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SEARCH

SPORT EDUCATION FOR ACTIVE AND RESPONSIBLE CITIZENSHIP THROUGH HEALTH CARING

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MODULE 2

ENCOURAGING SPORTS PRACTICE FOR ONE'S OWN PSYCHO-PHYSICAL WELLBEING AND TO CONTROL NATIONAL SOCIAL AND HEALTH COSTS

SEGMENT 3

Respiratory System

The primary function of the respiratory system is to allow the exchange of gases between the atmosphere and the body's cells.

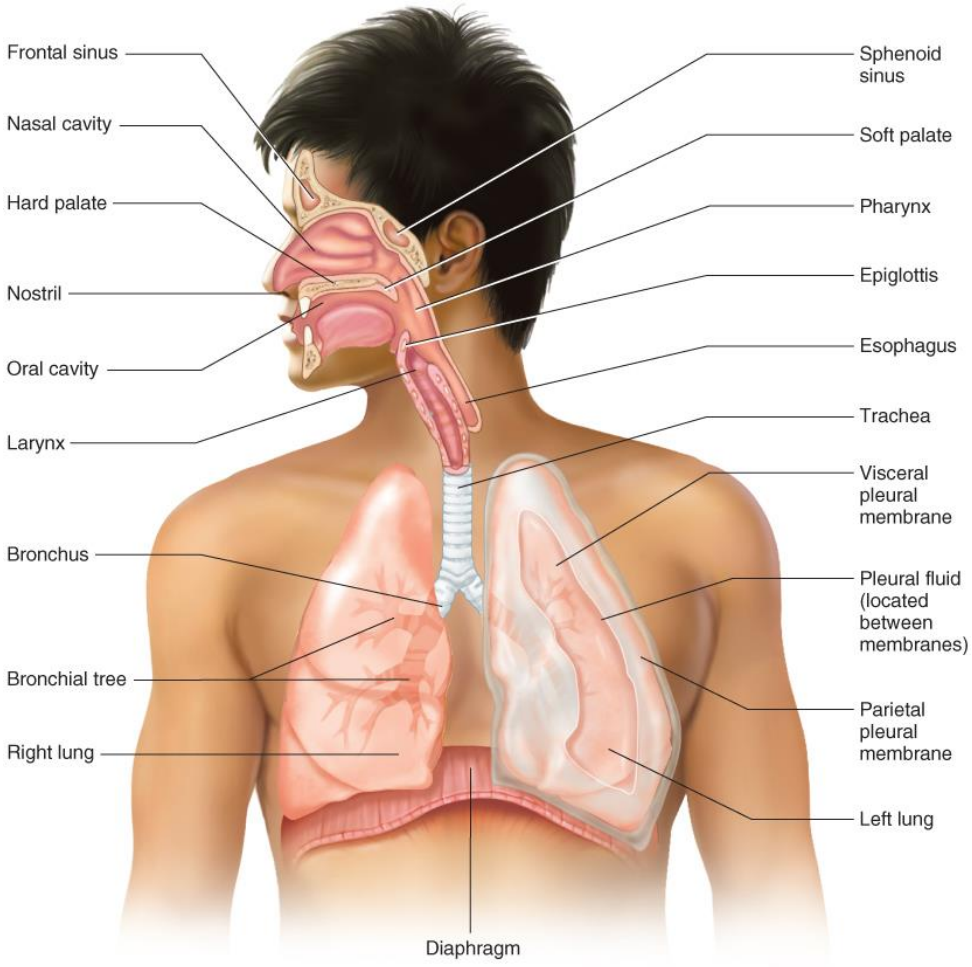
The lung also plays other non-metabolic (e.g. blood reservoir) and metabolic (e.g. conversion of angiotensin from 1 to 2 / active) roles.

The primary purpose is however to bring oxygen from the external environment and instead expel carbon dioxide, waste gas, produced by cellular metabolism.

Anatomy of the Respiratory System

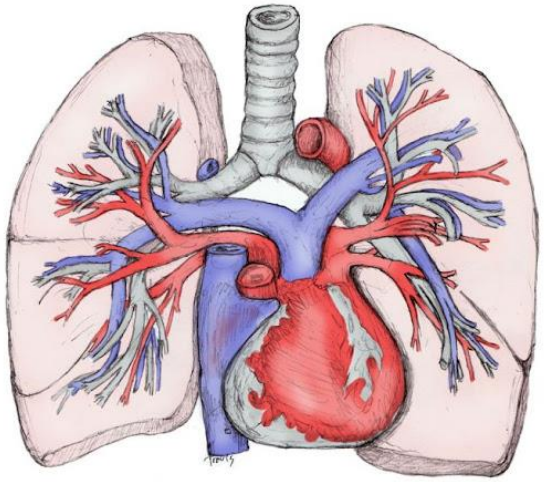
- **<u>Upper respiratory tract</u>**
  - Respiratory anatomy in the head and neck
    - Nasal cavity > nose > nasopharynx, oropharynx, and laryngopharynx > larynx

- **<u>Lower respiratory tract</u>**
  - Respiratory anatomy in the thoracic cavity
    - > Trachea > main bronchi > bronchial tree > alveoli

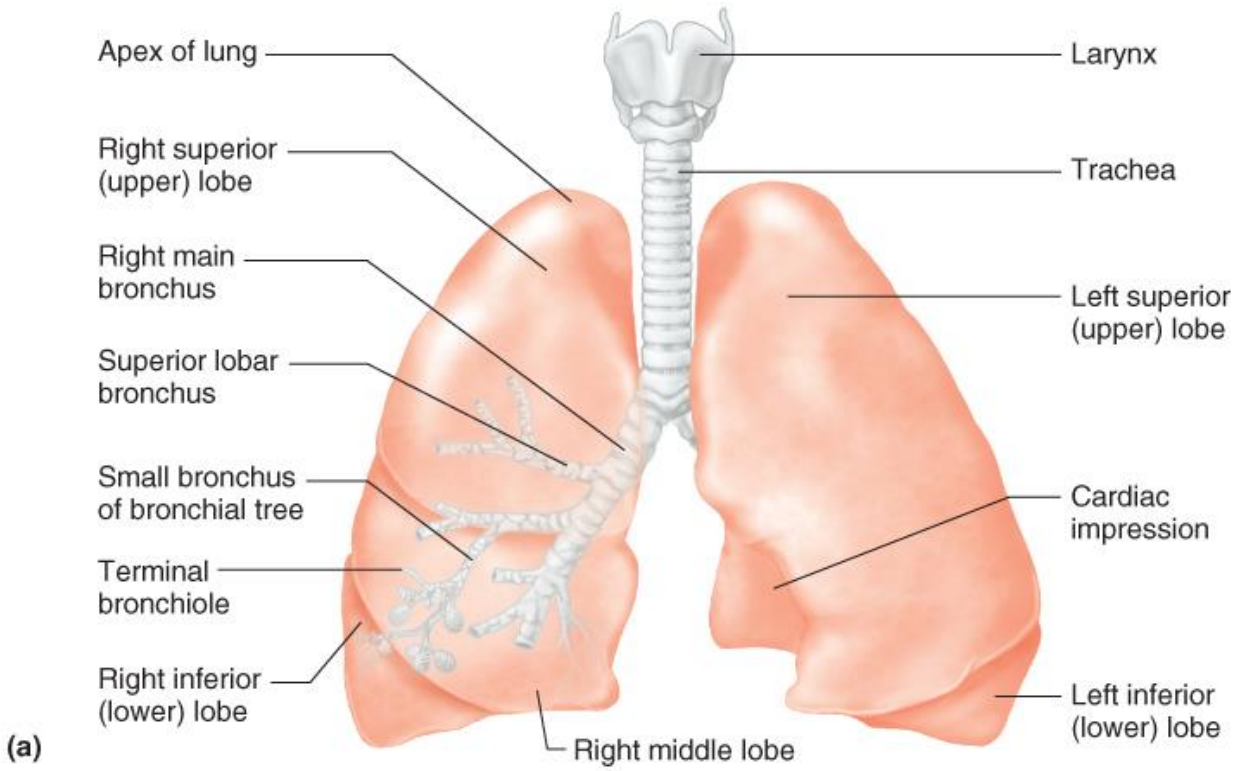

Frontal sinus
Nasal cavity
Hard palate
Nostril
Oral cavity
Larynx
Bronchus
Bronchial tree
Right lung
Diaphragm
Sphenoid sinus
Soft palate
Pharynx
Epiglottis
Esophagus
Trachea
Visceral pleural membrane
Pleural fluid (located between membranes)
Parietal pleural membrane
Left lung

As it passes through these upper airways, the inhaled air undergoes some physical changes (temperature adjustment, addition of water, partial purification of harmful substances) which favor the final exchange.

The alveolus is the meeting place between the respiratory system and the cardiovascular system where oxygen and carbon dioxide are respectively absorbed and eliminated.



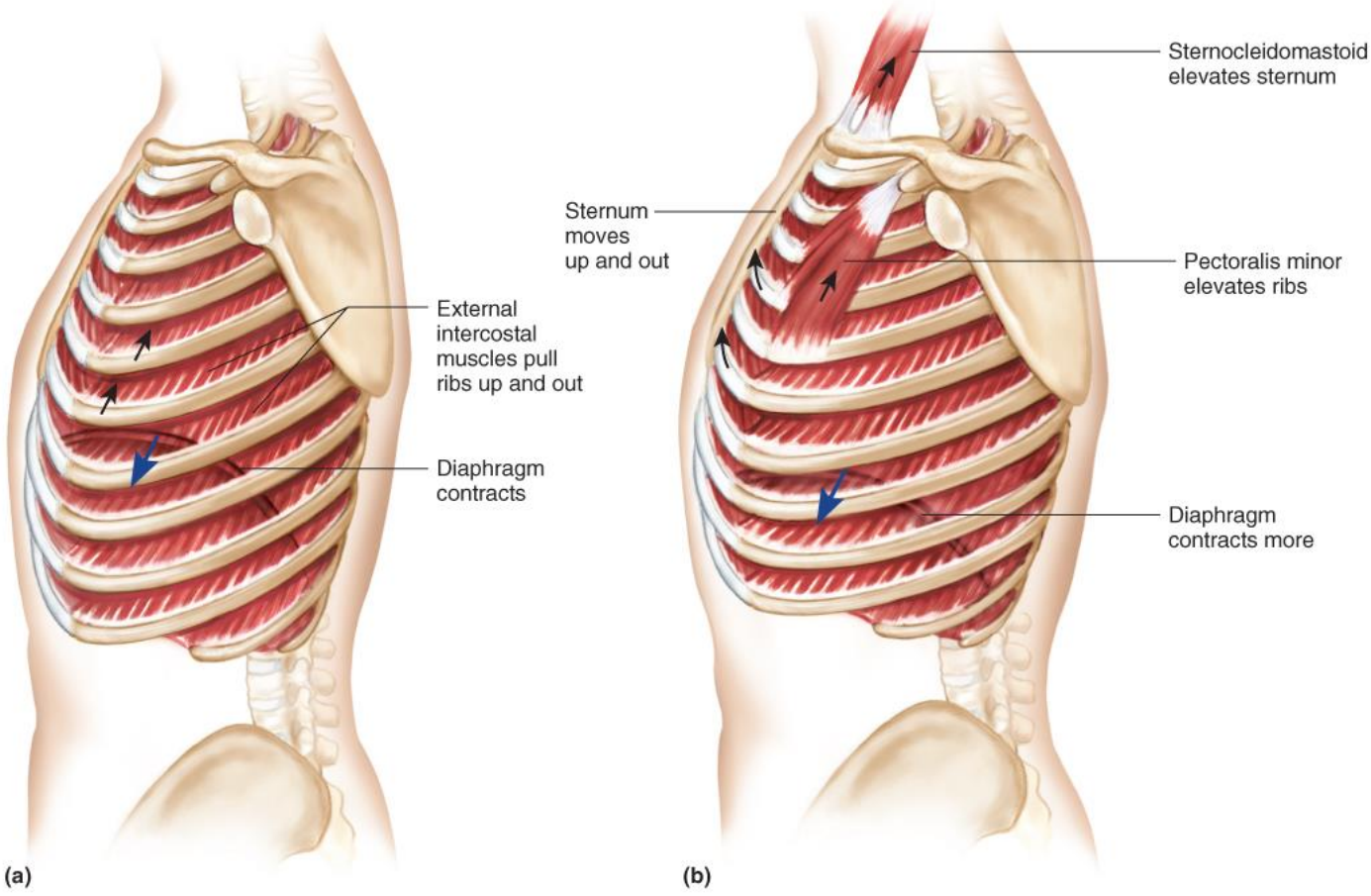
Lining of trachea

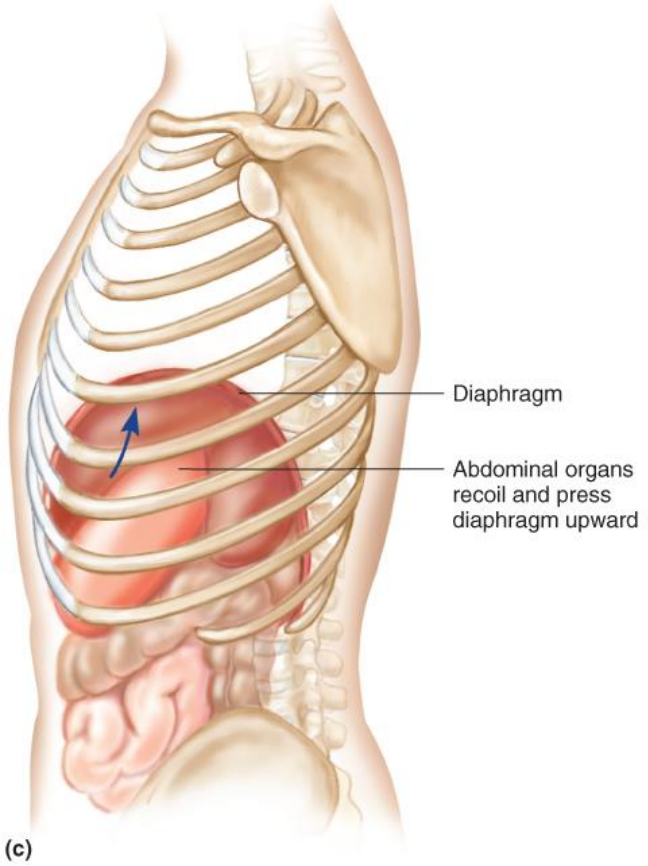

Apex of lung
Right superior (upper) lobe
Right main bronchus
Superior lobar bronchus
Small bronchus of bronchial tree
Terminal bronchiole
Right inferior (lower) lobe
Right middle lobe
Larynx
Trachea
Left superior (upper) lobe
Cardiac impression
Left inferior (lower) lobe
(a)

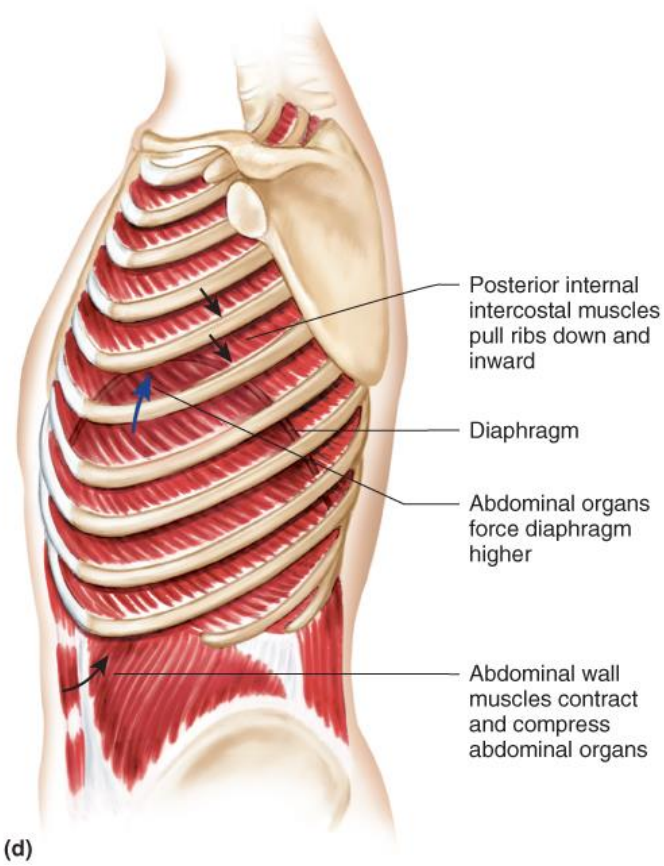
Physiology of the Respiratory System

Mechanics of Taking a Breath:

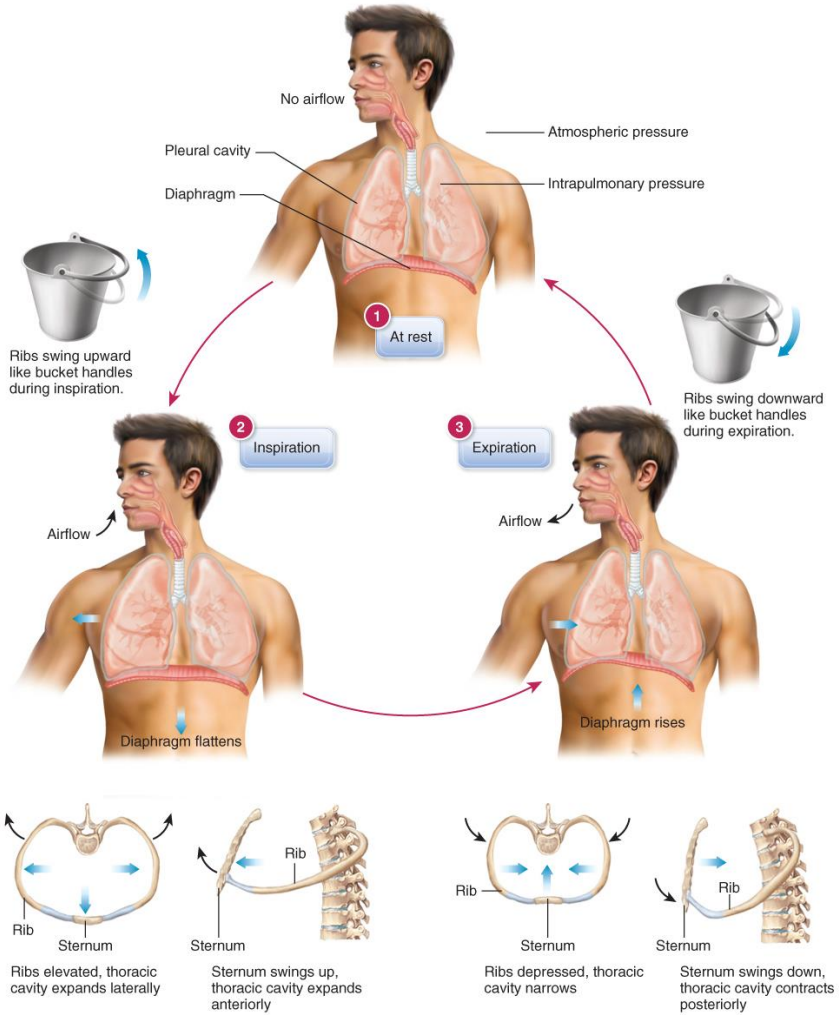
- Inspiration results from intercostal muscles and the diaphragm's contracting to increase the volume of the thoracic cavity, thereby decreasing its pressure.
- Air flows due to pressure gradients.
- Pleural membranes cause the lung to expand with the thoracic cavity.
- Normal inspiration is caused by contraction of the intercostal muscles and diaphragm.
  - Forced inspiration involves additional muscles such as the sternocleidomastoid and pectoralis minor.
- Normal expiration is caused by the relaxation of the intercostal muscles and diaphragm.
  - Forced expiration is caused by muscle contraction.


External intercostal muscles pull ribs up and out
Diaphragm contracts
(a)
Sternocleidomastoid elevates sternum
Sternum moves up and out
Pectoralis minor elevates ribs
Diaphragm contracts more
(b)


Diaphragm
Abdominal organs recoil and press diaphragm upward
(c)


Posterior internal intercostal muscles pull ribs down and inward
Diaphragm
Abdominal organs force diaphragm higher
Abdominal wall muscles contract and compress abdominal organs
(d)

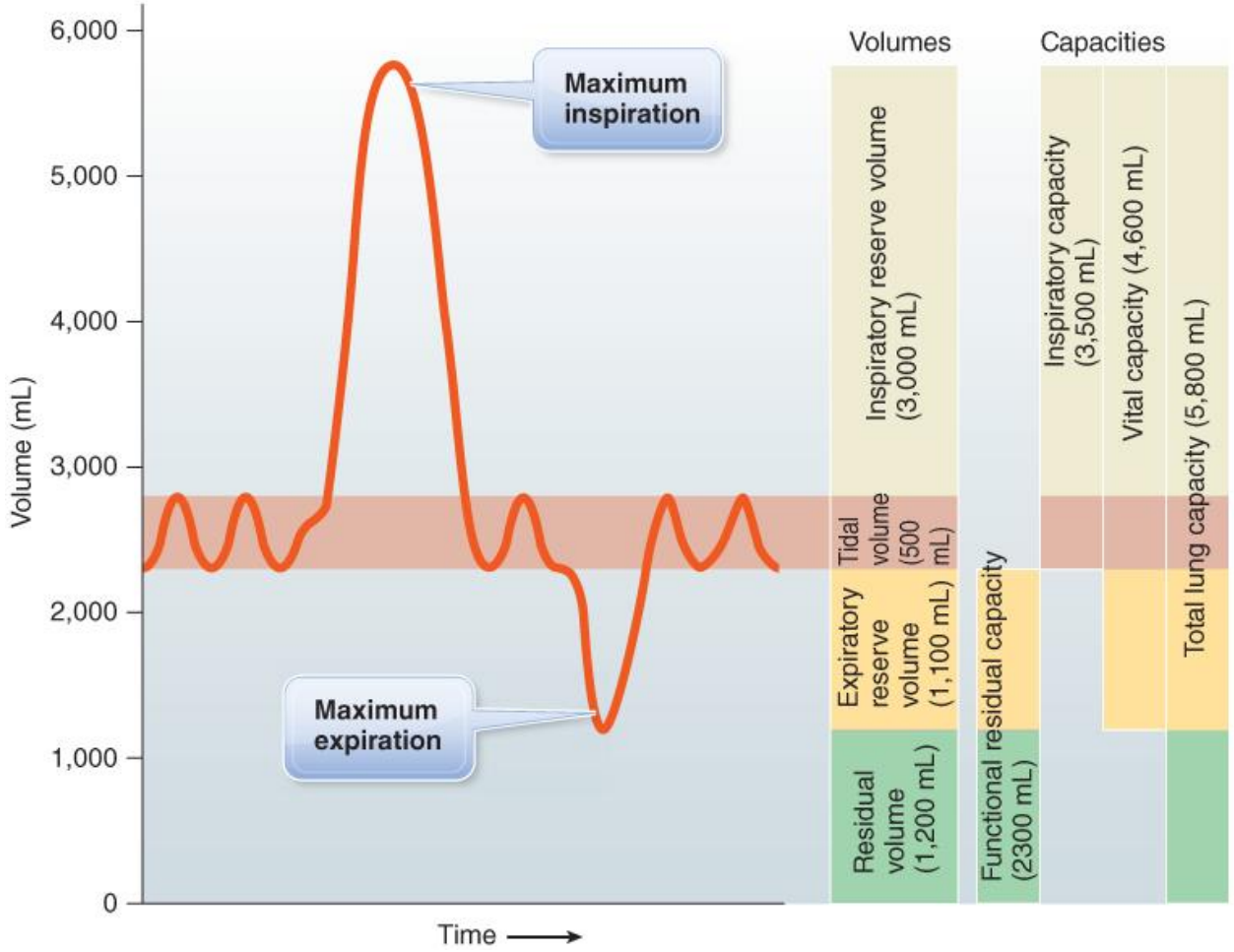
Respiratory Cycle



Physiology of the Respiratory System

Measurements of Pulmonary Function:

- A **spirometer** can be used to measure **lung volumes and capacities**.
- **Compliance** measures how well the lung can expand and return to shape.
  - Decreased compliance in **chronic obstructive pulmonary disorders**


6,000
5,000
4,000
3,000
2,000
1,000
0
Volume (mL)
Time
Maximum inspiration
Maximum expiration
Volumes
Capacities
Inspiratory reserve volume (3,000 mL)
Tidal volume (500 mL)
Expiratory reserve volume (1,100 mL)
Residual volume (1,200 mL)
Functional residual capacity (2300 mL)
Inspiratory capacity (3,500 mL)
Vital capacity (4,600 mL)
Total lung capacity (5,800 mL)

Physiology of the Respiratory System

Composition of Air:

- Air is a mixture of gases including nitrogen, oxygen, carbon dioxide and water vapor.

- **Partial pressure** is the amount of pressure an individual gas contributes to the total pressure of the mixture.

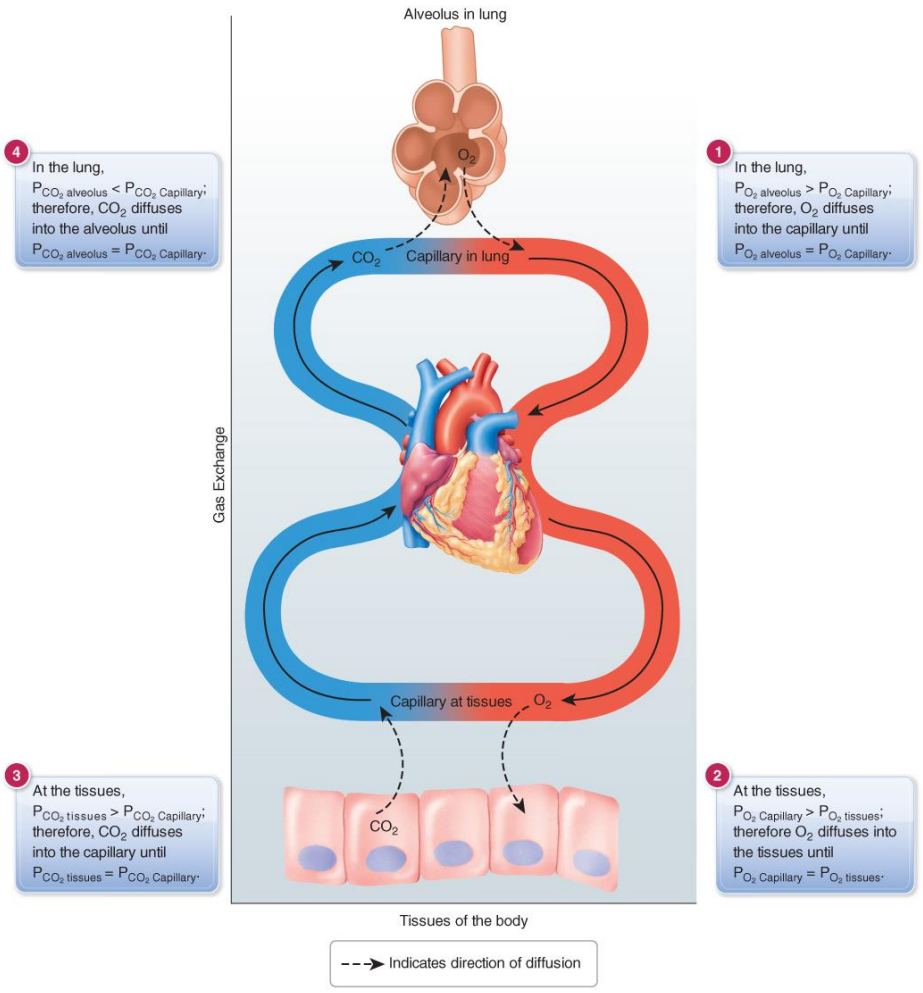
Physiology of the Respiratory System

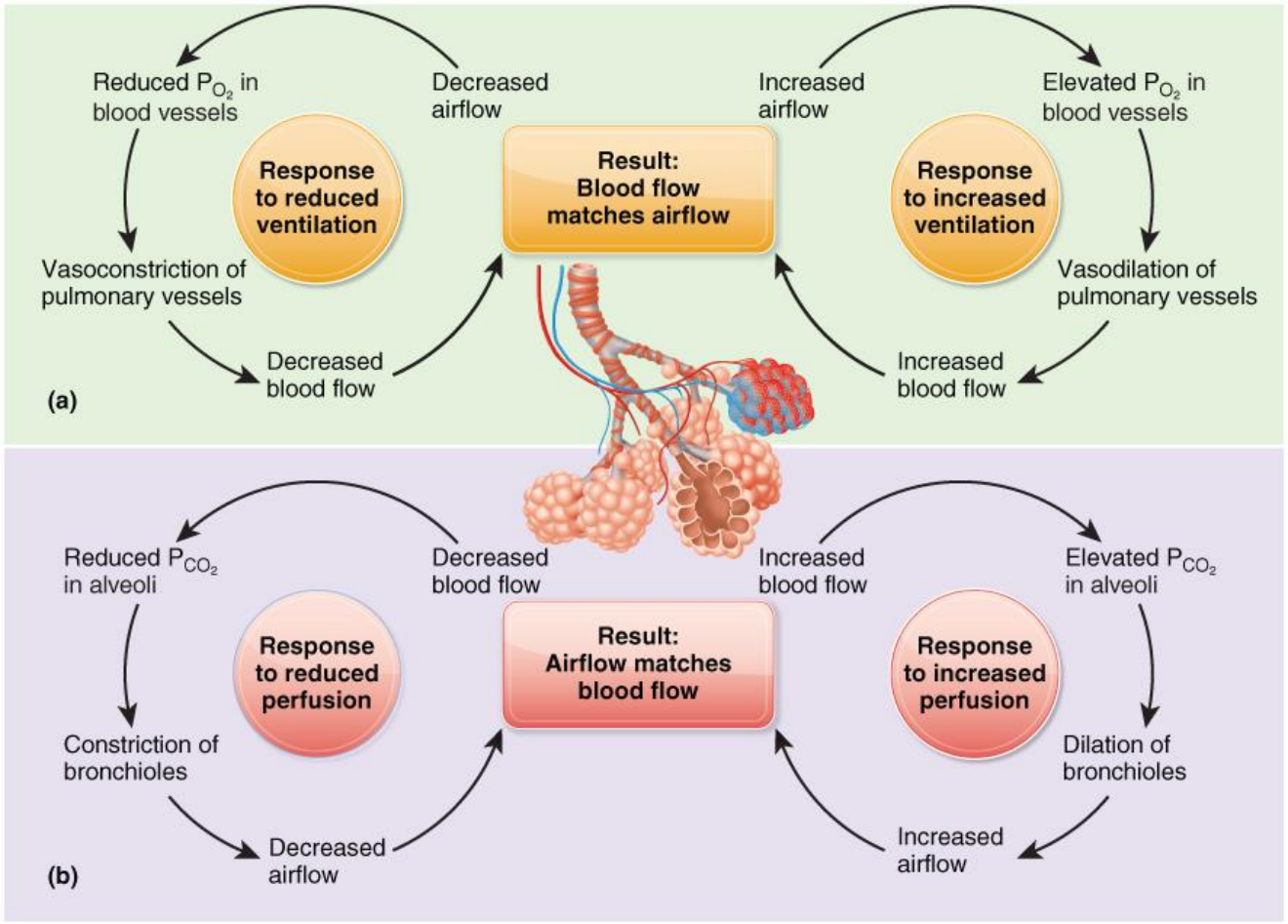
Gas Exchange:

- Gas exchange happens between the alveoli and the capillaries in the lung and between the capillaries and the tissues of the body.

- Gases diffuse across membranes because of a concentration gradient until the concentrations on both sides of the membrane are equal.

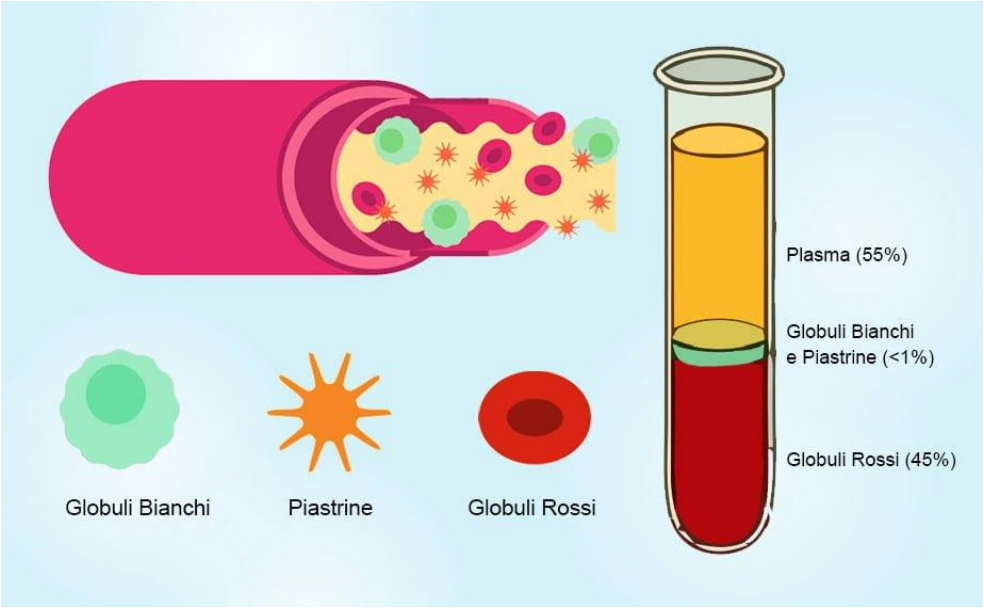
Gas exchange




Reduced P_{O_2} in blood vessels
Decreased airflow
Increased airflow
Elevated P_{O_2} in blood vessels
Response to reduced ventilation
Result: Blood flow matches airflow
Response to increased ventilation
Vasoconstriction of pulmonary vessels
Vasodilation of pulmonary vessels
Decreased blood flow
Increased blood flow
(a)
Reduced P_{CO_2} in alveoli
Decreased blood flow
Increased blood flow
Elevated P_{CO_2} in alveoli
Response to reduced perfusion
Result: Airflow matches blood flow
Response to increased perfusion
Constriction of bronchioles
Dilation of bronchioles
Decreased airflow
Increased airflow
(b)

Oxygen is thus 'pushed' by the pressure difference from the alveolus into the capillary, it dissolves in the **plasma** and then, again by a pressure operation, enters the **red blood cell**, where it binds to **hemoglobin** and is then transported to all our cells.

Carbon dioxide moves from the tissue cells into the plasma (partial pressure difference) and is transferred (dissolved or bound to proteins) into the venous circulation to the capillary in contact with the alveolus, and thence to the electrical pathways. An ideal amount of red blood cells and hemoglobin is therefore a crucial basis for an efficient transport of oxygen.



From an energy point of view, a good supply of oxygen is therefore fundamental. This is guaranteed by hemoglobin, which is able to form a bond with four O2 molecules.

The decrease in the partial pressure of O2 (which occurs, for example, when we climb to high altitudes) is the main stimulus for the production of a hormone (mainly renal) called **erythropoietin**.

This hormone stimulates the active **bone marrow** to produce red blood cells in order to increase the number of oxygen-carrying cells even though there is less oxygen available.

Effects of Aging on the Respiratory System

- The ciliated escalator becomes less efficient, so more mucus and debris accumulate in the respiratory tract and this can lead to infection.

- Thoracic wall compliance decreases, causing reduced vital capacity.

Effects of Aging on the Respiratory System

- Some alveolar walls break down with age and thicken, thereby reducing gas exchange.

- Obstructive sleep **apnea** may occur if the pharyngeal muscles block the airway.

Hematocrit is the percentage of red blood cells in relation to the liquid part of the blood (plasma). The value varies according to several factors. In athletes carrying out endurance activities (cycling, rowing, marathons, etc.), it is very important to have a relatively high value as it helps the muscle cell to always have oxygen available to use.

Altitude (i.e. partial decrease in oxygen) is the strongest physiological stimulus to produce erythropoietin. People living at high altitude always have a relatively higher hematocrit than those living at sea level.

Respiratory System Disorders

- **Respiratory Infections:**

  Respiratory infections include colds, flu, tuberculosis, pertussis, and pneumonia

- **COPDs:**

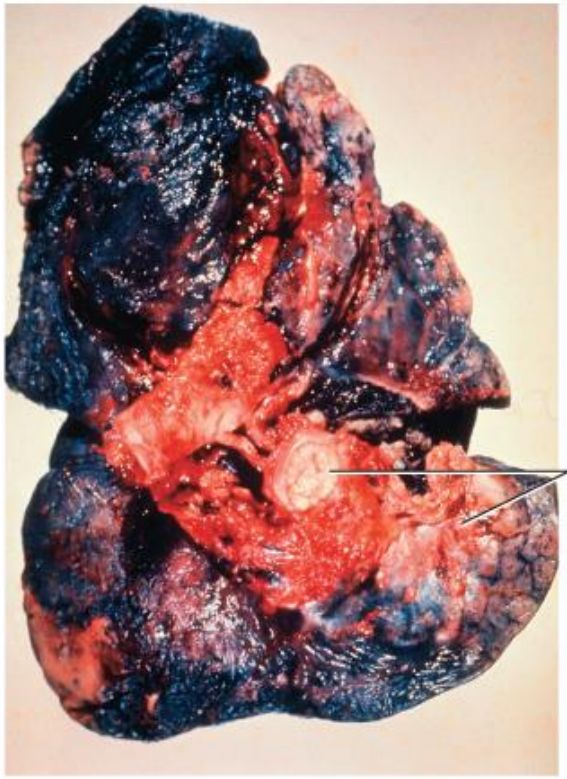
  COPDs are often the result of smoking and include chronic bronchitis, emphysema, and asthma.

- **Lung Cancer:**

  Lung cancer causes more deaths than any other form of cancer.

Effects of Smoking

(a)



(b)

Usually, the amount of oxygen reaching the periphery, whether dissolved in plasma (a little) or bound to (a high level of) hemoglobin, is more than sufficient to carry out basic metabolic activities.

It represents also a large reserve available to our organism when it needs a surplus of consumption linked to activity.

The activities for which it is necessary to guarantee ideal oxygen support of course are those requiring relatively high and above all long-lasting energy production, i.e. **endurance aerobic sports**.

Keywords

Respiratory

System

Lung

Oxygen

Diaphragm

Anaemia

Red blood

cell

Spirometer

Boyle’s Low

Bone Marrow

Carbon

Monoxide

Carbon

Dioxide