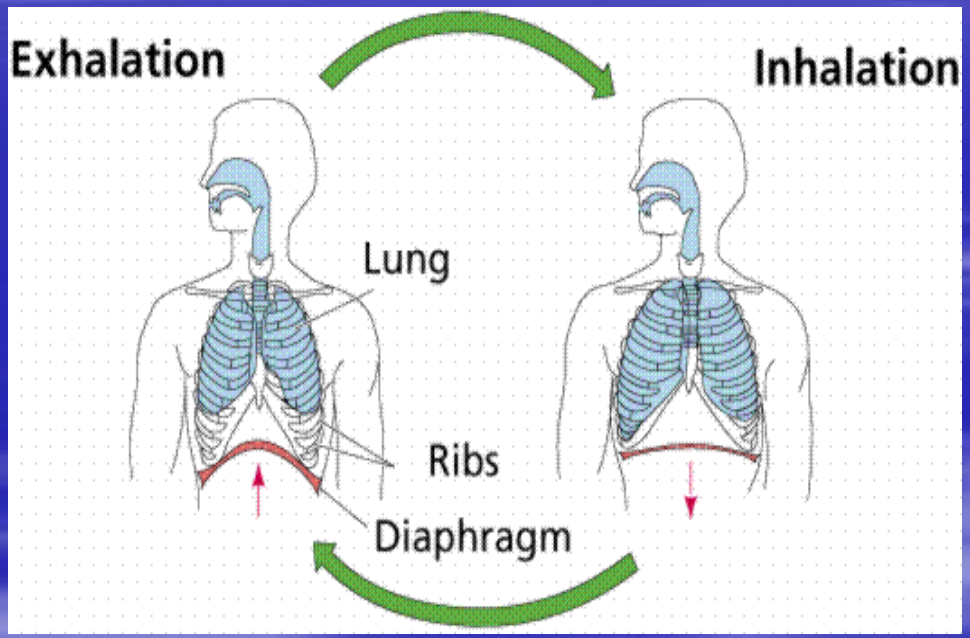
# Respiratory System

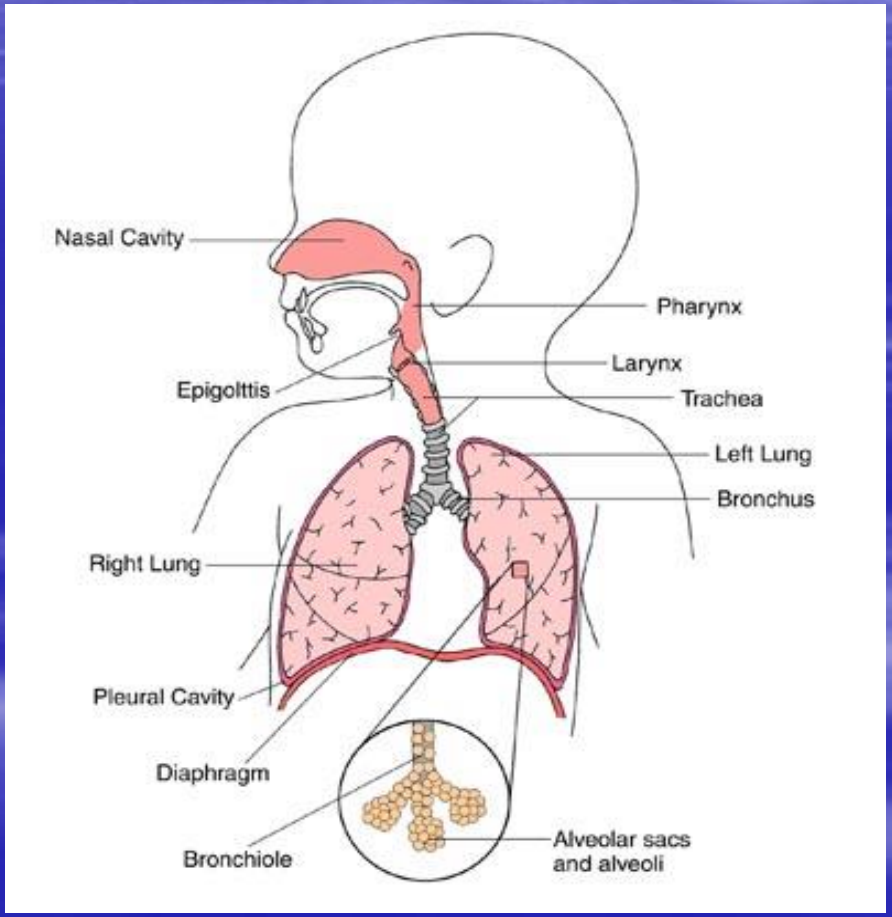
# Respiration is the act of breathing:

- inhaling (inspiration) - taking in oxygen
- exhaling (expiration) - giving off carbon dioxide



# The respiratory system is made up of the organs involved in breathing and consists of the:

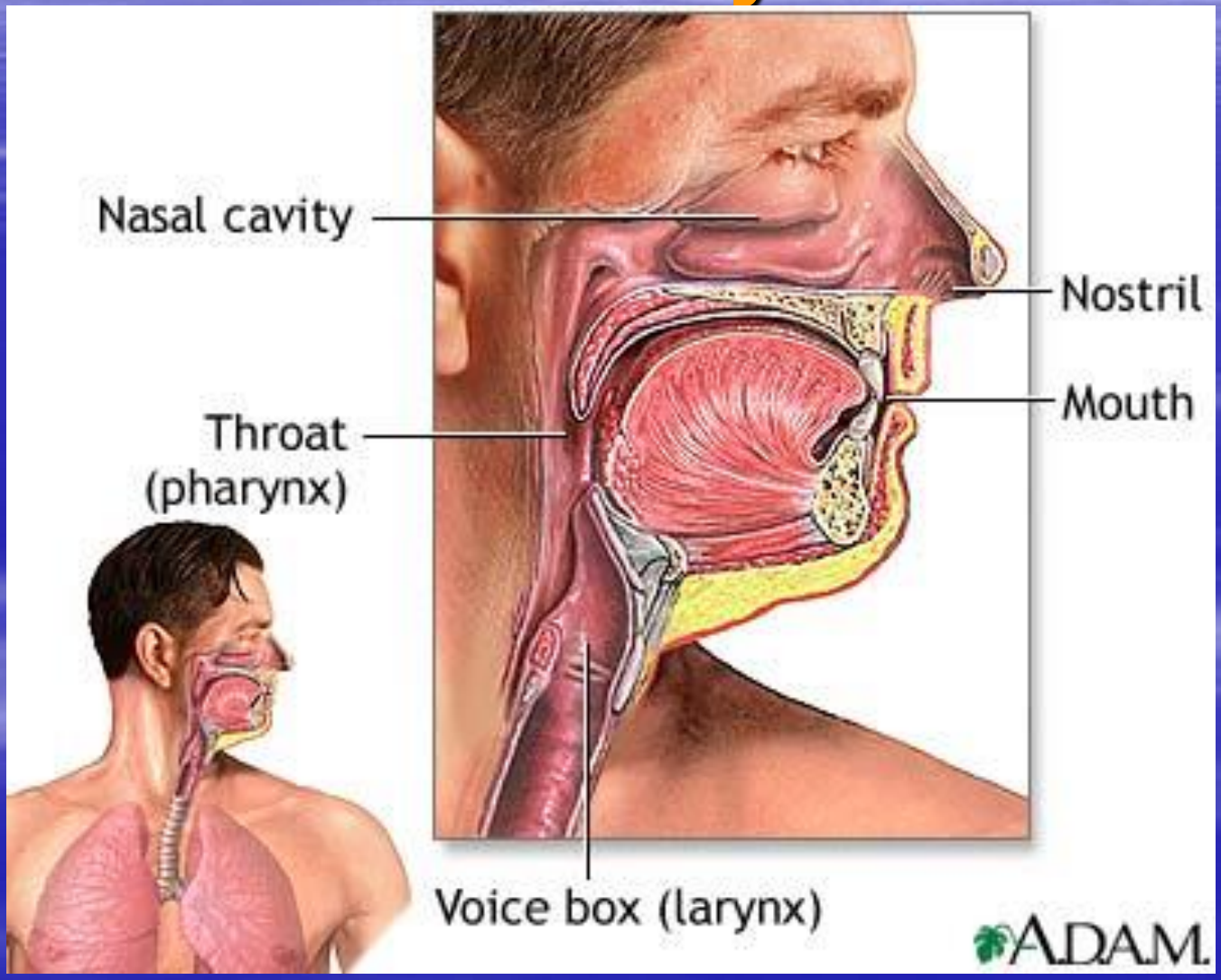
- nose
- pharynx
- larynx
- trachea
- bronchi
- lungs



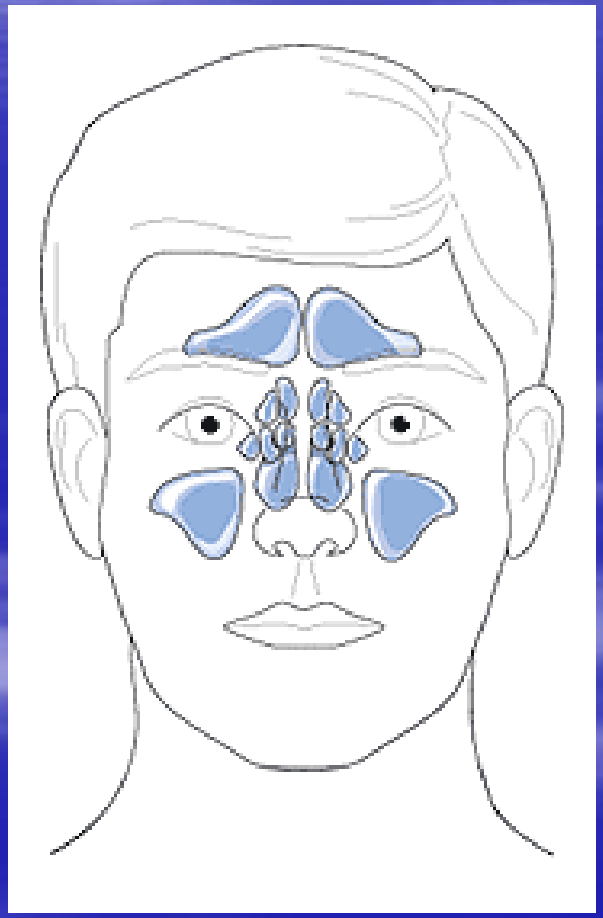
# The upper respiratory tract includes the:

- nose
- nasal cavity
- ethmoidal air cells
- frontal sinuses
- maxillary sinus
- larynx
- trachea

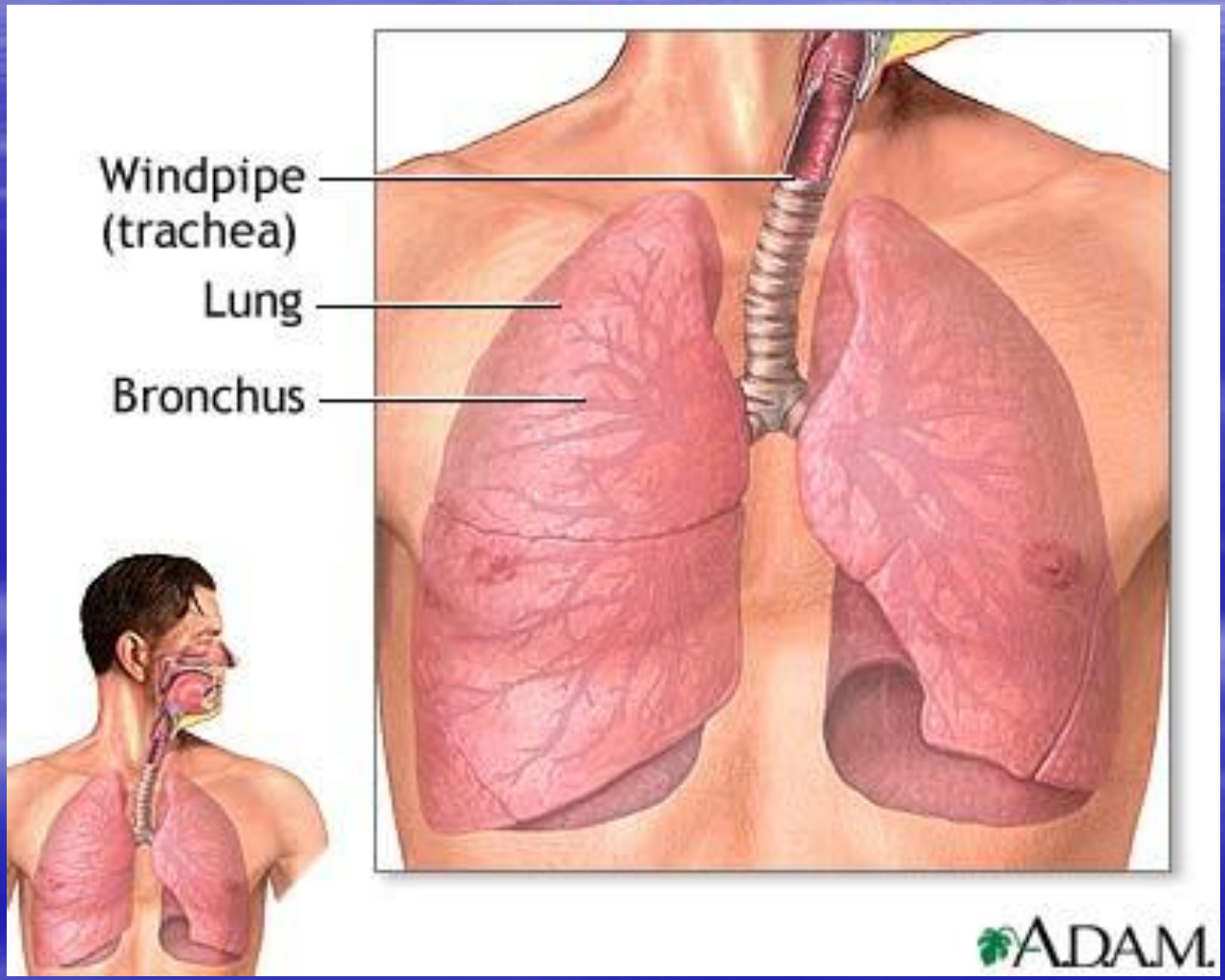
# nose
# nasal cavity



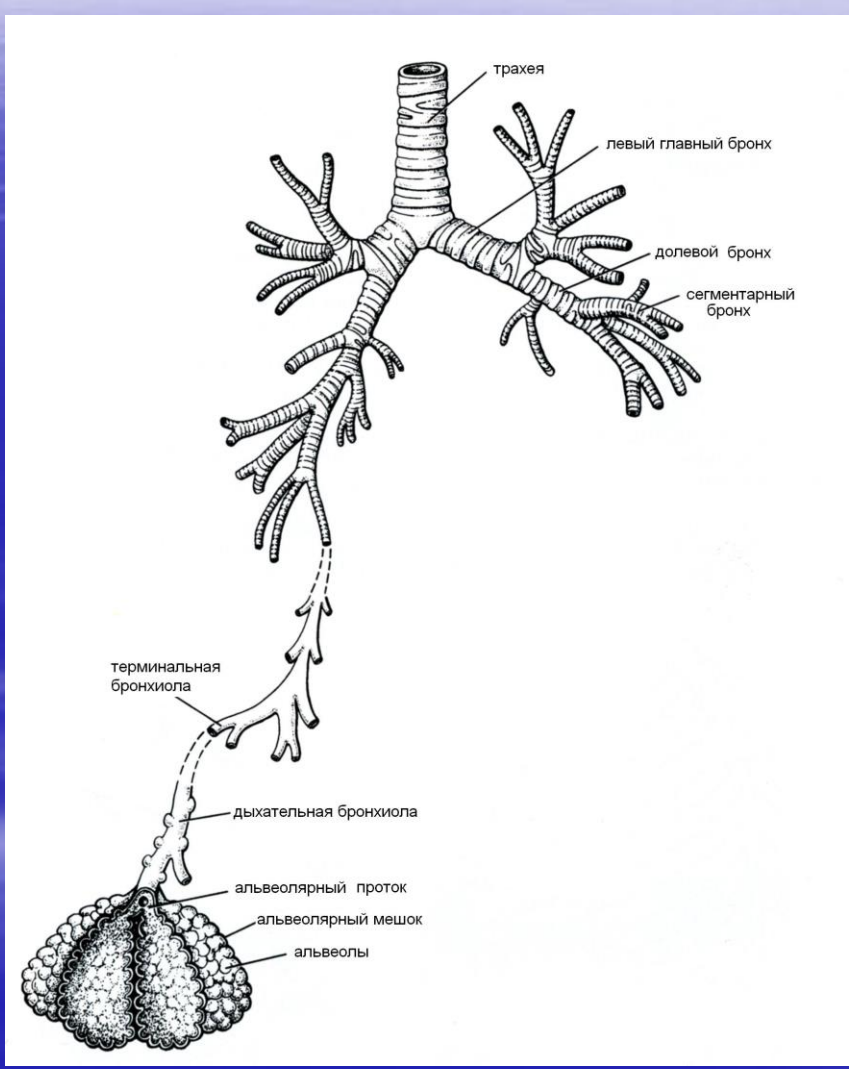
ethmoidal air cells
frontal sinuses
maxillary sinus



# larynx
# trachea

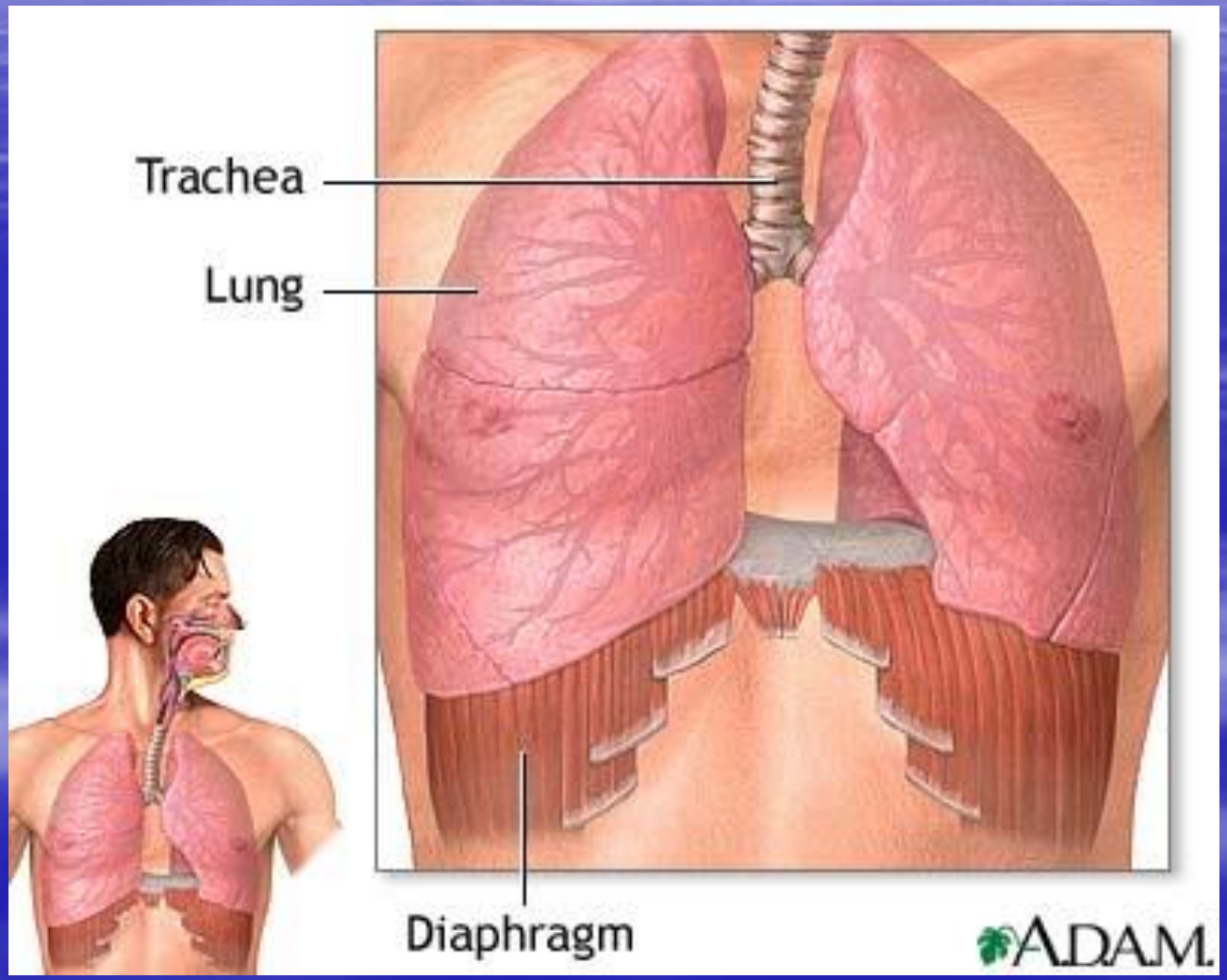


- The **trachea** (windpipe) extends from the neck into the thorax, where it divides ► into **right and left main bronchi**, which enter the right and left lungs, breaking up as they do so ► into **smaller bronchi** and ► **bronchioles** and ending in small ► **air sacs or alveoli**, where gaseous exchange occurs.



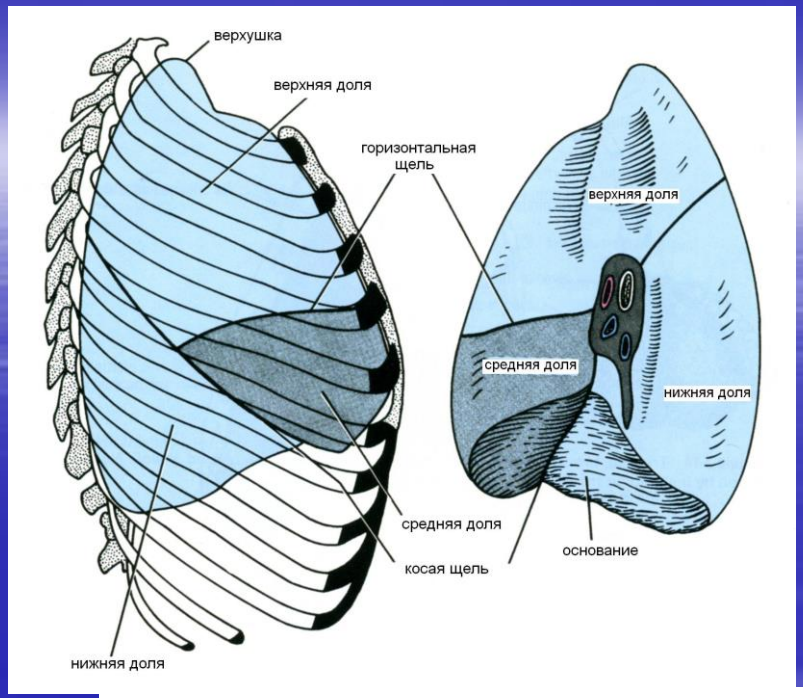
# The lower respiratory tract includes the:

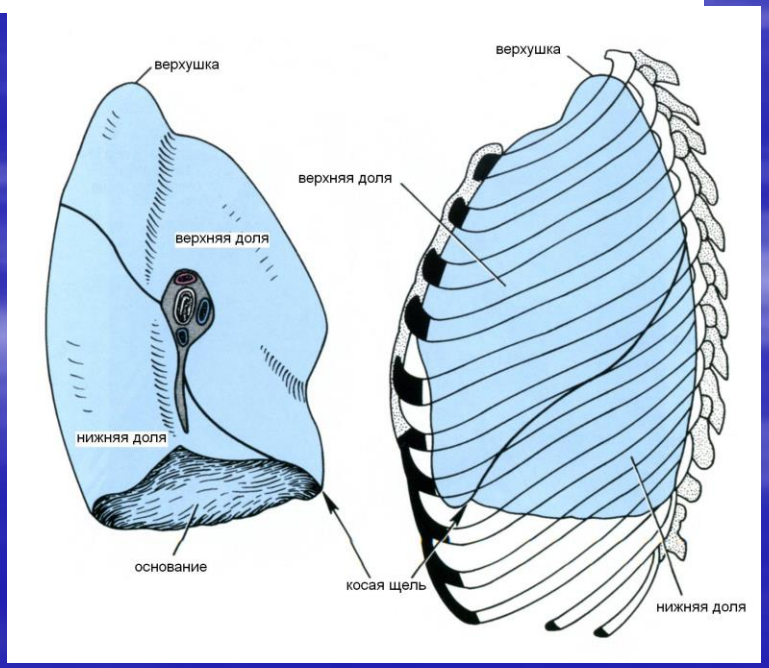
- lungs
- bronchi
- alveoli



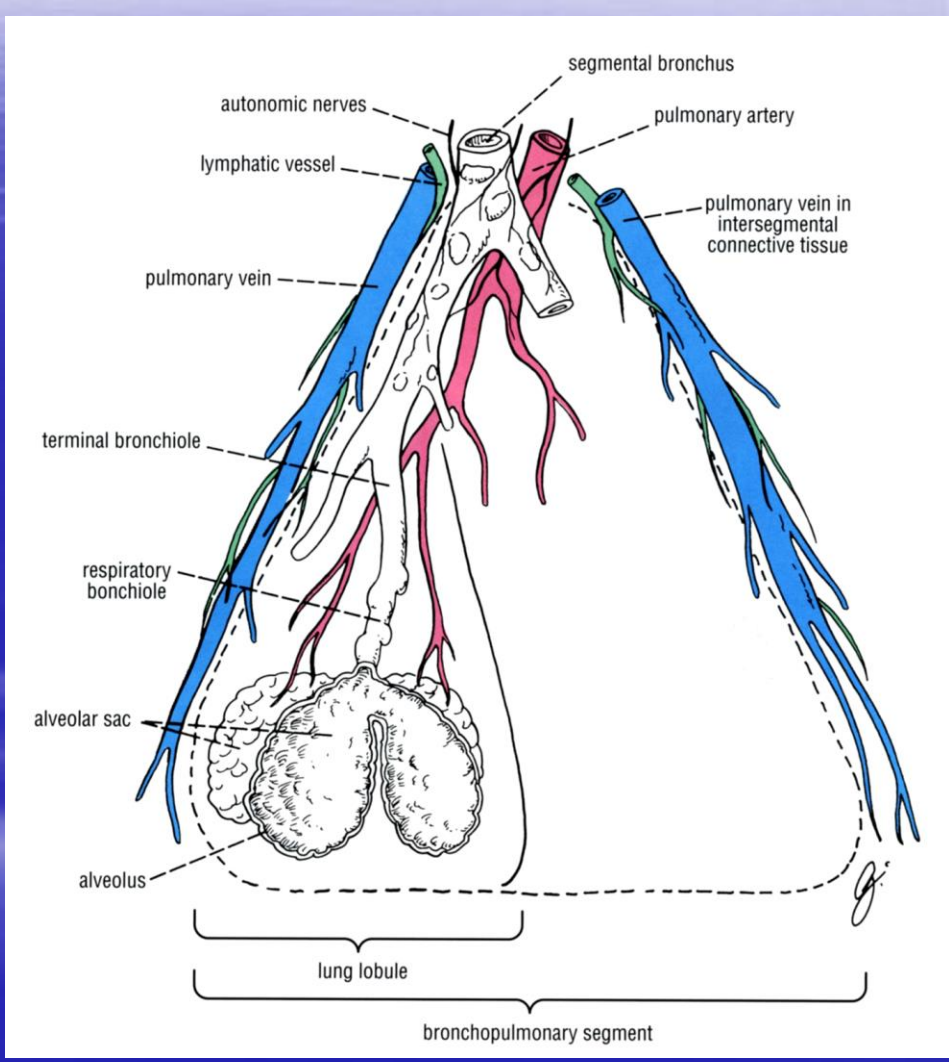
# The lungs

- **The lungs** are divided first into **right and left**, the left being smaller to accommodate the heart, **then into lobes *(three on the right, two on the left)*** supplied by lobar bronchi.



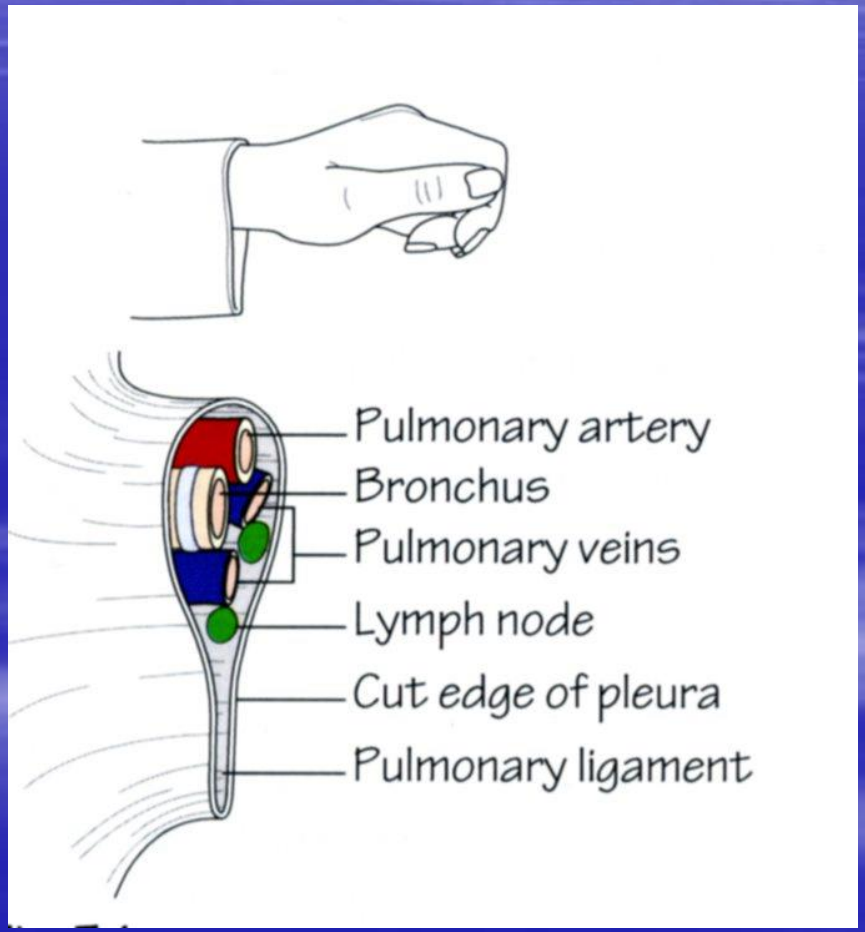



- ***Each lobe*** of the lung is further ***divided into*** a pyramidal **bronchopulmonary segments**. Bronchopulmonary segments have the apex of the pyramid in the hilum whence they receive a tertiary bronchus, and appropriate blood vessels.

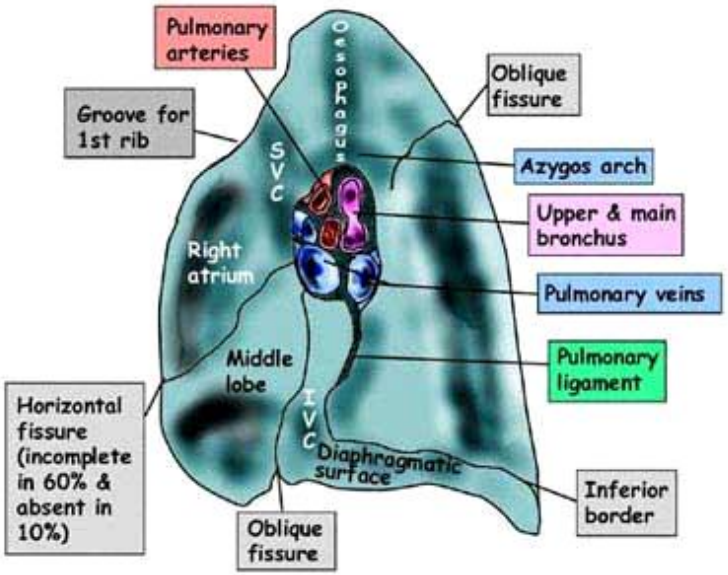


# The root (or hilum).

- **Bronchi, pulmonary arteries and veins** *(which supply deoxygenated blood and remove oxygenated blood*), **bronchial arteries and veins** *(which supply oxygenated blood to the substance of the lung itself)* all **enter and leave the lung by its root (or hilum).**



## MEDIAL SURFACE OF RIGHT LUNG

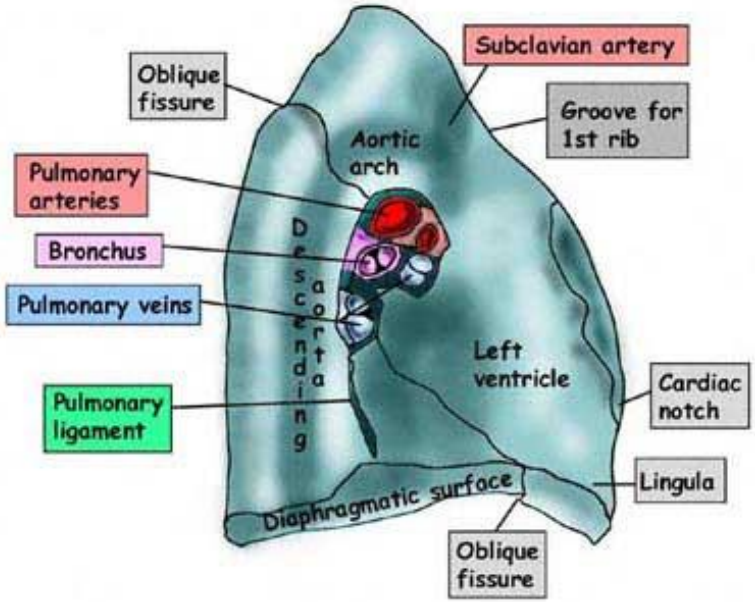



Note that the indentations on the lung are post-mortem effects. They indicate the relationships in life

**Hilum**

- Bronchi
- Pulmonary arteries & veins
- Bronchial arteries and veins
- Lymphatics
- Nerves

## MEDIAL SURFACE OF LEFT LUNG



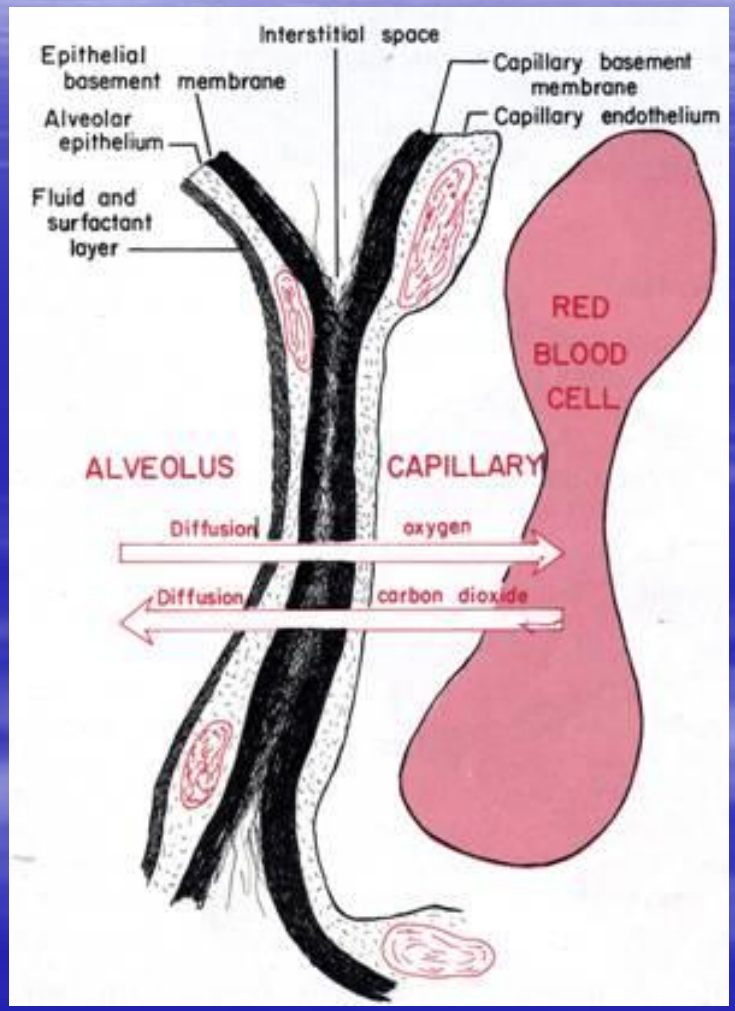

Note that the indentations on the lung are post-mortem effects. They indicate the relationships in life

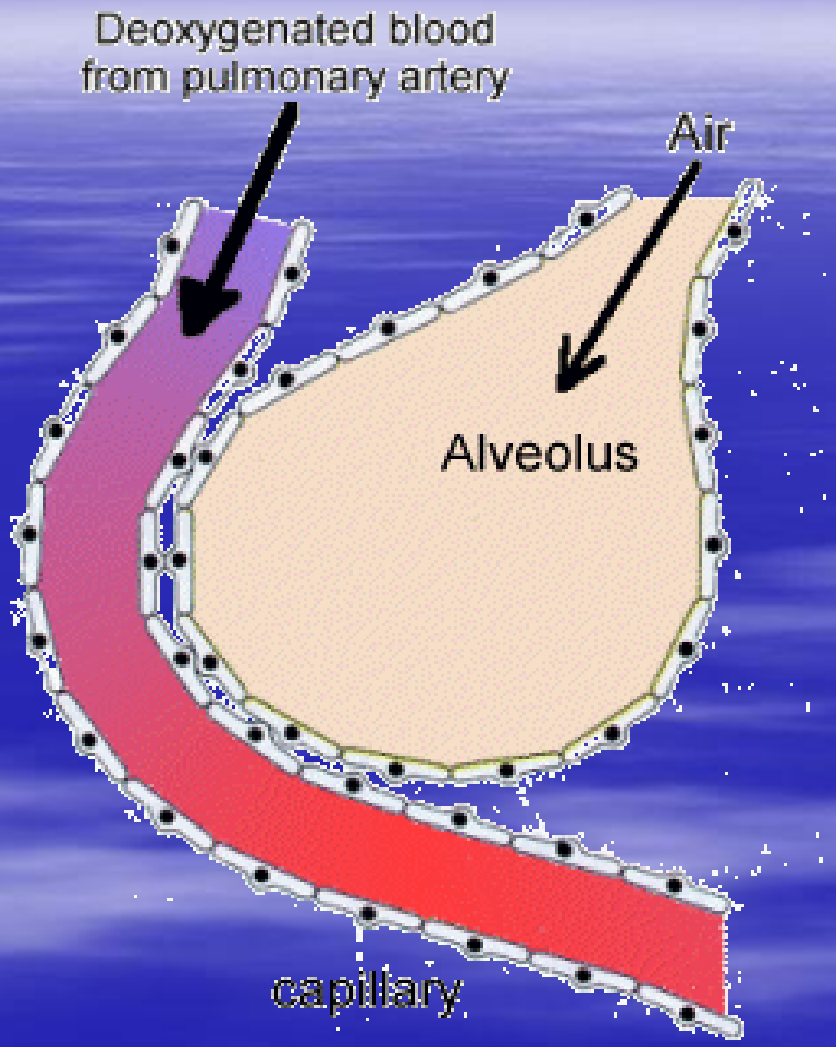
**Hilum**

- Bronchi
- Pulmonary arteries & veins
- Bronchial arteries and veins
- Lymphatics
- Nerves

# Gaseous exchange

- **Gaseous exchange** relies on simple diffusion. In order to provide sufficient oxygen and to get rid of sufficient carbon dioxide there must be
  - a **large surface** area for gaseous exchange
  - a **very short diffusion path** between alveolar air and blood
  - **concentration gradients** for oxygen and carbon dioxide between alveolar air and blood.

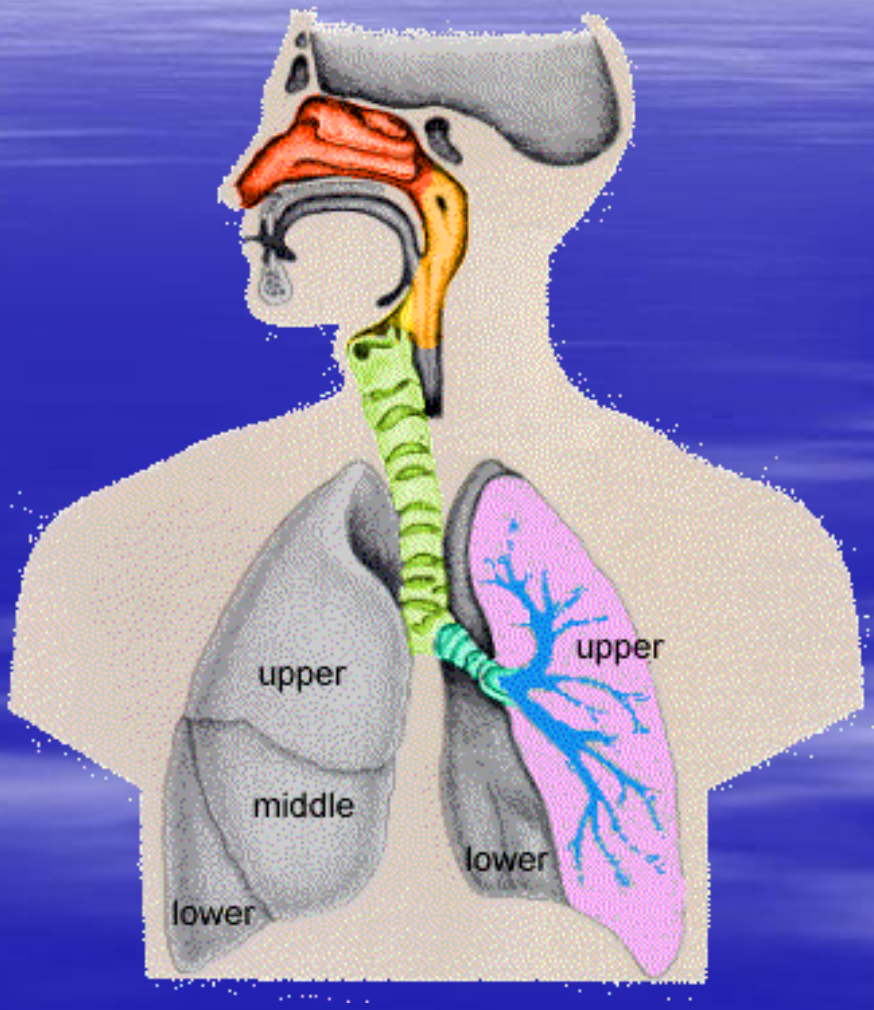



Deoxygenated blood
from pulmonary artery
Air
Alveolus
capillary

# *Outside air:*

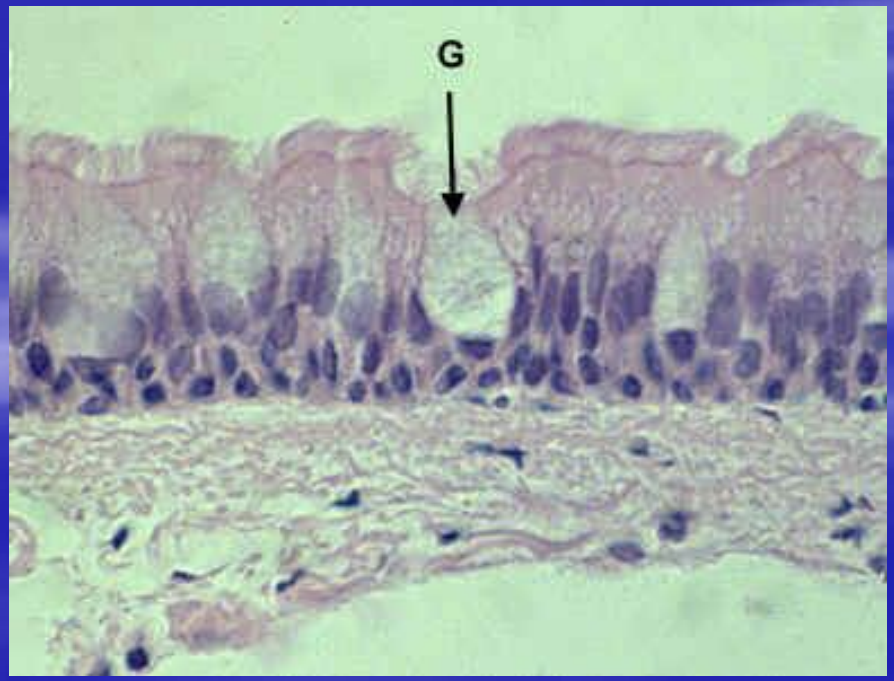
- **varies in temperature**. At the alveolar surface it must be at body temperature
- **varies from very dry to very humid**. At the alveolar surface it must be saturated with water vapour
- **contains dust and debris**. These must not reach the alveolar wall
- **contains micro-organisms**, which must be filtered out of the inspired air and disposed of before they reach the alveoli, enter the blood and cause possible problems

- *It is easy to see that the temperature and humidity of inspired air will increase as it passes down a long series of tubes lined with a moist mucosa at body temperature. The mechanisms for filtering are not so obvious.*



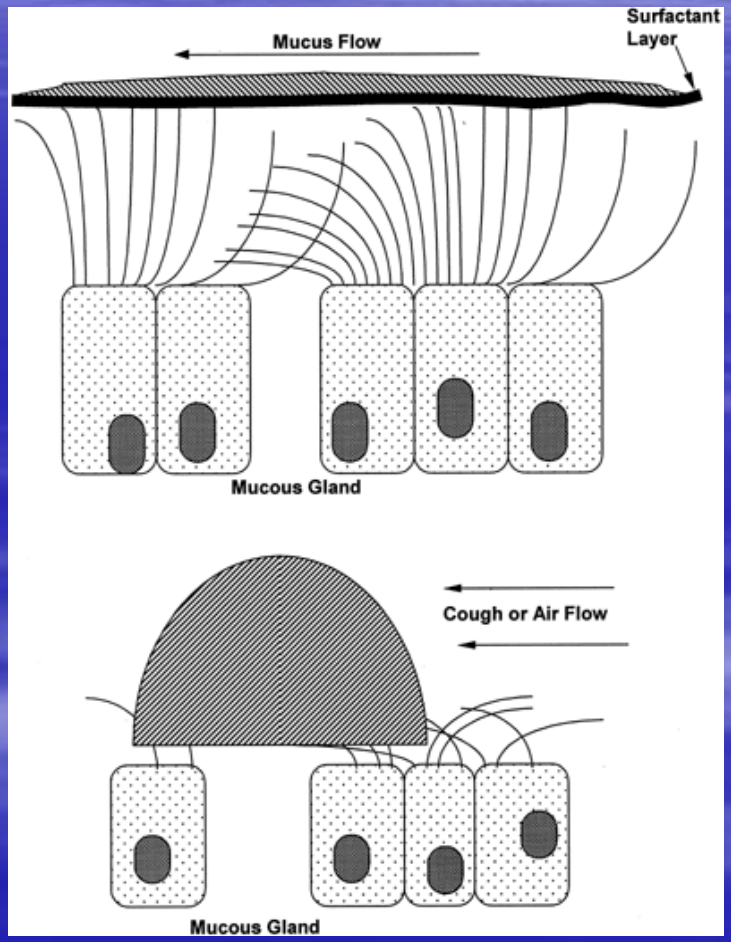
# Mucus

- The respiratory tract, from nasal cavities to the smallest bronchi, is lined by a layer of sticky mucus, secreted by the epithelium assisted by small ducted glands.



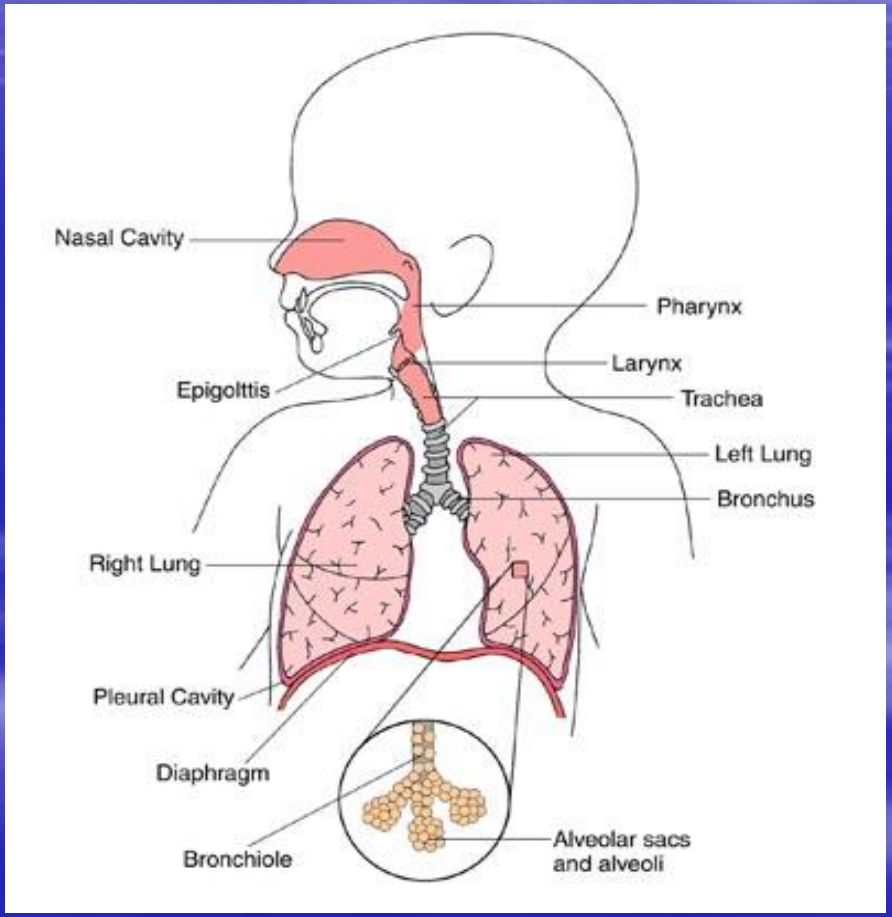
# Cilia

- Once the particles have been sidelined by the mucus they have to be removed, as indeed does the mucous. This is carried out by cilia on the epithelial cells which move the mucous continually up or down the tract towards the nose and mouth. The mucus and its trapped particles are and bacteria are then swallowed, taking them to the sterilising vat of the stomach.



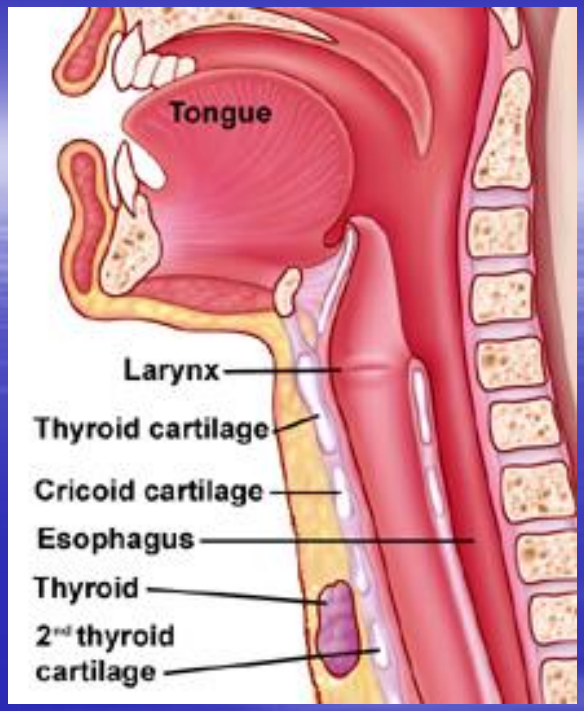
# Length

- The length of the respiratory tract helps in both bringing the air to the right temperature and humidity



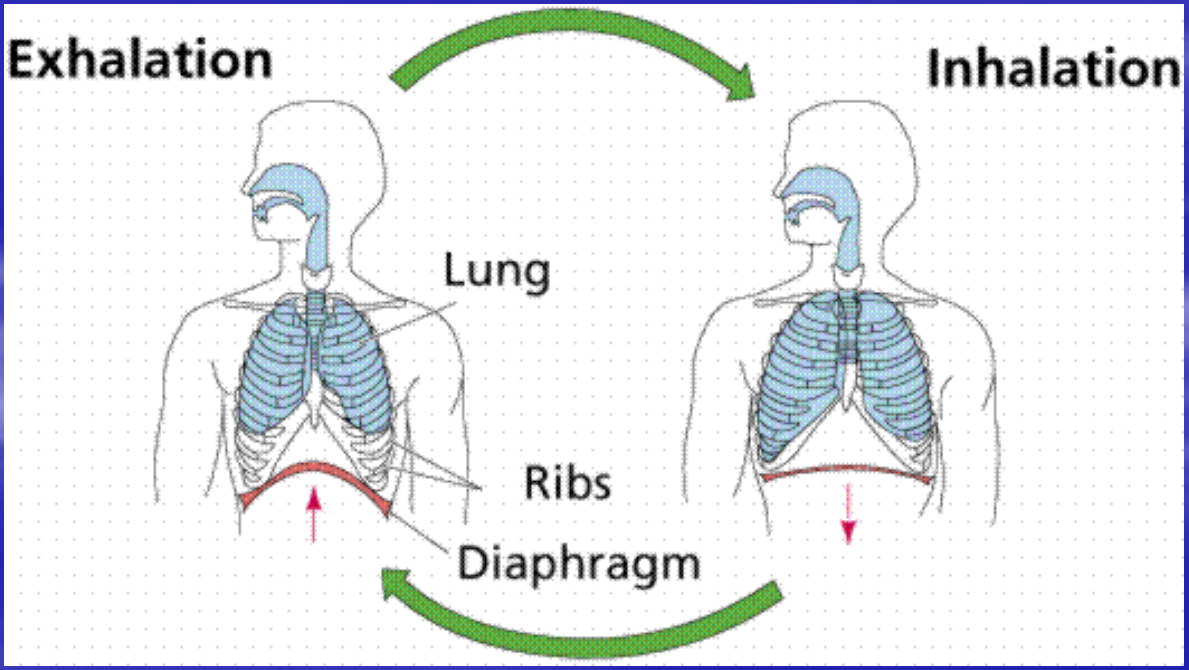
# Protection

- The entry of food and drink into the larynx is prevented by the structure of the larynx and by the complicated act of swallowing. The larynx is protected by three pairs of folds which close off the airway. In man these have a secondary function, they vibrate in the airstream to produce sounds, the basis of speech and singing




# Ventilation and perfusion

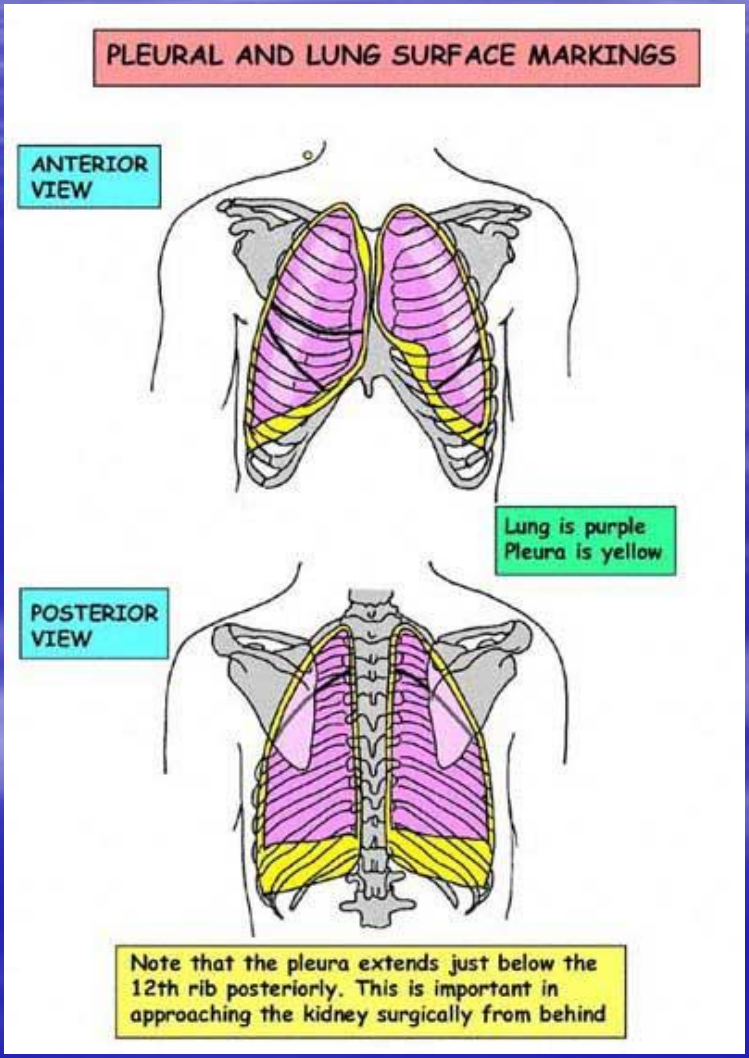
- Humans ventilate their lungs by breathing in and out. This reciprocal movement of air is achieved by alternately increasing and decreasing the volume of the chest in breathing



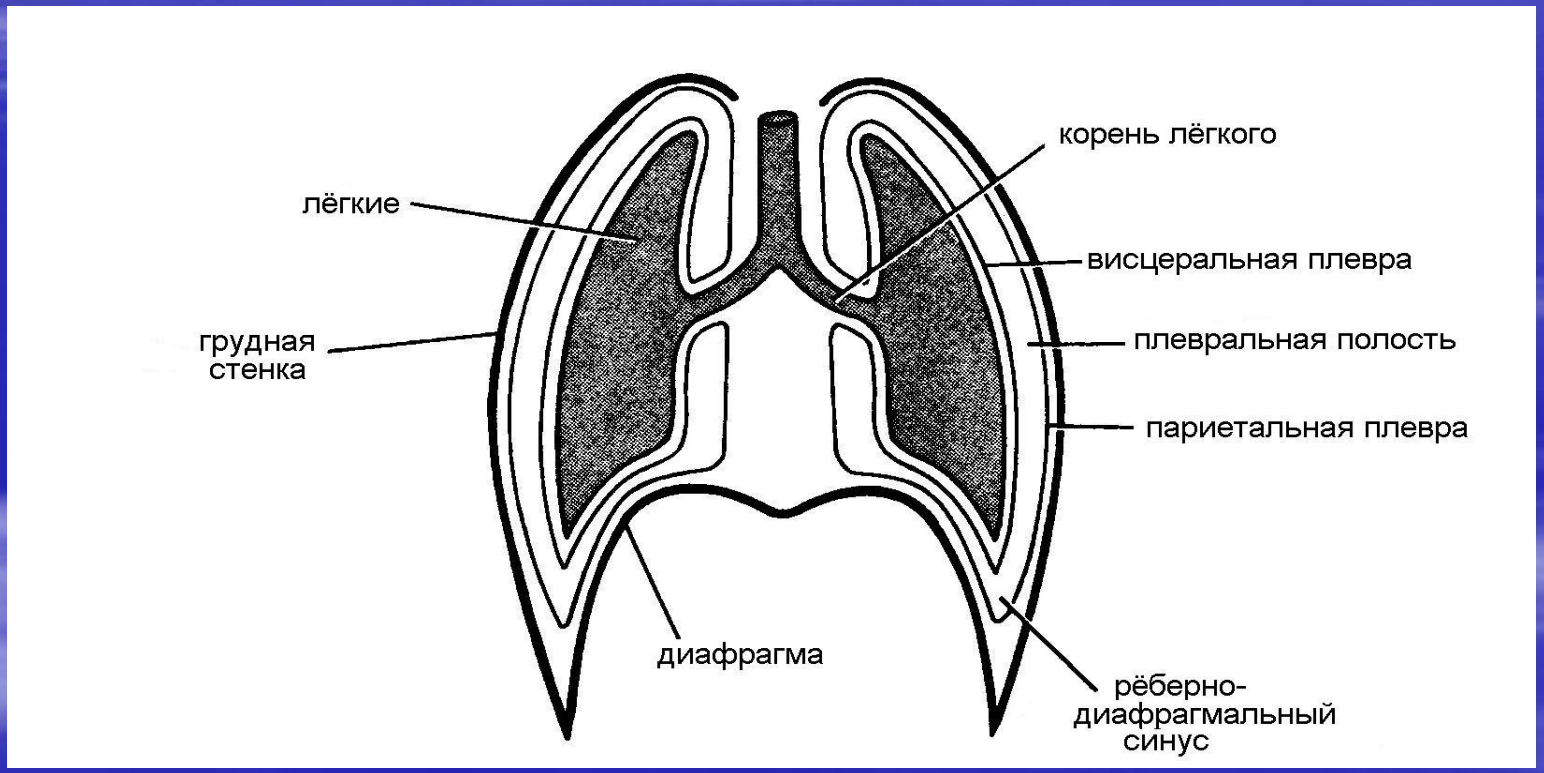
# Mechanism of breathing

- In order to grasp the way in which we breathe we have to grasp the following facts:

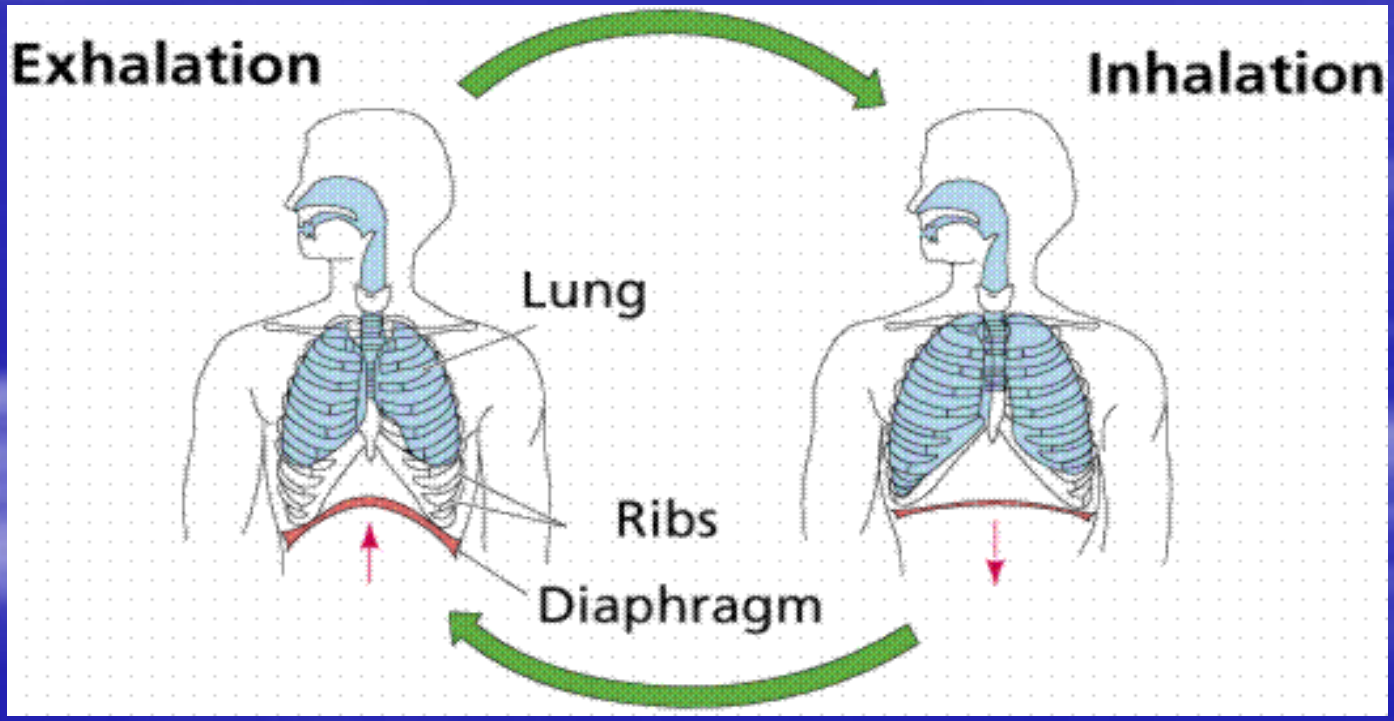
# Each lung is surrounded by a pleural cavity or sac



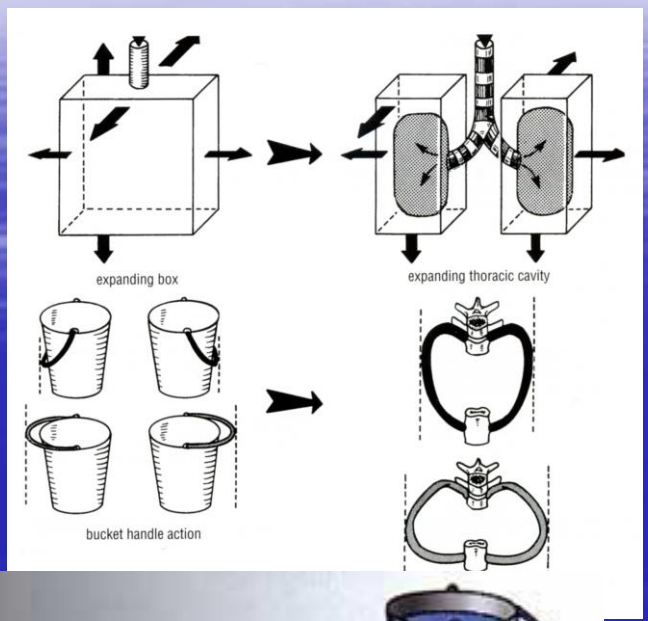
# Each lung is enclosed in a cage bounded below by the diaphragm

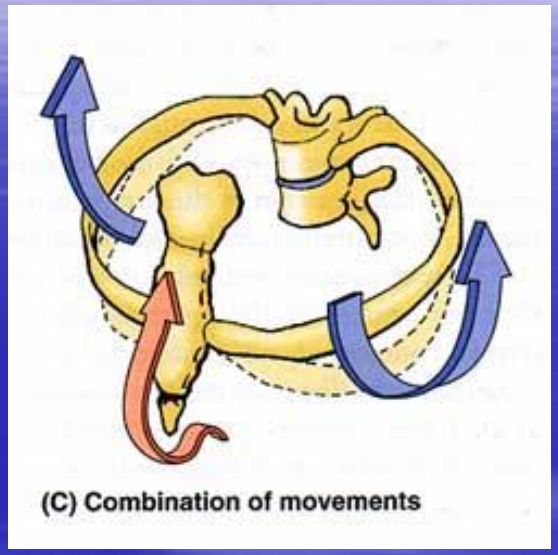


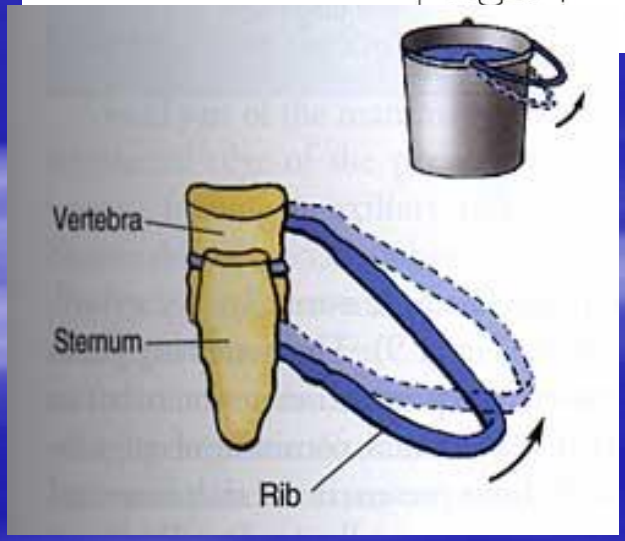
- **Breathing works by making the cage bigger.**
- **The main component acting here is the diaphragm.** When it contracts it flattens and increases the space above it. When it relaxes the abdominal contents push it up again.

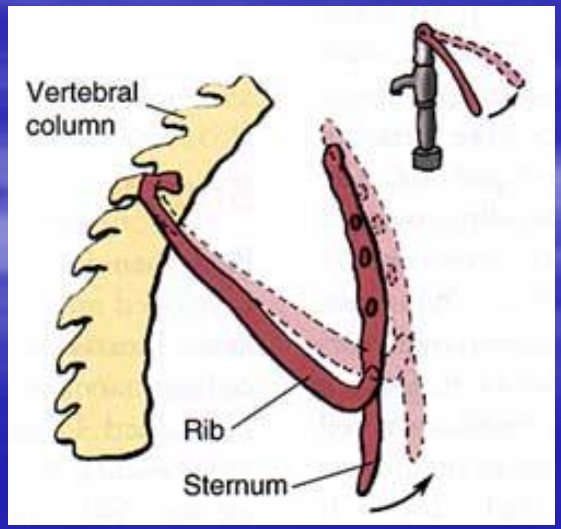


**The process is helped by the ribs** which move up and out also increasing the space available.

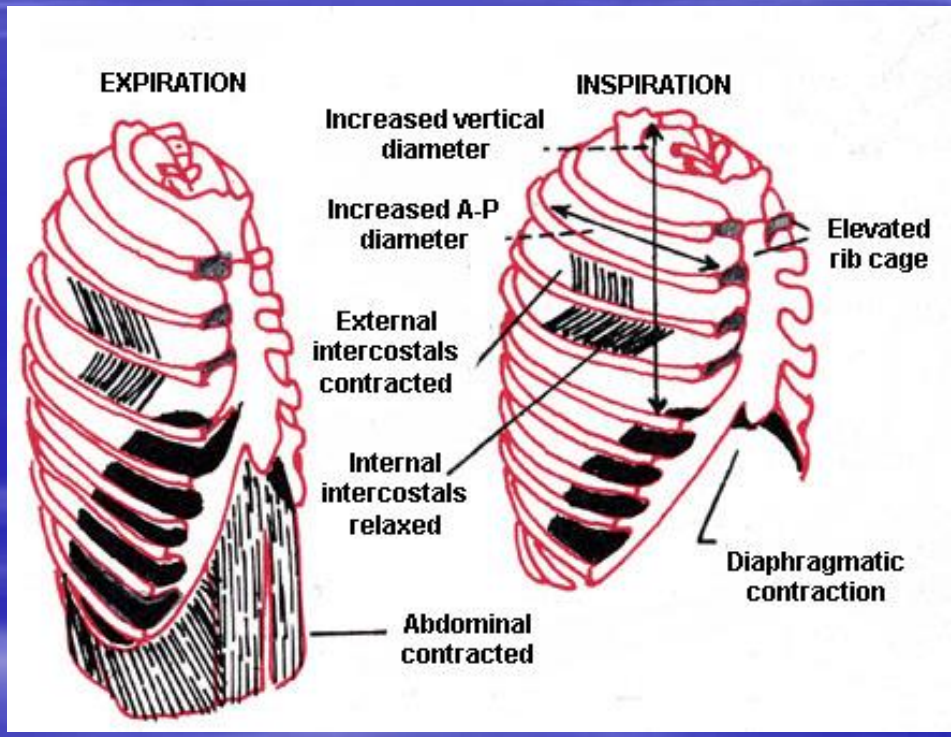


- **Deeper respiration brings in the muscles of the chest** wall, so that the ribs move too. The ribs are all, therefore pulled up towards the horizontal, increasing anteroom-posterior and lateral thoracic diameters.



# Problems.

- The lungs sometimes fail to maintain an adequate supply of air. The earliest cases of this are seen in infant ***respiratory distress syndrome***. In premature infants (less than about 37 weeks the cells which make surfactant are not yet active. Surfactant reduces the surface tension in the fluid on the surface of the alveoli, allowing them to expand at the first breath, and remain open thereafter. The sacs either fail to expand, or expand then collapse on expiration and result in laboured breathing. In adults a similar syndrome is due to accidental inhalation of water, smoke, vomit or chemical fumes.

- ***Acute bronchitis*** is due to infection of the bronchial tree, which may have impaired function due to fluid accumulation. ***Pneumonia*** involves the lung proper. ***Lung cancers*** a malignancy that may spread to other tissues via the lymphatics in the lung roots