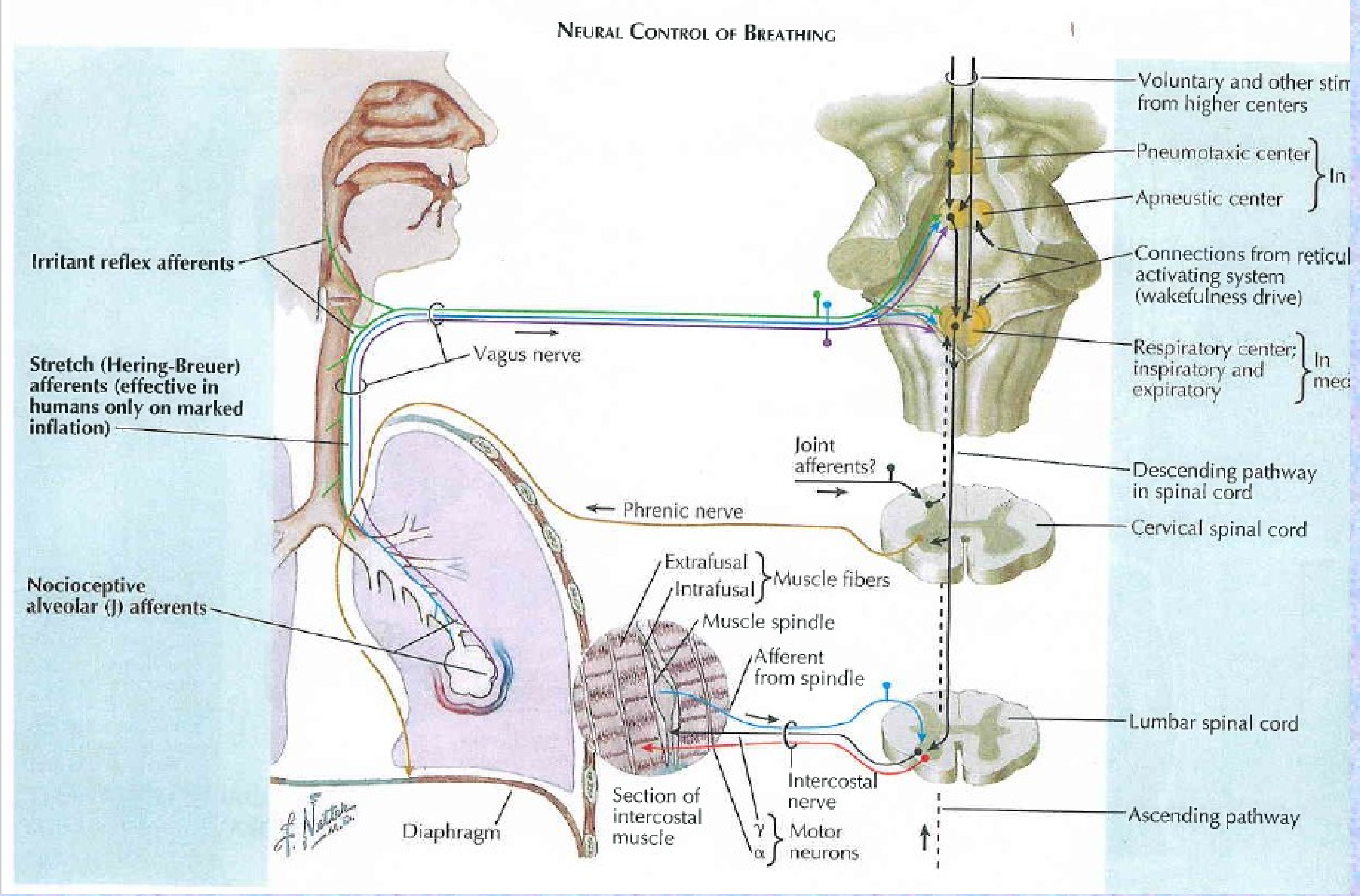
Respiration under various (physiological) condition



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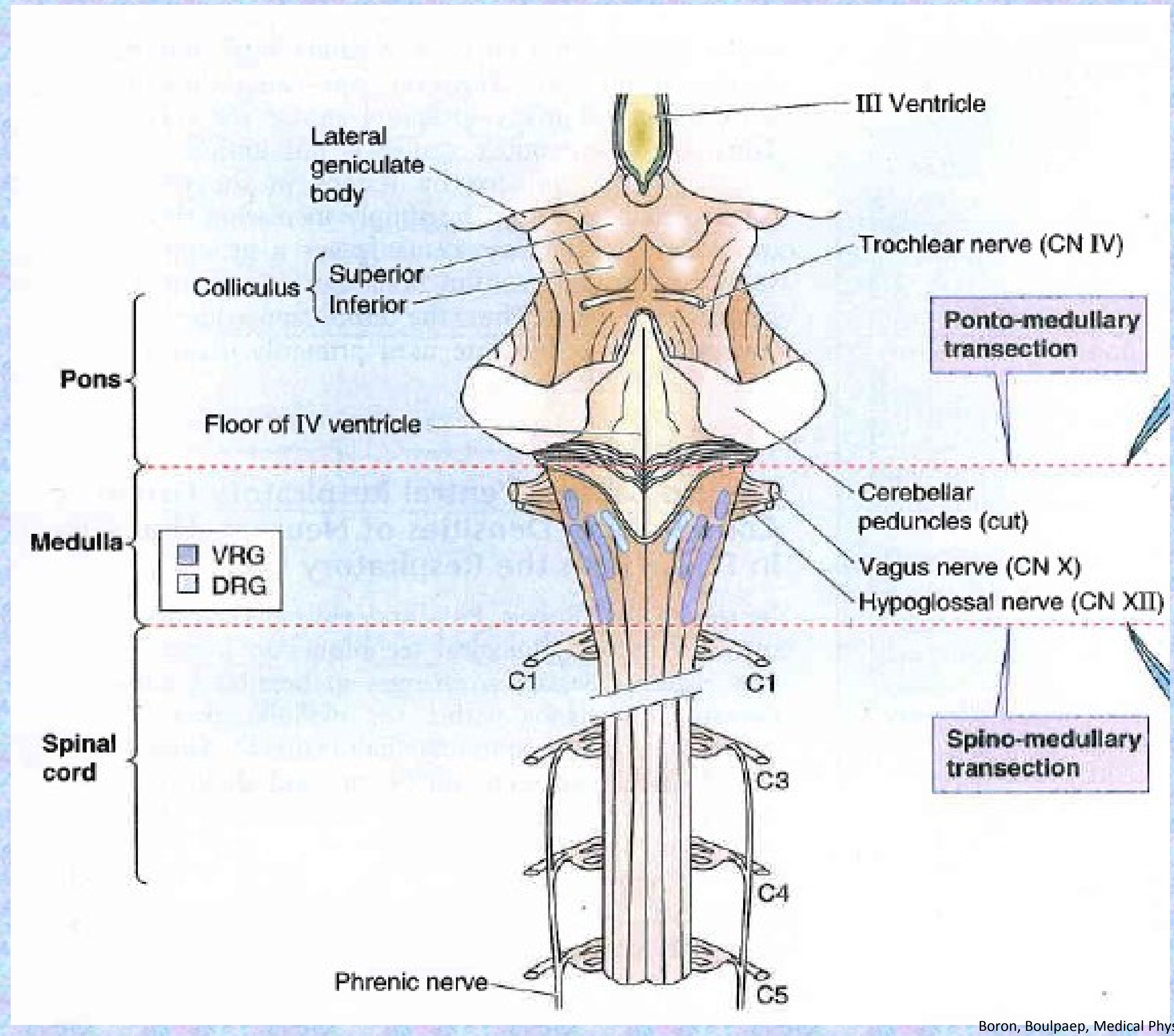
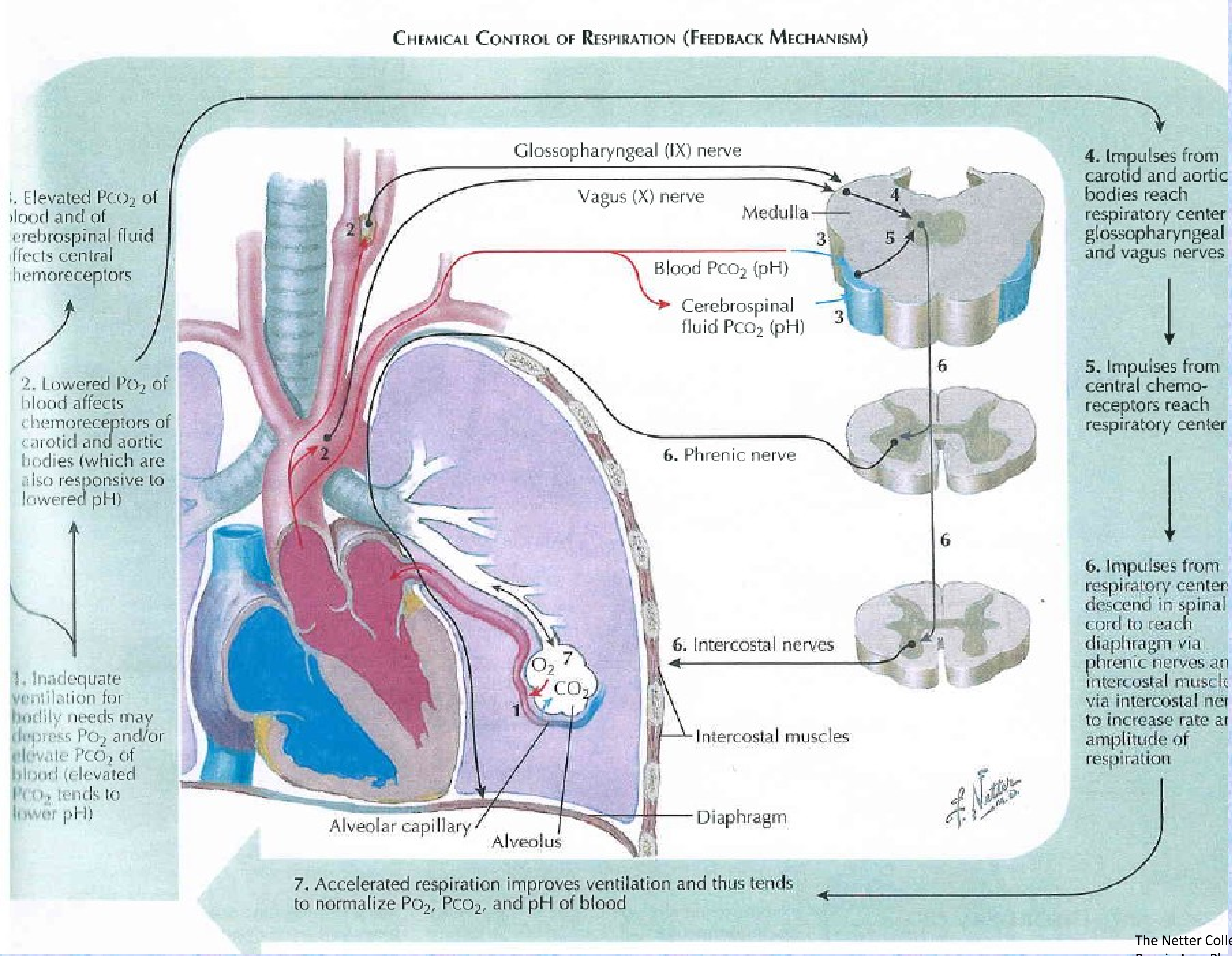


Boron, Boulpaep, Medical Physiology, 2003.



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Modulation of respiratory output

Major parameters for feedback control – classical gases:pO_2, pCO_2, pH

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

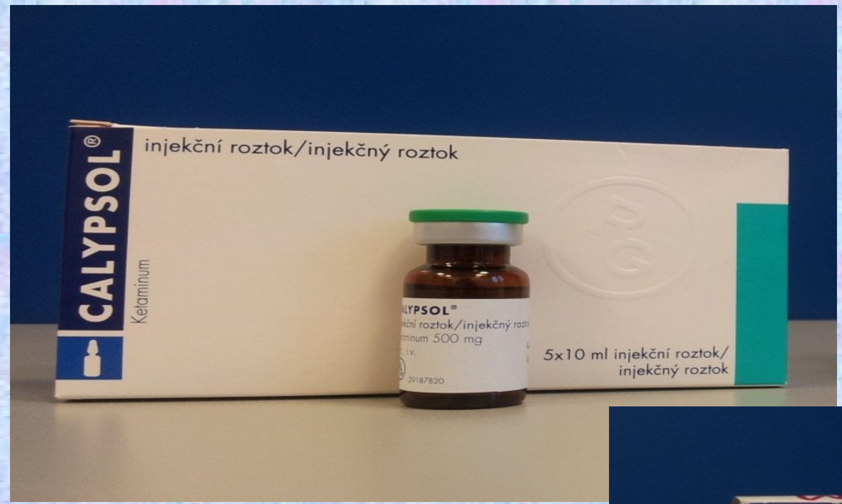
1. variety of stretch and chemical/irritant receptors that monitor the size of airways and the presence of noxious agents receptors in respiratory system

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)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Ketaminum
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5x10 ml injekční roztok/
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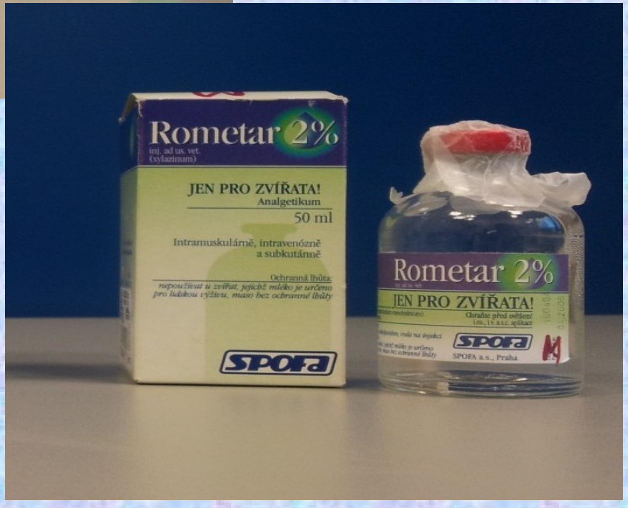
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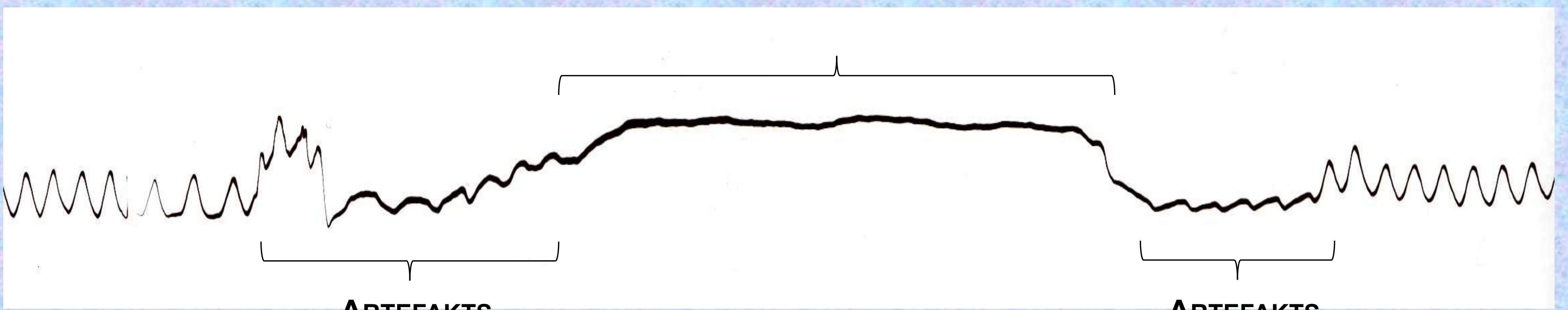
HERING-BREUER REFLEX

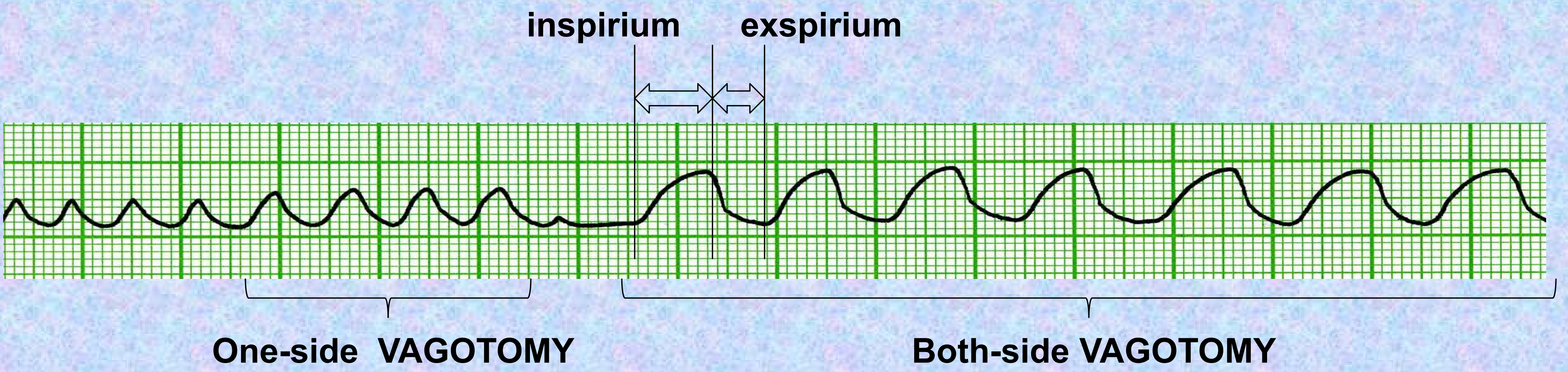
REFLEX STOP BREATHING



ARTEFAKTS

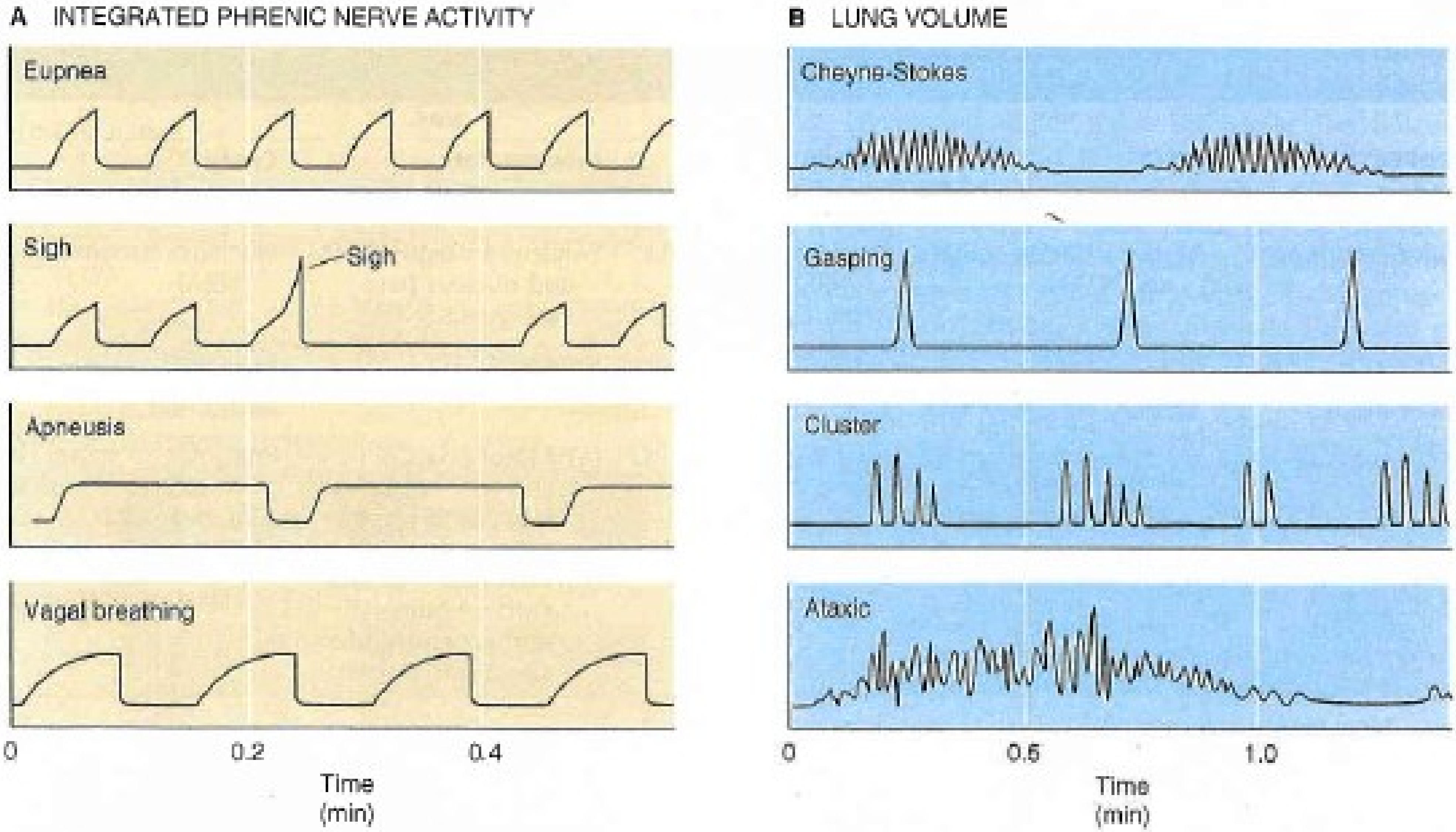
ARTEFAKTS

VAGOTOMY



Periodic breathing
(period of apnea followed again by a few breaths)

- **CHEYNE-STOKES**
- **BIOT‘S**
- „gasping“
- KUSSMAUL



Boron, Boulpaep, Medical Physiology, 2003.

The respiratory pattern can become abnormal for a variety of reasons. Several of these abnormal patterns have recognizable characteristics:

- Apnea – cessation of respiration
- Eupnea – normal breathing
- Tachypnea – an increase in respiratory rate
- Apneusis (inspiratory) – prolonged inspirations separated by brief expirations
- Ataxic breathing – highly irregular inspirations,often separated by long periods of apnea. Ussualy seen with medullary lesions.
- Biot breathing – first describe in patients with meningitis by Biot (in 1876) - with breaths of nearly equal volume separated by periods of apnea

- Cheyne – Stokes respiration –a benign respiratory pattern. Cycles of a gradual increase in tidal volume, followed by gradual decrease of tidal volume, and than a period of apnea. Seen a bilateral cortical disease or congestive heart failure, or in healthy people during sleep at high altitude
- Cluster breathing - groups of breaths, often of differing amplitude, separated by long periods of apnea
- Gasping – maximal, brief inspiratory efforts separated by long periods of expiration. Seen in severe anoxia, as well as a terminal, agonal breathing pattern in patients with brainstem lesions

- Hyperventilation – an increase of ventilation that decreases arterial pCO_2. Seen in pregnancy, panic attacks, metabolic acidosis.
- Kussmaul breathing refers as extremely deep, rapid breathing seen with metabolic acidosis, such as in diabetic ketoacidosis
- Sighs – larger than normal breaths than occur automatically at regular intervals in normal subjects
- Vagal breathing- slow, deep inspirations caused by interruption of vagus nerve input to the brain stem
- Yawn – an exaggerated sigh

Hypoxia, hypoxemia

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

- Hypercapnia - increase of concentration of carbon dioxide in the blood or in tissues that is caused by retention of CO_2 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% CO_2)
- hypercapnia around 10 kPa - CO_2 narcosis - respiratory depression (preceded by headache, confusion, disorientation, a feeling of breathlessness)
- hypercapnia over 12 kPa - significant respiratory depression - coma and death.

Cough reflex - defense mechanism

A cough reflex plays important role in ridding the tracheobronchioal tree of inhaled foreign substances

Mechanosensitive and irritants receptors in the larynx can trigger either coughing or apnea

The tickling sensation that is relieved by a cough is analogous to the cutaneous itch, and its probabaly mediated by C-fiber receptors. Thus, a cough is a respiratory scratch.

When lower airway receptors trigger a cough, it begins with a small inspiration that increases the coughing force. Than laryngeal receptors trigger the cough, inspiration is absent, minimizing the chances that offending foreign body will be forced lower into the lungs. A forced expiratory effort against a closed glottis raises intrathoracic and intraabdominal pressures to very high levels. The glottis than opens suddenly. And the pressure inside the larynx falls almost instantaneously to near-atmospheric levels

Sneeze

Sensors in the nose detect irritants and can evoke a sneeze.

Notice: the same receptors are probably also responsible for apnea in response to water applied to the face or nose, which is part of the diving reflex that evolved in diving mammals such as the seal prevent aspiration during submersion.

A sneeze differs from a cough in that is almost always preceded by a deep inspiration.
Like as cough, a sneeze involves an initial buildup of intrathoracic pressure behind a closed glottis. Unlike a cough, sneeze involves pharyngeal constriction during the builup phase, and an explosive forced expiration vie the nose, as well as the mouth.

The effect is to dislodge foreign bodies from the nasal mucosa.

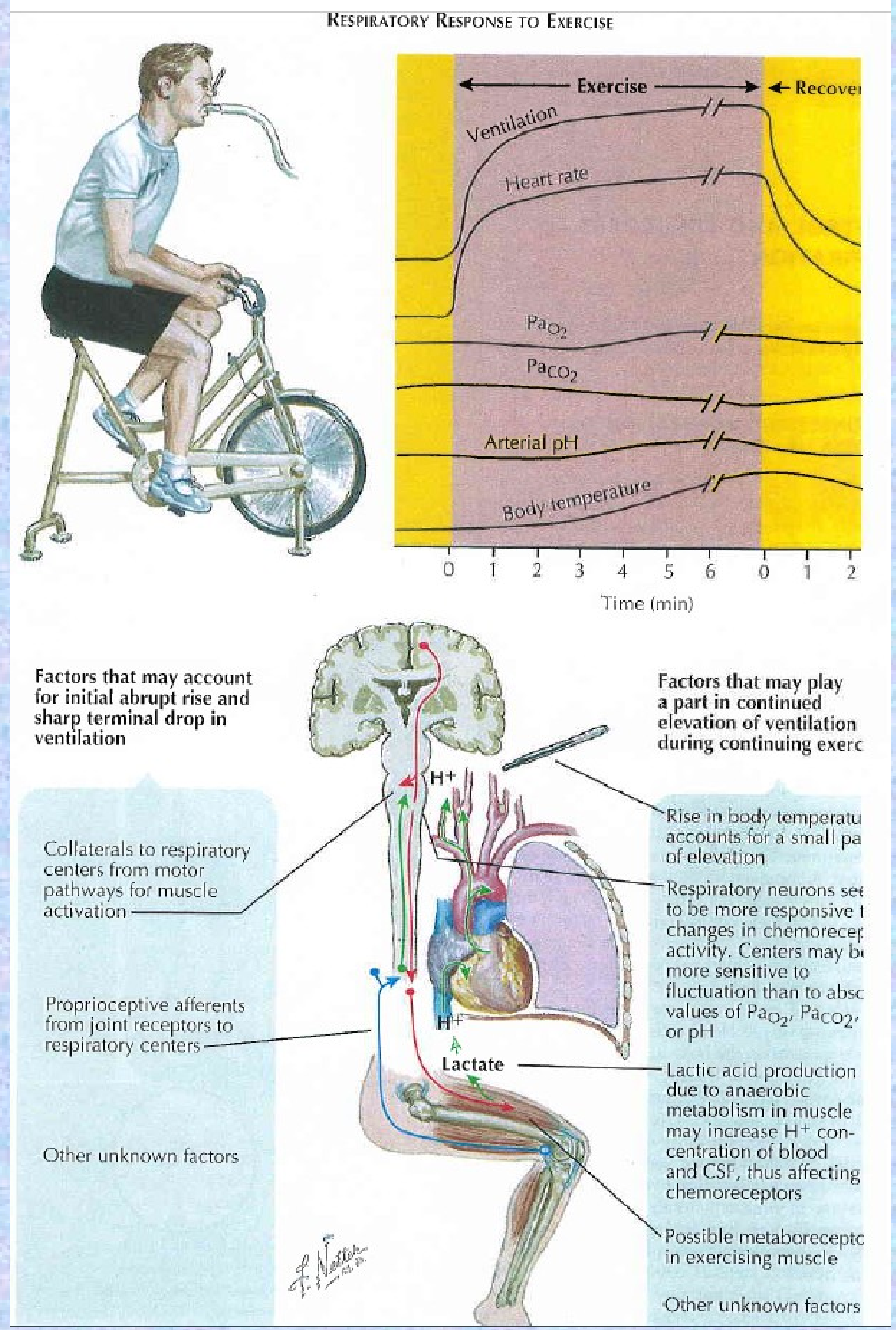
Sleep

Or even closing ones eyes, has powerful effects on the breathing pattern and CO_2 responsiveness.
During non-rapid eye movements sleep – there is an increase in the regularity of eupneic breathing;
Also, the sensitivity of the respiratoey system to CO_2 decreasees compared with wakefulness, and
The outflow to the muscles of the pharynx decreases.

During rapid eye movements sleep – there is further decrease in the sensitivity of the respiratory system to CO_2,
but now the pattern of breathing becomes markedly irregular, sometimes with no discernible rhythm.
The results is that CO_2 levels often increase during NREM sleep, and usually even more so during REM sleep

Sleep apnea

The collection of disorders in which ventilation ceases during deeper stages of sleep, particularly during REM sleep, is known as sleep apnea.
The symptoms are loud snoring, morning headache, fatique, daytime sleepiness
Some cases due to a lack of central drive – central sleep apnea. However most cases
are due to collapse of the airway with sleep - obstructive sleep apnea, usually in obese people



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