Al-Mustaqbal University

College of Engineering and Technologies

Biomedical Engineering Department

Systemic Physiology I

Lecture: 5

Respiratory System Physiology

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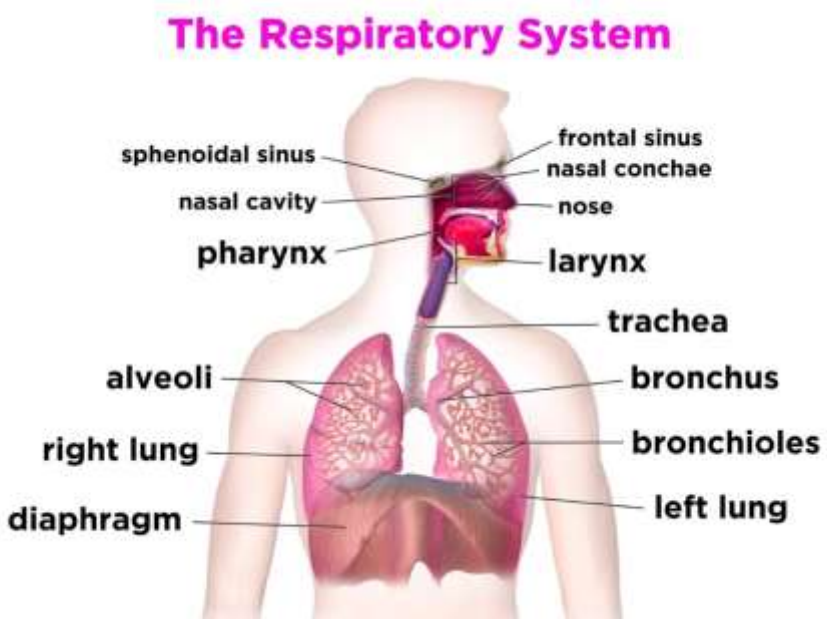
Physiology of Respiratory System

The respiratory system in humans consists of the lungs, the rib cage, and the pleura sacs inside which the lungs are located, and a system of airways that carries air to and from the lungs, as well as the muscles whose activity leads to an increase or decrease in the size of the rib cage, and the nerves connected to these muscles, as it expresses the main function of the respiratory system. Two main operations are performed at the same time. The first function is the continuous supply of oxygen and the continuous excretion of carbon dioxide. The second function includes helping to regulate the acidity of fluids outside the body cells, helping to regulate body temperature and getting rid of water.

Direct gaseous exchange between the body and the external environment is achieved through the respiratory system (lungs), and this process is known as external respiration. The respiratory process also includes the transfer of oxygen from the lungs to the tissues and the transfer of carbon dioxide from the tissues to the lungs, and this process is called internal respiration. It consumes O2 and is CO2, called physiological oxidation processes, uses the energy released as a result of oxidation processes to rebuild compounds that cells use to store energy, such as ATP and creatine phosphate (CP). The cell uses the energy stored in these compounds in its vital processes. Figure (1|). shows the shape of the lungs and the surrounding wall.



We can establish the following main steps of the breathing process as follows:

1. Ventilation: It includes the movement of oxygen from the air into the alveoli (alveoli) in the lungs (and the movement of carbon dioxide in the opposite direction).

2. Diffusion: The movement of gases across the blood-gas barrier.

3. Coordination between blood movement and ventilation, which is important in the gas exchange process.

4. Blood movement in the lungs: Gases are transported out of the lungs.

5. Transport of blood gases: making oxygen and carbon dioxide in the blood.

6. Transport of gases between capillaries and cells.

7. Utilizing oxygen and excreting carbon dioxide into body cells.

Structure of Respiratory System

The respiratory system in humans consists of the lungs, the tracts leading to them, the chest, the pleura, and the muscles and nerves connected to them (Figure 1). In birds, air sacs and spaces in some bones are added to them, which leads to the respiratory system of birds being wider than that of mammals.

The airways include:

1. Nostrils: They are the two external openings of the respiratory system and differ in shape, size and hardness depending on the animals.

2. Nasal cavity: Starting from the nostrils, it is lined with a moist, sticky mucous membrane, and in its posterior region are the sensory endings of the olfactory nerve.

3. Sinuses: They are air-filled gaps located in the cranial bones and opening into the nasal cavity.

4. Pharynx: It is a common passageway for the passage of food and air, as the two processes cannot be accomplished at the same time.

5. Larynx: - Or called the voice box, it is specially prepared to work as a regulating valve for the amount of air entering and exiting during the processes of inhalation and exhalation.

6. Trachea:-

It is an open, non-bending tube made up of (30-60) interconnected cartilage rings, incompletely round in mammals, in the shape of the letter (C), while birds are fully round and longer than mammals. Its inner wall is lined with a mucous membrane covered with pyramidal epithelial cells. It is columnar in shape and its function is to prevent dust and foreign materials from entering. The mucous membrane and the layer beneath it

contain mucous glands that open into the tracheal cavity. The trachea is divided at the base of the heart into two main sections, the bronchi, each of which enters a lung and then branches into smaller bronchi, which in turn branch into bronchioles. There are multiple systems of bronchioles that branch into finer branches, which are the alveolar ducts, which end in the alveolar sacs. sacs are made up of a group of alveoli, which are the smallest and last air passages in the lungs, in mammals. As for the smallest and last air passages in the lungs of birds, they are called **Parabronchi**, in which gas exchange occurs (Figure 3).

7- Lungs:-

A person breathes with the lungs located in the thoracic cavity. They are shaped like a cone and are elastic because they are filled with spaces that air enters. Thus, they fill the thoracic cavity until birth, after which the rib cage grows faster and the size of the lungs becomes relatively smaller. The lung is divided into lobes, the right has three lobes and the left has two lobes.

The lungs are surrounded by a double serous membrane. The membrane that surrounds the lungs is called the visceral pleura, while the serous membrane lining the cavity of the rib cage is called the parietal pleural. The space between the two layers is called the pleural cavity, which is a thin space filled with a lymphatic fluid secreted by the pleura. To prevent friction between the pleural membranes during the process of inhalation, in which the lungs expand, and when the pleural membranes become inflamed, it is called what is known as pleurisy, which is a symptom of pleural pain during inhalation. While breathing in birds is considered to be the lung's ability to expand and contract is very limited compared to the lungs of mammals, this is because the lungs of birds It is an air

passage in which gas exchange occurs and is connected to air sacs that have a wide ability to expand and contract, while the mammalian lung represents an air sac.

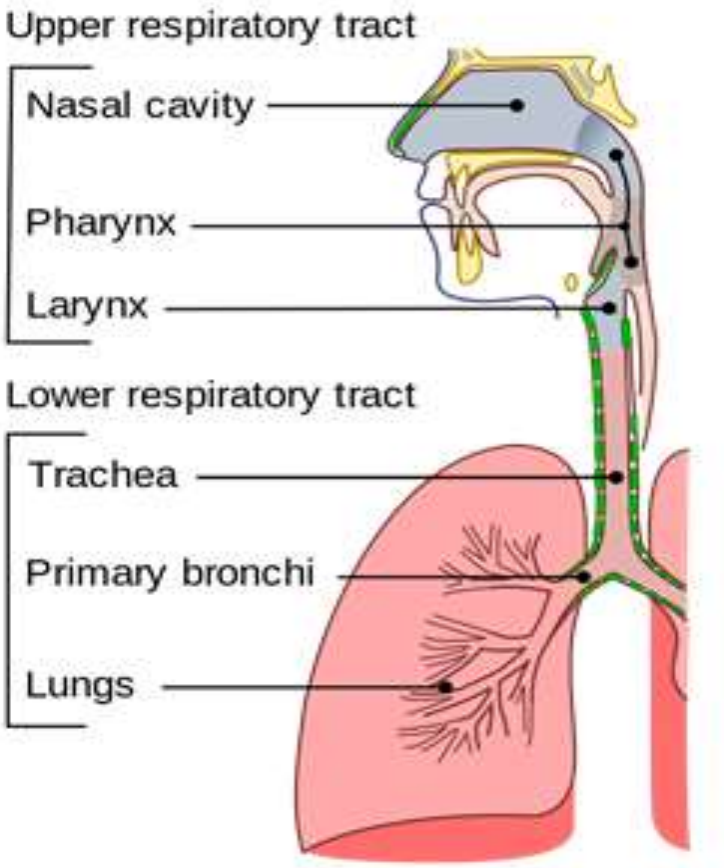


Figure 2. Structure of respiratory system.

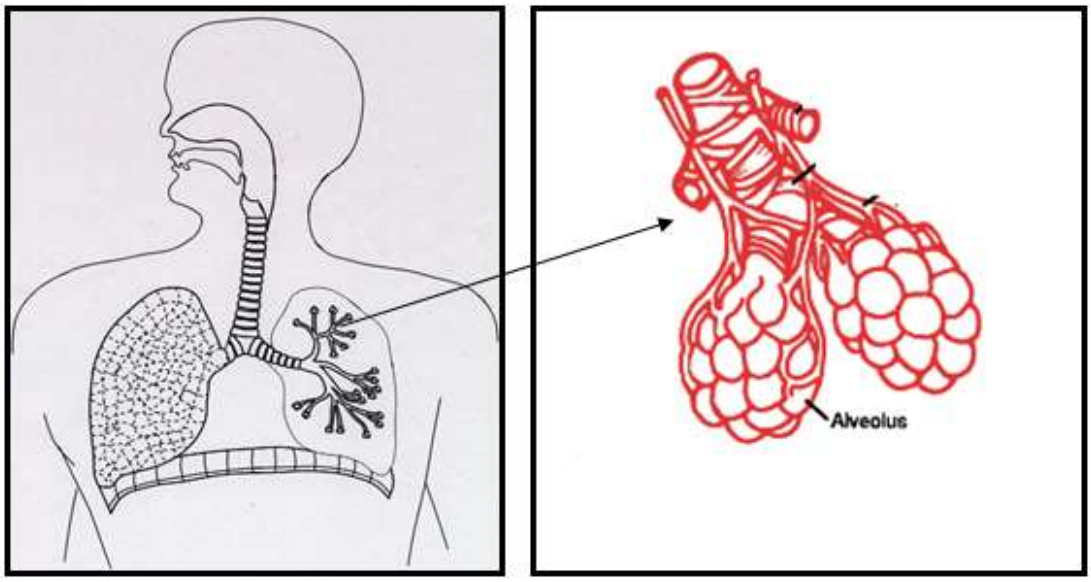


Figure 3. The branches into which the trachea branches, leading to the alveoli.

The mechanism of respiration

The air enters through the nostrils, which work to filter, moisturize, and adjust the temperature of the air entering through them. The air passes through the pharynx, larynx, trachea, and bronchioles, which end in finer branches that form at their end pockets called alveolar sinuses (Figure 3). The walls of these sinuses expand, forming what is known as alveoli, which There are approximately 300 million chambers in both lungs, and the diameter of each of them is 0.2 mm. The expansion and contraction of the chest in mammals leads to the constant entry and exit of air to and from the lungs, as the change in the size of the rib cage is due to the movements of both the thoracic ribs and the diaphragm.

- **In inhalation:** the rib cage expands, creating negative pressure (less than atmospheric pressure) in the pleural cavity, which leads to the expansion of the lungs and thus air enters them.

The occurrence of inhalation results in:

First: from the expansion of the ribs and their rotation forward and backward.

Second: From the contraction of the diaphragm towards the abdominal side.

- **In exhalation : -** which represents an attempt to return the rib cage to its normal position by pulling the ribs back and returning the diaphragm to its curved position towards the chest cavity, which leads to a reduction in the size of the chest and thus an increase in pressure or the exit of air from the lungs towards the outside and the main reason for the change in size. The lungs during the inhalation and exhalation processes are due to a change in the internal pressure of the pleura.

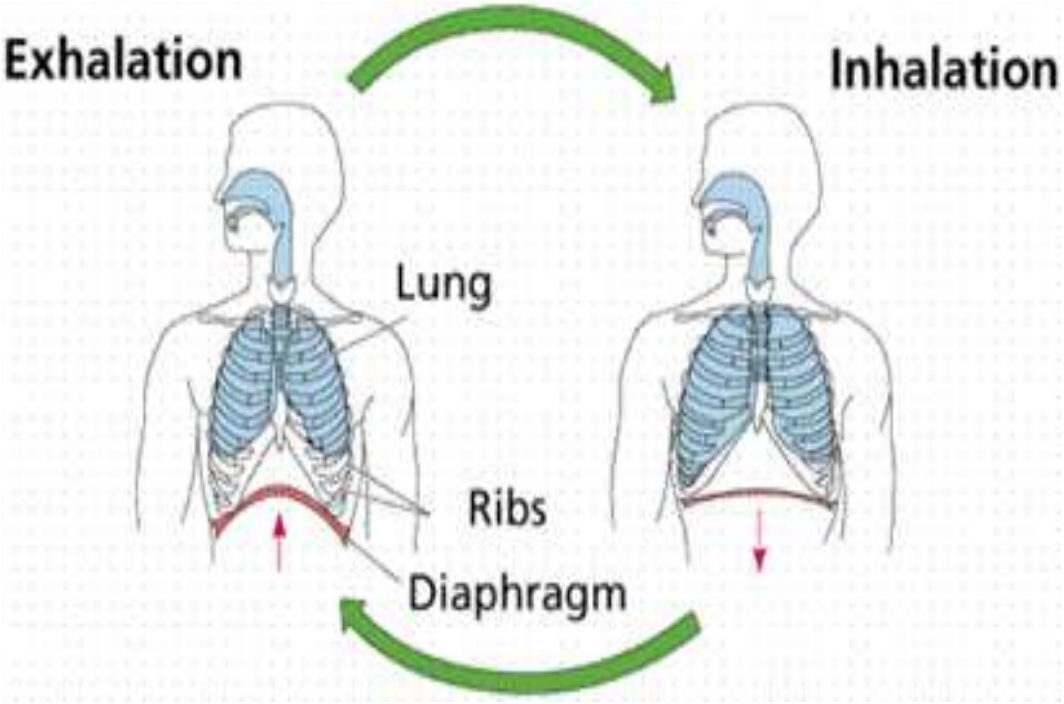
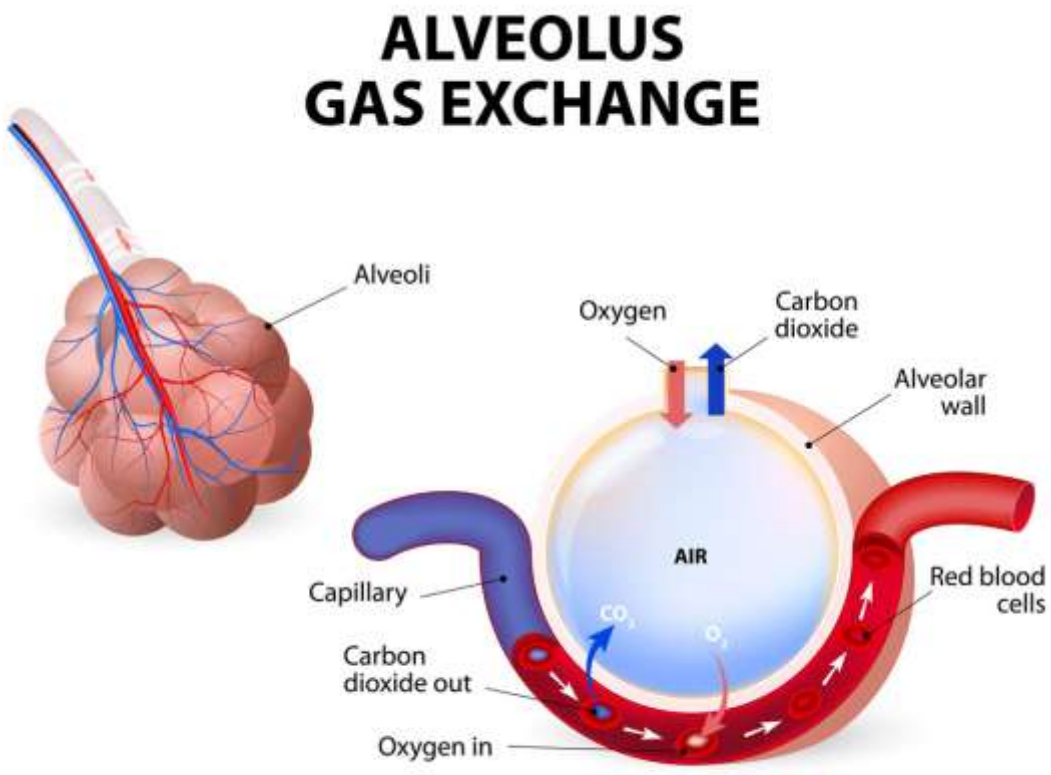


Figure 4. Inhalation and Exhalation processes.

Respiration Rate

It is known as the number of breathing times in one minute, and it is affected by several factors, the most important of which are the degree of assimilation of vital substances, the age of the animal, the physiological state, the nature of the digestive processes, muscle stress and the environment surrounding the animal (temperature), but there are functional damages from rapid respiratory movements and slow movements despite The stability of the particle size in both cases. In the first case, a sufficient amount of air is not renewed in the alveoli because a large portion of the particle size does not reach the alveoli due to dead space. In the second case, PCO2 rises and PO2 decreases a lot in the alveoli at the end of each respiratory movement due to the respiratory period between movements. Respiratory: In both cases, gaseous exchange between blood and air in the alveoli is not sufficient.



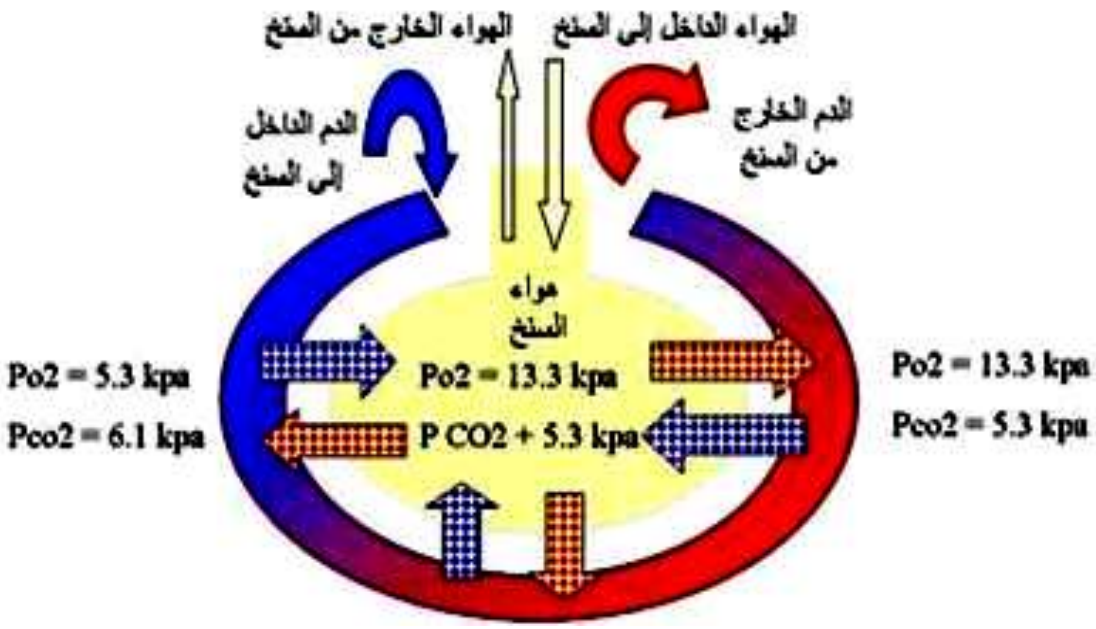


Figure 4. The pressure of oxygen and carbon dioxide within the alveoli (alveoli).

Vital capacity: It expresses the largest amount of air that can enter the lungs at the maximum inhalation or the largest amount of air released at the maximum exhalation.

There are four terms to express lung capacity:

1. Vital capacity of the lungs

It is the maximum amount of air that a person expels after taking the largest possible inhalation. It is the sum of the exhalation reserve, the normal breathing volume, and the inhalation reserve volume. The vital capacity is 4500 cubic centimeters during sports and hard work, and it is a measure of the health of the lungs, as the capacity decreases in a number of respiratory diseases.

2. Total lung capacity

It is the total volume of air (the sum of the four volumes) that the lungs can absorb, which is the vital capacity and the remaining volume, which is about 6 liters.

3. Normal capacity

It is the volume of air that remains in the lung after a normal exhalation process, and it is the sum of the remaining volume and the exhaled reserve volume, and it amounts to 2.3 liters.

4. Inspiratory capacity

It is the maximum amount of air that a person takes in after the deepest possible inhalation, and it is the sum of the normal breathing air and the inhaled reserve volume, and it amounts to 3.8 liters.

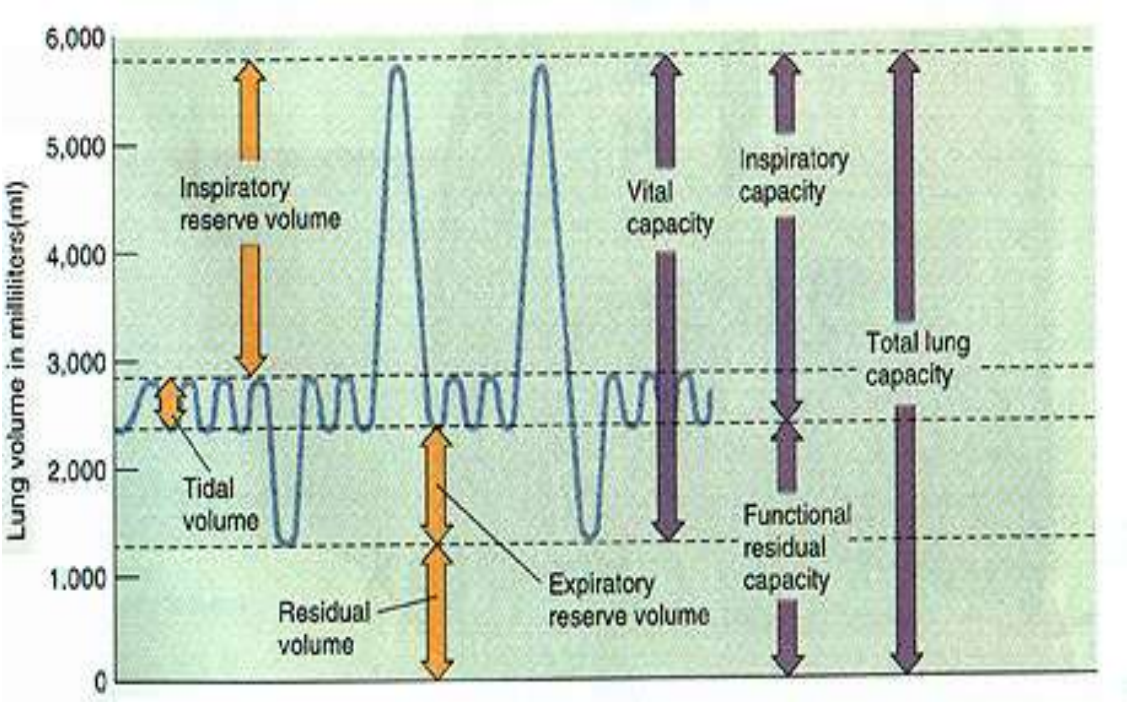


Figure 5. The volume of vital capacity resulting from the breathing mechanism during inhalation and exhalation.