

REGULATION OF RESPIRATION

Breathing is typically an involuntary process, occurring without conscious control. In a normal adult, the respiratory rate averages 12-16 breaths per minute, with inspiration lasting around 2 seconds and expiration around 3 seconds. Infants, on the other hand, breathe at a faster rate, approximately 44 times per minute. While breathing is regulated involuntarily, humans possess the ability to adjust the breathing rate based on the body's requirements. The regulation of respiration involves both neural and chemical controls.

Neural Regulation

The rhythm of respiration is primarily governed by the nervous system, which encompasses various respiratory centers situated within the brain. These centers, comprised of groups of neurons located in the medulla oblongata and pons, regulate both the frequency and depth of breathing.

Two main centers in the brain are responsible for respiratory regulation:

- **Respiratory Rhythm Center:** This specialized center, situated in the medulla oblongata of the hindbrain, orchestrates either inspiration or expiration based on the activation of specific neurons. Consequently, it adjusts the respiratory rhythm according to the body's requirements.
- **Pneumotaxic Center:** Located within the pons region of the hindbrain, this center moderates the functioning of the respiratory rhythm center. Signals from the pneumotaxic center can shorten the duration of inspiration, thereby influencing the respiratory rate. Intense signals from this area lead to rapid and shallow breathing by reducing the duration of inspiration.

Chemical Regulation

Adjacent to the rhythm center lies a chemosensitive area housing chemoreceptors sensitive to changes in carbon dioxide (CO_2) and hydrogen ion (H^+) concentrations. These chemoreceptors are activated by alterations in the partial pressure of CO_2 (pCO_2) and pH levels in the blood and bodily fluids. An increase in CO_2 and H^+ ion concentrations triggers activation of the chemosensitive area, subsequently stimulating the respiratory rhythm center to adjust the respiration rate accordingly. For instance, elevated levels of CO_2 in the blood prompt an increase in both the rate and depth of respiration, whereas a decrease in CO_2 levels depresses respiration.

Chemosensitive receptors for CO_2 and H^+ ions are located in:

- **Aortic Bodies:** Positioned along the aortic arch.
- **Carotid Bodies:** Found in the carotid arteries, which supply blood to the brain. Changes in CO_2 concentration affect blood pH, with higher CO_2 levels lowering pH and vice versa. Lowered blood pH triggers an elevation in the respiration rate.