

Pandemic Plan for the Church

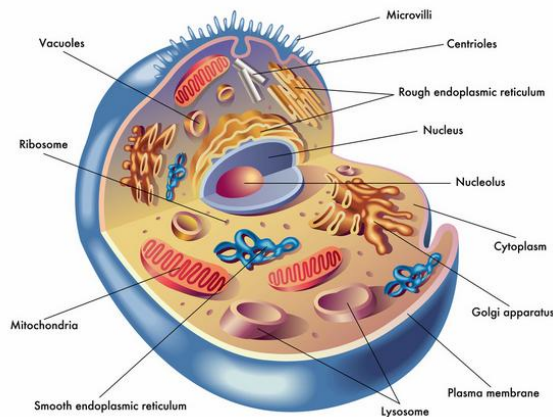
Ministering to the Community in a Time of Crisis

Anatomy and Physiology of Respiratory System

Many of those who died from the 1918 Influenza, and those who recently have suffered from the HPAI H5N1 virus succumbed through pneumonia. This is because the primary target for replication of these viruses is the respiratory **epithelial cells** (cells that line the cavities of the body). Due to the process of the disease of the HPAI H5N1 virus, the focus will remain on the Respiratory system.

After a clear comprehension of the respiratory system is achieved, we will move on to how our immune response to the invading virus can cause a **cytokine storm** (inflammation in the lungs) leading to pneumonia. Understanding these will help us to recognize, treat, and even prevent a cytokine storm.

The Cell



Human Cell
Quizlet.comⁱ

The cell is the basic building block of the human body. All cells contain structures that perform specific functions. There are different types of cells in the body with specialized functions including: epithelial, cardiac, osteocytes, etc.

Metabolism is the conversion of glucose and other nutrients into energy inside the cell. The conversion of glucose into adenosine triphosphate (ATP) is an essential process of metabolism.

Oxygen is used by the cell to metabolize glucose into energy. When oxygen enters the cell in the correct amount, metabolism is very efficient and yields a high quantity of energy in the form of ATP. The most essential functions of cells rely on some basic requirements principally water, glucose, and oxygen.

Cell Respiration Formula



The reason we breathe is to allow for the ventilation of atmospheric air (approximately 21% oxygen) to provide gas exchange at the cellular and molecular level. The function of the respiratory system, also known as the pulmonary system, is ventilation and oxygenation. Oxygen (O₂) is taken into the blood stream from inhaled air, and carbon dioxide (CO₂) picked up from the blood in the body and is expelled through exhalation.

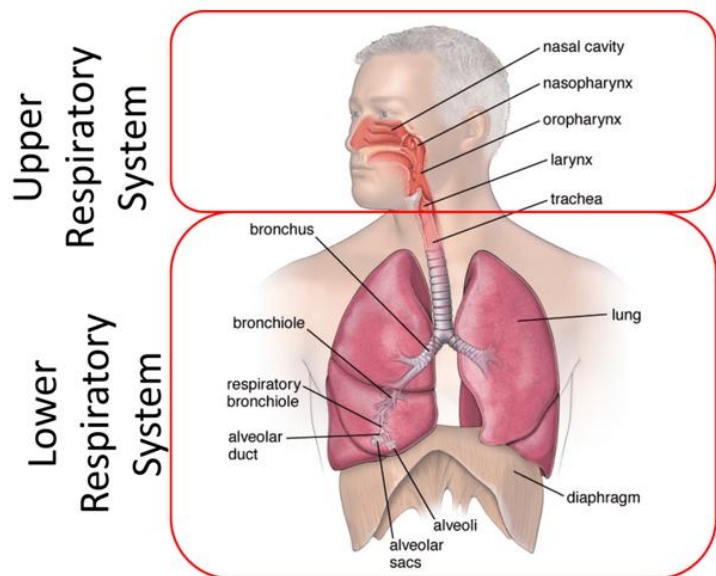
When this exchange is compromised, problems arise that can cause **hypoxia**. Hypoxia is a condition where there is not enough oxygen for the body's tissues and cells to function properly. This can be a serious medical issue, potentially causing brain damage, and if severe or prolonged it can lead to loss of consciousness and even death.

There are many causes of hypoxia, including: breathing problems such as COPD; environmental factors such as carbon monoxide poisoning; and circulatory issues with the heart or blood vessels. However, this document will focus on issues caused by viral and bacterial infections.

Respiratory Anatomy

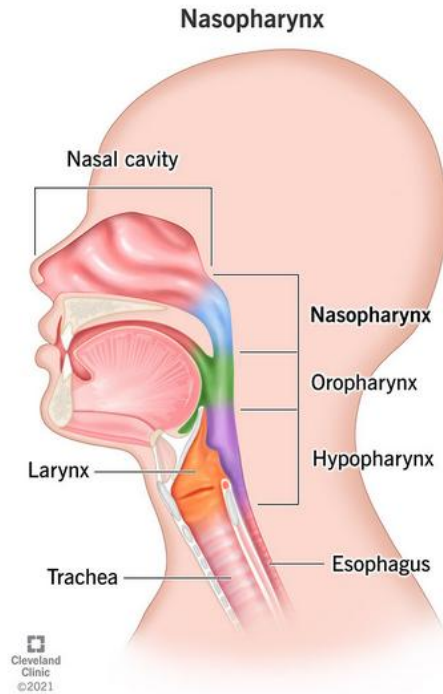
Anatomy is the study of body structure. Physiology is the study of body function. Understanding these will help you identify abnormal structure and function from what is normal. Having this basic understanding will help you assess and treat a person who is ill and in your care.

The respiratory system is comprised of two areas, upper and lower. They are divided by the larynx.



Respiratory Systemⁱⁱ

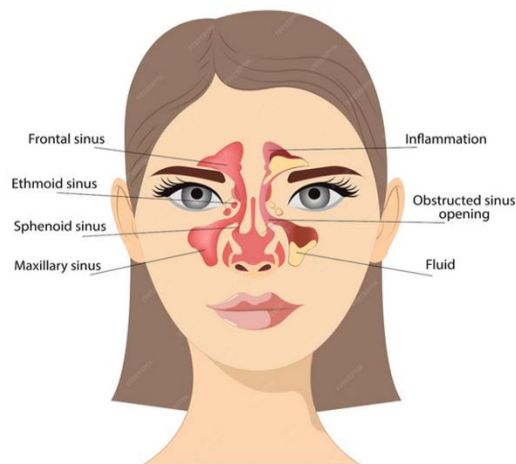
Air enters the body through the mouth and nose. It moves down from the nose through the **nasopharynx** (area behind the nose).



Nasopharynx
Cleveland Clinicⁱⁱⁱ

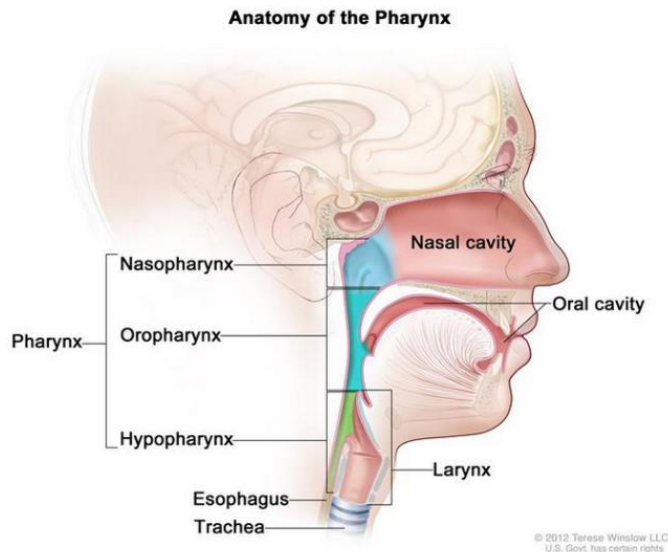
The **sinuses** located in the nasopharynx are air filled spaces lined with mucous membranes. While passing through the sinuses, air is filtered and dust and other particles are trapped, as well as being warmed.

HEALTHY SINUS SINUSITIS



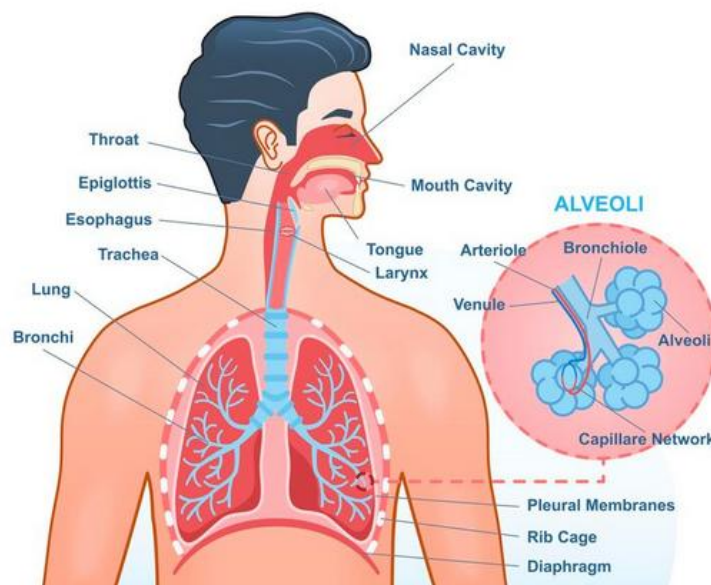
Sinuses
Tunrooman30/Freepik.com^{iv}

Air also enters the body through the mouth then through the **oropharynx** (area behind the mouth). The **pharynx** (the throat) is the area that encompasses both the nasopharynx and the oropharynx.



Parts of the Pharynx Cancer Help^v

From the pharynx the air continues through a leaf shaped structure called the **epiglottis**. When swallowing, the epiglottis closes over the glottis (the opening to the trachea) and prevents food, liquid, or foreign objects from entering the **trachea** (a cylindrical pipelike structure that connects the pharynx to the lungs). A blocked trachea can cause asphyxiation in minutes.

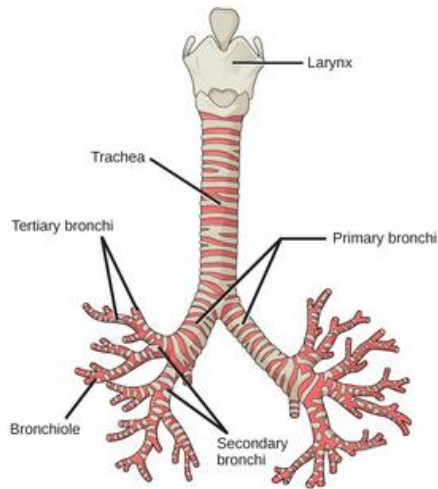


Human Respiratory System Edgecreative01^{vi}

Below the epiglottis is the **larynx** (also known as the voice box) which contains the vocal cords. A ring-shaped structure called the **cricoid cartilage** forms the lower part of the larynx.

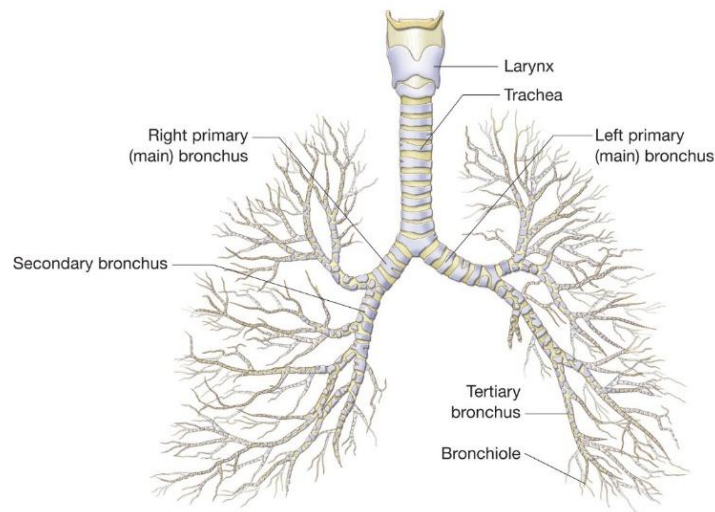
The trachea (also known as the windpipe) is a tube that carries the inhaled and exhaled air to and from the **lungs**. The lungs are organs in which the exchange of atmospheric oxygen and the waste carbon dioxide take place. When the trachea meets the lungs, it splits (bifurcates) into two branches called **bronchi**. Each branch or “mainstem” is called a **bronchus** and goes to each lung.

The Trachea



Trachea and Bronchi System
cuny.edu^{vii}

Inside each lung, like a tree, the bronchi continue to branch off and split into smaller branches called **bronchioles**. As these bronchioles continue to branch and split, the air passages continue to get smaller and smaller.



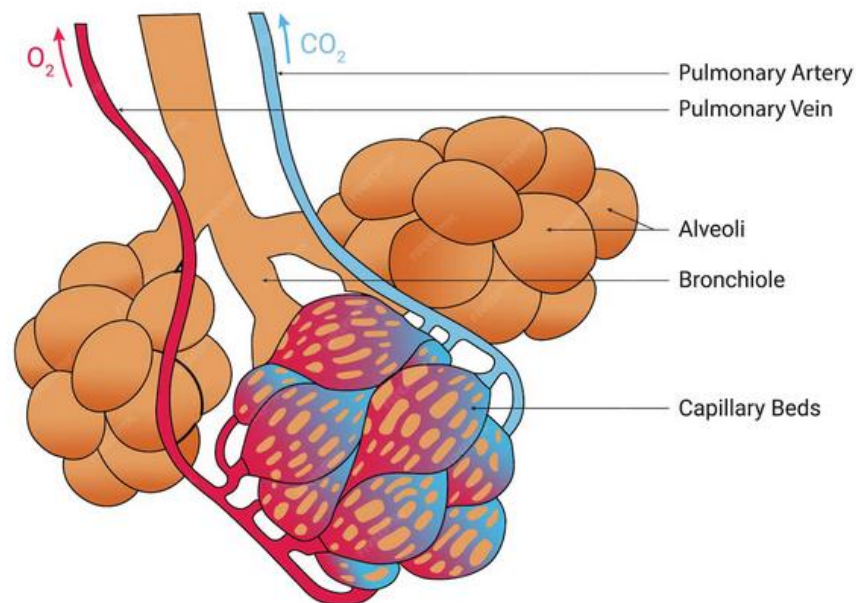
The Airway
Emergency Care^{viii}

Eventually, these smaller passages end at small air sacs called **alveoli**. It is in these small sacs of alveoli that the gas exchange of oxygen and carbon dioxide take place.

Alveolar sacs are clusters of tiny air sacs in the lungs at the end of bronchioles. They are crucial for gas exchange. They expand during inhalation to take in oxygen and contract during exhalation to release carbon dioxide.

Oxygenated blood is carried from the lungs to the heart, then is pumped to the body. Deoxygenated blood returns to the heart from the body, then to the lungs for the waste carbon dioxide to be expelled.

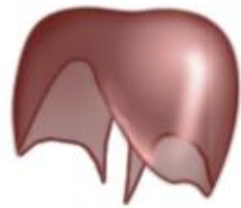
Lungs Alveoli



A diagram of the lungs showing capillary beds and gas exchange
Hamja.iu/Freepik.com^{ix}

The **diaphragm** is a large muscular structure that divides the chest cavity from the abdominal cavity. The diaphragm works together with the intercostal muscles of the ribs to create negative and positive pressure to enable inhalation and exhalation.

Diaphragm

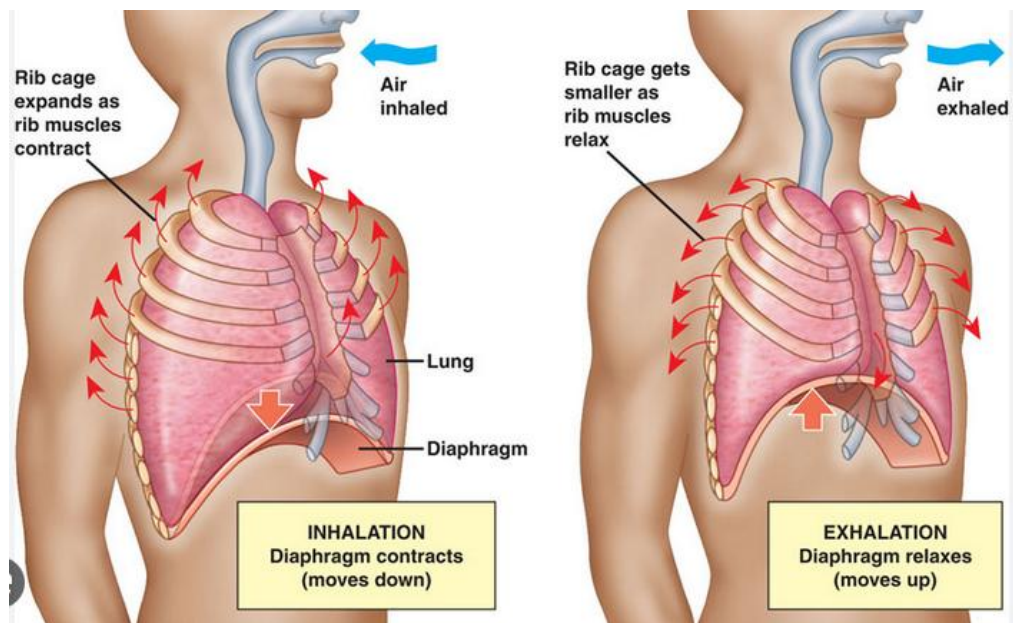


The diaphragm is shaped like a parachute



Diaphragm

A.D.A.M. Medical Encyclopedia^x



Muscles of Respiration
Medbullets^{xi}

Physiology of the Respiratory System

The function of the respiratory system is to facilitate the action of inhalation and exhalation, and to affect the process of ventilation, the exchange of gasses.

Inhalation is an active process involving the muscles of the rib cage and the diaphragm lowers. When these engage, they cause negative pressure drawing in atmospheric air into the lungs.

Exhalation is a passive process in which the muscles relax, the diaphragm rises, and positive pressure is formed, pushing the air out of the lungs.

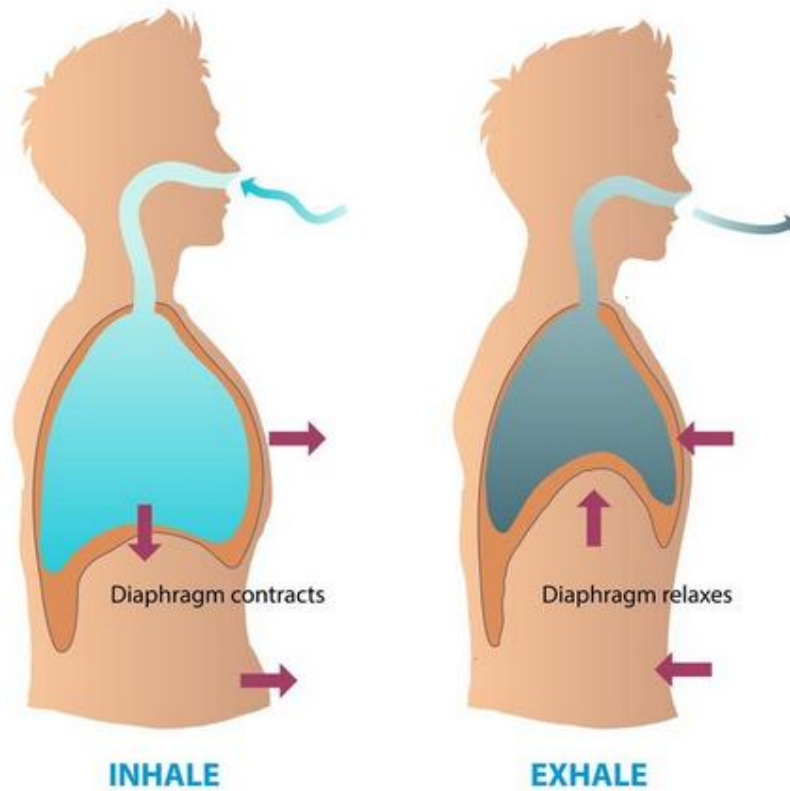
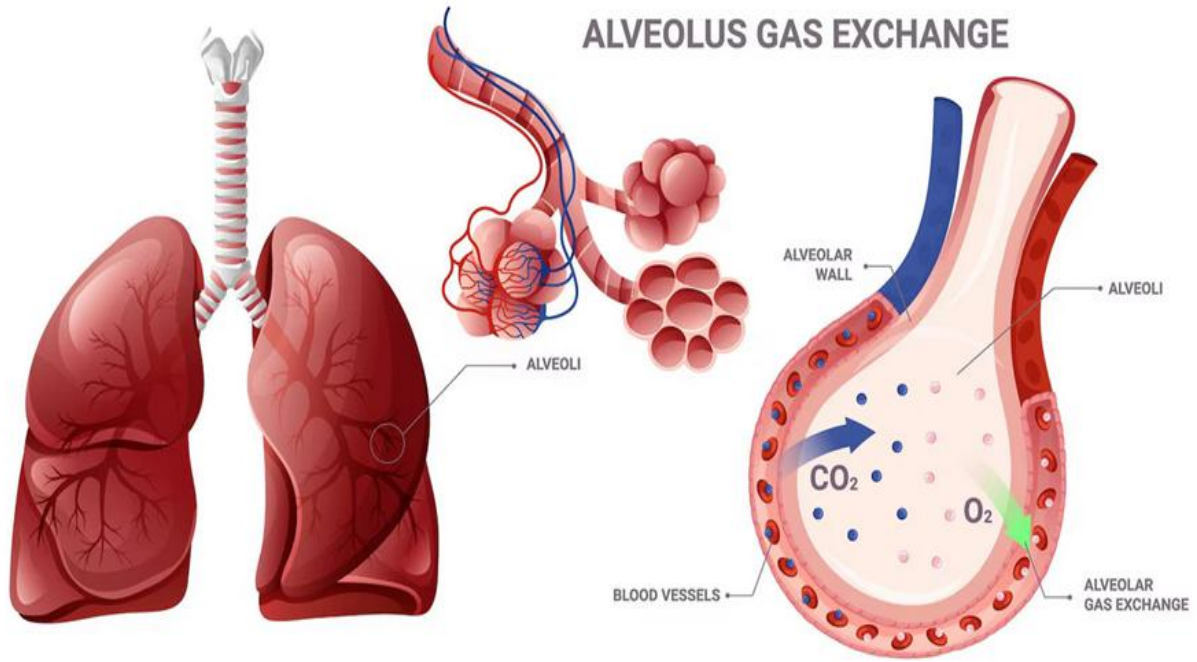


Illustration of Respiration Diagram
Zombiu26/Freepik.com^{xii}

Ventilation is the actual process of gas exchange in the alveoli.

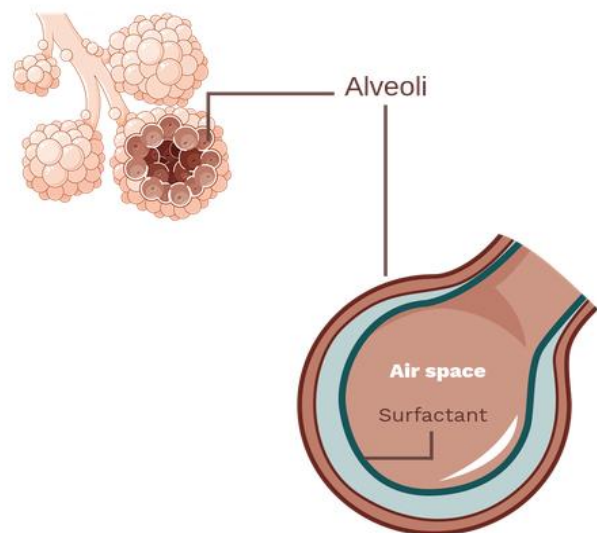
During inhalation, air is brought down to the alveoli. These tiny sacs are where the gas exchange takes place. Each single alveolus has a thin wall, only one cell thick. They are surrounded by pulmonary capillaries which bring circulating blood to the alveoli.

Through the thin walls of the alveoli, oxygen is passed through to the pulmonary capillaries to be brought to the bloodstream and to the body's tissues. At the same time carbon dioxide brought from the waste products of the body's tissues is passed in the opposite direction from the capillaries into the alveoli to be exhaled. This whole process is called ventilation.



Alveolus Gas Exchange in lungs
Vixanart/Freepik.com^{xiii}

Surfactant is a substance produced by alveolar cells. It coats the inner surface of the alveoli. This coating facilitates alveolar ventilation by allowing the surface to be more pliable when inflating during inspiration and prevents the alveolus from collapsing during expiration. This aids in the ease of breathing.



Surfactant
alveoli/Labster Theory Pages^{xiv}

Common Upper Respiratory Tract Diseases

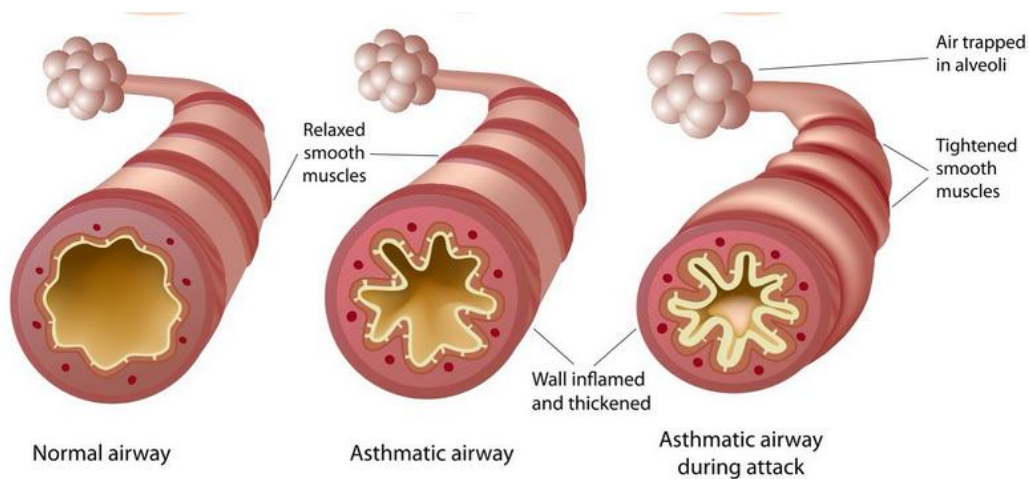
Upper Respiratory diseases are illnesses affecting the upper respiratory tract consisting of the nose, sinuses, throat, and larynx. They can be caused by viruses, bacteria, or allergies. Some common upper respiratory diseases include:

- Common Cold – caused by various viruses, characterized by nasal congestion, runny nose, sore throat, and cough.
- Influenza (Flu) – a viral infection that can cause fever, cough, sore throat, muscle aches, and fatigue.
- Strep throat – a bacterial infection causing sore throat, fever, and swollen tonsils.
- Sinusitis – Inflammation of the sinuses, often triggered by allergies or infections, leading to facial pain and congestion.
- Laryngitis – Inflammation of the larynx, causing hoarseness, or loss of the voice.
- Tonsillitis – Inflammation of the tonsils, often causing sore throat and difficulty swallowing.

Common Lower Respiratory Tract Diseases

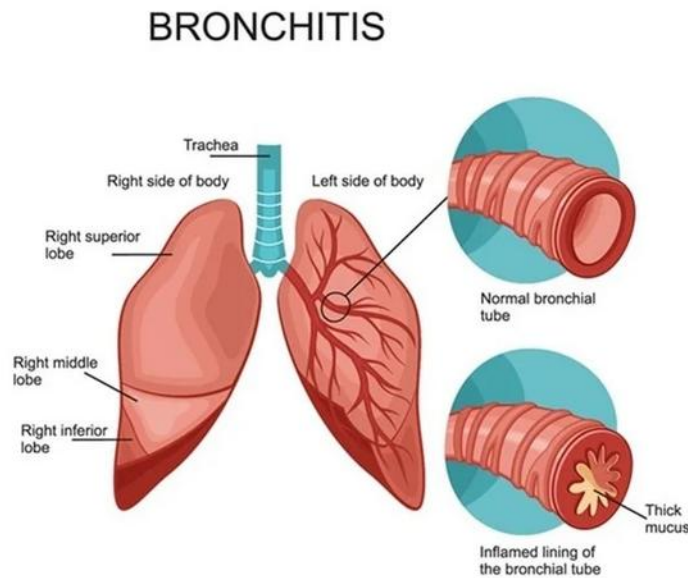
Lower Respiratory Tract diseases affecting the lower respiratory tract consisting of the lungs. They can be caused by viruses, bacteria, or environmental sources. Some may include:

Asthma – a chronic disease in which certain triggers can cause the airways to become inflamed and fill with mucus. The airways narrow, and breathing can become difficult.



What Causes Asthma?
Asthma Foundation^{xv}

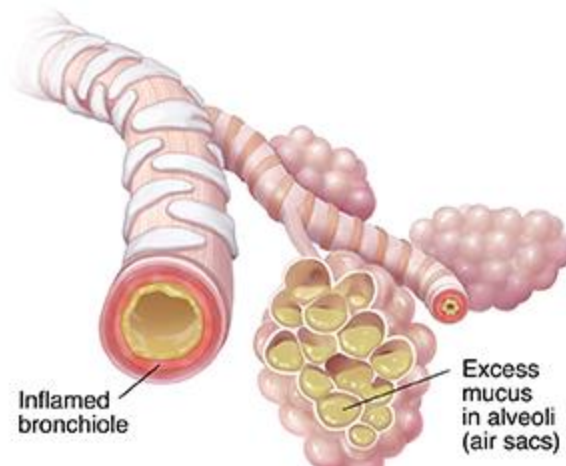
Bronchitis – is swelling in the air passages (bronchi). The bronchi fill with sticky mucus, making it difficult to breathe. It causes a cough with mucus which can last two to three weeks. It is usually caused by a virus.



Bronchitis
logika600 / Shutterstock^{xvi}

Pneumonia – is inflammation of one or both lungs that can be caused by bacteria or a virus. After the lungs become infected, the alveoli fill with pus and mucus. The swelling of the air sacs makes them unable to expand easily and inhibits oxygen from reaching the blood stream. The inflammation can cause shortness of breath, cough, fever, and chest pain.

Pneumonia



What is Pneumonia?
St Luke's^{xvii}

COPD (Chronic Obstructive Pulmonary Disease) – is a chronic progressive lung disease that causes the airways in the lungs to become swollen and blocked. Shortness of breath and increasing difficulty breathing with everyday activities are two common problems with COPD. Emphysema and chronic bronchitis are two common diseases that cause COPD.

Chronic Obstructive Pulmonary Disease^{xviii}

Chronic Obstructive Pulmonary Disease (COPD)

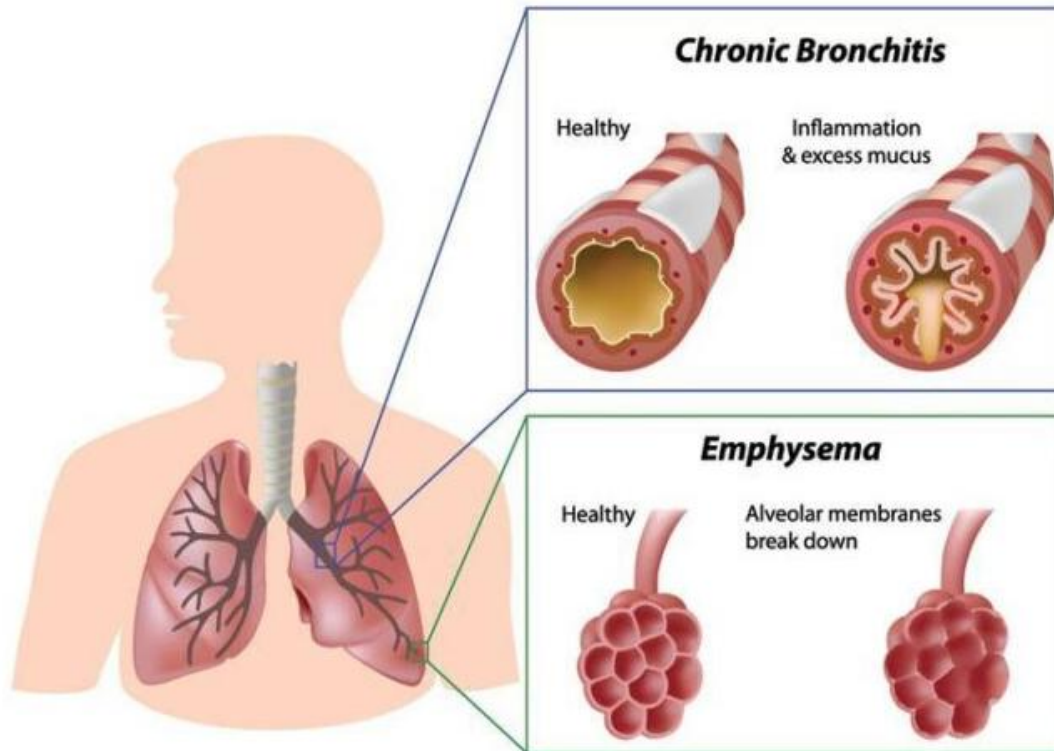


Illustration courtesy of healthflexhhs.com

Conclusion

Many of those who died from the 1918 Influenza, and those who recently from the HPAI H5N1 virus succumbed through pneumonia and ARDS. This is because the primary target for replication of these viruses is the respiratory epithelial cells (cells that line the cavity of the body). Understanding the respiratory system and how it works will help us to recognize, treat, and even prevent complications to this illness.

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- ⁱⁱ Respiratory System, <https://blogs.gwu.edu/smhs-histology/respiratory-system/>
- ⁱⁱⁱ Nasopharynx, Cleveland Clinic, <https://my.clevelandclinic.org/health/body/22376-nasopharynx>
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- ^v Parts of the Oropharynx, Cancer Help, https://www.cancerhelpessentiahealth.org/Cancer_Types/oropharyngeal_201521E1_01.html
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- ^{ix} A diagram of the lungs which shows the internal organs of the body, hamja.iu, Freepik.com, https://www.freepik.com/premium-vector/diagram-lungs-which-shows-internal-organs-body_386272677.htm#from_element=cross_selling__vector
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- ^{xiii} Alveolus gas exchange in lungs infographic alveoli and lungs structure medical vector illustration, vixanart, Freepik.com, https://www.freepik.com/premium-vector/alveolus-gas-exchange-lungs-infographic-alveoli-lungs-structure-medical-vector-illustration_416577499.htm#from_element=cross_selling__vector
- ^{xiv} Alveoli, Labster Theory Pages, <https://theory.labster.com/alveoli/>
- ^{xv} What Causes Asthma? Asthma Foundation, <https://www.asthmafoundation.org.nz/your-health/living-with-asthma>
- ^{xvi} Bronchitis – News-Medical.Net, *Bronchitis. Image Credit: logika600 / Shutterstock*, <https://www.news-medical.net/health/What-is-Bronchitis.aspx>
- ^{xvii} What is Pneumonia? Saint Luke’s, <https://www.saintlukeskc.org/health-library/what-pneumonia#>

^{xviii} Chronic Obstructive Pulmonary Disease (COPD), Illustration courtesy of healthflexhhs.com,
<https://www.asthmafoundation.org.nz/your-health/living-with-copd>