



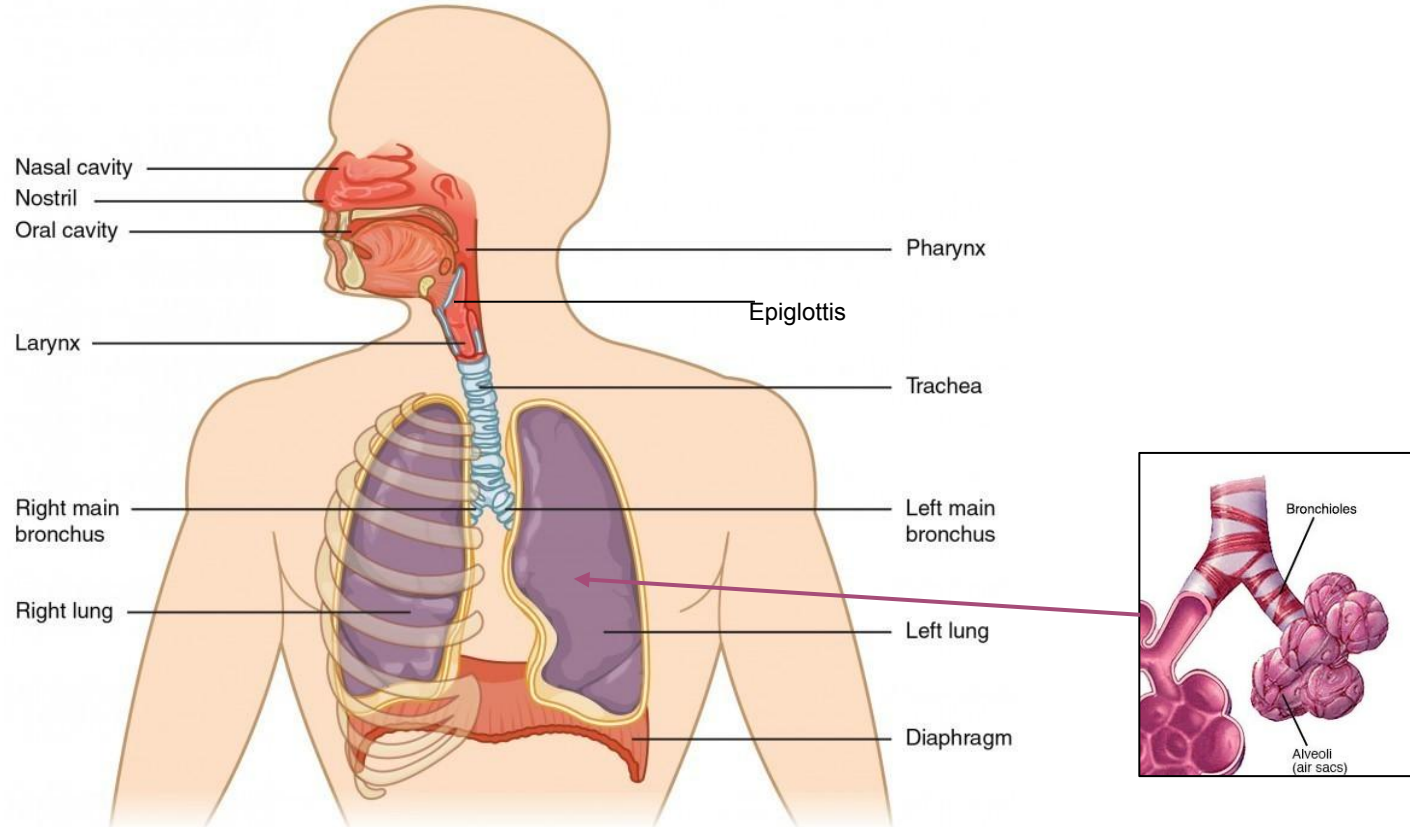
10.4

Interference of Gas Exchange

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Primary function of the respiratory system: *the uptake and delivery of oxygen to the body cells and the removal of carbon dioxide*



Disorders of the Respiratory System

Diseases and disorders of the lungs may prevent sufficient **delivery** of air to the alveoli or reduce the surface area for **diffusion**, impairing the process of gas exchange

Regardless of the cause or mechanism, the result is the same: **insufficient** oxygen is available to the tissues of the body.

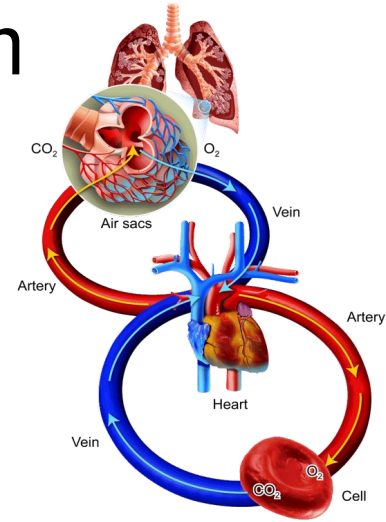
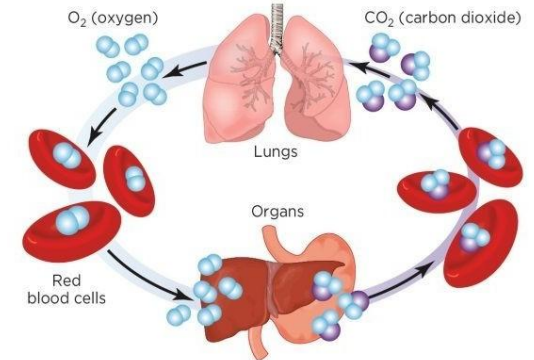
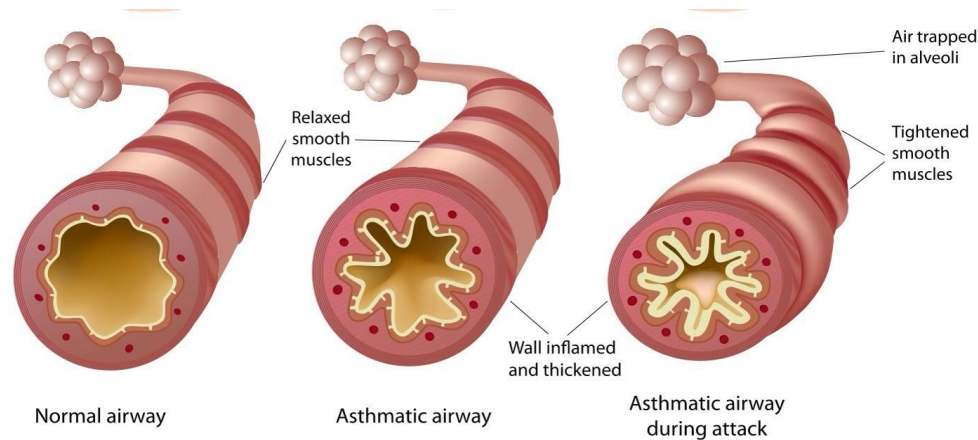


Fig 1. Gas exchange in humans



Asthma



- A chronic (no cure) respiratory disease characterized by inflammation and swelling of the **bronchi** and **bronchioles** that obstructs airflow
- **Inflammation** is a protective reaction to eliminate foreign substances or infection that is characterized by swelling and redness due to increased blood flow to the affected tissue
 - When the lining of the airways swell, airflow to the lungs is reduced
 - Inflammation also **stimulates** the overproduction of mucus, which contributes to reduced airflow
- Muscles around the bronchi and bronchioles become sensitive and contract, further
- **narrowing** the openings and restricting airflow

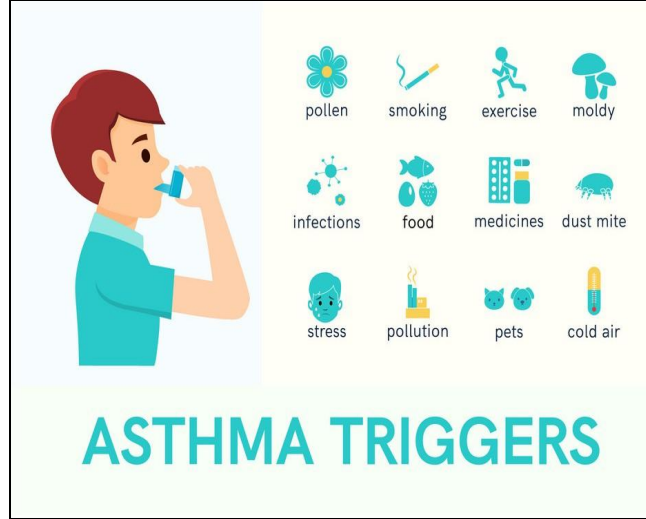
Asthma

Symptoms:

- Wheezing, tightness in chest, shortness of **breath**
- A sudden worsening of symptoms is called an asthma attack, which can be triggered by:
 - cigarette smoke, dust, cold air, physical exertion, allergens etc.



Asthma



Treatments:

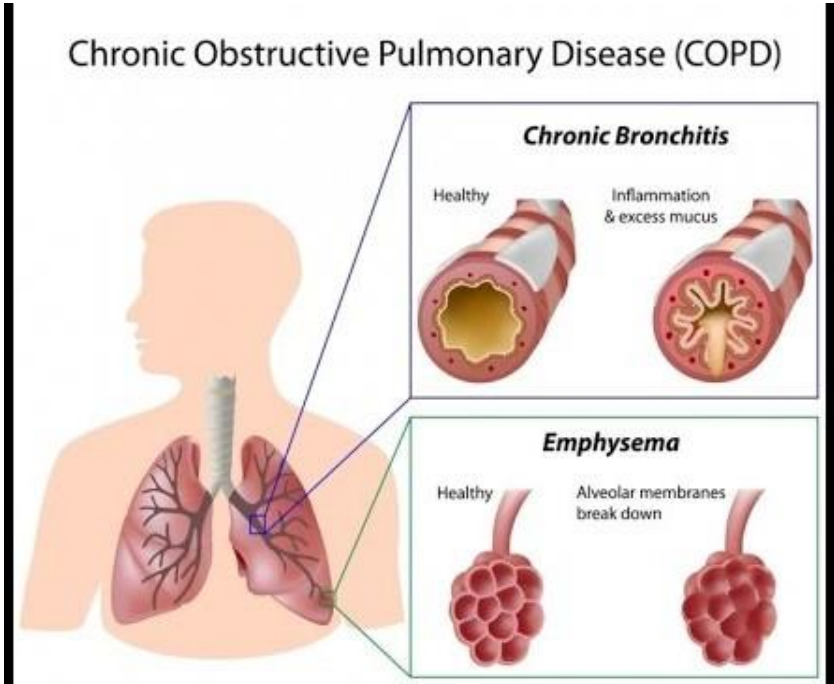
- Avoid triggers
- **Medications**: inhalers administer drugs that dilate the bronchi and bronchioles to allow greater airflow, and/or reduce inflammation
- Worldwide, the most prevalent respiratory problem and the most common chronic, or frequently recurring condition in children
- In Canada, nearly **10%** of the population suffers from asthma

How does asthma work?



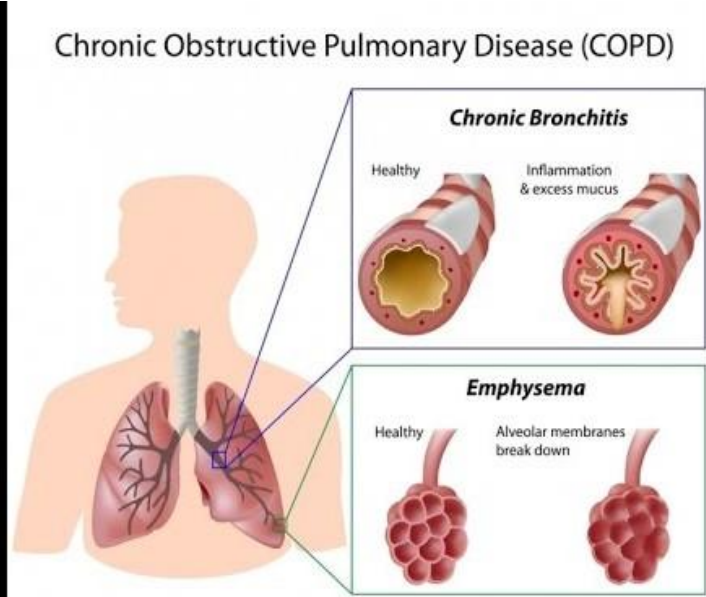
Chronic Obstructive Pulmonary Disease (COPD)

- A chronic, progressive disease that involves **both** obstructive bronchitis and emphysema
- **Obstructive Bronchitis** refers to the irritation and inflammation of the airways
 - The linings of the bronchi and bronchioles swell and produce excess mucus



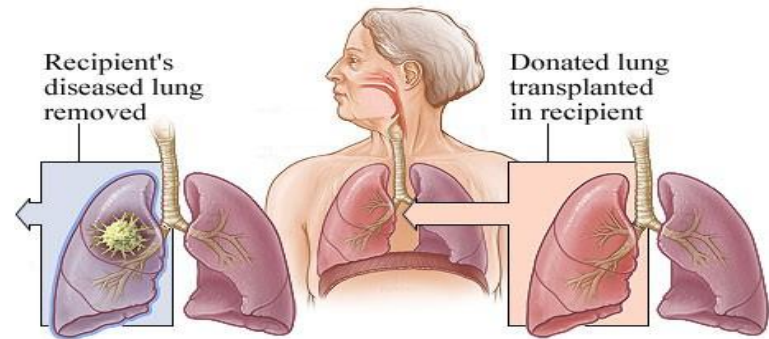
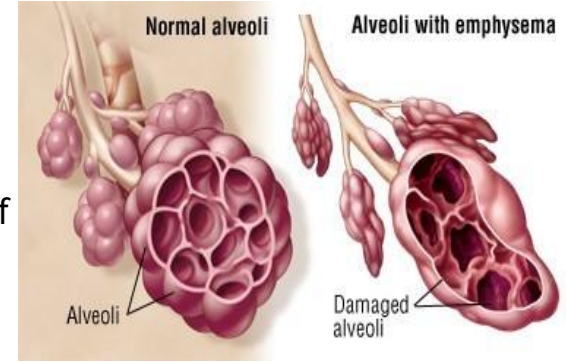
Chronic Obstructive Pulmonary Disease (COPD)

- **Emphysema** causes permanent damage to the alveoli by damaging the walls between the alveoli and reducing the alveolar elasticity and shape (less surface area so gas exchange is reduced)
 - Damage to alveoli worsens over time
- It is estimated that **80-90%** of COPD cases are caused by **cigarette smoke** but genetic disorders and prolonged exposure to pollution or fumes can contribute



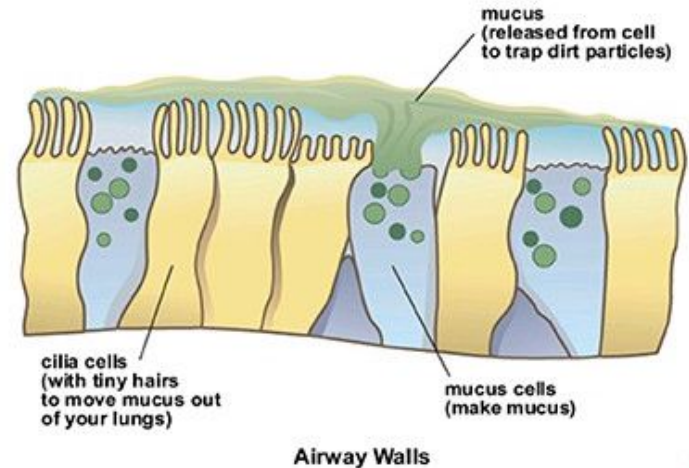
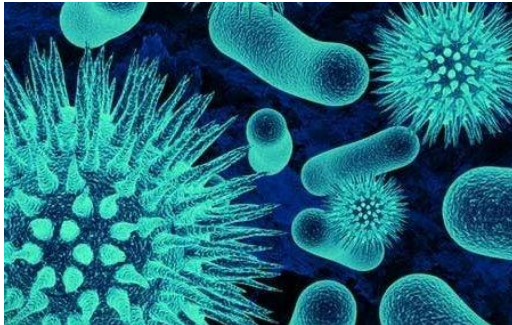
COPD cont'd

- **Symptoms:** coughing, wheezing, chest tightness, and shortness of breath
- People with COPD are likely to die from it, or from a related complication
- **Treatments:**
 - Proper management, medications, lifestyle changes may slow the progress of the disease
 - In severe cases, oxygen therapy or lung transplants may be necessary



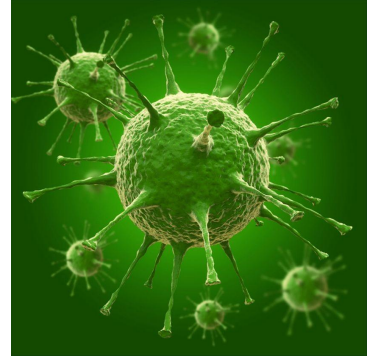
Respiratory infections

- The respiratory system is probably the most vulnerable part of our body because of the constant **exposure** of living tissue to the **external** environment
- Although there are many **safety mechanisms** (hairs, mucus, cilia etc.), there are many respiratory infections caused by viruses and airborne microorganisms like bacteria or fungi



Influenza – the Flu

- Caused by a **virus** – viruses are always **evolving** and new strains appear every year
- May affect the whole body or be confined to the lungs
- **Symptoms:** fever, dry cough, sore throat, runny nose, aches and pains
- Most people recover without treatment in a week, but **antiviral** drugs can also be administered to shorten the length of the infection
- Highly contagious through **droplets** (cough and sneeze) in the air, as well as through contact with contaminated surfaces
- **Vaccines** can prevent infection



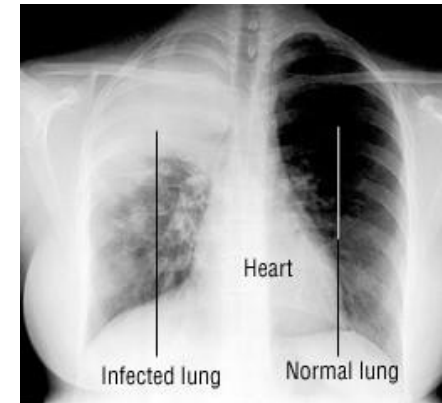
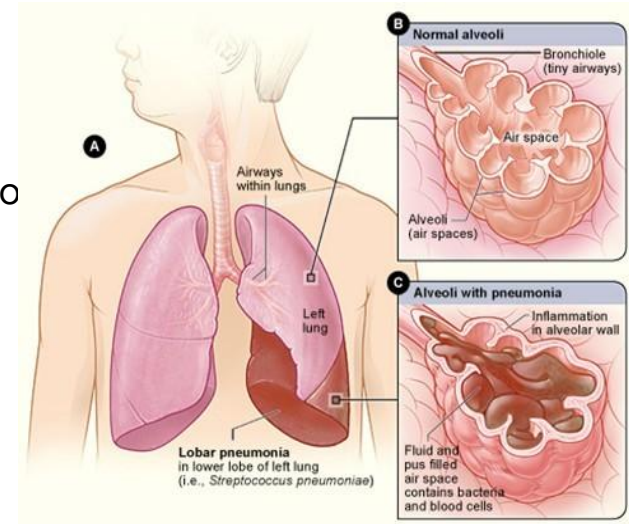
Shot every year?

Melvin Sanicas



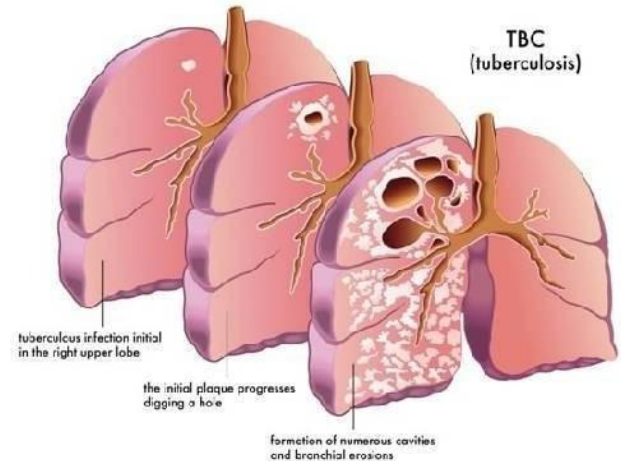
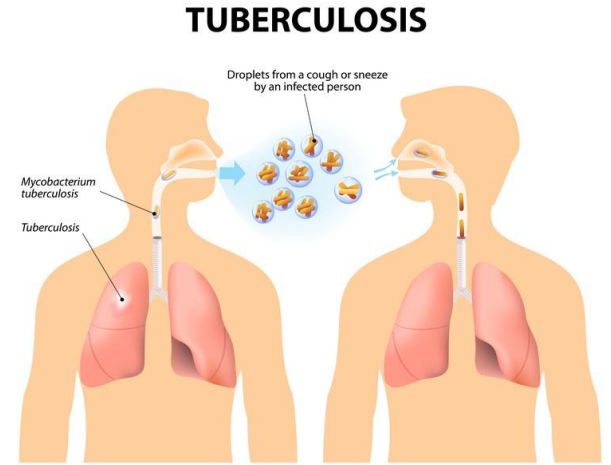
Pneumonia

- **Pneumonia:** an infection of the lungs that causes the alveoli to fill with pus and mucus, preventing gas exchange
- Also causes inflammation of the lining of the bronchi, bronchioles and alveoli
- Caused by bacteria, viruses, or fungi
- **Symptoms:** fever, cough, shortness of breath
- Diagnosed by analyzing mucus that is coughed up from the lungs, or by x-rays to show areas of the lungs blocked with fluids
- Those with **weakened** immune systems are especially susceptible
- Bacterial pneumonia can be treated with antibiotics
- **5%** fatality rate among those who develop pneumonia



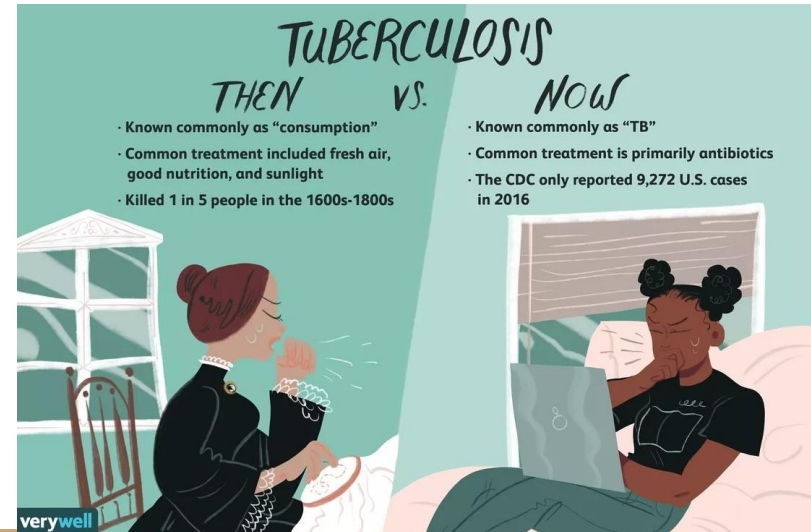
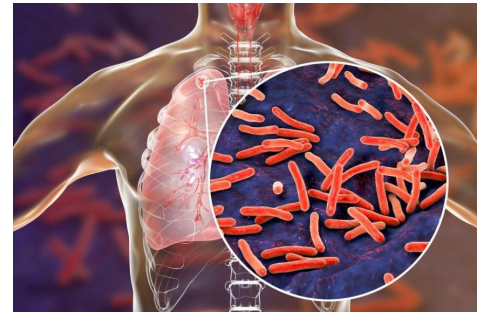
Tuberculosis

- **Tuberculosis (TB):** a **bacterial** infection that damages the tissues of the lungs causing cavities to form that are filled with gas
- Affects the lungs but can move from the lungs to affect the nervous system, the bones and joints in the spine and other parts of the body
- Spread through the air when infected people sneeze or cough
- **Symptoms:** coughing, chest pain, weight loss, night sweats, and coughing up blood
- Estimated that **one-third** of the world's population is currently infected, but most cases remain inactive
- Only a **5-10%** chance that an inactive infection becomes activated



Tuberculosis

- Treatment – six month course of **antibiotics**
- A vaccine has been available since 1921, however TB persists because some strains of bacteria are **resistant** to antibiotics
- TB kills almost **3 million** people annually, and is mostly found in developing countries

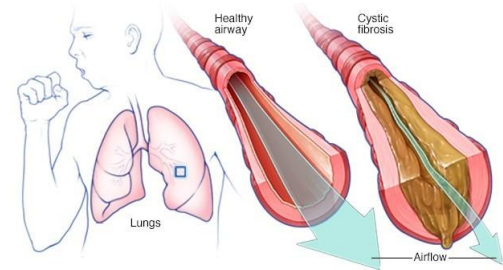


What makes tuberculosis (TB) the world's most infectious killer? - Melvin Sanicas



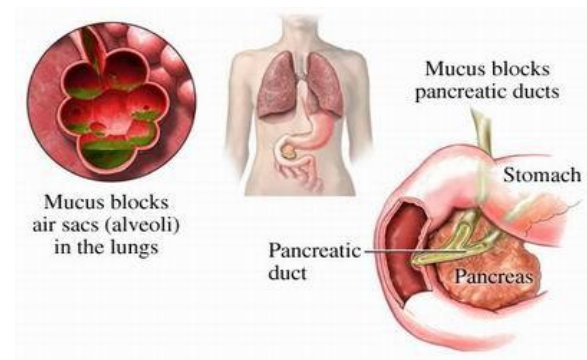
Cystic Fibrosis (CF)

- A **hereditary** disorder in which the gene that influences mucus production is defective
- A person with CF produces unusually thick and sticky mucus that clogs the airways; airflow to the lungs is **reduced**
- **Symptoms:** persistent cough and excess mucus
- This increased mucus creates the ideal environment for the growth of bacteria and fungi
 - CF patients often suffer from lung infections
- **Treatment:** Clearing excess mucus, ongoing therapy, even lung transplants



Cystic fibrosis

- Also affects the **digestive** system
- Thick secretions of mucus in the **pancreas** prevent it from secreting digestive enzymes
- Scar tissue in the pancreas can also lead to a form of **diabetes**
- It gets progressively worse with age so it is important to diagnose and start treatment early
- All newborns in Ontario are checked at birth for CF
- Research continues in **gene** therapy in hopes to find a cure



Effects of Smoking

- Smoking is the single **greatest** cause of respiratory diseases and preventable deaths in the developed world
- Smoking is known to cause lung cancer, COPD, bronchitis, emphysema and asthma (in addition to diseases of the circulatory system)



Smoker's Lung

Healthy Lung



Effects of Smoking on gas exchange

Three substances that cause the most problems: **nicotine, carbon monoxide, and tar**

- **Nicotine** – addictive chemical that stimulates our body's natural painkillers and blocks other chemicals that allow signals to be sent from the brain around the body. Also causes narrowing of the arteries and reduced blood flow affecting transport of blood gases
- **Carbon monoxide** - can replace oxygen molecules that bind to hemoglobin → reducing the amount of oxygen delivered to the cells
- **Tar** – black, sticky substance that accumulates in the alveoli
 - contains many chemicals that are carcinogenic, irritate the linings of airways and inactivate cilia on the cells
- Cigarette smoke also contains carcinogenic (cancer causing) substances



Summary

10.4 Summary

- Respiratory system diseases can affect the amount of airflow into the lungs, the process of gas exchange through the respiratory membrane, or both. Many diseases of the respiratory system interfere with the exchange of gases.
- Asthma is the inflammation of the lining of the bronchi and bronchioles, which reduces airflow into the lungs.
- COPD is the inflammation of the airways combined with the permanent destruction of alveoli. The reduced airflow and the damage to the respiratory membrane both contribute to reduced gas exchange.
- Infectious diseases such as influenza, tuberculosis (TB), and pneumonia are caused by viruses or bacteria.
- Cystic fibrosis (CF) is a genetic disorder that affects the respiratory and digestive systems. One of its main symptoms is an overproduction of sticky mucus in the airways; this mucus obstructs airflow to and from the alveoli.
- Cigarette and other tobacco smoke is a primary cause of lung disease. Air pollution and airborne irritants are also contributing factors.
- Carbon monoxide and tar from cigarette smoke cause problems in the respiratory and circulatory systems.