Anterior Scalene Muscle
      - Grooves for Subclavian Veins & Arteries

- **Rib 2:**

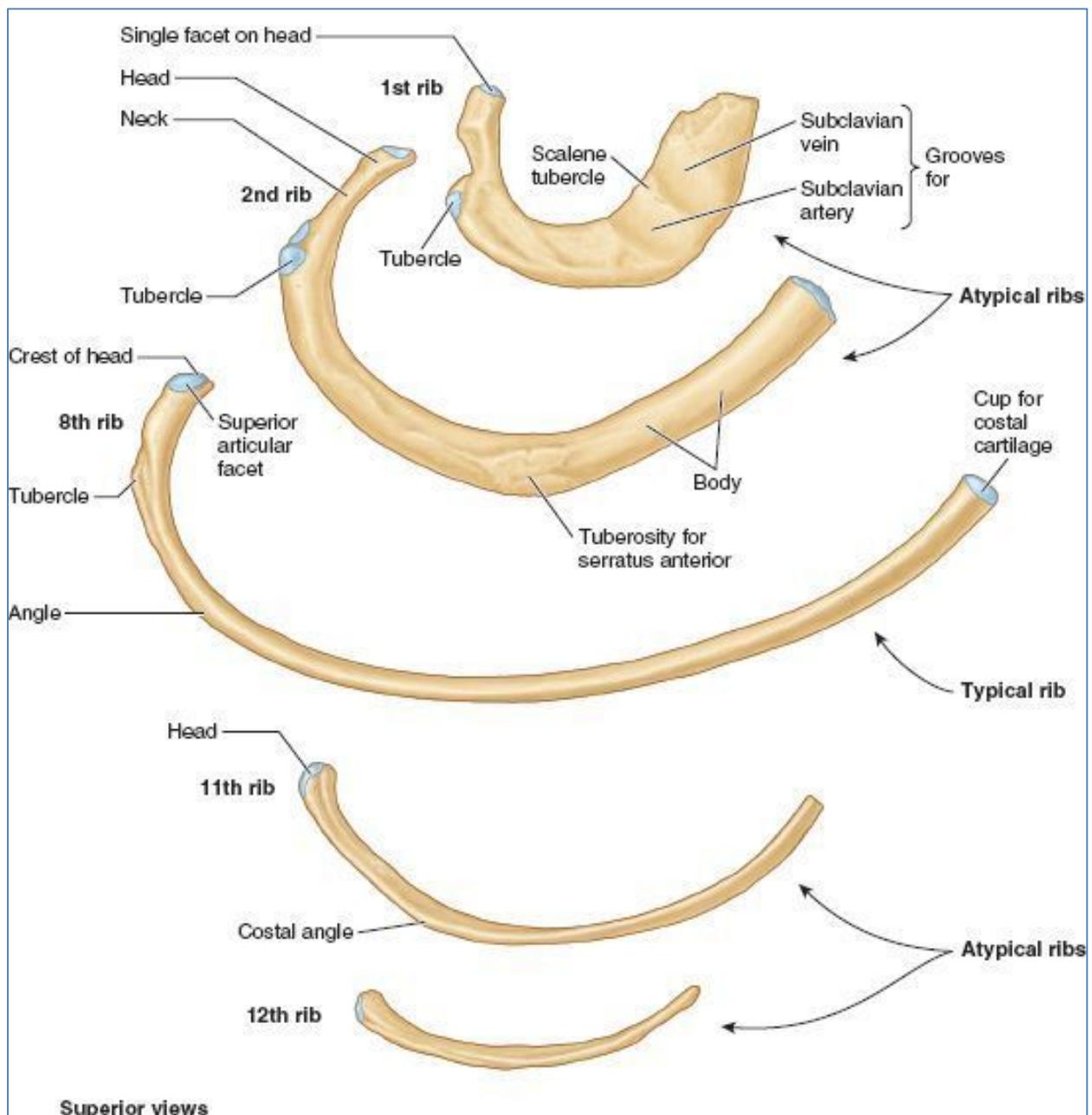
- Oriented horizontally (rather than vertically)
      - Otherwise typical

- **Rib 8:**

- Articulates *only with its own Vertebra* – only has 1 Facet on its head.

- **Rib 11 & 12:**

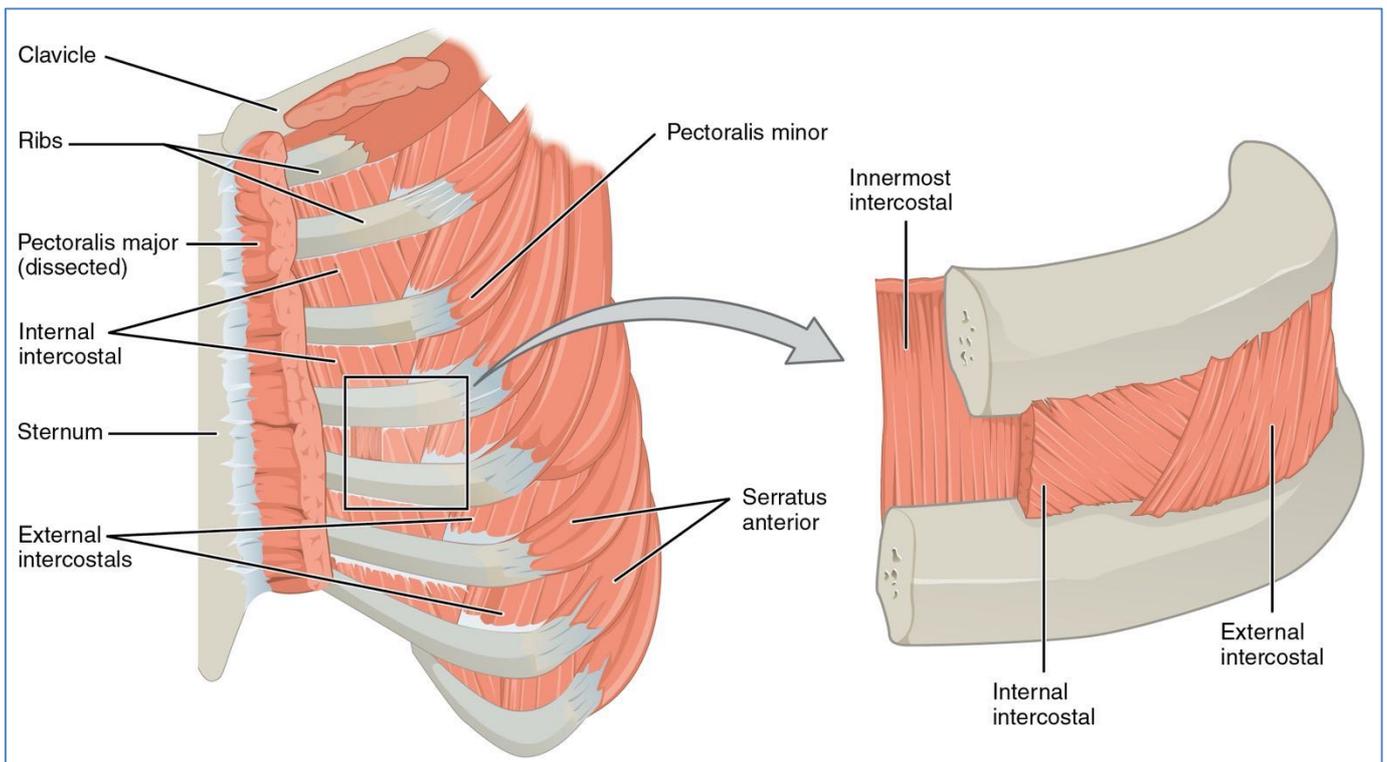
- Articulate *only with their own Vertebra*
      - No Tubercles / Necks
      - No Anterior Articulation



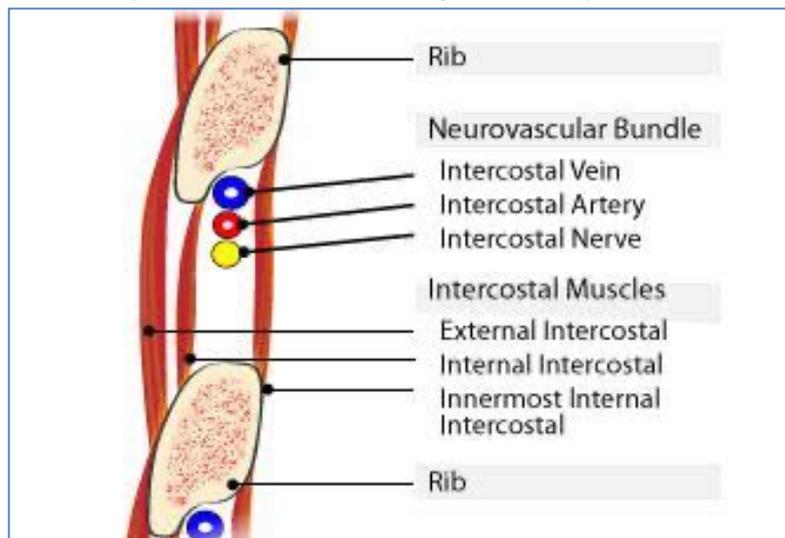
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## Thoracic Wall (Muscular Component):

- **3 Layers:**
  - **External Intercostal Muscle:**
    - Oriented Diagonally Inferio-Anteriorly
    - Incomplete Anteriorly → Transitions into the Anterior Intercostal *Membrane*
  - **Internal Intercostal Muscle:**
    - → Transitions into the Posterior Intercostal *Membrane*
  - **Innermost Intercostal Muscle:**
    - Oriented Diagonally Inferio-Posteriorly
    - Incomplete Posteriorly
- **Blood Supply:** (segmental)
  - **Posterior Intercostal Arteries** (Branches of Descending Aorta)
  - **Anterior Intercostal Arteries** (Branches of Internal Thoracic Arteries- From Subclavian Arteries)
- **Nerve Supply:**
  - Anterior Rami of Thoracic Spinal Nerves directly supply intercostals muscles.



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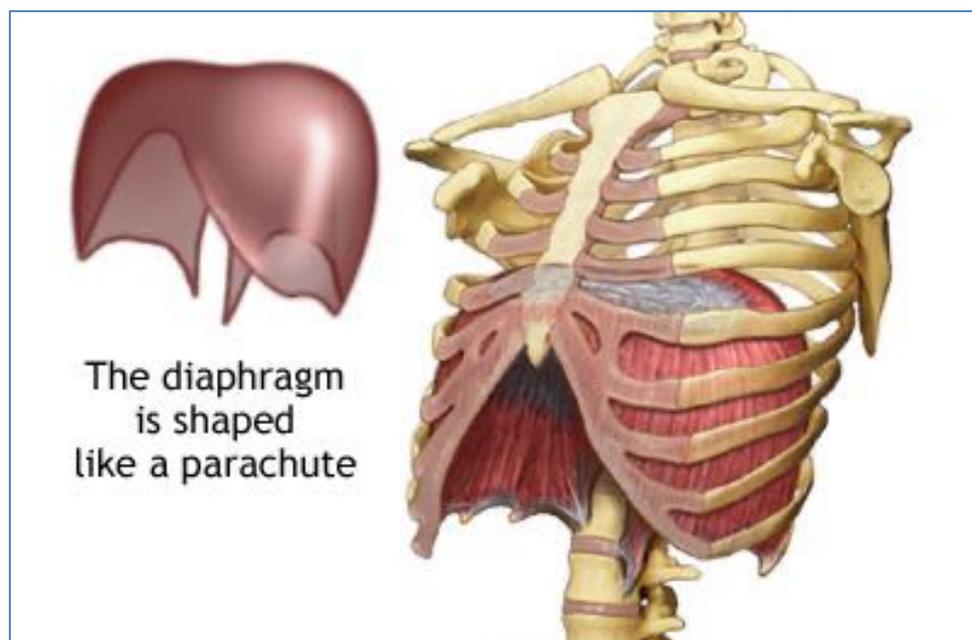
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### Accessory Muscles Of:

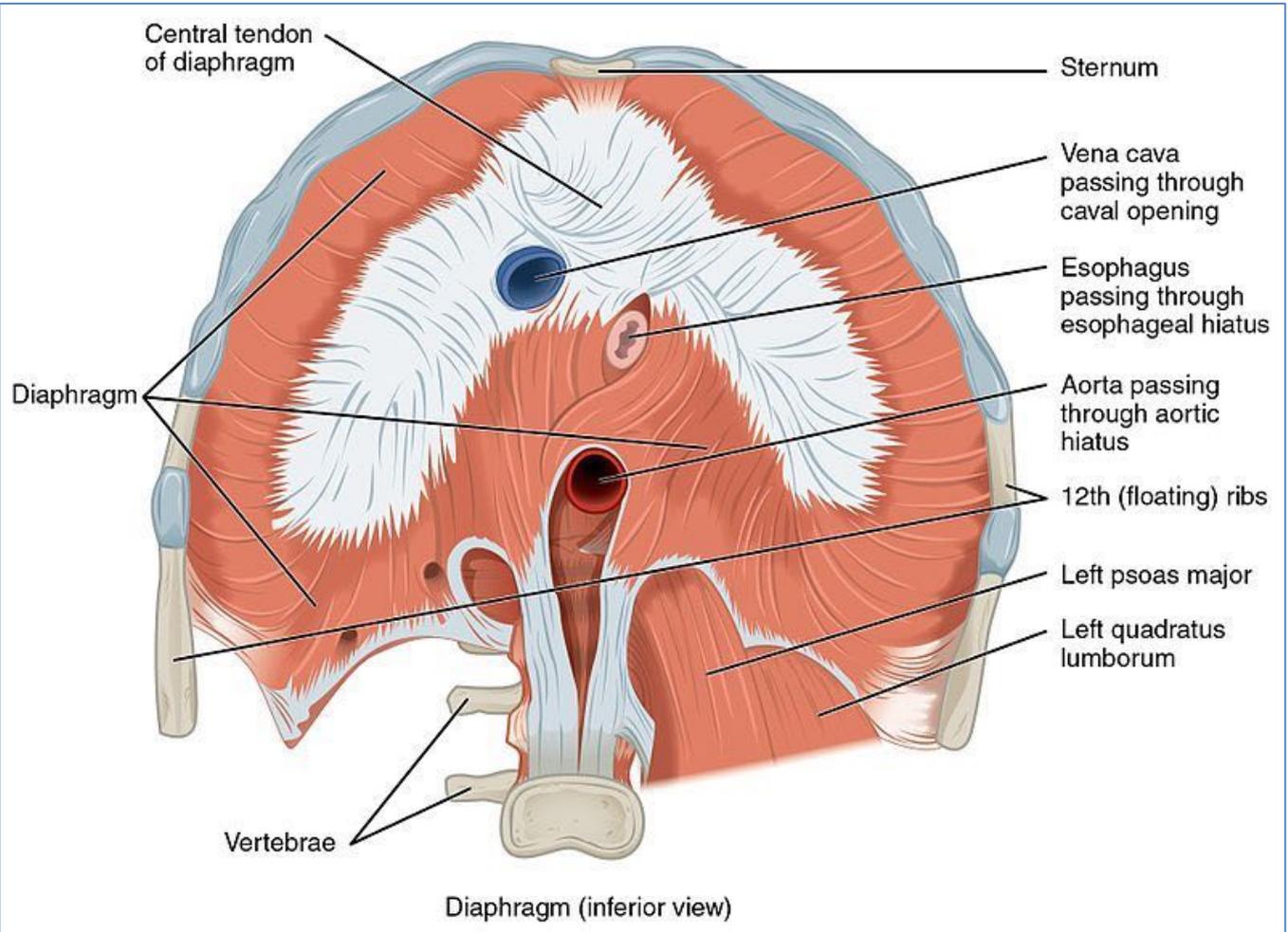
- **Inspiration:**
  - **Scalene Muscles**
  - **Sternocleidomastoid**
  - **External Intercostals**
  - **How:**
    - Pull the Ribs & Sternum *Superiorly* (i.e. Pump & Bucket-handle Movements)
- **Expiration:**
  - **Abdominal Wall Muscles**
    - By increasing intra-abdominal pressure (forces diaphragm up)
  - **Internal Intercostals**
    - Pull the Ribs & Sternum *Inferiorly* (i.e. Reverse of Pump & Bucket-Handle Movements)

### Primary Muscle: The Diaphragm:

- A MusculoTendinous Structure
- Divides thorax from abdomen
- Primary muscle of respiration
- Contraction = Flattening (i.e. Downward movement) → Inspiration
- Relaxation = Doming into thoracic cavity (upward movement) → Expiration
- **Origins:**
  - Xiphoid Process
  - **Costal Margin** (approx 7<sup>th</sup> rib)
  - Lateral Lower Ribs (11 & 12)
  - Body of T12 Vertebra.
- **Inserts Onto:**
  - A central tendon
- **Blood Supply:**
  - Phrenic Arteries (superior & Inferior)
- **Venous Drainage:**
  - Brachiocephalic Veins
  - Azygous Veins
  - Inferior Vena Cava
- **Nerve Supply:**
  - Phrenic Nerve (C3, 4 & 5)
    - Receives sympathetic fibres from Cervical Ganglia → Voluntary & Autonomic Nerve Supply



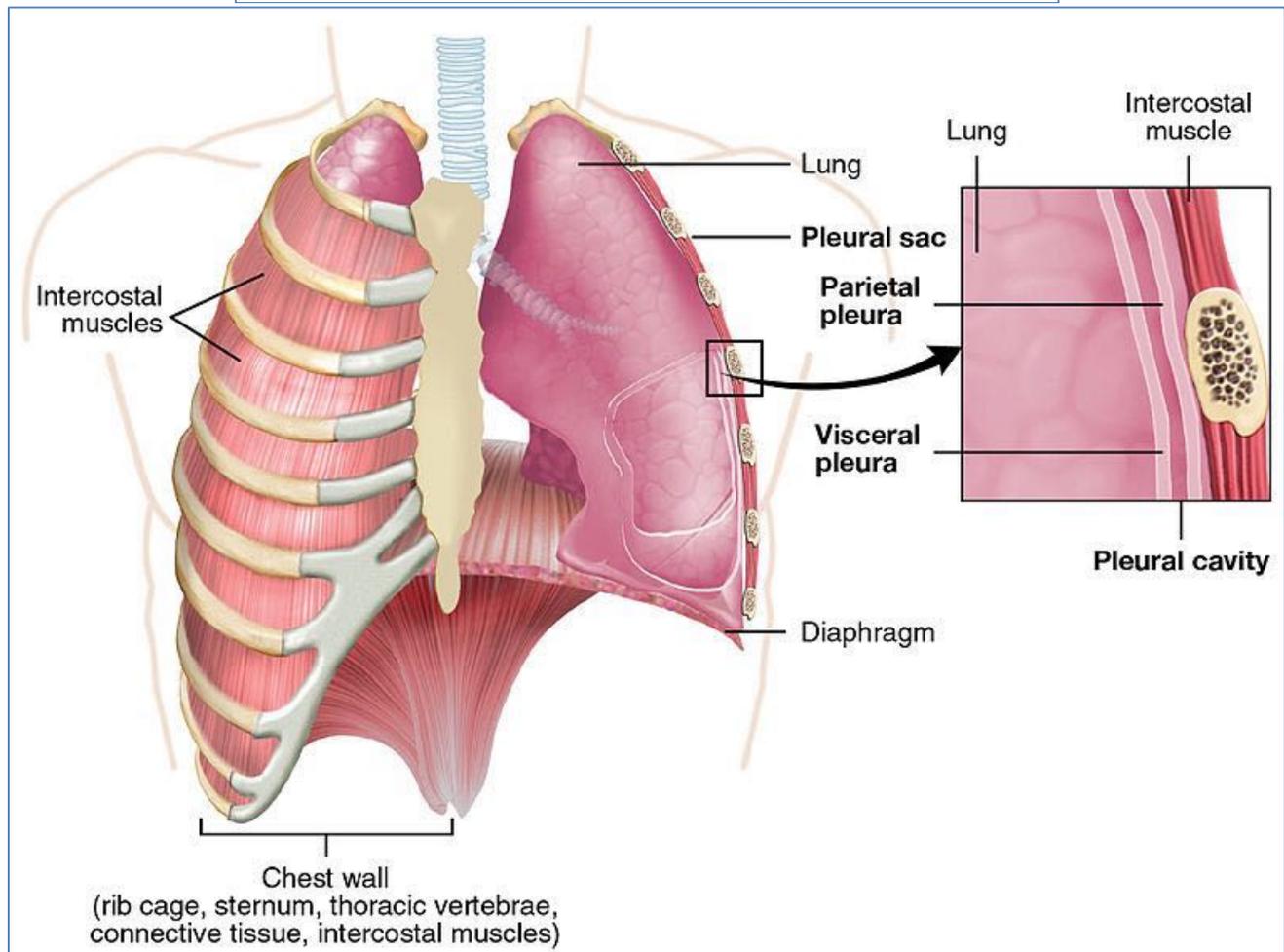
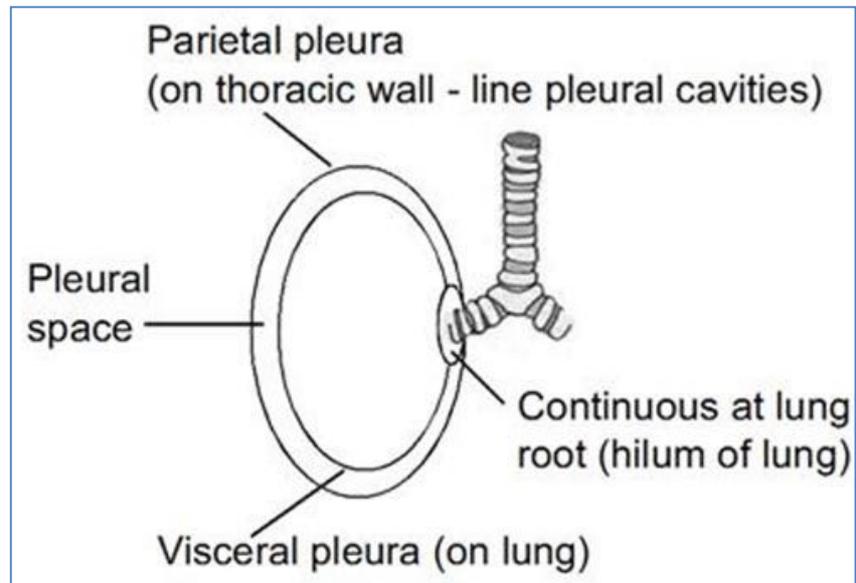
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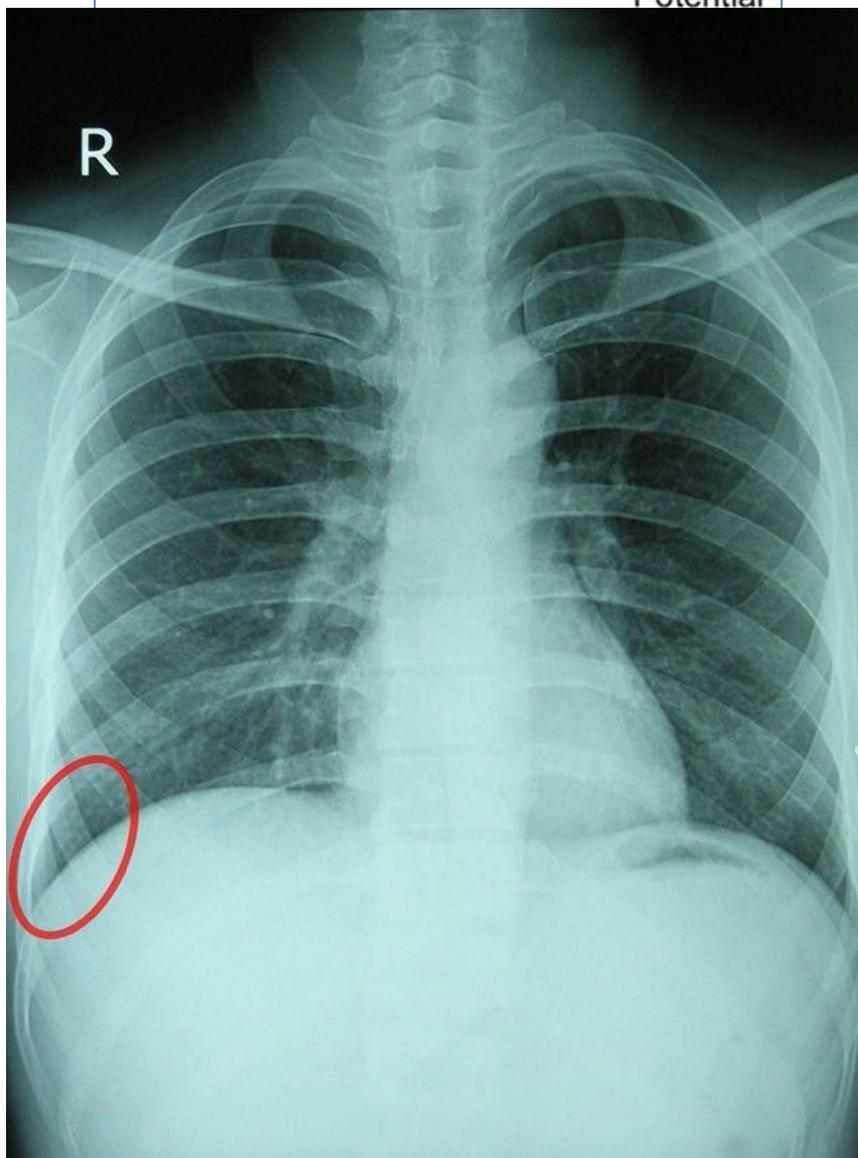
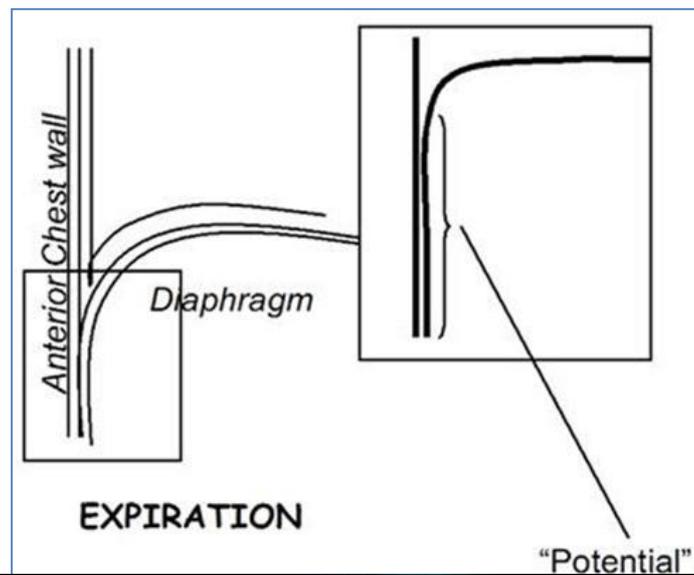
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## Pleura:

- Each are continuous Serous Sacs
  - Each has a Visceral 'pleura' & A Parietal 'pleura'
  - Between these layers is a 'potential' space aka. The "Pleural Space"
  - This Pleural Space is contains lubricating Serous Fluid
    - Fluid creates surface tension
      - Keeps the lung inflated even during expiration.
      - Keeps the pleurae together.
- Pleurae line the lung & Pulmonary Cavities



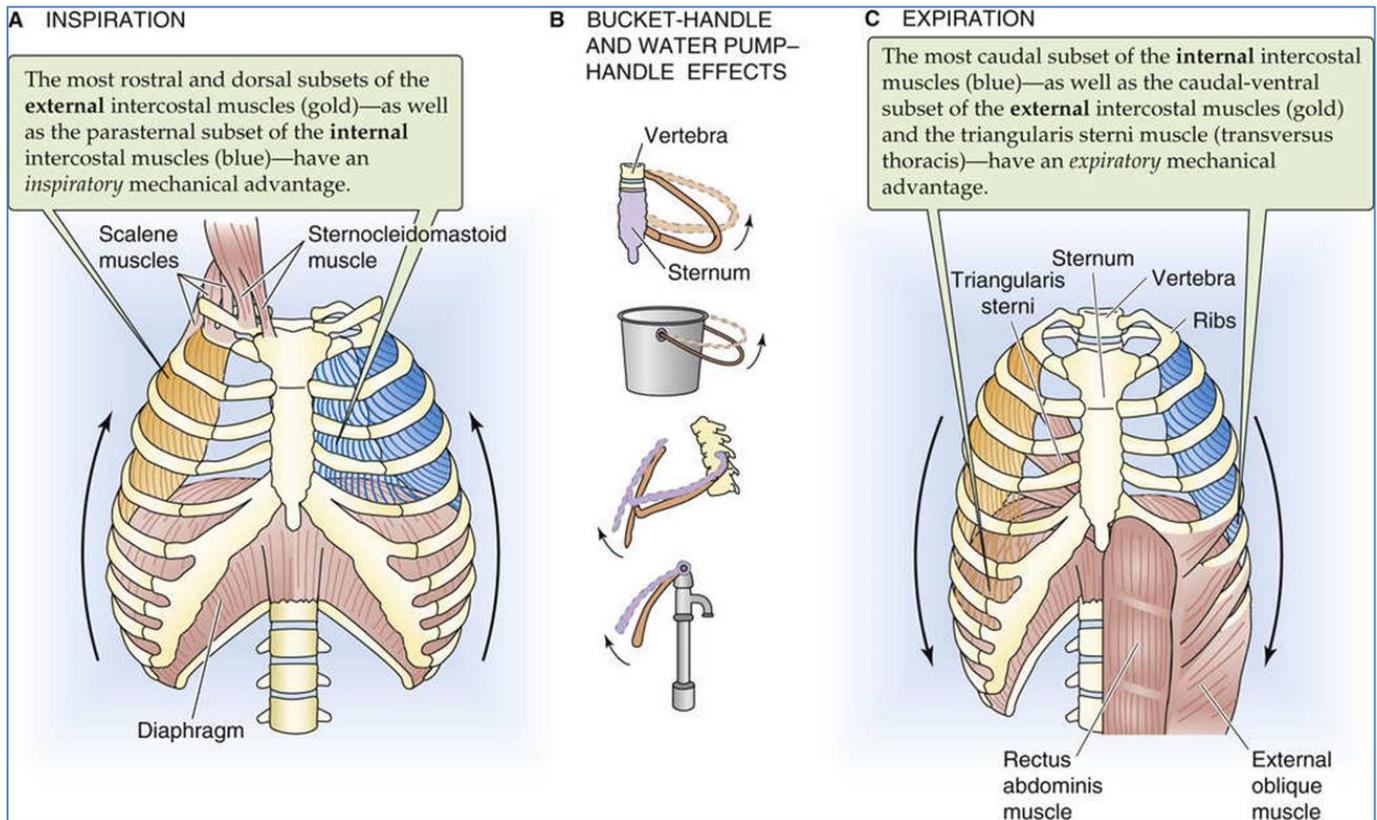
- **Costodiaphragmatic Recess:** (or just Diaphragmatic Recess)
  - 'Extra' space allocated to the lungs for use during forced inspiration
  - Allow extra expansion of the lungs



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## Thoracic Movements of Breathing:

- Brought about by muscles of the Thoracic Wall & Accessory Muscles
- Breathing is **not** just movement of the diaphragm
- Due to articulations, 2 groups of ribs create different movements:
  - **Upper 6 Ribs:**
    - *Pump Handle* Action
    - Increases **Antero-Posterior Diameter** of Thoracic Cavity
  - **Lower 6 Ribs:**
    - *Bucket Handle* Action
    - Increases the **Transverse Diameter** of Thoracic Cavity



<https://doctorlib.info/physiology/medical/146.html>

## ANATOMY OF THE AIRWAYS

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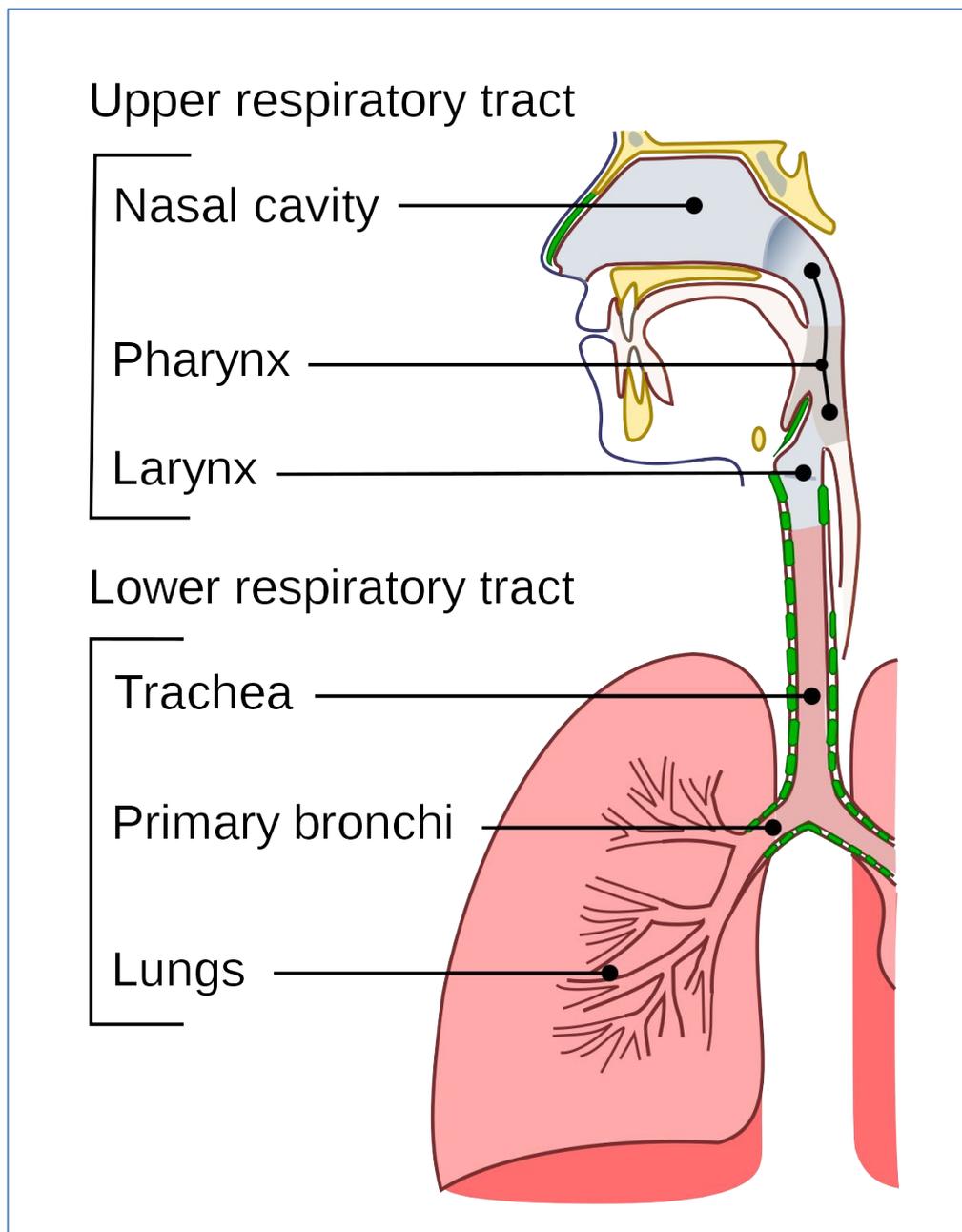
### Structural Divisions:

#### • Upper Airways:

- Aka. 'Conducting' zones: Due to its conduit-like structure
- Functions:
  - Filter particulate matter from air (debris & dust)
  - Mucosal Epithelium:
    - Warm incoming air
    - Moisten incoming air
- Nose → Trachea

#### • Lower Airways:

- Aka. 'Respiratory' zones: Due to site of gas exchange
- Functions:
  - Facilitate Gas Exchange
  - O<sub>2</sub> in CO<sub>2</sub> out.
- Bronchi → Lung

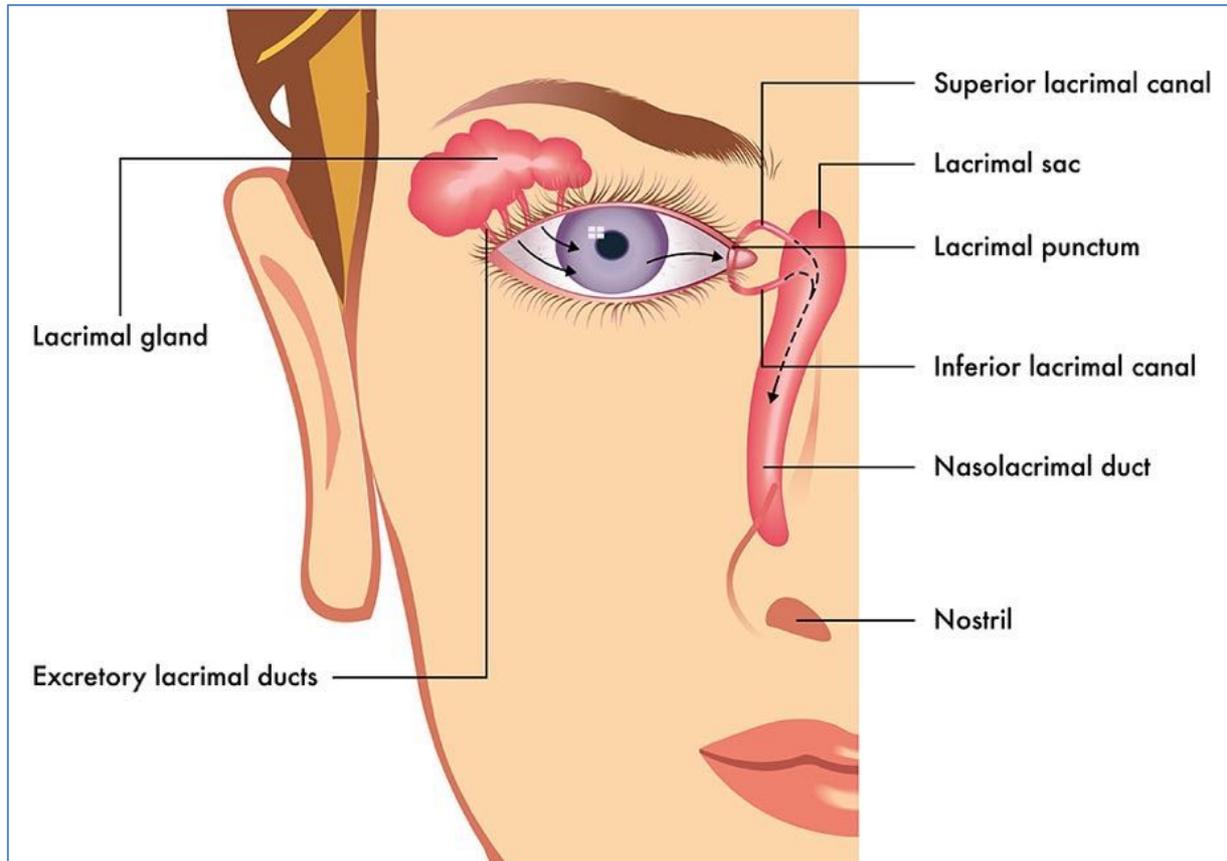


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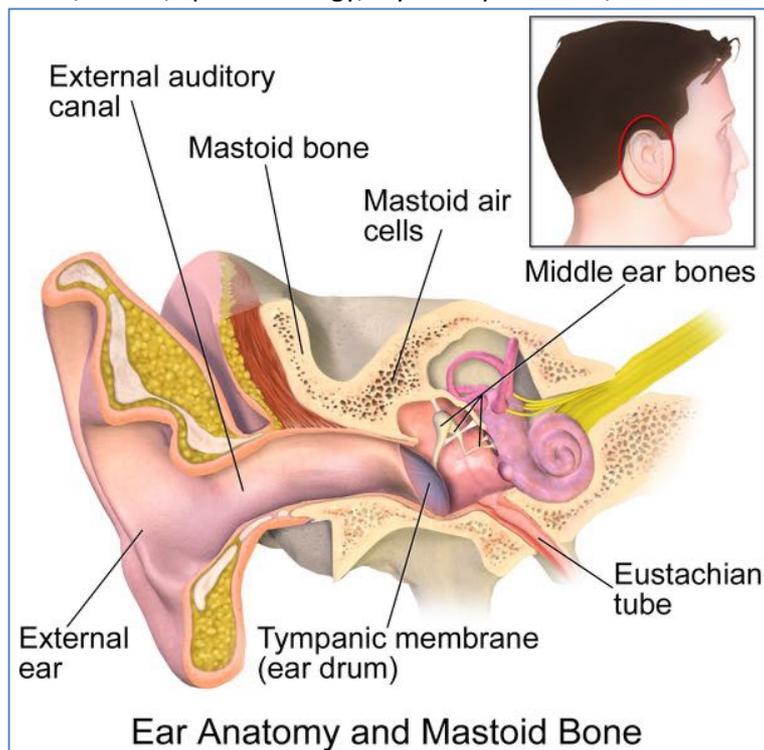
## The Facial Skeleton:

- **Important Communication Routes Exist Between:**

- Eye Orbits & Nasal Cavities (**Nasolacrimal Duct (Tear Duct)**)
- Nasal Cavities & Paranasal Sinuses
- Nasal Cavities & Oral Cavities
- Ears & Pharynx (**Eustachian Tube** – equalises pressure within mid ear)
- Pharynx & Larynx

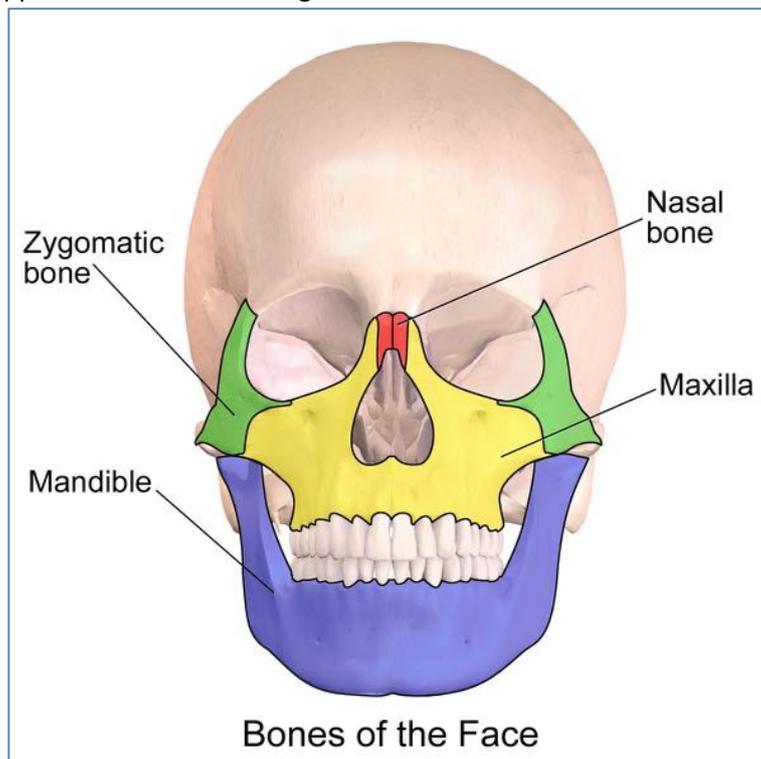


<https://healthcare.utah.edu/moran/ophthalmology/thyroid-eye-disease/nasolacrimal-duct-obstruction.php>



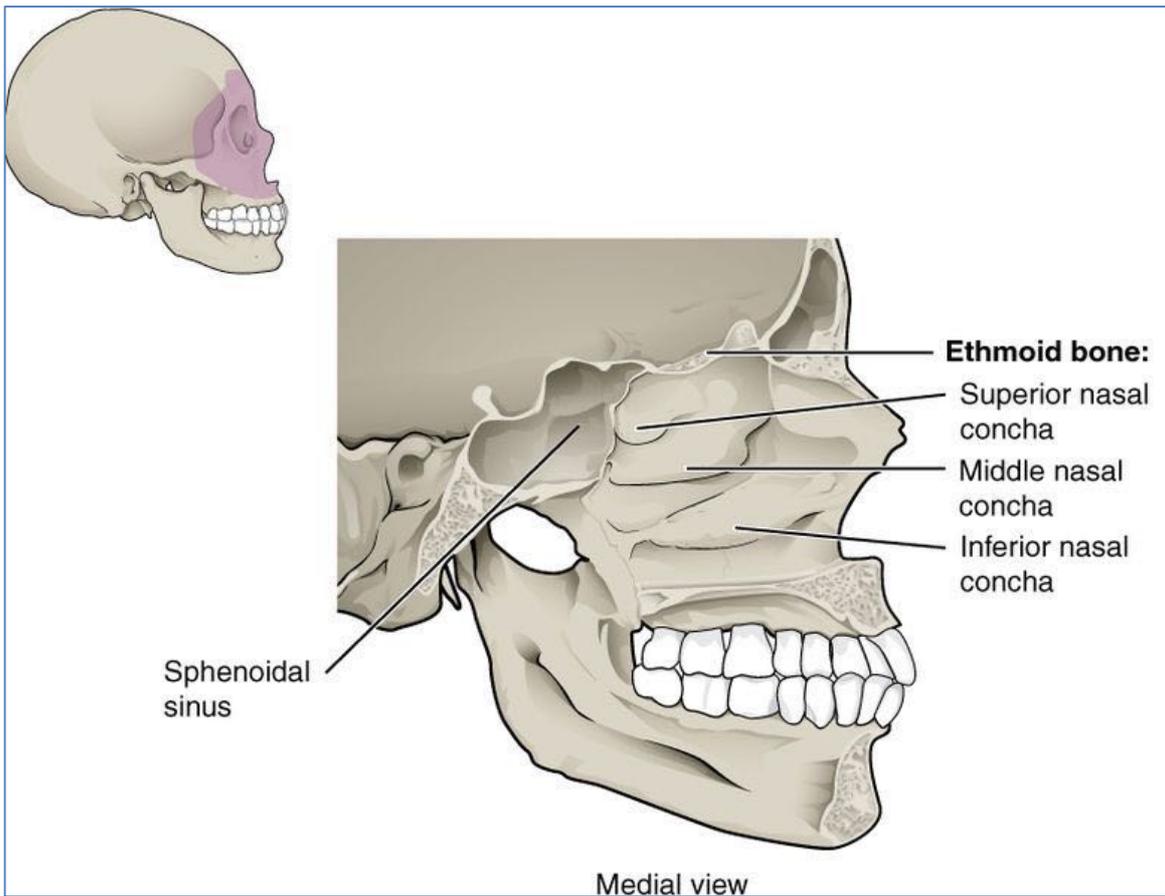
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- **2 Maxillae:**
  - Fused Medially
  - Carry the upper teeth
  - Forms front 2/3 of hard palate.
  - 'Keystone' of the facial skeleton (Articulates with all facial bones except mandible)
- **Frontal Bone:**
  - Anterior Cranium
  - Contains the (frontal) sinuses
  - Connects to Ethmoid bone
- **Nasal Bones:**
  - Form the 'bridge' of the nose
  - Provide support for external cartilage -->nose structure

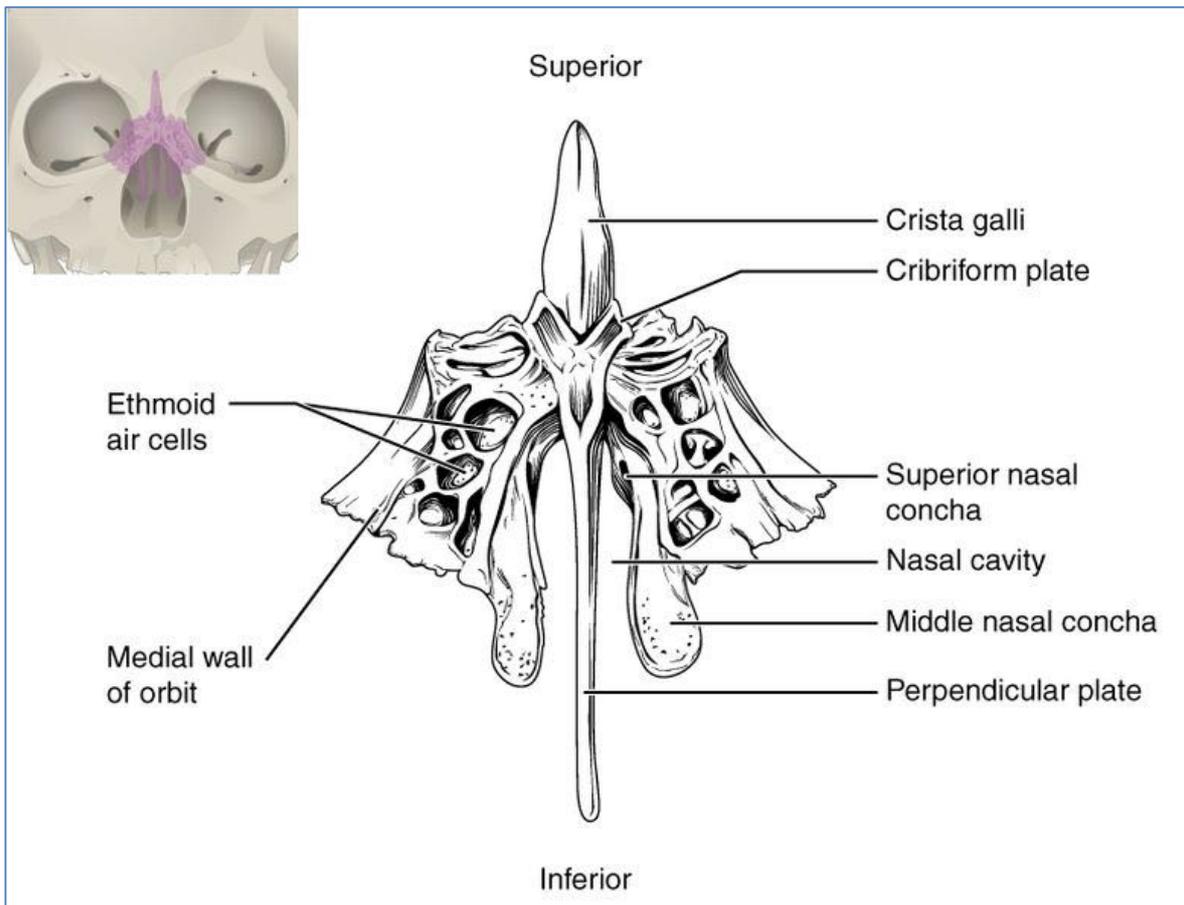


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- **Ethmoid:**
  - Forms majority of nasal cavity
  - Anchors the cartilage of the nose
  - Turbulates the air - moisten + warm + filters
  - **Important Components:**
    - **2 Cribriform Plates** - Punctured by *olfactory foramina* – for olfactory nerves
    - **Crista Gali** (inside cranium) - Triangular process between the Cribriform Plates – Anchors the brain.
    - **Perpendicular Plate** (superior part of nasal septum) - Separates R&L Nasal Cavities
    - **L & R lateral Masses** – riddled with *ethmoid sinuses*
  - **Superior Nasal Conchae**
    - Turbulates the air - moisten + warm + filters
  - **Middle Nasal Conchae**
    - Turbulates the air - moisten + warm + filters
  - **Inferior Nasal Conchae:**
    - Small scroll of bone
    - Sit in inferior portion of nasal cavity
    - Paired
    - Attach to part of maxilla
    - Turbulates the air - moisten + warm + filters



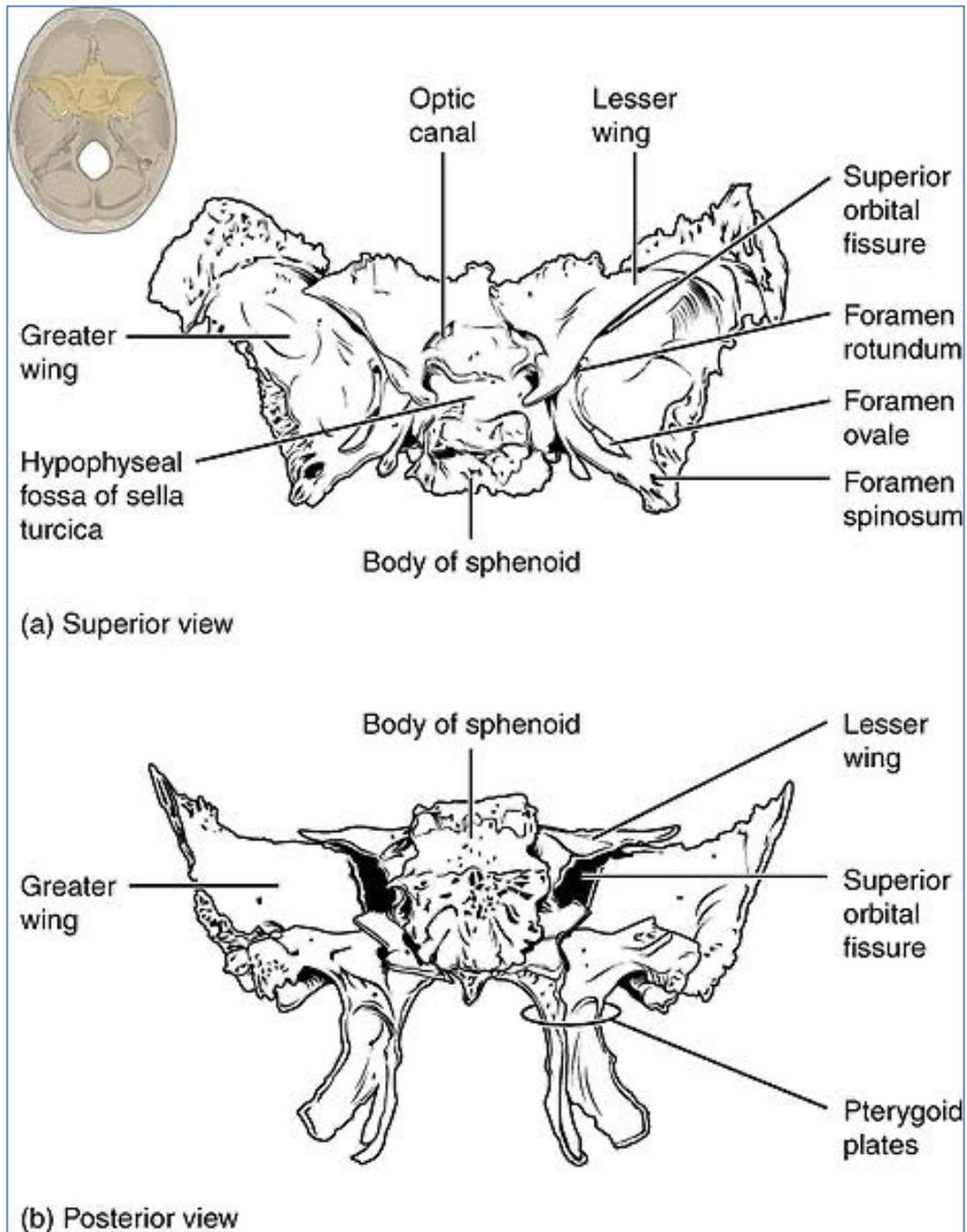
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- **Sphenoid:**

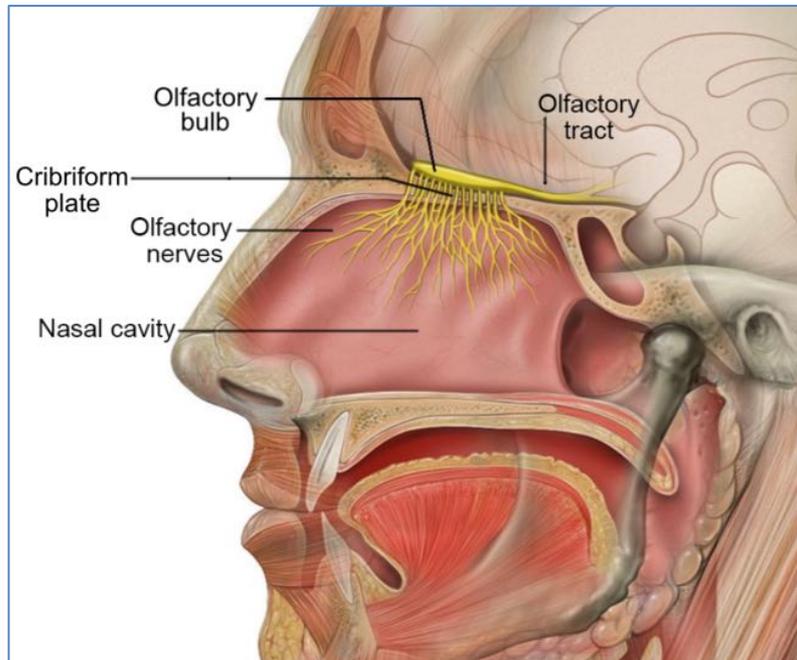
- 'keystone' of the cranium (articulates with all bones of cranium)
- Butterfly-shaped
- Contain paired Sphenoid sinuses



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## **The Nose:**

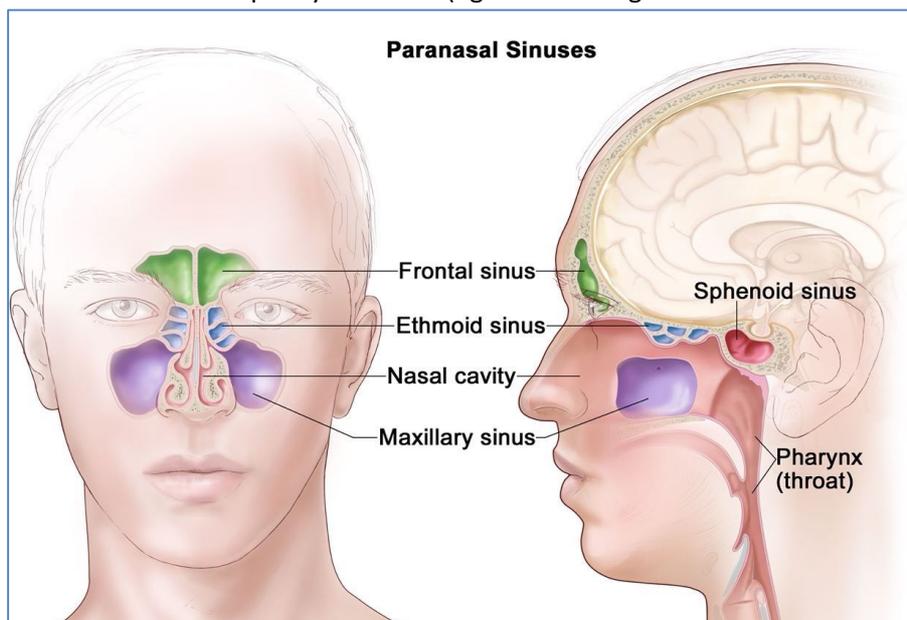
- Provides an airway for respiration
- Moistens & warms entering air
- Filters inspired air
- Doubles as a resonance chamber during speech
- Houses Olfactory (Smell) Receptors
- **External Nose:**
  - Skeletal framework consists of:
    - Nasal & Frontal bones Superiorly
    - Maxillary bones Laterally
    - Flexible Plates of Cartilage Inferiorly
- **Nasal Cavity:**
  - **Air Enters Through Nostrils:**
    - Lined with skin
    - Sebaceous & sweat glands
    - Numerous ***Vibrissae*** (Hair Follicles) – filter coarse particles from air.
  - **Epithelial Linings:**
    - **Olfactory Mucosa:**
      - Specialized epithelium involved with smell
      - Surface littered with olfactory neurons (receptors)
      - Olfactory neurons synapse with #1 CN (the Olfactory Nerve)
    - **Respiratory Mucosa:**
      - Pseudostratified Columnar Epithelium
      - Ciliated
      - Scattered Goblet Cells
      - Base of Lamina Propria rich in mucous & serous glands.
  - **Divided in the middle by the nasal septum:**
    - Perpendicular Plate of Ethmoid (upper 2/3)
    - Vomer of the Sphenoid (lower 1/3)
  - **Roof Formed by:**
    - Ethmoid Bone
    - Sphenoid Bone
  - **Floor Formed by the *Palate*:**
    - Hard Palate – Palatine Bone
    - Soft Palate (Uvula) – Musculo-Tendinous Structure
  - **Lateral Walls: *Conchae***
    - 3 on each wall
    - Superior/Middle/Inferior
    - Increase Mucosal Surface Area
      - Heat & Moisten the air during Inspiration.
      - Reclaims Heat & Precipitates Moisture during Expiration.
    - Enhance Turbulence – heavier, nongaseous particles are flung onto & stick to the mucosa



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• **Paranasal Sinuses:**

- **Exist In 4 Bones:**
  - Maxillae
  - Frontal
  - Sphenoid
  - Ethmoid
- All continuous with nasal cavity
- Increase surface area
- Create turbulence
- Help to humidify & warm inflowing air.
- Lighten the skull
- Provides resonance for 'quality' of voice. (eg. Voice changes with blocked sinuses)

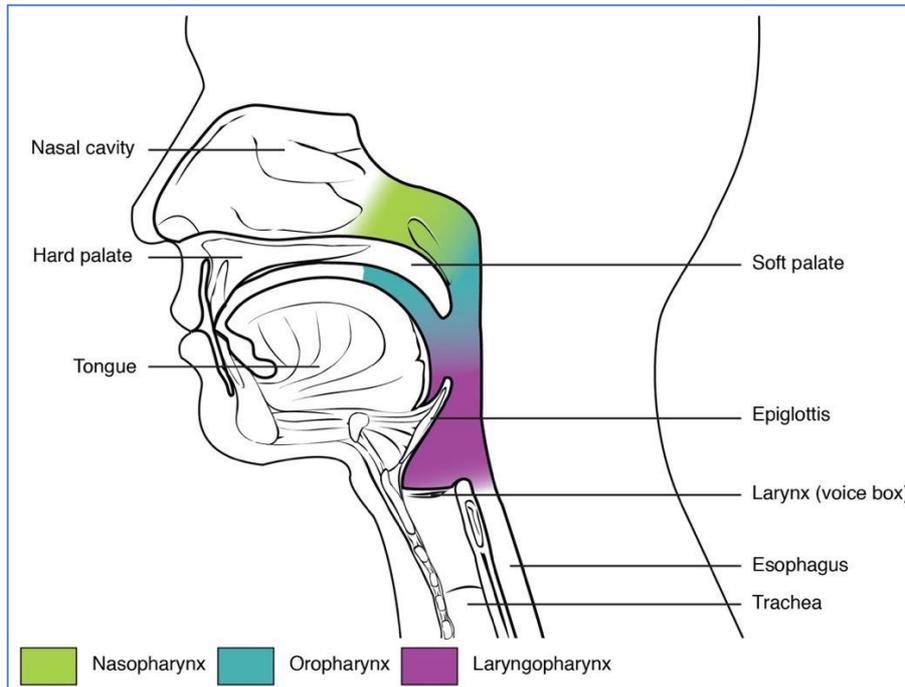


Public Domain: <https://www.cancer.gov/publications/dictionaries/cancer-terms/def/paranasal-sinus>

**Note: During infection, the openings of the sinuses may become blocked by excessive mucus production.**  
 - This can lead to excessive pressure inside the sinuses → pain

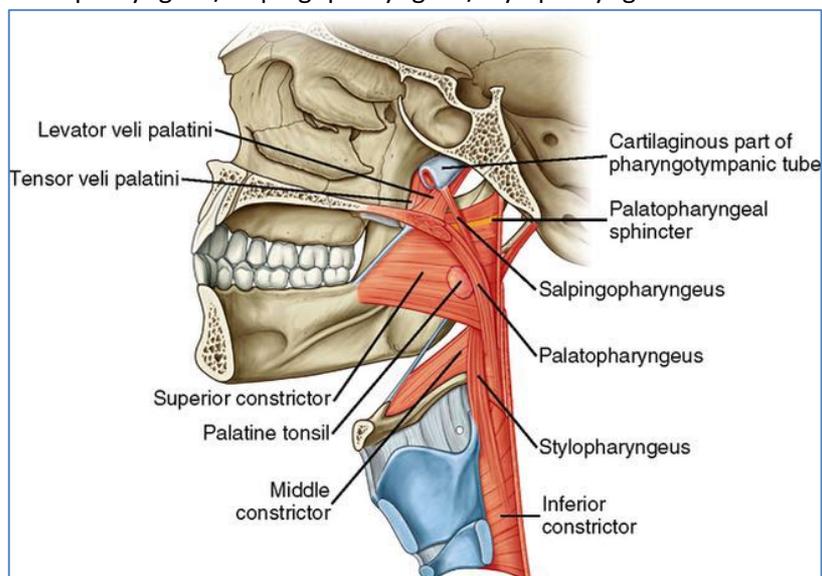
## The Pharynx:

- Connects Nasal Cavities, Oral Cavity & Oesophagus
- **Epithelium of Each Pharyngeal Region:**
  - **Nasopharynx:**
    - Air passageway ONLY.
    - *Pseudostratified Ciliated Epithelium*
  - **Oropharynx:**
    - Both Food & Air Pass Through it. → More protection is needed.
    - *Stratified Squamous Epithelium*
  - **Laryngopharynx:**
    - Both Food & Air Pass Through it. → More protection is needed.
    - *Stratified Squamous Epithelium*
    - During swallowing, food has 'right-of-way' (breathing is halted temporarily)



OpenStax College, CC BY 3.0 <<https://creativecommons.org/licenses/by/3.0/>>, via Wikimedia Commons

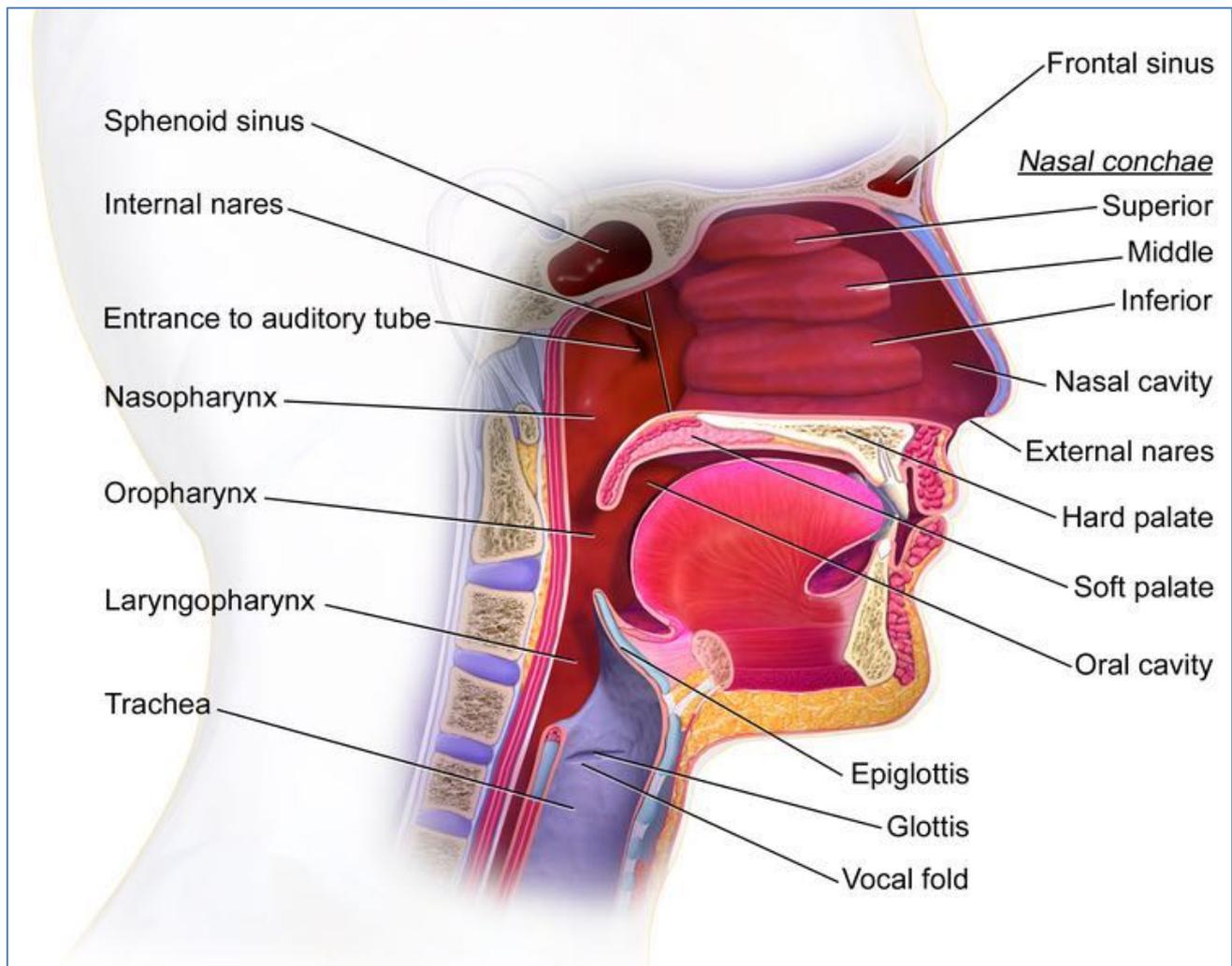
- **2 Muscle Groups of Pharynx:**
  - **3x Constrictor Muscles:** (move food down to the *laryngopharynx*)
    - Superior/Middle/Inferior
  - **3x Longitudinal Muscles:** (Elevate the Pharynx – prevent food in trachea)
    - Palatopharyngeus/Salpingopharyngeus/Stylopharyngeus



<https://www.tekportal.net/salpingopharyngeal-muscle/>

- **Soft Palate:**

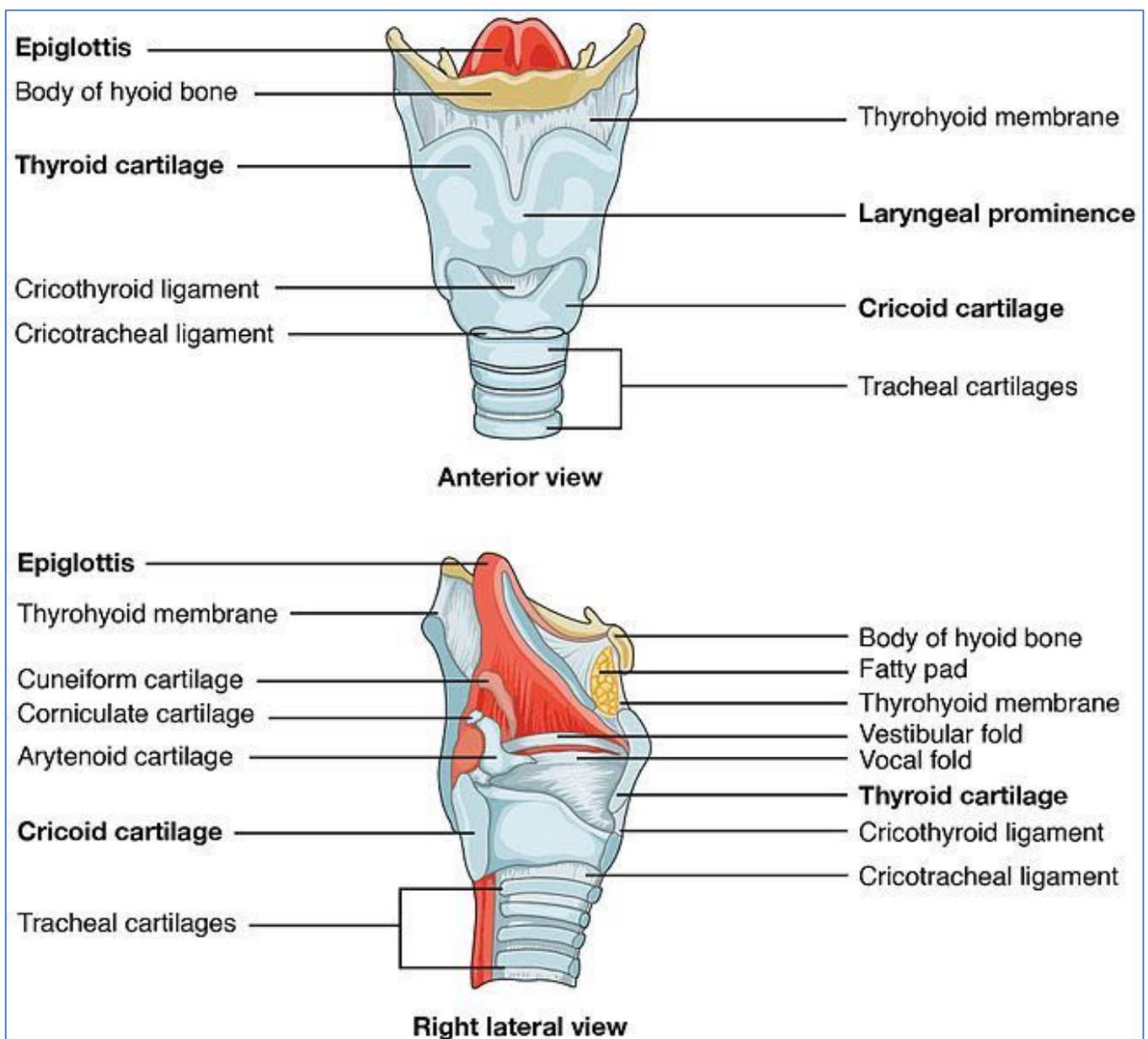
- Posterior aspect of oral cavity
- Separates Oral Cavity & Nasopharynx
- Involved during *Deglutition*
- Made of & Operated By 5 Muscles:
  - Levator Veli Palatini
  - Tensor Veli Palatini
  - Palatoglossus
  - Palatopharyngeus
  - Musculus Uvulae
- Supplied by *Vagus Nerve*



Blausen.com staff (2014). "Medical gallery of Blausen Medical 2014". WikiJournal of Medicine 1 (2). via Wikimedia Commons

## The Larynx: (“Voicebox”)

- Superiorly, it attaches to the Hyoid Bone
- Inferiorly, it merges with the Trachea
- **3 Functions:**
  - Provide an open airway (breathing)
  - Direct Air & Food into proper channels
  - Voice production. (Phonation)
- **Made of 9 Cartilages:**
  - **3 Unpaired Cartilages:**
    - Form the Tube-Like Skeletal Framework of Larynx
    - **Thyroid Cartilage**
    - **Cricoid Cartilage**
    - **Epiglottis**
  - **3 Paired Cartilages (6 total):**
    - Involved in moving the Vocal Ligaments (Adduction & Abduction)
    - **Arytenoid Cartilage**
    - **Cuneiform Cartilage**
    - **Corniculate Cartilage**

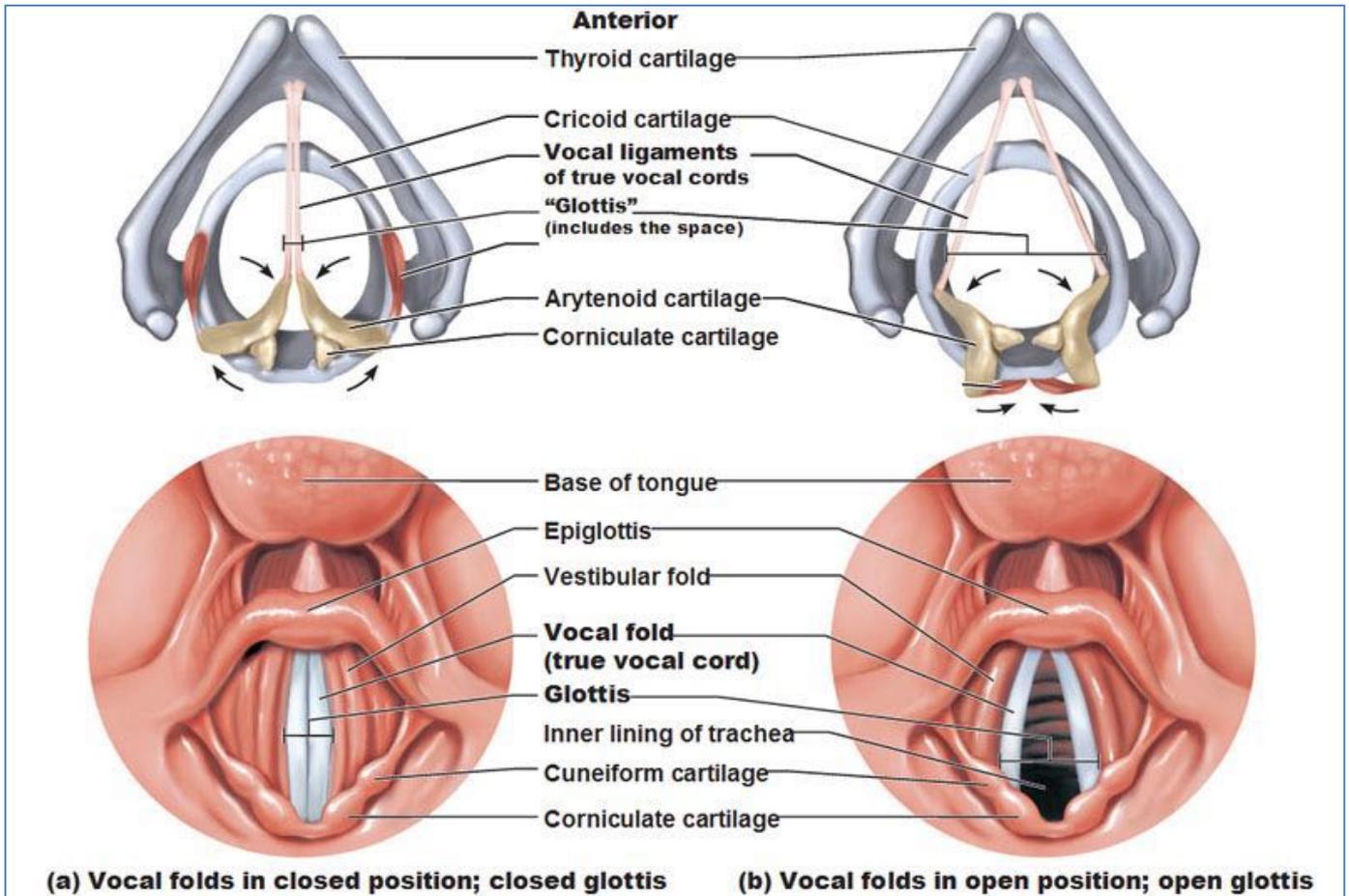


- **Vocal Ligaments: 'True Vocal Cords' ("Cricothyroid Ligament/Membrane")**

- Covered in mucosa
- Made of Elastic Fibres
- Fibres vibrate as air rushes up from lungs. (tighter = higher pitch)
- Appear white – no blood vessels
- Attach the *Arytenoid Cartilages* to the *Thyroid Cartilage*
- Form the 'Vocal Folds' or 'True Vocal Cords'.

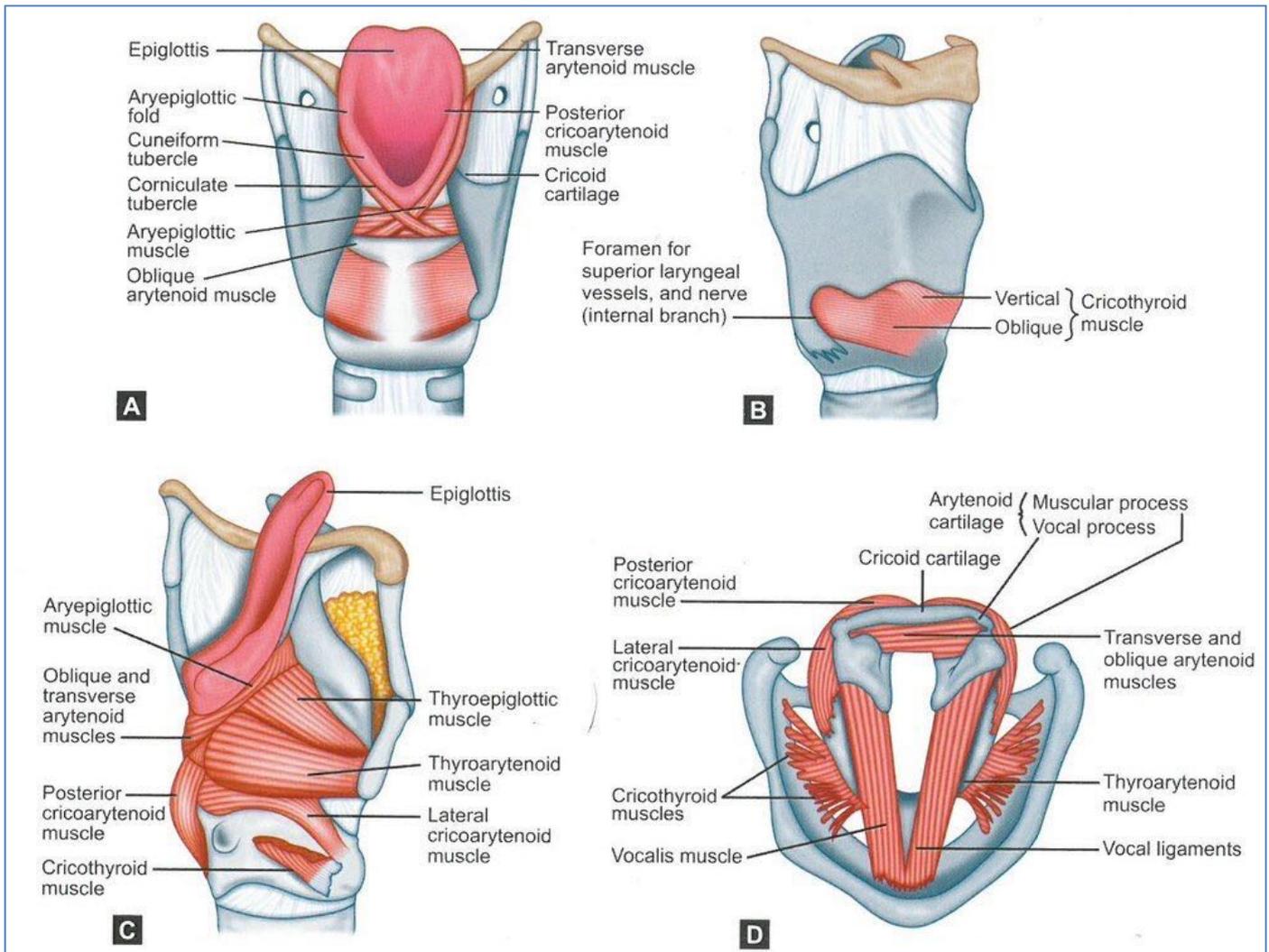
- **Vestibular Folds: 'False Vocal Cords' ("Quadrangular Ligament/Membrane")**

- Play no part in sound production
- Help to close the 'glottis' when swallowing.



<https://antranik.org/the-respiratory-system/>

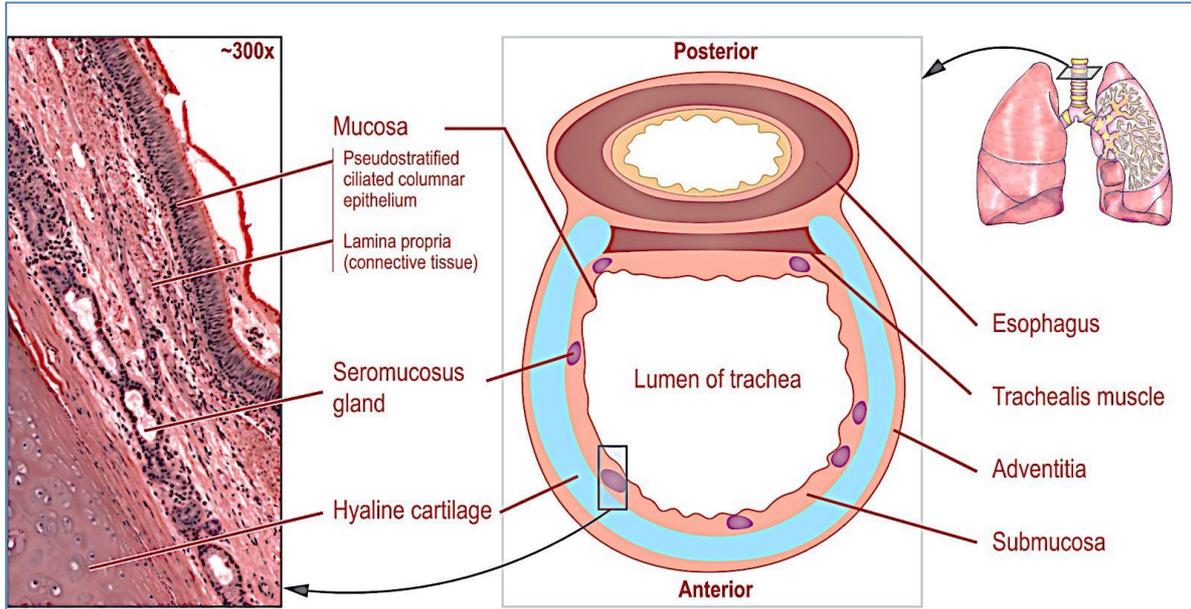
- **Muscles:** (aka. Intrinsic laryngeal muscles)
  - Work to affect tension/length/position of vocal cords.
  - All Controlled By the Vagus Nerve
    - **2x Cricothyroid Muscle**
    - **2x Vocalis**
    - **2x Transverse Arytenoids**
    - **2x Oblique Arytenoids**
    - **2x Posterior Crico-Arytenoids**
    - **2x Lateral Crico-Arytenoids**
    - **2x Thyromuscularis**



From Sataloff, R.T., Chowdhury, F., Portnoy, J., Hawkshaw, M.J., Joglekar S. Surgical Techniques in Otolaryngology – Head and Neck Surgery: Laryngeal Surgery.

## Trachea:

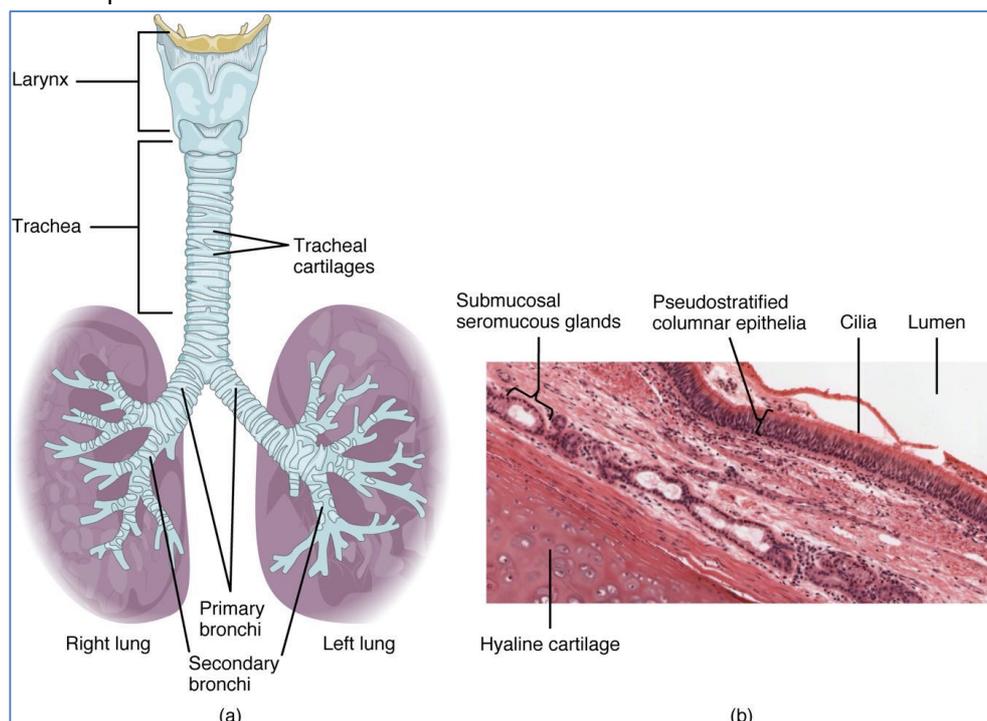
- The continuation of the pharynx
- A membranous tube of Conn. Tissue
  - + smooth muscle
  - Reinforced by 15-20 C-Shaped Cartilage Rings (incomplete posteriorly)
- Begins at C6
- Terminates at Bifurcation → Bronchi @ T4
  - Note: Right Bronchus is more vertical than the Left – hence inhaled objects tend to go down here.



PBrieux, CC BY-SA 4.0 <<https://creativecommons.org/licenses/by-sa/4.0/>>, via Wikimedia Commons

## The Bronchial Tree:

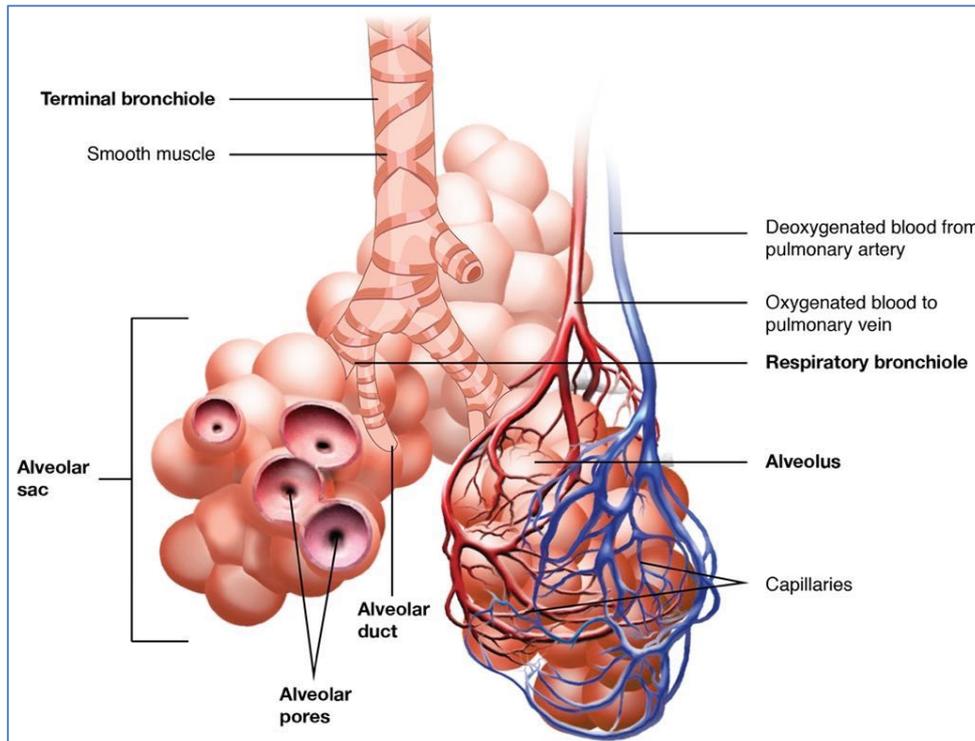
- Where *conducting structures* merge with *respiratory structures*.
- Once inside the lungs, the bronchi branch profusely until the *bronchioles* ("little bronchi") are <0.5mm thick.
- **Gradual Structural Changes:**
  - Cartilage rings replaced by irregular *plates* of cartilage.
  - No cartilage at all in *bronchioles*
  - Mucosal Epithelium thins from Pseudostratified → Columnar → Cuboidal in the bronchioles.
  - Cilia are sparse



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## The Respiratory Zone:

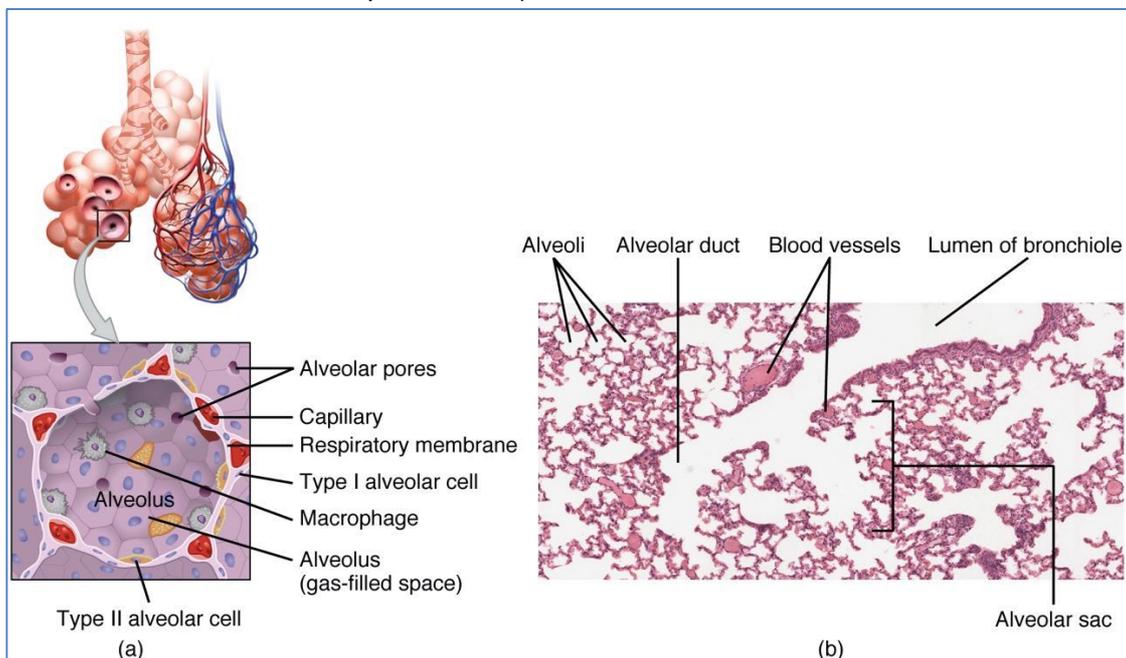
- Formed by alveoli
- Gas Exchange happens in 2 Places:
  - Tube-Like Ducts
  - Balloon-Like Sacs
- Large Surface Area – for Gas Exchange



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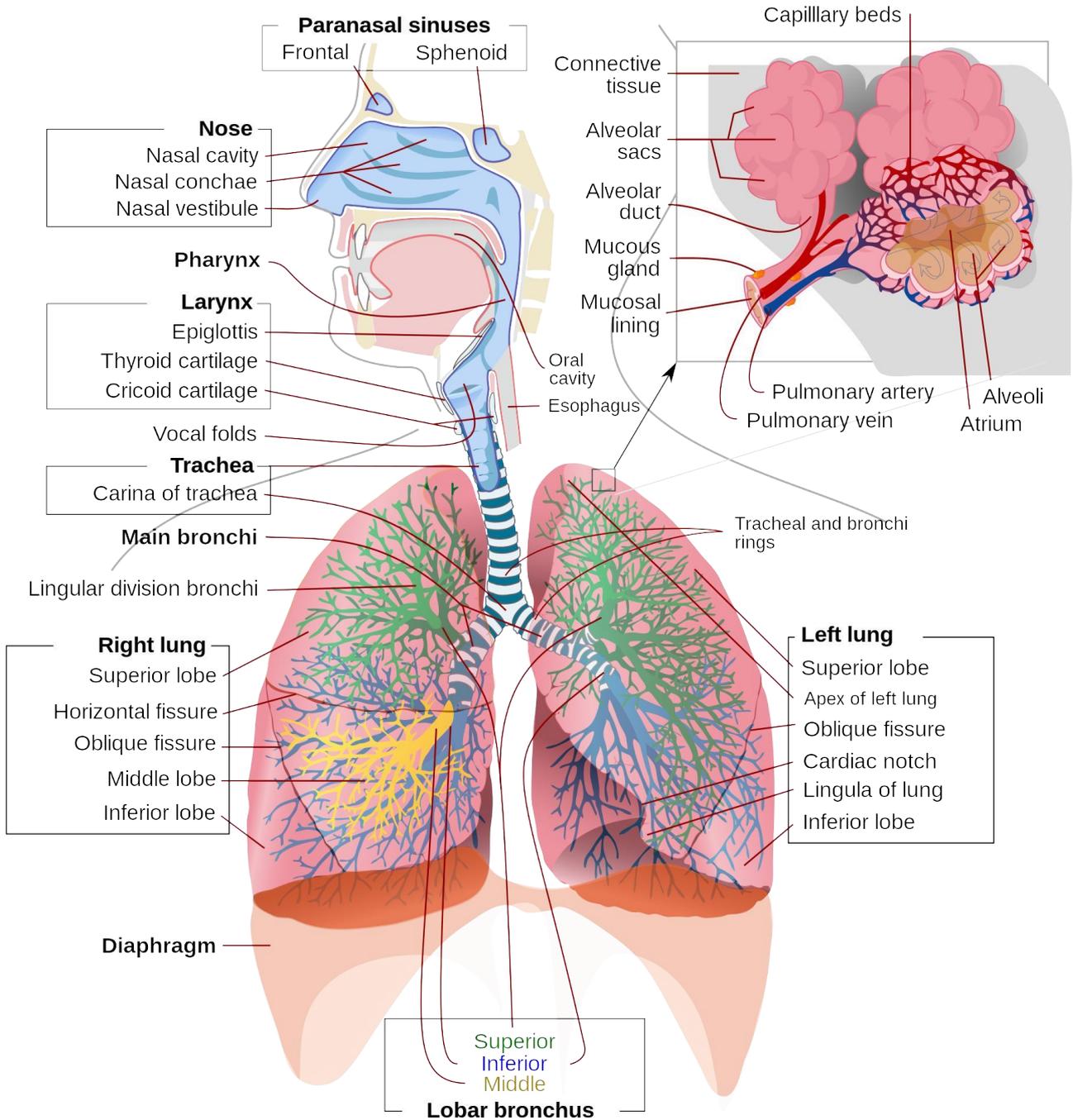
## 2 Types of Alveolar Cells:

- **Type I Alveolar Cells:**
  - Aka. Squamous Alveolar Cells
  - Gas Exchange Alveolar
  - Make up the Alveoli Walls
- **Type II Alveolar Cells:**
  - Aka. Great Alveolar Cells
  - Secrete Pulmonary Surfactant (lower the surface tension of water → easier breathing).



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**Review of Entire Respiratory Anatomy:**



[https://en.wikipedia.org/wiki/File:Respiratory\\_system\\_complete\\_en.svg#filelinks](https://en.wikipedia.org/wiki/File:Respiratory_system_complete_en.svg#filelinks)

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