



THE RESPIRATORY SYSTEM

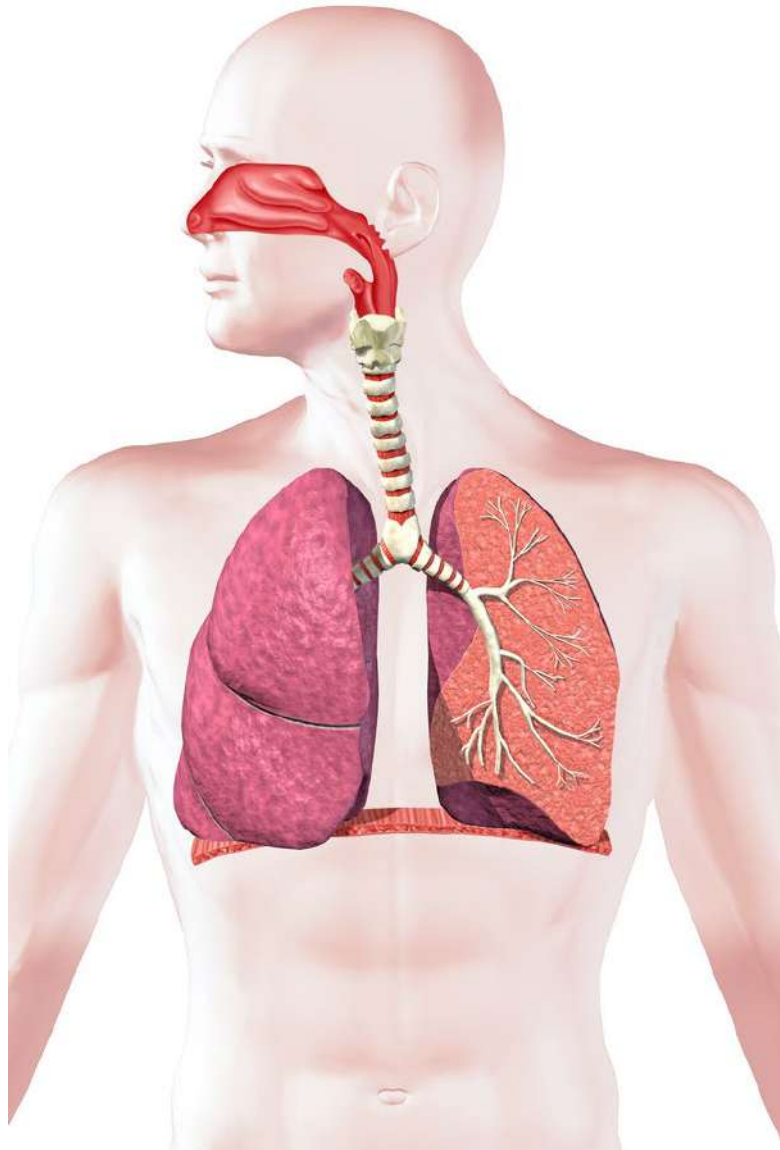
MS. MARTEL



7.1 – THE RESPIRATORY SYSTEM

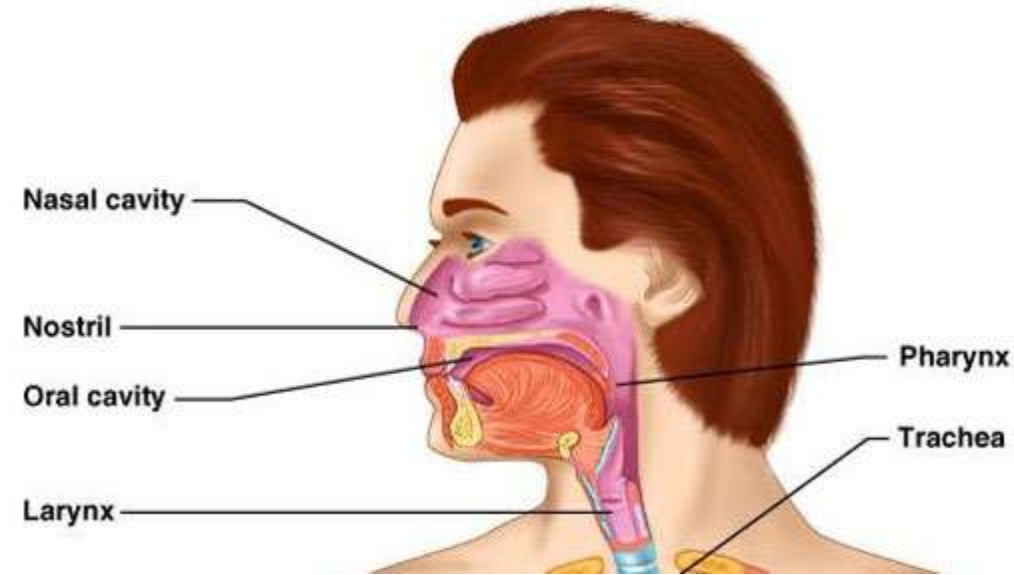
- The primary function of the respiratory system is to allow **oxygen from the air to enter the blood**, and **CO₂ from the blood to exit into the air**.
- During inhalation and exhalation, air is conducted **toward or away from the lungs**.
- Ventilation encompasses both **inhalation and exhalation**.





- The respiratory system works with the circulatory system to accomplish the following **homeostatic functions**:
 - External respiration, the **exchange of gases between air and the blood**.
 - Transport of **gases to and from the lungs and the tissues**.
 - Internal respiration, the **exchange of gases between the blood and tissue**.

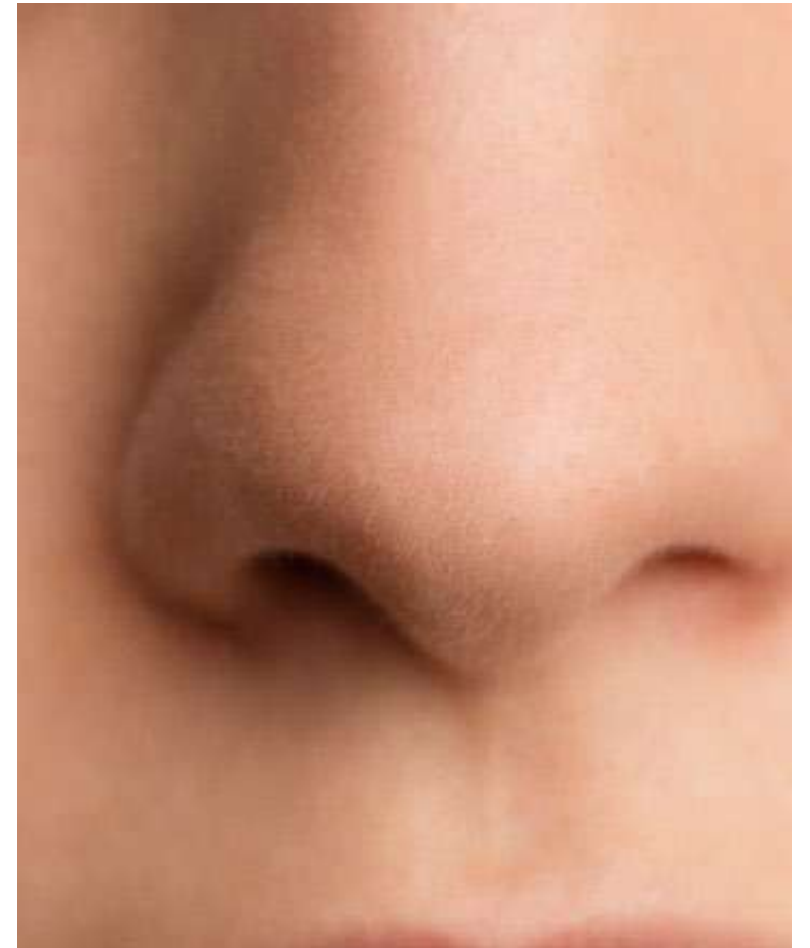
THE RESPIRATORY TRACT

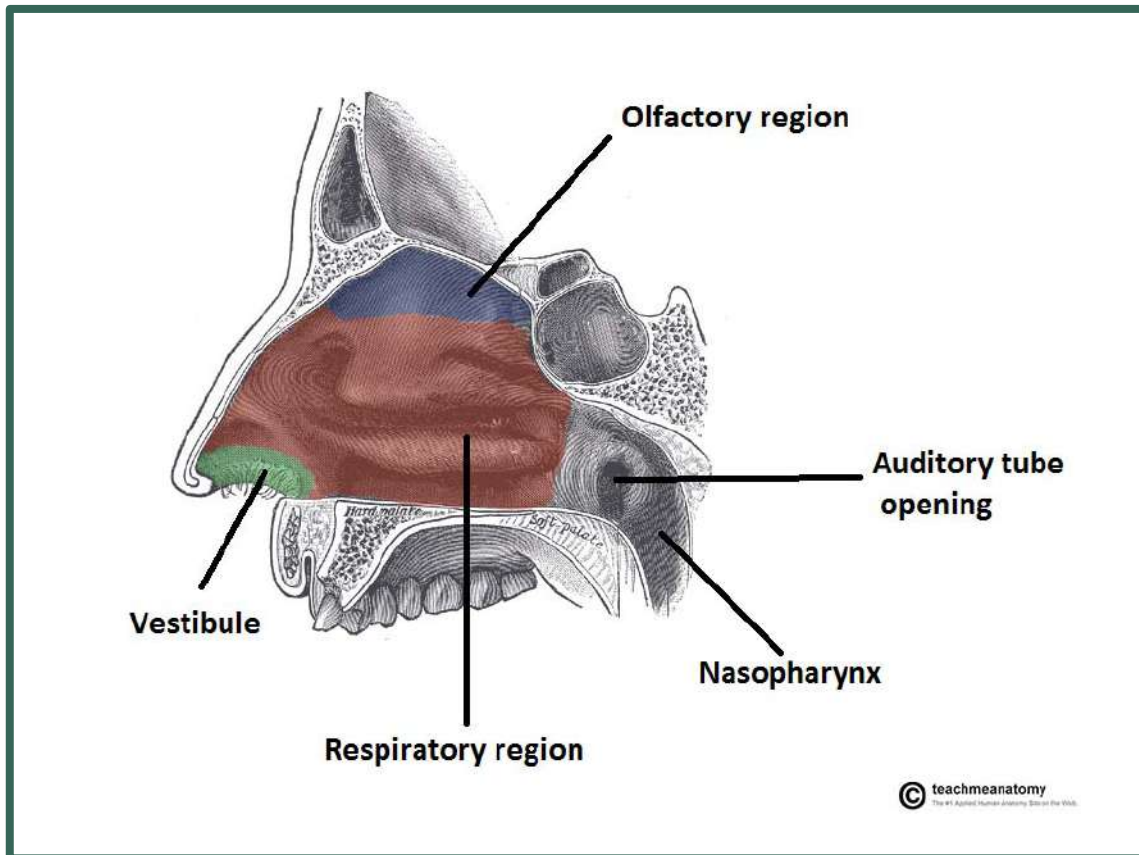


- As air moves into the lungs, it is **filtered, warmed, and moistened**.
 - Filtering is accomplished by coarse hairs inside the nostril, and by **cilia and mucus in the nasal cavities and respiratory tract**.
 - The air is warmed by heat given off by the **blood vessels lying close to the surface** of the lining of the airways.
 - It is moistened by the **wet surface of these passages**.

THE NOSE

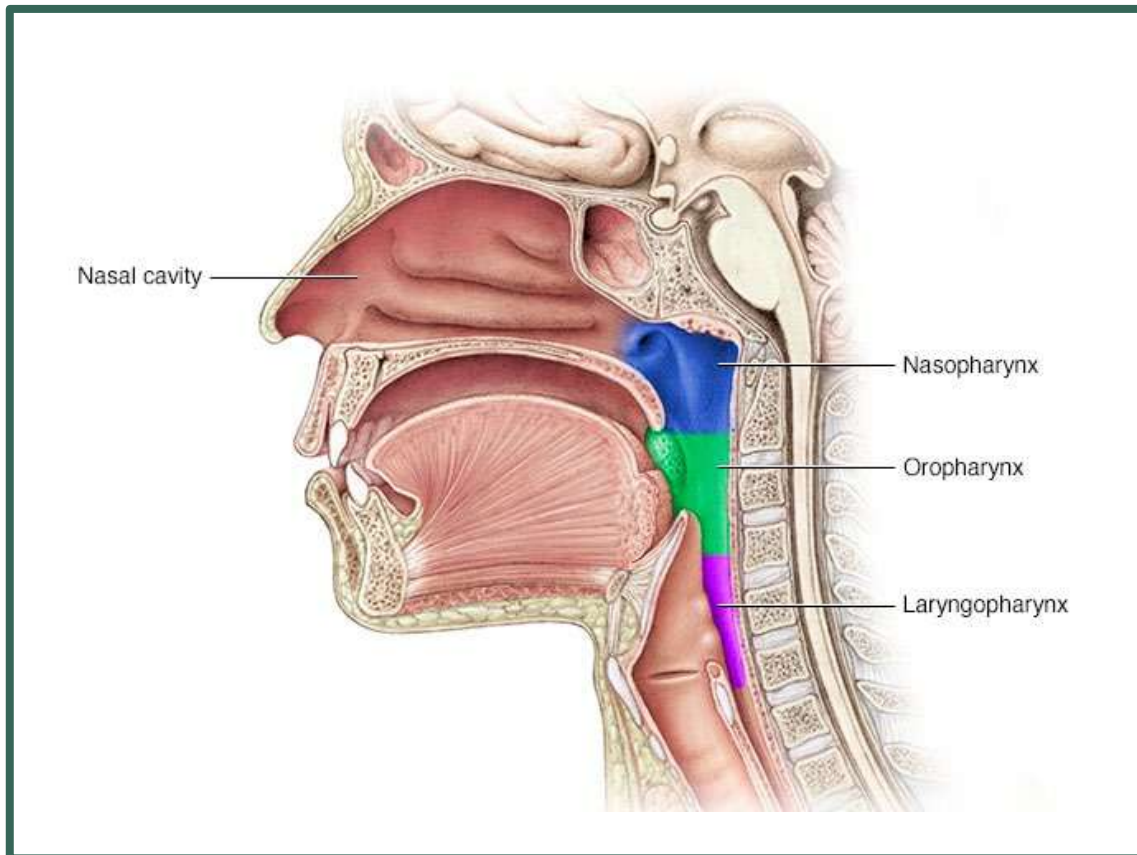
- The nose is the only **external portion** of the respiratory system.
- It is part of the upper respiratory tract which also includes the **nasal cavity, the pharynx, and the larynx.**
 - The nose contains two nasal cavities **separated by a septum.**
 - Mucous membranes **line the nasal cavity.**
 - Bony ridges increase the surface area for **moistening and warming.**



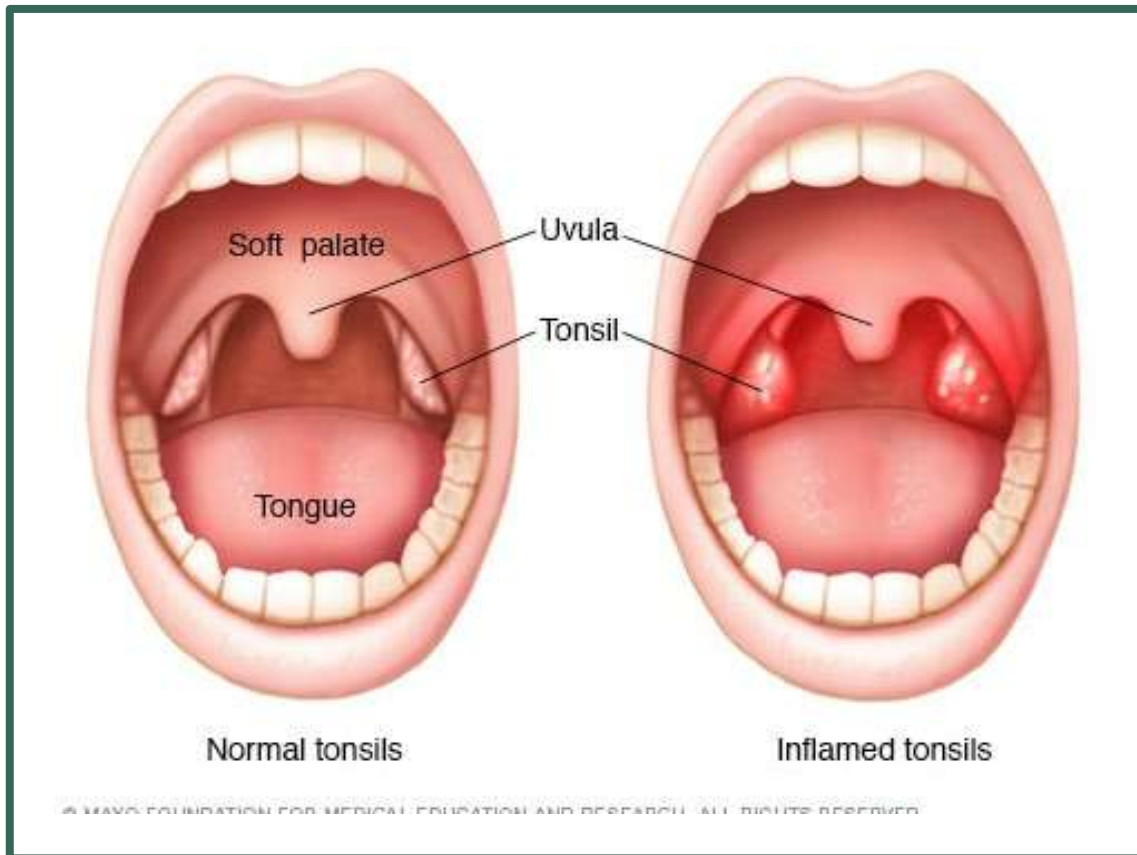


- Chemoreceptors are on the **endings of ciliated cells.**
- The tear glands drain into the nasal cavities through **the tear ducts.**
- The nasal cavities also communicate with the sinuses, air-filled spaces that reduce weight of the skull and act as **resonating chambers for the voice.**
- The nasal cavities are **separated from the mouth by the palate.**

THE PHARYNX



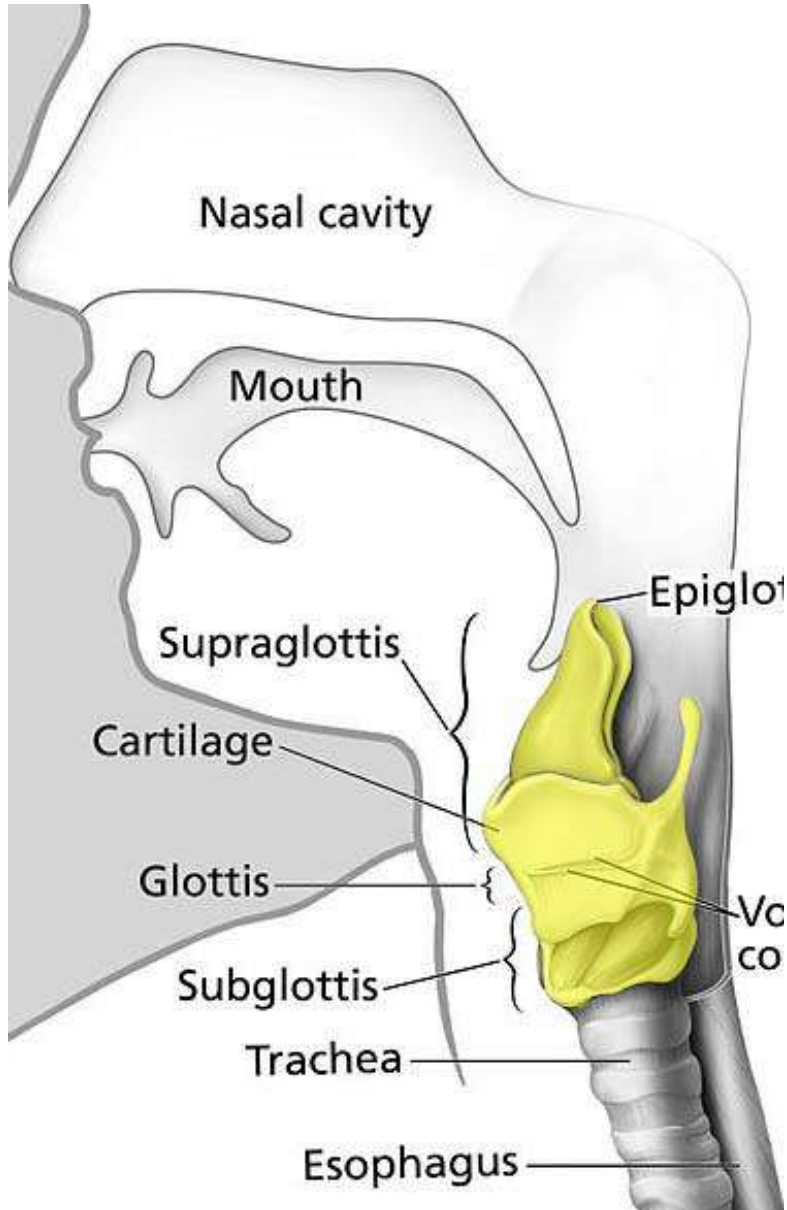
- The pharynx connects the **nasal and oral cavities to the larynx**. It has three parts:
 - Nasopharynx, where the nasal cavities **open posterior to the soft palate**.
 - Oropharynx, **where the mouth opens**.
 - Laryngopharynx, **which opens to the larynx**.

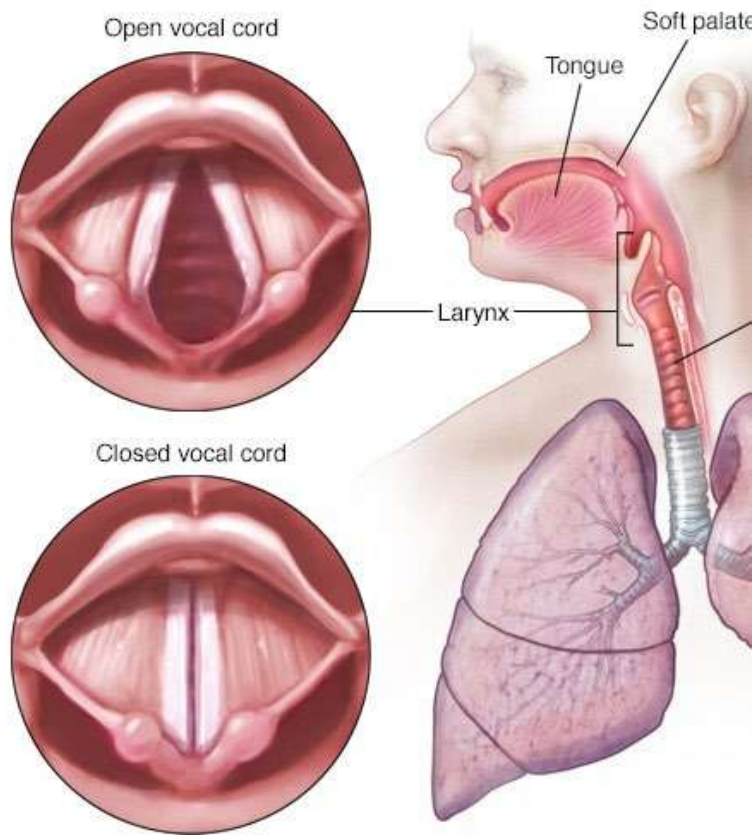


- The tonsils form a protective ring at the **junction of the mouth and pharynx.**
 - The tonsils are lymphatic tissue containing **lymphocytes that protect against pathogens.**
- **Air and food both pass in the pharynx.** The larynx, located above and in front of the esophagus, **leads to the trachea.**
 - Both the larynx and trachea are normally open, **allowing air to pass.**

THE LARYNX

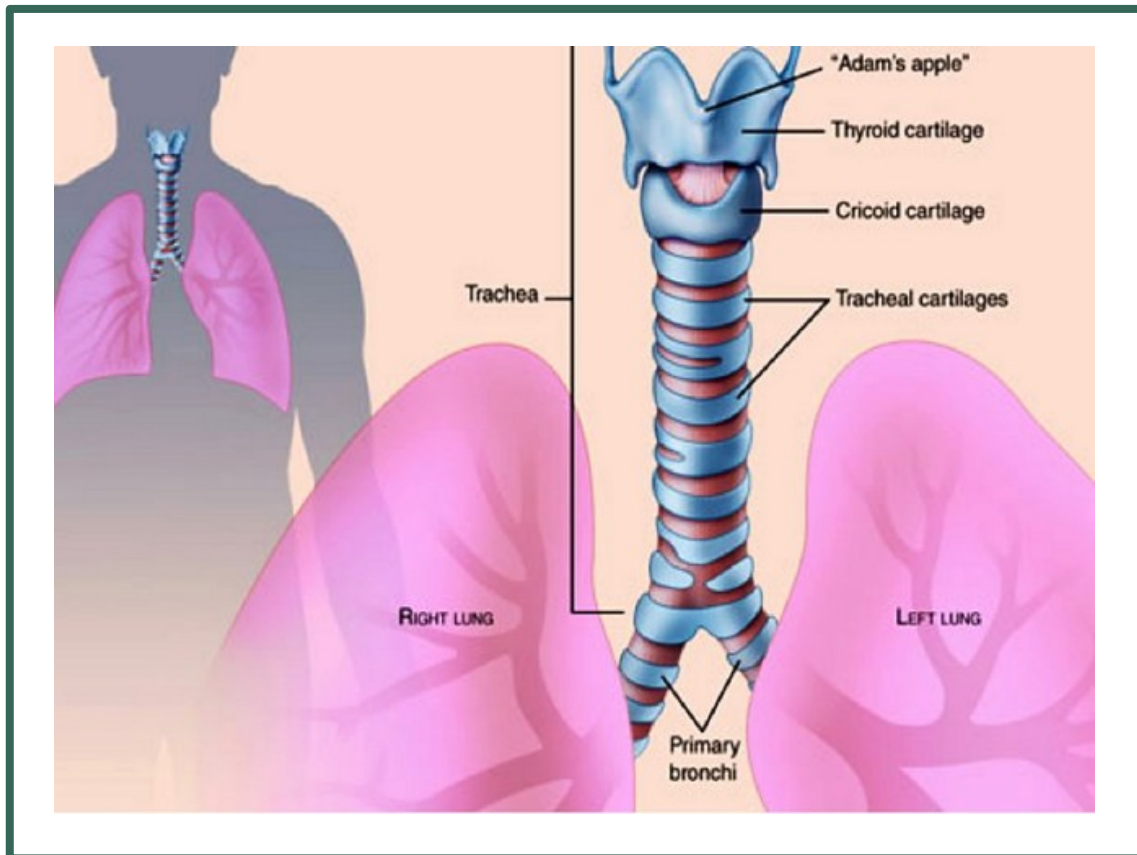
- The larynx is a cartilaginous structure that serves as a passageway for **air between the pharynx and the trachea.**
 - The larynx is called the voice box because it **houses the vocal cords.**
 - The vocal cords are mucosal folds supported by elastic ligaments, and the **slit between the vocal cords is an opening called the glottis.**
 - When air is expelled past the vocal cords through the glottis, **the vocal cords vibrate, producing sound.**





- The high or low pitch of the voice is regulated when speaking and singing by **changing tension on the vocal cords.**
 - The greater the tension, the **higher the pitch.**
 - The loudness, or intensity of the voice depends on **the amplitude of the vibrations.**
- When food is swallowed, the larynx moves **upward against the epiglottis.**

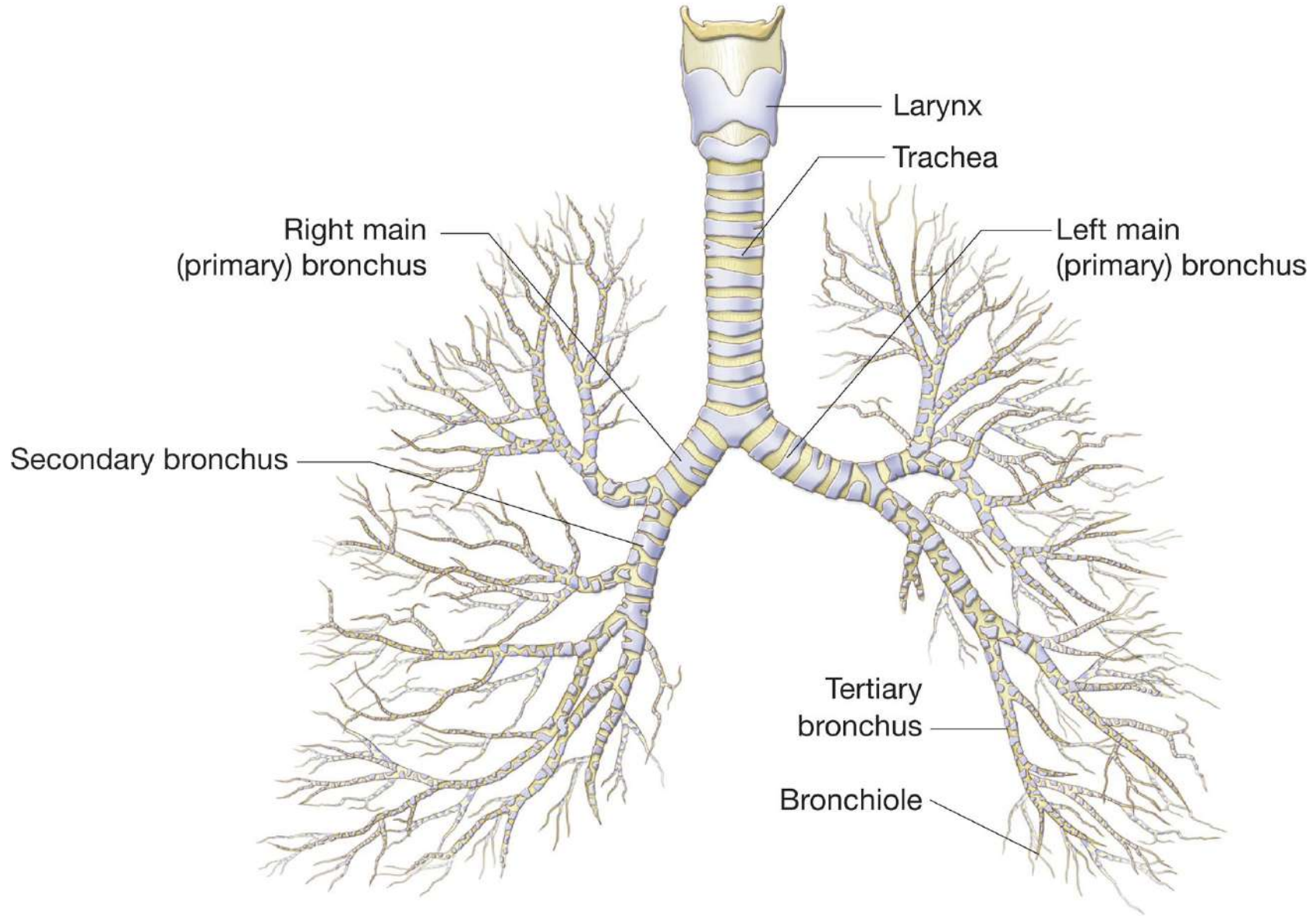
THE TRACHEA

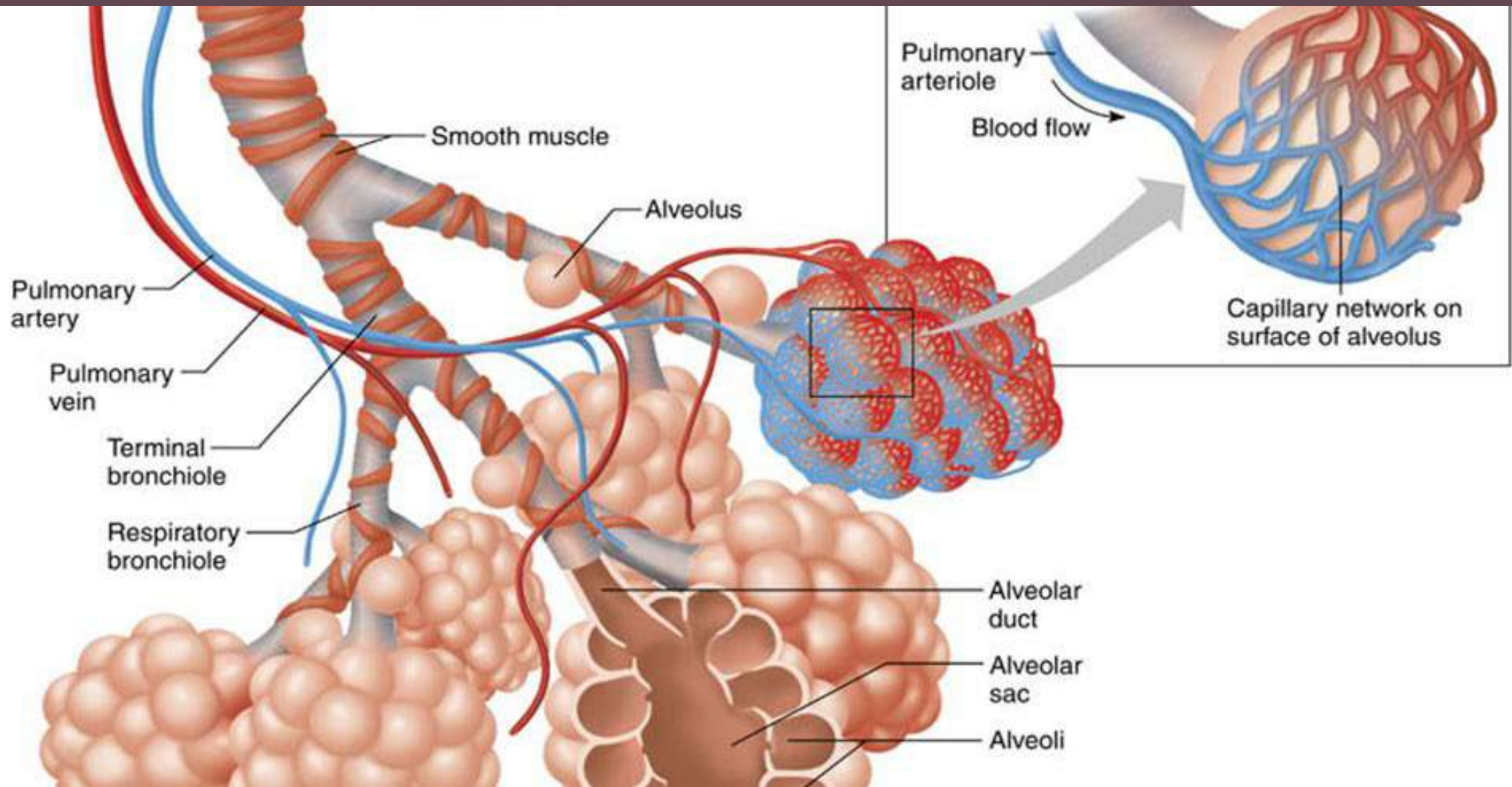


- The trachea is commonly called the **windpipe**.
- The trachea lies in front of the esophagus and is **held open by cartilage rings**.
- The mucosa that lines the trachea has ciliated cells that keep the lungs clean by **sweeping mucus and debris towards the pharynx**.
 - Smoking is known to have **destroyed these cells**.

THE BRONCHIAL TREE

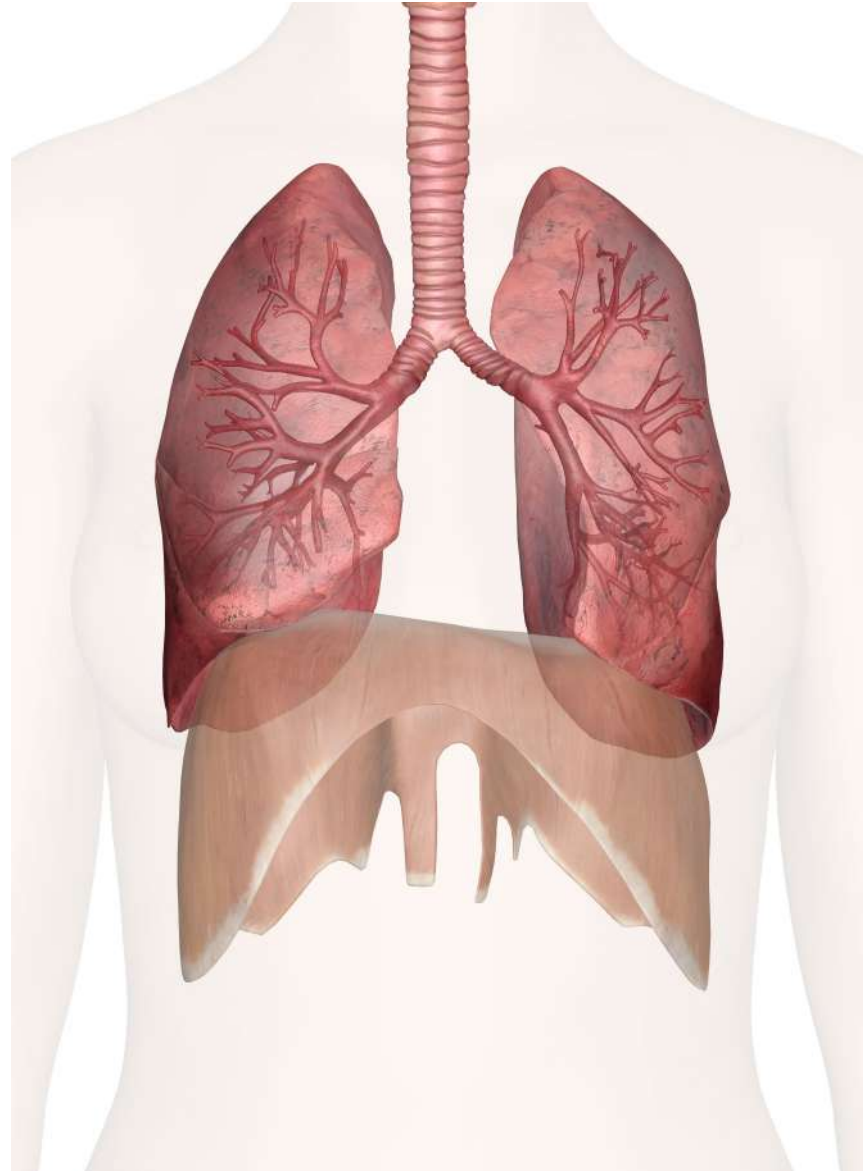
- The trachea divides into right and left primary bronchi, which lead into the **right and left lungs**.
- The bronchi branch into a greater number of **secondary bronchi that eventually lead into bronchioles**.
 - Bronchi resemble trachea in structure, but as the bronchial tubes divide they become **smaller and thinner, and the cartilage slowly disappears**.
 - Each bronchiole leads to a space enclosed by **millions of thin-walled sacs called alveoli**.



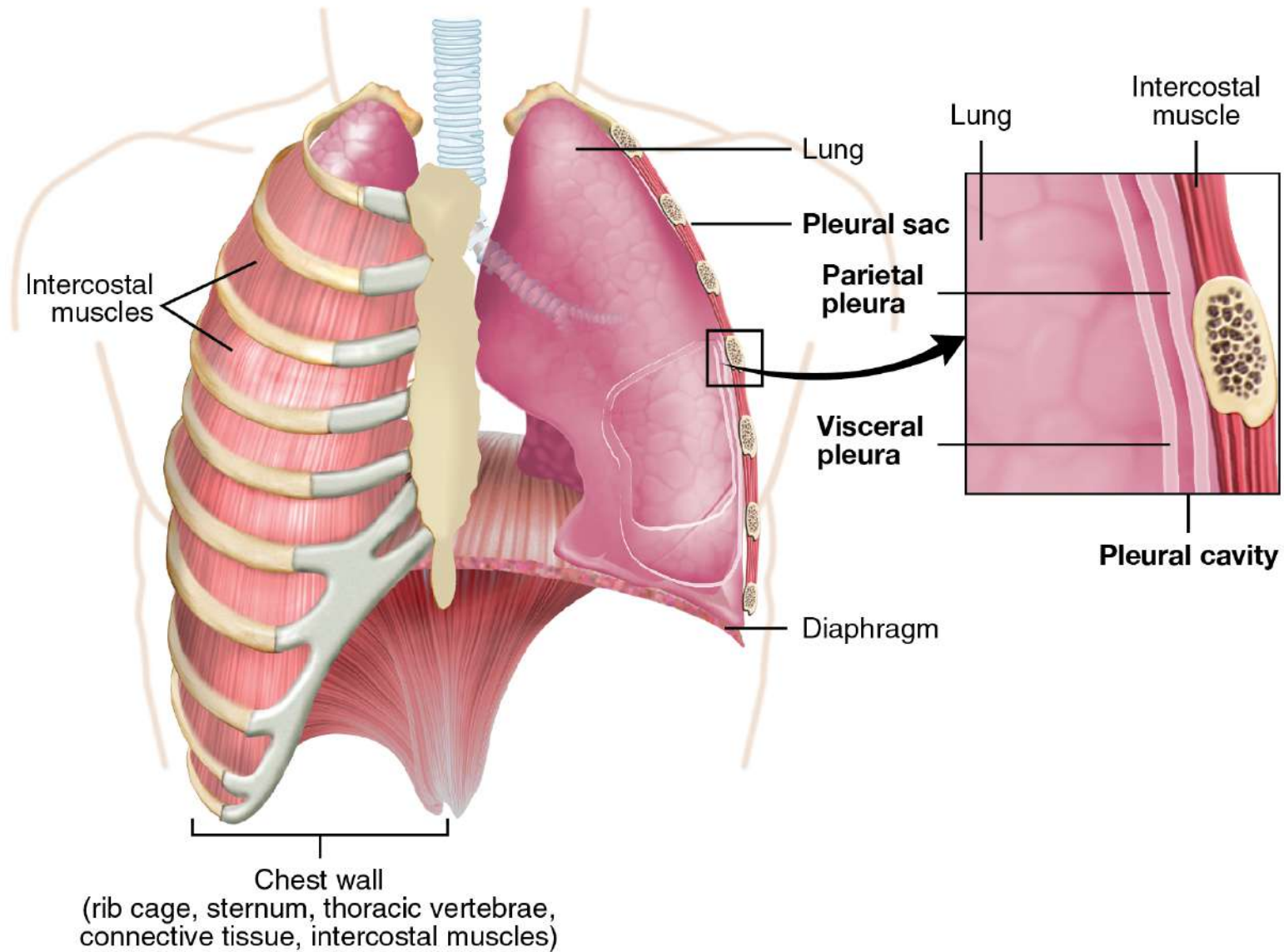


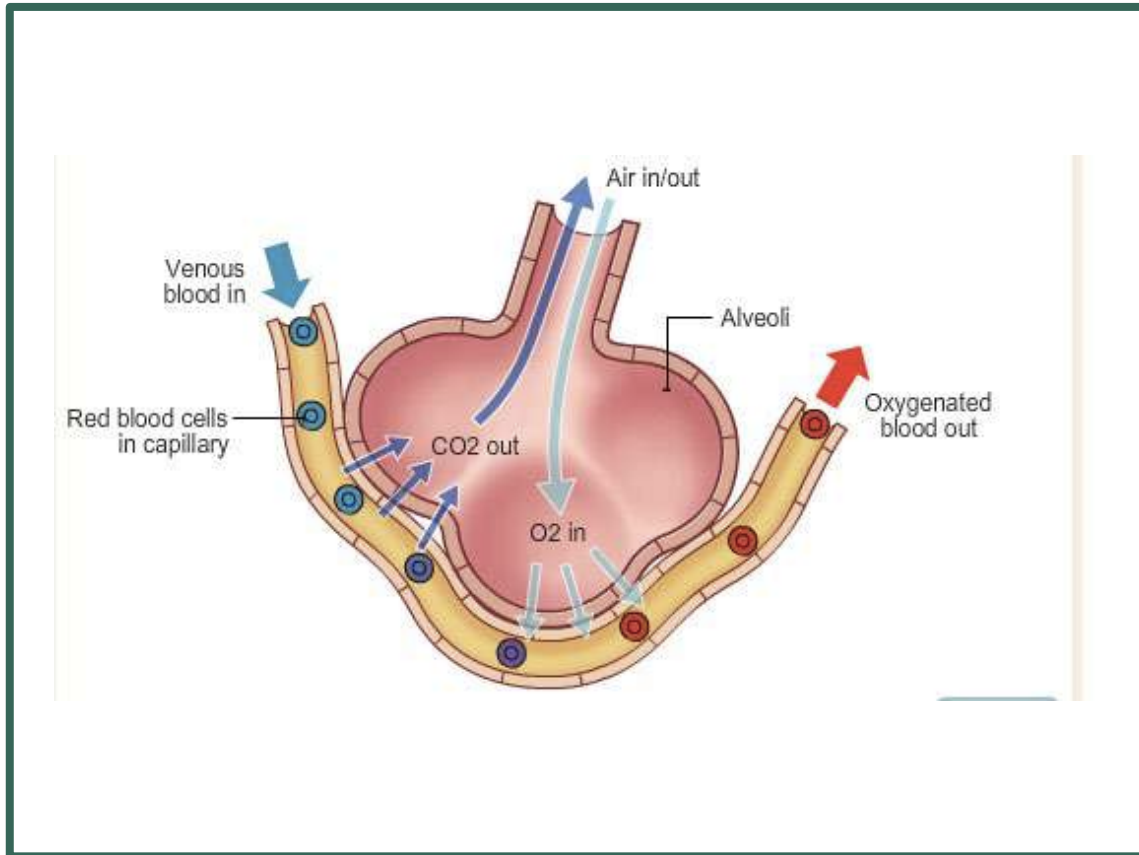
THE LUNGS

- The lungs are paired, cone shaped organs that occupy the thoracic cavity, **except for the trachea, thymus, heart, and esophagus.**
- The **right lung has three lobes and the left has two** allowing room for the heart.
- A lobe is further divided into lobules, and each **lobule has a bronchiole serving many alveoli.**
- The **base of the lungs are broad and curve to fit the dome-shaped diaphragm**, the muscle that separates the thoracic cavity from the abdominal cavity.



- Each lung is covered by a very thin **serous membrane called a pleura.**
 - A pleura covers the **internal chest wall and diaphragm.**
 - Both membranes produce a **lubricating fluid that helps the pleurae slide freely against each other** during inspiration and expiration.
 - Surface tension is the tendency for H₂O molecules to **cling to each other due to hydrogen bonding.**
 - Surface tension holds the **two pleural layers together when the lungs recoil during exhalation.**





- With each inhalation, **air passes to the alveoli.**
- Each alveolus is made up of simple epithelium **surrounded by blood capillaries.**
- Gas exchange occurs between **air in the alveolus and the blood in the capillaries.**
 - **O₂ diffuses across alveolar and capillary walls** to enter the bloodstream.
 - **CO₂ diffuses from the blood across these walls** to enter the alveoli.

- If gas exchange is to occur, the **alveoli must stay open to receive the inhaled air.**
 - The surface tension of fluid coating the alveoli is **capable of causing them to close up.**
 - To prevent this, alveoli are coated with **pulmonary surfactant that lowers the surface tension.**
 - The lungs collapse in some newborn babies, **especially premature infants who lack this film.**




7.2 – MECHANISM OF BREATHING




- During ventilation (breathing), a **free flow of air is vitally important.**
- Spirometer's are used to record the **volume of air exchanged during both normal and deep breathing.**

RESPIRATORY VOLUMES

- The amount of air inhaled and exhaled **at rest is called the tidal volume.**
- It is possible to **increase the amount of air inhaled and exhaled by deep breathing.**
- The maximum volume of air that can be moved **in and out during a single breath is called vital capacity.**

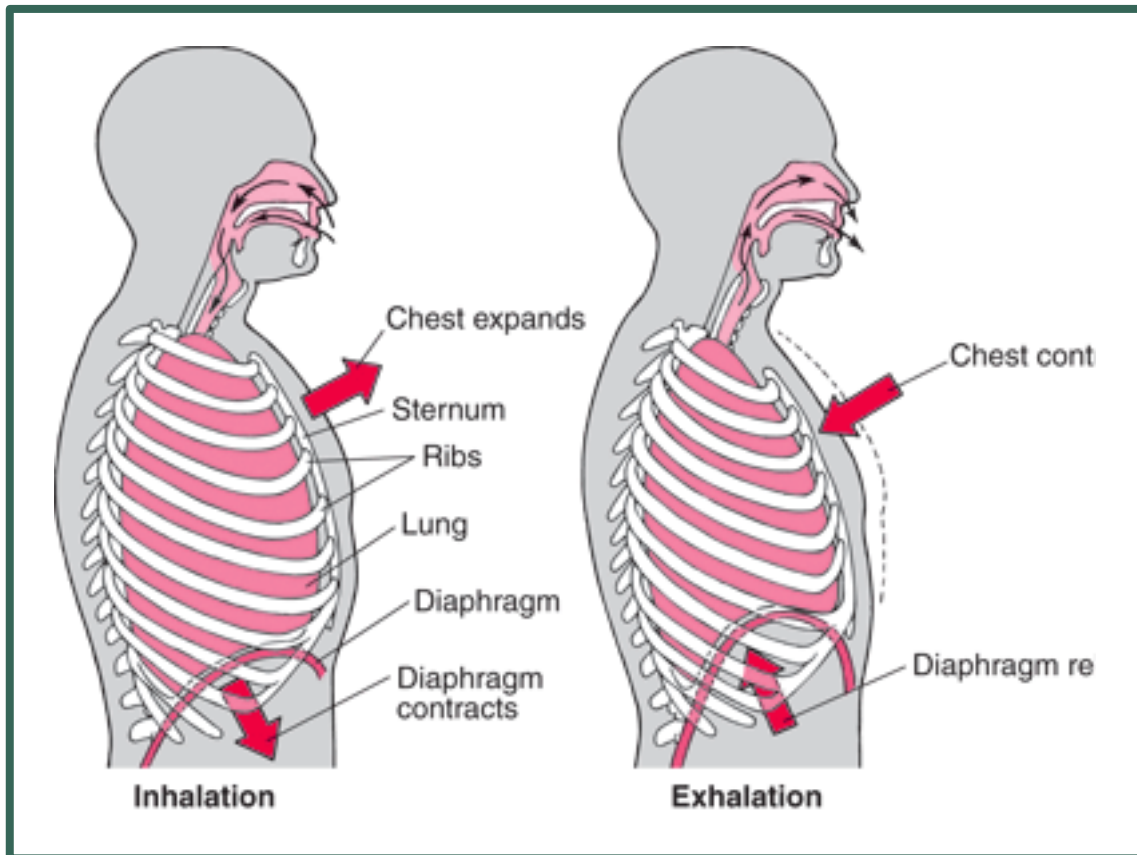
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- When taking a very deep breath, a healthy person can increase the volume of inhaled air **beyond the tidal volume by about 3.0L.**
 - This is called the **inspiratory reserve volume.**
 - Similarly, you forcefully **exhale beyond the tidal volume.**
 - This **expiratory reserve volume** is approximately 1.5L.
 - Vital capacity is the **sum of the tidal, inspiratory reserve, and expiratory reserve volumes.**

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- These respiratory volumes depend on various factors such as **age, gender, and physical activity.**
 - During normal breathing, only about 7% of the **tidal volume actually reaches the alveoli.**
 - Even after a very deep exhale, some air remains in the lungs, this is called **residual volume.**
 - This air is not useful for gas exchange because it has been **depleted of O₂.**


INSPIRATION & EXPIRATION

- To understand ventilation, the following facts should be remembered:
 1. There is a continuous **column of air from the pharynx to the alveoli.**
 2. The lungs lie within the sealed-off thoracic cavity. The rib cage forms the top and sides of the thoracic cavity. The intercostal muscles lie between the ribs. **The diaphragm and connective tissue form the floor of the thoracic cavity.**
 3. The lungs **adhere to the thoracic wall due to the pleura.**

INSPIRATION

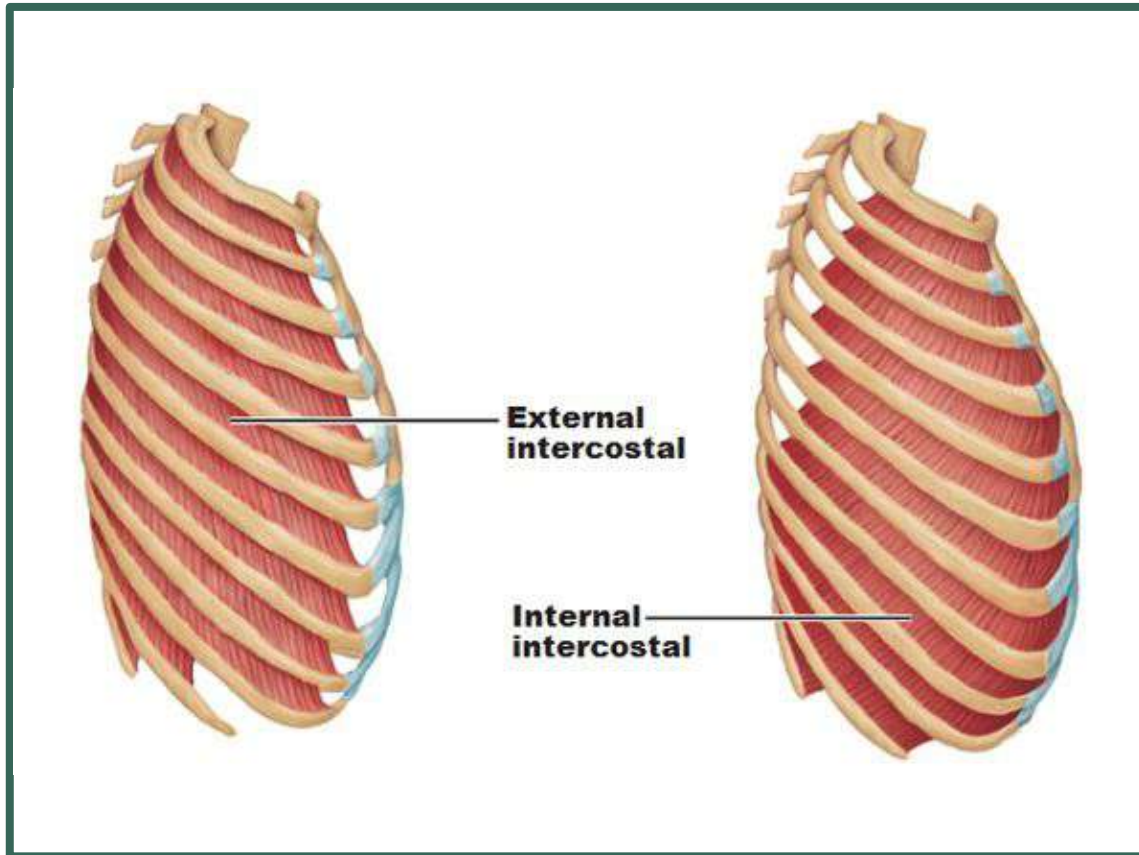


- This is the active phase of ventilation because the **diaphragm and intercostal muscles contract.**
- When the diaphragm contracts:
 - **It lowers**
- When the intercostal muscles contract:
 - **The rib cage moves up and outward.**

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- Following this contraction, the **volume of the thoracic cavity increases, as a result the lungs expand.**
 - Now the air pressure within the **alveoli decreases.**
 - Because alveolar pressure is now less than atmospheric pressure outside the lungs, **air naturally flows from outside the body into the respiratory passages.**
 - Note that air does not **force the lungs to open.**
 - Humans inhale by **negative pressure.**

EXPIRATION

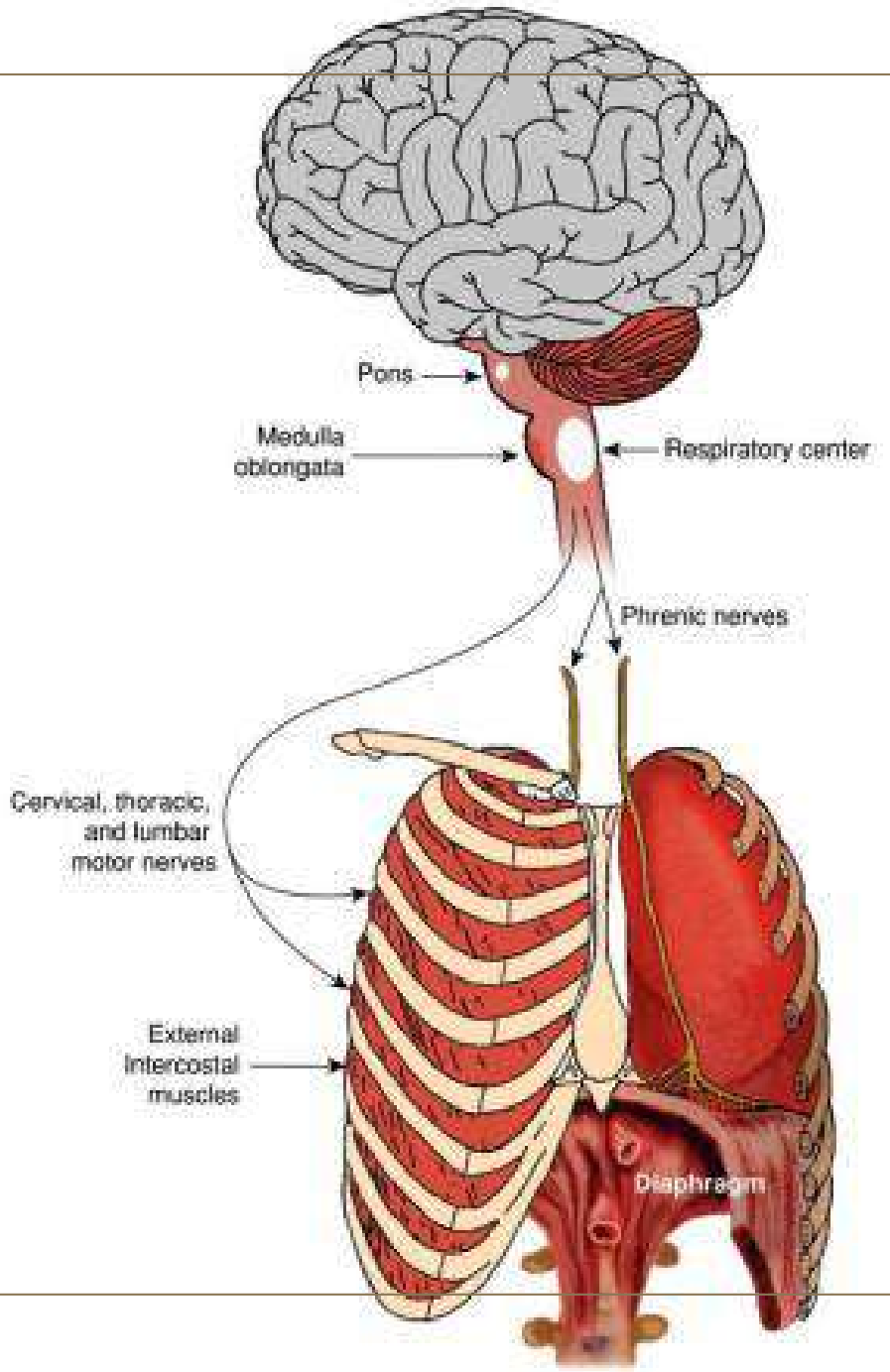
- This is the **passive phase of breathing**.
- Here, the elastic properties of the **thoracic wall and lungs cause them to recoil**.
 - Additionally, the surface tension of the fluid lining the **alveoli draws them closed**.
- The abdominal organs press up against the diaphragm, **and the ribcage moves down and inward**.




- The diaphragm and **external intercostal muscles** are usually relaxed during expiration.
- But when breathing is deeper and/or more rapid, **expiration can be active.**
- The **internal intercostal muscles** can contract, forcing the rib cage down and inward.

CONTROL OF BREATHING

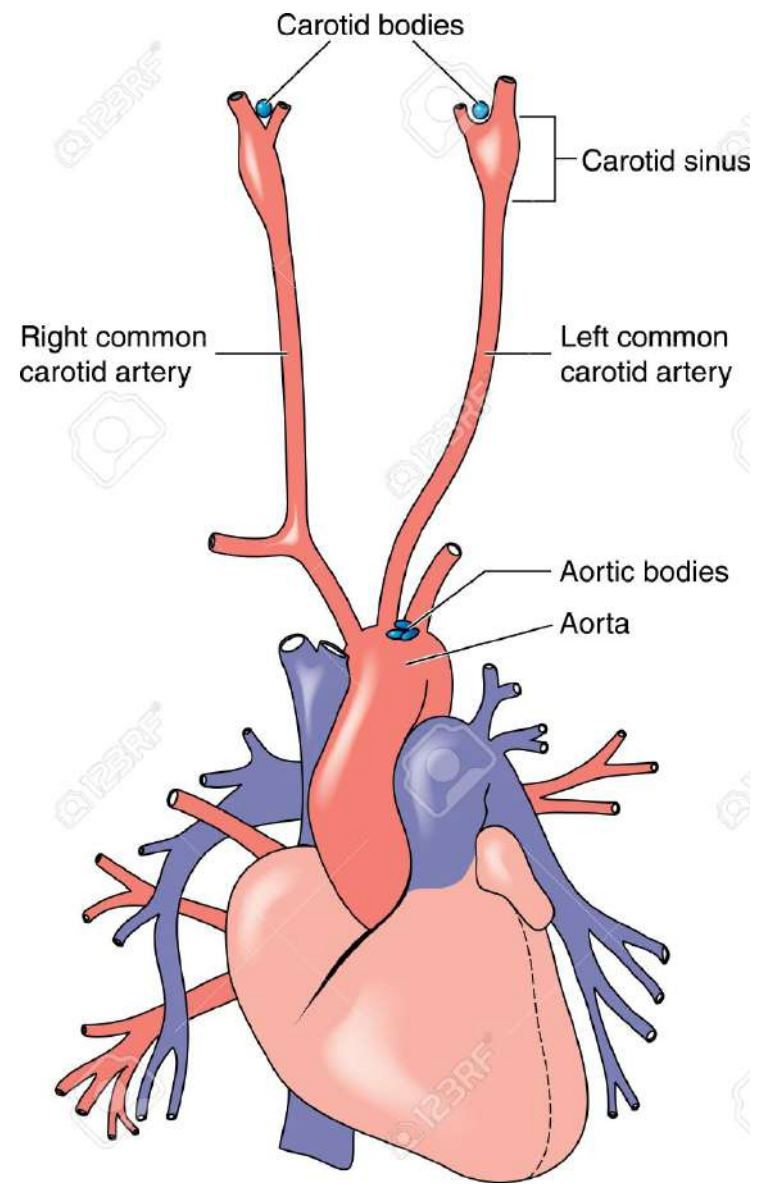
- Adults typically have a resting breathing rate of **12-20 ventilations per minute.**
- The rhythm of ventilation is controlled by a **respiratory centre located in the medulla oblongata.**
 - This stimulates inhalation by sending impulses to the **diaphragm via the phrenic nerve**, and to the **intercostal muscles via the intercostal nerves.**
 - When the respiratory centre temporarily stops sending neuronal signals to **the diaphragm and rib cage, the diaphragm relaxes.**



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- The respiratory centre automatically controls the **rate and depth of breathing**.
 - However, its activity can be influenced by **nervous and chemical input**.
 - Following forced inhalation, stretch receptors in the alveolar wall sends **inhibitory nerve impulses via the vagus nerve**, which temporarily inhibit the **respiratory centre from sending out nerve impulses**.

CHEMICAL INPUT

- Most of the **CO₂** that enters the blood combines with **H₂O** forming an acid, which breaks down and gives off hydrogen ions.
- The respiratory centre has cells that are **sensitive to levels of CO₂ and H⁺ in the blood.**
 - When either rises, the **respiratory centre increases rate and depth of breathing.**
- Respiration rate is also influenced by **carotid bodies located in the carotid arteries, and aortic bodies located in the aorta.**
 - When the concentration of **O₂** decreases, these bodies communicate with the respiratory centre, and the **rate and depth of breathing increases.**



7.3 – GAS EXCHANGES IN THE BODY

- Respiration includes the **exchange of gases in the lungs, and the exchange of gases in the tissues.**
- Most of the O₂ carried in the blood is attached to the **iron-containing heme portion of hemoglobin (Hb).**

EXTERNAL RESPIRATION

- External respiration refers to the exchange of **gases between air in the alveoli and blood in the pulmonary capillaries.**
- Here CO₂ diffuses **out of the plasma into the lungs.**
 - Most of the CO₂ is carried in the plasma as **bicarbonate ions (HCO₃⁻)**
 - The enzyme carbonic anhydrase speeds the **breakdown of carbonic acid (H₂CO₃).**

CHEMICAL FORMULA FOR THIS PROCESS:

- When you hyperventilate, removing more CO₂, **this reaction is pushed to the right.**
 - Blood will have fewer hydrogen ions and **respiratory alkalosis results.**
 - Here your breathing is inhibited and you may feel **dizzy and disoriented.**
- When you hypoventilate, **this reaction is pushed to the left.**
 - H⁺ builds up in the blood, and **respiratory acidosis occurs.**
 - Increased H⁺ and CO₂ levels will stimulate your **respiratory centre to increase breathing rate.**

- During external respiration, **O₂ diffuses into plasma and then into red blood cells.**
 - Since hemoglobin has a higher affinity for O₂ at lower temperatures and higher pH, it **takes up O₂ and becomes oxyhemoglobin (HbO₂).**
 - Only a small percentage of the O₂ present in the atmospheric air is **used during normal external respiration.**

Chemical formula

INTERNAL RESPIRATION

- Internal respiration refers to the exchange of gases between the **blood in the systemic capillaries and the tissue fluid.**
 - Internal respiration **services tissue cells.**
 - Blood in the systemic capillaries is bright red because the **RBC's contain oxyhemoglobin.**
 - Oxyhemoglobin gives up O₂ which **diffuses out of the blood into the tissues.**



CHEMICAL FORMULA

- In the warmer, more acidic conditions of the tissues, **oxygen diffuses out of the blood into the tissue.**
- CO₂ diffuses into the **blood from the tissues.**
 - After CO₂ diffuses into the blood, it enters the RBC's where 10% is taken up by **hemoglobin forming carbaminohemoglobin (HbCO₂).**
 - Most of remaining CO₂ combining with H₂O, forming carbonic acid, **which dissociates to hydrogen ions and bicarbonate ions.**
 - The increased CO₂ in the blood drives the reaction to the right:

- The enzyme carbonic anhydrase, **speeds up the reaction.**
- Bicarbonate ions diffuse out of RBC's and are **carried in the plasma.**
- The globin portion of hemoglobin combines with excess hydrogen ions, and **becomes reduced hemoglobin (HHb).**
 - This is how the pH of the blood **remains constant.**
- When blood reaches the lungs, **CO₂ readily diffuses out of the blood and is exhaled.**
 - Carbon monoxide has a much higher affinity for hemoglobin than O₂.
 - Therefore it stays combined for several hours, **making hemoglobin unavailable for O₂.**

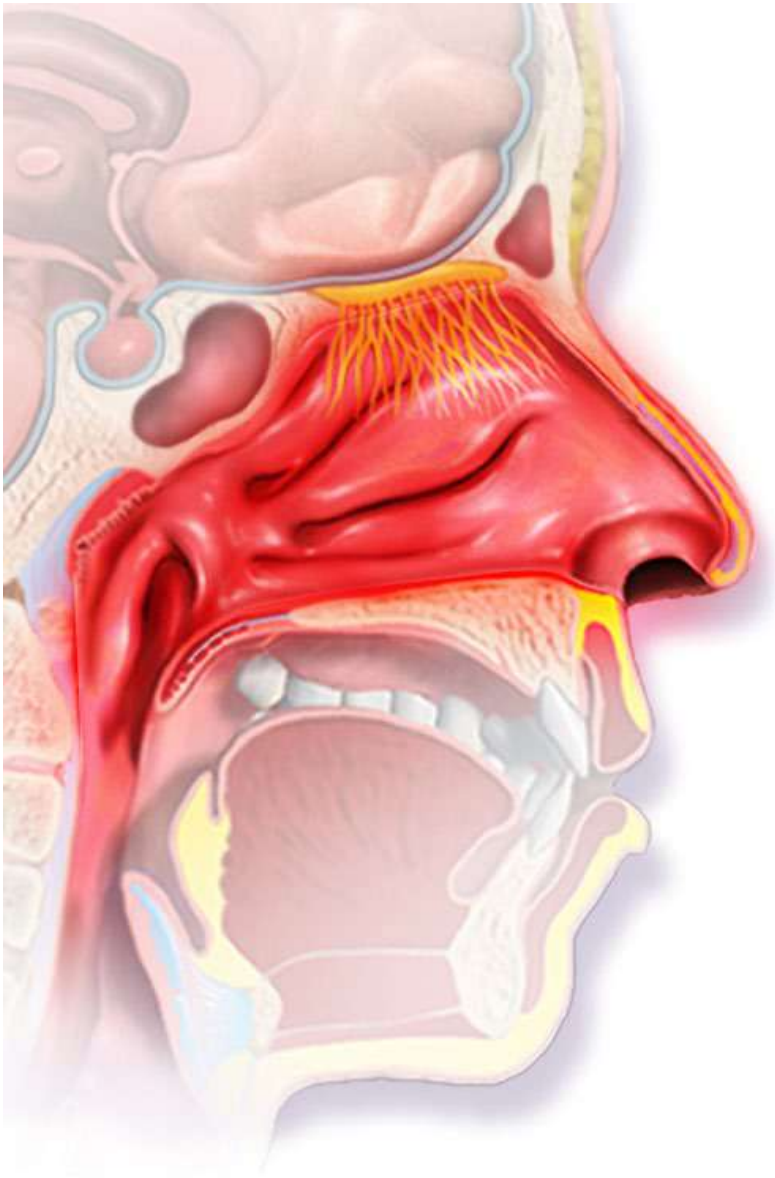
7.4 – DISORDERS OF THE RESPIRATORY SYSTEM

- The respiratory tract is constantly exposed to air in our environment, and is therefore **susceptible to various infectious agents, pollution, and tobacco smoke.**



DISORDERS OF THE UPPER RESPIRATORY TRACT

- The upper respiratory tract consists of **nasal cavities, the pharynx, and the larynx.**
 - Because it is responsible for filtering pathogens and **materials present in the air, it is susceptible to infections.**
 - These infections can spread to the **middle ear or sinus.**

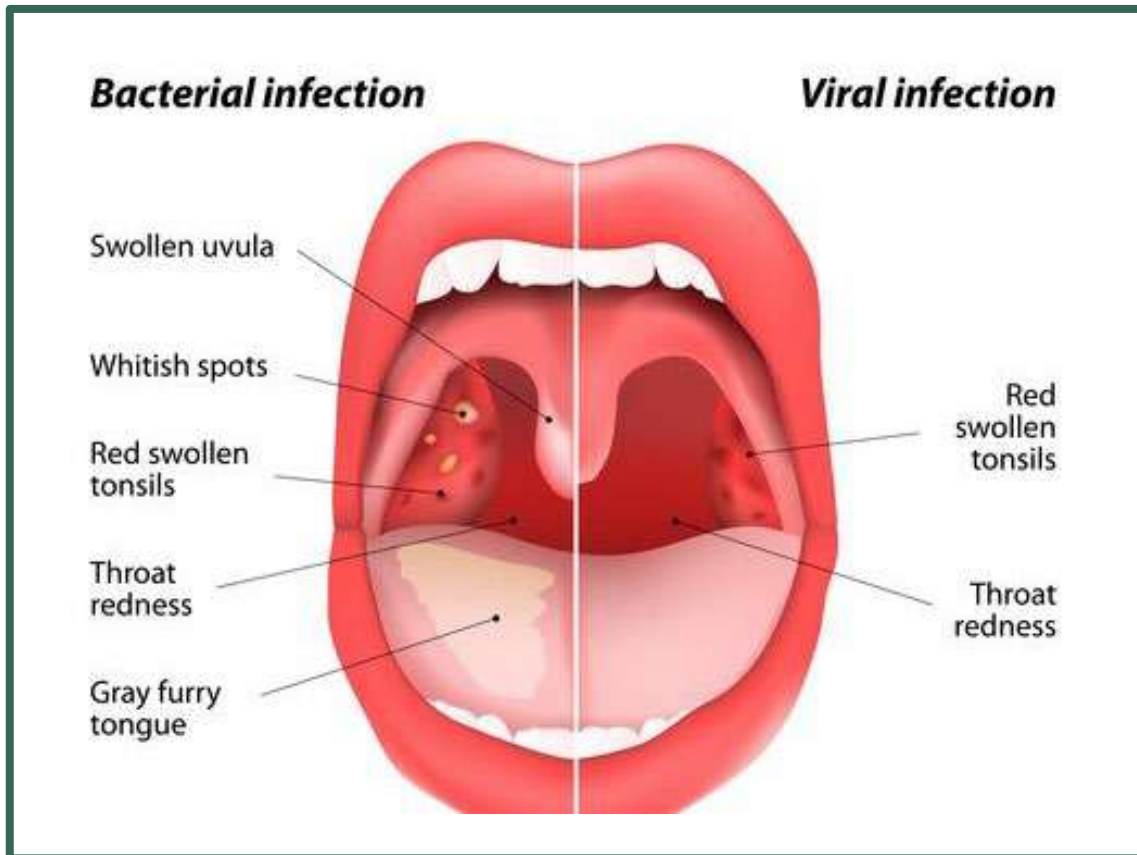


THE COMMON COLD



- Most colds are **relatively mild viral infections of the upper respiratory tract** characterized by sneezing and runny nose.
- The most common group of viruses that cause colds are the **rhinoviruses**.
- Most colds last from a few days to a week.
- Colds are caused by **viruses**, so **antibiotics will not help**.

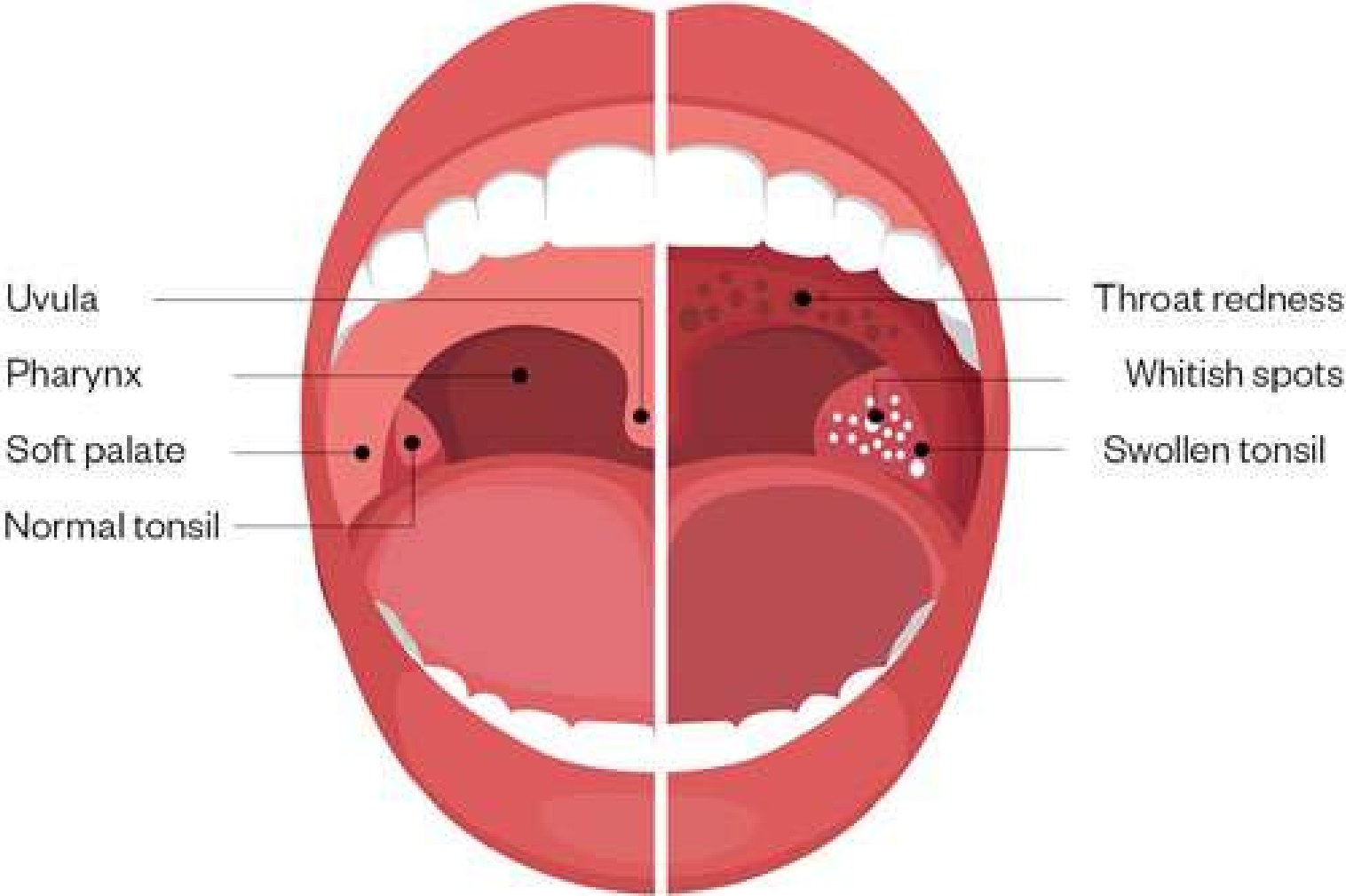
PHARYNGITIS, TONSILLITIS, & LARYNGITIS



- Pharyngitis is an inflammation of the throat, **usually because of an infection.**
- Strep throat is pharyngitis caused by *Streptococcus pyogenes*. Symptoms are **severe sore throat, high fever, and white patches on the tonsillar area.**

- Tonsillitis occurs when the **tonsils become inflamed and enlarged**.
 - If tonsillitis occurs frequently and make breathing difficult, the **tonsils can be removed surgically**.
 - Fewer tonsillectomies are performed than in the past because we now know **tonsils help initiate immune responses**.
- Laryngitis is an inflammation of the larynx with **accompanying hoarseness, often leading to loss of voice**.
 - This usually disappears after **resting the vocal cords**.
 - Laryngeal polyps are more likely to occur in people who put their vocal cords through **excessive wear and tear such as professional singers**.

Normal Abnormal



Uvula

Pharynx

Soft palate

Normal tonsil

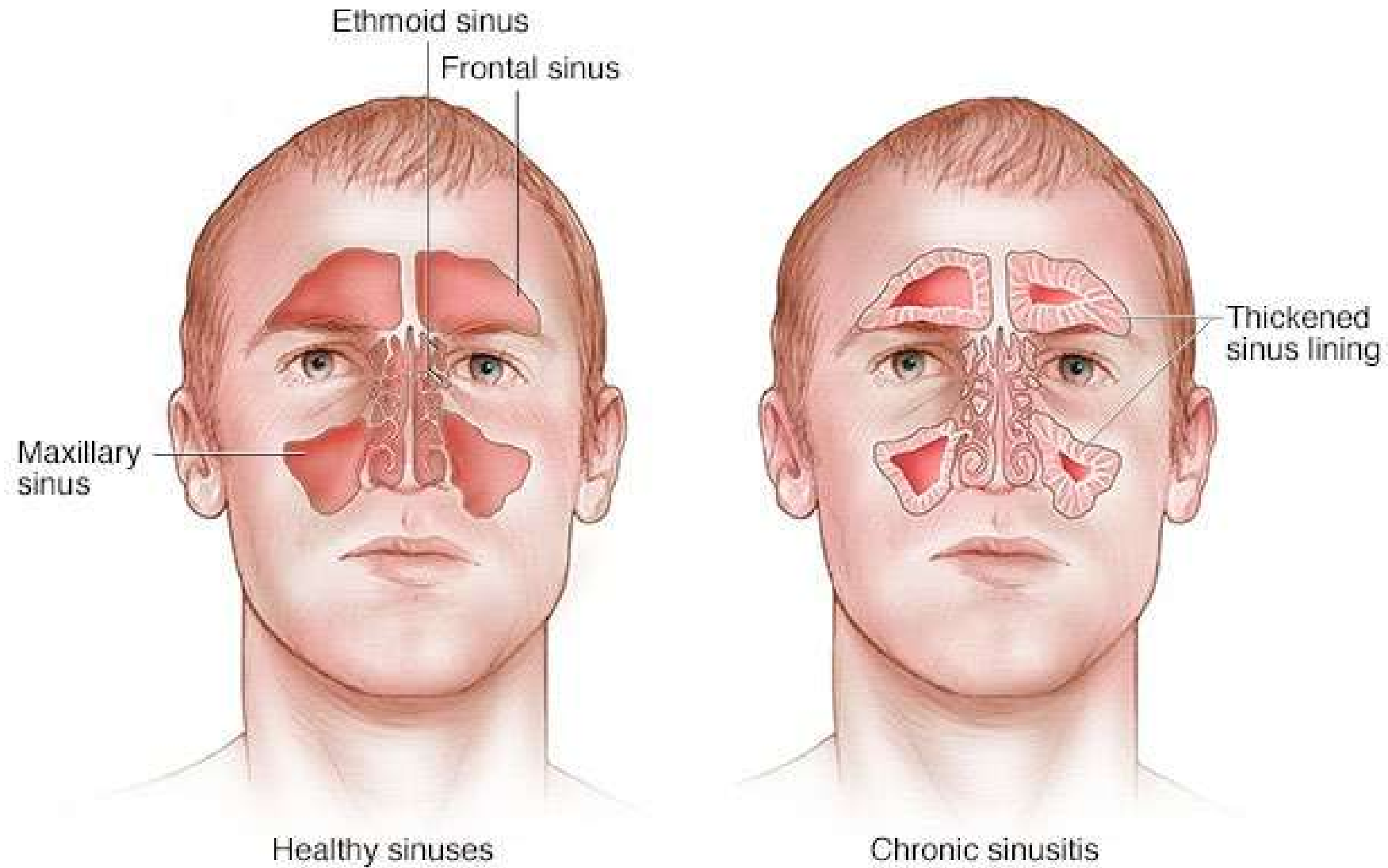
Throat redness

Whitish spots

Swollen tonsil

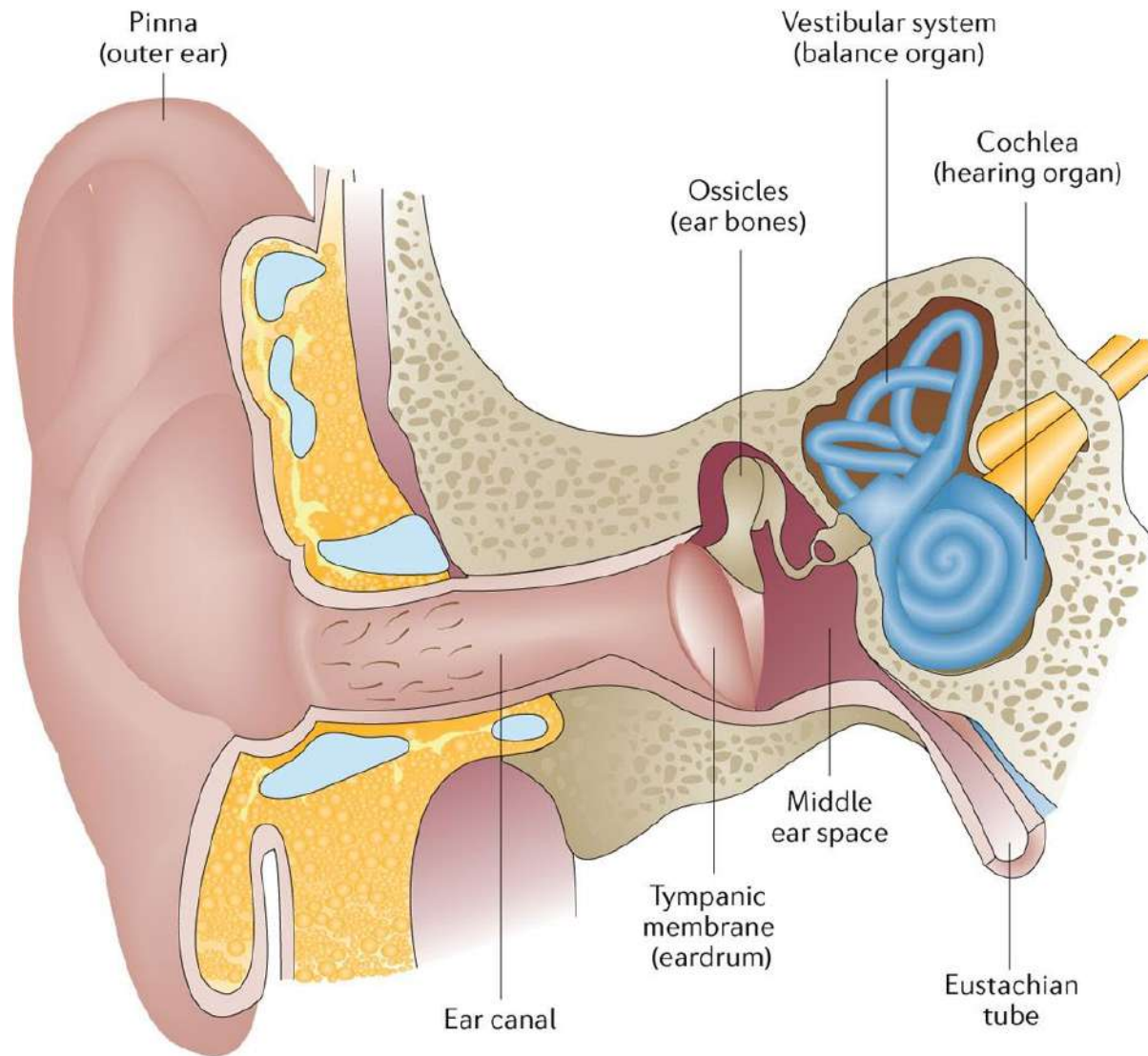
SINUSITIS

- Sinusitis is an **inflammation of the cranial sinuses.**
- This develops when nasal congestion blocks the tiny openings **leading to the sinuses.**
 - Symptoms include **postnasal discharge, headache, and facial pain**
 - Rinsing the sinuses by instilling a warm saline solution into one nostril, and out the other can **help remove irritants and rinse out mucus.**



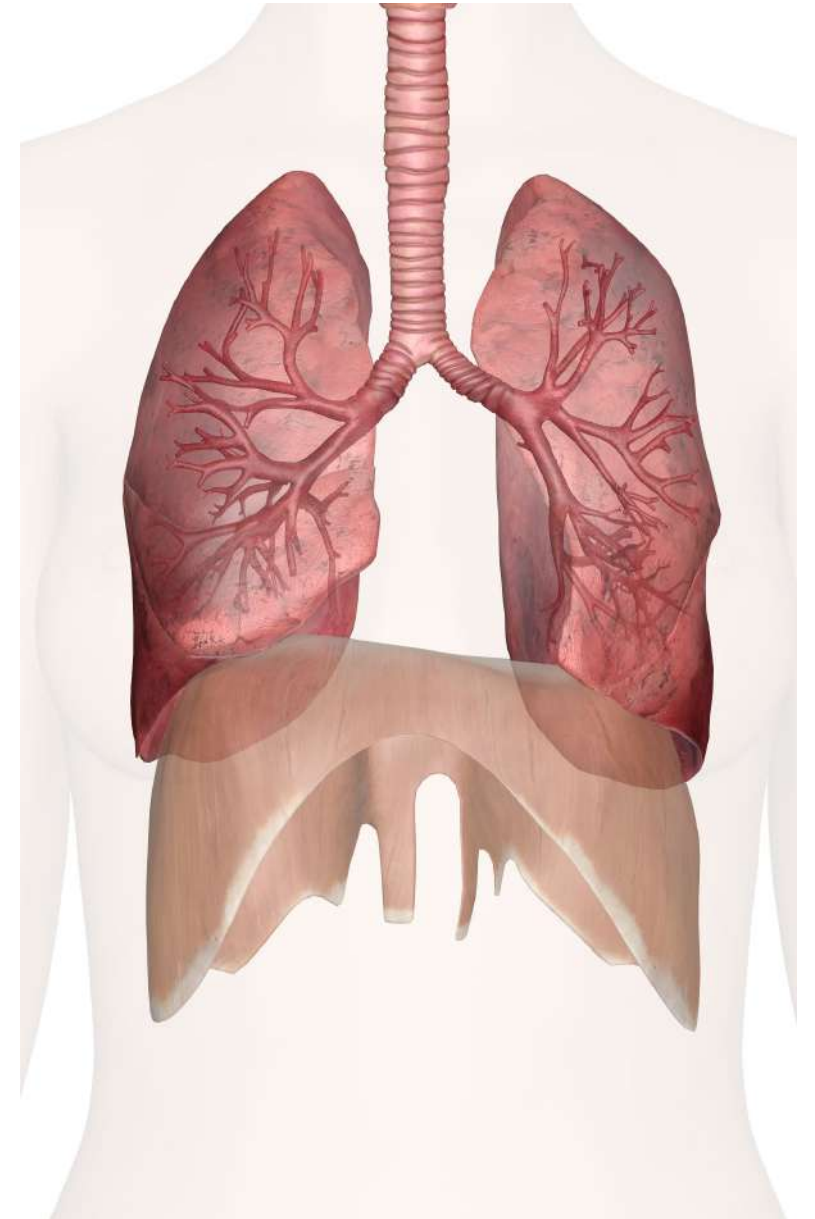
OTITIS MEDIA

- Otitis media is an **inflammation of the middle ear**.
- The middle ear is not a part of the respiratory tract, but **nasal infections can spread to the ear through the auditory tubes**, especially in children.
 - Pain is the primary symptom, a sense of fullness, **hearing loss, vertigo, and fever can also be present**.
 - Depending on the type of infection, **antibiotics can sometimes be used for treatment**.



DISORDERS OF THE LOWER RESPIRATORY TRACT

- Several disorders of the lower respiratory tract cause problems by **obstructing airflow**.
 - Their causes range from a **foreign object and excessive mucus**.
 - Other conditions tend to **restrict elasticity of lung tissue itself**.



DISORDERS OF THE TRACHEA & BRONCHI

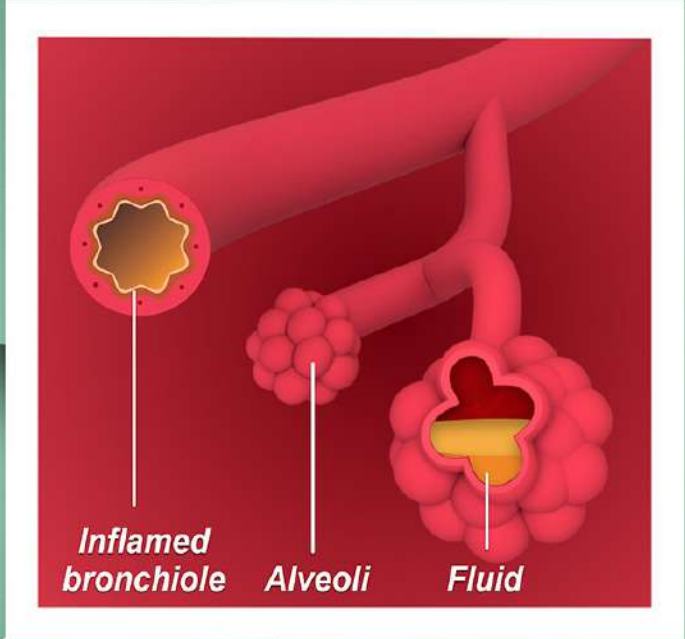
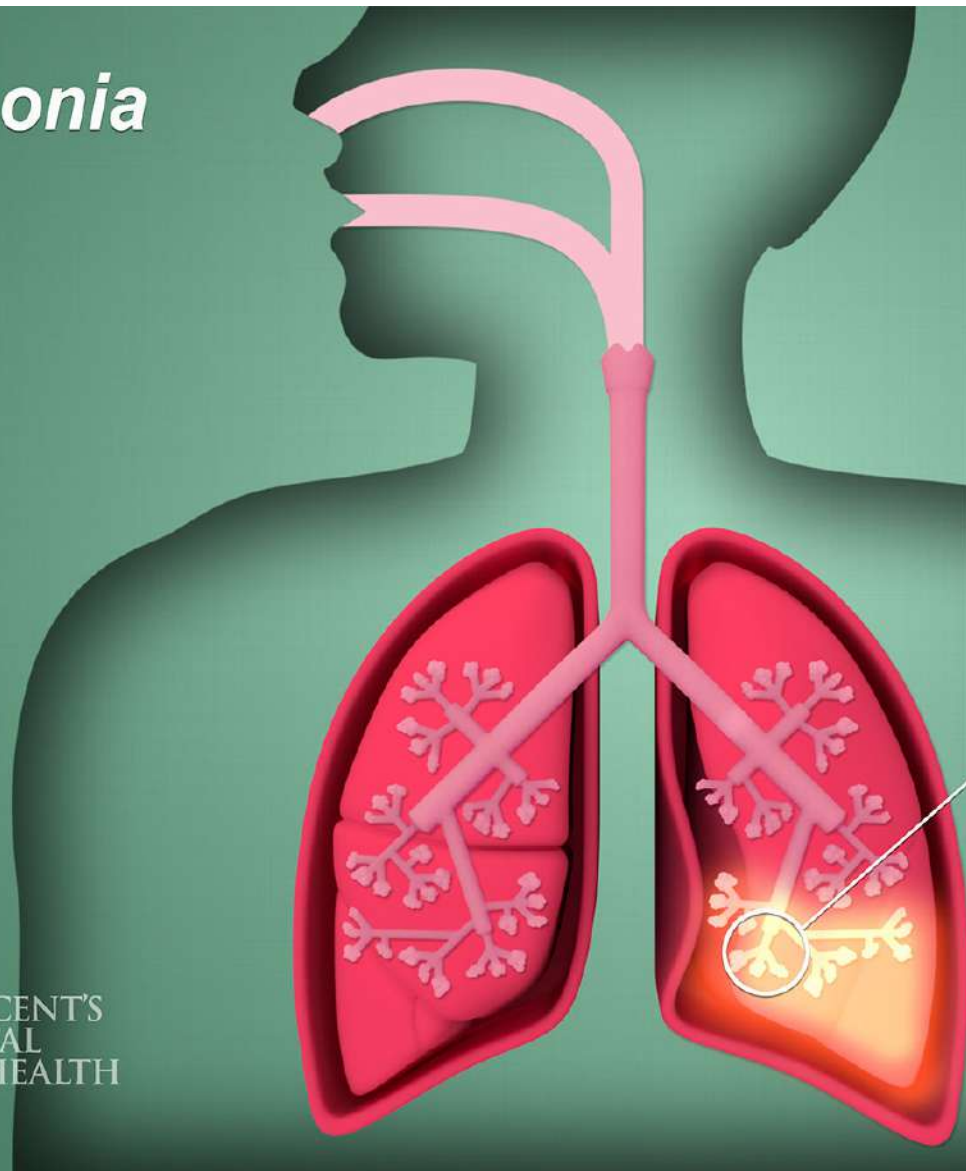
- One of the simplest but most life threatening disorder that affects the trachea is **choking**.
 - The best way to help someone who is choking is to **perform the Heimlich maneuver**.
- Acute bronchitis is an **inflammation of the primary and secondary bronchi**.
 - Usually it is preceded by a viral infection that has **led to a secondary bacterial infection**.

- In chronic bronchitis, the airways are **inflamed and filled with mucus**.
 - Here the bronchi have undergone degenerative changes **including loss of cilia and normal cleansing action**.
 - The most frequent cause of **chronic bronchitis is smoking**.
- Asthma is a disease of the bronchi and bronchioles that is marked by **wheezing, breathlessness, and sometimes a cough**.
 - The airways are unusually sensitive to specific irritants, **which include a wide range of allergens**.
 - When exposed to the irritant, **the smooth muscles in the bronchioles undergo spasms**.
 - Asthma is not curable, but several types of drugs can **prevent or treat asthma attacks**.

DISEASES OF THE LUNGS

- Pneumonia is an infection of the lungs in which the **bronchi or alveoli fill with thick fluid.**
 - **High fever, chills, headache, and chest pain** are symptoms of pneumonia.
 - Pneumonia may be localized in specific **lobules of the lungs.**
 - The more lobules involved, **the more serious the infection.**
 - Pneumonia can be caused by **bacteria, viruses, and other infectious agents.**


Pneumonia




*Inflammation of
lower lobe of lung*




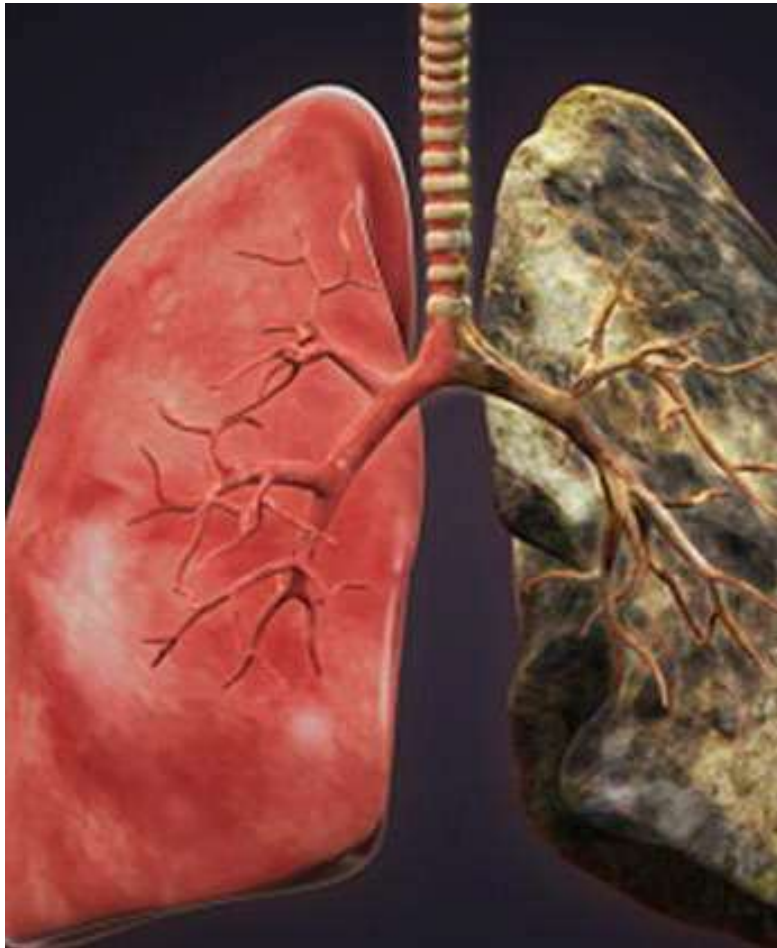
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- Pulmonary tuberculosis is **caused by a bacterium.**
 - When it invades the lung tissue, cells accumulate around the invading bacteria, **isolating them from the rest of the body.**
 - If the body's resistance is high, the organism will die. If the resistance is low, **the organism will escape and spread.**

- Emphysema is a chronic and incurable disorder where the **alveolar walls are damaged and the surface area for gas exchange is reduced.**
 - It is often preceded by **chronic bronchitis.**
 - The elastic recoil of the lungs is reduced, so the **driving force by expiration is reduced.**
 - Those afflicted will often feel **out of breath and may have a cough.**
 - Less oxygen reaches the **heart and brain.**

- 
- Cystic fibrosis is **genetic rather than infectious**.
 - The defective gene codes for a protein needed for proper transport of **Cl- ions out of the epithelial cells of the lung**.
 - This results in sticky mucus that can form **plugs interfering with breathing**.
 - Symptoms include **shortness of breath and coughing**.

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- Pulmonary fibrosis is when fibrous connective tissue **builds up in the lungs causing a loss of elasticity.**
 - This restricts the ability of the lungs to expand during inhalation, **reducing the vital capacity and other lung volumes.**
 - This occurs most commonly in elderly persons. **The risk increases after being exposed to asbestos.**



- Lung cancer is more prevalent in **men than women.**
- About 85% of lung cancers are associated with **cigarette smoking.**
 - The first step is **thickening of the cells lining bronchi.**
 - Then cilia are lost, making it impossible to prevent **dust and dirt from settling in the lungs.**
 - Cells with atypical nuclei will then appear **followed by a tumour.**