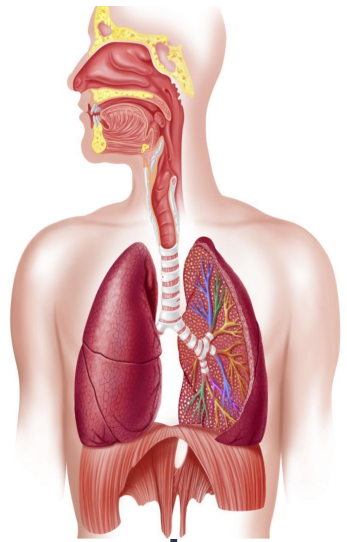
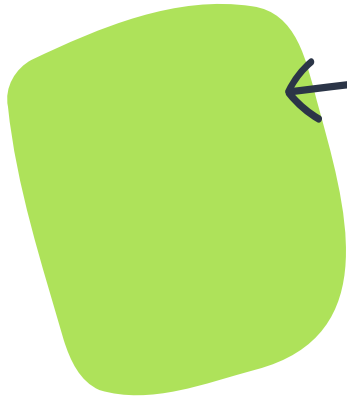




# 10.2 RESPIRATORY STRUCTURES AND PROCESSES

P. 440 - 445



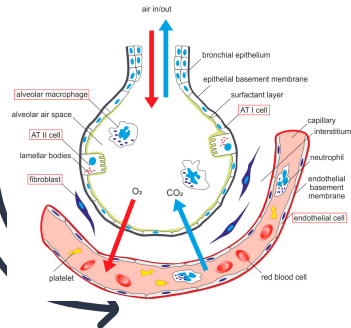
## FOUR IMPORTANT STRUCTURAL FEATURES:

1. A thin **permeable** respiratory membrane through which diffusion can take place
2. A **large surface area** for gas exchange
3. A good **supply of blood**.
4. A **breathing system** for bringing oxygen rich air into the respiratory membrane

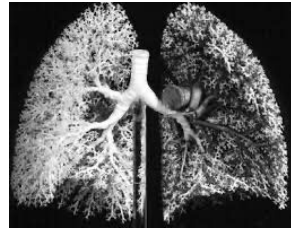
# FOUR MAIN STEPS IN RESPIRATION

## THIN MEMBRANE

The walls of the alveoli are one cell thick allowing for diffusion to occur.



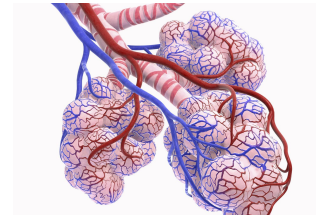
## LARGE SURFACE AREA



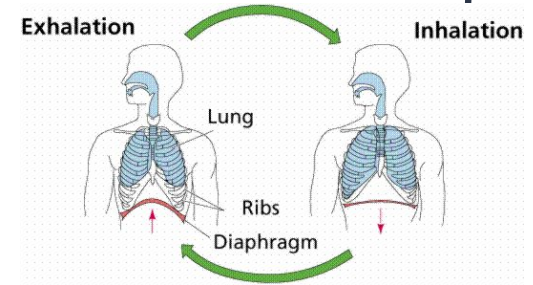
Thin membrane is folded into about 300 million alveoli. Total surface area of lungs is **50 -75 m<sup>2</sup>**. This encourages maximal diffusion.

## GOOD BLOOD SUPPLY

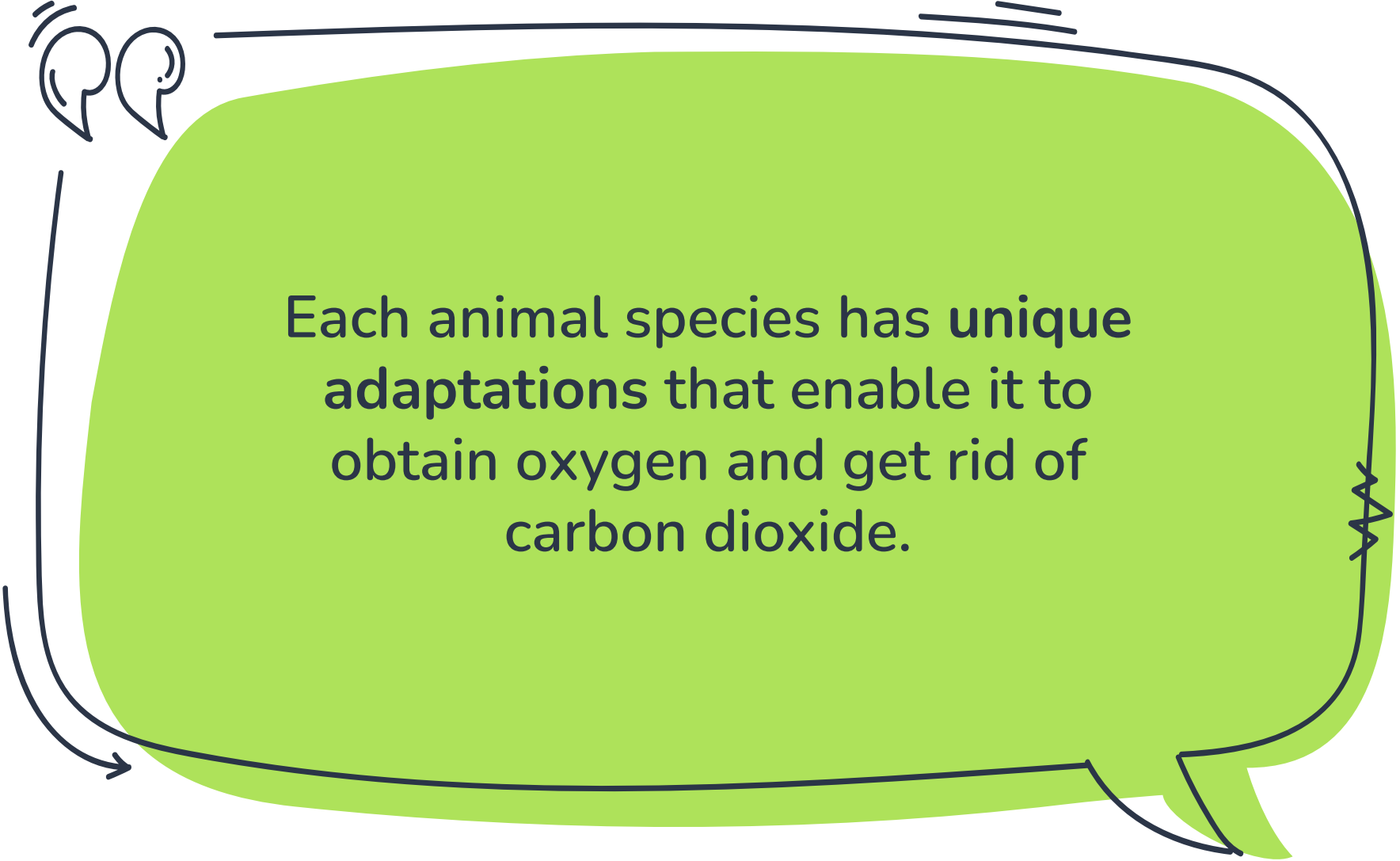
Alveoli are surrounded by capillaries to move gases to and from lungs.



## VENTILATION



Ventilation system allows O<sub>2</sub> to enter from the environment and CO<sub>2</sub> to exit lungs.



Each animal species has unique adaptations that enable it to obtain oxygen and get rid of carbon dioxide.

# HUMAN RESPIRATORY TRACT

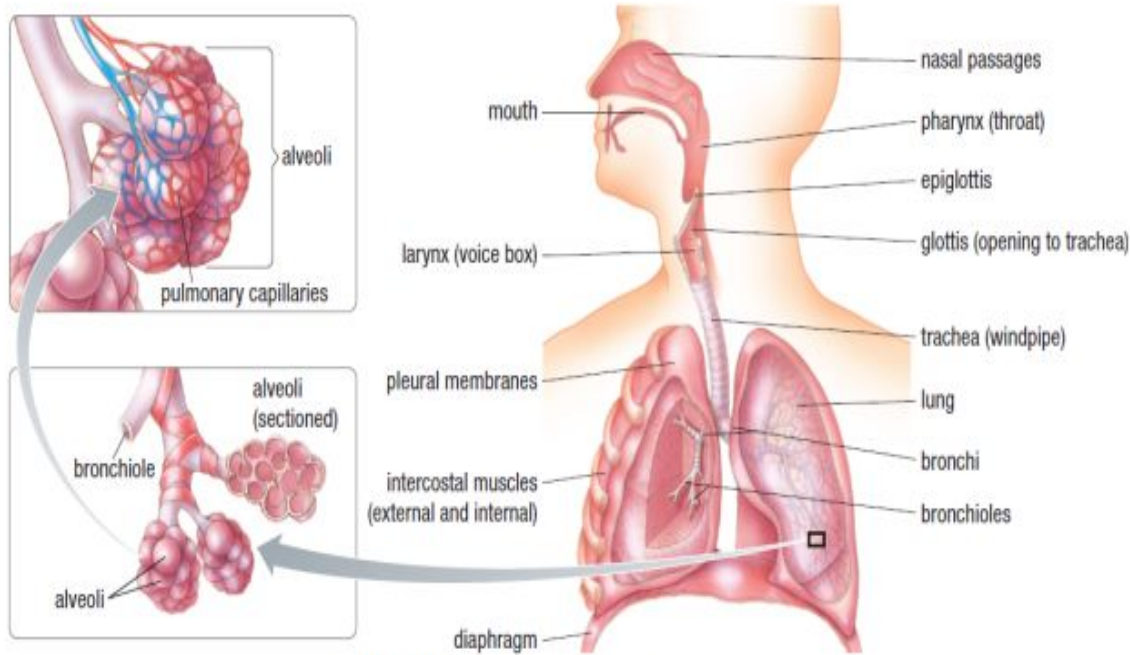


Figure 1 The human respiratory system

# UPPER RESPIRATORY TRACT

- Nose
- Pharynx
- Larynx

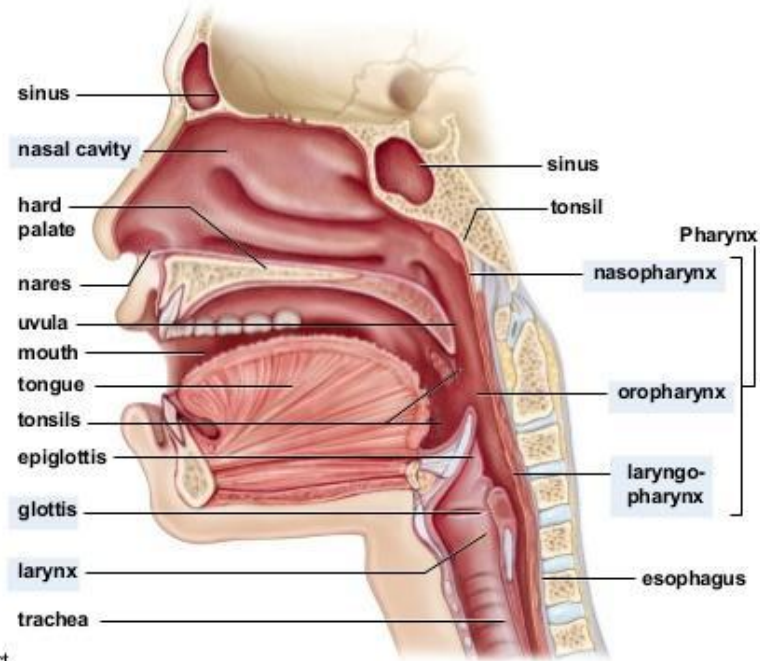
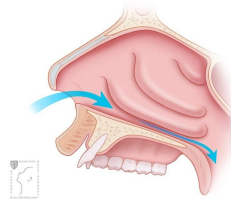


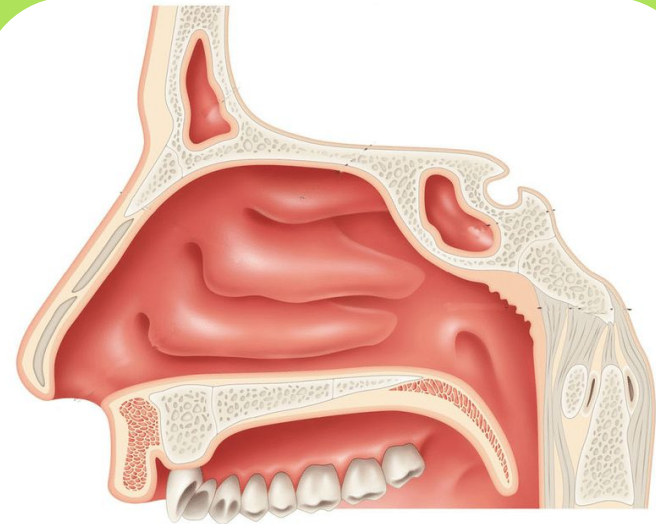
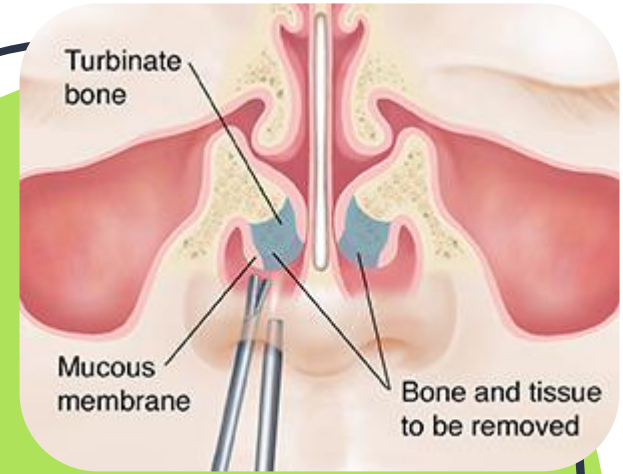
Figure 10.2 The upper respiratory tract.

# ADAPTATIONS



## Nasal passages/cavity:

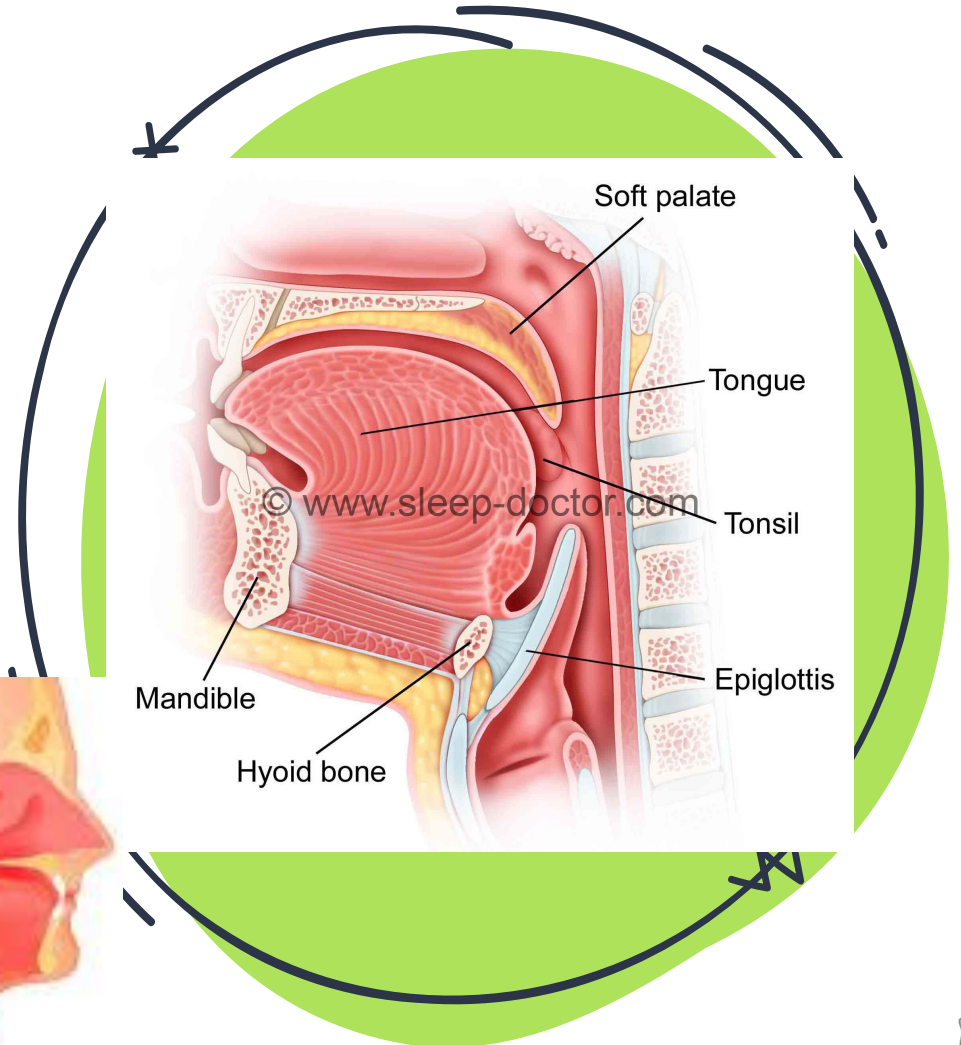
- X contains **turbinate bones** for more surface area
- X *warms the air to body temperature*
- X adds moisture to make it easier for oxygen to dissolve
- X *hairs and mucus filter out bacteria and other airborne particles*



# ADAPTATIONS

## Epiglottis

- ✗ flap that the trachea presses against when food is in the **pharynx**
- ✗ *prevents choking - food and other substances cannot enter the trachea and lungs*

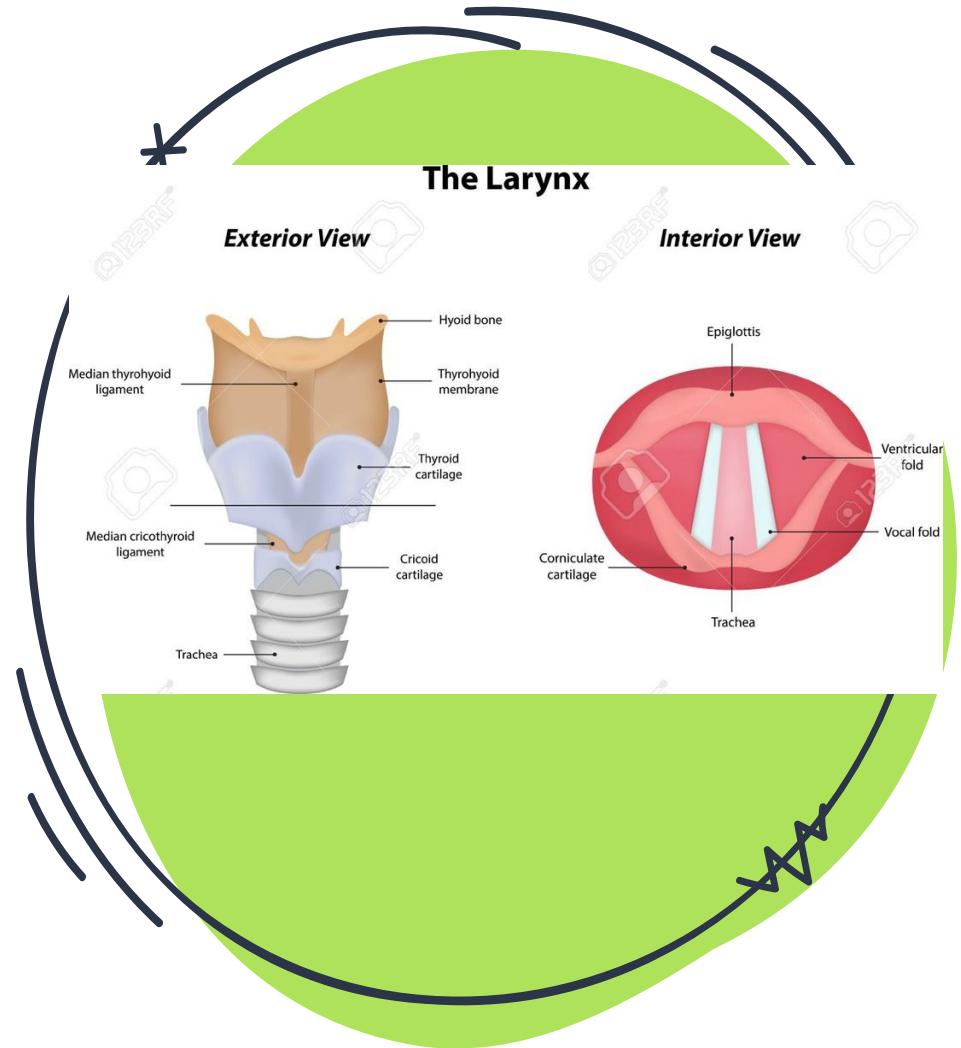




# ADAPTATIONS

## Larynx

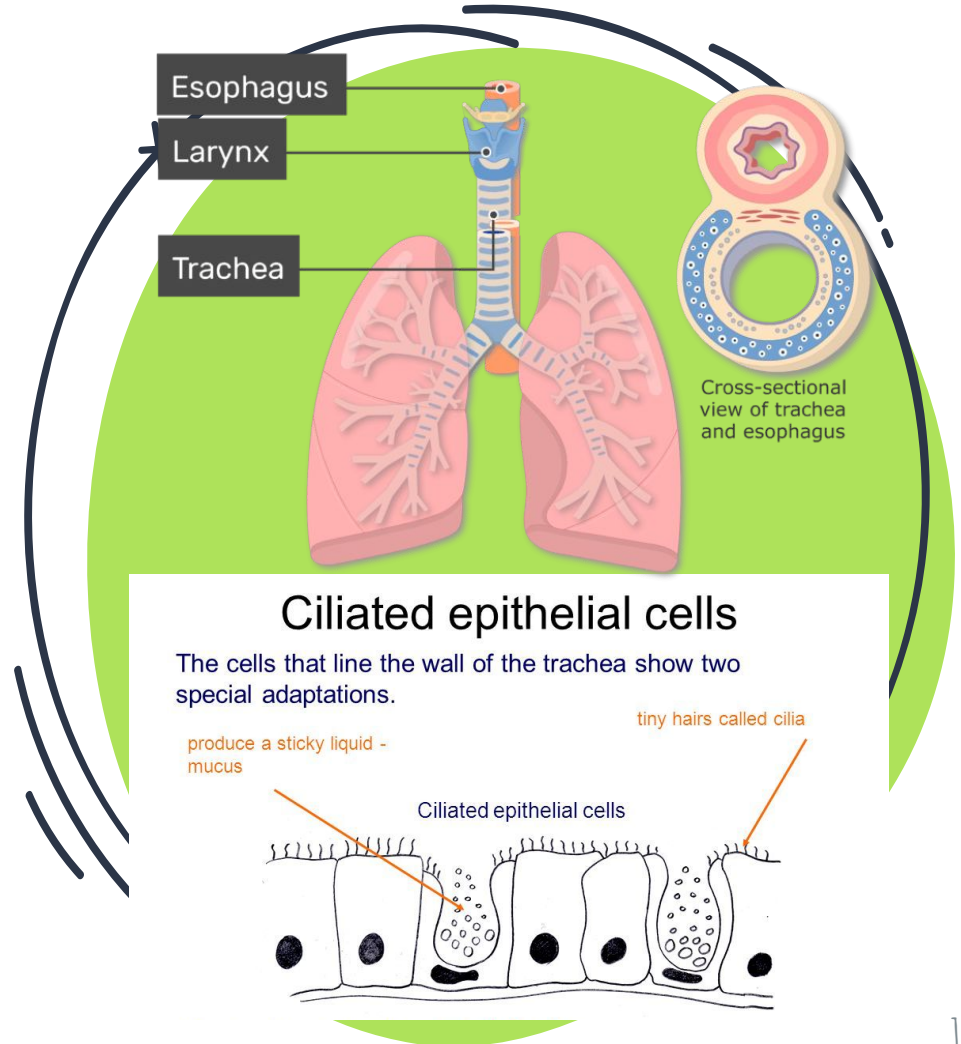
- ✓ Voice box
- ✗ allows the production of sound
- ✗ used for communication of ideas, concepts, emotions, etc.



# ADAPTATIONS

## Trachea

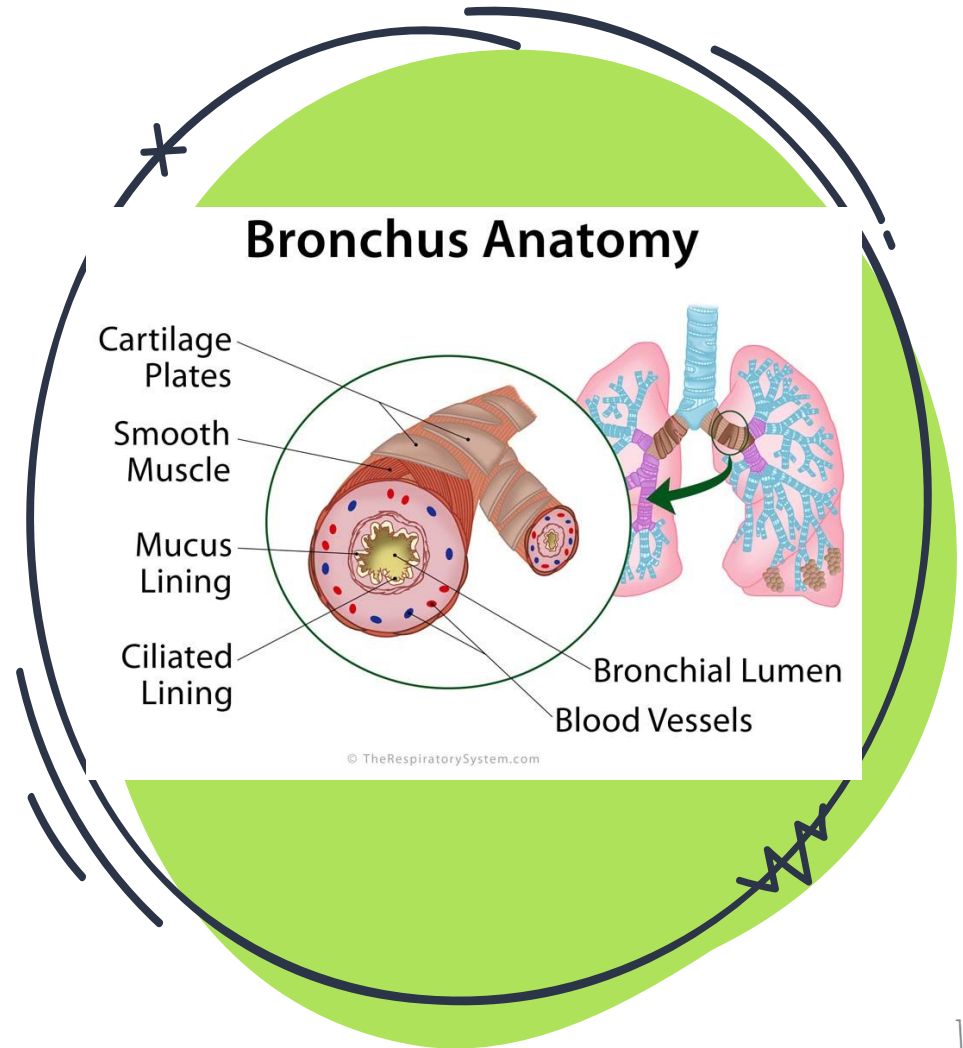
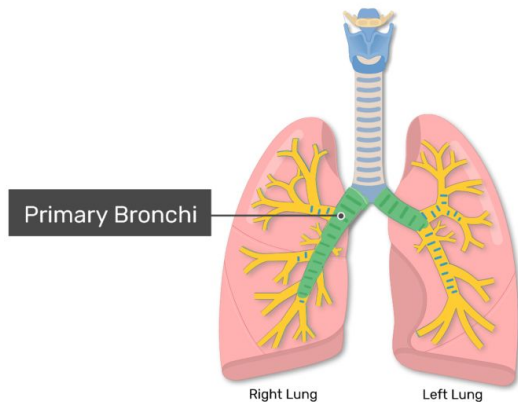
- x connects nose/mouth to lungs*
- x lined with rings of cartilage to prevent collapse*
- x lined with mucus to trap airborne particles and wave-like motion of cilia sweep the particle up and out*



# ADAPTATIONS

## Bronchus (bronchi)

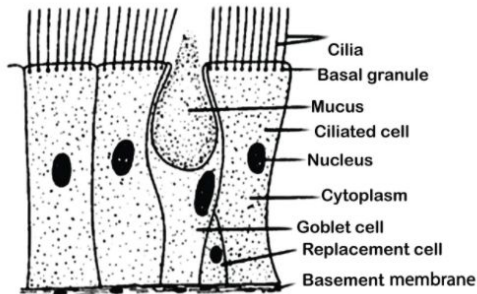
- X one in each lung
- X branch off of the trachea
- X reinforced by cartilage
- X lined with cilia and mucus like trachea.



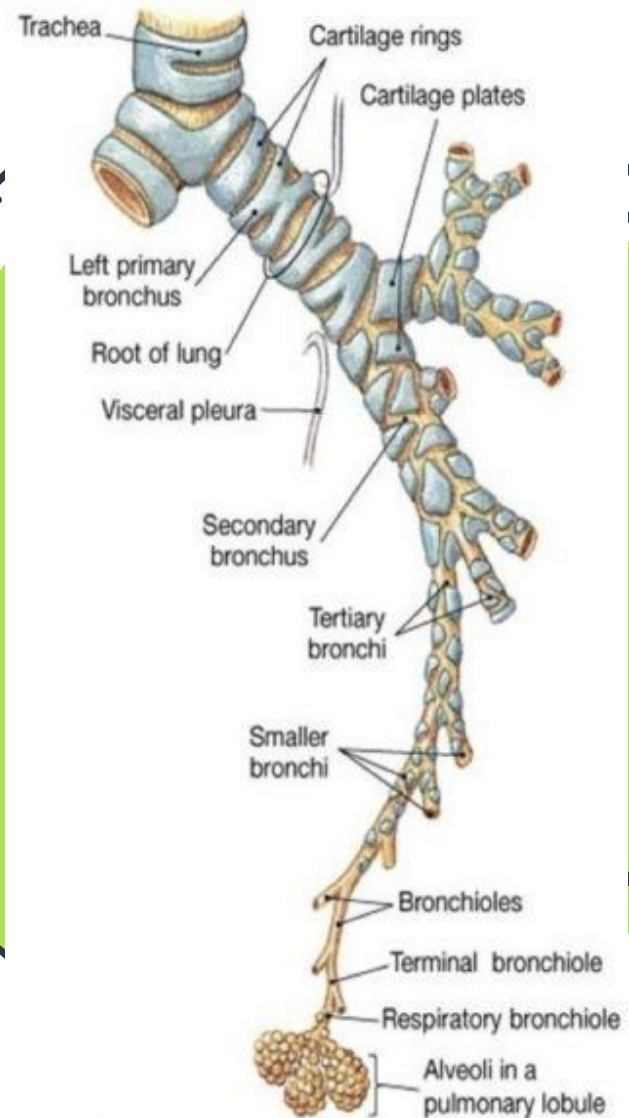
# ADAPTATIONS

## Bronchiole(s)

- ✗ smaller tubes branching off of each bronchus
- ✗ reinforced by cartilage
- ✗ lined with cilia and mucus to trap airborne particles, bacteria and fungi



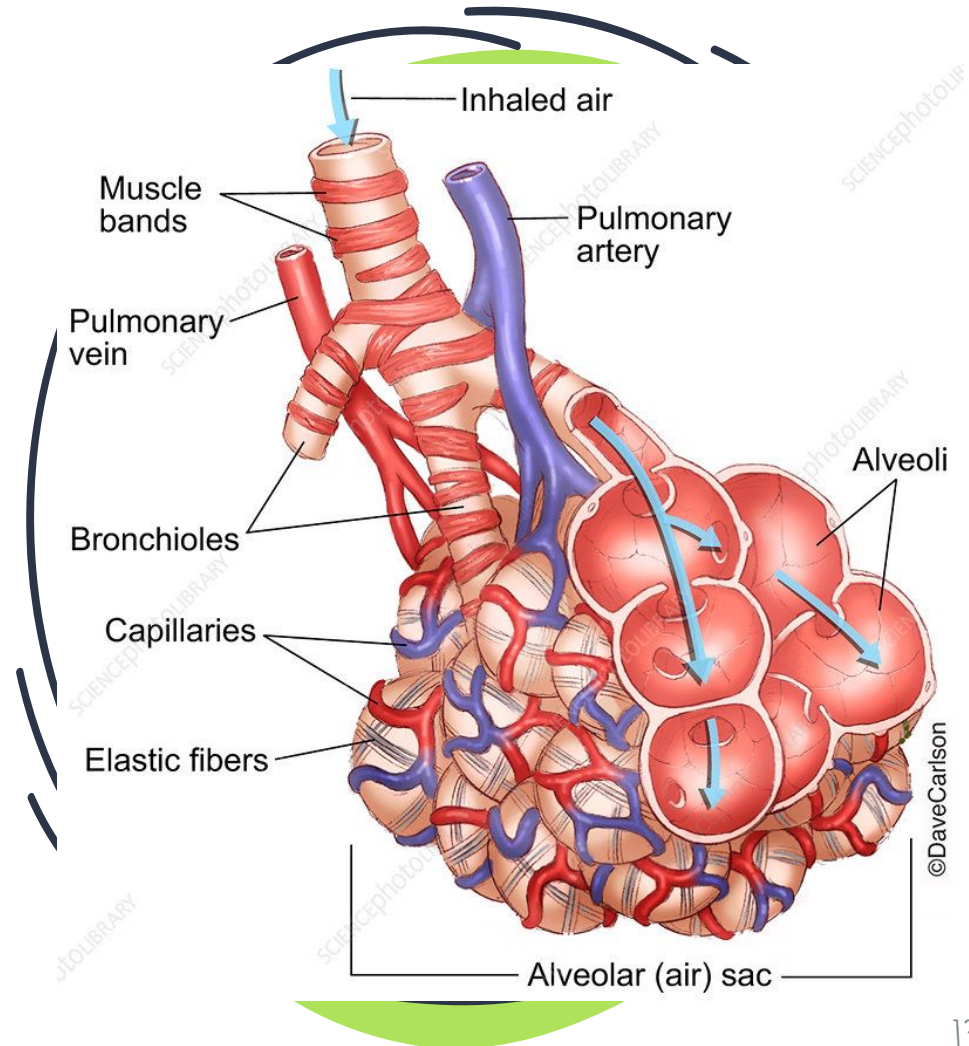
Simple columnar ciliated epithelium



# ADAPTATIONS

## Alveolus (alveoli)

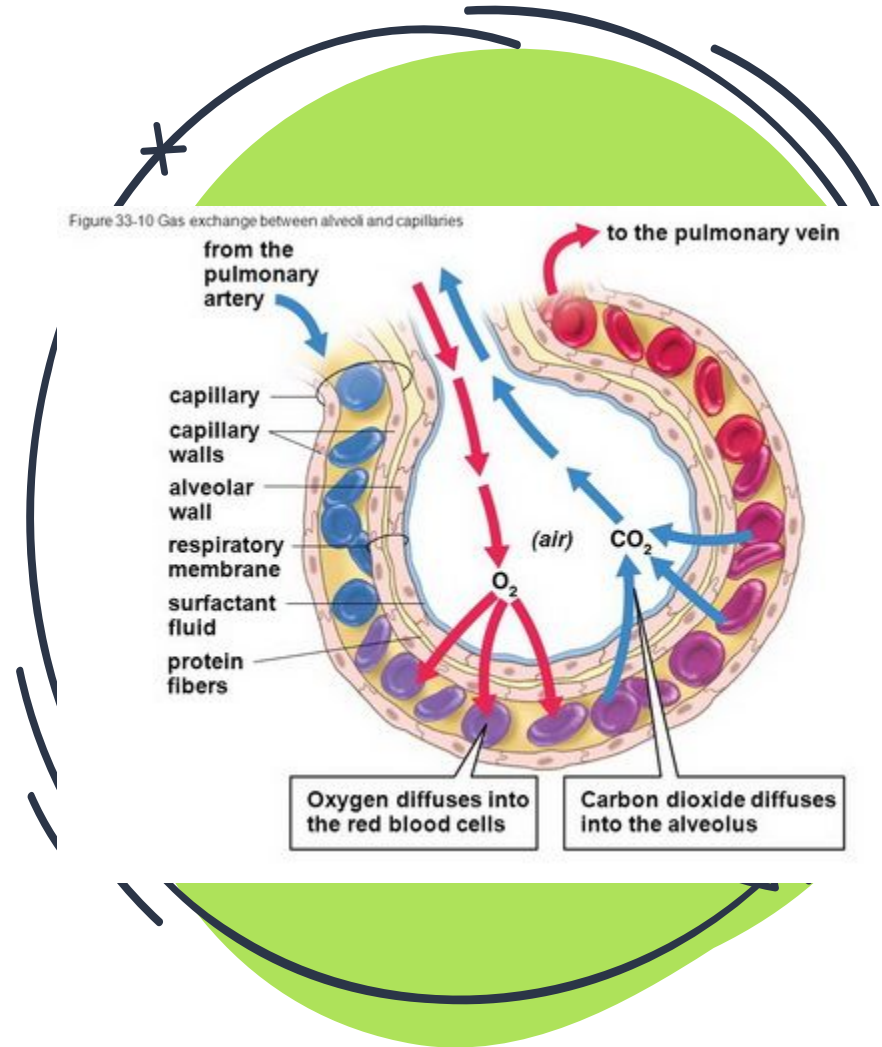
- X microscopic air sacs
- X surrounded by capillaries (microscopic blood vessels)
- X lots of surface area (size of tennis court)
- X **only** location for gas exchange in the lungs
- X NO cartilage
- X single layer of cells for diffusion

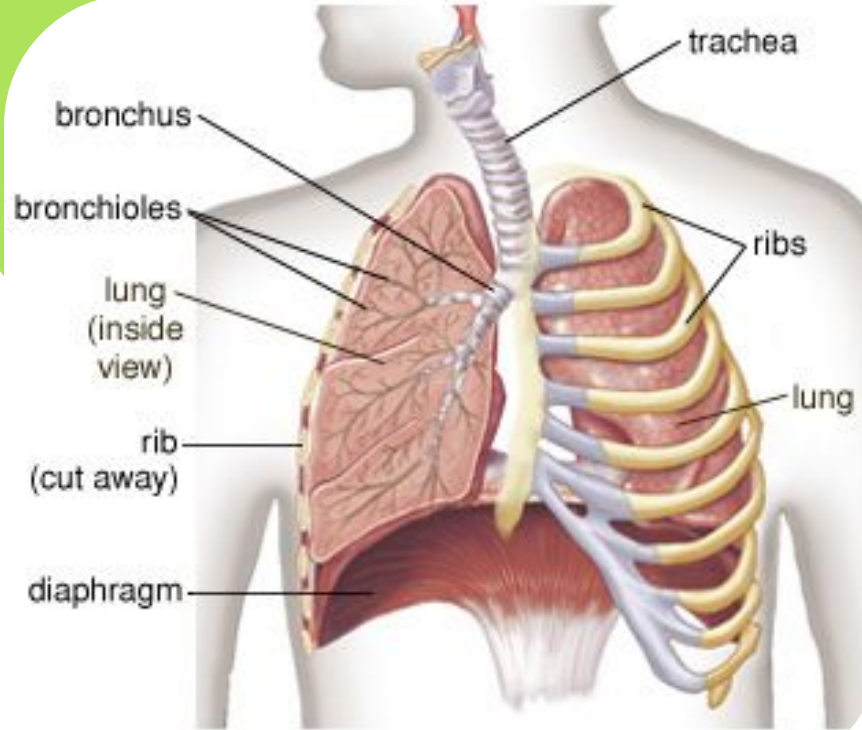


# ADAPTATIONS

## Pulmonary capillaries

- X microscopic blood vessels
- X wrap around alveoli
- X contain the plasma and red blood cells
- X **Plasma** - liquid containing dissolved substances
- X **Red blood cells** - contain hemoglobin to carry oxygen to body cells and pick up carbon dioxide from body cells.





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# THE STRUCTURES OF VENTILATION

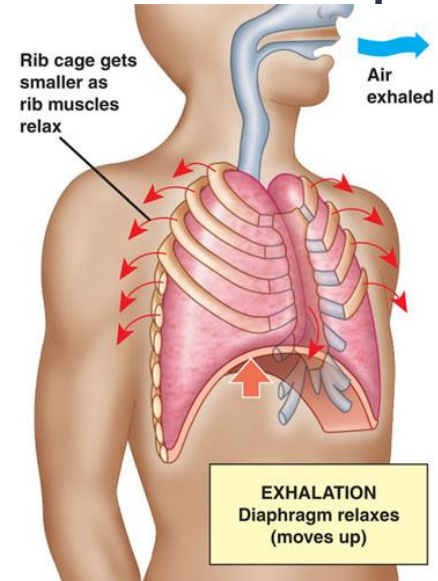
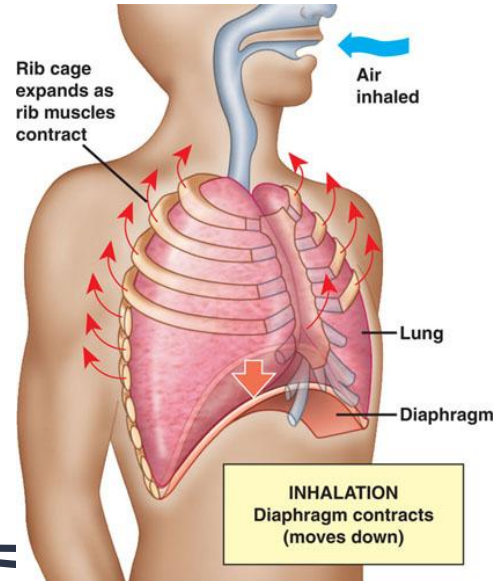
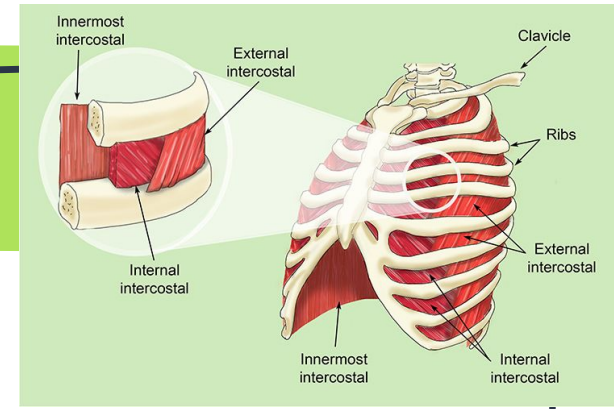
# CHEST CAVITY

## Ribs and Intercostal Muscles

Two types of muscles - external and internal intercostal muscles

### External intercostal muscles:

- ✗ Contract to move rib cage up (and out) to increase the size of the chest during inhalation;
- ✗ Relax to move rib cage down during exhalation

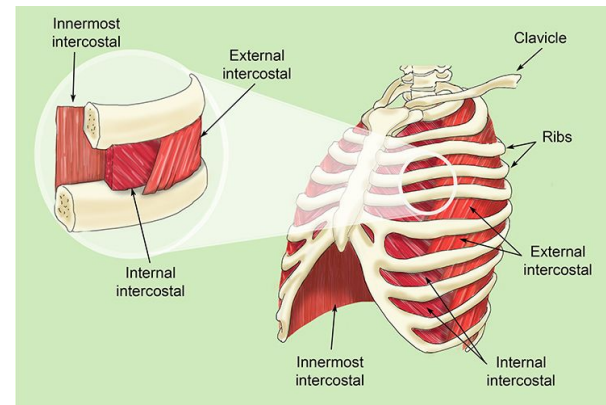




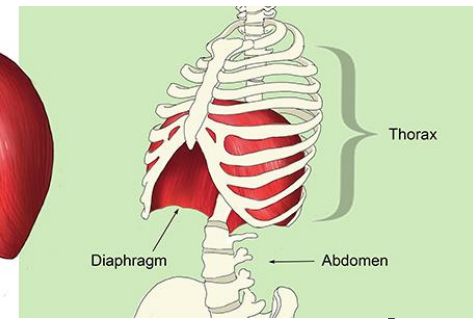
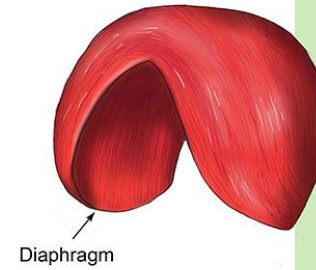
# CHEST CAVITY

## Internal Intercostal Muscles

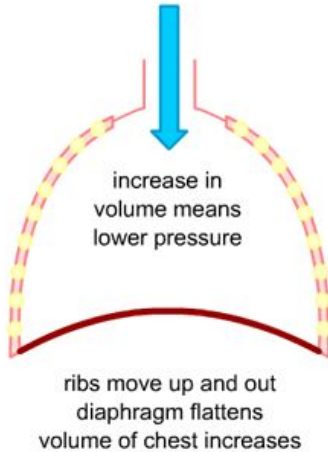
- x These come into play during strenuous exercise and forced exhalation
- x When they contract, they pull the rib cage down and force more air out of the lungs



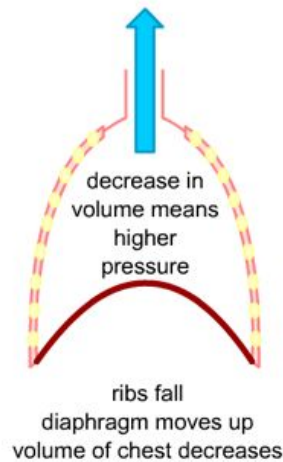
# CHEST CAVITY



breathing in



breathing out



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## Diaphragm

- X large dome - shaped muscle
- X separates thoracic cavity from the abdominal cavity
- X flattens when it contracts increasing the size of the chest cavity
- X ,makes an upside "U" when it relaxes, decreasing the size of the chest cavity.



# INTERNAL ORGANS

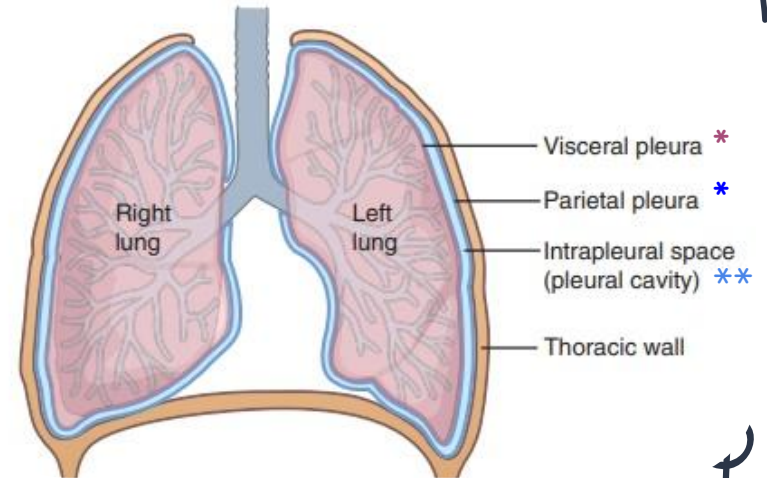
## Lungs

- X two sacs
- X contain microscopic air sacs (alveoli), blood vessels (arteries, capillaries, veins), and bronchioles

## 2 Pleural Membranes

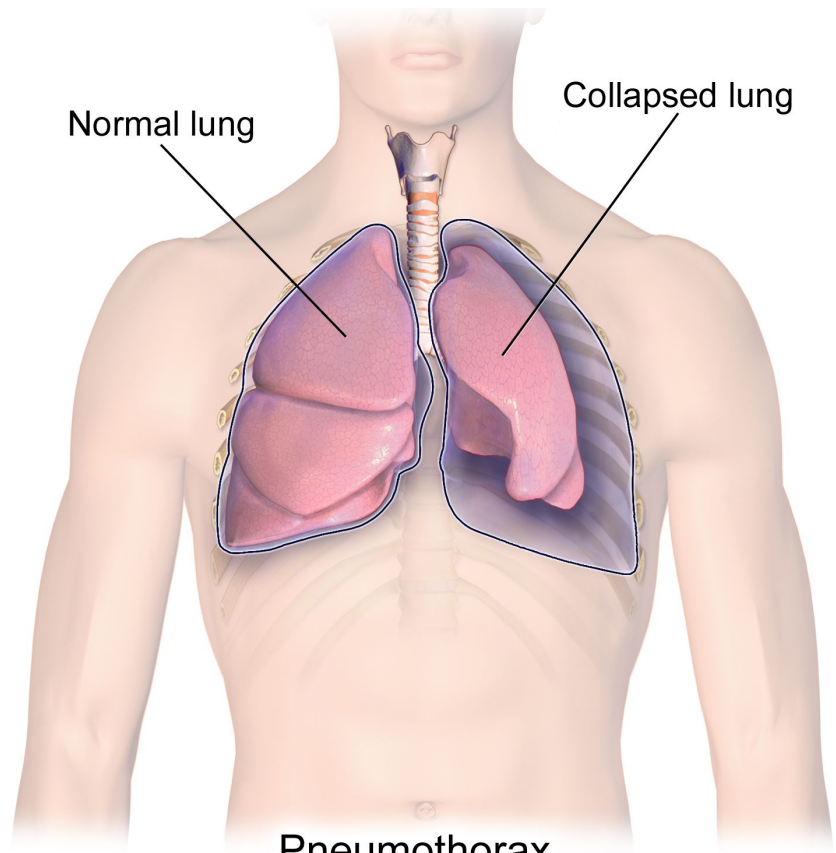
(Visceral\* pleura and parietal\* pleura)

- X cover the lungs and line the thoracic cavity
- X creates intrapleural space (fluid-filled layer)\*\*
  - X keeps the lungs and ribs from creating friction when they slide by each other.



Normal lung

Collapsed lung



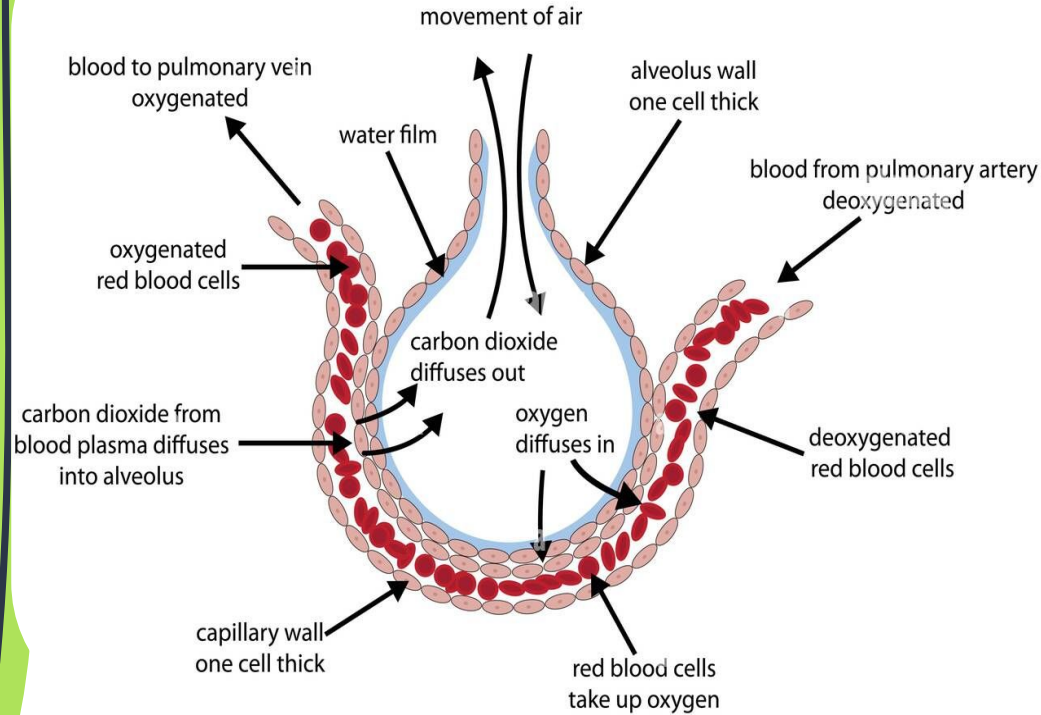
Pneumothorax

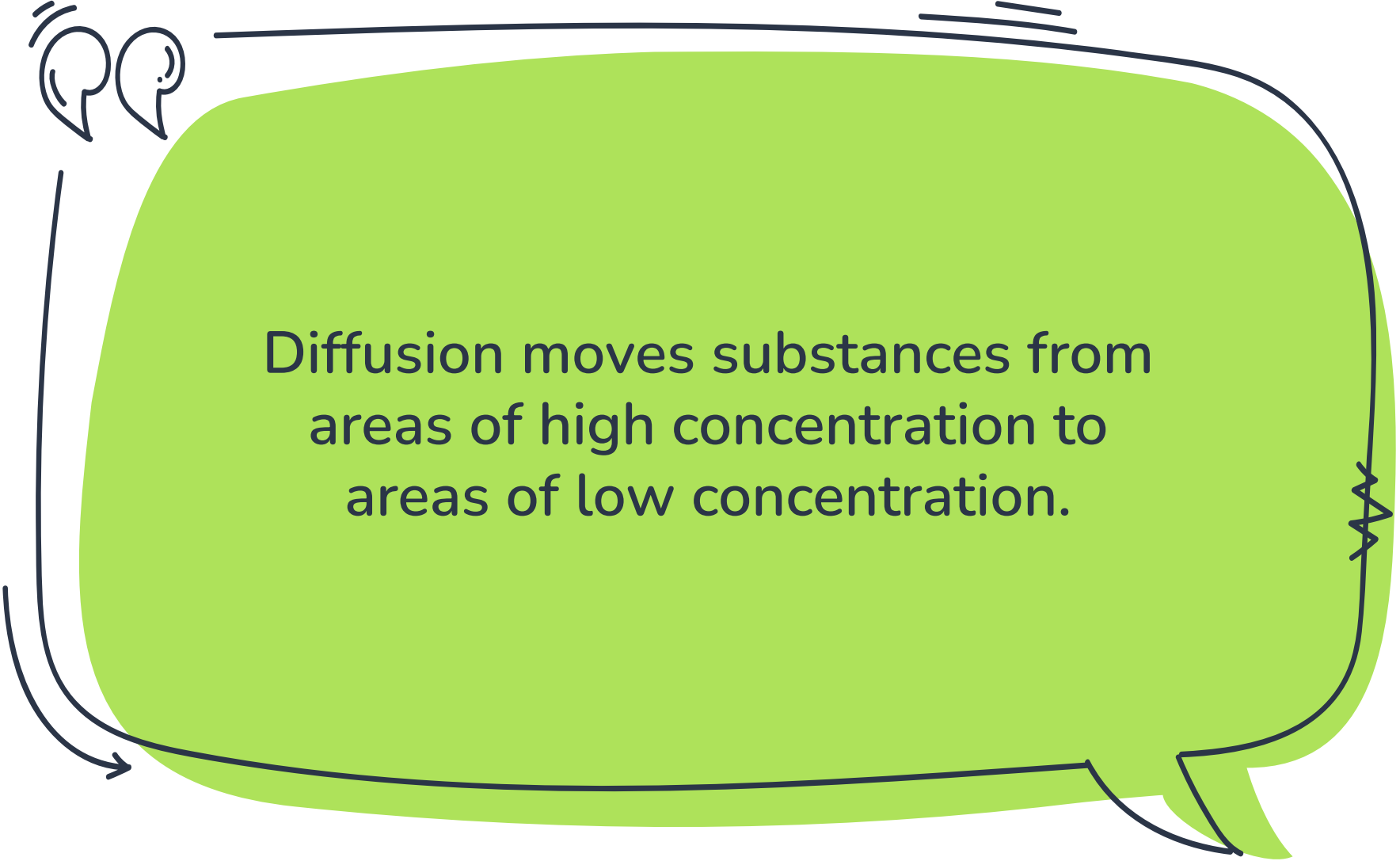
**PNEUMOTHORAX:**  
a collapsed lung caused by air getting between the pleural membranes.

# GAS EXCHANGE IN THE ALVEOLI

- X air in alveoli is at body temp. and saturated with moisture
- X the membrane is also moist
  - X moisture allows for better diffusion
- X alveoli are ONE cell layer thick (thin respiratory membrane)
- X capillary walls are ONE cell layer

Function of the Alveolus in the Lungs



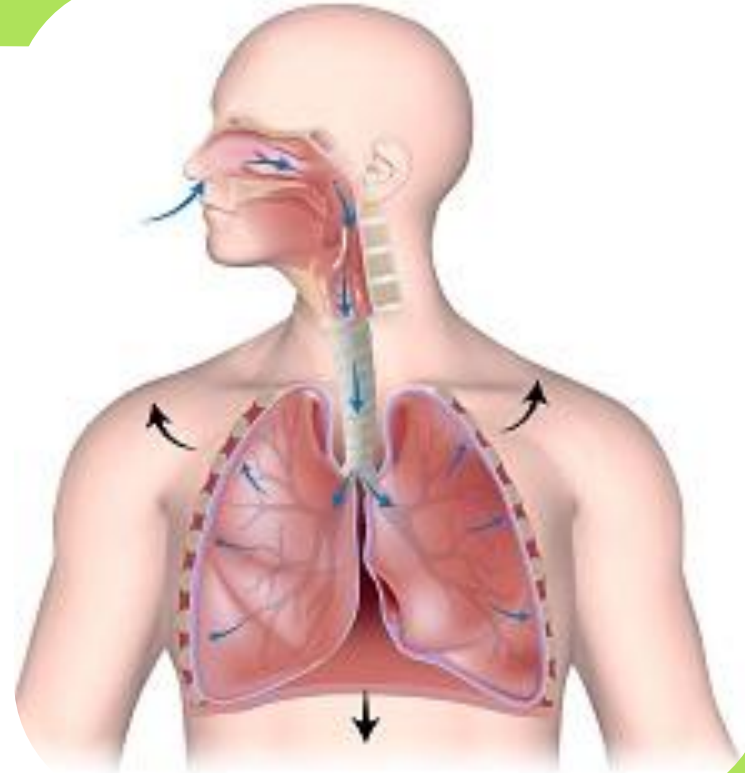


Diffusion moves substances from areas of high concentration to areas of low concentration.

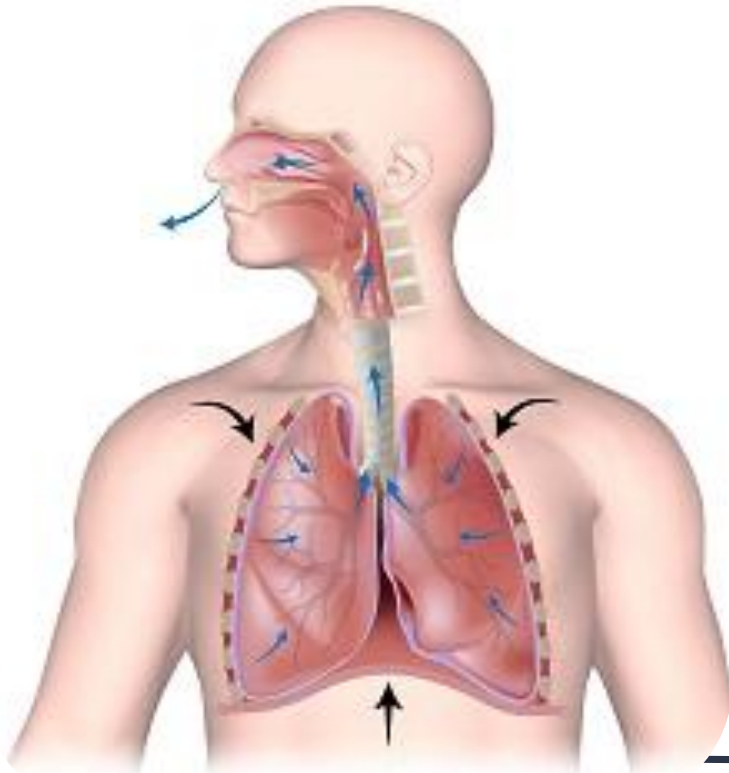
# VENTILATION - INSPIRATION

## Inspiration

- X inhalation
- X diaphragm contracted, moves down, flattens
- X ribs up and outward
- X volume in chest increases
- X high pressure outside the body compared to low pressure inside the lung (due to expansion of lungs)
  - X therefore, air moves into the lungs



# VENTILATION - EXPIRATION

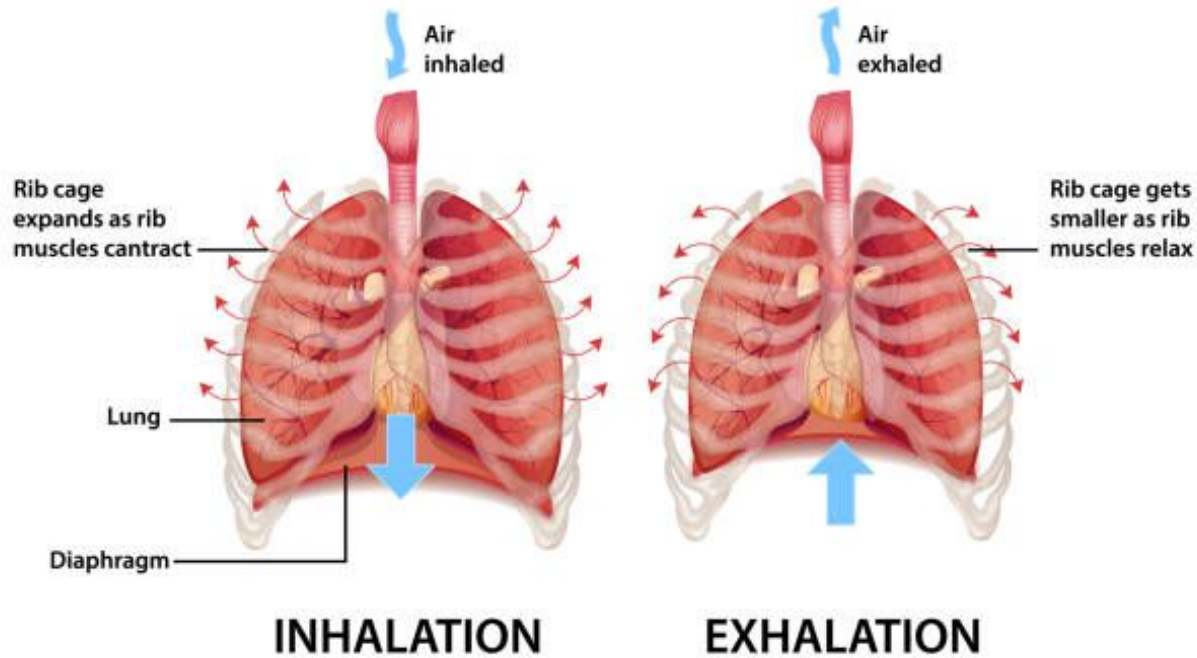


## Expiration

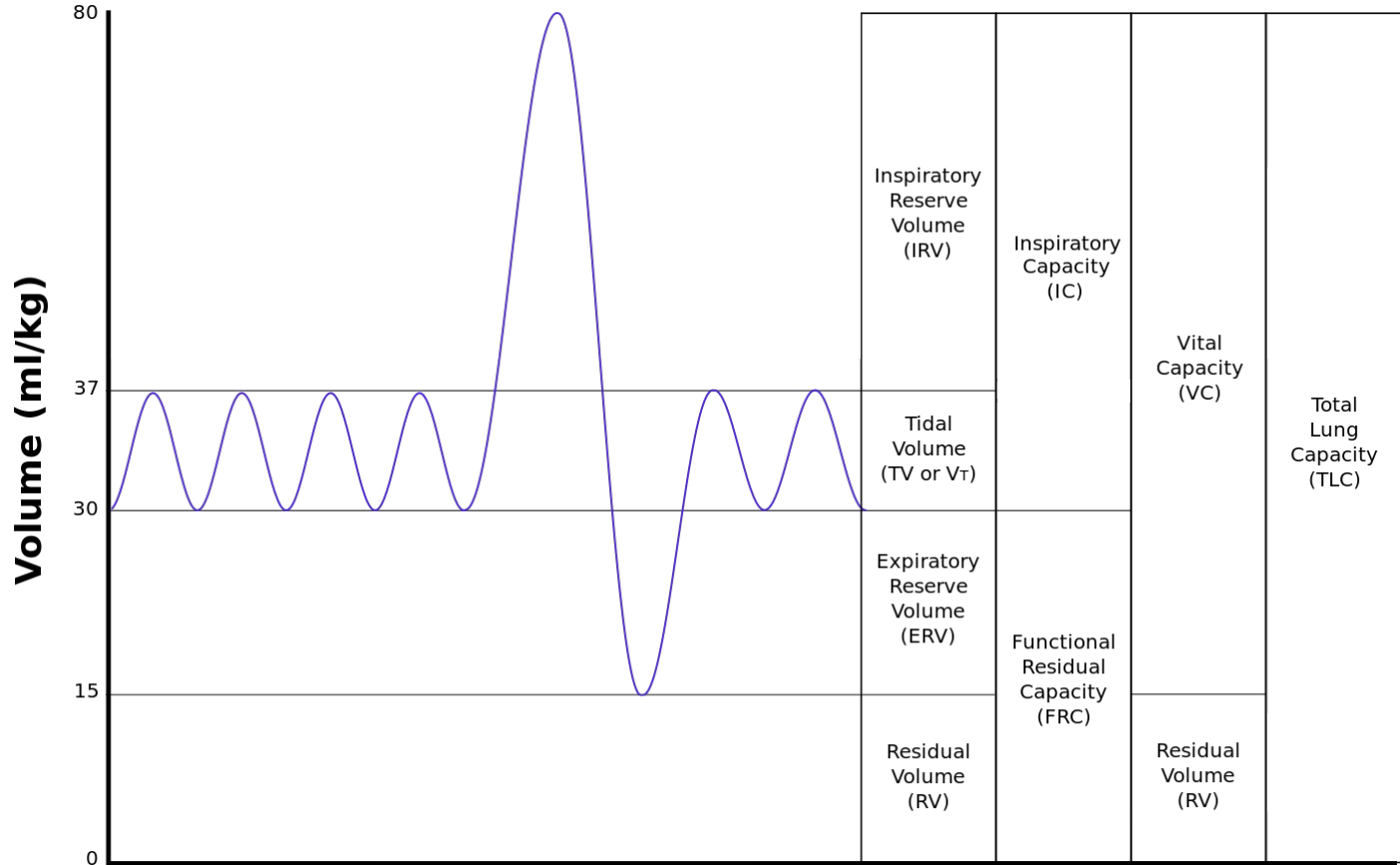
- X exhalation
- X diaphragm relaxed, moves up, upside down “U” shape
- X ribs move down and inward
- X volume in chest decreases
- X high pressure inside the lung (due to compression of lungs) compared to low pressure outside the body
  - X therefore, air moves out of lungs.



# THE DIAPHRAGM FUNCTIONS IN BREATHING



# LUNG VOLUMES



# LUNG VOLUME DEFINITIONS

- X **Total lung capacity:**  
volume of air in lungs after maximum inspiration
- X **Tidal volume:**  
the volume of air inhaled or exhaled during a normal, involuntary breath
- X **Inspiratory reserve volume:**  
the volume of air that can be forcibly inhaled after a normal inhalation
- X **Expiratory reserve volume:**  
the volume of air that can be forcibly exhaled after a normal exhalation
- X **Residual volume:**  
the volume of air remaining in the lungs after a forced exhalation
- X **Vital capacity:**  
the maximum amount of air that can be inhaled or exhaled (excludes residual capacity).
- X This is the maximum amount of air that can be inhaled after a forced exhalation.

## 10.2 Summary

- The respiratory system, along with the circulatory system, is responsible for delivering oxygen to, and removing carbon dioxide from, each cell of the body.
- In the human respiratory system the lungs provide the large surface area through which oxygen and carbon dioxide diffuse.
- Lung ventilation depends on negative pressure. Negative pressure is created in the lungs when the diaphragm and external intercostal muscles contract to increase the volume of the lungs, sucking air into the lungs. When the diaphragm and external intercostal muscles relax, volume decreases and air pressure increases, forcing air out of the lungs.
- The volume of air used in normal breathing, called the tidal volume, is only a small fraction of the total capacity of the lungs.
- $VO_2$  is the rate at which oxygen is used by the body. It can be determined from direct measurements or estimated by indirect methods. The maximum amount of oxygen that can be used by the body is called  $VO_{2max}$ .
- Fish and many other aquatic animals have gills that are adapted to obtaining oxygen from water.

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1, 3 – 5, 7, 9