Human Spirometry Chapter

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Experiments

Basic Level Difficulty Rating:

HS-1: Breathing Parameters at Rest and After Exercise

HS-2: Breathing and Gravity

HS-3: Factors that Affect Breathing Patterns

Advanced Level Difficulty Rating:

HS-4: Lung Volumes and Heart Rate

HS-5: Breathing Techniques and Heart Rate

HS-6: Ventilation and Oxygen Saturation Levels - Part I

HS-7: Ventilation and Oxygen Saturation Levels - Part II

HS-8: Restrictive and Obstructive Airways Diseases

Overview

Respiration is the process by which the body obtains and utilizes oxygen, and produces and eliminates carbon dioxide. It can be divided into 5 parts:

- Pulmonary ventilation, which is the movement of gases between the lungs and the environment. This will be studied in this chapter.
- Pulmonary gas exchange, which is the movement of gases between the lungs and the blood stream.
- Gas transport, which is the movement of gases within the blood stream.
- Tissue/blood gas exchange, which is the movement of gases between the bloodstream and the tissues.
- Cellular respiration, which is the consumption of oxygen and the production of carbon dioxide by cells and organelles.

The human respiratory system consists of a series of tubes that branch and terminate as clusters of small membranous air sacs called alveoli. Oxygen and carbon dioxide cross the wall of the alveoli that separates the air in the alveoli from the blood in the capillaries. Factors that influence diffusion include surface area, diffusion distance, and concentration gradient. The total area of the alveoli is about the size of a tennis court, and their thin walls provide a short diffusion distance. A high concentration gradient is insured by (1) movement of blood with low oxygen and high carbon dioxide levels to the lungs and (2) pulmonary ventilation (breathing), which maintains a high level of oxygen and a low level of carbon dioxide in the alveolar air. Thus, the alveoli and associated blood supply are well suited for the diffusion of oxygen into the blood and carbon dioxide into the air in the alveoli.

Ventilation of the human lung is produced by muscular contraction. The resulting ch volume is conveyed to the elastic lungs by the fluid-filled pleural cavity. Inspiration contraction of the diaphragm and the intercostal muscles, both of which increase the thoracic cavity. In the resting individual, expiration is usually passive since muscle relaxation and gravity act to decrease thoracic volume. Under certain circumstances, like during exercise, forced expiration is produced by contraction of intercostal muscles.

The amount of air moving into or out of the lungs during any one breathing cycle is called the tidal volume. The tidal volume is smaller than the maximum amount of air that can be moved through the lungs, the vital capacity. The difference between the tidal volume and the vital capacity are the reserve volumes that can be "tapped" to change the tidal volume and increase the depth of breathing. The amount of air moving into and out of the lungs can also be altered by changing the breathing rate. These the depth and the rate of breathing are controlled by the respiratory control center, which is located in the medulla of the brain. The center insures that the exchange of oxygen and carbon dioxide at the lungs takes place at a rate that matches the body's requirements. This is a dynamic process, since the body's requirements change over time.

In this chapter, there are experiments which examine the effects of exercise, gravity, movement, body position, and health on breathing and functions altered by breathing, like cardiac activity.