

# Chemical Regulation of Breathing

**Chemical regulation of breathing** is part of the involuntary (autonomic) control of breathing. This mechanism is part of the body's homeostasis to maintain an appropriate balance and concentration of  $\text{CO}_2$ ,  $\text{O}_2$ ,  $\text{HCO}_3^-$  and pH. There are two types of chemoreceptors that react strongly to a change in the blood gases: **central** and **peripheral** chemoreceptors.

## Chemoreceptors

- detects arterial  $\text{pCO}_2$  and pH
- increase in alveolar  $\text{pCO}_2$  causes an increase in breathing rate
- $\text{pO}_2$  normally stimulates ventilation when it falls below  $\sim 8\text{kPa}$  (60 mmHg). When the fall is accompanied by an increase in  $\text{PCO}_2$ , the increase in ventilation is greater

## Central Chemoreceptors

Central chemoreceptors are located on the ventrolateral surface of the medulla oblongata. They respond indirectly to blood  $\text{pCO}_2$  but not to  $\text{pO}_2$ .  $\text{CO}_2$  diffuses across the blood-brain barrier from blood to cerebral spinal fluid (CSF) while  $\text{H}^+$  and  $\text{HCO}_3^-$  are unable to.

As the blood  $\text{CO}_2$  readily passes the blood-brain barrier into the CSF it will react with  $\text{H}_2\text{O}$  to make  $\text{H}_2\text{CO}_3$ , that will split into  $\text{HCO}_3^-$  and  $\text{H}^+$ .



An increase in  $\text{H}^+$  concentration will directly stimulate the chemoreceptor neurons in the medulla oblongata. They will relay this information and cause an increase in ventilation which will lead to a decrease in  $\text{CO}_2$ .

The central chemoreceptors are responsible for  $\sim 80\%$  of the response to  $\text{CO}_2$  concentration.

## Peripheral Chemoreceptors

Peripheral chemoreceptors are located in carotid and aortic bodies that have neuro-epithelial cells that contact with sensory nerve terminals. They respond to changes in  $\text{pO}_2$ ,  $\text{pCO}_2$  and pH. When they are stimulated,  $\text{K}^+$  channels close and  $\text{Ca}^{2+}$  channels open. This causes an increase in initiation of dopamine, impulses to respiratory center via the glossopharyngeal nerves (N IX) and an increase in ventilation.

The peripheral chemoreceptors are responsible for  $\sim 20\%$  of the response to an increase in  $\text{pCO}_2$ .

## Links

## Bibliography

- GUYTON, Arthur – HALL, John. *Textbook of Medical Physiology*. 11. edition. Saunders, 2005. 1104 pp. ISBN 978-0721602400.
- WARD, Jeremy, et al. *Physiology at a glance*. 2. edition. Wiley-Blackwell, 2008. 160 pp. ISBN 978-1405177238.
- KAPIT, Wynn, et al. *Physiology Coloring Book*. 2. edition. Benjamin Cummings, 1999. 320 pp. ISBN 978-0321036636.

## External Links

- Regulation of Respiration Brain Stem Centre (<http://ak47boyz90.wordpress.com/2009/08/06/13-regulation-of-respiration-brain-stem-centre/>)
- Mechanics of Breathing and Gas Exchange-Transport (<http://www.colorado.edu/intphys/Class/IPHY3430-200/015breathing.htm>)
- Breathing oxygen level (<http://www.tutornext.com/help/breathing-oxygen-level>)