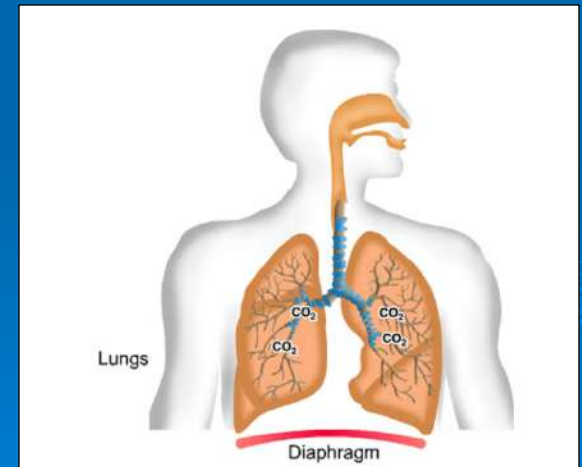
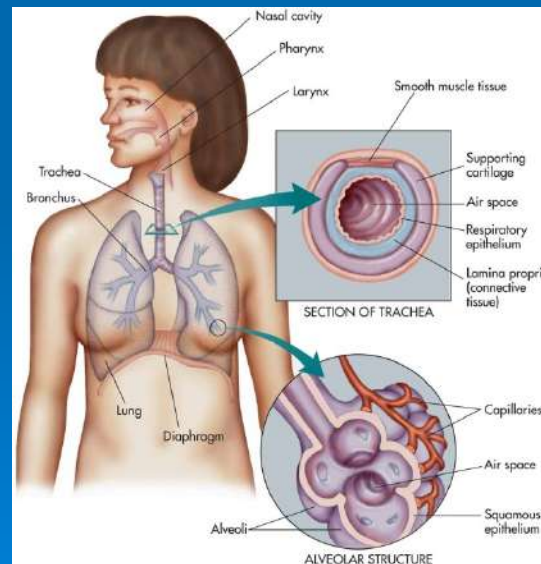


# Anatomy, Physiology and Disease

## Chapter 13

### The Respiratory System

“It’s a Gas!”



# Introduction

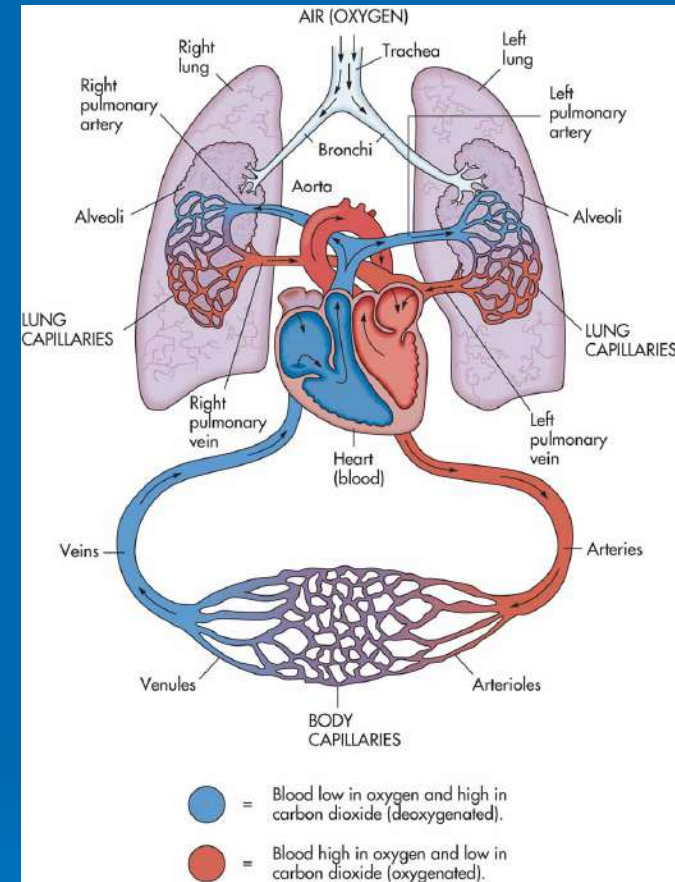
## Respiratory system purpose

- to **transport oxygen** from environment and get it into blood stream to be utilized by **cells**.
- **moves** 12,000 quarts of air per **24** hrs
- **removes waste** gas – or carbon dioxide – from body to avoid “**hyper-carbia**.”
- closely related to **cardio-vascular** system and they are sometimes grouped together as the **cardio-pulmonary** system.



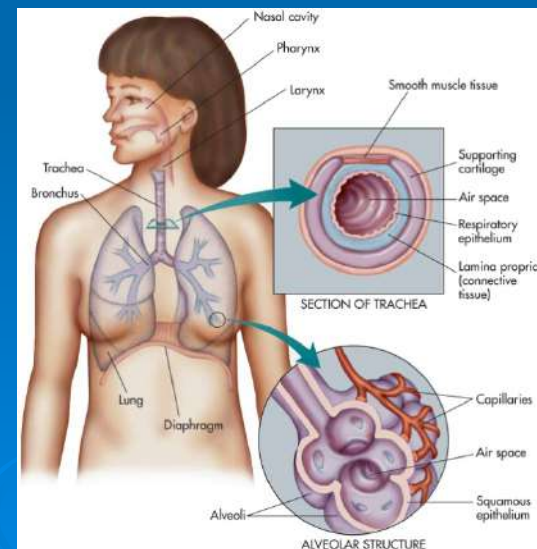
# System Overview

- **Components include** heart, blood, and network of blood vessels.
- **Arteries** carry blood away from heart, branch into smaller vessels called **arterioles**, which become **capillaries**, where nutrients are exchanged; capillaries become **venules**, that enlarge and become **veins**.

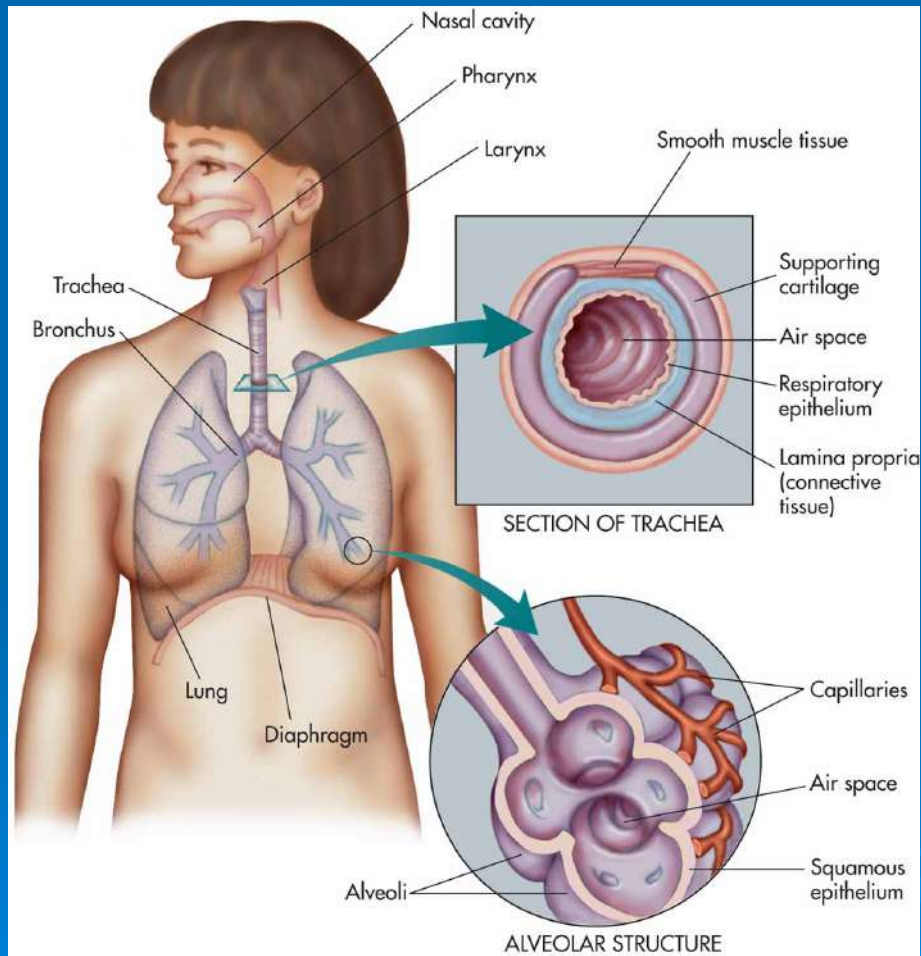


# Components of Respiratory System

- **Two lungs** that serve as vital organs
- **Upper and lower airways** that conduct, or move, gas through system.
- **Terminal air** sacs called **alveoli** surrounded by network of capillaries that allow gas exchange.
- **Thoracic cage** that houses, protects, and facilitates function for system.
- **Muscles** of breathing



# Respiratory System



# “Air” contains many gases...

- **Nitrogen (78.08%)** which is a **support gas** that **keeps lungs open** by adding **volume**, or filler, to vitally needed oxygen
- **Oxygen (20.95%)** **essential** to life
- **Carbon Dioxide (0.03%)** found in **very small** concentrations
- **Argon (0.93%)**
- **Neon & Krypton:** trace amounts



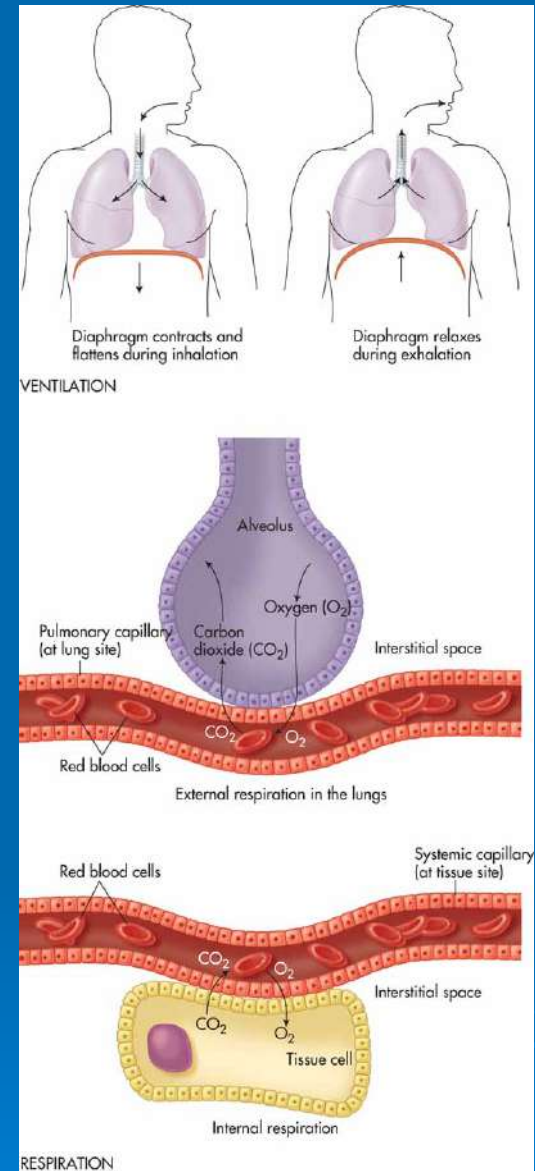
# Ventilation **vs.** Respiration

- **Ventilation**: is **bulk movement** of air down to terminal air sacs, or **alveoli**, of lungs.
- **Respiration**: the process of **gas exchange**, where oxygen is **added** to blood and carbon dioxide is **removed**.
- **External Respiration**: **Movement** of oxygen from **alveoli** to **blood**.
- **Internal Respiration**: **Movement** of oxygen **from** **blood** to **cells**.



# “Gas Law’s”

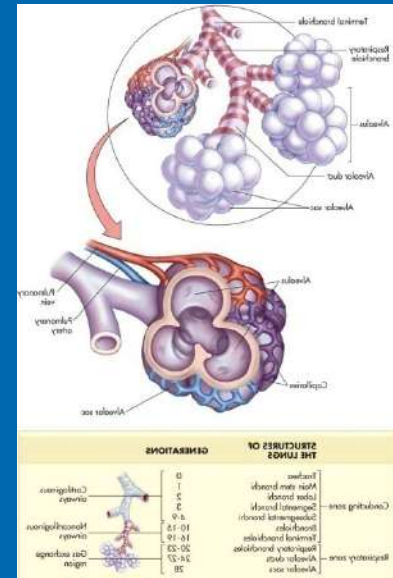
- **Boyle’s Law** ( $PV=k1$ ): when **temp** is constant so is pressure & volume.
- **Charles’ Law** ( $V=k2T$ ): when **pressure** is constant so is volume.



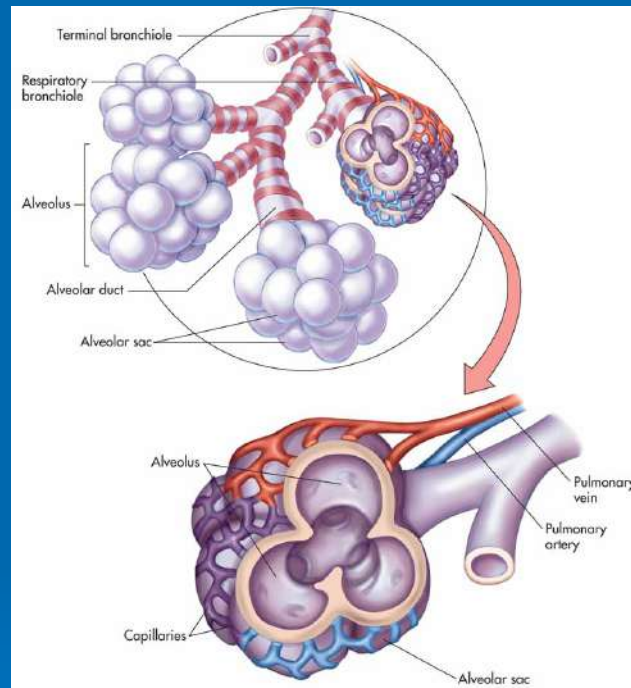


# The Airways and Lungs

- Human reserve oxygen: 4 to 6 minutes
- Respiratory system is series of branching tubes called bronchi.
- As branches get smaller they are called bronchioles & end in alveoli, terminal or distal end of respiratory system.
- alveolus is surrounded by alveolar-capillary membrane & provides interface between respiratory and cardiovascular systems



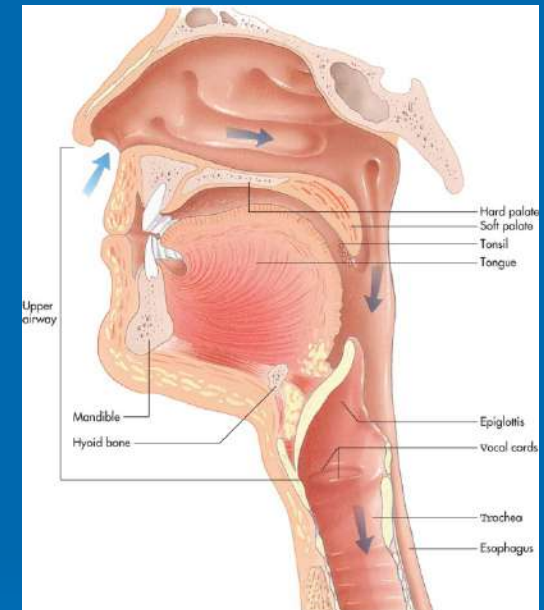
# alveolar-capillary membrane



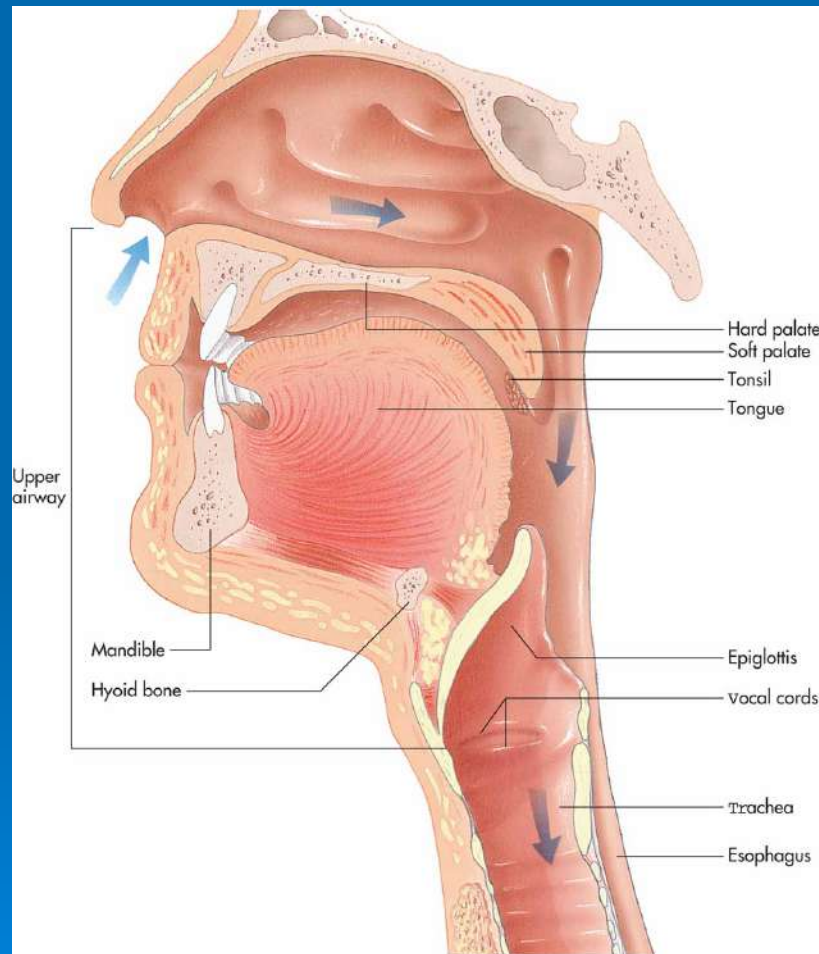
STRUCTURES OF THE LUNGS		GENERATIONS	
Conducting zone	Trachea	0	Cartilaginous airways
	Main stem bronchi	1	
	Lobar bronchi	2	
	Segmental bronchi	3	Noncartilaginous airways
	Subsegmental bronchi	4-9	
Respiratory zone	Bronchioles	10-15	Gas exchange region
	Terminal bronchioles	16-19	
	Respiratory bronchioles	20-23	
	Alveolar ducts	24-27	
	Alveolar sacs	28	

# Upper Airways

- begin at nostrils, or nares, & end at vocal cords.
- Functions:
  1. heat/cool air
  2. filtering & humidifying
  3. olfaction (to smell)
  4. phonations (produce sound)
  5. ventilation: or conducting gas to lower airways.



# Upper Airways



# Pathology Connection:

## ➤ Allergic Rhinitis:

**DX:** when allergens (like pollen) trigger nasal mucosa to secrete excessive mucous.

**S/S:** runny nose, itchy, red or edematous eyes

**Rx:** antihistamines



# Pathology Connection:

## ➤ Nasal polyps:

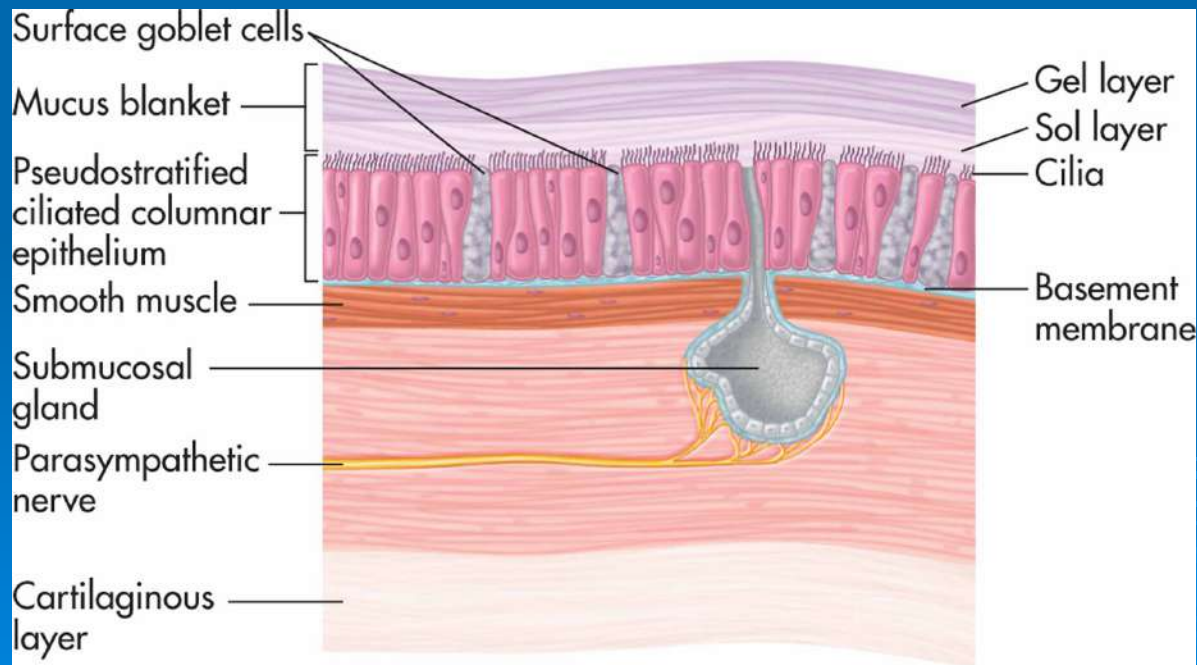
**DX:** non-cancerous growths within nasal cavity

**S/S:** chronic inflammation, dyspnea, nocturnal apnea

**Rx:** surgically removed if they become large enough to block nasal passageway

# Mucociliary Escalator

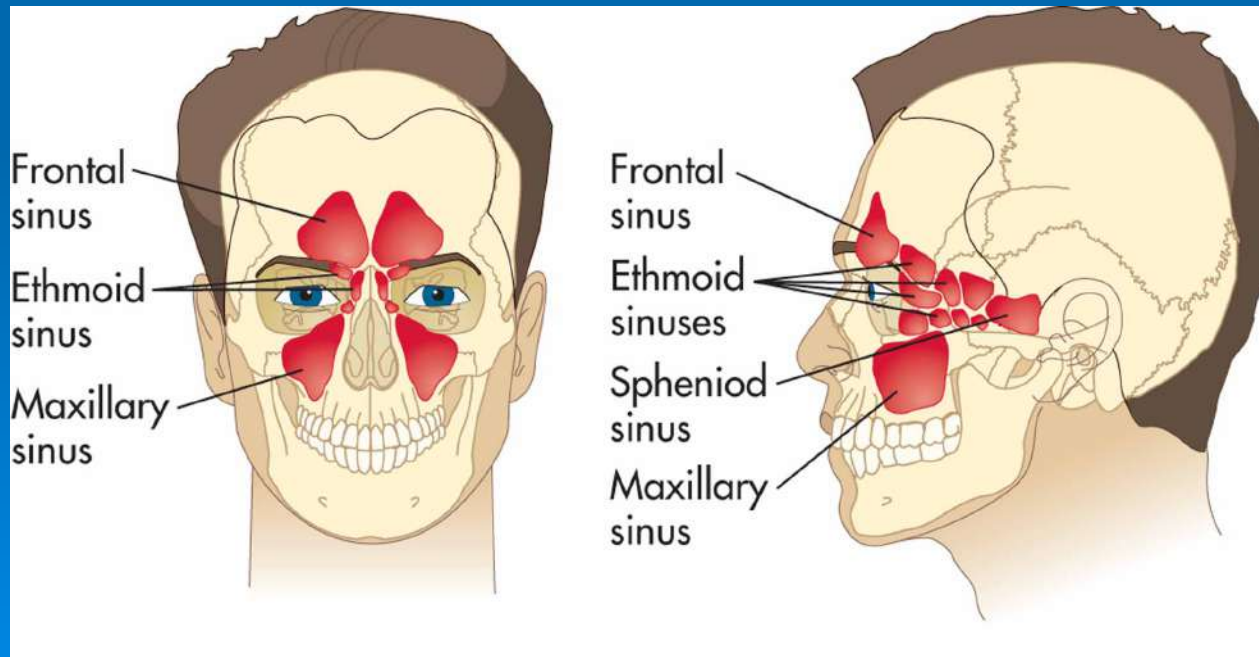
- **Nasal Cilia** beat 1,000–1,500 times/min
- **propel** gel layer & its trapped debris **upward 1 inch/min** to be expelled.
- **smoking** paralyzes this escalator





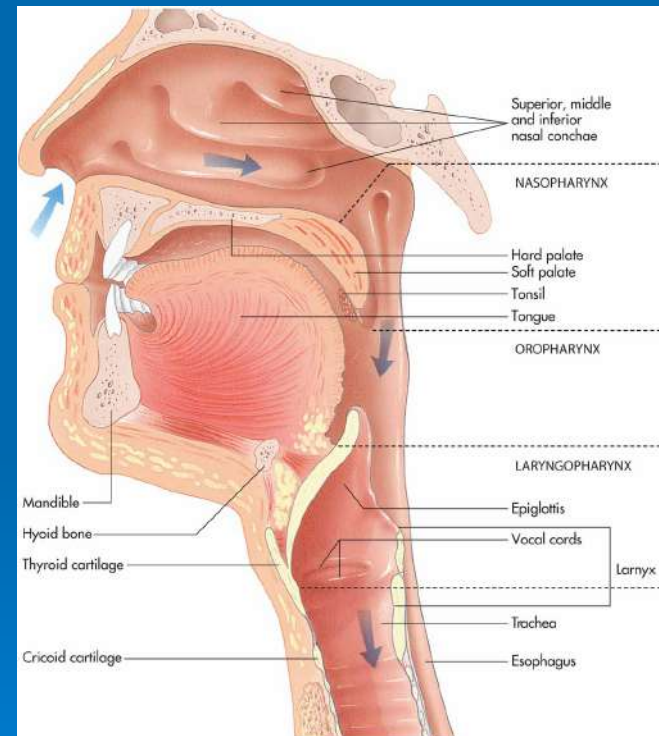
# Paranasal Sinuses

- **air-filled cavities** found around nose
- **prolong** and **intensify** sound
- **warm & humidify** air
- **Not born with them**: develop over time resulting in **reformation** of face and head.



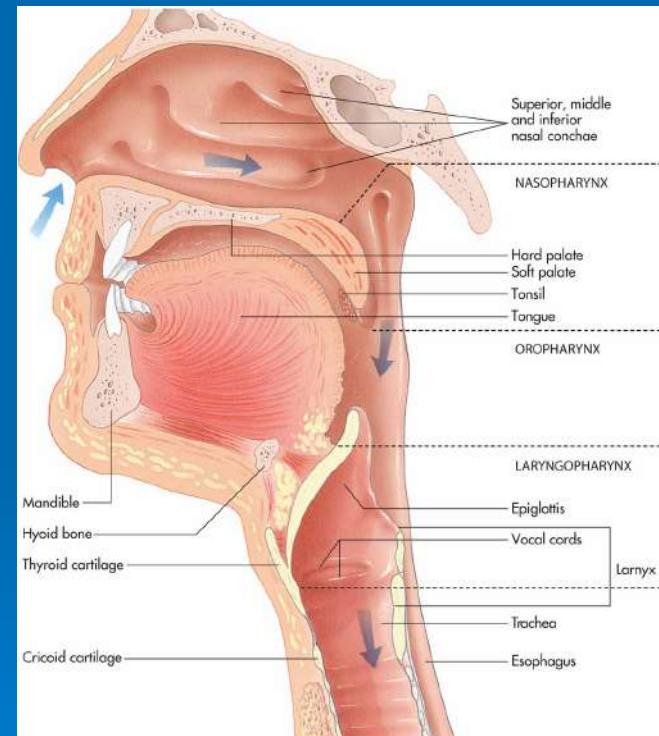
# Pharynx

- **hollow muscular structure** starting behind nasal cavity, lined with **epithelial** tissue.
- divided into **3** sections
  - **nasopharynx**
  - **oropharynx**
  - **laryngopharynx**



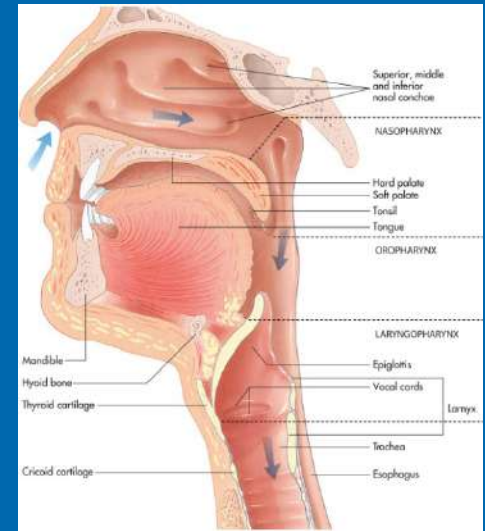
# Nasopharynx

- contains lymphatic tissue called adenoids; passageways into middle ear called Eustachian tubes.



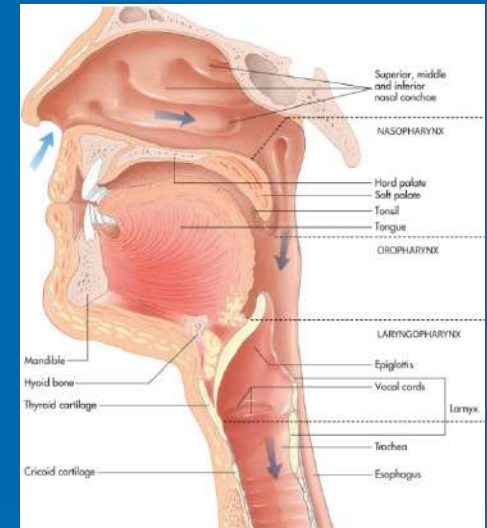
# Oropharynx

- **center** section of pharynx
- **located** behind oral, or **buccal** cavity
- air, food and liquid, from oral cavity pass through
- Contains tonsils
- **During swallowing uvula** and **soft palate** move in posterior and superior position to **protect** nasal pharynx from entry of food or liquid



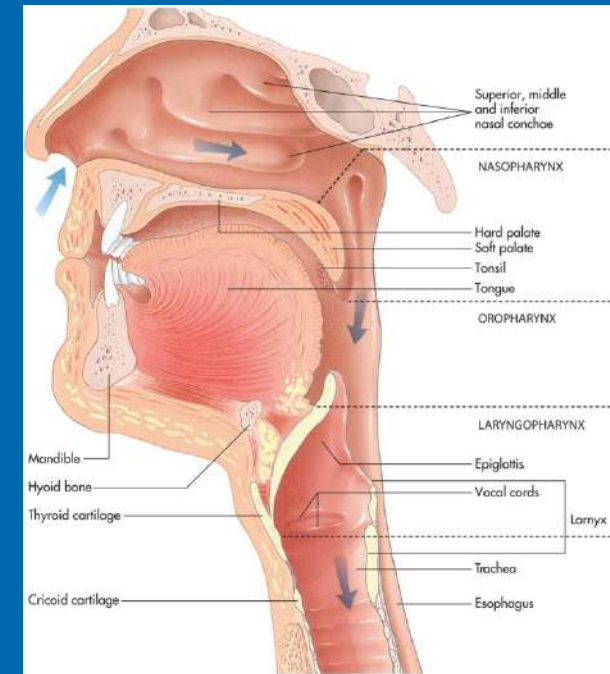
# Laryngopharynx

- **Connects** to both larynx, part of respiratory system, and esophagus, part of digestive system
- Both **food & air** pass through
- **Potential problem:**
  - **airway obstruction**
  - **infection**
  - **trauma**



# Larynx (voice box)

- **Semi-rigid structure** composed of **cartilage** provide movement of vocal cords to control speech.
- “**Adams apple**” (thyroid cartilage) is **largest** of cartilages found in larynx.
- **Cricoid cartilage** lies below providing **structure & support** in exposed area of airway to prevent collapse.
- **Food travels** into esophagus; **air travels** into larynx.
- **Glottis** is opening that leads into larynx, & eventually lungs
- **Epiglottis**: closes tightly when we swallow to **prevent** food from entering lungs





# Oropharyngeal Airways





# Pathology Connection

## ➤ Common cold

**Etiology:** over 200 different types of viruses

**Dx:** acute inflammation of upper respiratory mucous membranes

**Rx:** managing symptoms: antipyretics, antihistamines.

- can be prevented with good hand-washing
- not an allergy or influenza



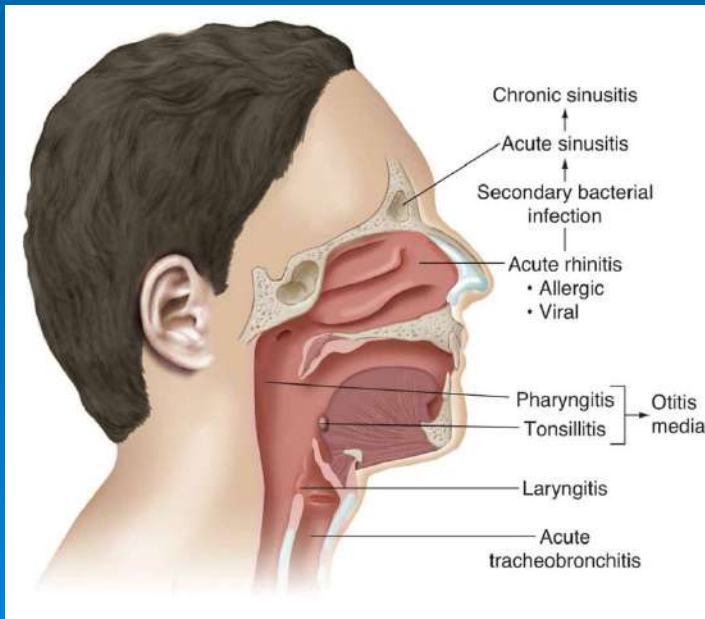
# Sinusitis

**Dx:** Infection & inflammation of sinuses

**Etiology:** chemical irritation vs bacterial

**S/S:** pressure, pain, fever & headaches

**Rx:** antipyretics, anti-inflammatory meds,  
antibiotics if bacterial **not** viral.



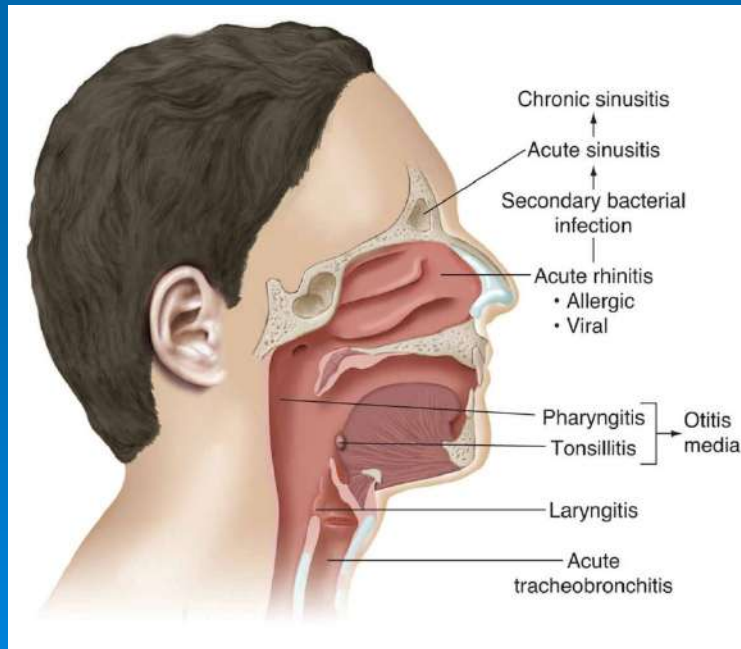
# Tonsillitis

**Dx:** Inflammation of tonsils

**Etiology:** bacterial

**S/S:** pain, dysphasia, fever, edema

**Rx:** antibiotics, antipyretics, possible tonsillectomy.



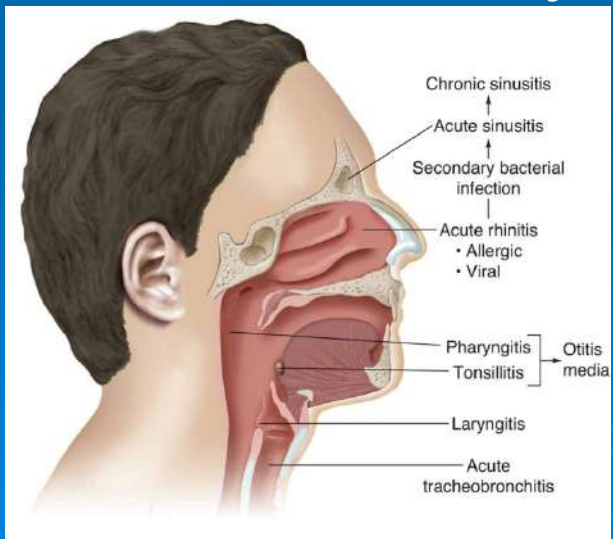
# Pharyngitis

**Dx:** sore throat

**Etiology:** Bacterial frequently Strep throat

**S/S:** similar to Tonsillitis but with edema to neck glands.

**Rx:** warm salt-H<sub>2</sub>O gargle antipyretics/anti-inflammatory meds, antibiotics if severe.



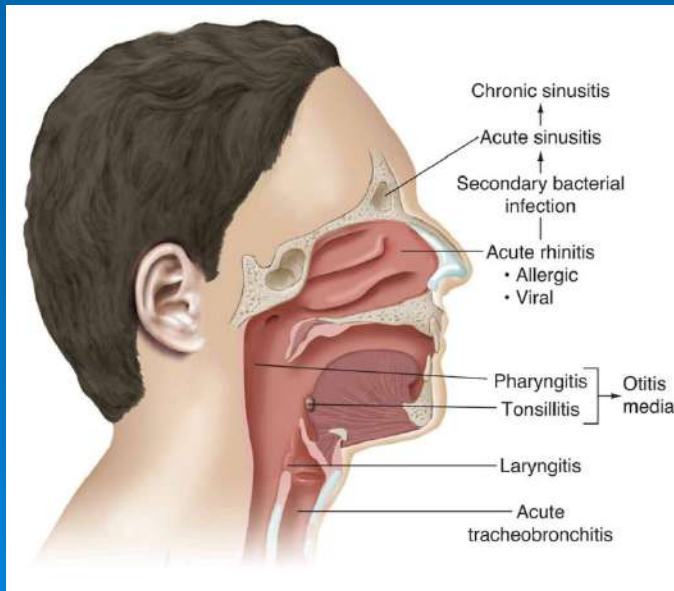
# Laryngitis

**Dx:** viral inflammation of voice box

**S/S:** hoarseness

**Etiology:** excessive use of voice

**Rx:** complete voice rest, humidification

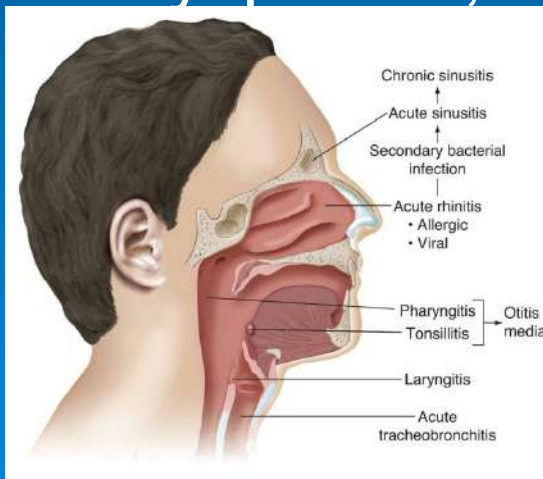


# Acute Epiglottitis

**Dx:** Dangerous infection causes swelling of epiglottis and airway obstruction.

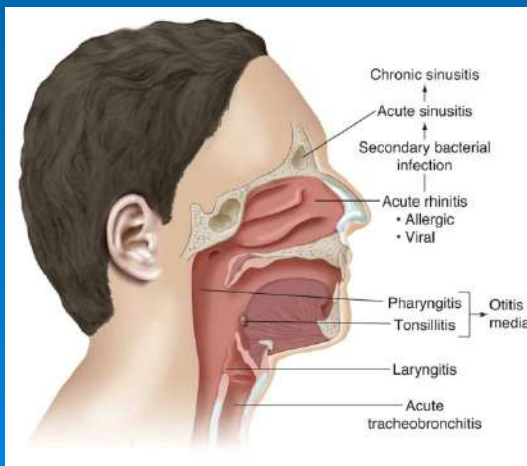
**Etiology:** 1. usually *Haemophilus influenzae* type B  
2. most common in children 2-6 y/o  
3. incidence lower when Flu shot taken

**S/S:** fever, sore throat, respiratory distress, drooling, dysphasia, and dysphonia.



# Acute Epiglottitis, cont'd

- Rx:** - onset is **fast**, & requires **rapid treatment**
- maintain open airway
  - cool humidified O<sub>2</sub>
  - orotracheal intubation or cricothyroidotomy
  - IV antibiotics, anti-inflammatory meds
  - hospitalization





# Laryngotracheobronchitis

## “Croup”

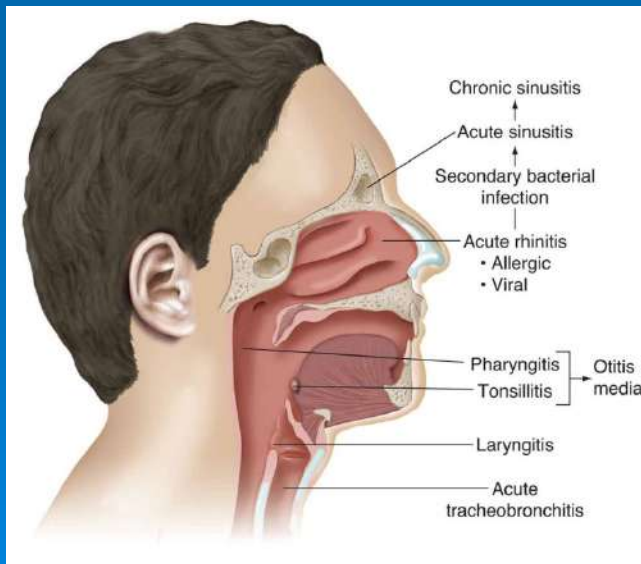
**Dx:** infection of laryngeal area

**Etiology:** viral or bacterial

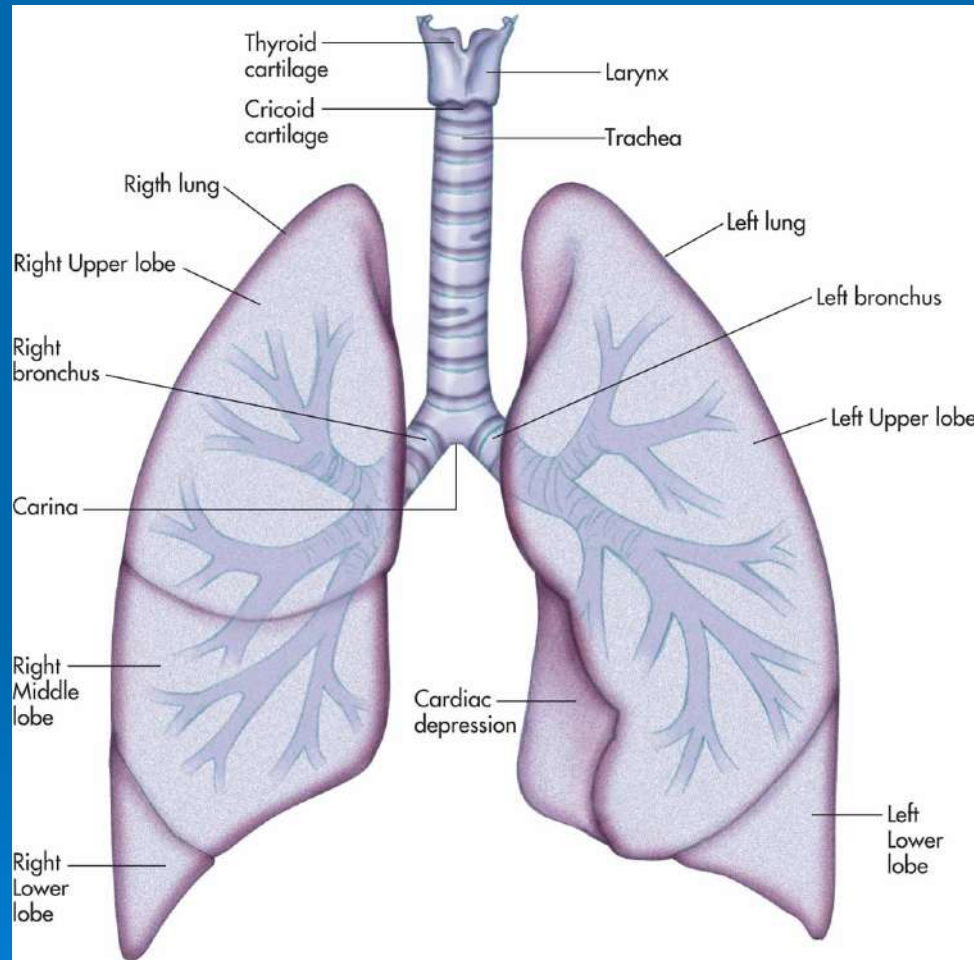
**S/S:** barking cough like a goose, inspiratory stridor

**Rx:** rest, antibiotics & anti-inflammatory meds

**Note:** Sometimes called “Croup” or “Pertussis”

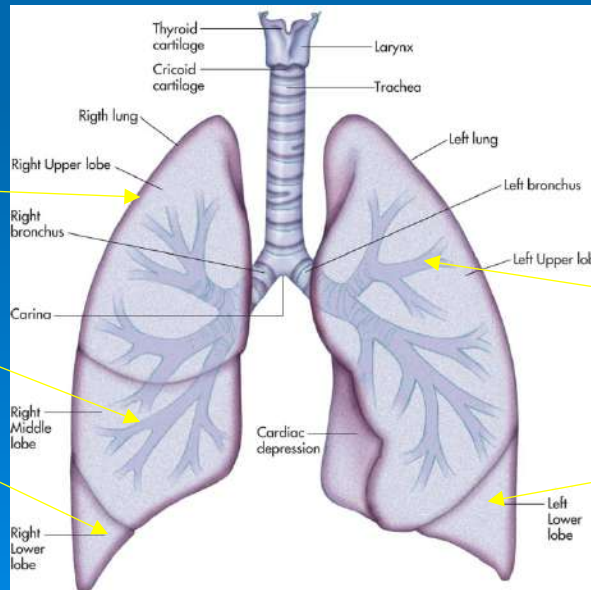


# The Lower Respiratory Tract



# Trachea

- **Largest pipe** in respiratory system
- **Begins bifurcating** at center of chest into **left** and **right** mainstem bronchi @ **carina**.
- **Each bronchi branch** into lobular bronchi that correspond to **five lobes** of lungs (3 in right; 2 in left)



**Lobes**

Upper

Middle

Lower

**Lobes**

Upper

Lower



# Epithelial Layers

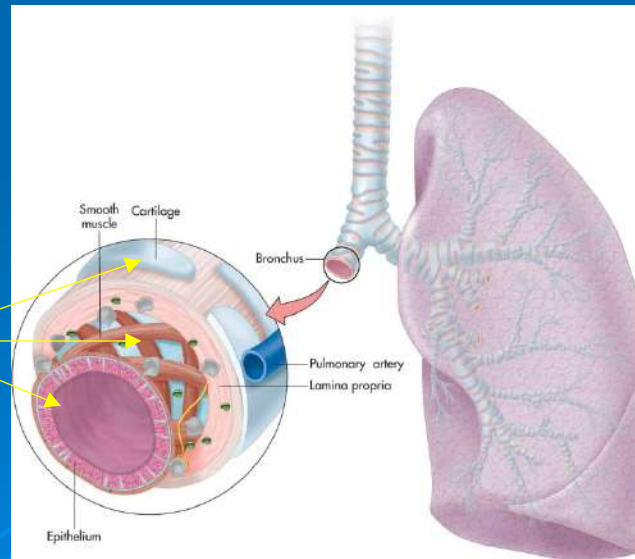
- **First** contains **mucociliary** escalator
- **Middle** is lamina propria layer which contains **smooth muscle**, lymph, and **nerve tracts**
- **Third layer** is protective and supportive basement **cartilaginous** layer

## Epithelial Layers

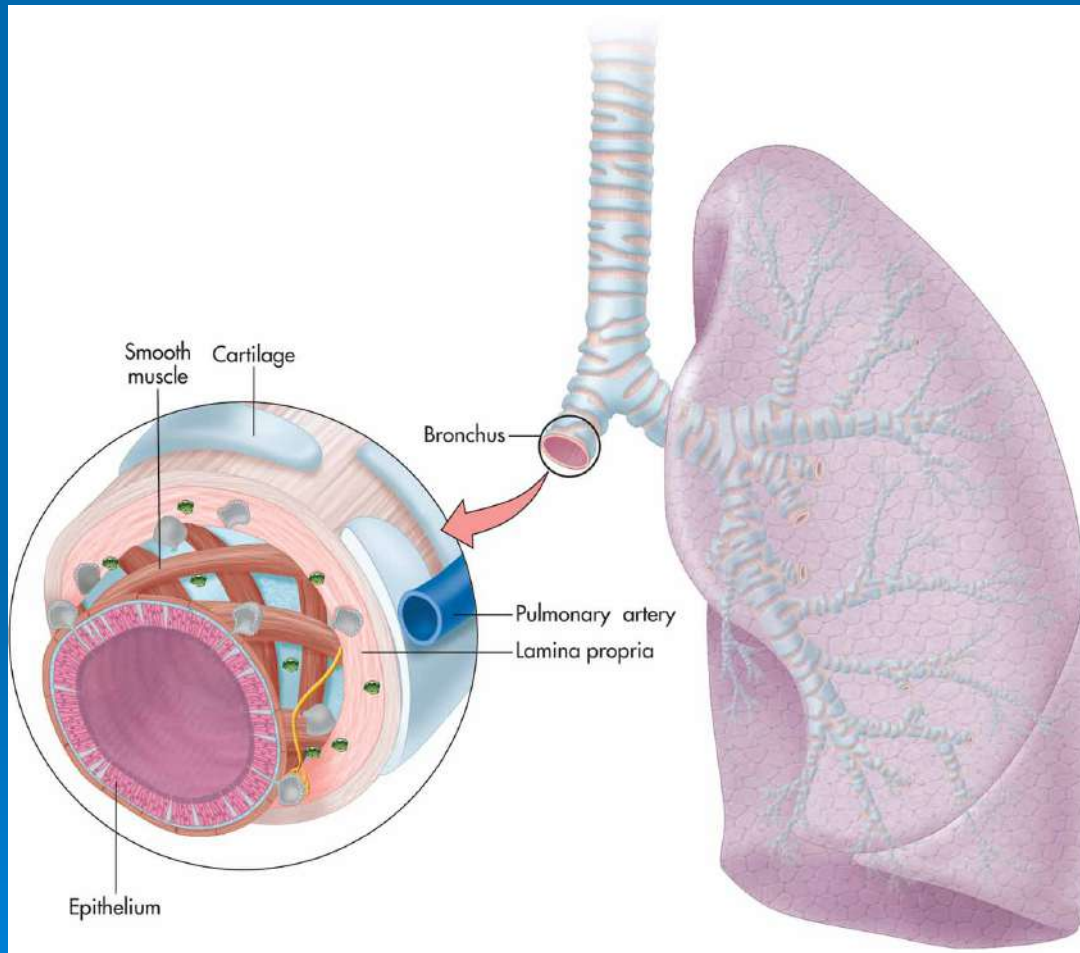
First

Middle

Third



# Tissue layers in the bronchi



# Bronchi

Branching continues getting more numerous and smaller

**Cartilaginous rings** become more irregular and eventually fade away



# Bronchioles

Bronchioles average only 1 mm in diameter;  
have 10-15 generations

There is no cartilage layer.

There is no gas exchange yet.

Terminal bronchioles (generation 16) have  
average diameter of 0.5 mm

Next airways beyond terminal bronchioles  
are respiratory bronchioles: some gas  
exchange occurs here



# Alveolar Ducts and Sacs

**Alveolar ducts** originate from respiratory bronchioles

Terminal air sacs called **alveoli**

Adults have 300–600 million **alveoli** = 80 m<sup>2</sup> surface area

Surrounded by **alveolarcapillary membrane**

# Components of Alveolar Capillary Membrane

- 1<sup>st</sup> component: First layer is liquid surfactant layer that lines alveoli, lowers surface tension in alveoli and prevents alveolar collapse
- 2<sup>nd</sup> component: tissue layer that produces surfactant and allows easy gas molecule movement
- 3<sup>rd</sup> component: interstitial space that contains interstitial fluid
- 4<sup>th</sup> component: capillary endothelium that contains capillary blood and RBCs

# Pathology Connection: Atelectasis

➤ **Etiology:** air sacs of lungs are either partially or totally collapsed due to inability to take deep breaths due to injury or surgery

**S/S:** decreased breath sounds

**TX:** **PREVENTION!!** Incentive spirometer, deep breathing, coughing, splinting incisional site during coughing

# Pathology Connection: Pneumonia

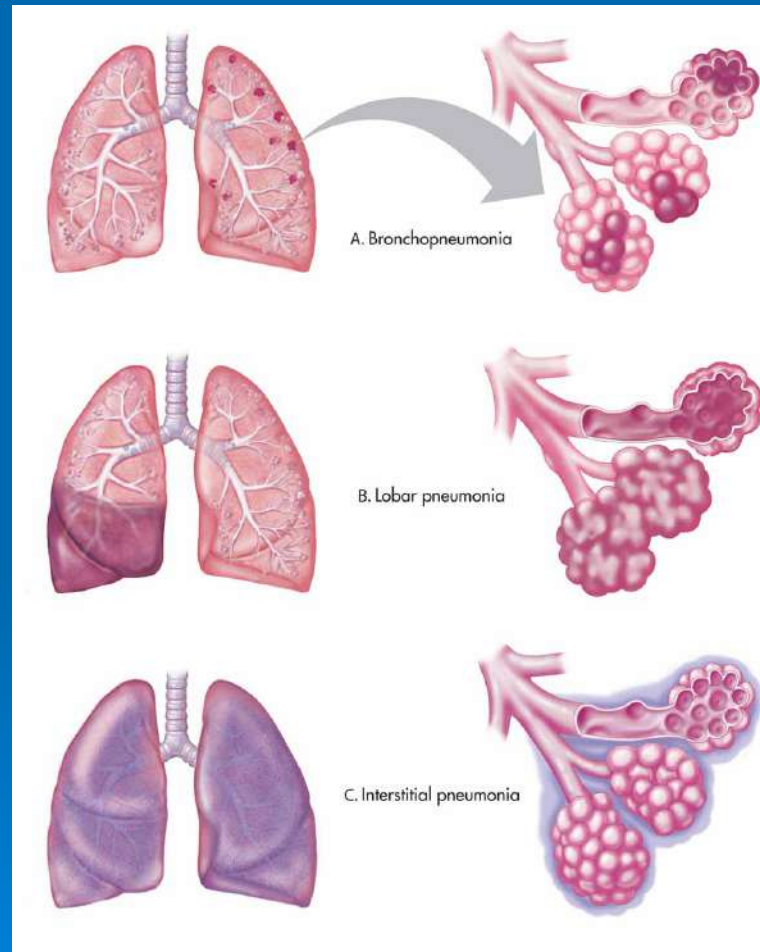
➤ **Etiology:** Lung infection that can be caused by virus, fungi, or bacteria

**S/S:** inflammation of infected area with accumulation of cell debris and fluid, decreased breath sounds and/or rhonci, possible fever

**DX:** CXR (chest x-ray)

**TX:** antibiotics, nebulizer treatments, O<sub>2</sub>

# Pneumonia



# Chronic Obstructive Pulmonary Disease (COPD)

➤ Group of diseases characterized by difficulty evacuating air from lungs

Types: asthma; emphysema; chronic bronchitis

Associated with

Cough

Sputum production

Dyspnea

Airflow obstruction

Impaired gas exchange

# Asthma

**Etiology:** many triggers such as allergens, food, exercise, cold air, inhaled irritants, smoking

**S/S:** dyspnea, wheezing, productive cough, hypoxia

- **DX:** history and physical exam, lung function tests
- **TX:** bronchodilators, steroids, and anti-asthmatic agents; O<sub>2</sub> if needed



# Triggers for Asthma

**TABLE 13-4 Triggers for Asthmatic Attacks**

## ALLERGENS

Animal dander (pets with fur or feathers)	House dust mites (in mattresses, pillows, upholstered furniture, carpets)
Pollen (grass, trees, weeds)	Mold
	Cockroaches

## INHALED IRRITANTS

Tobacco smoke	Strong odors or spays (perfumes, paint fumes, pesticides, hair sprays, cleaning agents)
Wood smoke	
Sulfur dioxide	Occupational inhalants
Air pollution	

## VIRAL RESPIRATORY INFECTIONS (RHINOVIRUS, INFLUENZA, PARAINFLUENZA, CORONA VIRUS, RSV)

## COLD AIR

## EXERCISE

## STRONG EMOTIONS

## MENSES

## DRUGS

Aspirin	Methacholine (used to provoke bronchoconstriction during diagnostic testing)
NSAIDs	
Beta-adrenergic blockers (oral or ophthalmic)	Histamine (alternative agent to provoke bronchoconstriction during testing)
Preservatives (sulfites and benzalkonium chloride)	

## OTHER FACTORS

Allergic rhinitis	Gastroesophageal reflux (GERD)
Rhinosinusitis	

# Chronic Bronchitis

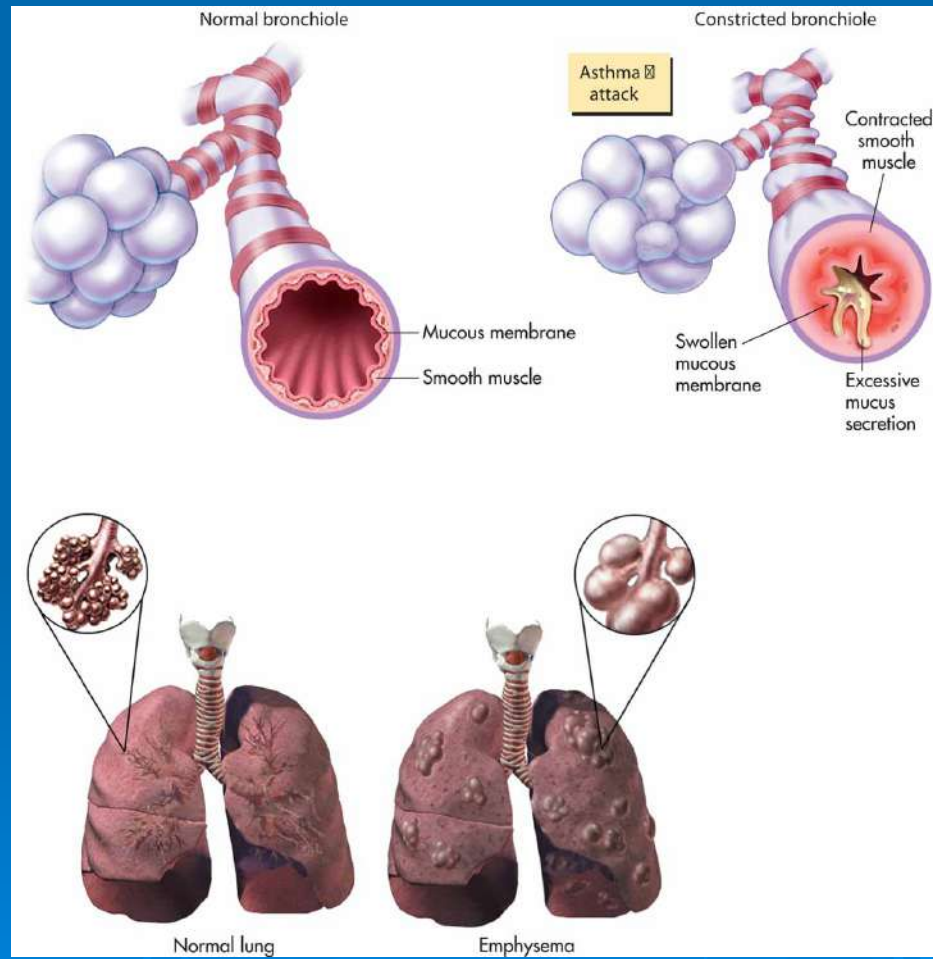
- **Etiology:** cigarette smoking and long term exposure to air pollutants
- **S/S:** dyspnea, wheezing, productive cough, hypoxia
- **DX:** H and P, lung function tests
- **TX:** antibiotics if bacterial, bronchodilators, O<sub>2</sub> if needed

# Emphysema

**Etiology:** cause not fully known but associated with smoking and one genetic form from alpha 1-antitrypsin deficiency

- **S/S:** dyspnea, tachypnea, wheezing, productive cough, hypoxia
- **DX:** H/P, lung function tests
- **TX:** O<sub>2</sub>, bronchodilators, alpha 1-antitrypsin replacement

# Asthma and Emphysema



**TABLE 13-3 COPD Diseases**

<b>DISEASE</b>	<b>DESCRIPTION</b>
Asthma	A chronic inflammatory disorder of the airways in which many cells and cellular elements play a role. In susceptible individuals, this inflammation causes recurrent episodes of wheezing, breathlessness, chest tightness, and cough, particularly at night and in the early morning. These episodes are usually associated with widespread but variable airflow obstruction that is often reversible either spontaneously or with treatment.
Chronic Bronchitis	Usually defined in clinical terms as the presence of productive cough during 3 months of the year for 2 consecutive years, provided that other causes of chronic sputum production, such as tuberculosis, are excluded. Airway hyperreactivity may be present, but airflow limitation is not fully reversible.
Emphysema	A pathologic diagnosis marked by destruction of alveolar walls, with resultant loss of elastic recoil in the lung. Dyspnea on exertion is the predominant clinical feature, and airway hyperreactivity may also be present.