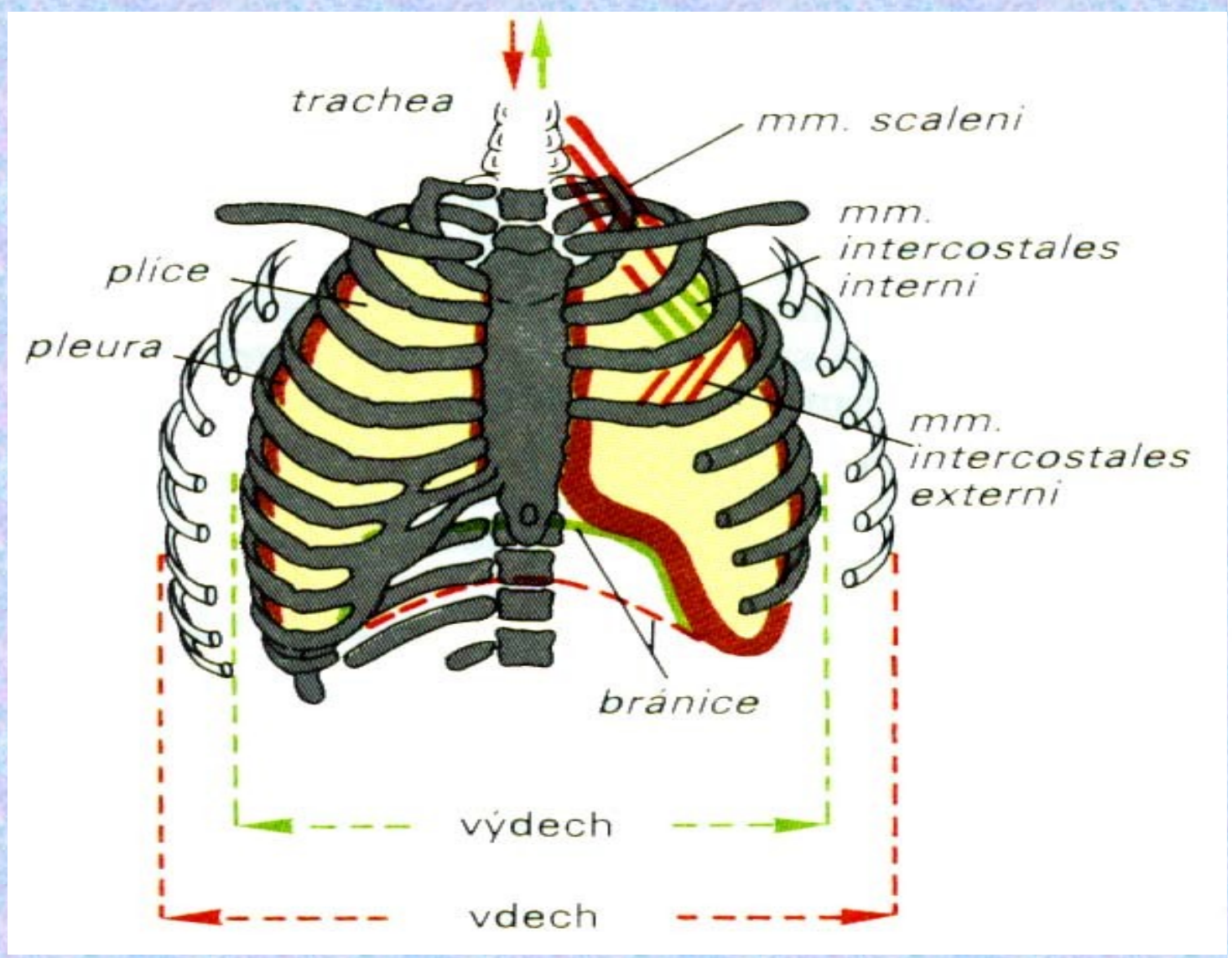
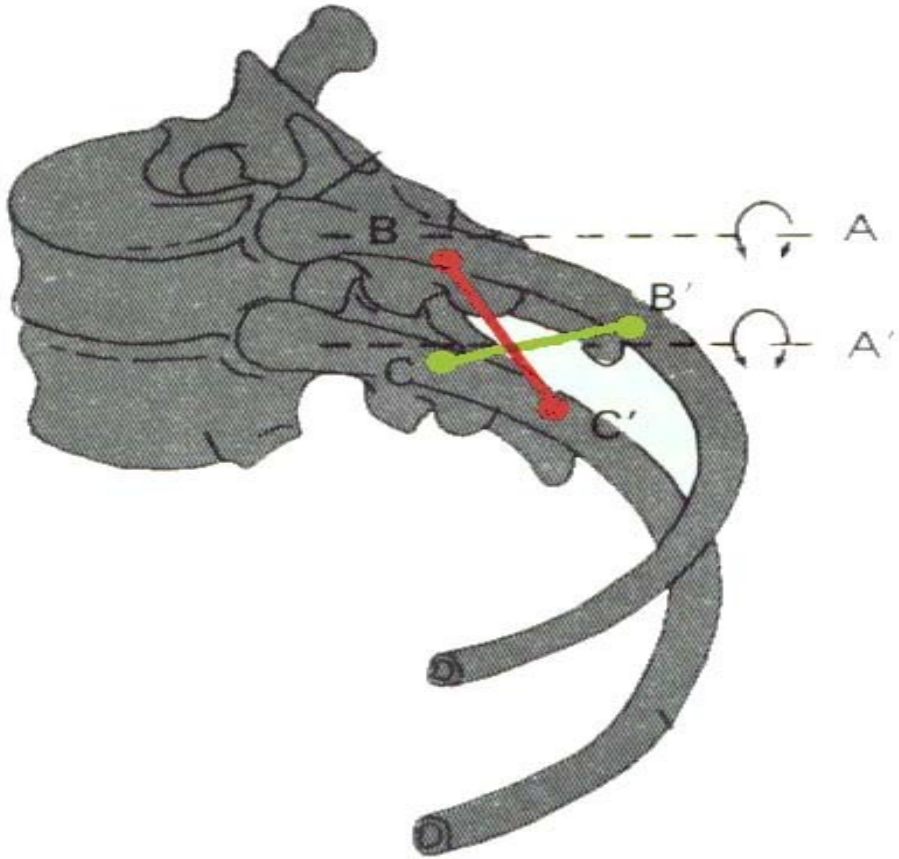
Respiratory system

Bucket-handle and water-pump handle effects

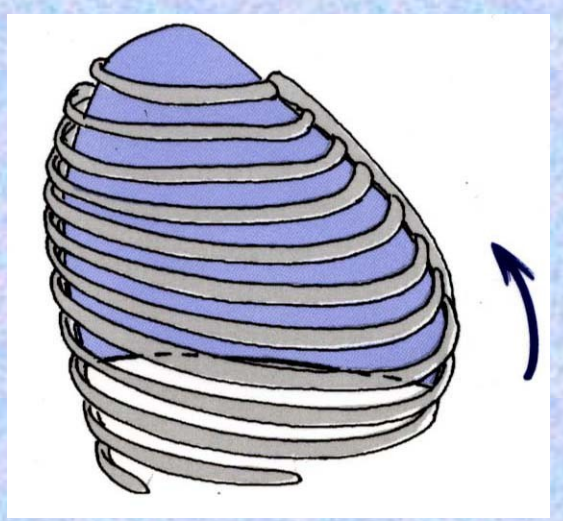


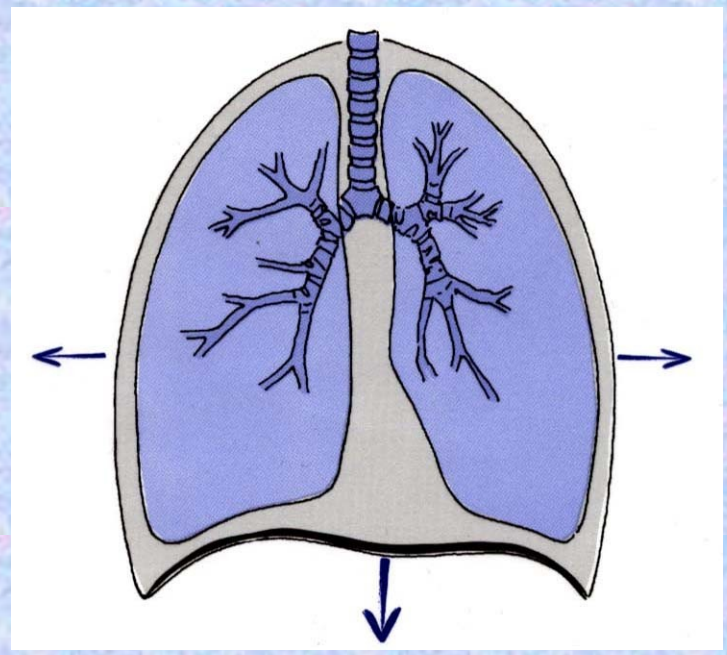


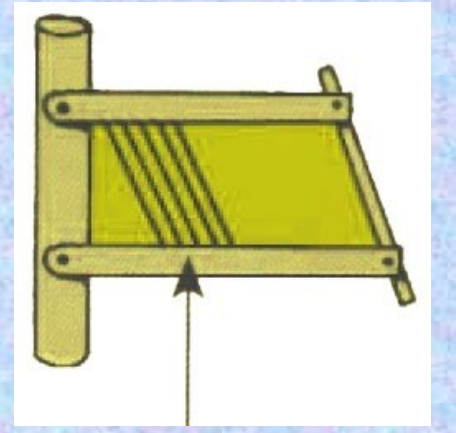
páka A — B < A′ — C′ → zvedání žeber

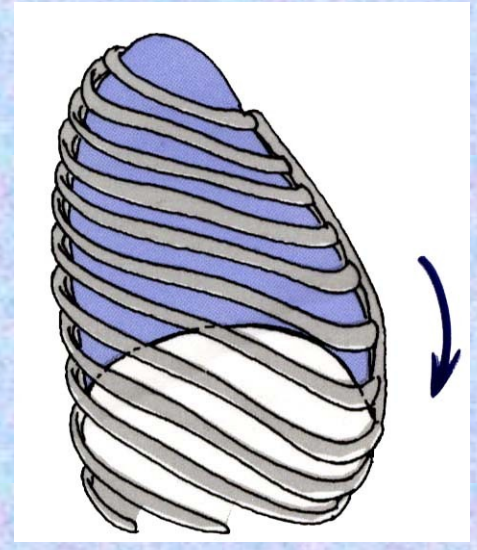
páka A — B′ > A′ — C → klesání žeber

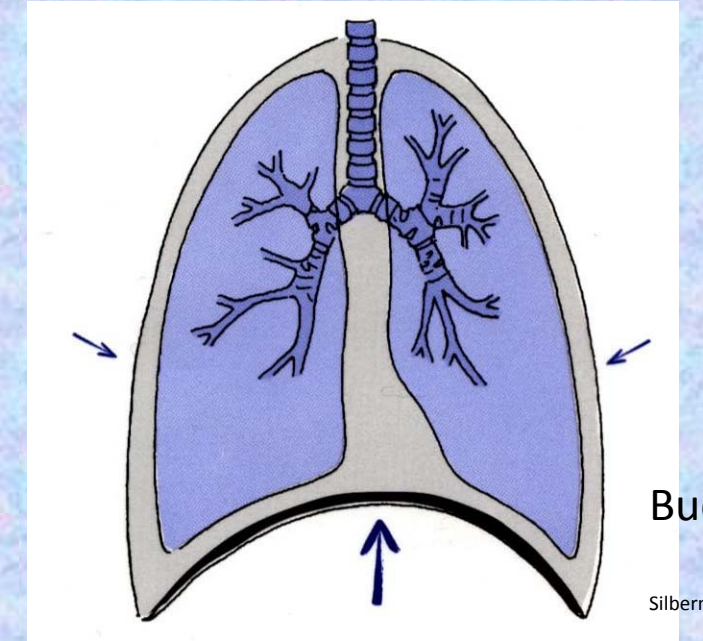
Silbernagl, Despopoulos: Color atlas of physiology, 2006.

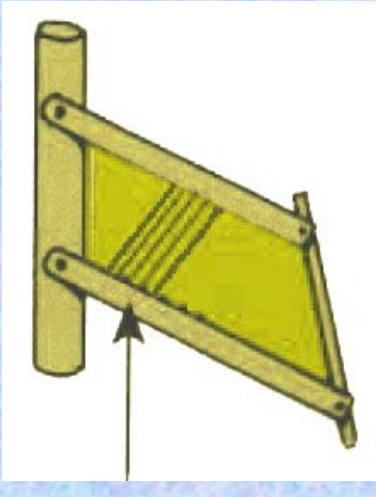












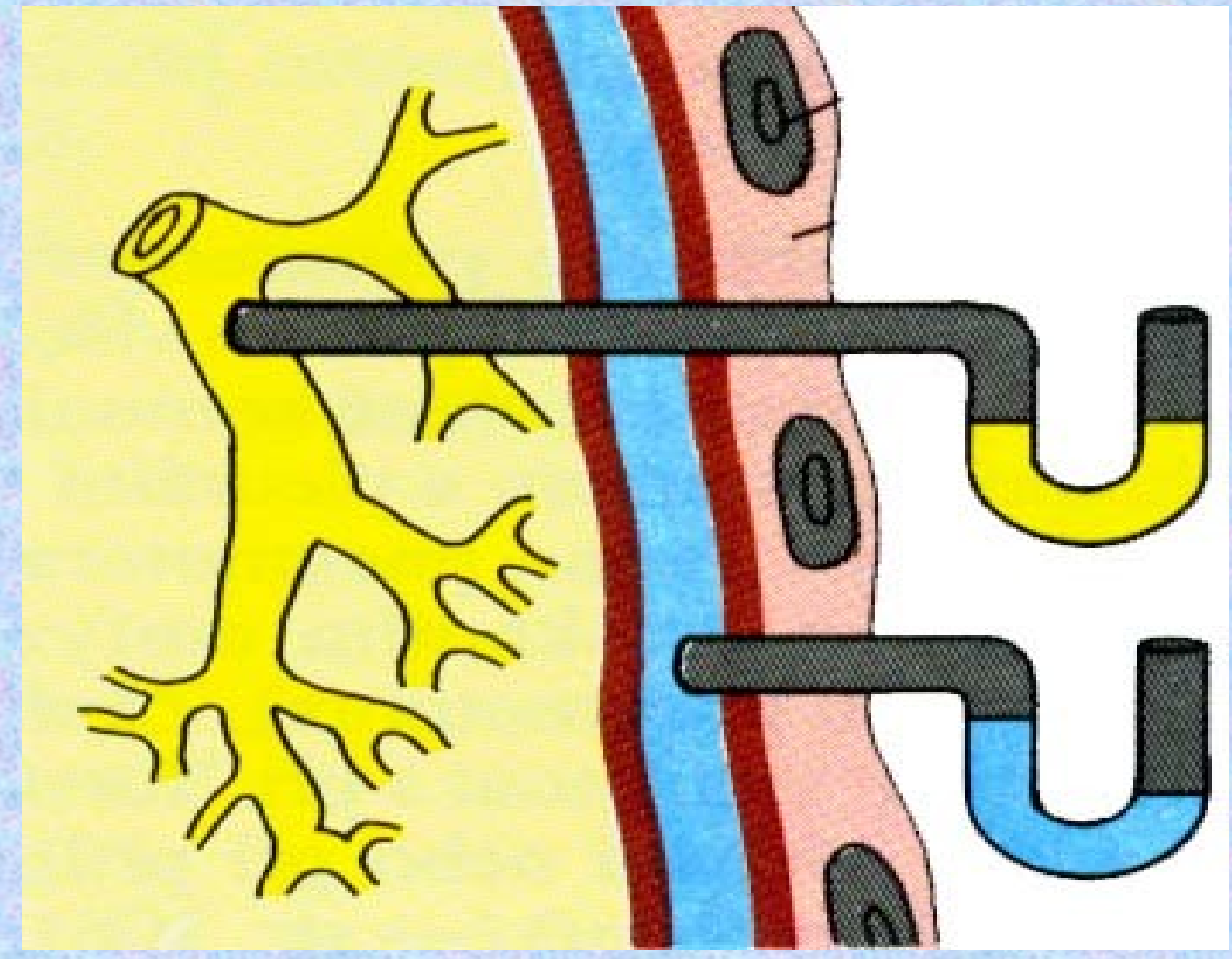
Bucket-handle and water-pump handle effects

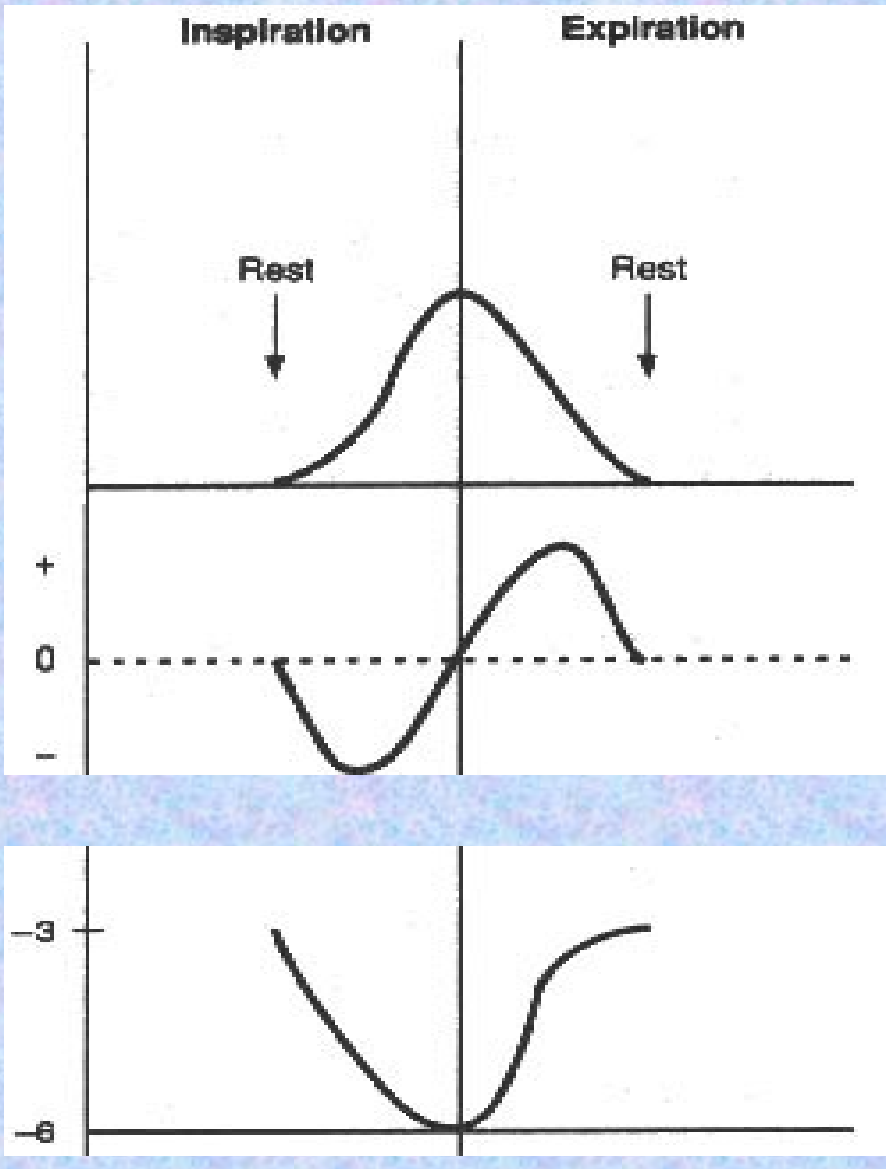
Silbernagl, Despopoulos: Color atlas of physiology, 2006.

PLEURA

pulmonalis

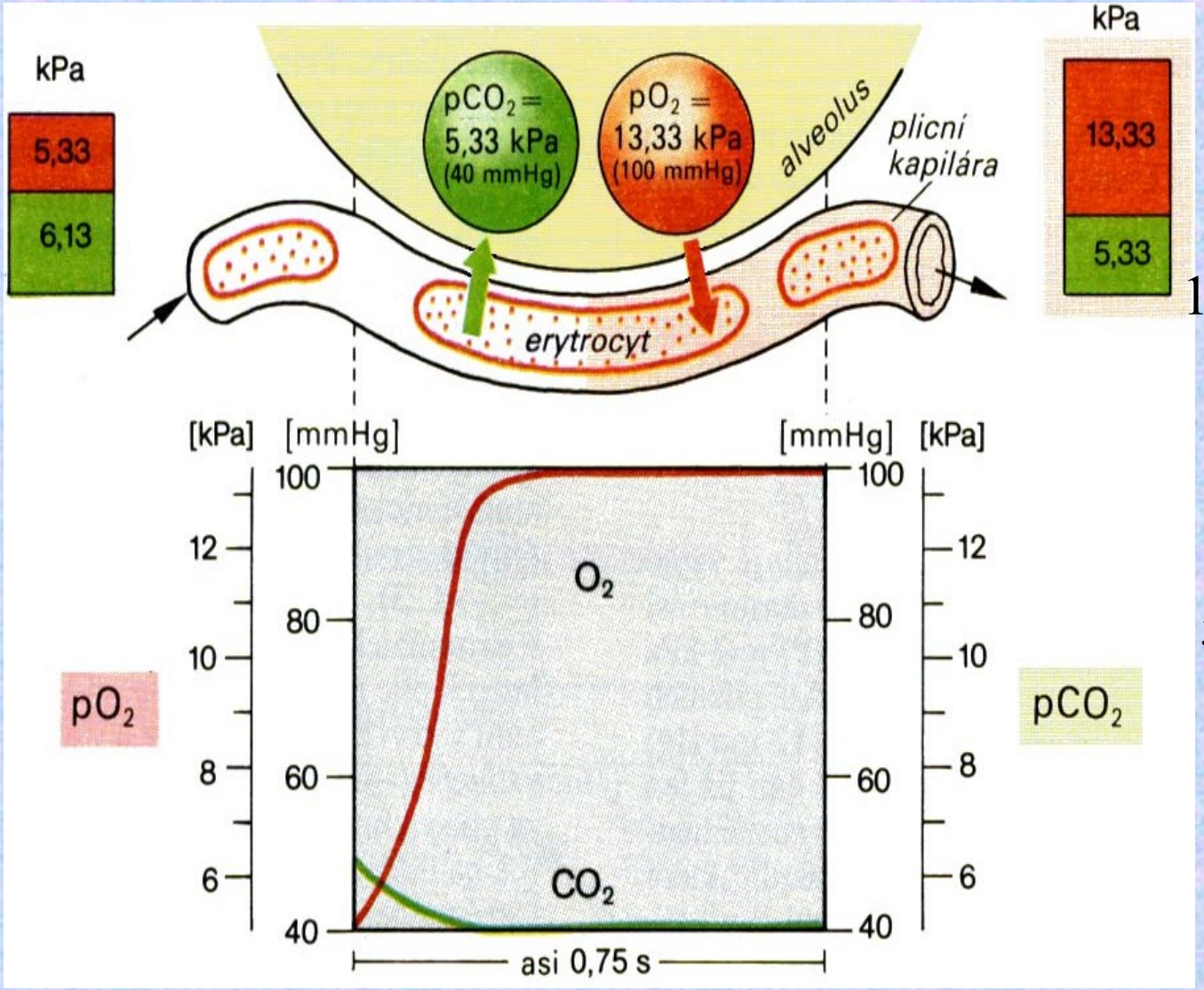
parietalis





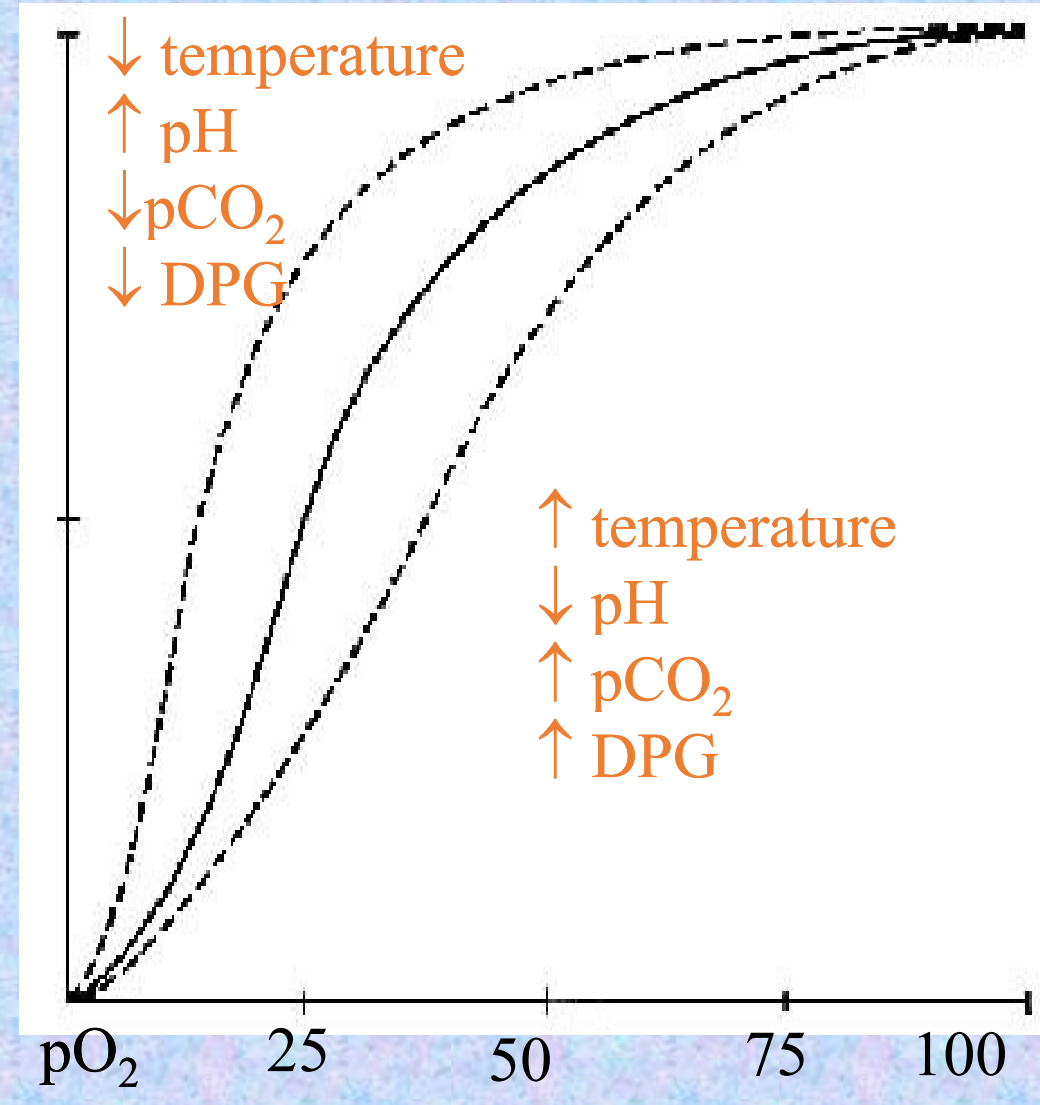
Silbernagl, Despopoulos: Color atlas of physiology, 2006.

TRANSPORT of O_2



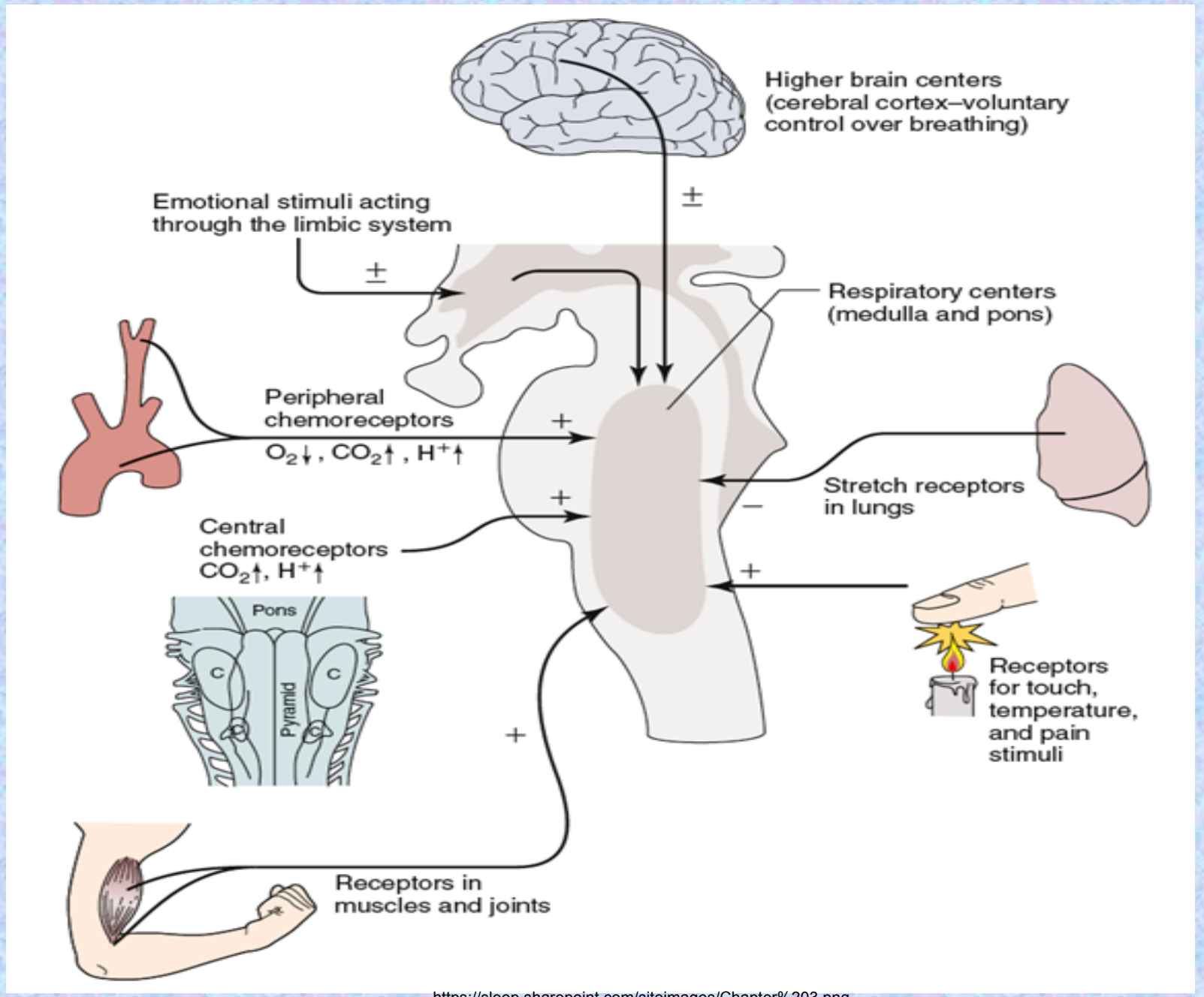
100%

50%

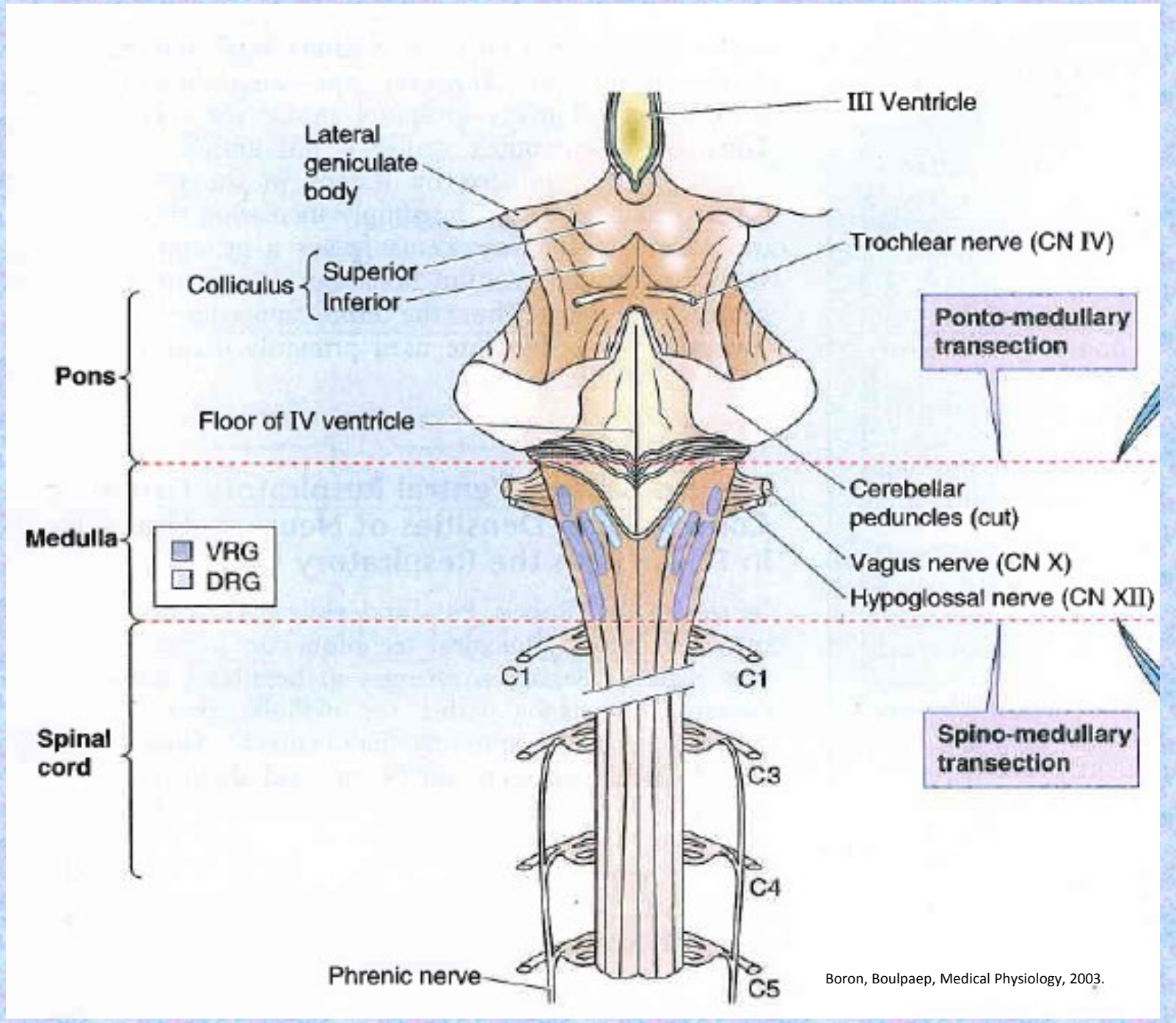


Silbernagl, Despopoulos: Color atlas of physiology, 2006.

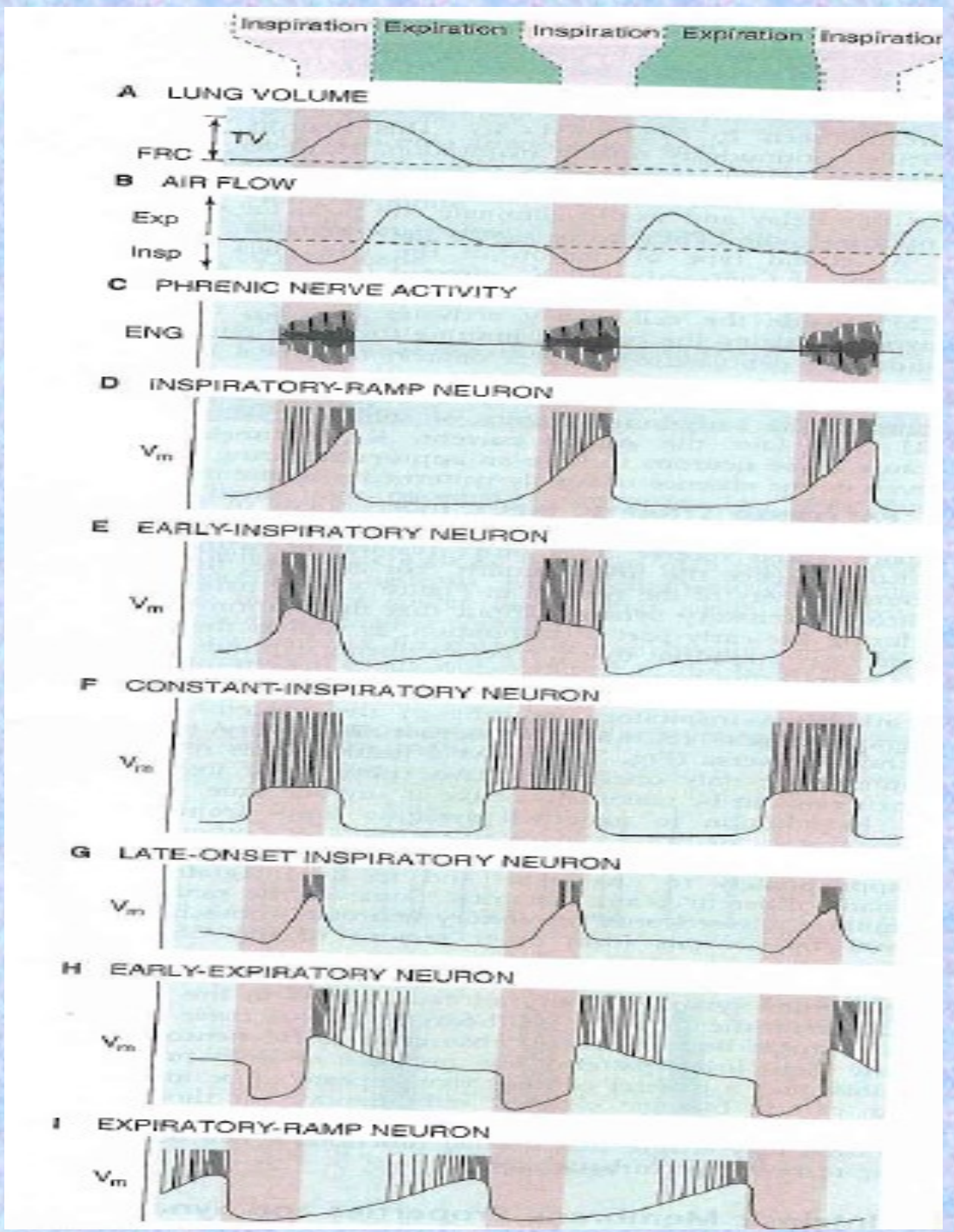
Control of ventilation



https://sleep.sharepoint.com/siteimages/Chapter%203.png



Boron, Boulpaep, Medical Physiology, 2003.



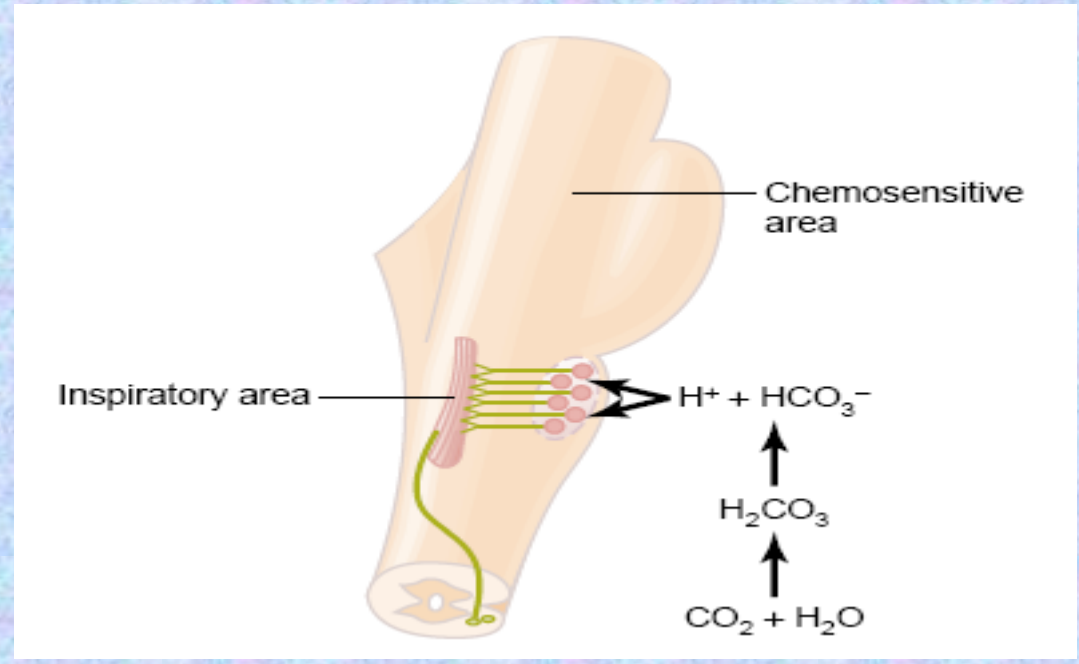
Boron, Boulpaep, Medical Physiology, 2003.

- **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*** – placed bilaterally on the dorsal side of the medulla oblongata, only inspiratory neurons, sending axons to motoneurons of inspiratory muscles (diaphragm, external intercostal muscles; their activation=inspiration, their relaxation=expiration; participates on inspiration at rest and forced inspiration
  - ***ventral respiratory group*** - located on the ventrolateral part of the medulla oblongata, the upper part: neurons whose axons of motor neurons activate the main and auxiliary inspiratory muscles; the lower part: expiratory neurons which innervate expiratory muscles (internal intercostal muscles). Neurons in this group operate only during forced inspiration and forced expiration.
  - ***Pontine respiratory group*** - *pneumotaxic center* - dorsally placed on top of the pont, contributes to the frequency and depth of breathing; affects the activity of respiratory neurons in the medulla oblongata.

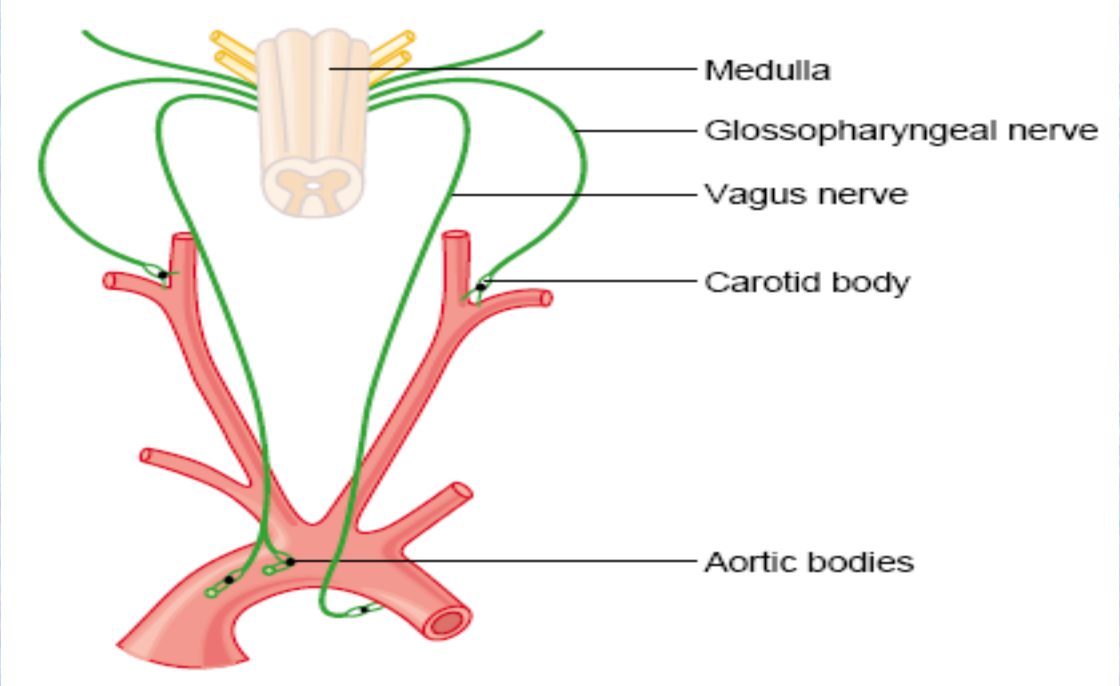
Chemical factors affecting the respiratory center:

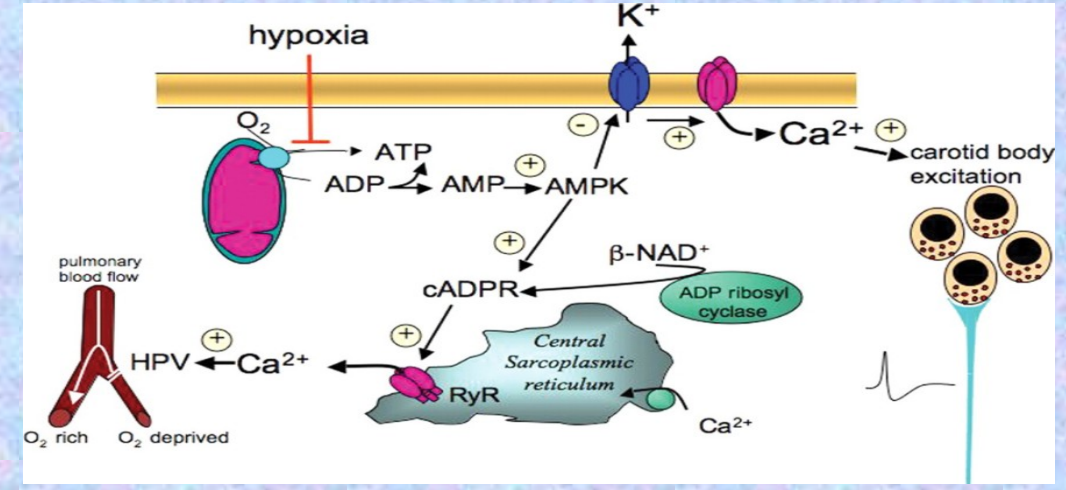
Central chemoreceptors

- on the front side of the medulla
- sensitive only to increase of arterial pCO_2 (by increasing H^+)
- central chemoreceptor are stimulated by other types of acidosis (lactate acidosis, ketoacidosis)



http://www.medicine.mcgill.ca/physio/resp-web/sect8.htm





Peripheral chemoreceptors

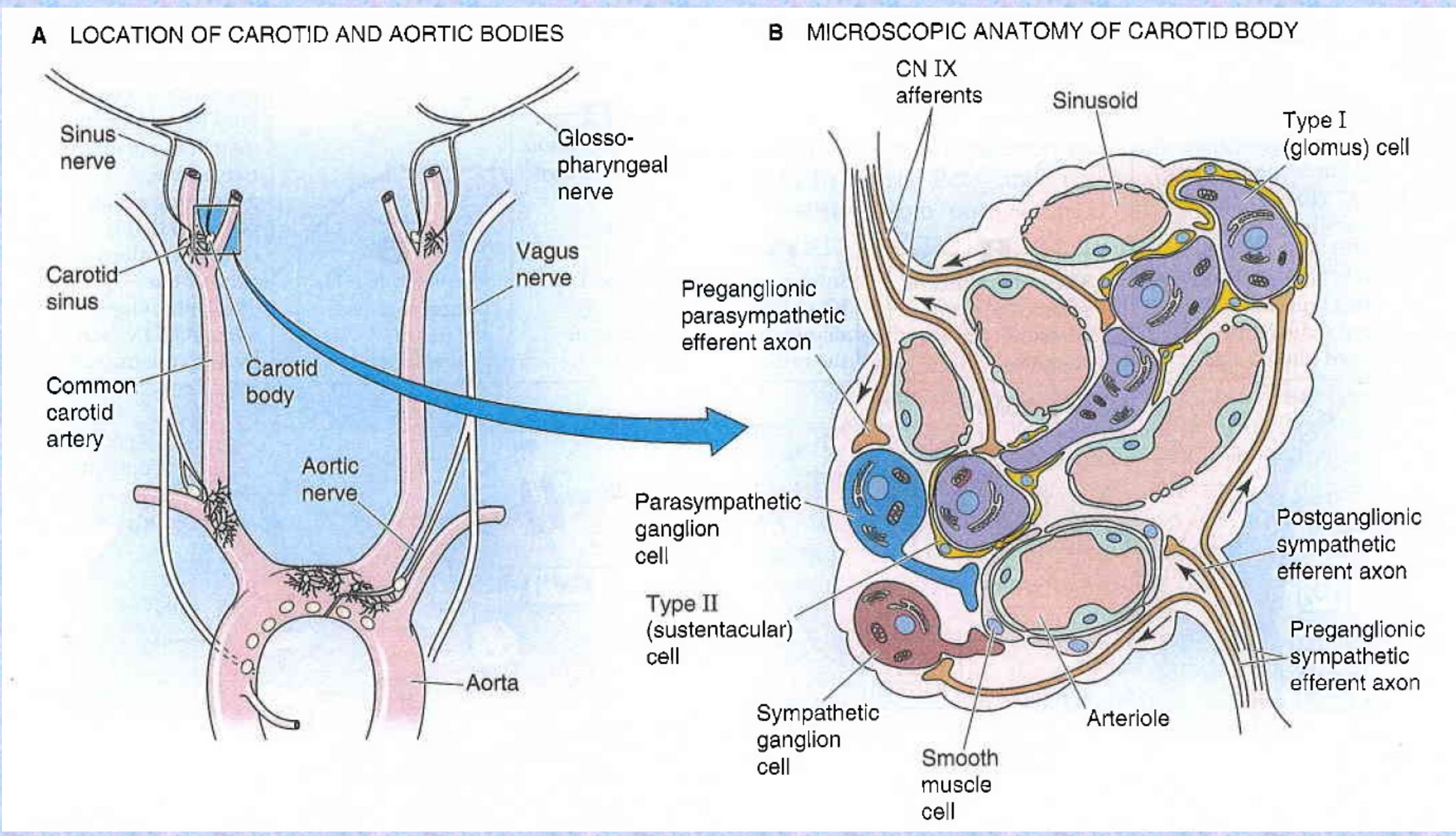
– located in the aortic and carotid bodies

-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.

Mechanism of action: Decreased ATP production in mitochondria leads to depolarization of receptors membrane and to excitation of chemoreceptor

http://www.medicine.mcgill.ca/physio/resp-web/sect8.htm,



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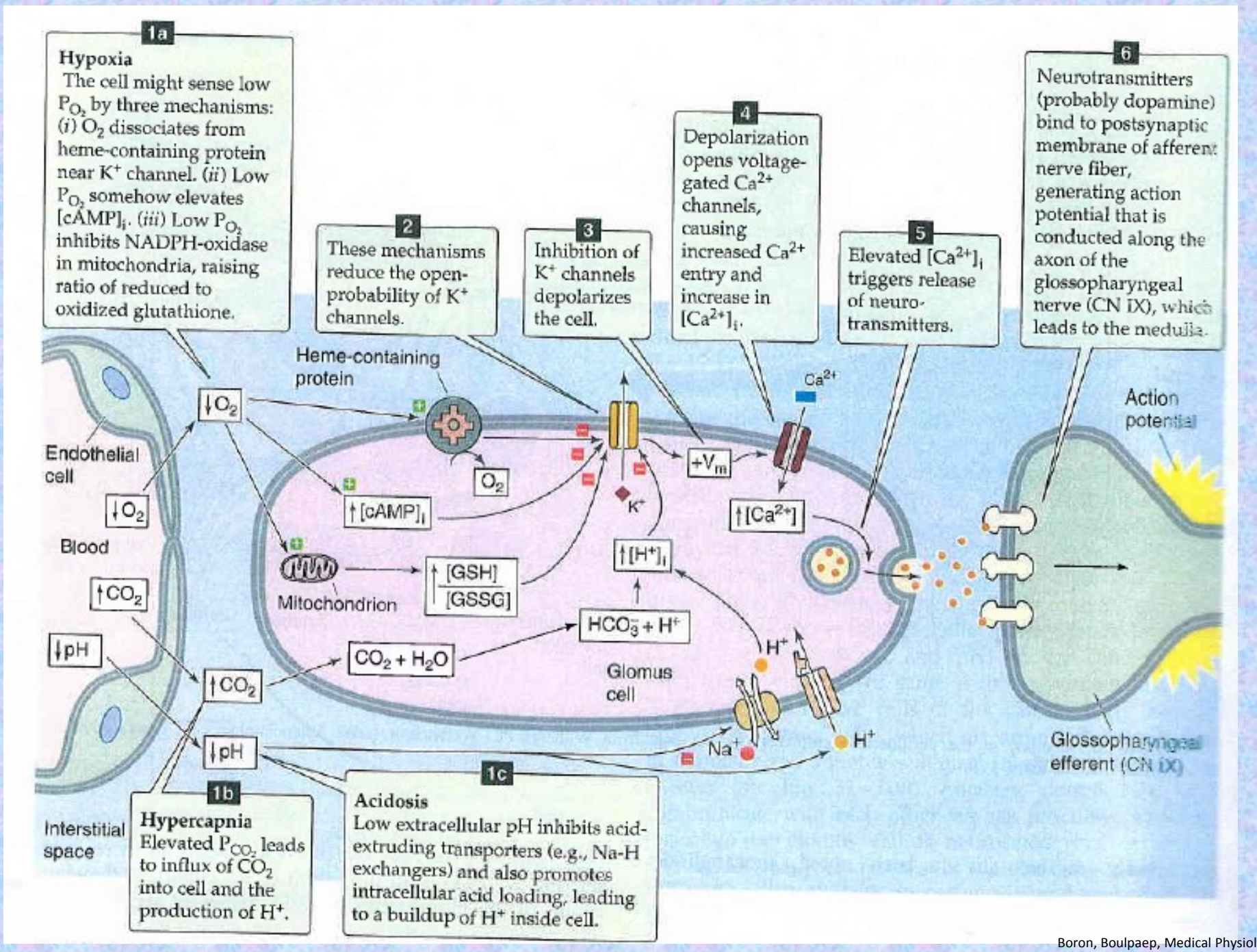

Boron, Boulpaep, Medical Physiology, 2003.

Modulation of respiratory output

Major parameters for feedback control – classical gases:pO2, pCO2, pH

In additin to these, the respiratory system receives input from two other major sources:

1. variety of stretch and chemical/irritant receptors that monitor the size of airways and the presence of noxious agentsreceptors in respiratory systém

2. Higher CNS centers that modulate respiratory activity for the sake of nonrespiratory activities

Irritants receptors on mucose of respiratory system – rapidly adapting
Stimulus: agens - chemical substances (histamin, serotonin, prostaglandins, ammonia, cigarette smoke).
Respons: increase mucus secretion, constriction of larynx and brochus

C-fibre receptors (juxtacapillary=J receptors)– free nerve ending of n.vagus (unmyelinated axon) in intersticium of bronchus and alveolus;
Stimulus: Mechanical irritans (pulmonary hypertension, pulmonary oedema)+chemical
Response: hypopnoe, rapid shallow breathing, bronchoconstriction, cough

Stretch receptors slowly adapting (mechanoreceptors in tracheobronchial tree that detect the changes in lung volume by sensing the stretch receptors of the airway wall), inform to brain about the lung volume to optimize respiratory; its irritants triggered decrese activity of respiratory centre – **Hering-Breuer´s reflexes**. (protecting the lungs from overinflation/deflation)

Baroreceptors – suppresses activity of respiratory centre (only slight effect)

Irritants of **proprioreceptors of muscles, tendons** during active and pasive movements of limbs
Influenced activity of respiratory neurons (increase minute ventilation during work load)

The Limbic system and affective states – fear, horror, rage – can be associated with major and highly characteristic changes of the respiratory pattern
- descending pathways from the limbic structure of the forebrain may mediate these **emotional effects on breathing**

Various behaviors

Playing on musical wind instruments
strong pain
Tractus corticospinalis =cortex – activated RC during work load
temperature