The Human Respiratory System and Homeostasis

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The Respiratory System

- respiratory system system responsible for gas exchange (bringing oxygen into the body and removing carbon dioxide from the body)

Respiration and Homeostasis

- There are three main requirements for respiration.

1) The respiratory surface must be large enough for the exchange of oxygen and carbon dioxide to occur at fast enough rates to meet the body's needs.

2) The respiratory surface must be moist: respiration must take place in a moist environment so that the oxygen and carbon dioxide are dissolved in water.

3) The respiratory surface must be thin enough to allow oxygen and carbon dioxide to diffuse across it.

Stages of Respiration

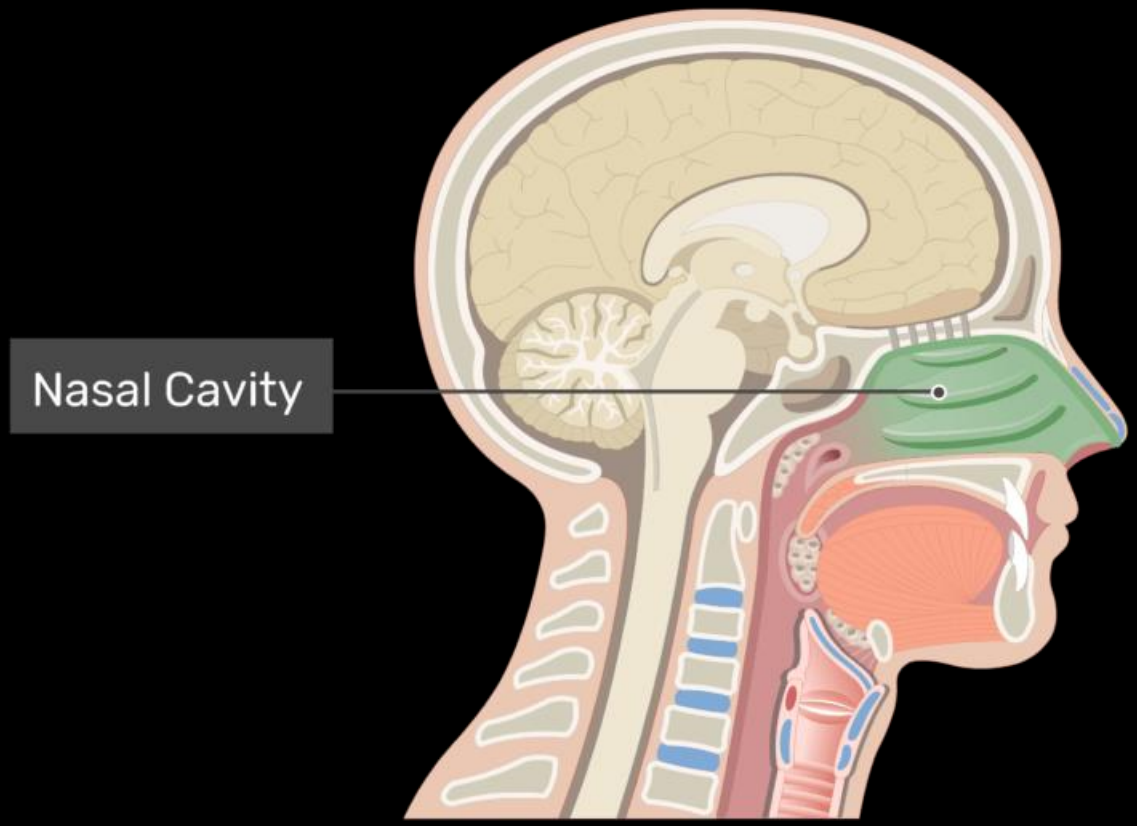
1) Breathing involves two basic processes: inspiration (breathing in, or inhaling) and expiration (breathing out, or exhaling). Inspiration moves air from the external environment to the lungs inside the body. Expiration moves air from the lungs back to the external environment.

2) Gas exchange is the exchange of oxygen and carbon dioxide between the air and the blood.

3) Cellular respiration is the series of energy-releasing chemical reactions that take place inside cells. Cellular respiration is the final stage in respiration; it is the only means of providing energy for all cellular activities, and it helps the body maintain homeostasis.

Structures of the Respiratory System
The Upper Respiratory Tract

- nasal cavity passage from the nostrils to the back of the throat through which air enters the body



Structures of the Respiratory System Nasal Cavity Continued

- It is lined with ciliated cells, like those shown in Figure 6.3. Other cells secrete mucus, which cleans the air by trapping foreign particles, such as dust and bacteria.
- The action of the ciliated cells moves the foreign particles back up into the nose and throat.
- The foreign particles can then be expelled by coughing or sneezing.

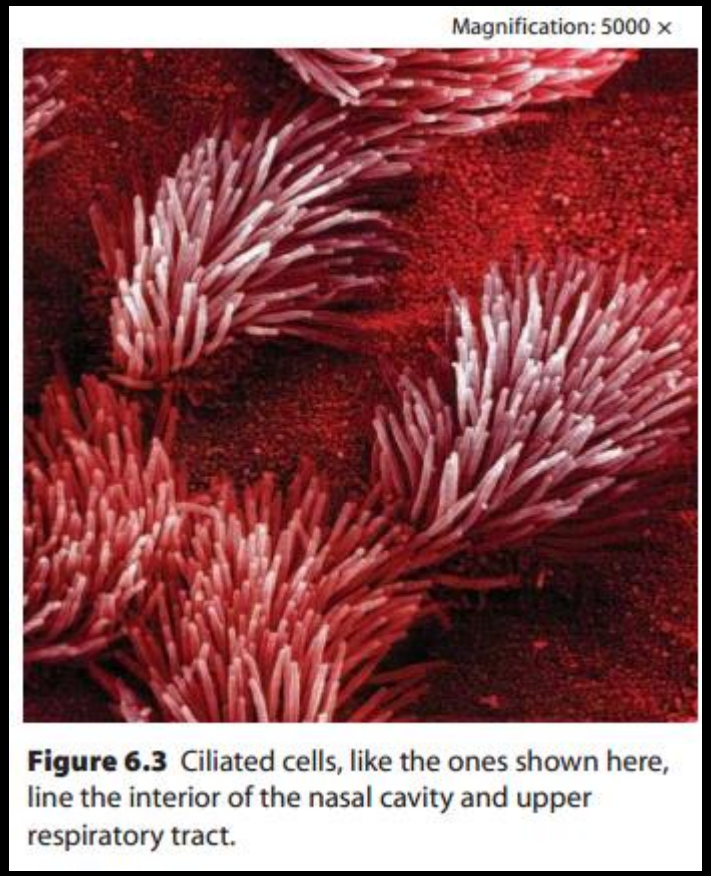
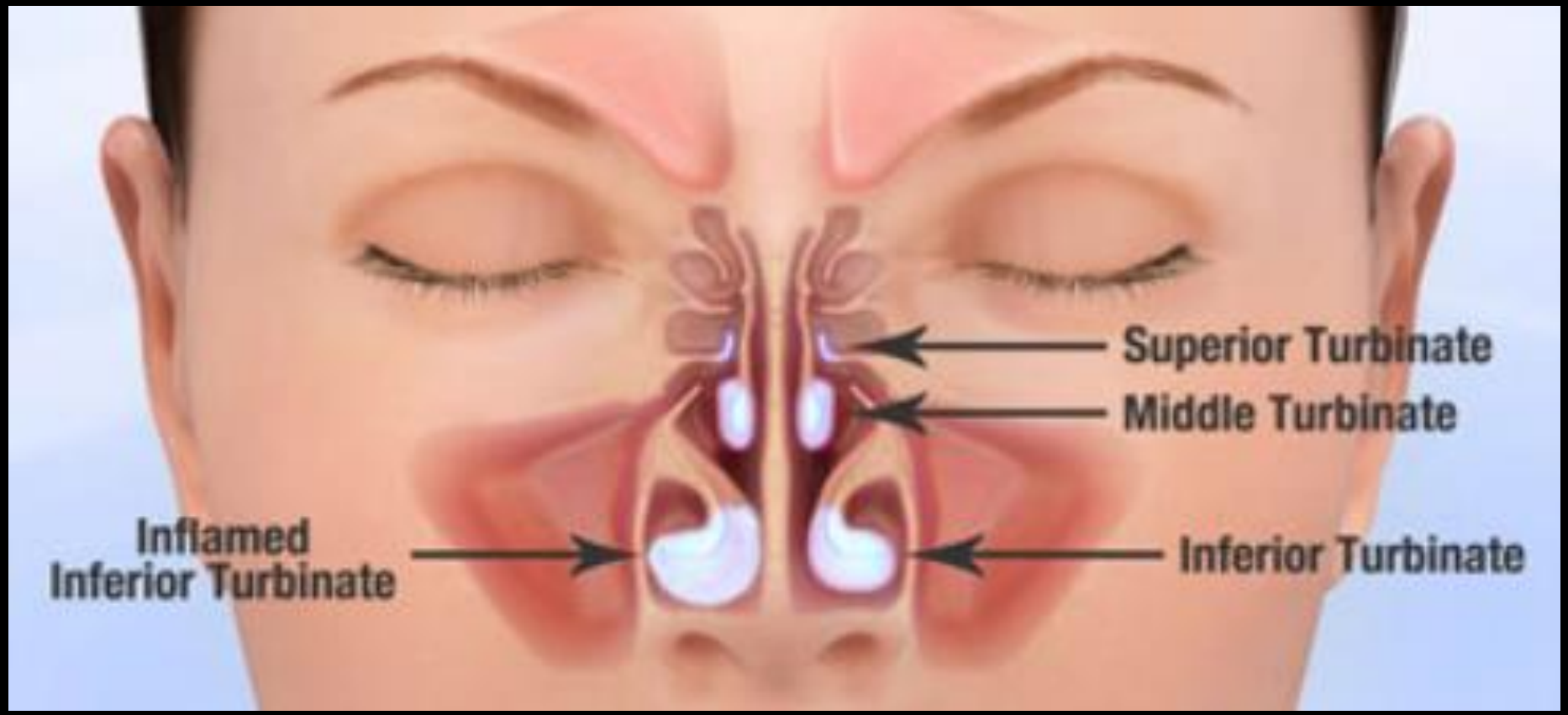


Figure 6.3 Ciliated cells, like the ones shown here, line the interior of the nasal cavity and upper respiratory tract.

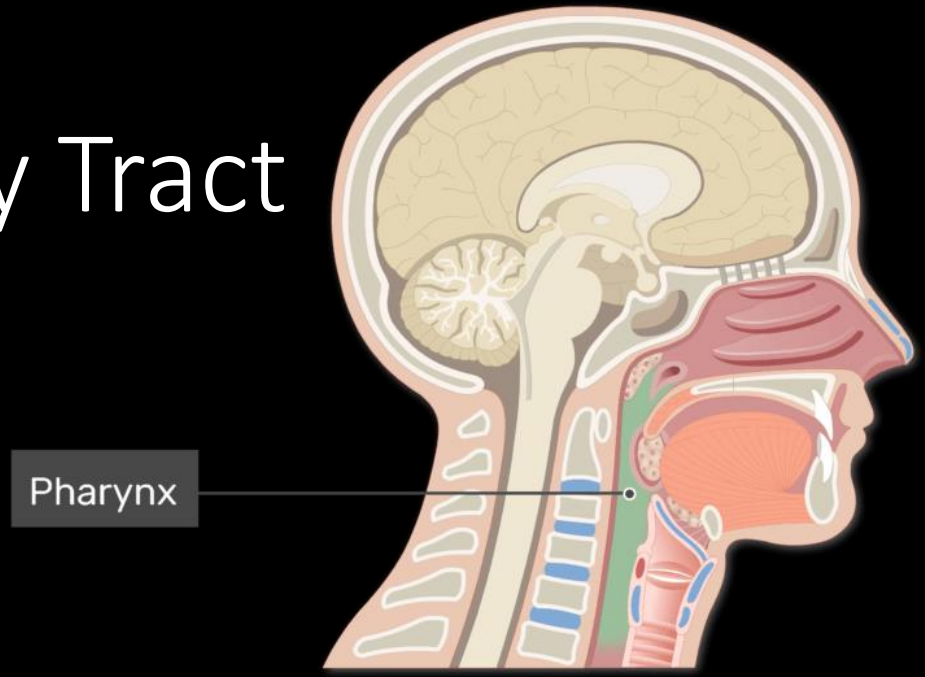
Nasal Cavity Continued

- Very thin bones, called turbinate bones, project into the nasal cavity. These bones serve an important function by increasing the surface area of the nasal cavity. They are covered in cilia, which catch and remove particles in the air. The turbinate bones, and the rest of the lining of the nasal cavity, are covered with a thin membrane that secretes mucus and is well-supplied with blood vessels. The heat from the blood warms the air as it passes through, and the mucus moistens the air. Both the warming and the moistening of the air are necessary to protect the delicate structures that are found in the lower respiratory tract.

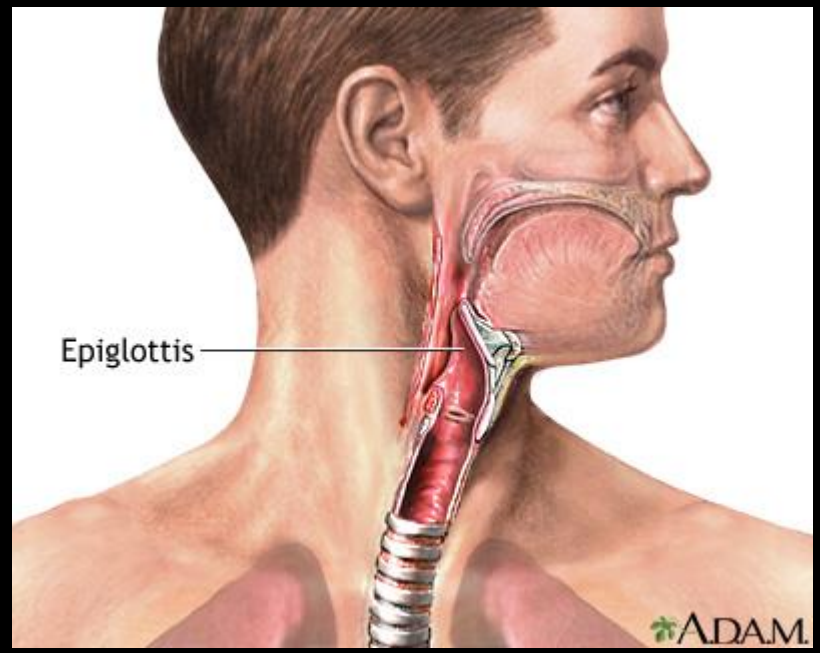

Superior Turbinate
Middle Turbinate
Inflamed
Inferior Turbinate
Inferior Turbinate

The Upper Respiratory Tract

- pharynx passage way that connects back of mouth and nasal cavity to larynx and esophagus

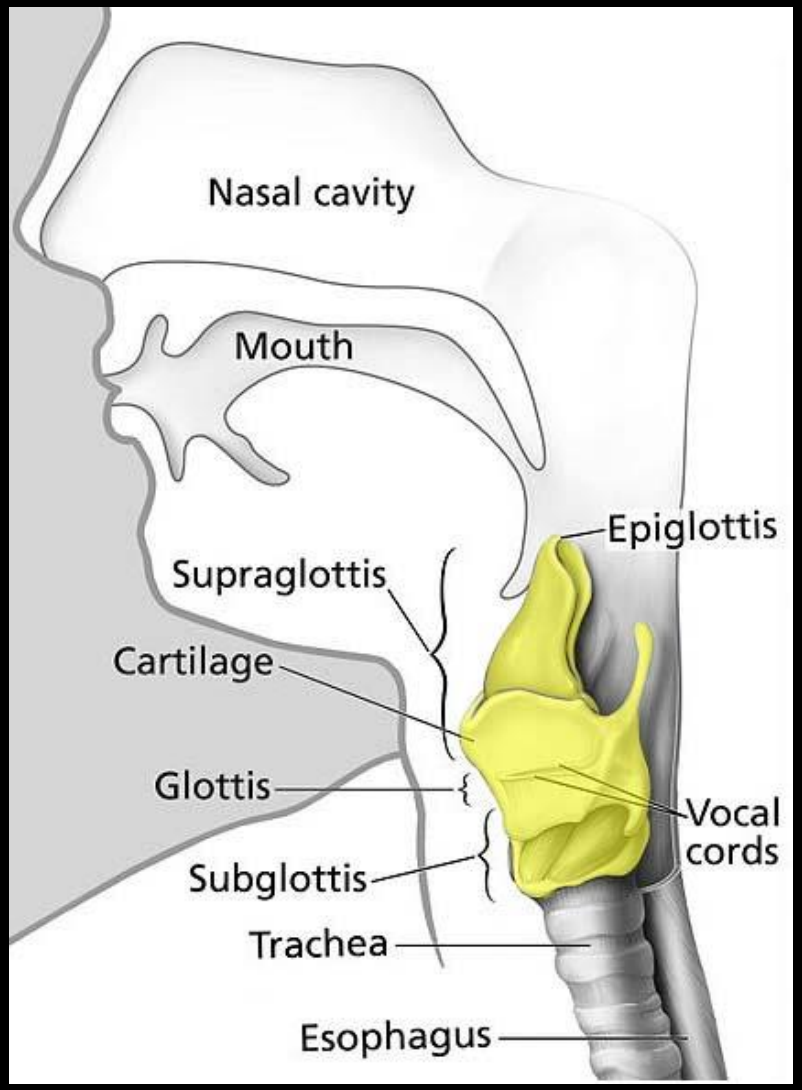


- epiglottis flap of cartilage over entrance of trachea
- This prevents food and drink from entering the trachea and passing into the bronchi of the lungs. When the epiglottis is at rest, it is upright and allows air to pass unobstructed into the lower respiratory tract.



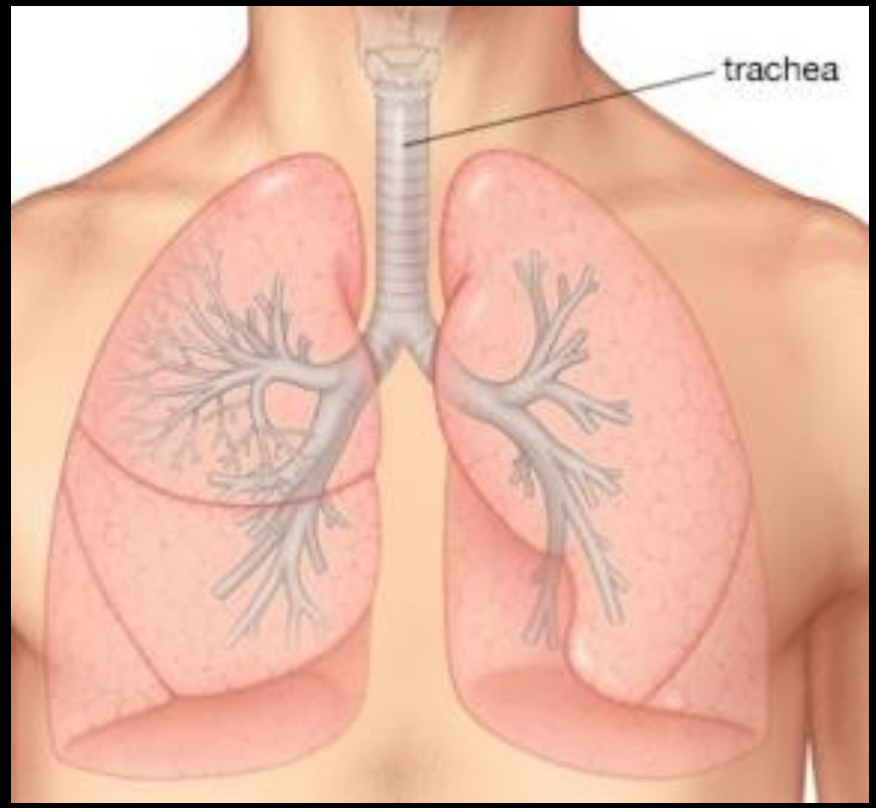
The Upper Respiratory Tract

- larynx structure that contains the vocal cords
- Also known as the voice box.
- Made from cartilage - a tough and firm connective tissue
- - Not curriculum



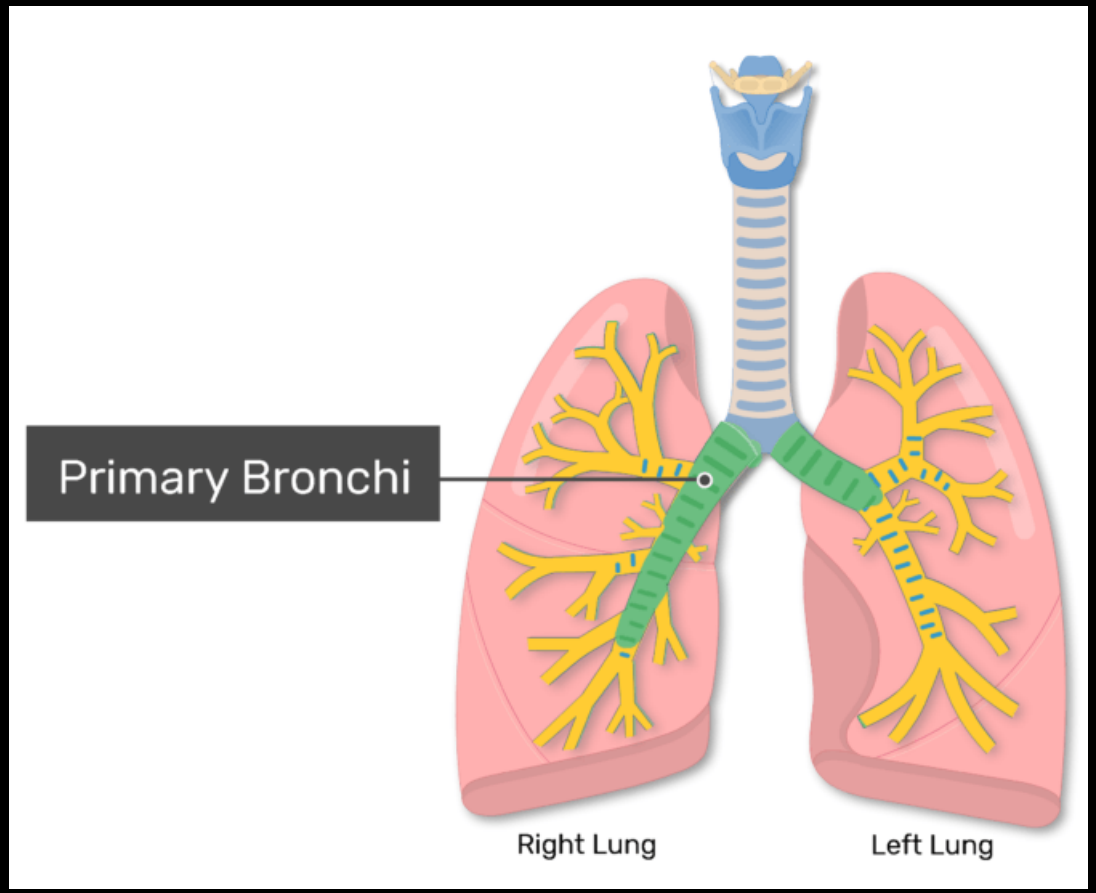
The Upper Respiratory Tract

- trachea flexible tube through which air moves from the mouth to the bronchi
- Also known as the windpipe.
- The trachea is strengthened by semicircular, cartilaginous arches that prevent it from collapsing. The open part of the semicircle faces the esophagus and allows the esophagus to expand when food is being swallowed.



The Lower Respiratory Tract

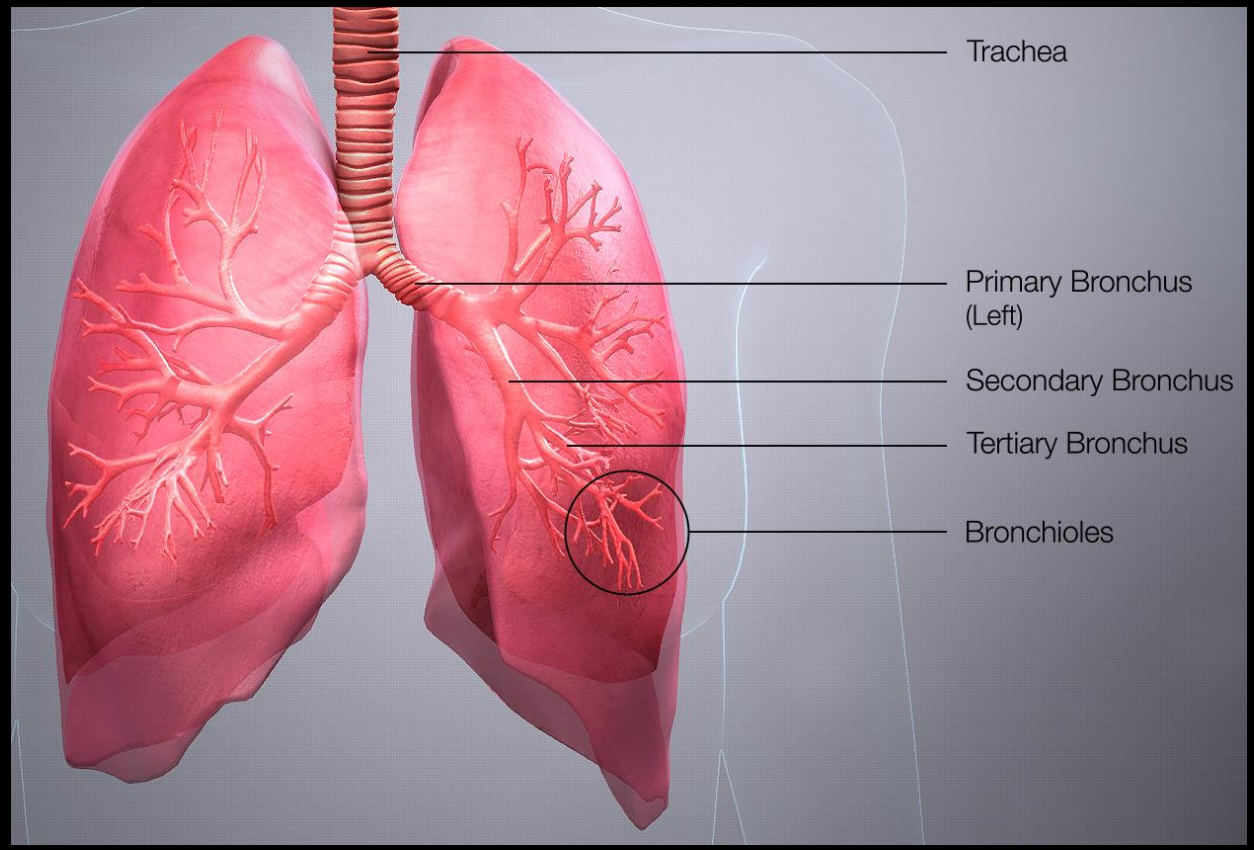
- bronchi passageways that branch from trachea into lungs (singular: bronchus)
- The bronchi contain C-shaped cartilaginous rings that surround and are part of the bronchus wall. They are stacked one on the next, running the length of the bronchus and providing support.



The Lower Respiratory Tract

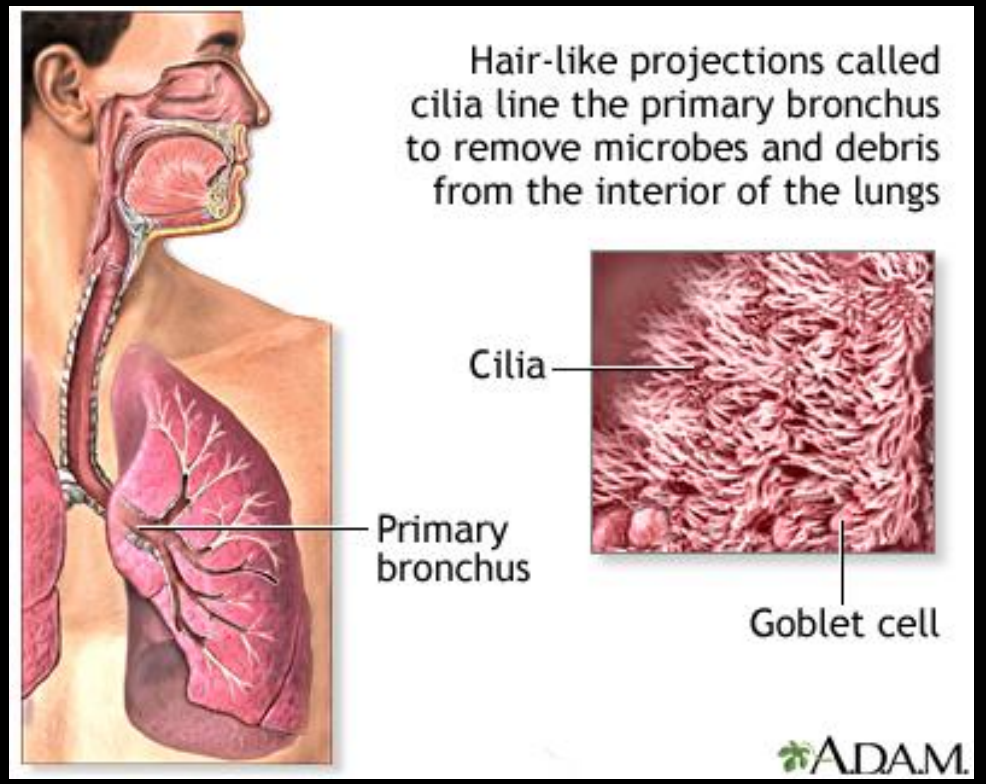
- bronchioles passageways that branch from bronchi into lobes of lungs

- Bronchioles do not have C rings.



The Lower Respiratory Tract

- Both the bronchi and bronchioles are lined with cilia and mucus-producing cells, just as in the upper respiratory tract.
- The mucus captures foreign particles, such as microscopic pollutants and pathogens.
- The cilia move the foreign particles up into the upper respiratory tract.
- From there, the foreign particles can be ejected from the body by coughing or sneezing, or they can be swallowed.

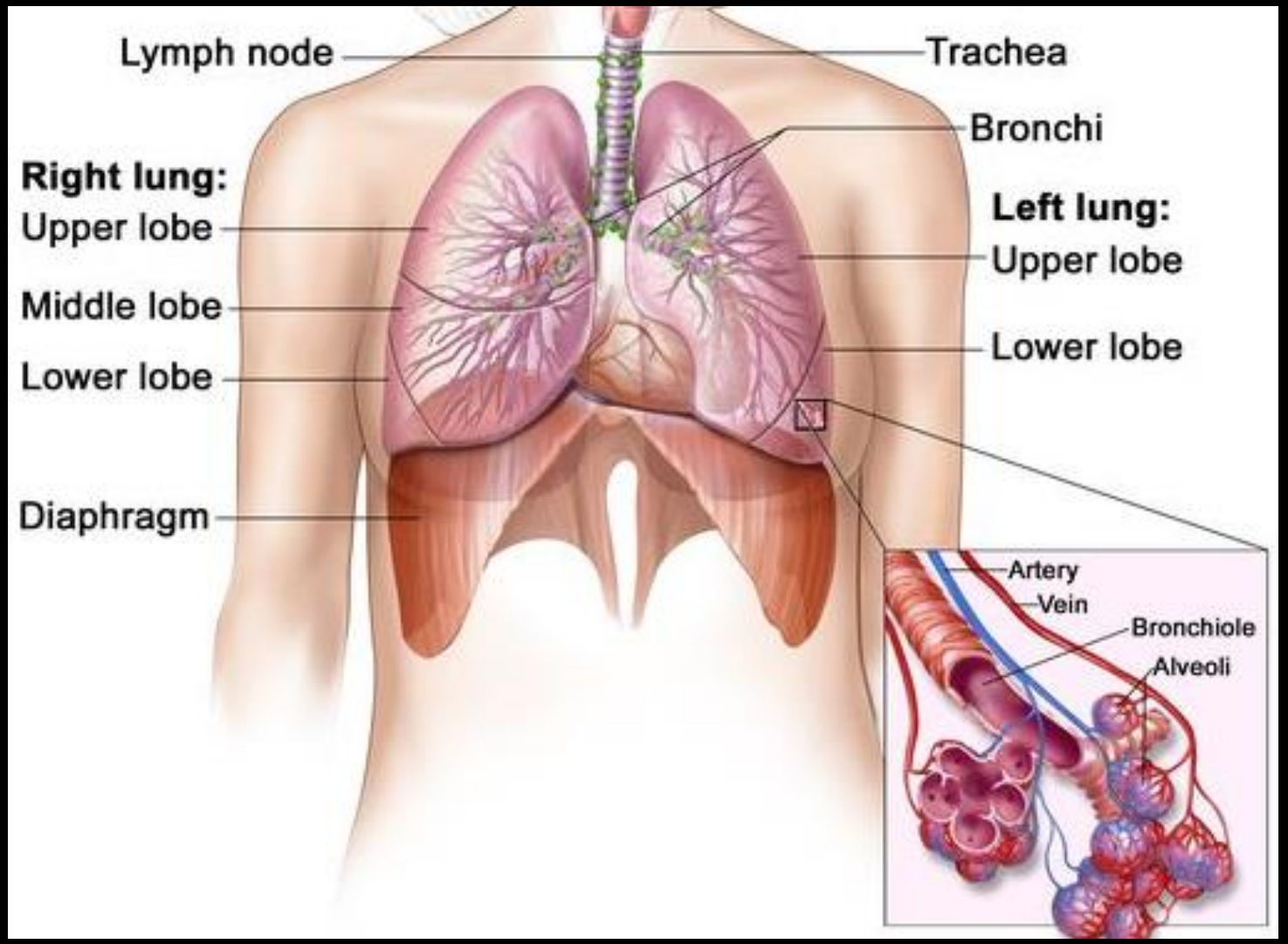


The Lower Respiratory Tract

- Lungs are the principal organs of respiration. Site of gas exchange in the human body.

The Lower Respiratory Tract

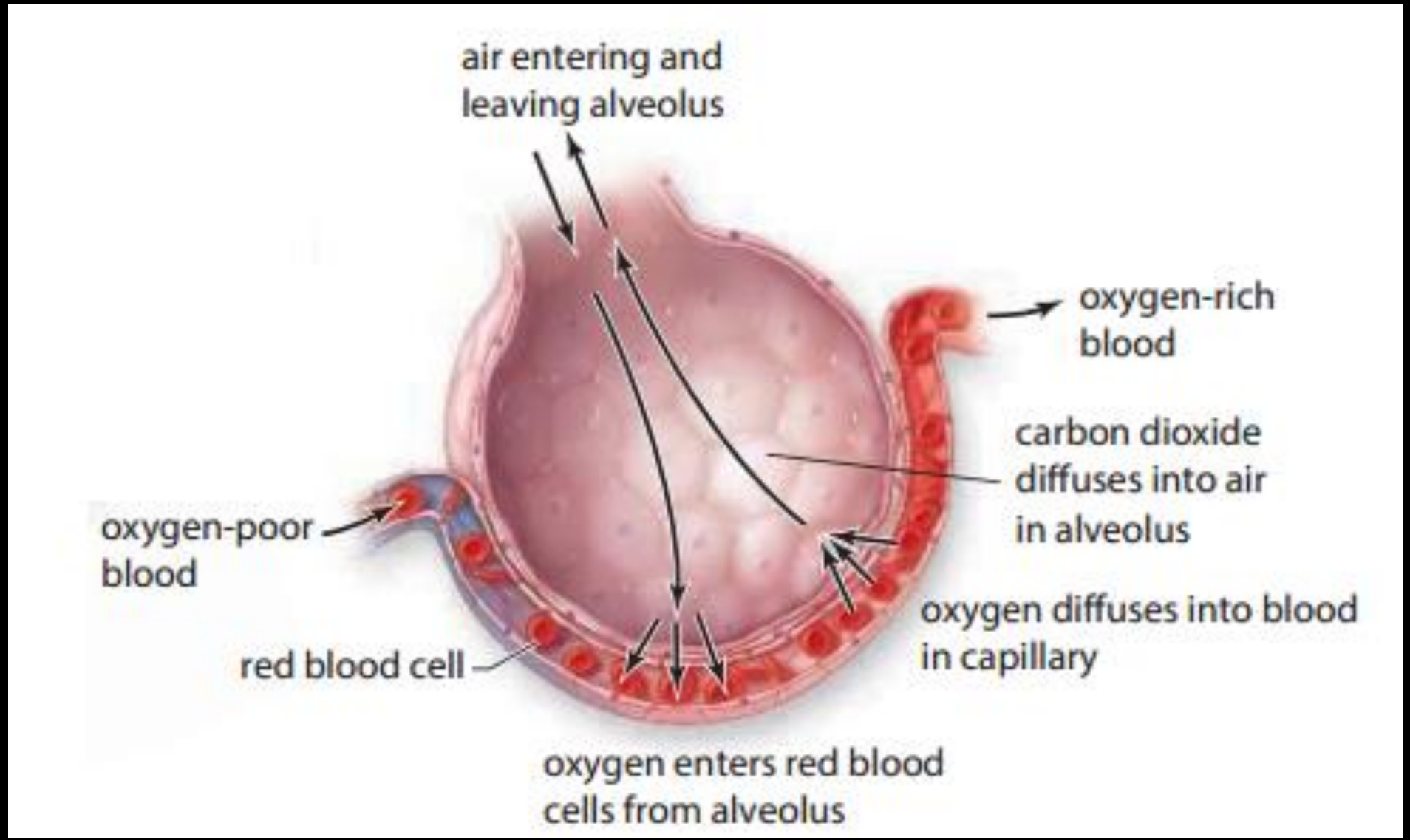
- alveoli gas exchange structures within the lungs (singular: alveolus)



Alveoli Continued

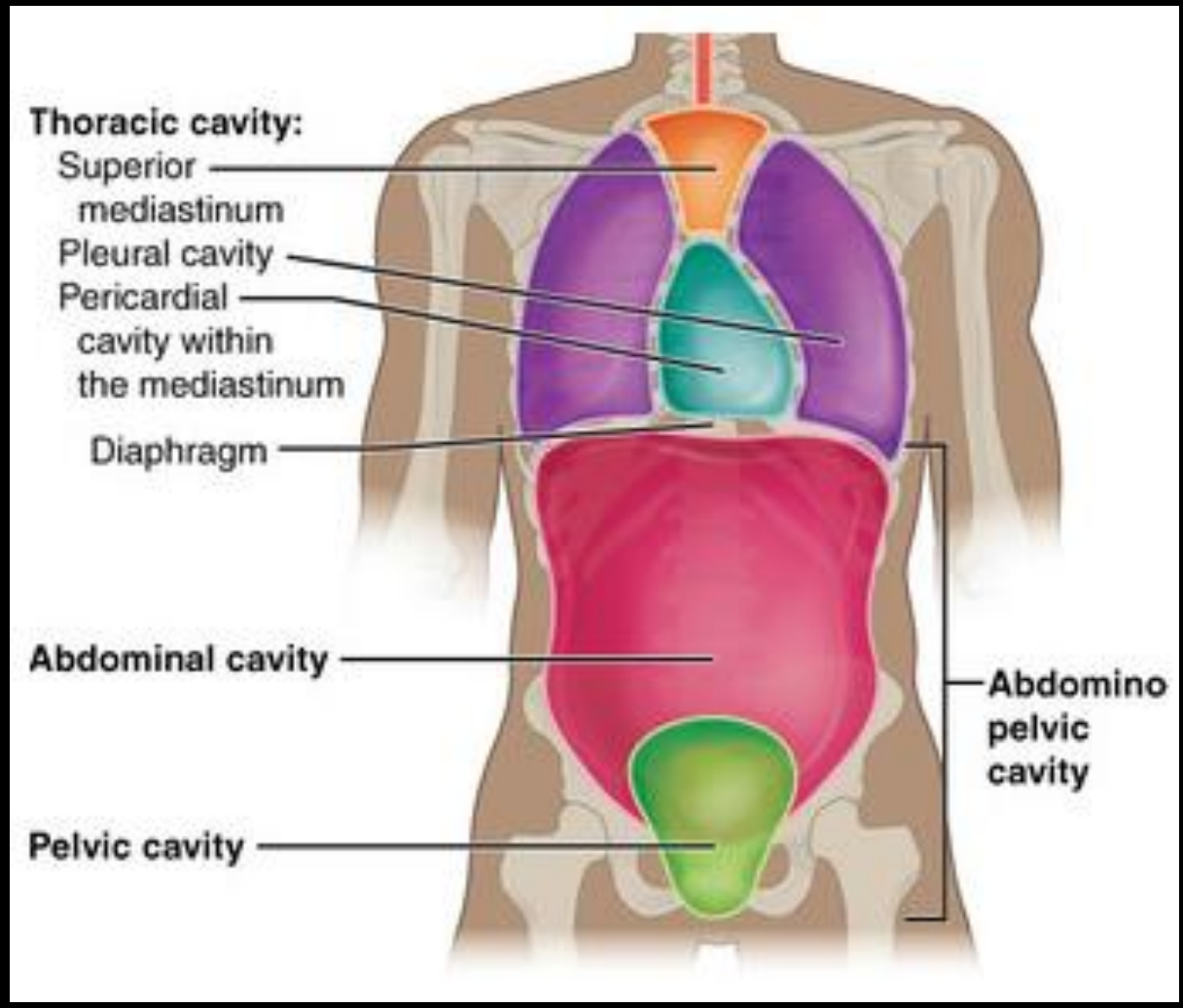
- The alveolar wall is one cell thick and is surrounded by a network of tiny capillaries
- Capillaries are tiny blood vessels—their walls are also one cell thick—that link the arteries with the veins. (Arteries carry oxygen-rich blood from the heart to the body tissues. Veins carry oxygen-poor blood from the body tissues back to the heart.) Where capillaries surround the alveoli, carbon dioxide dissolved in the blood is exchanged for oxygen.
- The alveoli are lined with a fluid that permits the diffusion of gases and that helps to keep them from collapsing and prevents their sides from sticking together and closing.

Alveoli Continued



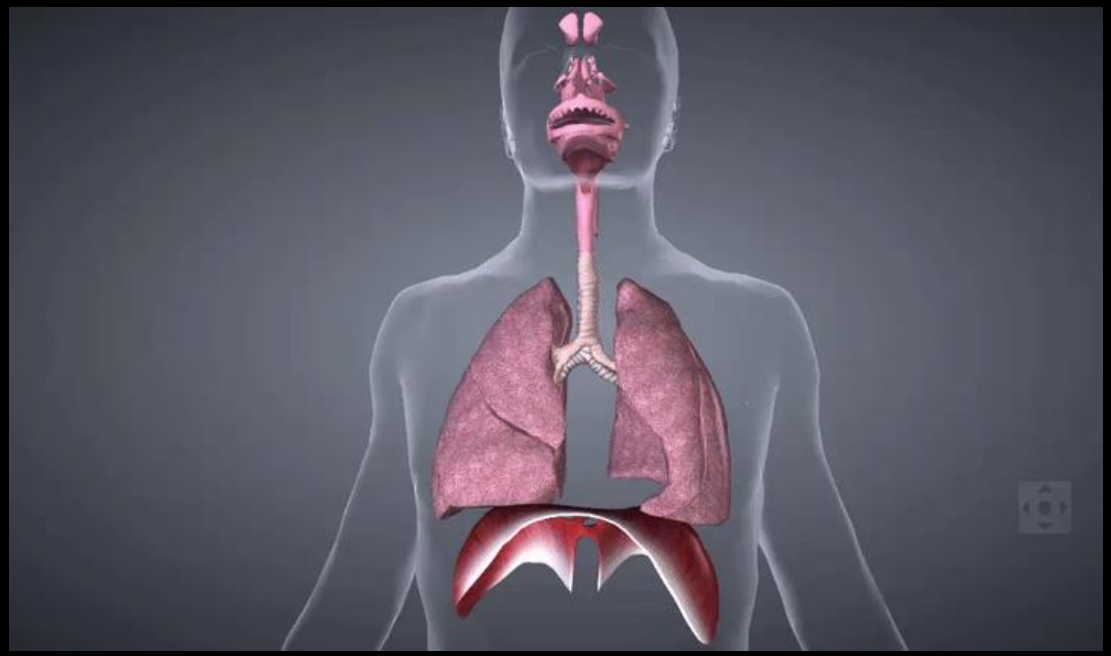
The Lower Respiratory Tract

- diaphragm sheet of muscle separating thoracic and abdominal cavities



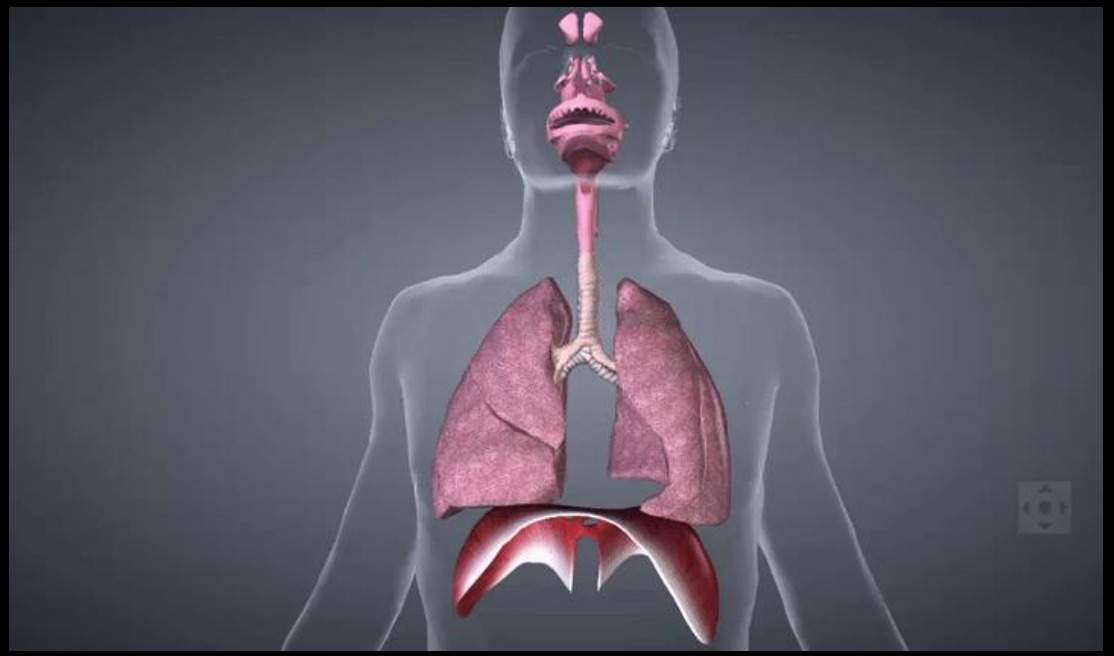
The Mechanics of Breathing

- inspiration movement of air into lungs
- the external rib muscles and the diaphragm contract.
- This action expands the rib cage upward and outward, and the floor of the chest cavity downward. Since the thoracic cavity is airtight, its volume increases. The increase in volume means that the same amount of air is contained in a larger space. When the molecules of a gas are farther apart, as they are when the volume of the thoracic cavity increases, they exert less outward pressure. As a result, the air pressure in the thoracic cavity decreases.



The Mechanics of Breathing

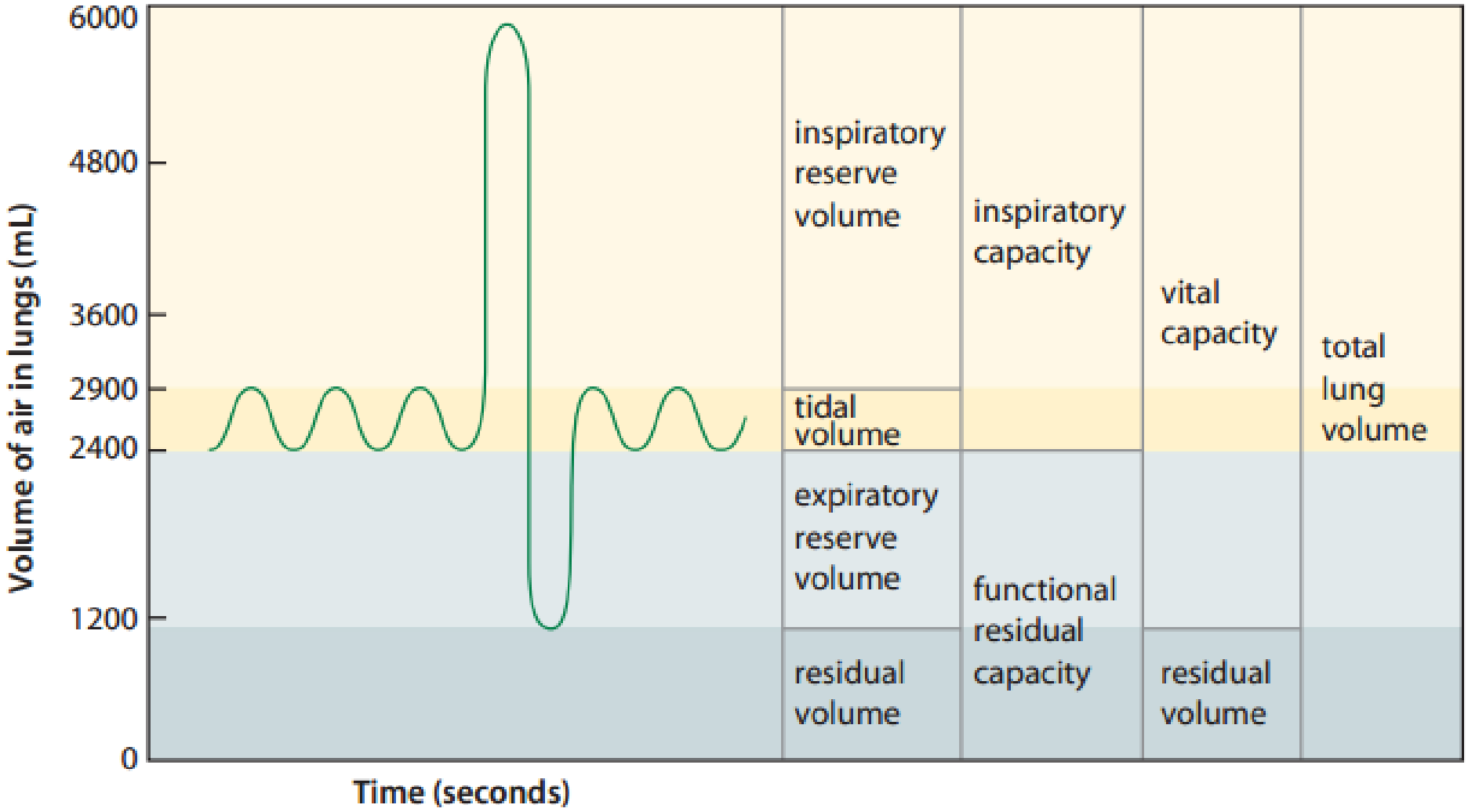
- expiration movement of air out of lungs
- the diaphragm and the rib muscles relax, reducing the volume of the thoracic cavity.
- As a result, the volume of the lungs decreases, the air pressure inside the lungs increases, and air moves from the lungs to the lower-pressure environment outside the body.
- In other words, a change in air pressure causes air to move from an area of high pressure (the lungs) to an area of lower pressure (the external environment).



Respiratory Volume

- tidal volume volume of air inspired and expired in normal breathing at rest
- inspiratory reserve volume the additional volume of air that can be taken into the lungs, beyond a regular inspiration
- expiratory reserve volume additional volume of air that can be forced out of the lungs, beyond a regular expiration
- vital capacity total volume of gas that can be moved in or out of lungs
- residual volume amount of gas left in lungs after a full expiration

A Typical Spirograph



Investigation 6.B

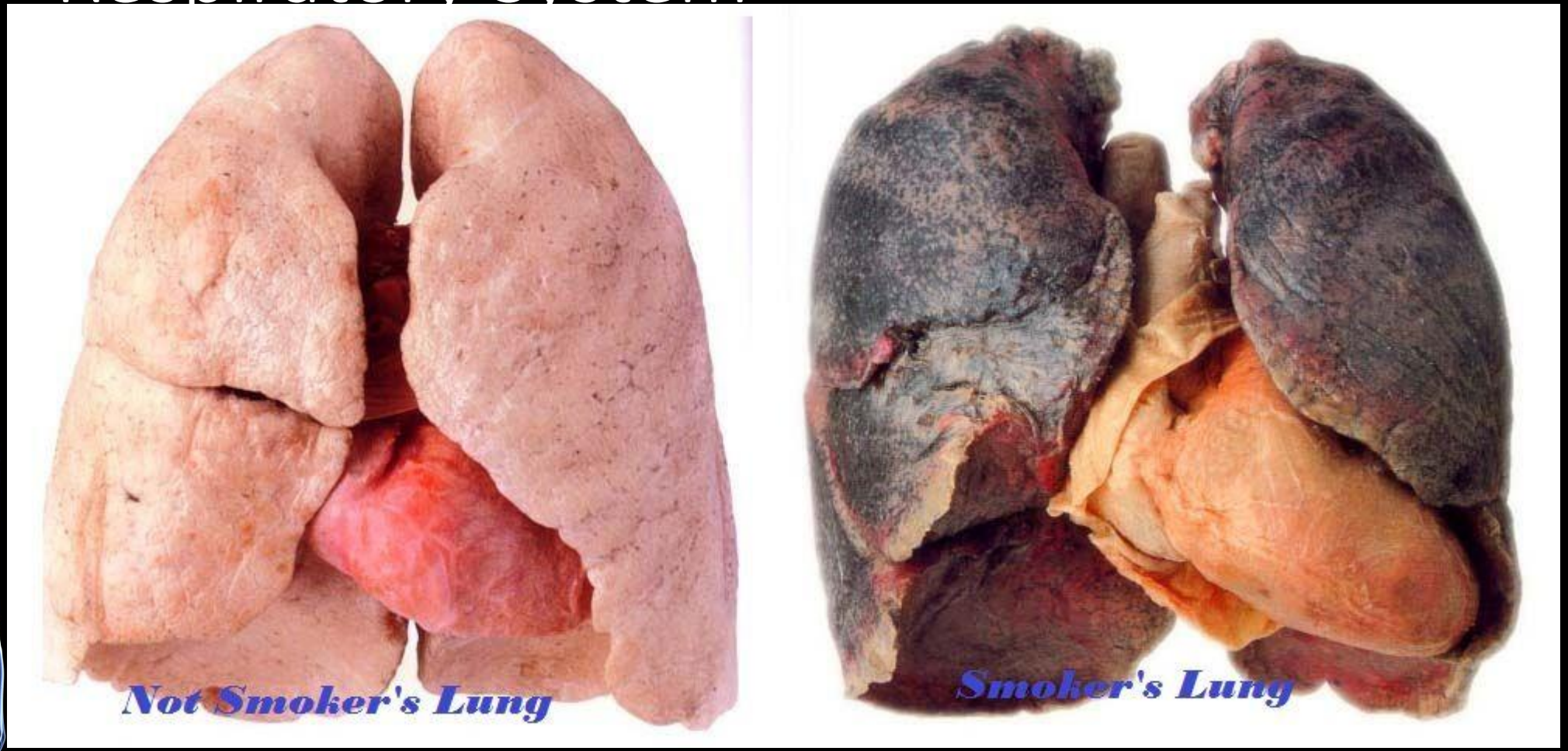
- Measuring Respiratory Volumes

- Launch Lab Modeling Your Lungs

Environmental Factors Affecting the Respiratory System

- **Dangerous chemicals in tobacco smoke**
- Highly damaging components of tobacco smoke include:
- **tar** – is the word for the solid particles suspended in tobacco smoke. The particles contain chemicals, including cancer-causing substances (carcinogens). Tar is sticky and brown, and stains teeth, fingernails and lung tissue
- **carbon monoxide** – is a poisonous gas. It is odourless and colourless and, in large doses, quickly causes death because it takes the place of oxygen in the blood. In people who smoke, the carbon monoxide in their blood makes it harder for oxygen to get to their organs and muscles
- **oxidizing chemicals** – are highly reactive chemicals that can damage the heart muscles and blood vessels of people who smoke. They react with cholesterol, leading to the build-up of fatty material on artery walls. Their actions lead to heart disease, stroke and blood vessel disease
- **metals** – tobacco smoke contains several metals that cause cancer, including arsenic, beryllium, cadmium, chromium, cobalt, lead and nickel
- **radioactive compounds** – tobacco smoke contains radioactive compounds that are known to be carcinogenic.

Environmental Factors Affecting the Respiratory System



Environmental Factors Affecting the Respiratory System

- Cigarette Smoke
- The effects of tobacco smoke on the respiratory system include:

1) Irritation of the trachea (windpipe) and larynx (voice box)
2) Reduced lung function and breathlessness due to swelling and narrowing of the lung airways and excess mucus in the lung passages
3) Impairment of the lungs' clearance system, leading to the build-up of poisonous substances, which results in lung irritation and damage
4) Increased risk of lung infection and symptoms such as coughing and wheezing
5) Permanent damage to the air sacs of the lungs.

Environmental Factors Affecting the Respiratory System

- Vaping Fumes
- Nicotine dependence: vaping products contain large amounts of nicotine, which is a highly addictive drug. For instance, 1 Juul Pod (Juul is one brand name of a vaping product) has the same amount of nicotine as 20 cigarettes (approximately one pack). This means people may develop dependence quickly and it may even increase your chances of smoking traditional cigarettes.
- Short-term symptoms: Individuals should watch for signs of cough, shortness of breath, chest pain, nausea, vomiting and/or diarrhea. These may be signs of lung damage. If you are experiencing these symptoms, seek medical attention.
- Lung disease: Vaping can make asthma and other existing lung diseases worse. Breathing in the harmful chemicals from vaping products can cause irreversible (cannot be cured) lung damage, lung disease and, in some cases, death. Some chemicals in vaping products can also cause cardiovascular disease and biological changes that are associated with cancer development.

Environmental Factors Affecting the Respiratory System

- Allergens – dust and mold
- Allergies can cause inflammation in your lungs. This inflammation can result in coughing, wheezing, shortness of breath, and other symptoms.
- The symptoms of allergies, such as nasal congestion and watery eyes, come from inflammation of your body tissues. Allergies can also cause inflammation in your lungs. This inflammation is the result of your body's misguided attempt to protect itself from the allergens.
- Allergies can cause lung problems. Exposure to allergens can cause allergy-induced asthma, a condition in which the airways swell and produce extra mucus.
- Individuals with allergies are at higher risk of developing respiratory infections, such as bronchitis. Exposure to seasonal allergies can compromise the immune system and increase mucus production, which can promote the development of bronchitis and other respiratory infections.
- People can develop hypersensitivity to dust, tiny organisms, and chemicals. This hypersensitivity can cause hypersensitivity pneumonitis, a type of allergic reaction that causes inflammation of the lung's air sacs.

Environmental Factors Affecting the Respiratory System

- The Respiratory Systems Allergic Response

- During an asthma attack, the bronchi and bronchioles swell, the bronchial muscles tighten, and mucus production increases. These changes obstruct the airways and make breathing difficult or impossible.

Environmental Factors Affecting the Respiratory System

- Other airborne chemicals
- Many types of gases—such as chlorine, phosgene, sulfur dioxide, hydrogen sulfide, nitrogen dioxide, and ammonia—may suddenly be released during industrial accidents and may severely irritate the lungs. Gases have also been used as chemical warfare agents.
- Gases such as chlorine and ammonia easily dissolve and immediately irritate the mouth, nose, and throat. The parts deep inside the lungs are affected only when the gas is inhaled deeply. A common household exposure occurs when a person mixes household ammonia with cleansers containing bleach. The irritant gas chloramine is released.

Environmental Factors Affecting the Respiratory System

- Some gases—for instance, nitrogen dioxide—do not dissolve easily. Therefore, they do not produce early warning signs of exposure, such as irritation of the nose and eyes, and they are more likely to be inhaled deeply into the lungs. Such gases can cause inflammation of the small airways (bronchiolitis) or lead to fluid accumulation in the lungs (pulmonary edema).
- Silo filler's disease (which mostly affects farmers) results from inhaling fumes that contain nitrogen dioxide given off by moist silage, such as fresh corn or grains. Fluid may develop in the lungs as late as 12 hours after exposure. The condition may temporarily resolve and then recur 10 to 14 days later, even without further contact with the gas. A recurrence tends to affect the small airways (bronchioles).

Environmental Factors Affecting the Respiratory System

- Inhalation of some gases and chemicals may also trigger an allergic response that leads to inflammation and, in some cases, scarring in and around the tiny air sacs (alveoli) and bronchioles of the lung. This condition is called hypersensitivity pneumonitis.
- Radioactive gases, which may be released in a nuclear reactor accident, may cause lung cancer and other cancers many years after the exposure.
- Other inhaled gases may cause a general body poisoning (including breathing difficulty) because they are poisonous to the body's cells (such as cyanide) or because they displace oxygen in the blood and therefore limit the amount of oxygen reaching the tissues (such as methane or carbon monoxide).
- In some people, inhalation of small amounts of gas or other chemicals over a long period may result in chronic bronchitis (inflammation of the airways). Also, inhalation of some chemicals, such as arsenic compounds and hydrocarbons, can cause cancer. Cancer may develop in the lungs or elsewhere in the body, depending on the substance inhaled.

Respiratory System Disorder Poster

- Tonsillitis
- Laryngitis
- Bronchitis
- Bronchitis
- Pneumonia
- Pleurisy
- Emphysema
- Cystic Fibrosis
- Asthma
- Lung Cancer

- Investigation 6.A The Alveoli Area Advantage
- Investigation 6.C Breathing Rate and Oxygen Demand