8th lecture

Control of Breathing

Physiology Team 434
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OBJECTIVES

- 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 like e.g. The Hering-Breuer reflexes, b- The proprioreceptor reflexes, and 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.

CONTENTS

COLOR INDEX:

- Red = important
- Grey = additional notes

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1-CONTROLS OF RATE AND DEPTH OF RESPIRATION

Rate and the depth of respiration are controlled by three variables:

- The partial pressure of O_2
- The partial pressure CO_2
- pH level in our blood.

The most sensitive and important regulator is the arterial PCO_2 level.

When the PO_2 is very low (Hypoxia) in arterial bloodstream, respiratory ventilation rate increases.

When the PCO_2 is slightly high in the arterial bloodstream , respiratory ventilation increases as well.

When the pH level is low - H^+ ↑ - in the arterial bloodstream , respiratory ventilation in will increases, we call this case (acidosis of blood).

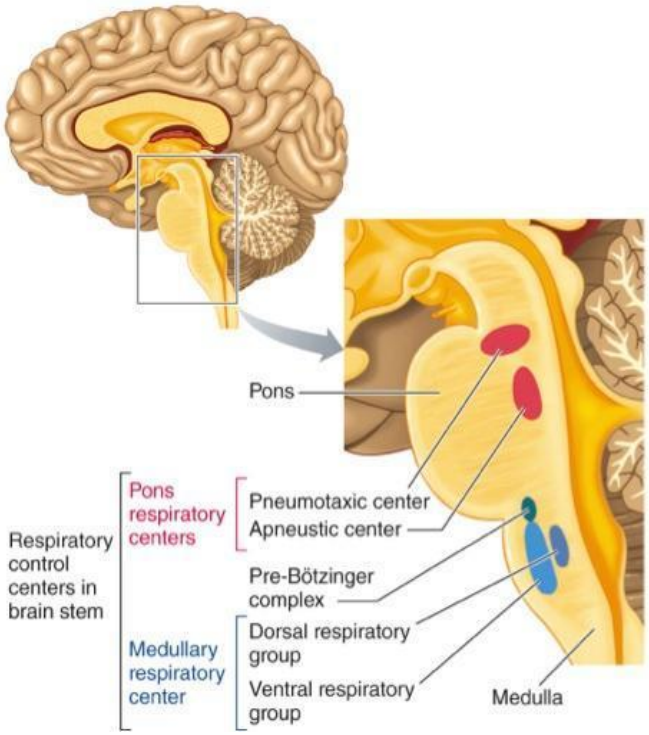
2-RESPIRATORY CENTERS

The respiratory center is composed of several groups of neurons located bilaterally in the Medulla Oblongata and Pons of brain stem .

We can divide them as the following :

1) The medullary respiratory center.
2) Pontine[1] respiratory center.

Will be explaining respectively.



[1] Of or relating to pons

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3-THE MEDULLARY RESPIRATORY CENTER

Subdivided into two groups,

To remember it easily Inspiratory has (S) and dorsal has S

Group	1- Inspiratory group	2- Expiratory group
Description	Group of Neurons	
Location	**dorsal** aspect of the medulla oblongata	**ventrolateral** aspect of the medulla oblongata
Action	Determination of basic rhythm of breathing	Activated by inspiratory area during forceful breathing
	contraction of Diaphragm	Contraction of the internal intercostal
	contraction of external intercostal muscles	Contraction of the abdominal muscles.

(via phrenic nerve & intercostal nerves)

**Important notes:

- The expiratory center is mostly inactive in the normal respiration
- The normal expiration is due to the elasticity of our lungs
- If this elasticity is insufficient then ➡ the inspiratory group activates the expiratory group , to expire more air (forceful breathing) e.g. During Exercise
- Basic respiration is stimulated by the medullary center
- Basic Inspiration takes about 2 seconds, expiration on the other hand, takes about 3 seconds, and so overall we take 5 seconds per a basic breath, so we take by mouth 12 breaths in each minute.

4-PONTINE RESPIRATORY CENTERS

We have two centers in pons which controls transition between inspiration and expiration, so basically we can say that the Pontine respiratory centers controls the medullary respiratory centers in an indirect style , and they are :

1. Pneumotaxic center:
inhibits medullary inspiratory center (stops inspiration) therefore we can say that when the Pneumotaxic center is in the action , it increases our breathing rate (respiratory rate) .

2. Apneustic center
Stimulate the medullary inspiratory center resulting in prolonged inspiratory period (increasing time of inhalation).

Note:

The pontine center is located in the dorsum of the superior portion of the Pons.

In addition to control of respiratory activity by the respiratory center itself, still another mechanism is available for controlling respiration. This is the **peripheral chemoreceptor system .**

5-CHEMICAL REGULATION OF RECPIRATORY CENTERS

i. Central chemoreceptor : CO_2↑, H^+↑ **ii. Peripheral chemoreceptor : O_2↓, CO_2↑, H^+↑**

I-CENTRAL CHEMORECEPTOR SYSTEM :

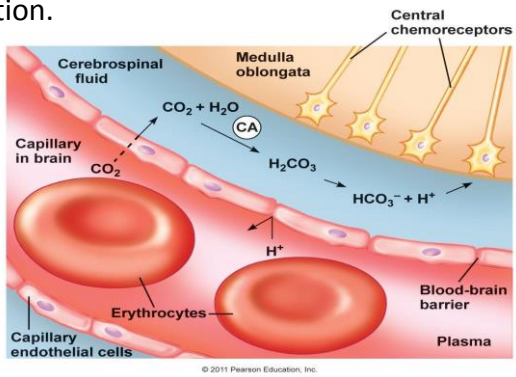
Located in the CNS on the ventrolateral medullary surface and are sensitive to the pH of their environment . they detect the changes in pH of nearby CSF that are indicative of altered O_2 or CO_2 concentrations available to brain tissues . An increase in CO_2 indirectly causes the blood to become more acidic ,the CSF PH is closely comparable to plasma , as CO_2 easily diffuses across BBB .

However, a change in plasma pH alone will not stimulate central chemoreceptors as H^+ are not able to diffuse across the blood–brain barrier into the CSF.

II-PERIPHERAL CHEMORECEPTOR SYSTEM :

They are especially important for detecting changes in blood oxygen . Oxygen, in contrast with CO_2 does not have a significant direct effect on the respiratory center of the brain in controlling respiration. Instead, it acts almost entirely on peripheral chemoreceptors. Which then transmit appropriate nervous signals to the respiratory center for control of respiration.

Those Chemoreceptors are located in the carotid bodies. However, some are found in the aortic bodies, and very few are located elsewhere in association with other arteries of the thoracic and abdominal regions .



**** Hering-Breuer inflation reflex**

Is a reflex triggered to prevent over-inflation of the lung. When the lung becomes overstretched (tidal volume is 1 L or more), stretch receptors located in the wall bronchi and bronchioles transmit signals through vague nerve to dorsal respiratory group, producing effect similar to pneumotaxic center stimulation. Which switches off the inspiratory signal, causing less inspiration , but increase in the rate of respiration.

7-OTHER RECEPTORS AFFECTING RESPIRATORY CENTERS

Receptors	Site of the receptor	Stimulated by	Action
Irritant receptors	Epithelium of Trachea, bronchi, bronchioles	Irritants (its supplied by irritant receptors)	Coughing, sneezing, bronchoconstriction (in bronchial asthma+emphysema)
Lung j receptors	In the wall of the alveoli near to the pulmonary capillaries	When pressure of interstitial fluid increase [2]	Eg; Feeling of dyspnea in CHF

[2] If pulmonary capillaries are engorged (congested) by blood or if pulmonary edema occurred

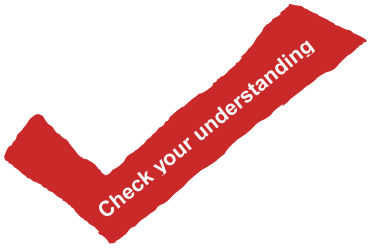
8-RESPIRATORY AND METABOLIC CHANGES IN PH

Respiratory acidosis	Respiratory Alkalosis
is a medical emergency in which decreased ventilation causes increased blood carbon dioxide concentration which end up accumulating and decreased PH	is a medical condition in which increased respiration elevates the blood pH beyond the normal range (7.35-7.45) with a concurrent reduction (loss) in arterial levels of CO_2
Hypoventilation	**Hyperventilation**
High PCO_2	**Low PCO_2**
Low PH	**High PH**

Metabolic Acidosis	Metabolic Alkalosis
Ingestion, infusion, or production of a fixed acid[3].	Excessive loss of fixed acids from the body
decreased renal excretion of hydrogen ions.	Ingestion, infusion, or excessive renal reabsorption of bases such as bicarbonate
loss of bicarbonate or other bases from the extracellular compartment	PH increases.
The respiratory system can compensate for metabolic acidosis or alkalosis by altering alveolar ventilation	

[3] Non-volatile

Respiratory Centers; khan academy medicine



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