

# Pranayama

Teachers Training

Level 1 2023

Anatomy & Physiology

Class 5

Regulation of breathing



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ॐ ॐ ॐ

श्री गुरुभ्यो नमः हरिः ॐ

Om Om Om

Sri Gurubhyo Namah Harih Om

Salutations to the Gurus!

ॐ सह नाववतु ।  
सह नौ भुनक्तु ।  
सह वीर्यं करवावहै ।  
तेजस्वि नावधीतमस्तु मा विद्विषावहै ।  
ॐ शान्तिः शान्तिः शान्तिः ॥

oṃ saha nāvavatu saha nau bhunaktu  
saha vīryaṃ karavāvahai  
tejasvi nāvadhītam astu mā vidviṣāvahai  
oṃ śāntiḥ śāntiḥ śāntiḥ

May that Brahman protect us together. May it nourish us together. May we both gain great vitality. May our learning be brilliant. May we never argue. Om peace, peace, peace.

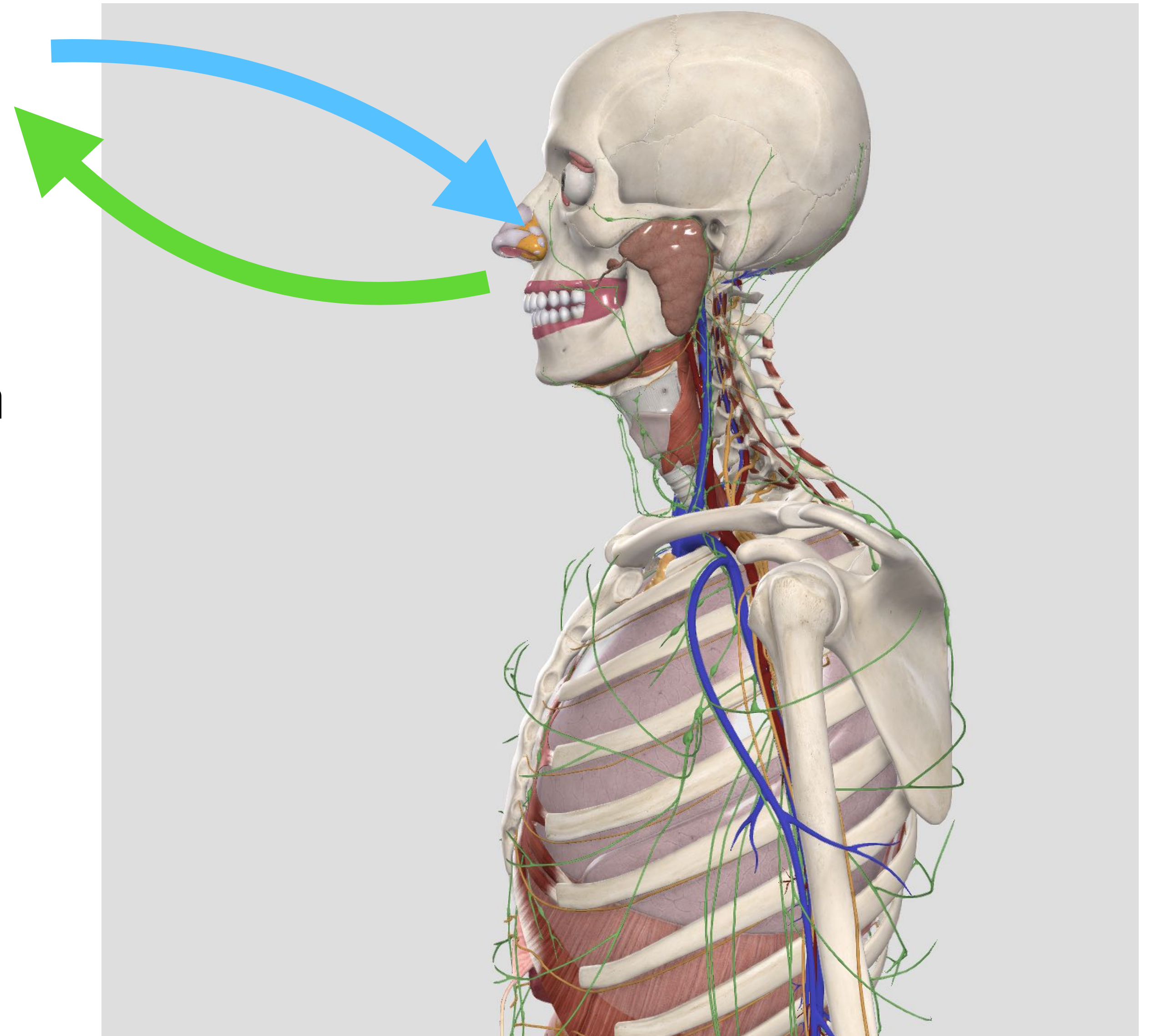
# Breathing is mostly an involuntary/automatic process

Oxygen (O<sub>2</sub>) in

Carbon dioxide (CO<sub>2</sub>) out

This involuntary automatic process is determined by the nervous system which is constantly monitoring the levels of CO<sub>2</sub> & O<sub>2</sub> in the blood.

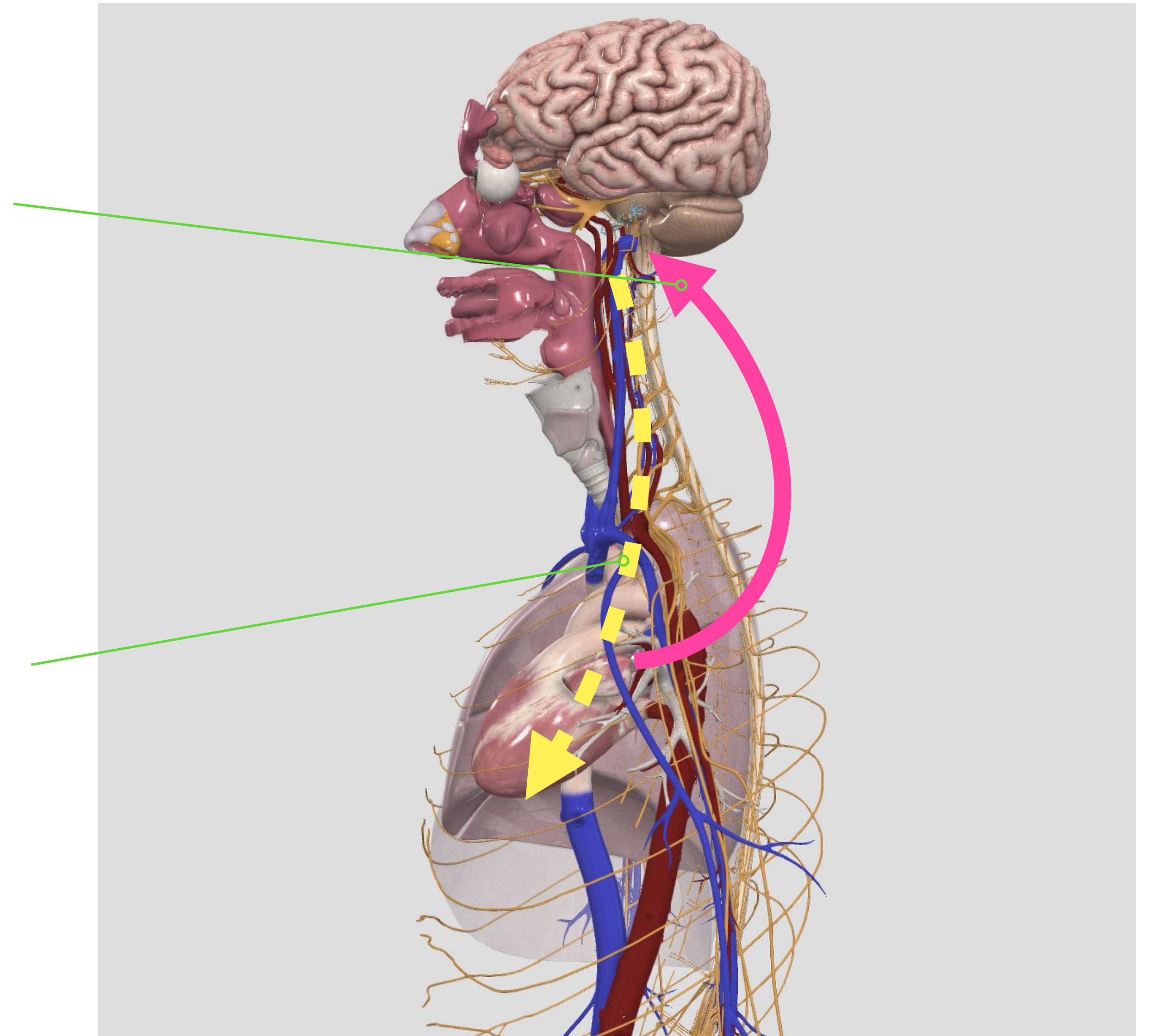
For example when you exercise and need more oxygen, respiration will accelerate.



# Receptors

Receptors in the body feed information about its metabolic state to the Respiratory Center in the brain stem

The Respiratory Center responds by changing the firing pattern of inspiratory and expiratory neurons

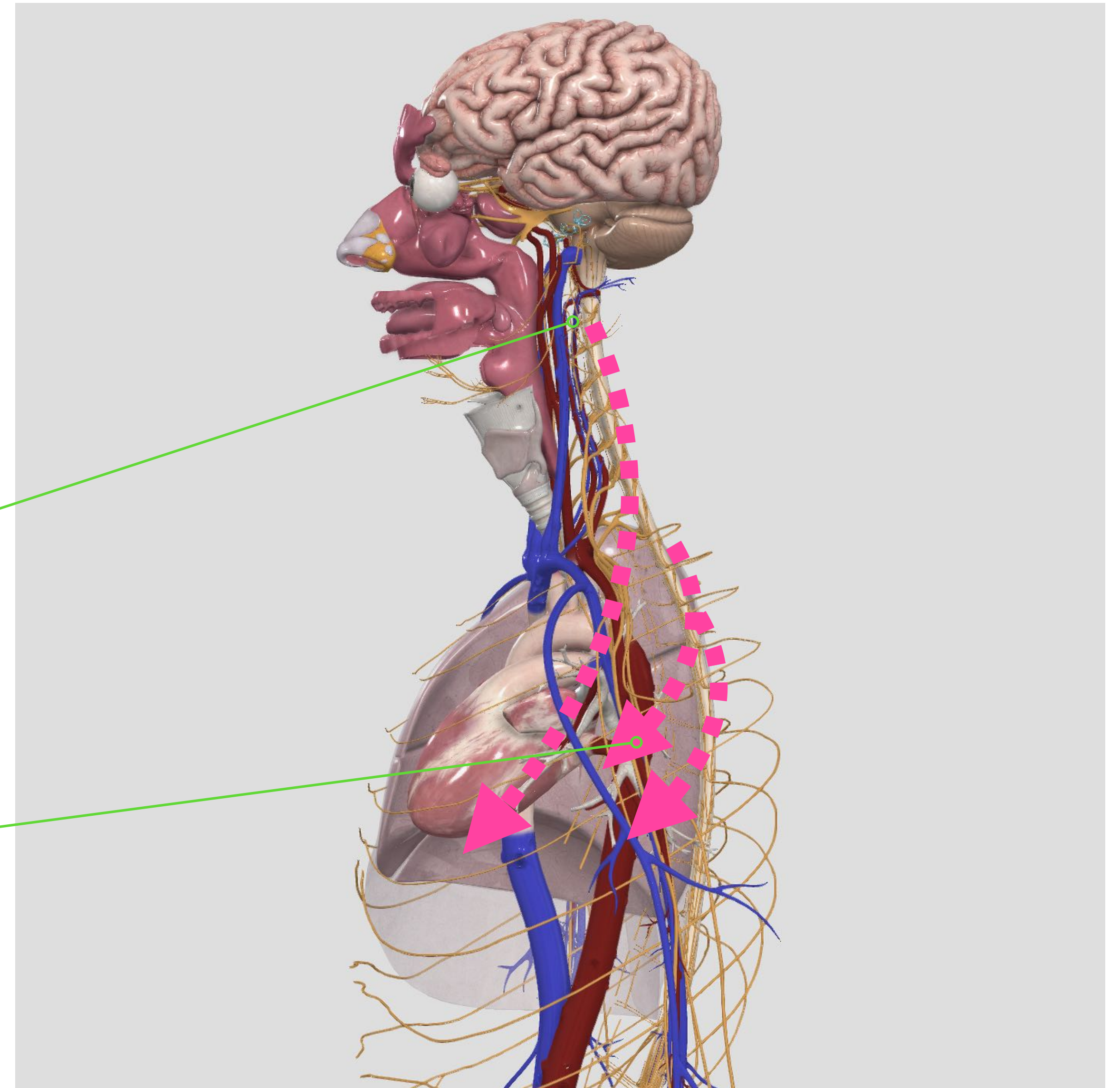


# Inspiration

Inspiratory neurons are activated during inspiration to increase the volume of the thoracic cavity

The Phrenic Nerve exits at C3, C4 & C5 and innervates the diaphragm

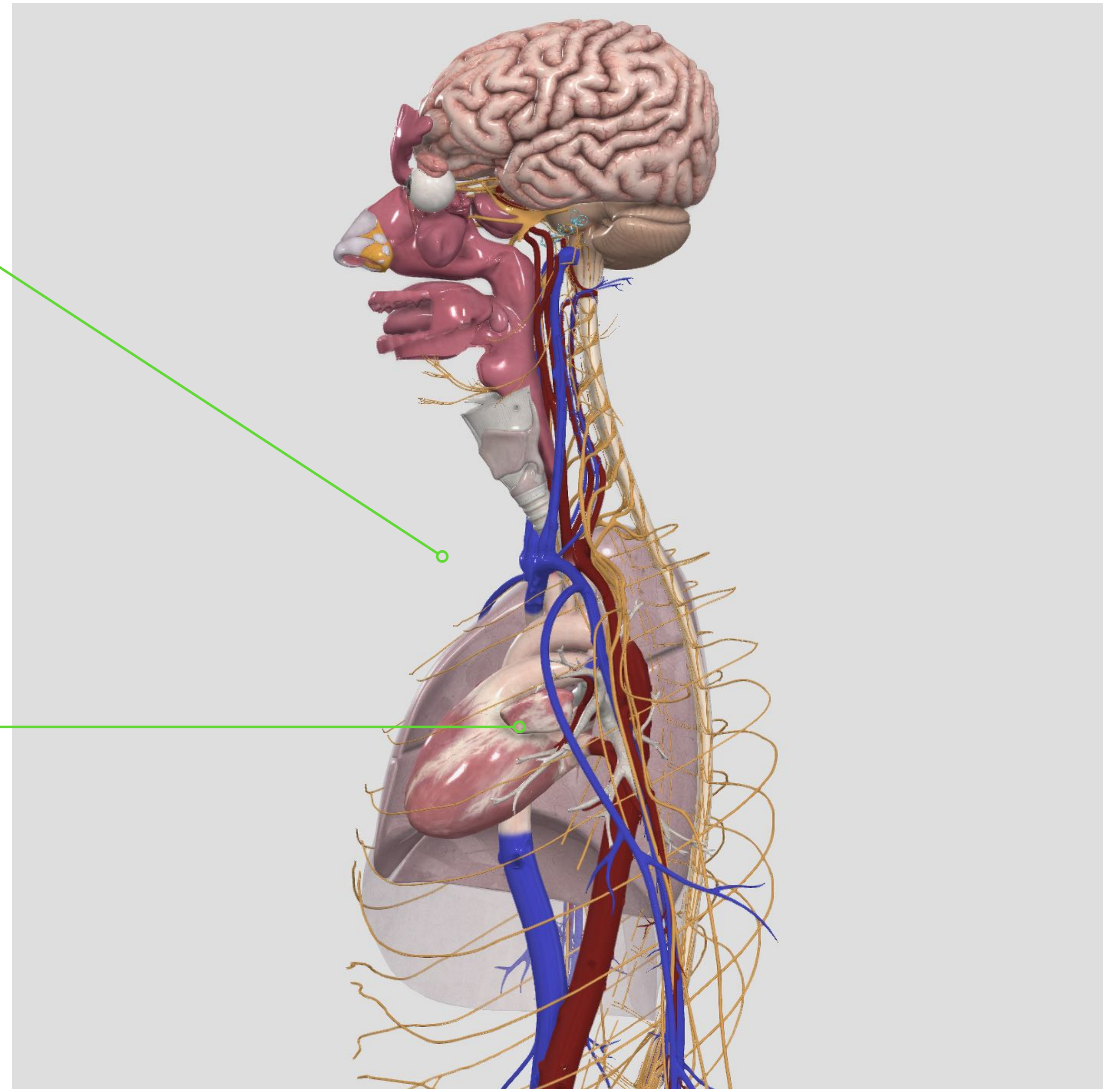
Intercostal nerves exit from T1 - T11 and innervate the intercostal muscles



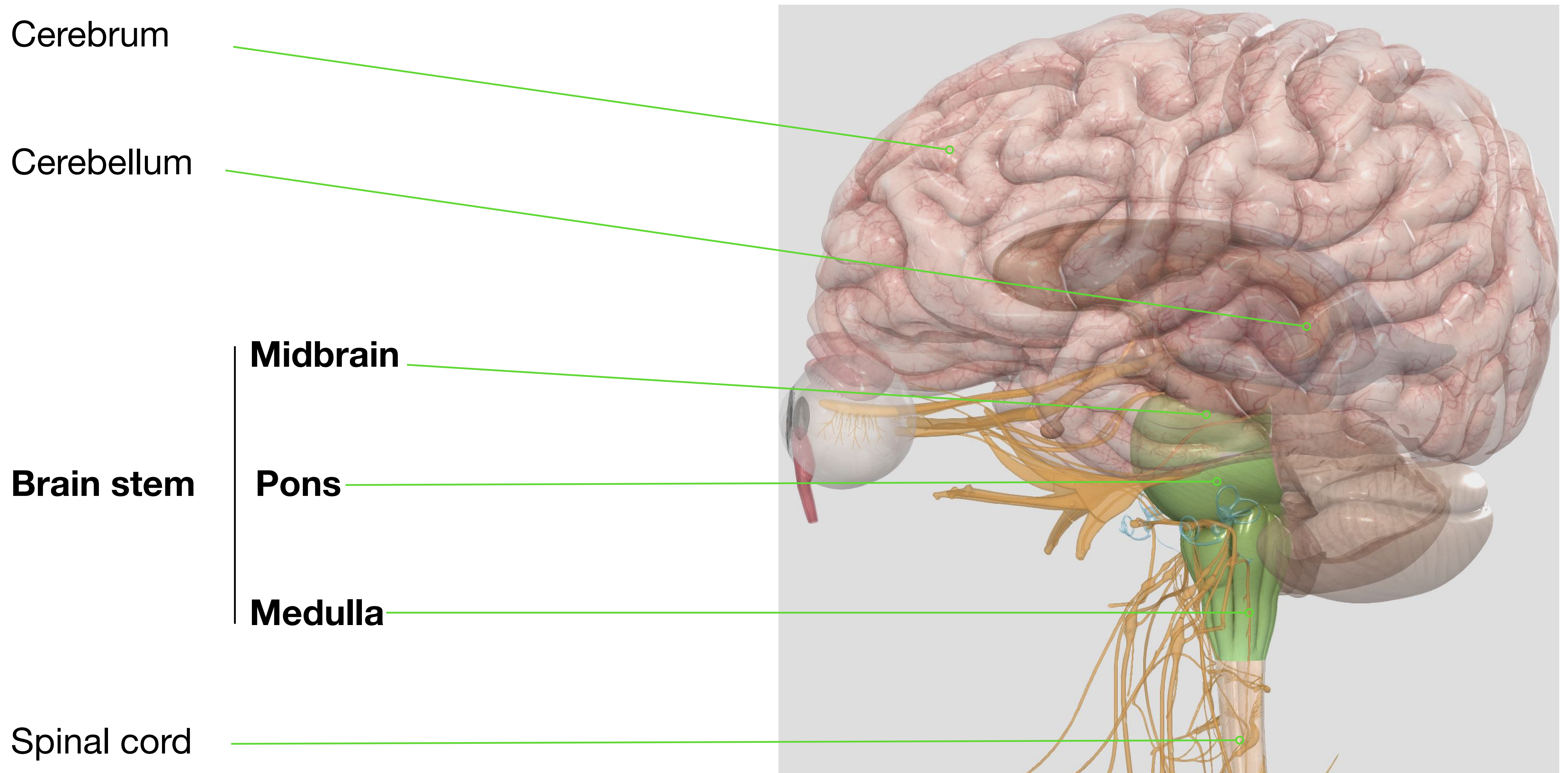
# Expiration

Expiration mostly occurs owing to the elasticity of the lungs, pleura and respiratory muscles

Expiratory neurons are activated during deep expiration, pulling the sternum and ribs back downwards decreasing the volume of the thoracic cavity

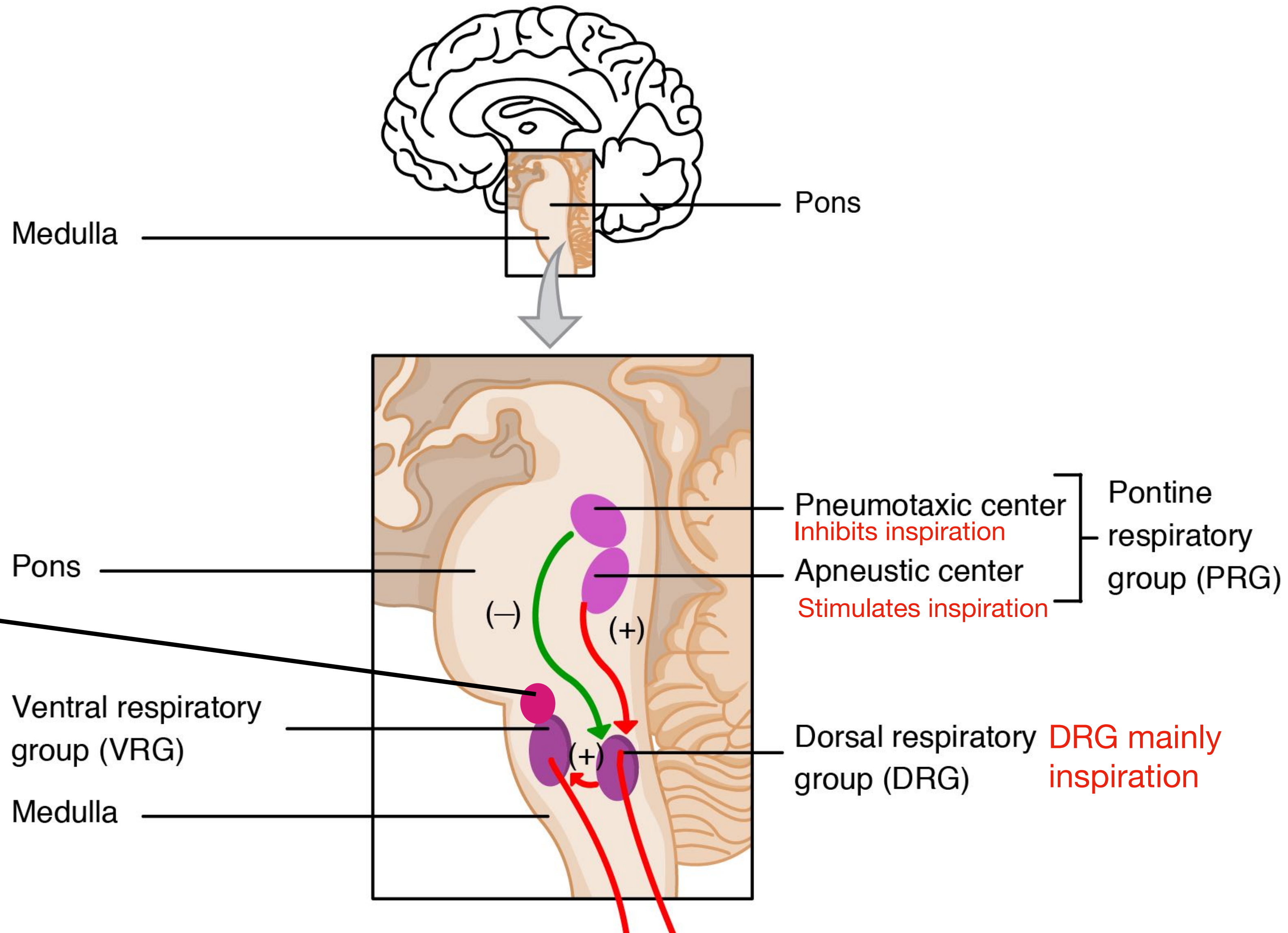


# Respiratory Centers regulate the rate of respiration





# Respiratory Centers in the Brain stem



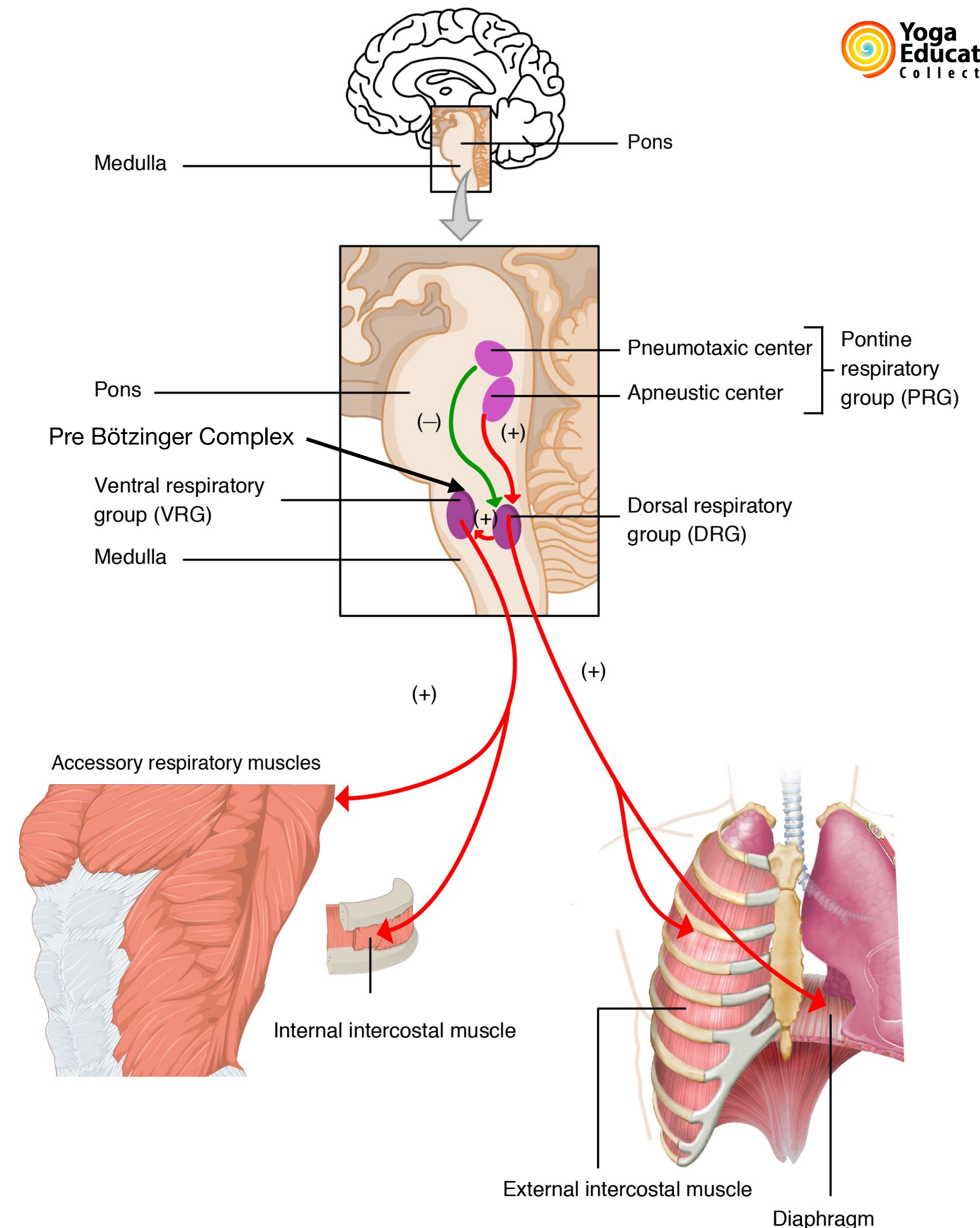
[Dr. Jack Feldman](#)

Pre Bötzing Complex  
Rhythm generator

VRG  
mainly expiration

# Respiratory centers

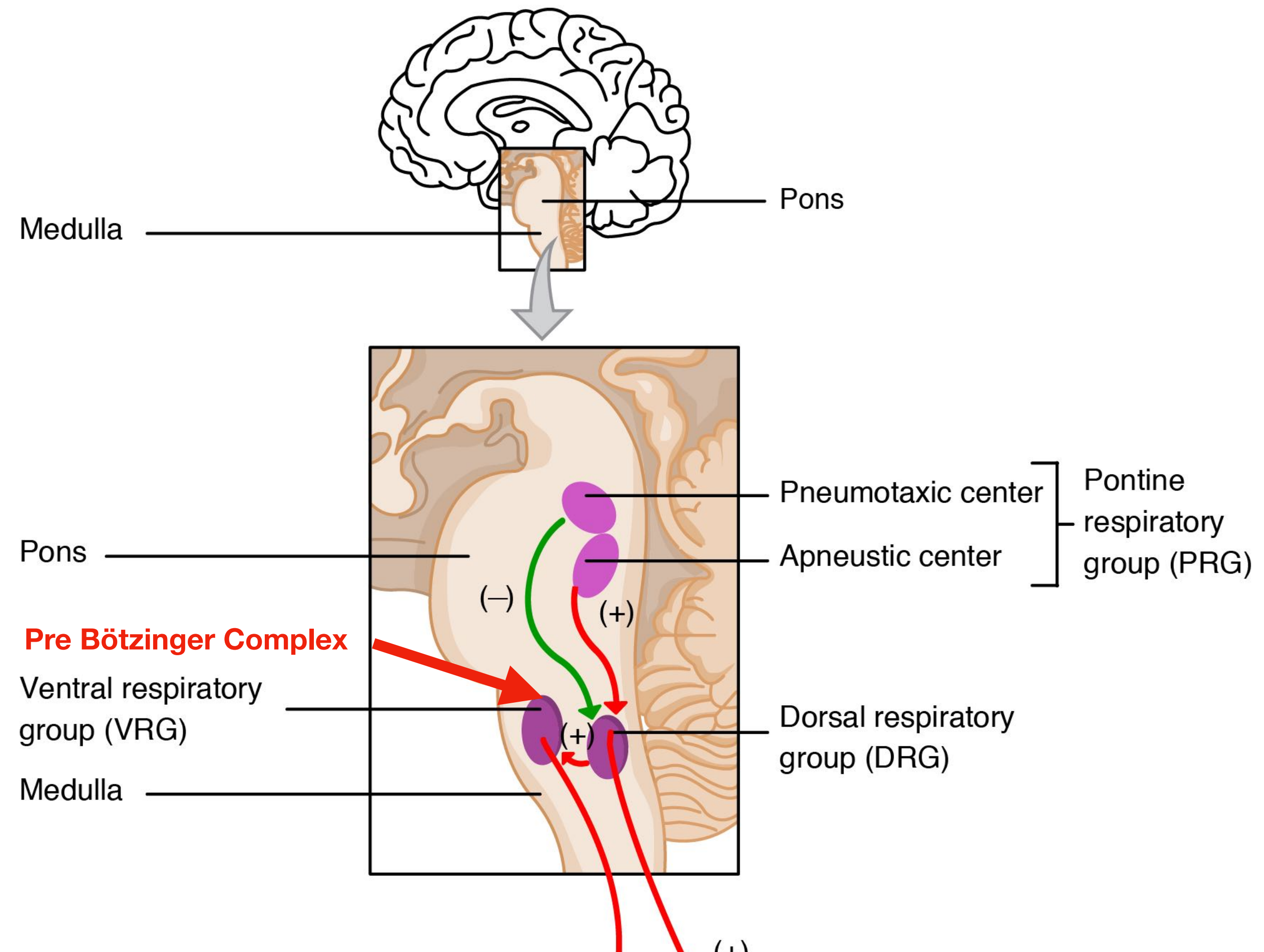
- Located in the medulla oblongata and pons in the brainstem.
- In the medulla they are the dorsal respiratory group and the ventral respiratory group.
- In the pons, the pontine respiratory group includes two areas known as the pneumotaxic centre and the apneustic centre.
- Responsible for generating and maintaining the rhythm of respiration and also of adjusting this in homeostatic response to physiological changes.
- Receives input from **chemoreceptors**, **mechanoreceptors**, the **cerebral cortex**, and the **hypothalamus** in order to **regulate the rate and depth** of breathing.
- **Input is stimulated by altered levels of oxygen, carbon dioxide, and blood pH, by hormonal changes relating to stress and anxiety from the hypothalamus, and also by signals from the cerebral cortex to give a conscious control of respiration.**



[https://en.wikipedia.org/wiki/Respiratory\\_center](https://en.wikipedia.org/wiki/Respiratory_center)

# Pre-Bötzinger complex

- The **pre-Bötzinger complex** is a cluster of interneurons in the ventral respiratory group of the medulla of the brainstem
- This complex has been proven to be essential for the generation of the respiratory rhythm in mammals.<sup>(1)</sup> The exact mechanism of the rhythm generation and transmission to motor nuclei remains controversial and the topic of much research

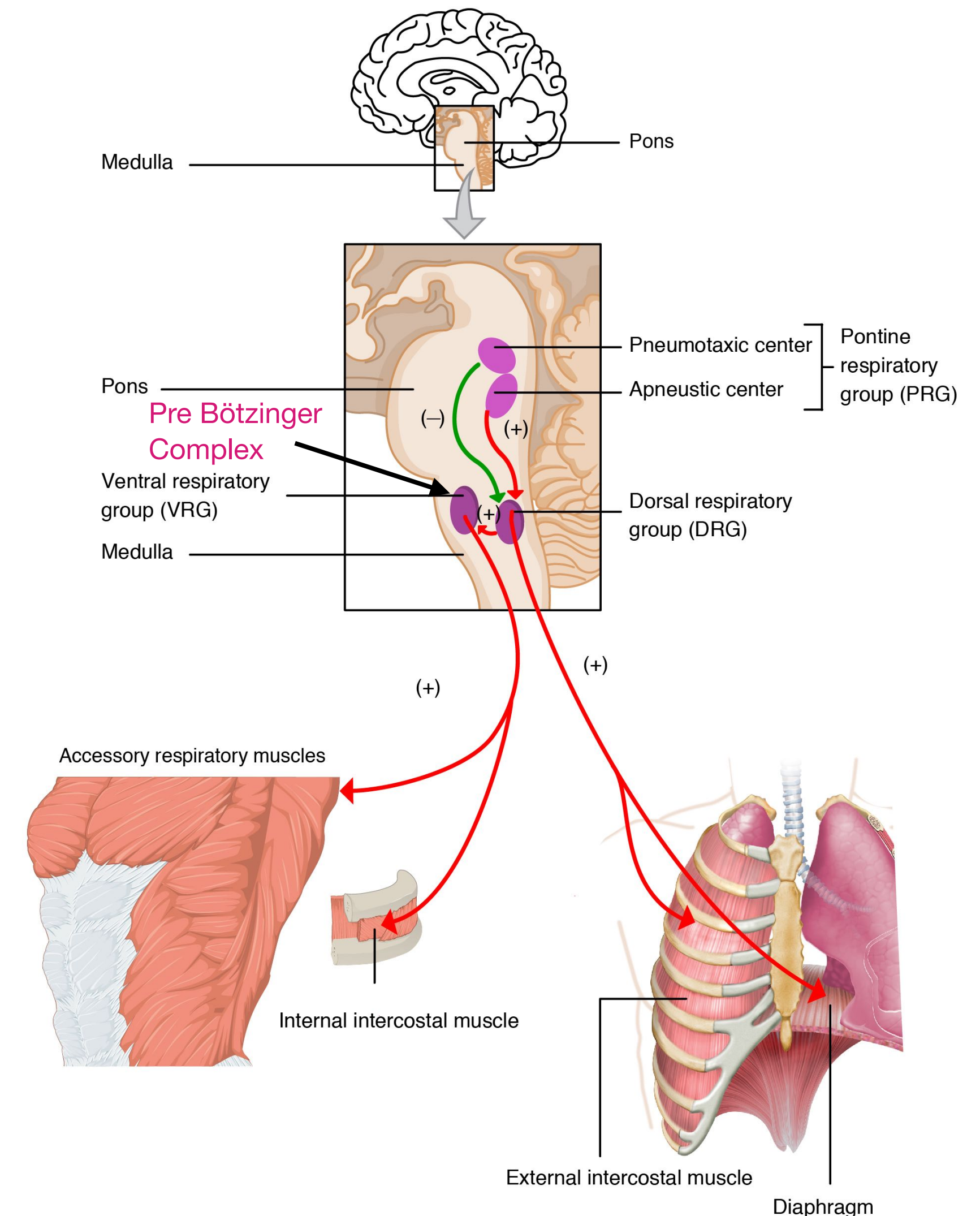


[https://en.wikipedia.org/wiki/Respiratory\\_center](https://en.wikipedia.org/wiki/Respiratory_center)

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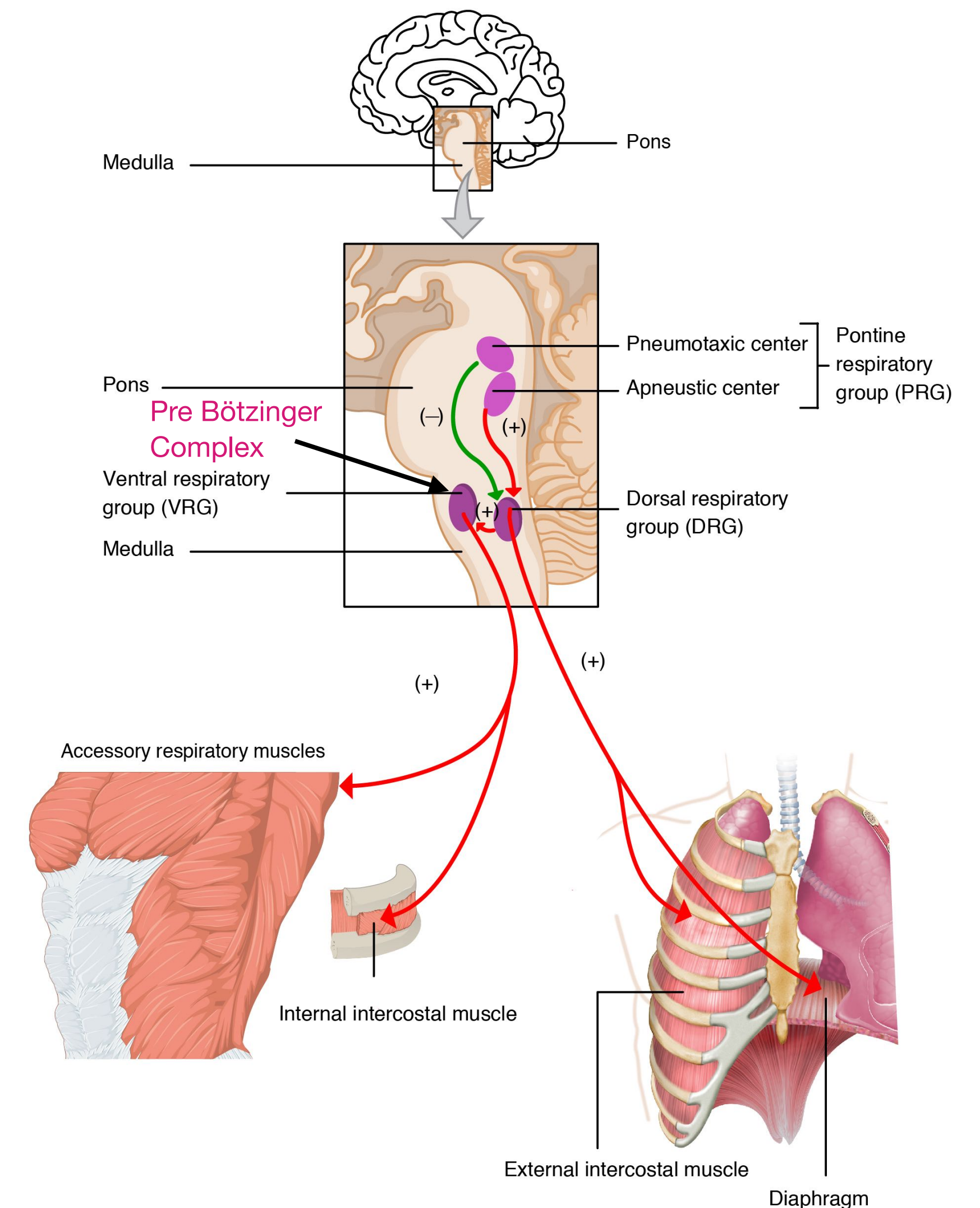
# Respiratory rhythm

- Breathing is the repetitive process of bringing air into the lungs and taking waste products out.
- The oxygen brought in from the air is a constant, ongoing need of an organism to maintain life. This need is still there during sleep so the functioning of this process **has to be automatic and be part of the autonomic nervous system.**
- The in-breath is followed by the out-breath, **giving the respiratory cycle of inhalation and exhalation.** There are three phases of the respiratory cycle: inspiration, post-inspiration or passive expiration, and late or active expiration.
- The number of cycles per minute is the **respiratory rate.** The respiratory rate is set in the respiratory center by the dorsal respiratory group, in the medulla.



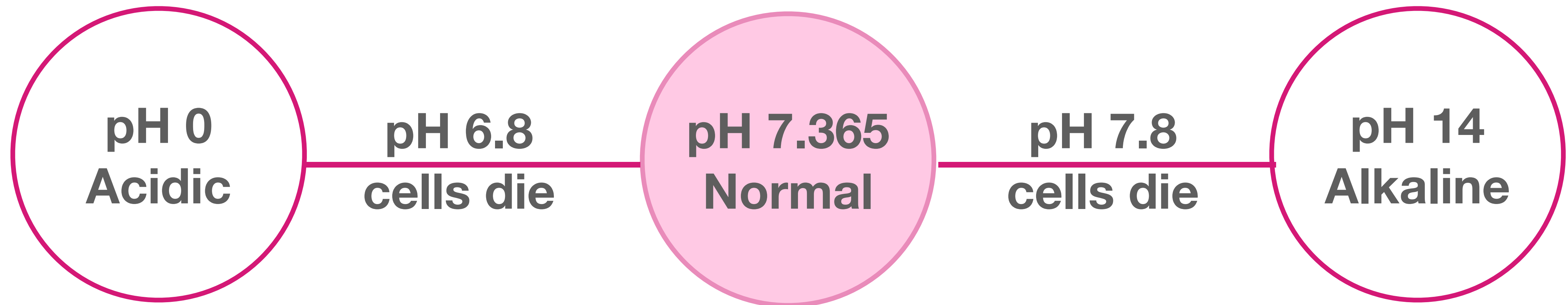
# Respiratory rhythm

- The **basic rhythm of respiration is that of quiet, restful breathing** known as eupnea. Quiet breathing only requires the activity of the dorsal group which activates the diaphragm and the external intercostal muscles. **Exhalation is passive** and relies on the **elastic recoil** of the lungs.
- When the metabolic **need for oxygen increases**, inspiration becomes more forceful and the neurons in the ventral group are activated to bring about **forceful exhalation**.



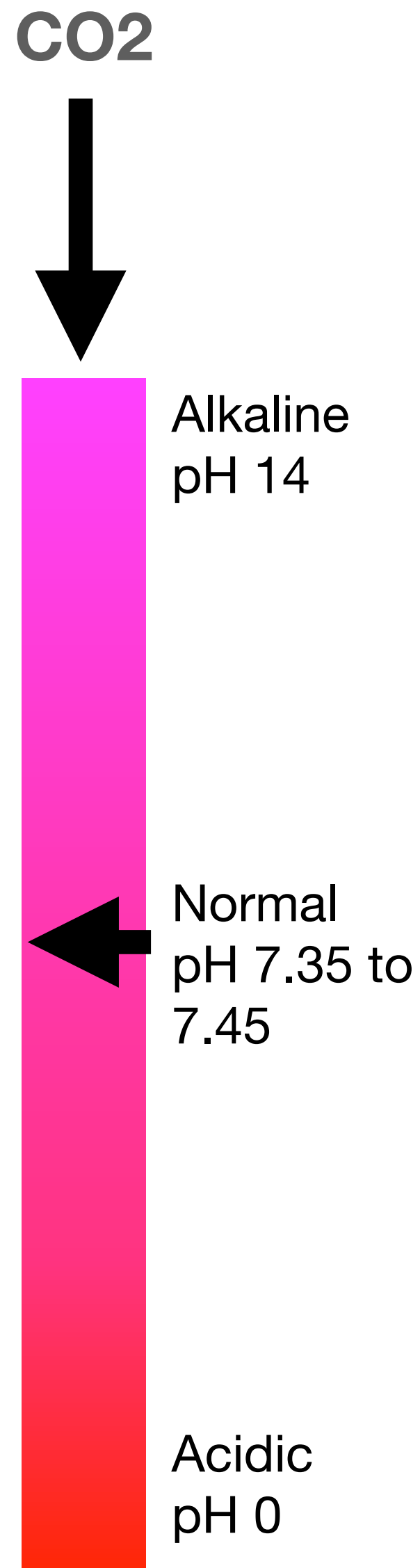
# Regulation of Blood pH

1. CO<sub>2</sub> helps regulate blood pH. How acidic or alkaline your blood is.
2. Normal pH in the blood is 7.365. Maintaining normal level is essential for survival.

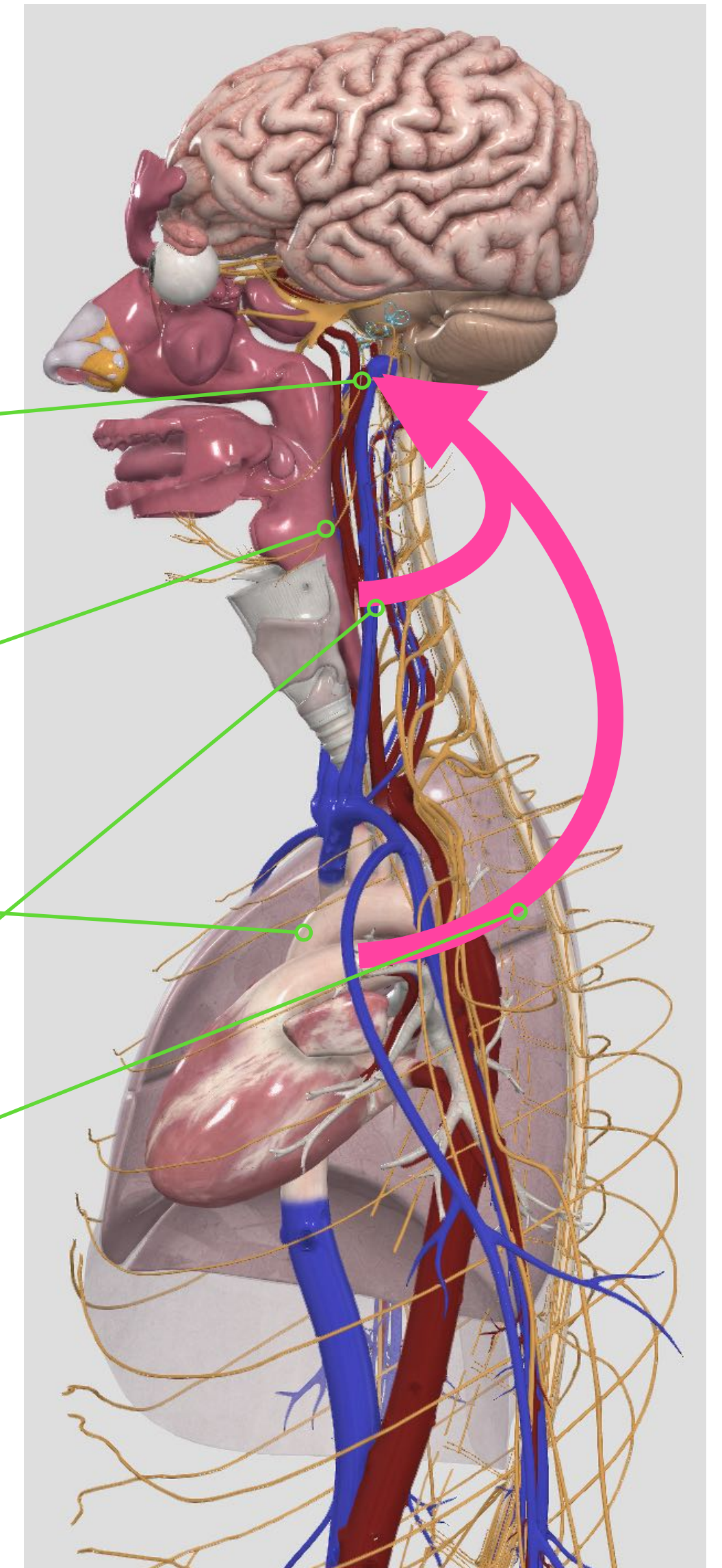


3. When blood become more alkaline, breathing reduces allowing CO<sub>2</sub> to rise and balance is restored.
4. When blood is more acidic (eg. processed foods), breathing increases to offload CO<sub>2</sub> and balance is restored.

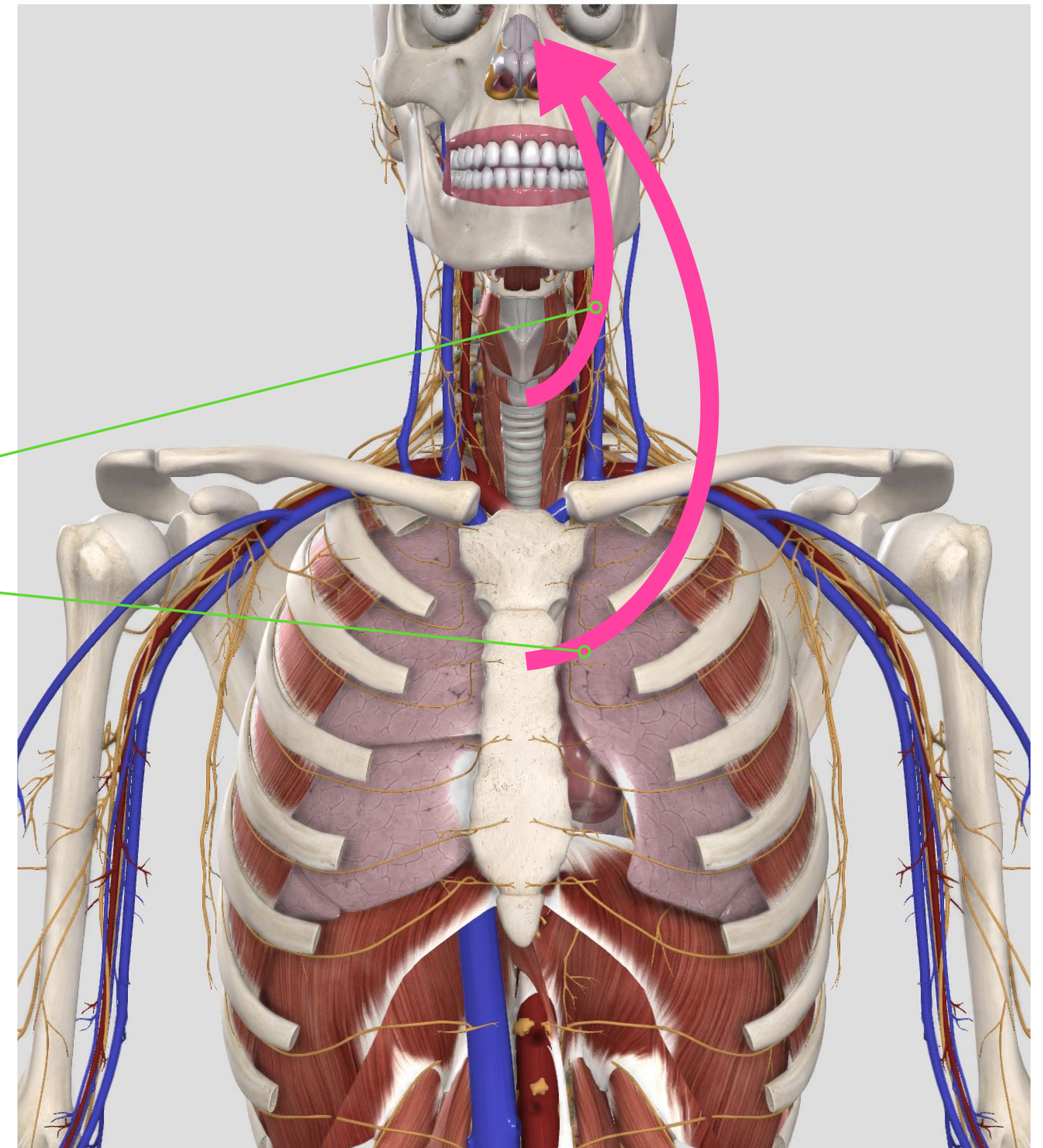
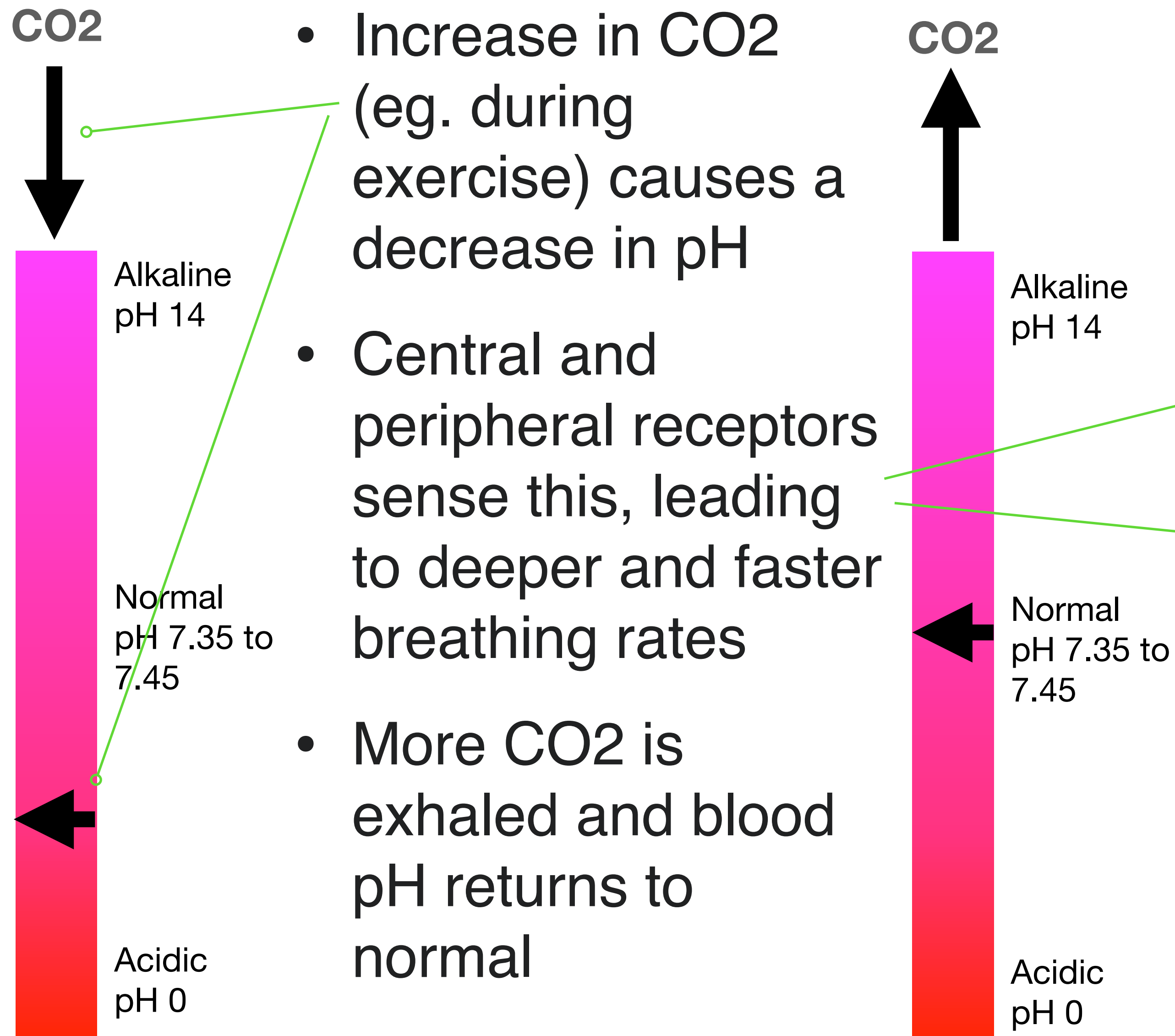
# Regulation of breathing rate



- Concentration of CO<sub>2</sub> in the blood changes the blood pH
- Central chemoreceptors on the surface of the medulla monitor pH in the cerebrospinal fluid
- Peripheral chemoreceptors in the aorta and carotid bodies respond to pH, O<sub>2</sub>, and CO<sub>2</sub> in the blood
- The peripheral chemoreceptors transmit signals to the Respiratory Center via the **Glossopharyngeal nerve** and the **Vagus nerve**



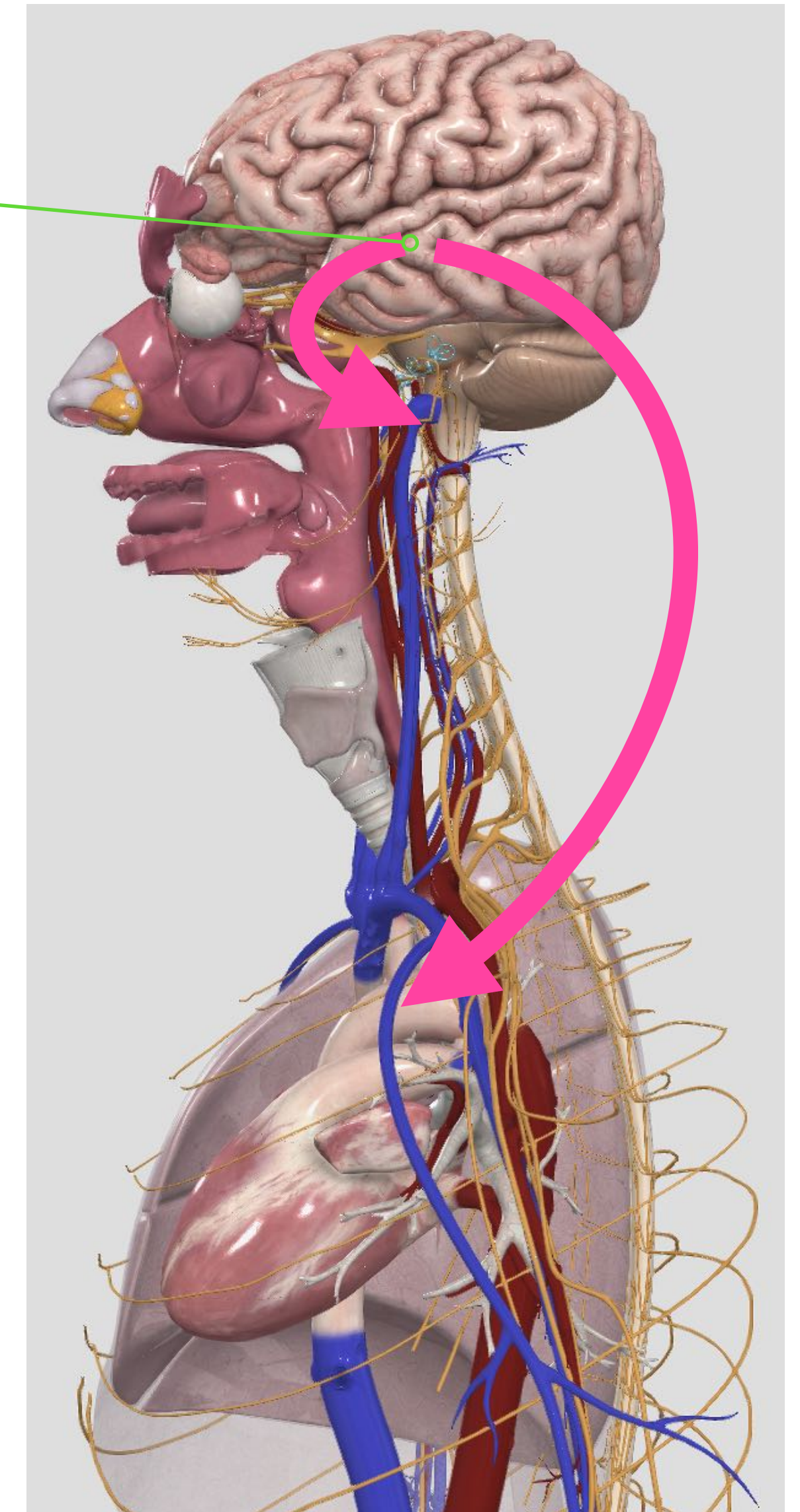
# Respiratory rhythm - Chemoreceptors - **Kapalabhati** !





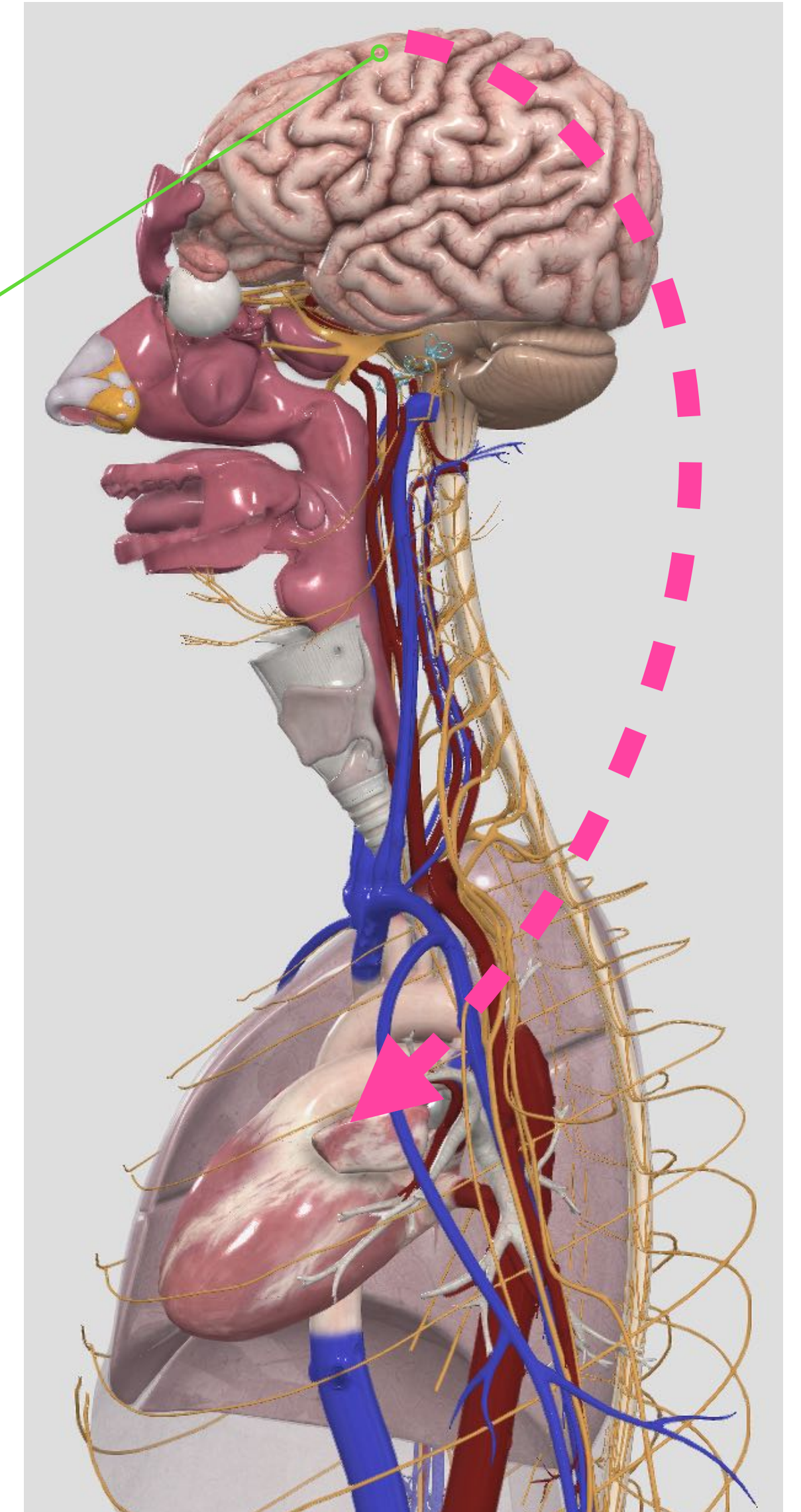
# Respiratory rhythm - Emotions, pain-pleasure.

- The limbic system (part of the brain involved in emotional responses) and hypothalamus (various homeostatic systems) can send signals to the Respiratory Centers to change the respiratory rate
- For example pain or strong emotions can cause gasping, and anxiety can cause uncontrolled hyperventilation



# Voluntary control

- During singing, playing wind instruments or holding breath underwater
- **Pranayama**
- Control originates in the primary motor cortex which sends signals directly to the spinal cord and bypasses the Respiratory Center in the brain stem
- The limits of this control can be slowly overcome by constant training



ॐ सर्वे भवन्तु सुखिनः  
सर्वे सन्तु निरामयाः ।  
सर्वे भद्राणि पश्यन्तु  
मा कश्चिद्दुःखभाग्भवेत् ।  
ॐ शान्तिः शान्तिः शान्तिः ॥

oṃ sarve bhavantu sukhinaḥ  
sarve santu nirāmayāḥ  
sarve bhadrāṇi paśyantu  
mā kaścid duḥkha bhāgbhavet  
oṃ śāntiḥ śāntiḥ śāntiḥ

May all be happy, may all be free from disease, may all see goodness,  
may none suffer from sorrow.

ॐ असतो मा सद्गमय ।  
तमसो मा ज्योतिर्गमय ।  
मृत्योर्मा अमृतं गमय ।  
ॐ शान्तिः शान्तिः शान्तिः ॥ हरिः ॐ तत्सत् ॥

asato mā sadgamaya  
tamasomā jyotir gamaya  
mrityormāamritam gamaya  
Om śhānti śhānti śhāntiḥ harih om tat sat

Lead me from changing existence to unchanging being,  
lead me from the darkness of tamas to the light of knowledge,  
lead me from death to immortality. Harih om that is truth.