MEDICINE
KING SAUD UNIVERSITY

Physiology Team 436

RESPIRATORY
BLOCK

Control of Breathing

Red: very important.
Green: Doctor's notes.
Pink: formulas.
Yellow: numbers.
Gray: notes and explanation.

Physiology Team 436 – Respiratory Block Lecture 8

Lecture: If work is intended for initial studying.
Review: If work is intended for revision.

Objectives

By the end of this lecture you should be able to:

- Understand the role of the medulla oblongata in determining the basic pattern of respiratory activity.
- List some factors that can modify the basic breathing pattern e.g.

A- The Hering-Breuer reflexes

B- The proprioceptor reflexes

C- The protective reflexes, like the irritant, and the J-receptors.

- Understand the respiratory consequences of changing PO2 , PCO2 , and PH.
- Describe the locations and roles of the peripheral and central chemoreceptors.
- Compare and contrast metabolic and respiratory acidosis and metabolic and respiratory alkalosis

Controls of Rate and Depth of Respiration

- Arterial PO2
  - When PO2 is VERY low (Hypoxia), ventilation increases.

- Arterial PCO2
  - The most important regulator of ventilation is PCO2, small increases in PCO2, greatly increases ventilation.
  - Changes in PCO2 stimulate the respiratory center immediately. Unlike Po2 because the accumulation of CO2 is very dangerous for the body.

- Arterial pH
  - As hydrogen ions increase (acidosis), alveolar ventilation increases.

"اذا زادت ايونات الهيدروجين يقل الpH"

Respiratory Centers

Generally located in the medulla oblongata and the pons of the brainstem.

Medullary Respiratory Center

Inspiratory area (Dorsal Respiratory Group) DRG

- Determines basic rhythm of breathing.
- Causes contraction of diaphragm and external intercostals.
- It will stimulate the phrenic nerve which supplies the diaphragm.

Expiratory area (Ventral Respiratory Group) VRG

- Inactive during normal quiet breathing.
- Activated by inspiratory area during forceful breathing.
- Causes contraction of internal intercostals and abdominal muscles.

The medullary respiratory center stimulates basic inspiration for about 2 seconds and then basic expiration for about 3 seconds (5sec/ breath = 12breaths/min).

Pontine Respiratory Center

Pneumotaxic area (in pons)

Inhibits inspiratory area of medulla to stop inhalation.

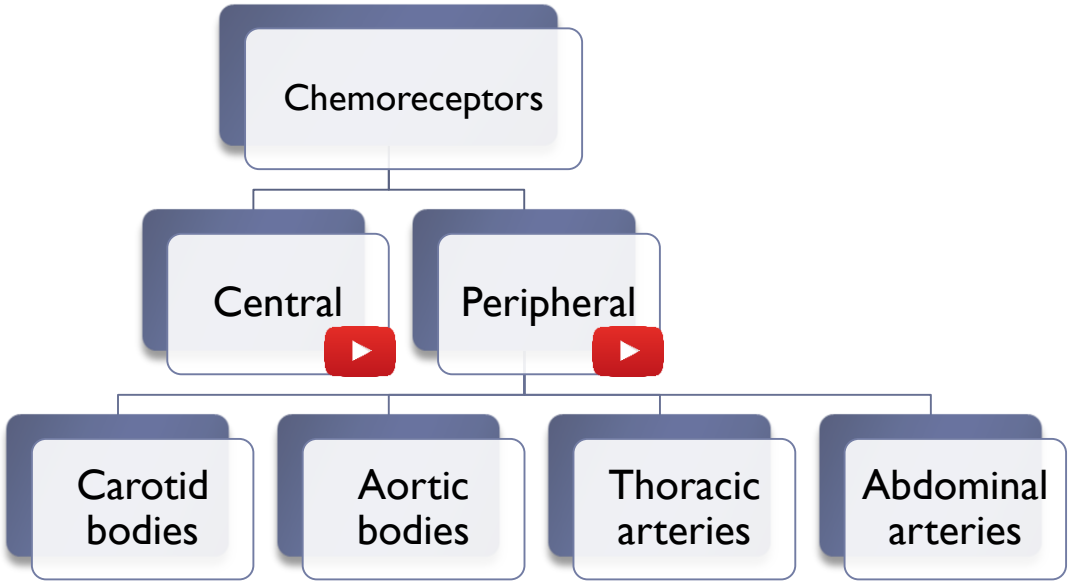
Breathing is more rapid when pneumotaxic area is active.

Apneustic area (in pons)

Stimulates inspiratory area of medulla to prolong inhalation.

Pontine Respiratory center is the transition between inhalation and exhalation it is controlled by pneumotaxic and apneustic areas.

Respiratory Centers Cont.



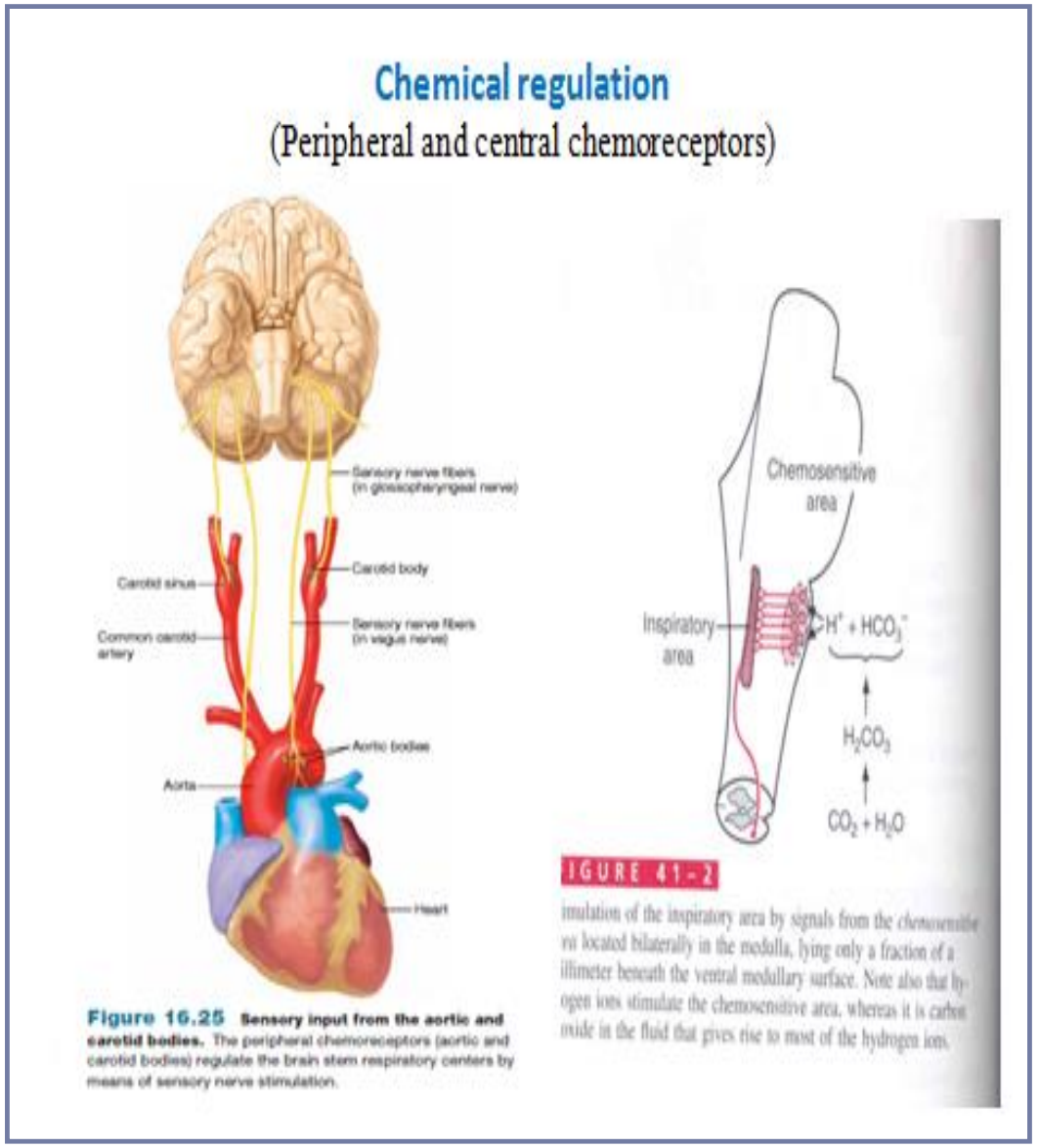
Most of the chemoreceptors are in the *carotid bodies*. However, a few are also in the *aortic bodies*, and very few are located elsewhere in association with other arteries of the thoracic and abdominal regions.

1- Excess CO_2, H^+ in the blood mainly acts directly →Central

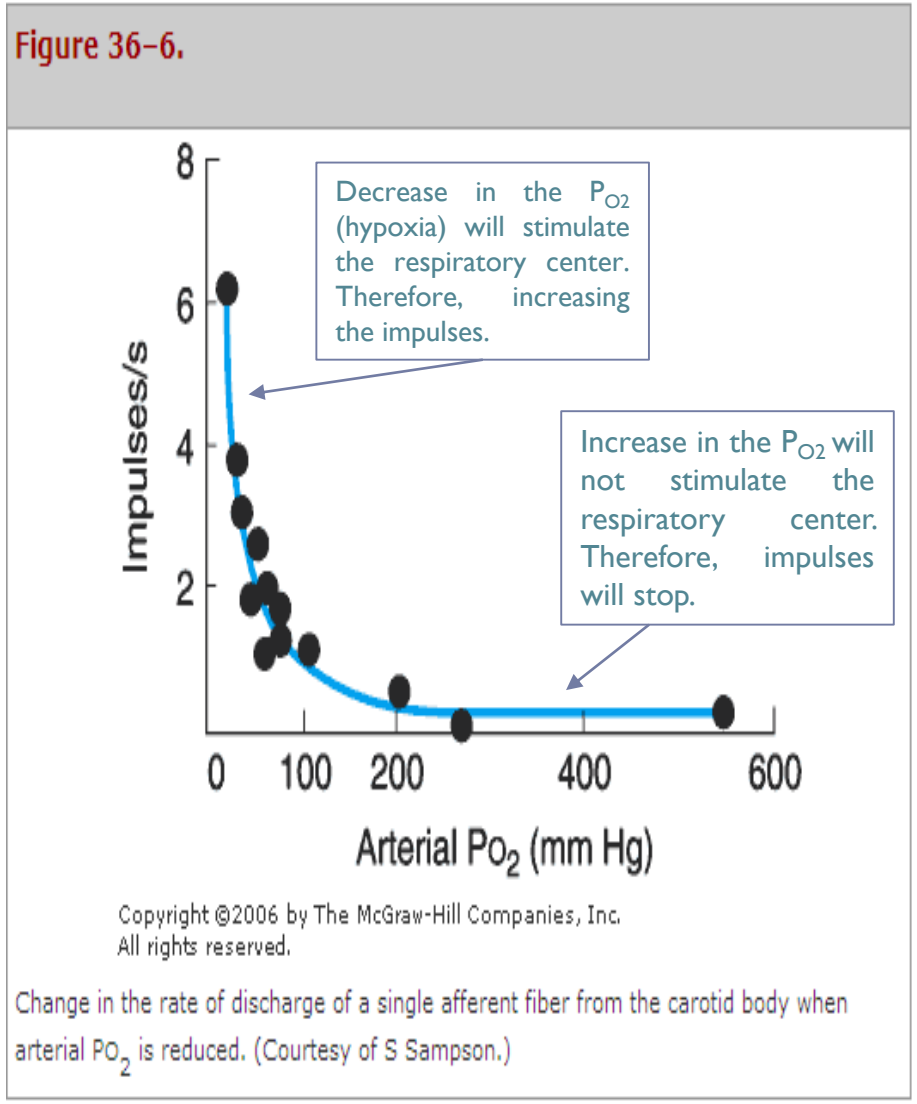
2- Others in arteries of the thoracic and abdominal regions →Peripheral

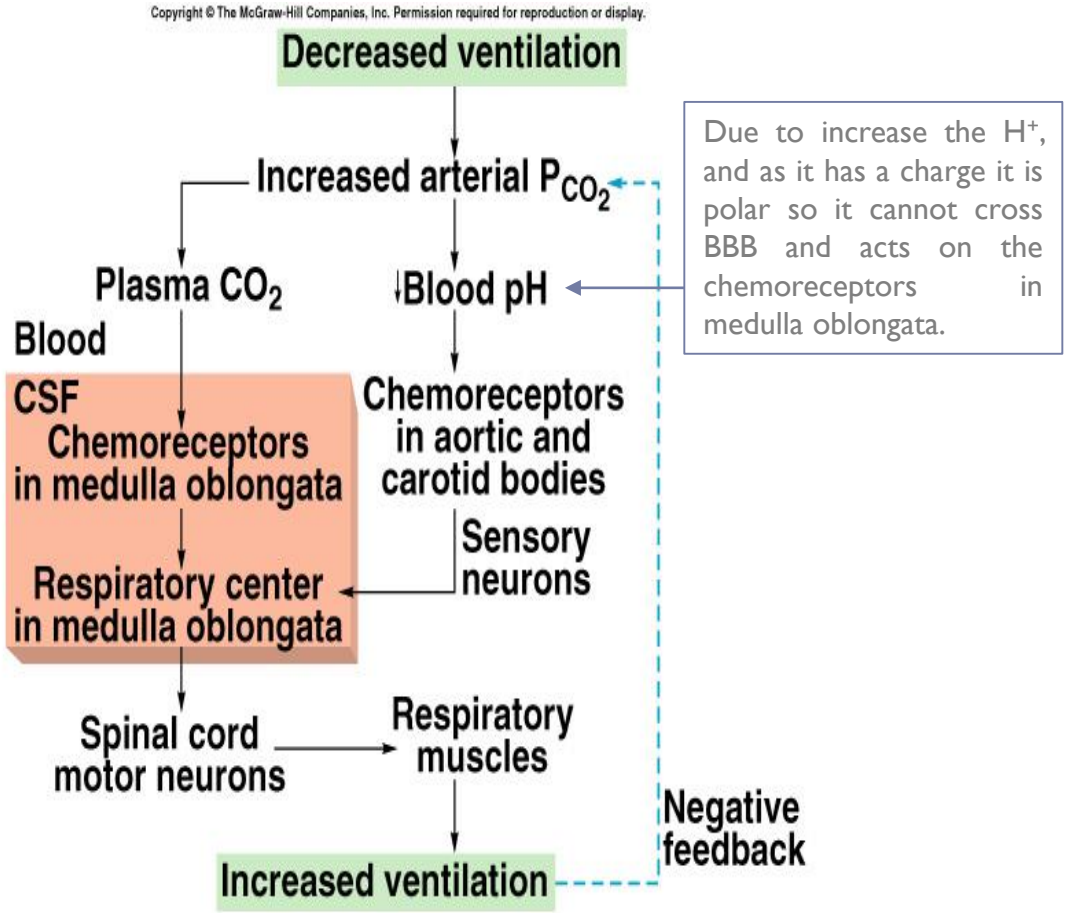
If we compare the peripheral and the central: if there is an increase in P_{CO2} the peripheral is faster but weaker (e.g. increase ventilation 2 times within seconds), the central is slower but more powerful (e.g. increase the ventilation 4 times within minutes).

ONLY IN MALES' SLIDES



Chemoreceptor Control of Breathing

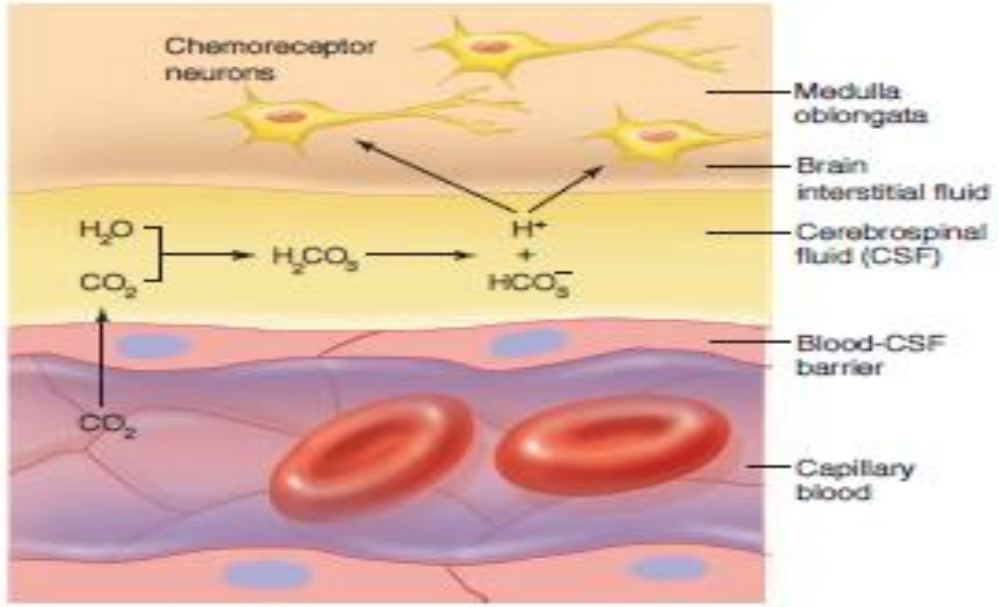




If the person has acidosis due to metabolic problem only the 2nd pathway will be stimulated, but if he has a problem which leads to an increase in P_{co2} the two pathways will be stimulated, so the effect will be more than if the problem were only in the pH.

Effect of Blood CO2 Level on Central Chemoreceptors

An increase in blood CO_2 stimulates breathing indirectly by lowering the pH of blood and cerebrospinal fluid (CSF). This figure illustrates how a rise in blood CO_2 increases H^+ concentration of CSF and thereby stimulates chemoreceptor neurons in the medulla oblongata.



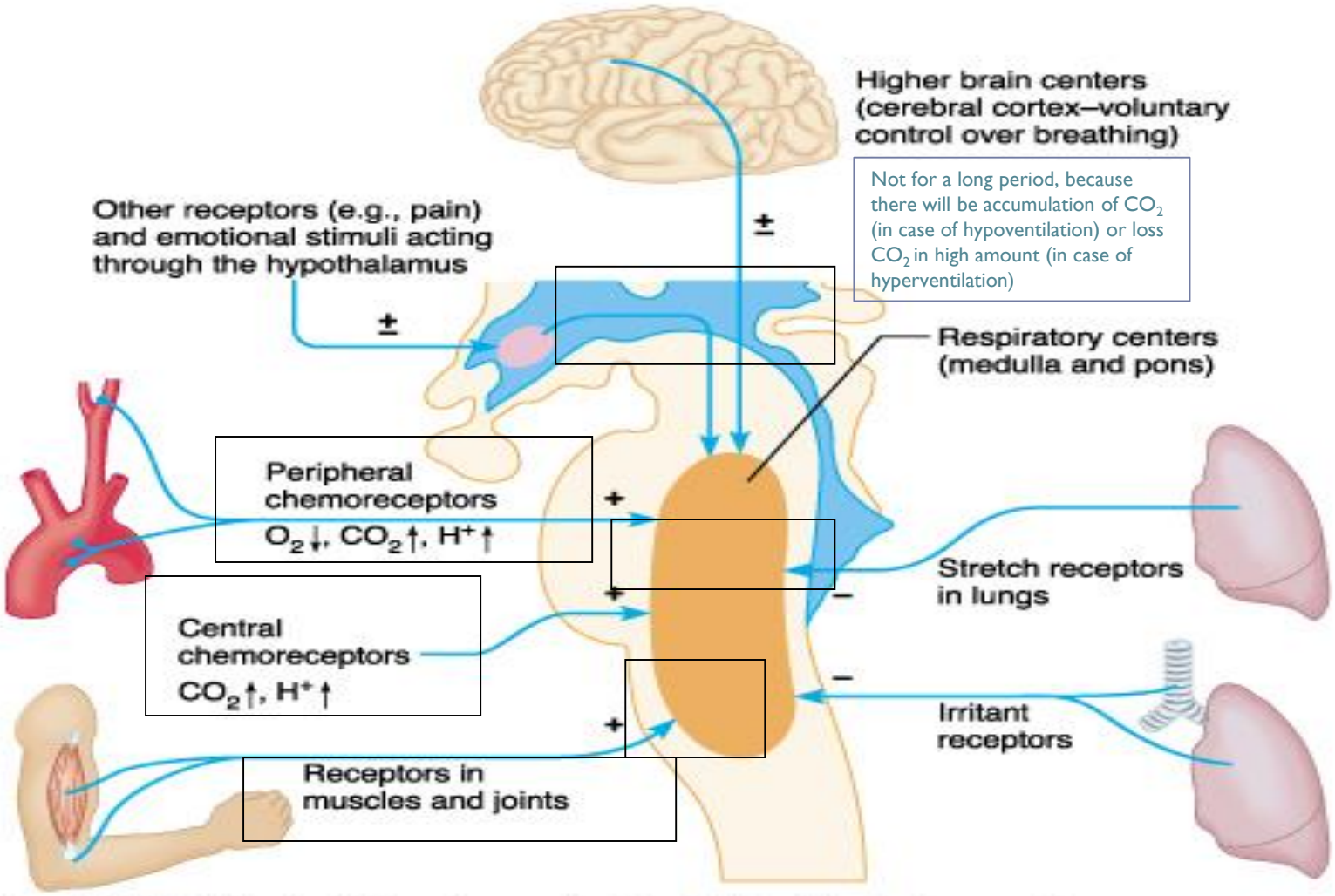
Summary

The effect on central chemoreceptors:

1- increase the H^+ itself in CSF the hydrogen will stimulate the chemoreceptors → direct effect.

2- increase CO_2 in the blood which diffuse to CSF and increase H^+ which will stimulate the chemoreceptors → indirect effect (the CO_2 does not effect it directly).

Factors Influencing Respiration



- Central chemoreceptors are affected by CO_2 and H^+
- Peripheral chemoreceptors are affected by CO_2, H^+ and O_2
- Central chemoreceptors are NOT affected by O_2

Cont. (Factors Affecting Respiratory Centers)

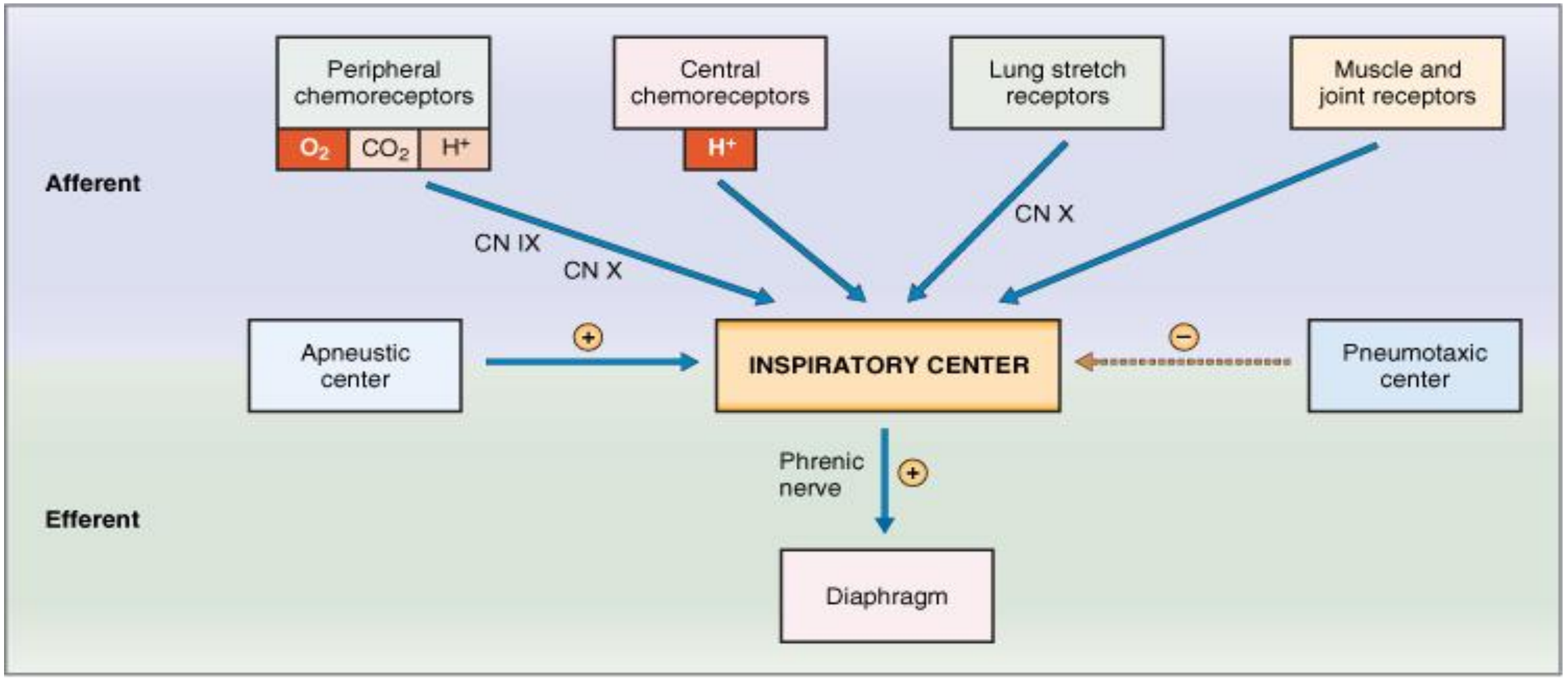
- Effect of irritant receptors in the airways:

The epithelium of trachea, bronchi, and bronchioles is supplied by irritant receptors that are stimulated by irritants (i.e. dust) that enter the respiratory airways causing coughing, sneezing, and bronchoconstriction in bronchial asthma and emphysema.

- Function of lung J receptors:

Few receptors in the wall of the alveoli in juxta position (placed close together) to the pulmonary capillaries. They are stimulated especially when pulmonary capillaries become engorged (cause to swell with blood, water, or another fluid) by blood or when pulmonary edema occurs i.e. in congestive heart failure (CHF), their excitation cause the person a feeling of dyspnea.

Cont. (Factors Affecting Respiration)



Hering-Breuer Inflation Reflex

- When the lung becomes overstretched (tidal volume is 1L or more –recall normal value: 500ml or 0.5L-), stretch receptors located in the wall of bronchi and bronchioles transmit signals through vagus nerve to DRG producing an effect similar to **pneumotaxic center** stimulation:

1. Switches off inspiratory signals and thus stops further inspiration.
2. This reflex also increases the rate of respiration as does the pneumotaxic center.

Extra information from Guyton:
In humans the Hering-Breuer reflex is probably inactivated until the tidal volume increases to more than three times the normal (>1.5 liters per breath). Therefore this reflex appears to be mainly a protective mechanism for preventing excess lung inflation rather than an important ingredient in normal control of ventilation.

ONLY IN FEMALES' SLIDES

Respiratory Acidosis*

- Hypoventilation.
- Accumulation of CO_2 in the tissues.
  - P_{CO2} increases.
  - pH decreases.
  - Acidity increases.

Respiratory Alkalosis*

- Hyperventilation.
- Excessive loss of CO_2.
  - P_{CO2} decreases (35 mmHg).
  - pH increases.
  - Acidity decreases.

Acidosis* means an increase in Acidity or a Decrease in pH of the blood.
Alkalosis* means a decrease in Acidity or an Increase in pH of the blood.

Metabolic Acidosis*

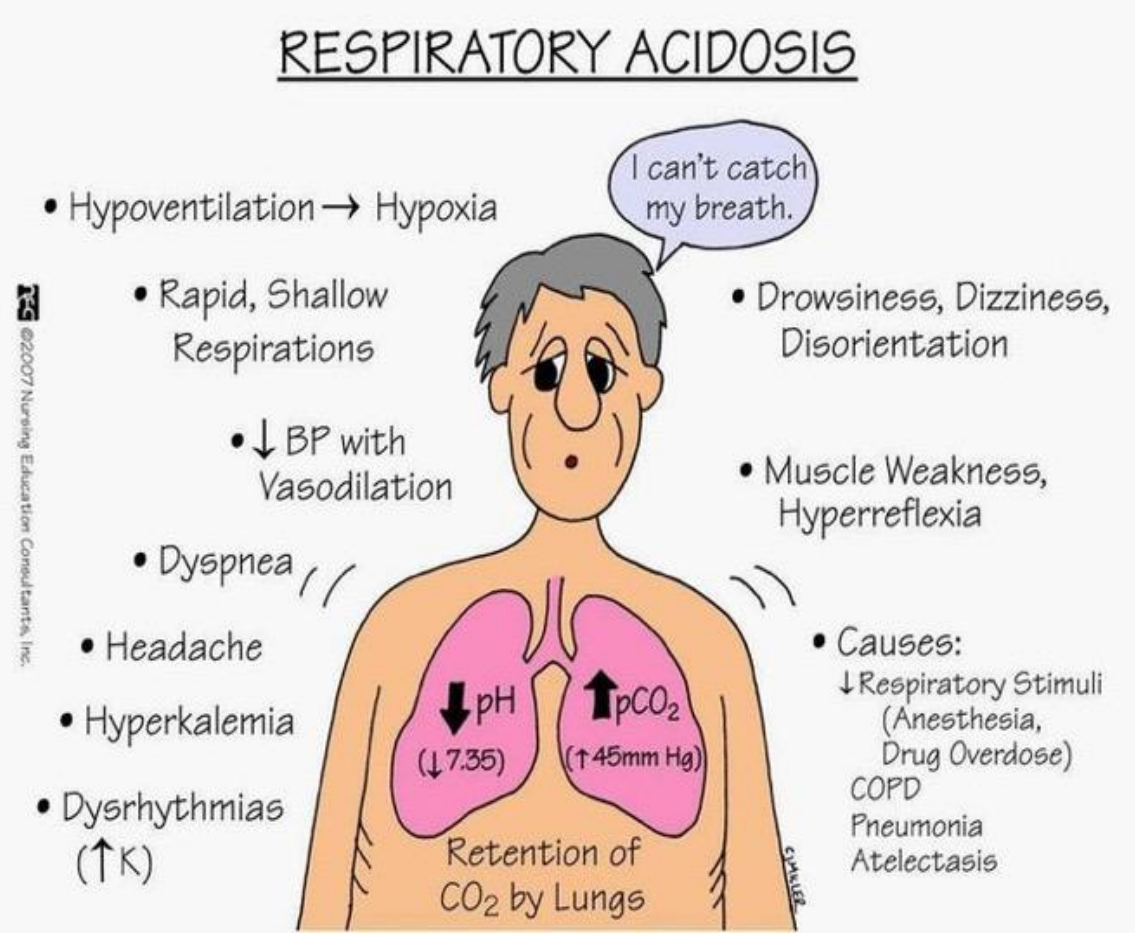
- ✓ Ingestion, infusion, or production of fixed acid.
- ✓ Decreased renal excretion of hydrogen ions.
- ✓ Loss of bicarbonate or other bases from the extracellular compartment.

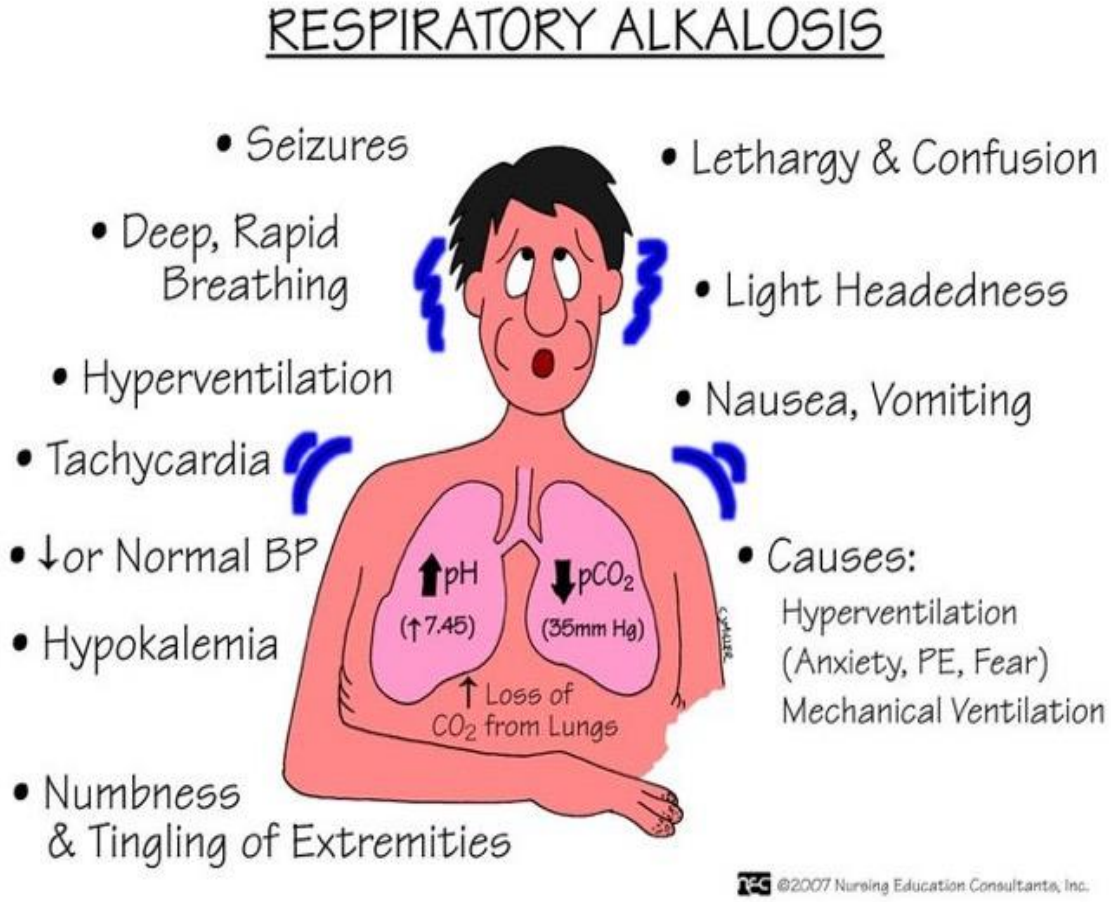
Metabolic Alkalosis*

- ✓ Excessive loss of fixed acids from the body.
- ✓ Ingestion, infusion, or excessive renal reabsorption of bases such as bicarbonate.
- ✓ pH increases.

The respiratory system can compensate for metabolic acidosis or alkalosis by altering alveolar ventilation.
If the patient has ACIDOSIS the respiratory system will respond by HYPERVENTILATION, if he has ALKALOSIS the response will be HYPOVENTILATION.

Cont. (Extra Images: to help you remember)





Quiz

- https://www.onlineexambuilder.com/lecture-8/exam-129878

Link to Editing File

(Please be sure to check this file frequently for any edits or updates on all of our lectures.)

References:

- Girls' and boys' slides.
- Guyton and Hall Textbook of Medical Physiology (Thirteenth Edition.)

Thank you!

اعمل لترسم بسمة، اعمل لتمسح دمعة، اعمل و أنت تعلم أن الله لا يضيع أجر من أحسن عملا.

The Physiology 436 Team:

Female Members:
Allulu Alsulayhem
Najd Altheeb
Ghada Alhadlaq
Ghada Alskait
Heba Alnasser

Male Members:
Faisal Alfawaz
Faris Alnafeesah
Omar albabteen

Team Leaders:
Qaiss Almuhaideb
Lulwah Alshiha

Contact us:
Physiology436@gmail.com
@Physiology436