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Respiratory System

Why breathing?

Every couple of seconds, we breathe in air from the atmosphere, and then breathe out.

This is to supply every cell in our bodies with one component of the atmosphere, **oxygen**.

Our cells need oxygen to perform **cellular respiration**, which generates the energy we use to think and move around.

Without oxygen, we can't produce energy, and we don't last very long.

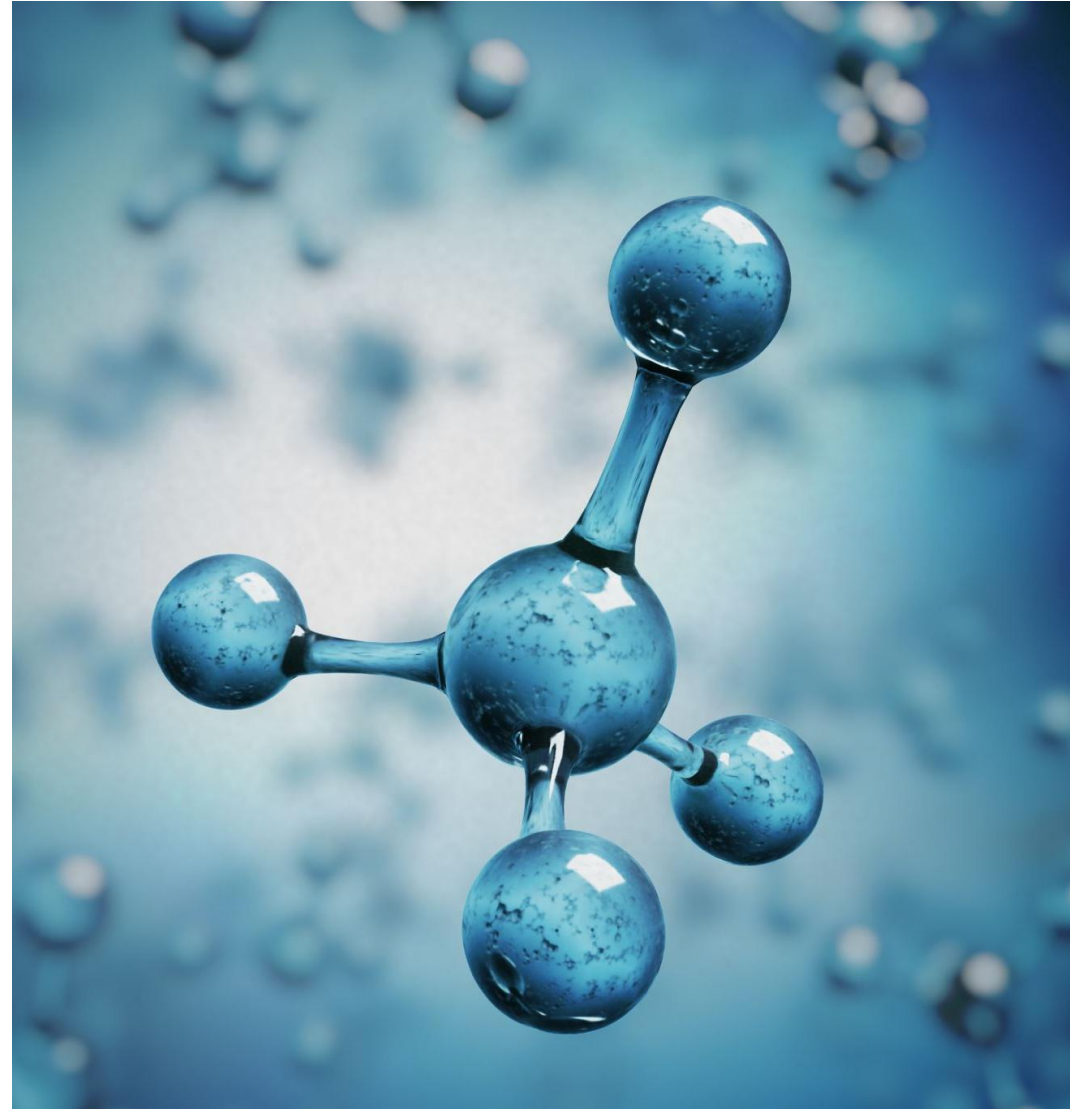
So how exactly does the respiratory system work?



Oxygen and Carbon Dioxide

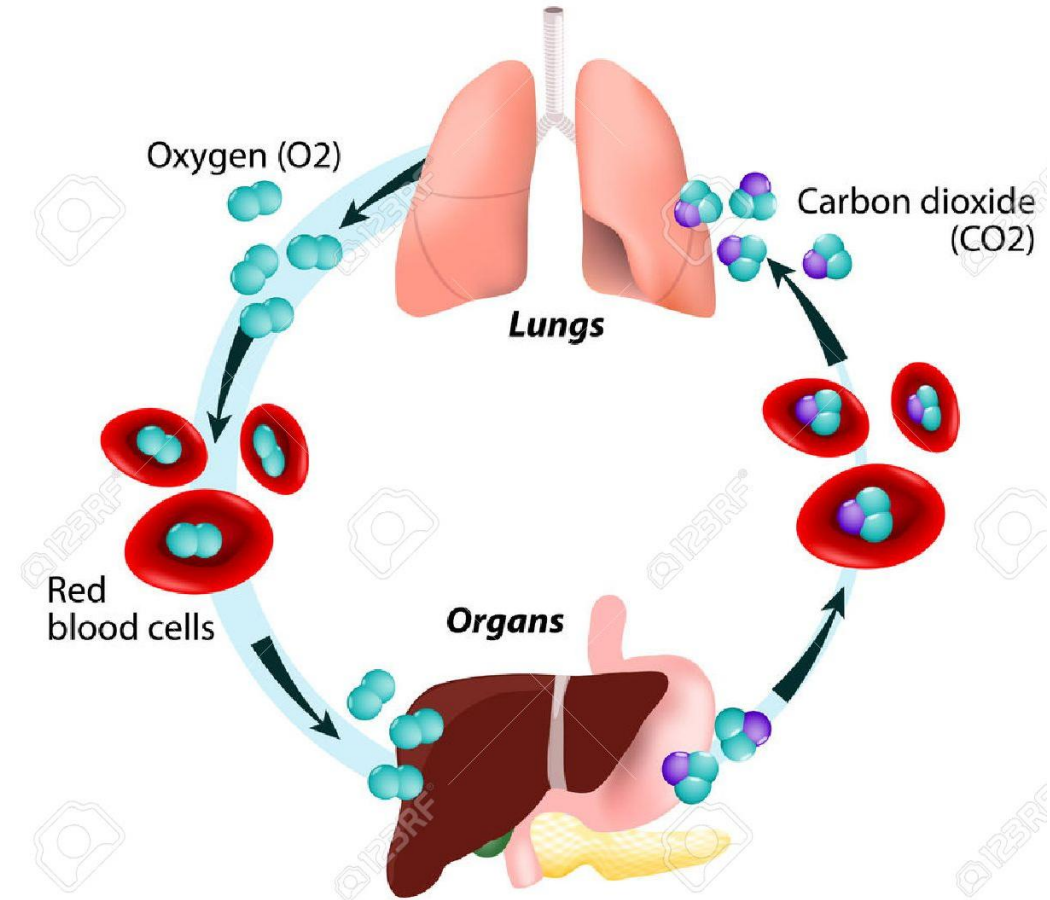
- As we said, the major function of the respiratory system is to supply every nook and cranny of the body with **oxygen**, and it also serves to collect **carbon dioxide**, a byproduct of cellular respiration, and expunge it from the body when we exhale.

Nook and cranny = Every part or aspect of something.



- Body cells \rightarrow Cellular Respiration \rightarrow CO₂
- CO₂ \rightarrow Blood Cells \rightarrow Lungs \rightarrow Exhale
- Air \rightarrow O₂ \rightarrow Lungs \rightarrow Blood Cells \rightarrow Body Cells \rightarrow Cellular Respiration \rightarrow CO₂

GAS EXCHANGE IN HUMANS



- Pulmonary Ventilation

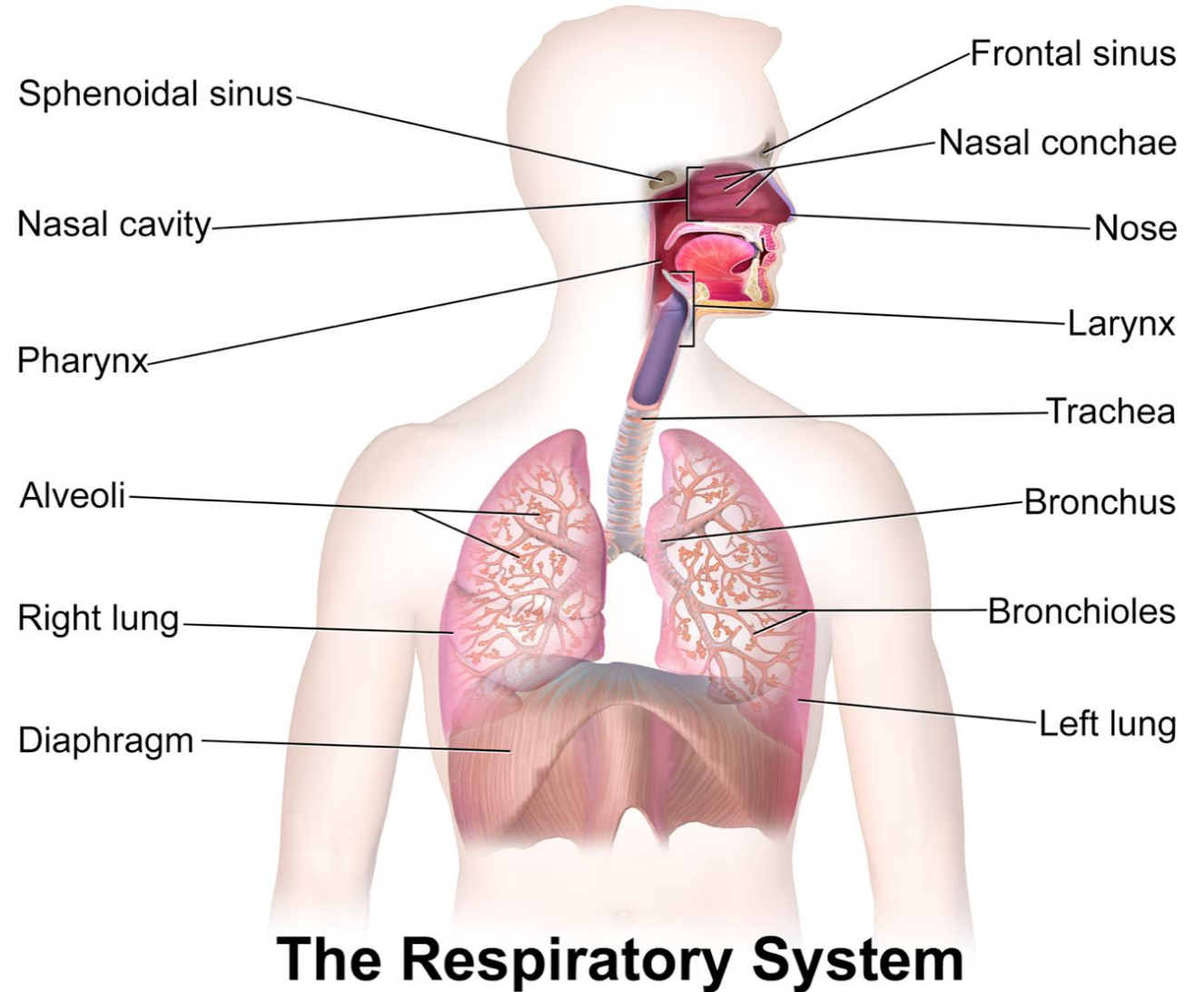
- The way oxygen enters the lungs from the surroundings.

- External Respiration

- The way oxygen gets from the lungs into the blood and carbon dioxide from the blood into the lungs.

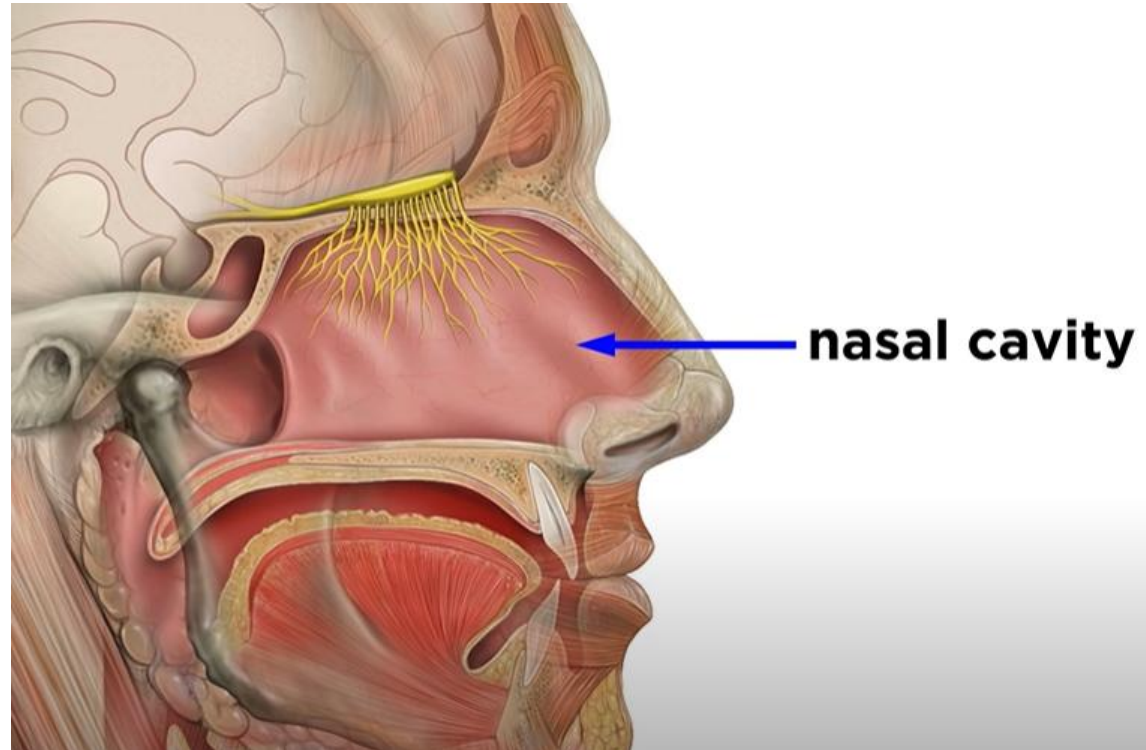
Respiratory System

- The respiratory system includes the nose, nasal cavity, paranasal sinuses, larynx, trachea, bronchi, and lungs, which contain little sacs called alveoli.



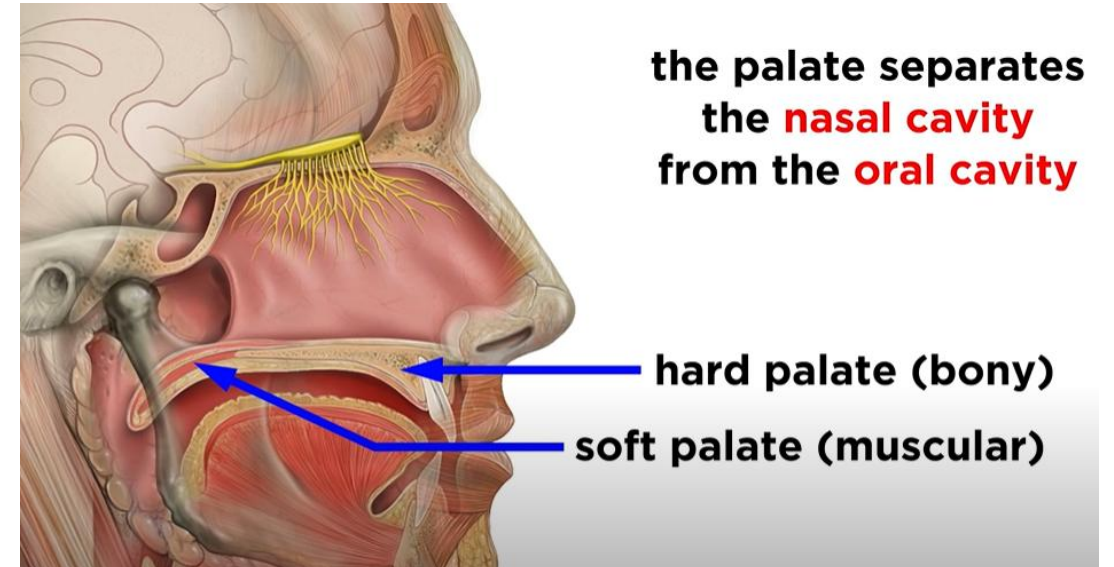
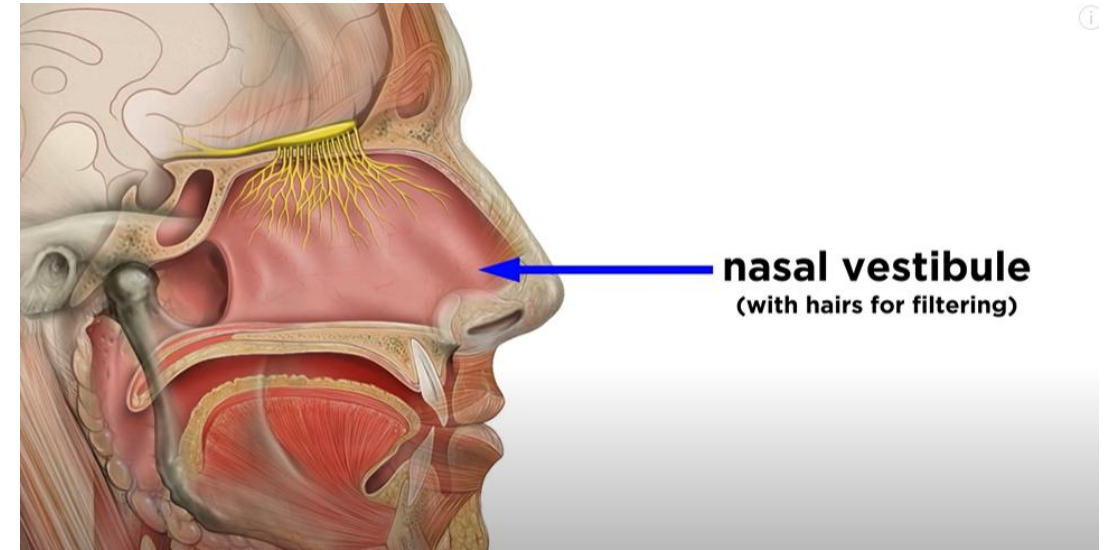
Airflow - Nasal Cavity

- Starting with the nose, we probably know that air enters through the nostrils.
- The next step of the airflow is jumping straight to the **nasal cavity**.



Palate

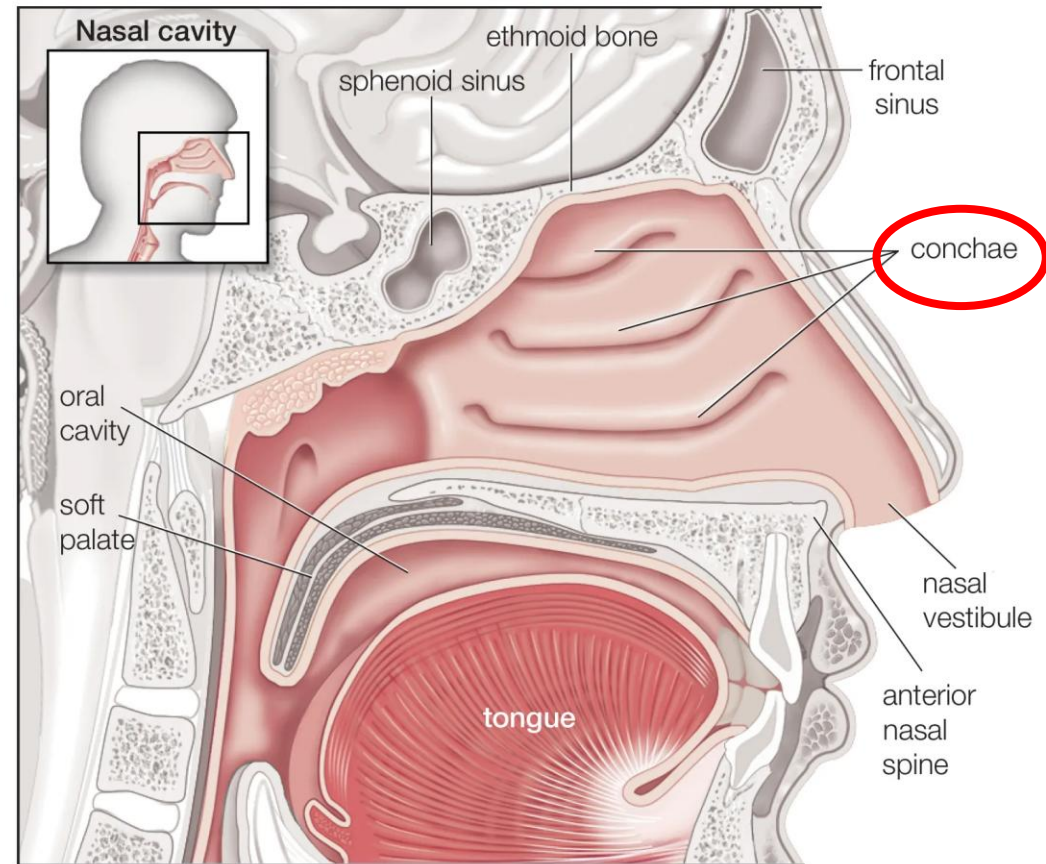
- This is separated from the oral cavity by the palate, which has two sections, the **bony hard palate** and the **muscular soft palate**.
- We can also see the **nasal vestibule**, with hairs for filtering.



Nasal conchae

Nasal conchae are mucosa-covered projections.

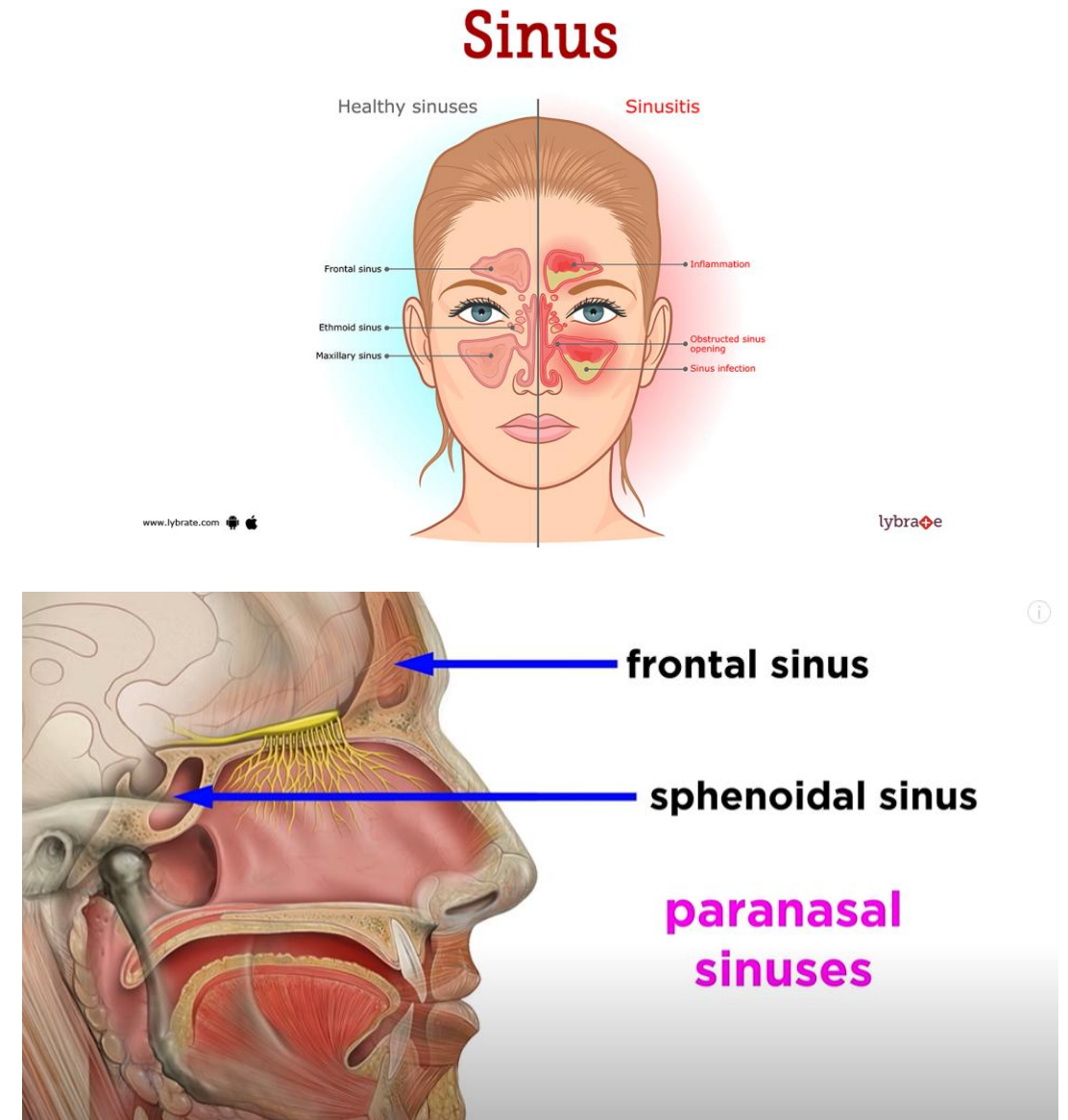
These, together with nasal vestibule serve to filter, heat, and moisten the air.



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Paranasal sinuses

- The nasal cavity is surrounded by the **paranasal sinuses**, which produce **mucus** that flows into the nasal cavity.
- **Note:**
- The sinuses are air-filled spaces in the skull. They are located behind the forehead, nasal bones, cheeks, and eyes. Healthy sinuses contain no bacteria or other germs. Most of the time, mucus is able to drain out and air is able to flow through the sinuses.



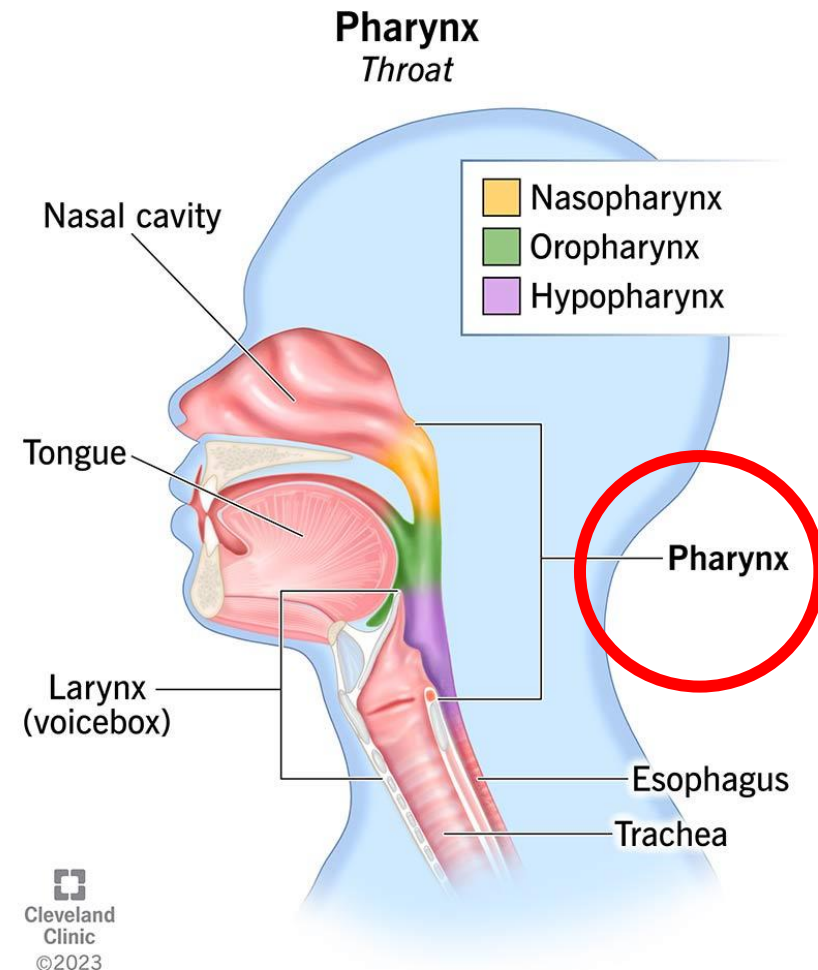
Pharynx

This connects the nasal cavity with the mouth.

This has three regions, the nasopharynx, the oropharynx, and the laryngopharynx.

This passageway continues down into the **esophagus** when eating food, but as far as air goes, the next stop is the **larynx**, or **voice box**.

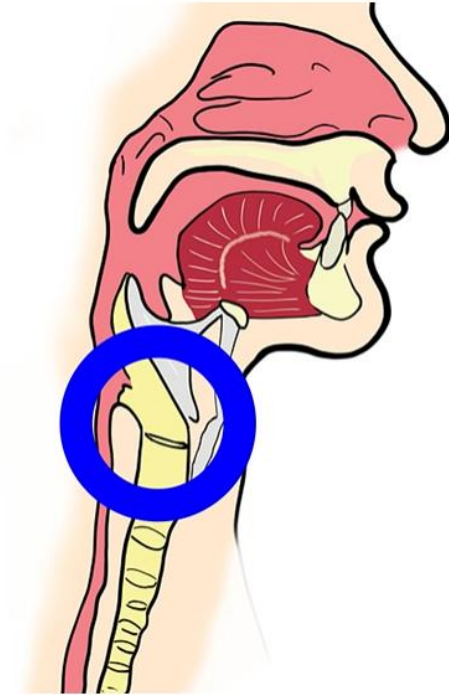
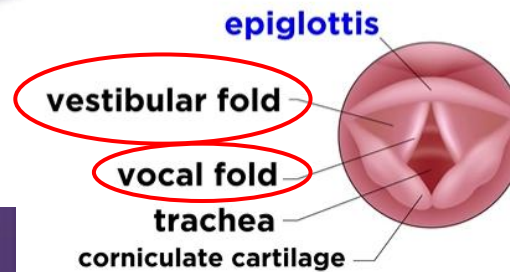
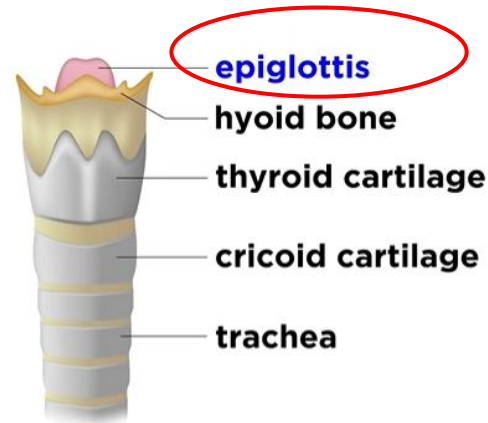
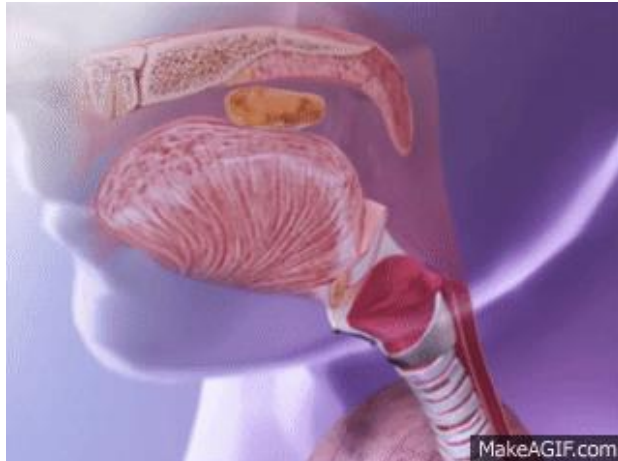
This provides an airway and also serves as the site of **voice production**.



Epiglottis

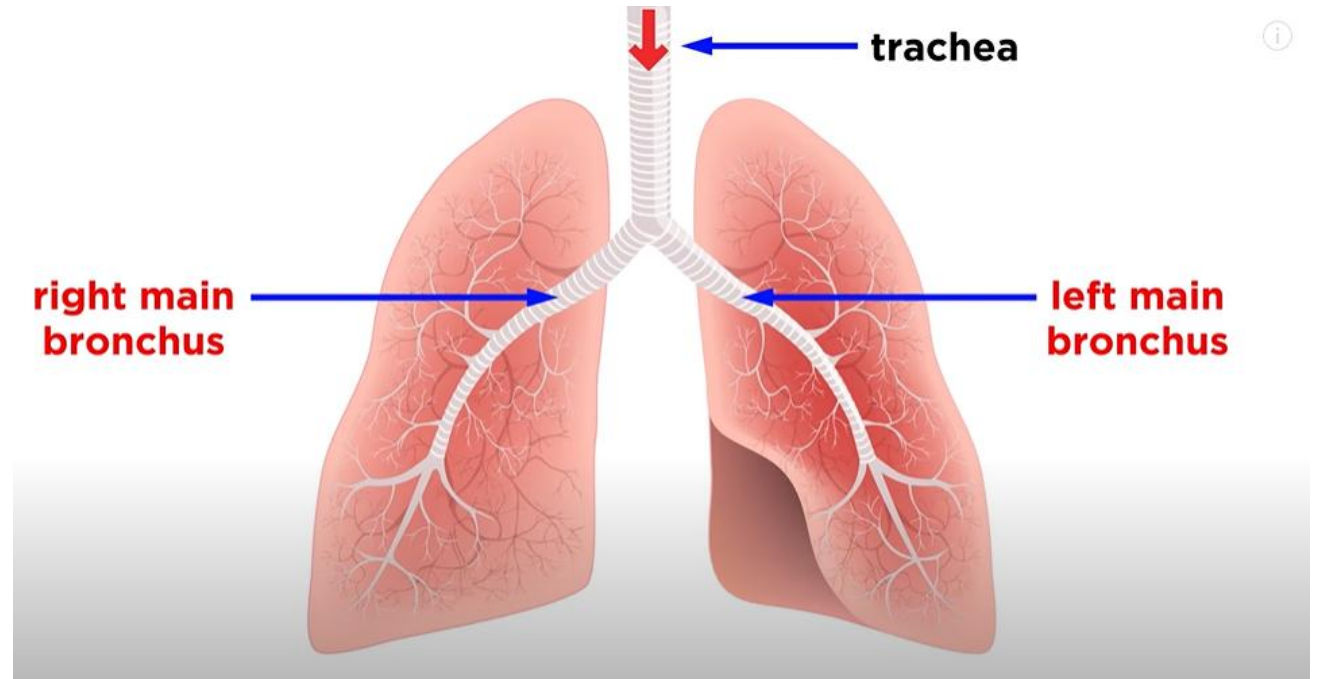
The larynx is comprised of a variety of cartilages, including the **epiglottis**, which stays **open for air flow**, but **when swallowing, it will cover up the laryngeal inlet** so that we don't end up breathing our food.

Then we see the **vocal folds** and **vestibular folds**, which are the true vocal cords and false vocal cords respectively.



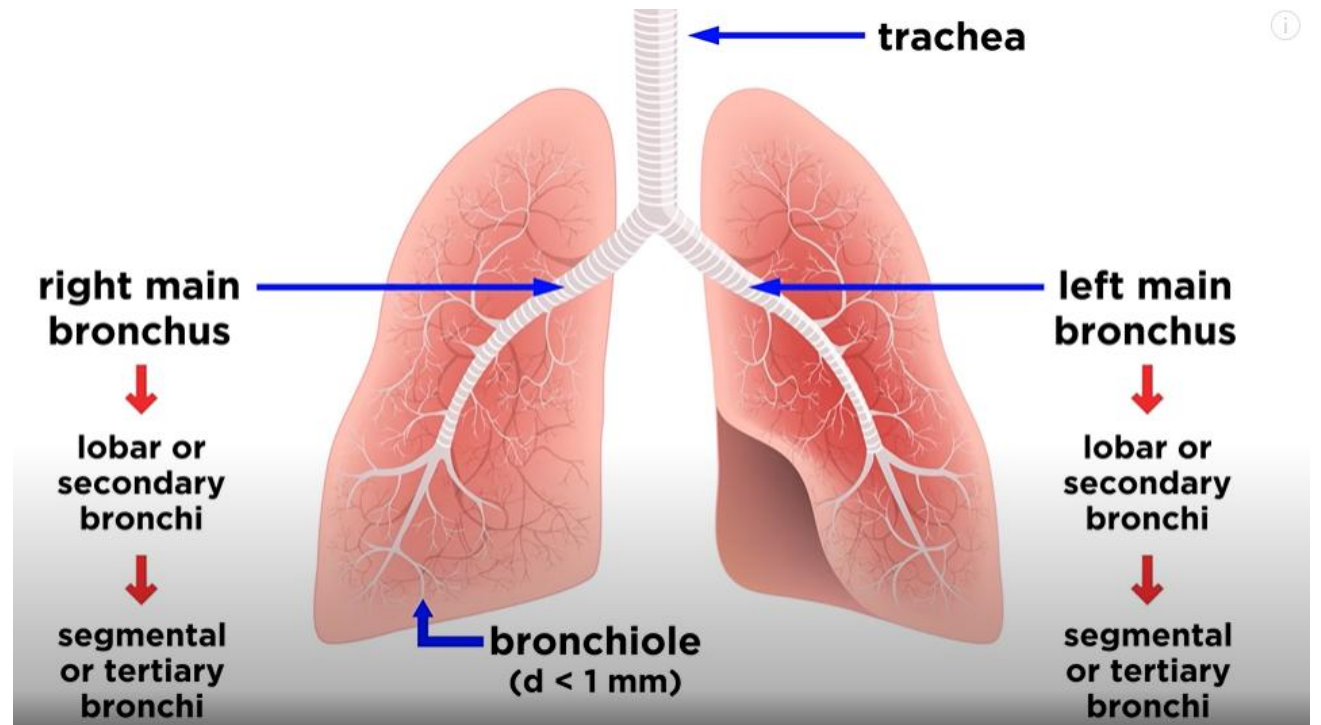
Trachea

Next, we find the **trachea, or windpipe**, which descends and divides into two main, or **primary bronchi**, one to the right, and one to the left.



Bronchus and Bronchiole

Each **bronchus** will quickly subdivide into lobar, or secondary bronchi, which in turn branch into segmental, or tertiary bronchi, and this continues even further, until we get to passageways **less than a millimeter in diameter**, which are called **bronchioles**.

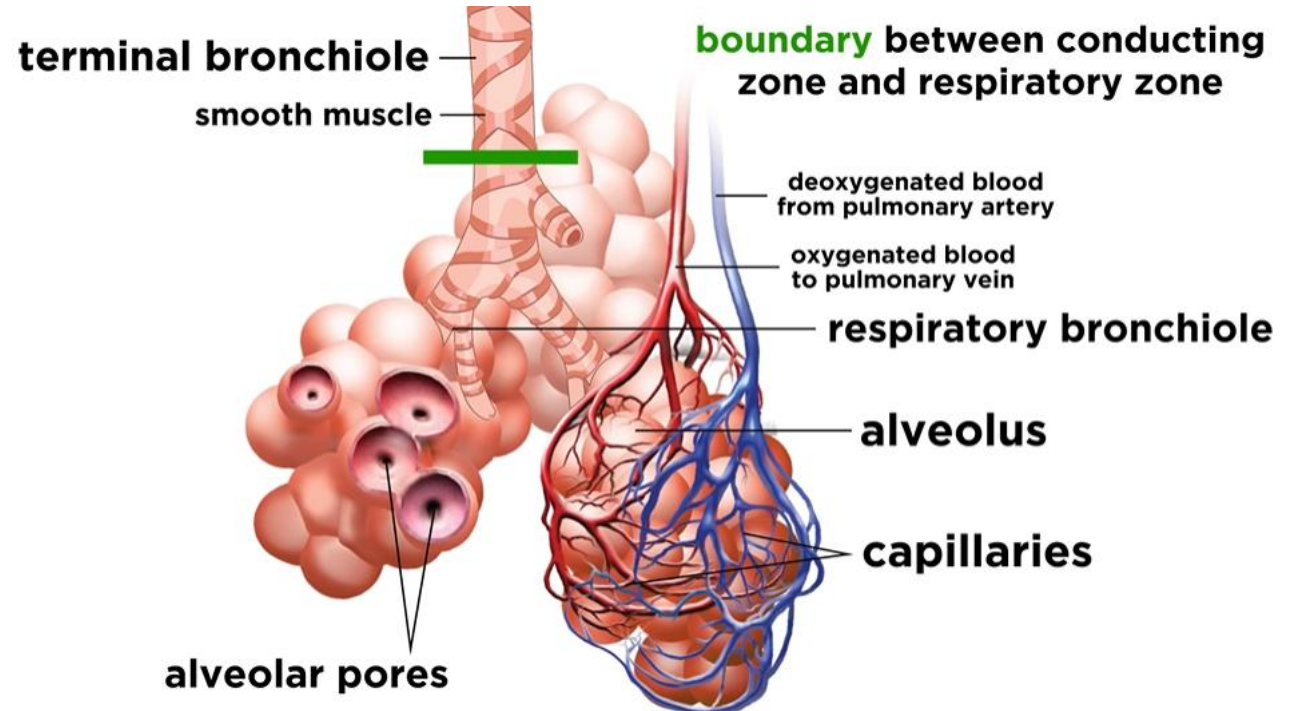


Alveoli

This ends at the **terminal bronchioles**, which feed into the **respiratory bronchioles**, and this marks the boundary between the **conducting zone** and the **respiratory zone**.

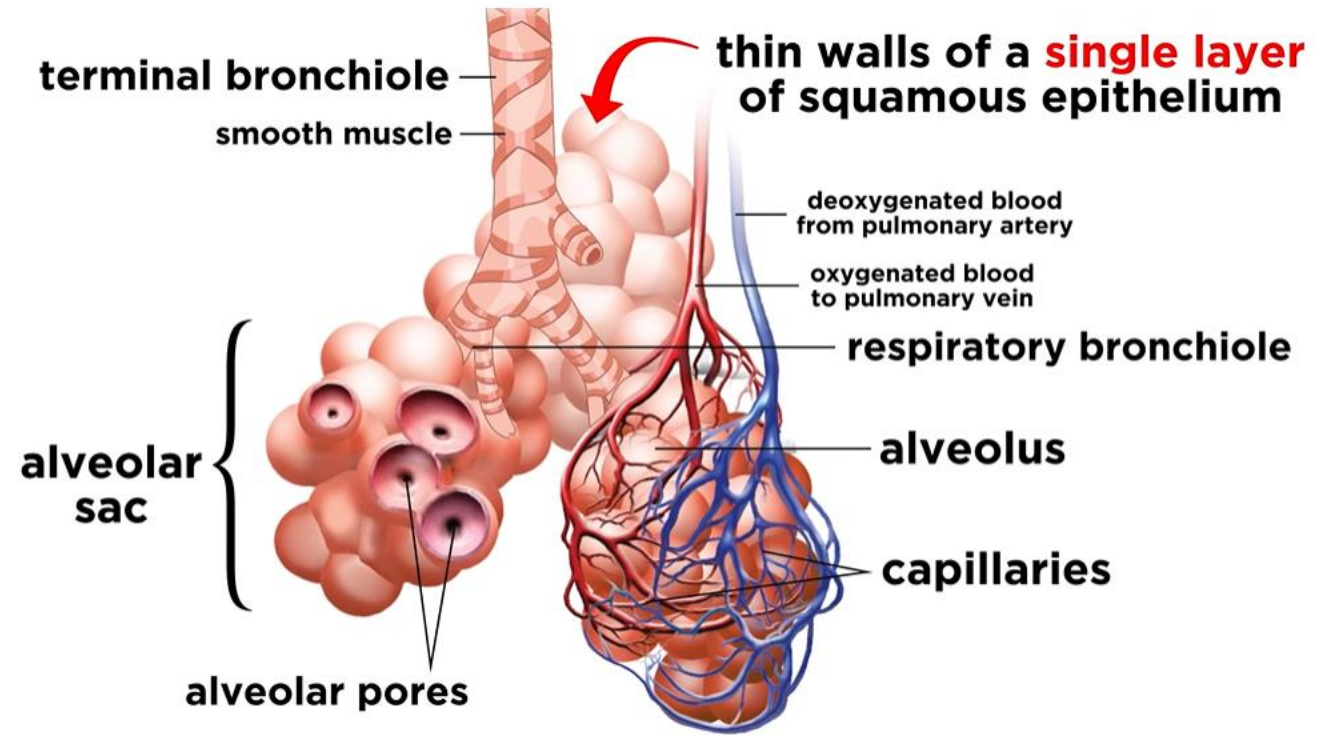
The respiratory bronchioles have structures that protrude called **alveoli**, which are **collected in alveolar sacs**, like **grapes in a bunch**.

Because of the extensive branching in the bronchi, this results in **hundreds of millions of alveoli**, and this is where **gas exchange takes place**.



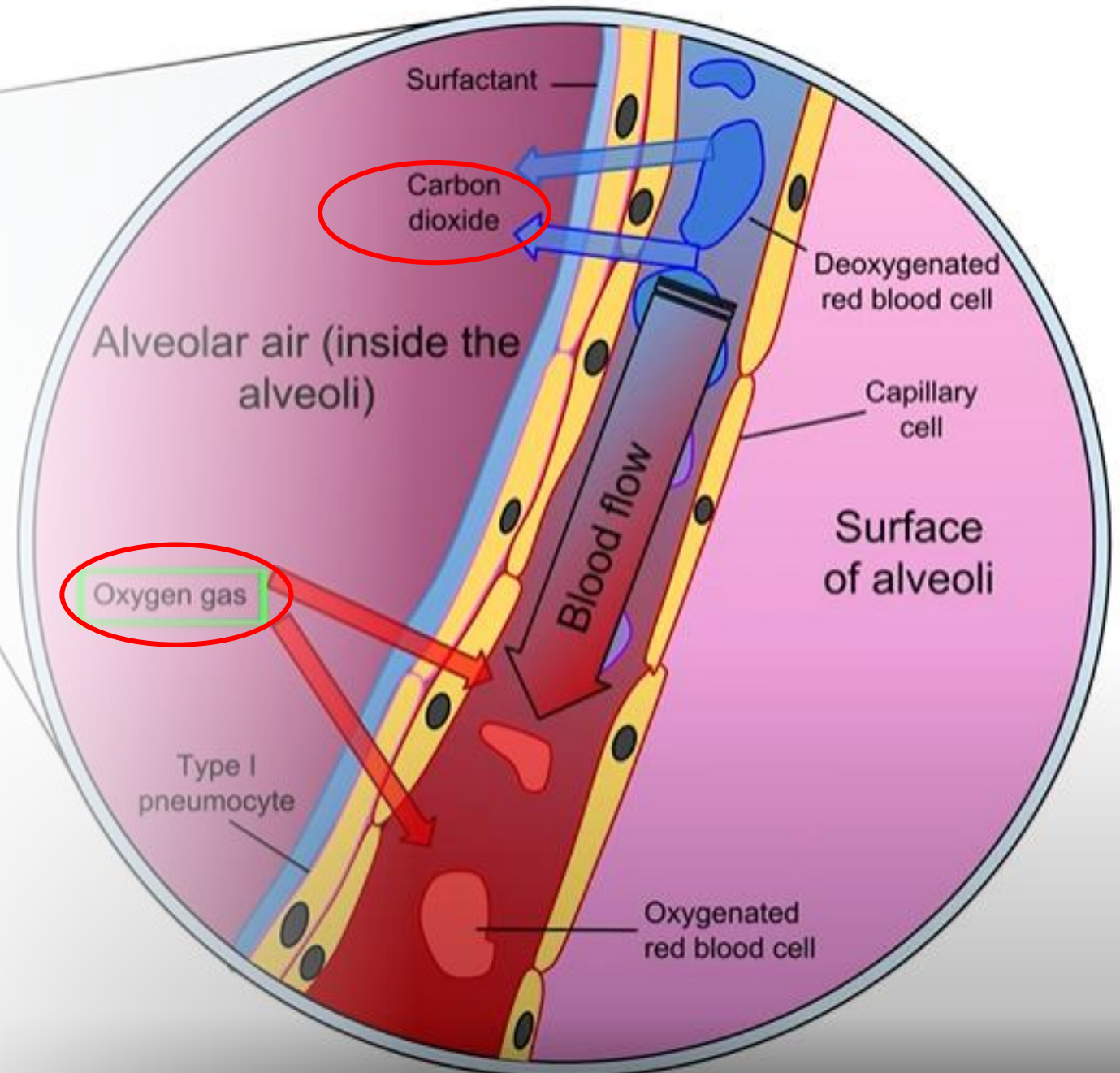
Alveoli

These structures have very thin walls made of a **single layer of squamous epithelial cells**, which is what allows for the **diffusion of gases**, and they are covered by a cobweb of pulmonary capillaries, so blood vessels are right up against the alveoli, ready to make a trade.

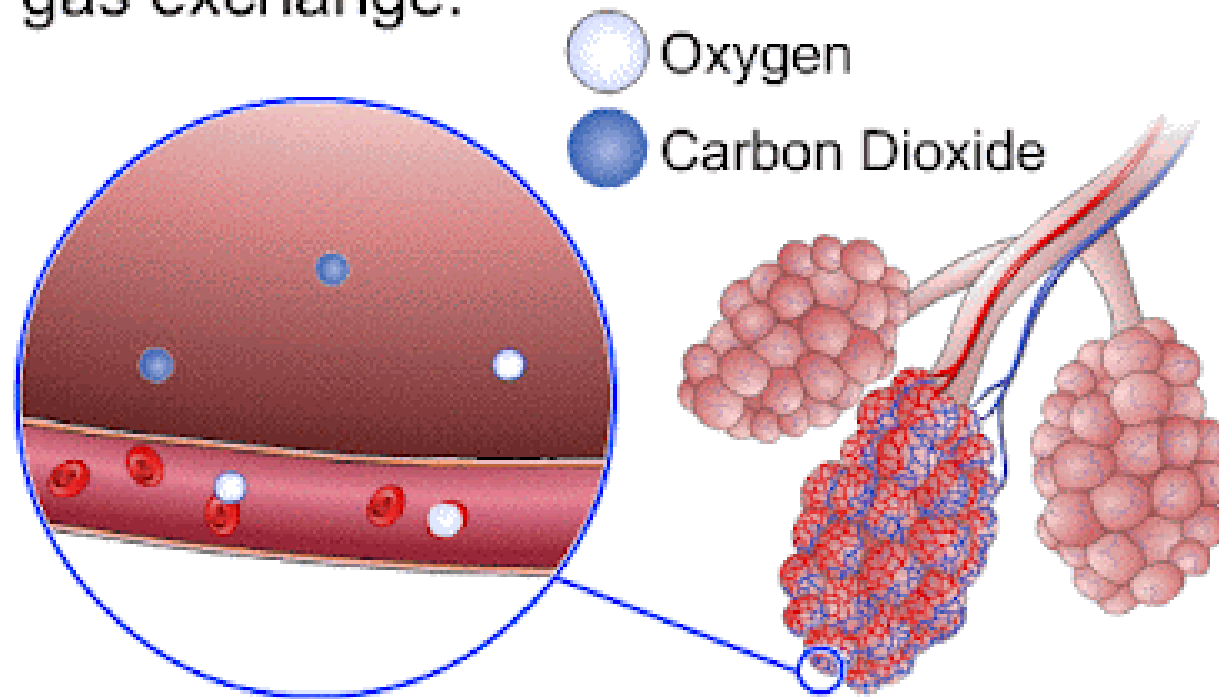


Gas exchange

- The air in the sacs has plenty of oxygen and the blood doesn't, so diffusion occurs spontaneously, and the blood has a good amount of carbon dioxide, and that will diffuse in the opposite direction, so that it can be exhaled.



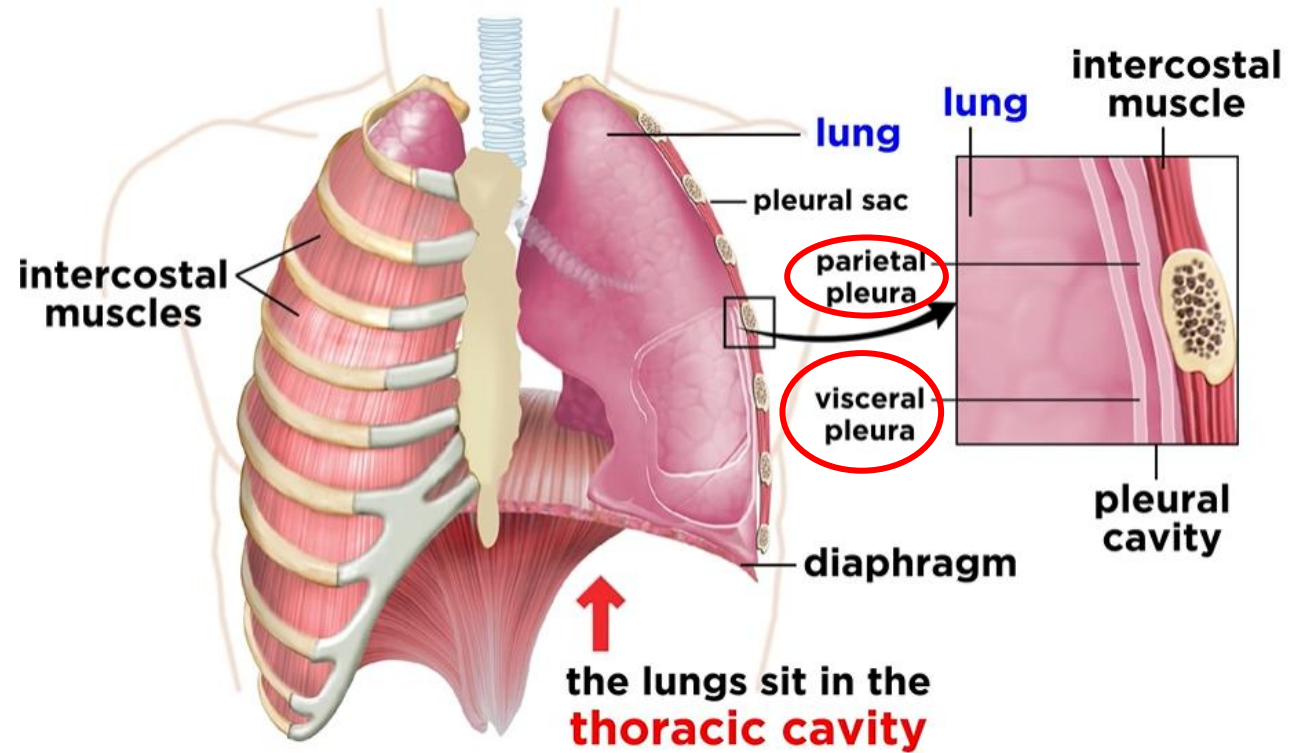
The alveoli are lined with very small blood vessels. In the alveoli, blood gets rid of carbon dioxide and picks up oxygen from the air we breathe in. This process is called gas exchange.



Lungs

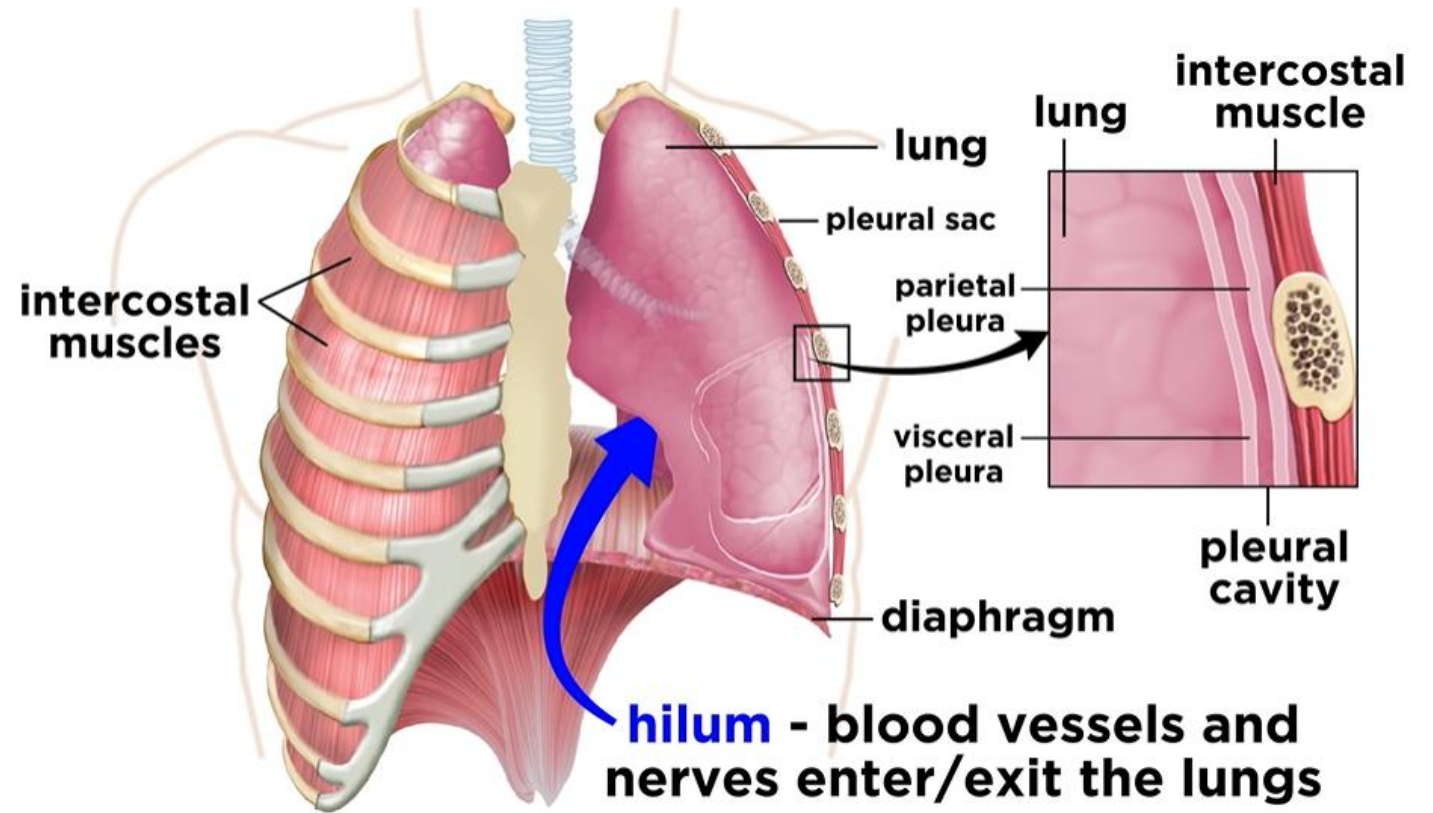
Now let's discuss the lungs, which house all of this internal structure.

These cone-shaped organs occupy almost all of the **thoracic cavity**, and they are surrounded by the **visceral pleura** and **parietal pleura**, while lying in close contact with the ribs, from the **apex down to the base**.



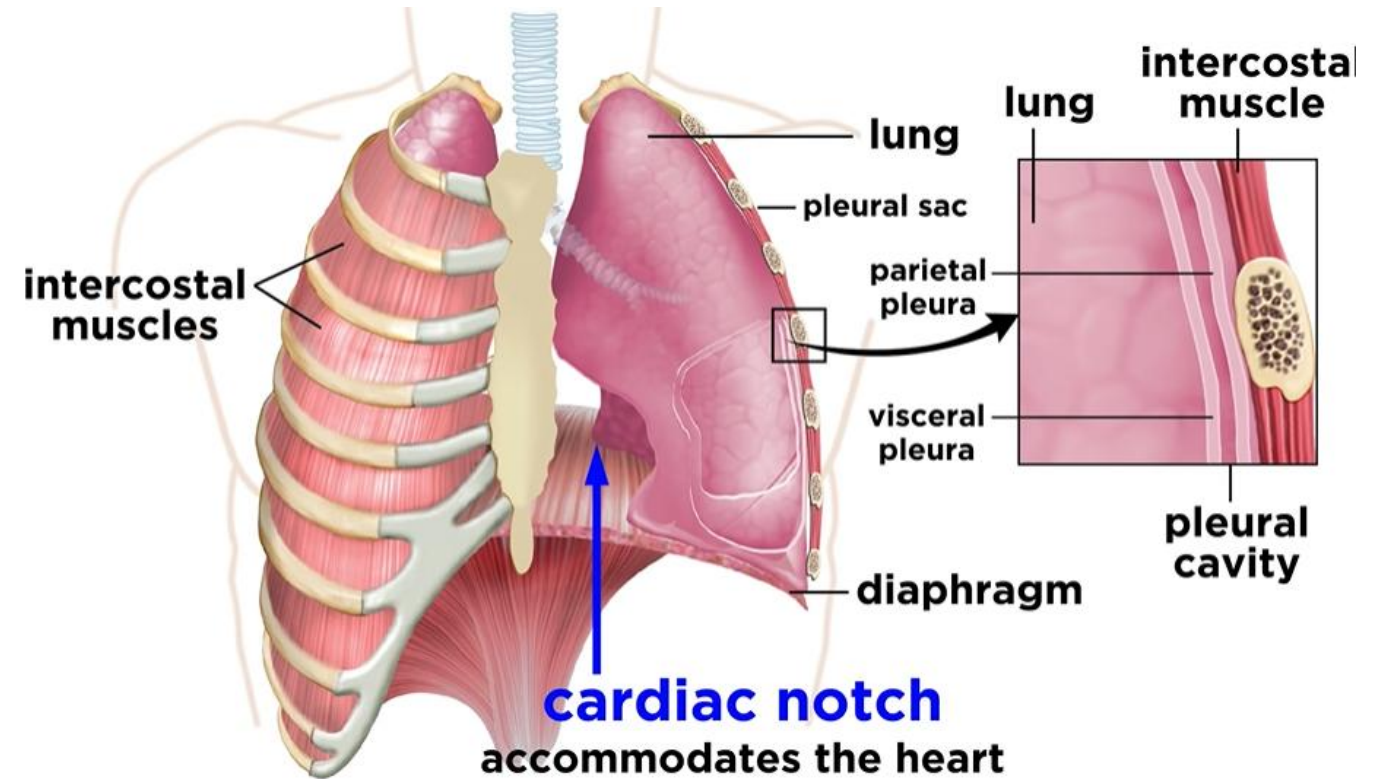
Hilum

The hilum is where blood vessels and nerves enter and leave the lungs.



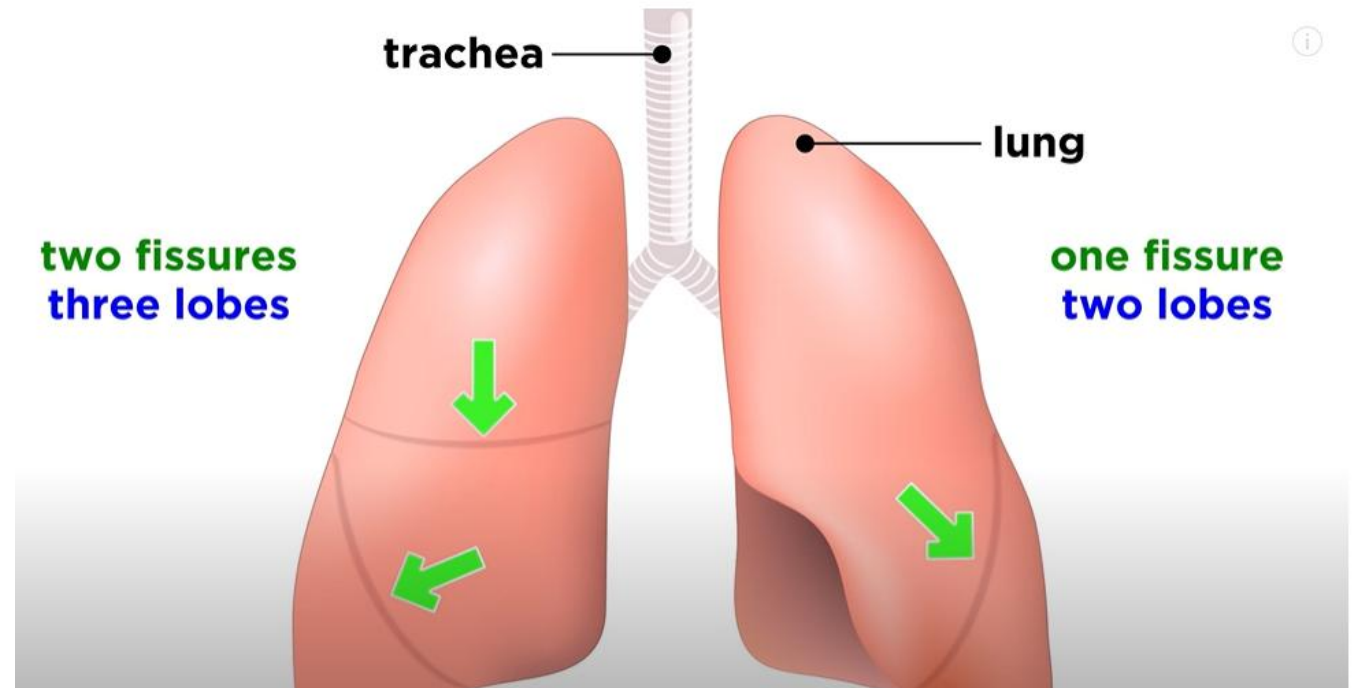
Cardiac notch

- The cardiac notch is a small cavity in the left lung that accommodates the heart.



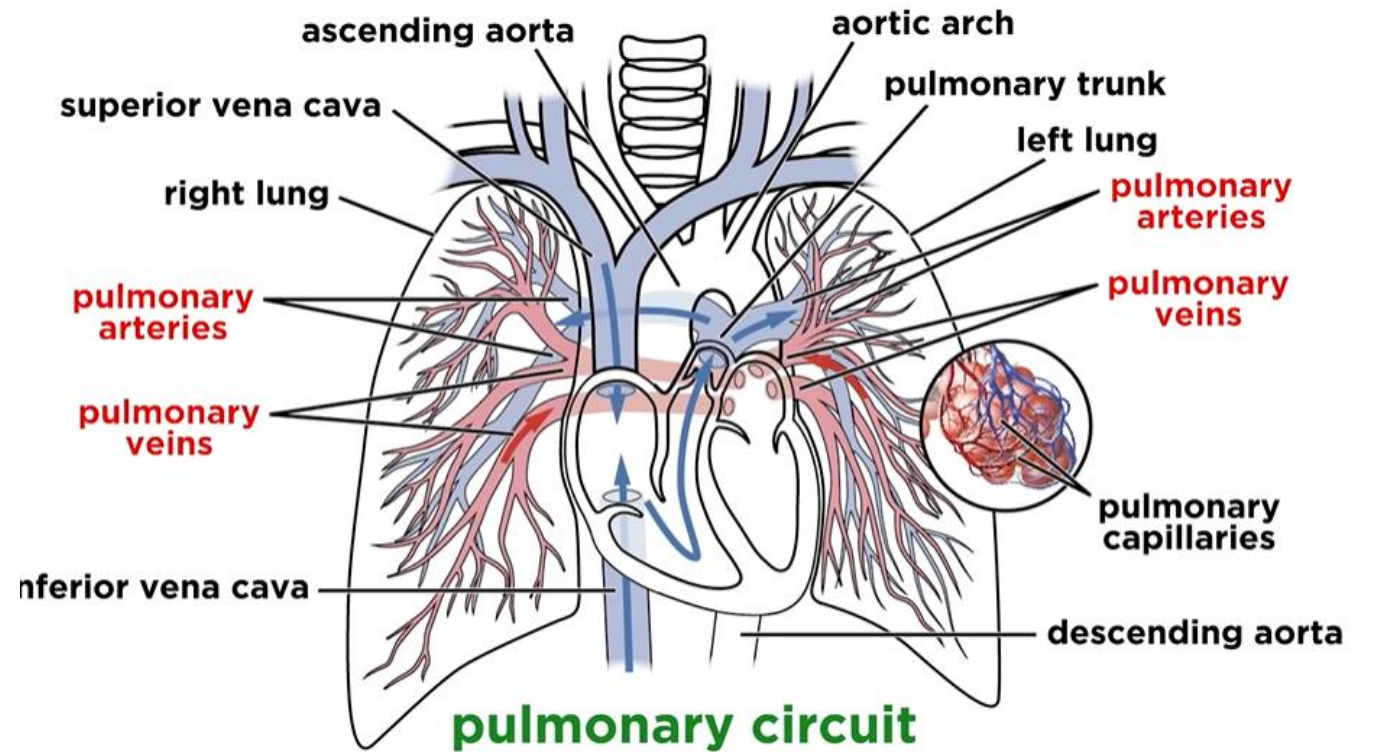
Lobes of lungs

- We can see different fissures in each lung that divide them into different lobes, with two fissures and three lobes in the right lung, and one fissure and two lobes for the left.



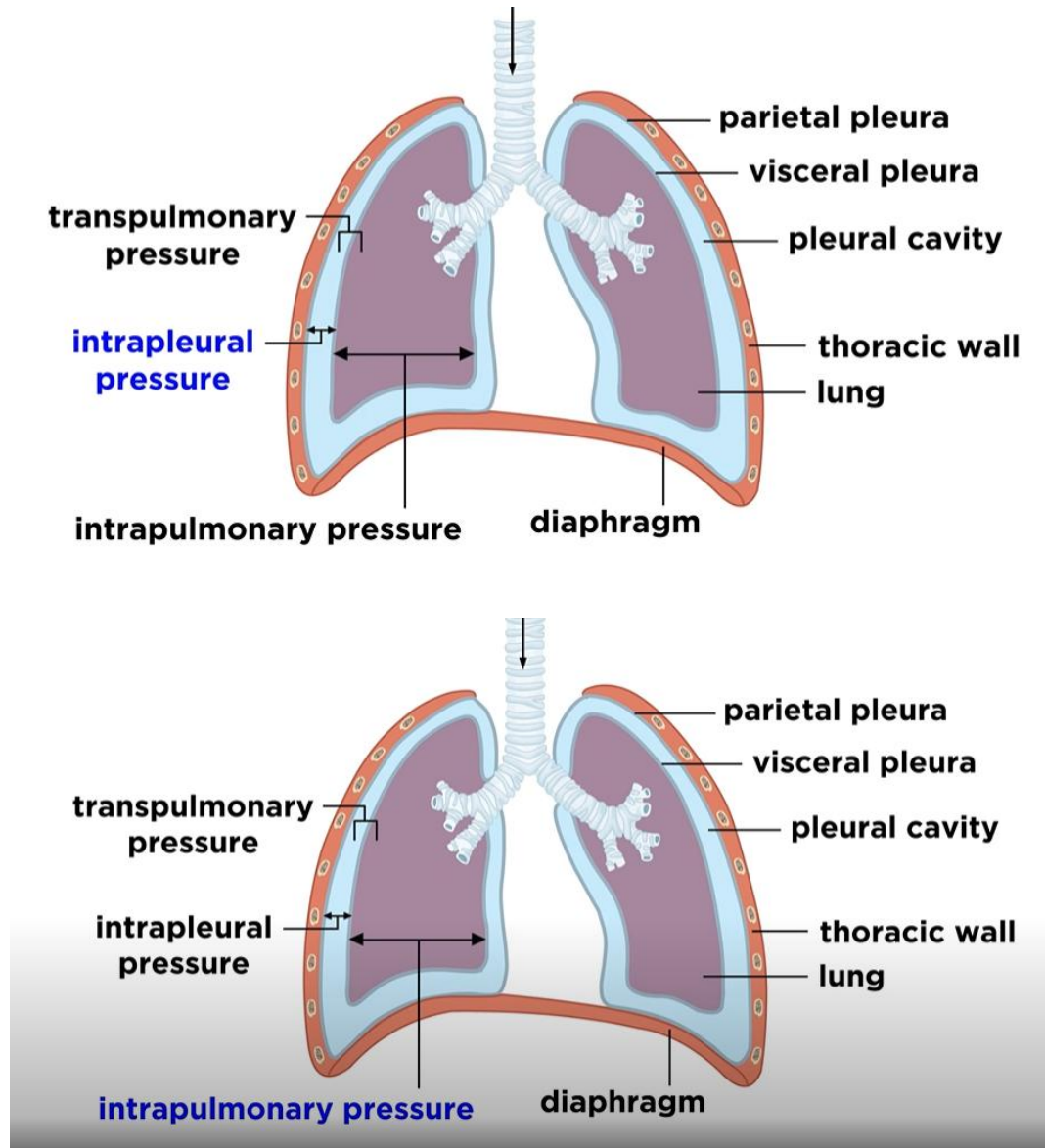
Pulmonary circuit

- When we looked at the circulatory system, we mentioned the pulmonary arteries and veins that bring blood to and from the lungs, arriving oxygen-poor, and leaving oxygen-rich, so we can imagine those connecting to the pulmonary capillaries to complete the circuit.



Lung pressure

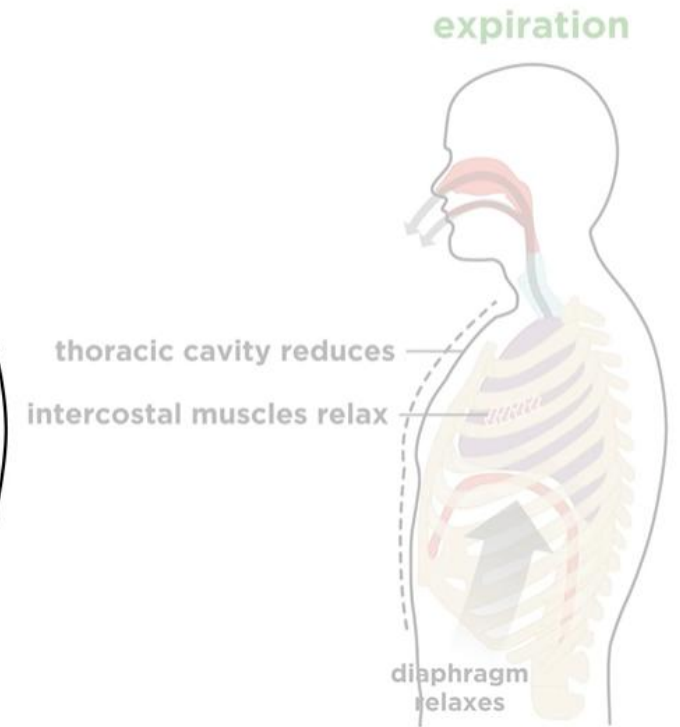
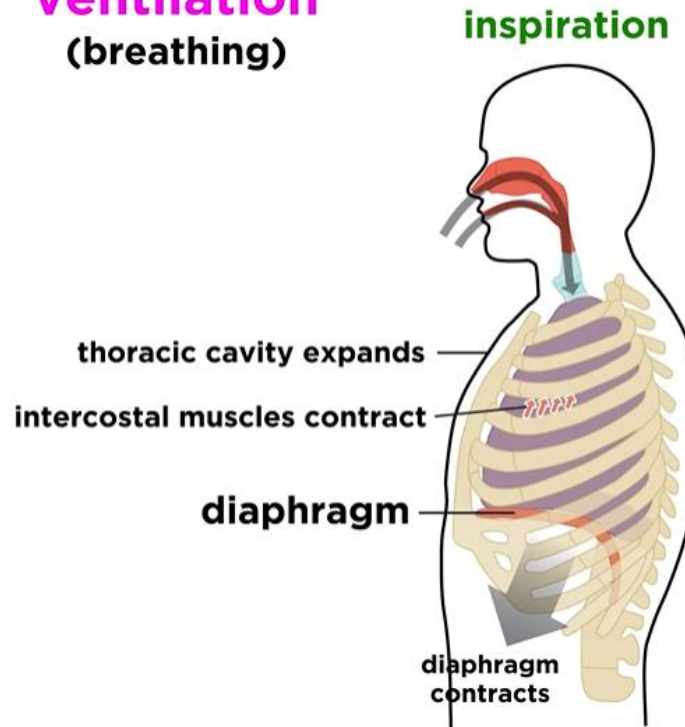
- Within the lungs, there is the **intrapulmonary pressure**, or the pressure in the alveoli, and the **intrapleural pressure**, the pressure in the pleural cavity that sits between the two pleurae.
- The **intrapleural pressure** is negative, which is what keeps the lungs open.



Inspiration

- Ventilation, or breathing, is the result of the activity of inspiratory muscles, namely the **diaphragm** and **intercostal muscles**, which produces a **change in volume**, and thereby a change in pressure, allowing air to enter along the pressure gradient.

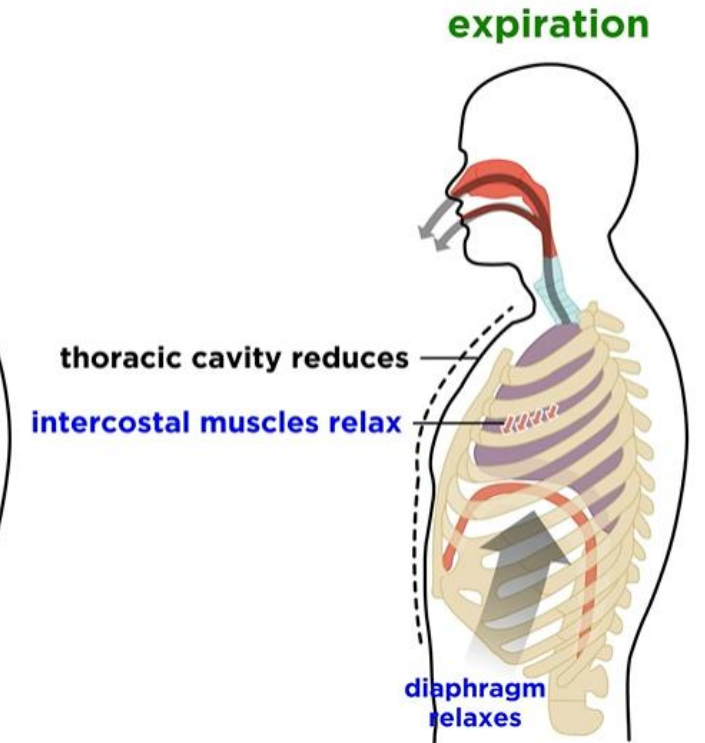
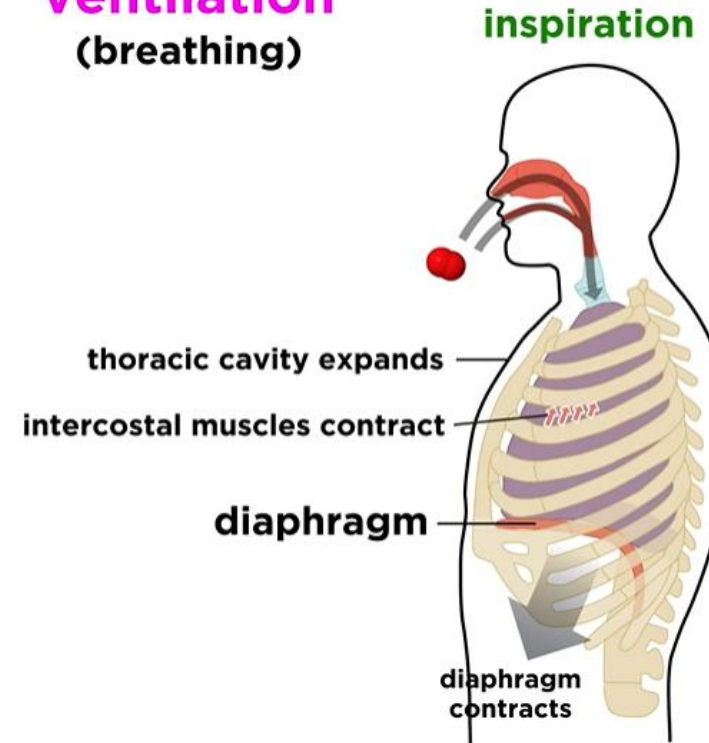
ventilation (breathing)



Expiration

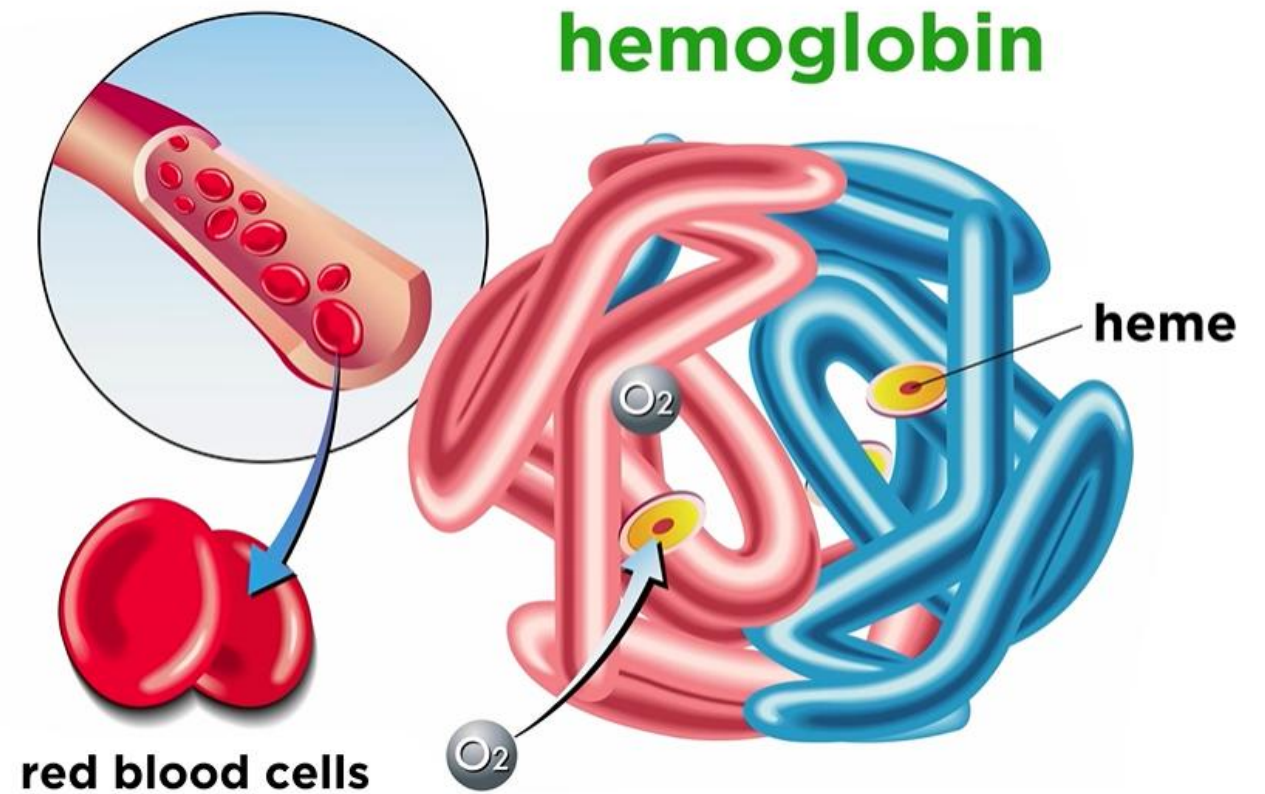
- As they relax, **expiration occurs**.
- In between, **oxygen diffuses and binds to hemoglobin present in the blood**, so that it can then be transported to tissues all around the body.

ventilation (breathing)



Hemoglobin

- In between, oxygen diffuses and binds to hemoglobin present in the blood, so that it can then be transported to tissues all around the body.



Animation

- https://biomanbio.com/HTML5GamesandLabs/Physiologygames/respiratory_journeyhtml5page.html
- <https://www.youtube.com/watch?v=7FhzSSQxM54&t=526s>