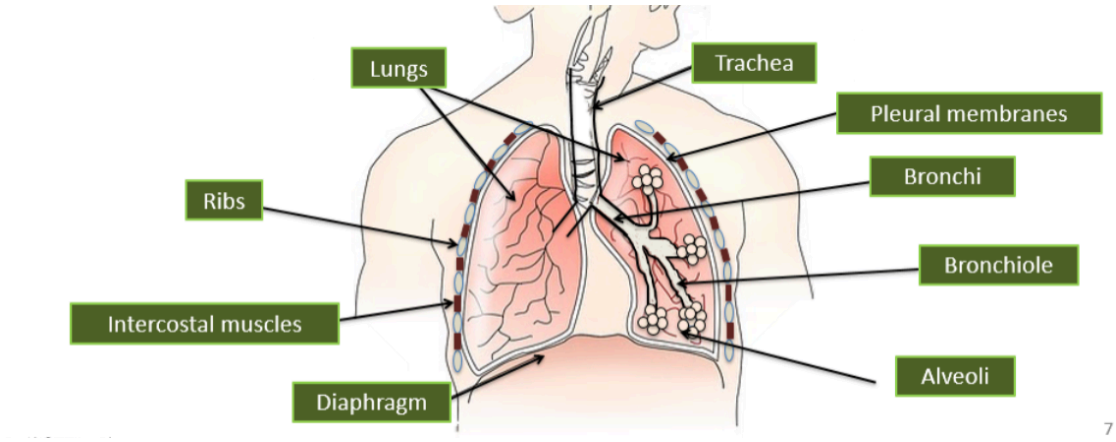
Gas Exchange in Humans



Structure of Lungs:

- Thorax is the top part of the body - separated from the lower part (abdomen) by a muscle called the diaphragm.
- Breathing/Ventilation - movement of air into and out of the lungs in two stages: inspiration and expiration (controlled by movement of diaphragm and ribcage.
- Gas exchange - The exchange/diffusion of oxygen and carbon dioxide to and from the blood at the alveoli.
- Lungs are like pink sponges surrounded by the pleural membranes.
- Lungs are protected by the ribcage.
- The intercostal muscles are found between the rib bones.

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Process:

- The air breathed in goes through the trachea.
- It is split into two by the bronchi (bronchus for singular), going to each lung.
- The bronchi are split into smaller tubes called bronchioles.
- The bronchioles end up in small bags called alveoli (for gas exchange).

Functions:

Trachea	• Tube with incomplete rings of cartilage carries air to lungs • Lined with cells making mucus • Lined with cells with cilia (hairs) to move mucus out
Bronchi	• Carries air to lungs
Bronchioles	• Carries air to alveoli
Alveoli	• Small air sacs adapted for gas exchange
Diaphragm	• Sheet of muscles in a dome shape • Helps make breathing movements • Separates thorax from abdomen
Ribs	• Bones that protect and ventilate the lungs
Intercostal Muscles	• Move ribs for ventilation (breathing)
Pleural Membranes	• Moist membranes forming an airtight seal around lungs • Separate inside of thorax from lungs

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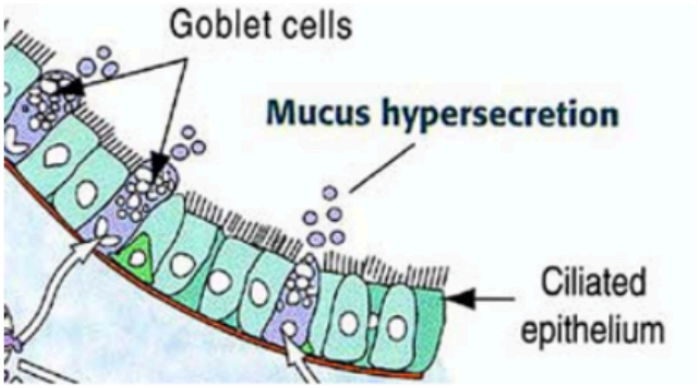
Trachea Walls (similar structure in Bronchioles):



- The trachea walls have a lining containing cells that trap dust and bacteria and prevent them from getting into the lungs.
    - The Goblet cells secrete mucus, which trap dust and bacteria.
    - The Ciliated cells have cilia which constantly sway/waft to sweep the mucus with dust and bacteria up into the mouth, which can then be swallowed (this time through the oesophagus instead).

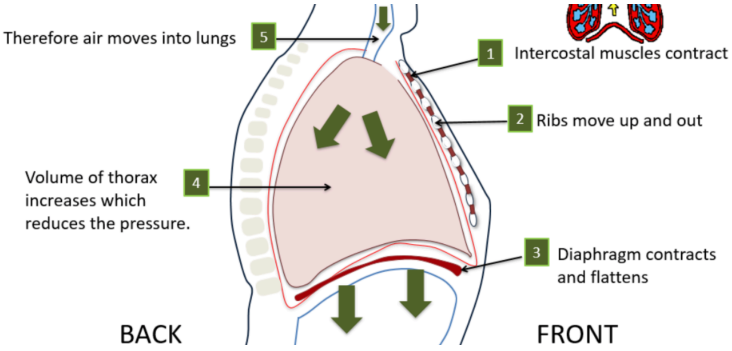
Ventilation (Inspiration & Expiration):

- Ventilation (breathing) means moving air in and out of the lungs.
- This requires a difference in air pressure and relies on the thorax being and airtight cavity (an empty space).
- Movements of the intercostal muscles and diaphragm change the volume inside the cavity/air pressure - this causes the air to move in or out.

Gas Exchange in Humans

- **Inspiration** (Inhalation - active)

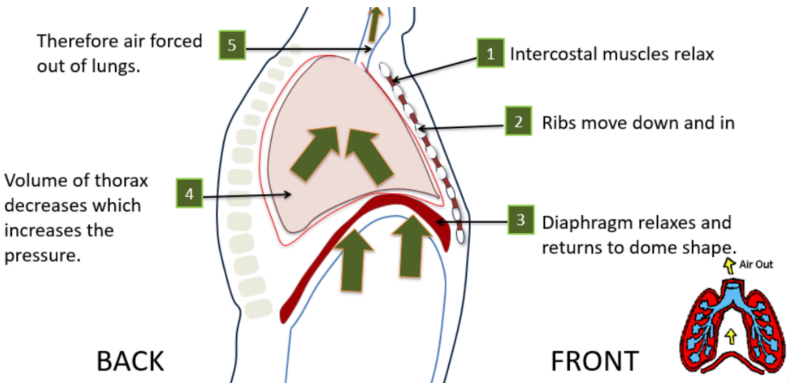
  - The (external) Intercostal muscles contract.
  - The Ribs move up and out.
  - The Diaphragm contracts and flattens.



  - Thorax volume increases, reducing the pressure (low concentration of air).
  - This brings air into the lungs (from high to low concentration).

- **Expiration** (Exhalation - passive)

  - The (internal) intercostal muscles contract.
  - The ribs move down and in.
  - The Diaphragm relaxes and returns to dome shape.



  - Volume of thorax decreases, increasing the pressure (high concentration of air).
  - Therefore air is forced out the lungs.

Gas Exchange in Humans

Gas Exchange in Alveoli:

- The lungs contain 700 million tiny air sacs called alveoli (alveolus for singular)
- They are surrounded by a network of blood capillaries.
- The blood that has returned to the lungs from the rest of the body (and heart through the pulmonary arteries) contains a lot of carbon dioxide and very little oxygen (deoxygenated blood).
- The oxygen diffuses out of the alveolus into the blood, and binds with red blood cells (from a higher concentration to a lower concentration).
- The carbon dioxide diffuses out of the blood into the alveolus (from a higher concentration to a lower concentration).

- After the oxygenated blood reaches the body cells, oxygen is released from the red blood cells, diffusing into the body cells (from high to low concentration).
- Simultaneously, the carbon dioxide diffuses out of the body cells into the deoxygenated blood (from high to low concentration), which is brought back to the lungs to get oxygenated.

How Alveoli are adapted for gas exchange:

- They have a moist lining for gases to help dissolve gases and increase diffusion rate.
- They have a large surface area for diffusion.
- They have very thin walls, a cell thick, so gases have to travel a small distance to diffuse, which increases diffusion rate.
- They have a great blood supply to maintain a high concentration gradient between the alveoli and blood.
- The walls are permeable, allowing gases to diffuse across easily.

Gas Exchange in Humans

Respiratory System Disorders:

- **Asthma**: a severe allergic reaction in which contraction of bronchioles makes breathing difficult.
- **Bronchitis**: an inflammation of the lining of the bronchial tubes. The passageways to the alveoli become swollen and clogged with mucus.
- **Bronchiolitis:** inflammation and swelling of the bronchiole.
- **Emphysema:** Lungs lose their elasticity, which leads to deterioration of the lung structure.
- **Pneumonia:** The alveoli become filled with fluid, usually caused by bacterial or viral infections.
- **Lung Cancer:** a disease in which tumors form in the lungs as a result of irregular and uncontrolled cell growth.

Effects of smoking on gaseous exchange system:

- Smoking contributes to:
  - Lung cancer
  - Chronic Bronchitis
  - Emphysema
- Smoking damages the walls inside the alveoli, reducing the surface area for gas exchange and leading to diseases like emphysema.
- Mucus and cilia in the respiratory passages protect the lungs - pollutants, including tobacco smoke, can destroy these protection.
- **Lung Cancer:**
  - Tobacco smoke and tar contain chemicals that cause cells to mutate into cancerous tumors. The chemicals are carcinogens - chemicals that can lead to cancer.

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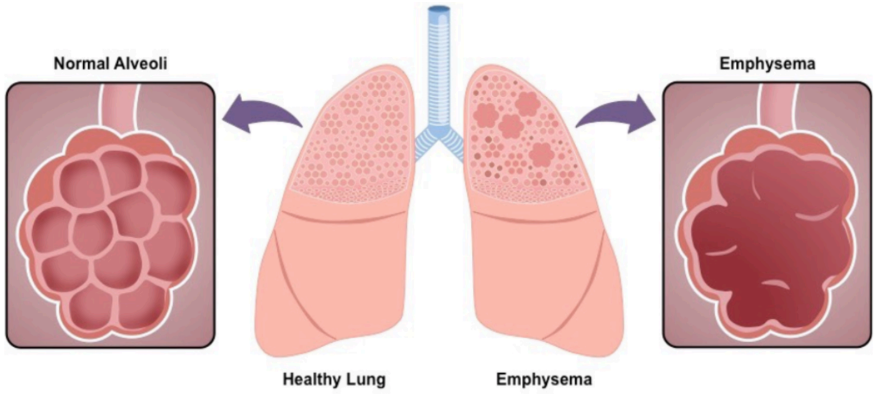
- **Chronic Bronchitis:**
    - Cilia are small hairs in the lung and trachea, and along with mucus, catch a lot of dust and bacteria before they reach the lungs.
    - There are also cells called goblet cells which secrete mucus.
    - The mucus traps bacteria and dust to stop it entering the lungs.
    - The cilia waft the mucus up to the throat where it can be swallowed and destroyed in the stomach acid.
    - Cilia help to keep the trachea clear by sweeping mucus back towards the mouth.
    - Tar in cigarettes damages the cilia, and therefore, bacteria build up and cause more chest infections.
    - The tar also irritates the bronchi and bronchioles, encouraging mucus to be produced which can't be cleared (due to the damaged cilia) - causes smoker's cough and chronic bronchitis.

- **Emphysema:**



- Smoke damages the alveoli walls - they burst/rupture and fuse together (small holes break to connect to make larger holes)
- This greatly reduces the surface area for gaseous exchange.
- The sufferer is unable to carry out basic tasks like walking due to lack of oxygen.
- There is no cure for this.