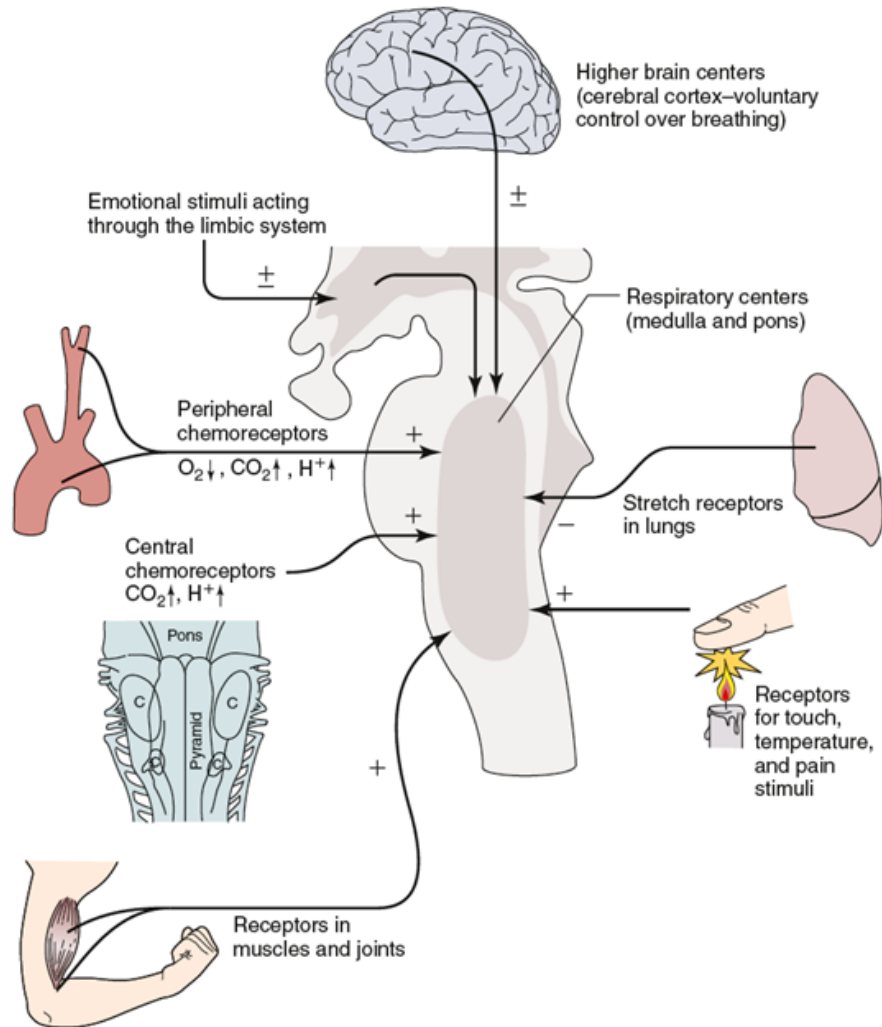


Determination of the sensitivity of the respiratory center to hypercapnia

Control of ventilation

- Breathing is an automatic process that takes place unconsciously. Automaticity of breathing comes from regular (rhythmic) activity of groups of neurons anatomically localized in the medulla and its vicinity. They can be divided into three main groups:

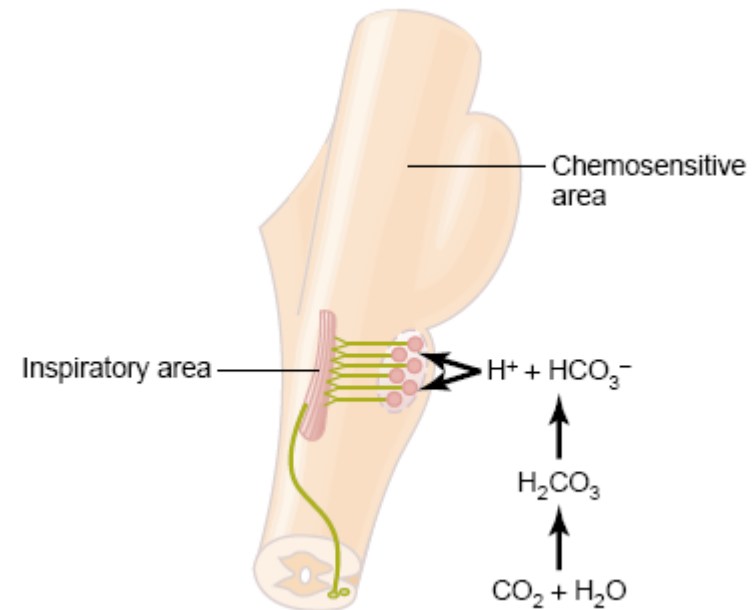


- dorsal respiratory group*
- ventral respiratory group*
- Pontine respiratory group - pneumotaxic center*

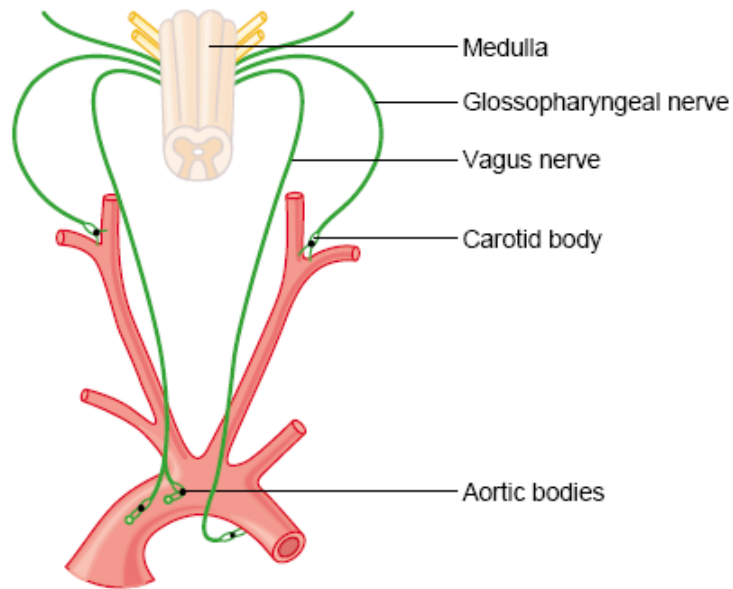
Chemical factors affecting the respiratory center

Central chemoreceptors

- on the front side of the medulla
- sensitive only to increase of arterial $p\text{CO}_2$ (by increasing H^+)
- central chemoreceptors are stimulated by other types of acidosis (lactate acidosis, ketoacidosis)
- $p\text{CO}_2$ sudden change does not take effect immediately, changes in ventilation through central chemoreceptors occur after 20-30 s



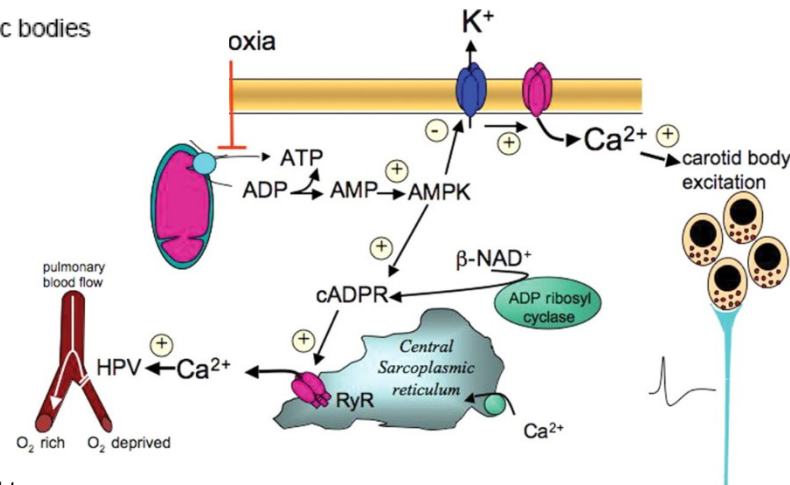
Chemical factors affecting the respiratory center



Peripheral chemoreceptors

- located in the aortic and carotid bodies
- primarily sensitive to decrease in arterial pO_2 , particularly to decrease of O_2 under 10-13 kPa in the arterial blood.

They convey their sensory information to the medulla via the vagus nerve and glossopharyngeal nerve.



Hypoxia, hypoxemia vs. ischemie

11-16 kPa

- Hypoxia is a general name for a lack of oxygen in the body or individual tissues.
- Hypoxemia is lack of oxygen in arterial blood.
- Complete lack of oxygen is known as anoxia.

The most common types of hypoxia:

1. Hypoxic - physiological: stay at higher altitudes, pathological: hypoventilation during lung or neuromuscular diseases
2. Transport (anemic) - reduced transport capacity of blood for oxygen (anemia, blood loss, CO poisoning)
3. Ischemic (stagnation) - restricted blood flow to tissue (heart failure, shock states, obstruction of an artery)
4. Histotoxic - cells are unable to utilize oxygen (cyanide poisoning - damage to the respiratory chain)

Hypercapnia

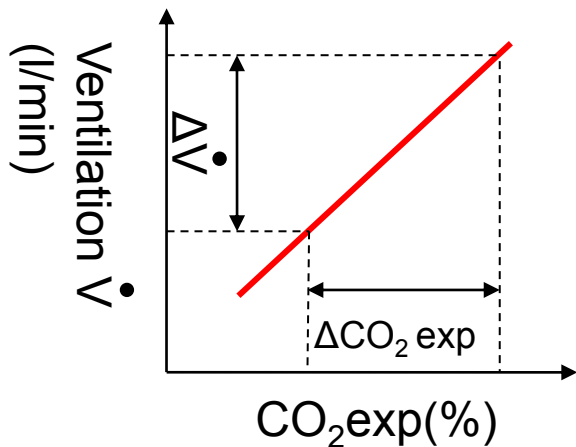
5.3-6.65 kPa

Increase of concentration of carbon dioxide in the blood or in tissues that is caused by retention of CO₂ in the body

possible causes: total alveolar hypoventilation - decreased respiration or extension of dead space

- mild hypercapnia (5 -7 kPa) causes stimulation of the respiratory center (therapeutic use: pneumoxid = mixture of oxygen + 2-5% CO₂)
- hypercapnia around 10 kPa - CO₂ narcosis - respiratory depression (preceded by headache, confusion, disorientation, a feeling of breathlessness)
- hypercapnia over 12 kPa - significant respiratory depression - coma and death.

Determination of the sensitivity of the respiratory center to hypercapnia



$$K_s = \frac{\Delta \dot{V}}{\Delta \text{CO}_2 \text{ exp}}$$

- Objective: to demonstrate the changes in ventilation during induced hypercapnia and to compare the sensitivity of the respiratory center to hypercapnia in several subjects
- Method: Hypercapnia is induced by re-breathing of air expired into Krogh respirometer with closed circuit (Krogh respirometer with oxygen, without the soda lime - naturally increases the concentration CO₂)
- Interpretation: The slope of the curve shows the sensitivity of the respiratory center to hypercapnia (see hypoxia)
- Clinical note: the sensitivity of the respiratory center to change of partial pressure of CO₂ is reduced in patients with chronic end-stage lung disease, in patients with heart failure as well as in subjects training breath holding (e.g. divers without oxygen tanks)