



# 9- Control of Respiration

## A- Nervous

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# Control of Respiration

## 1) Automatic mechanism:

- Its centers are present in the pons and medulla.
- It allows subconscious(**spontaneous**) rhythmic respiration.

## 2) Voluntary mechanism:

- Its center is present in the **cerebral cortex** and control the anterior horn cells of the respiratory muscles via the cortico-spinal tract.

It allows voluntary control of respiration e.g voluntary hyper-ventilation and apnea but cannot be maintained for long time.

- Inspiratory muscles, diaphragm and external intercostal, composed of skeletal muscle and must be stimulated to contract
- Two **phrenic nerves** responsible for diaphragm originate at the **3<sup>rd</sup>, 4<sup>th</sup>, and 5<sup>th</sup> cervical spinal nerves**
- **11 pairs** of intercostal nerves originate **1- 11<sup>th</sup> thoracic spinal nerves**

# INSPIRATORY CENTER

The inspiratory center sends nerve impulses along the phrenic nerve to the diaphragm and along the intercostal nerves to the external intercostal muscles.

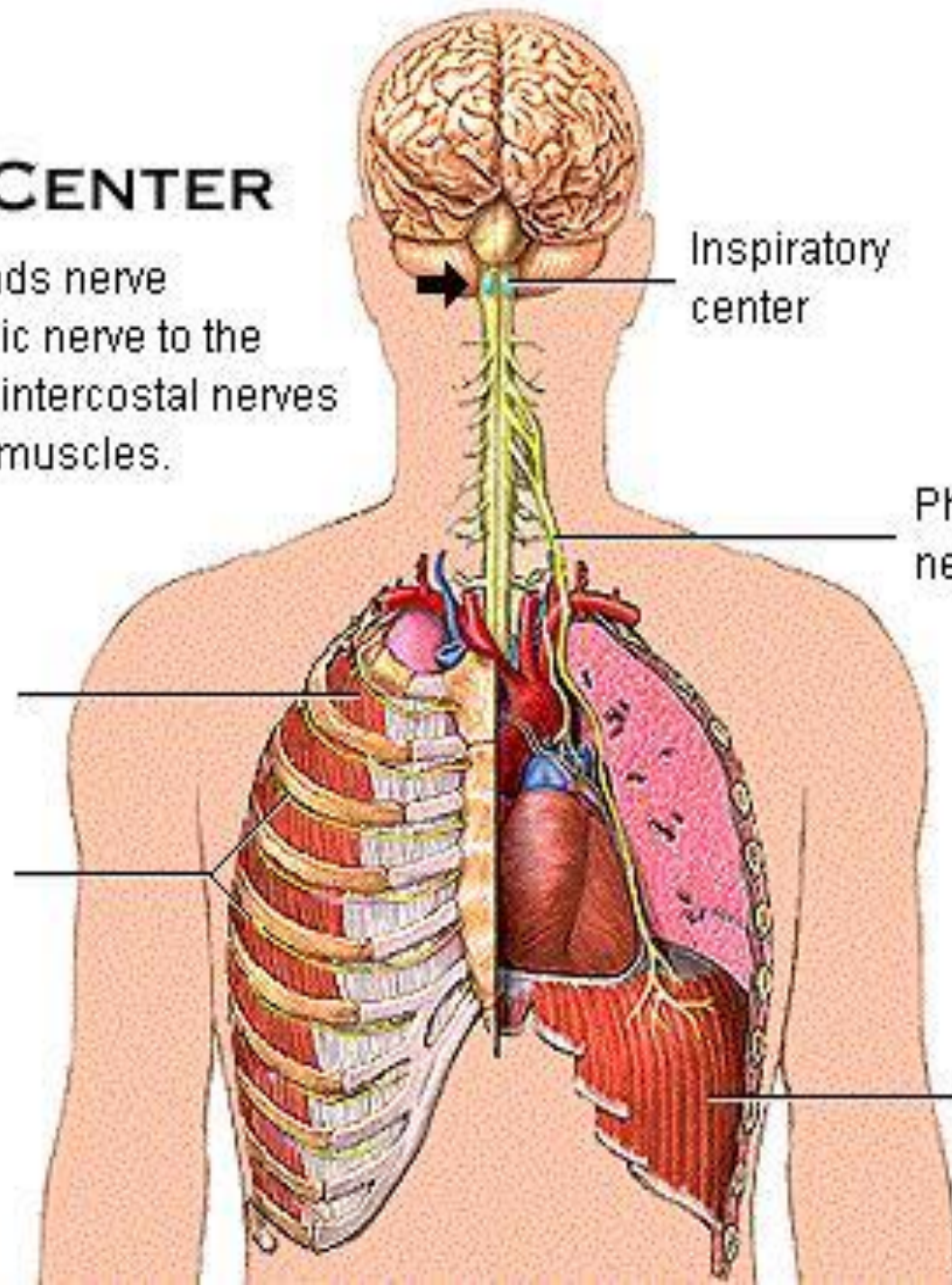
External  
intercostal  
muscles

Intercostal  
nerves

Inspiratory  
center

Phrenic  
nerve

Diaphragm

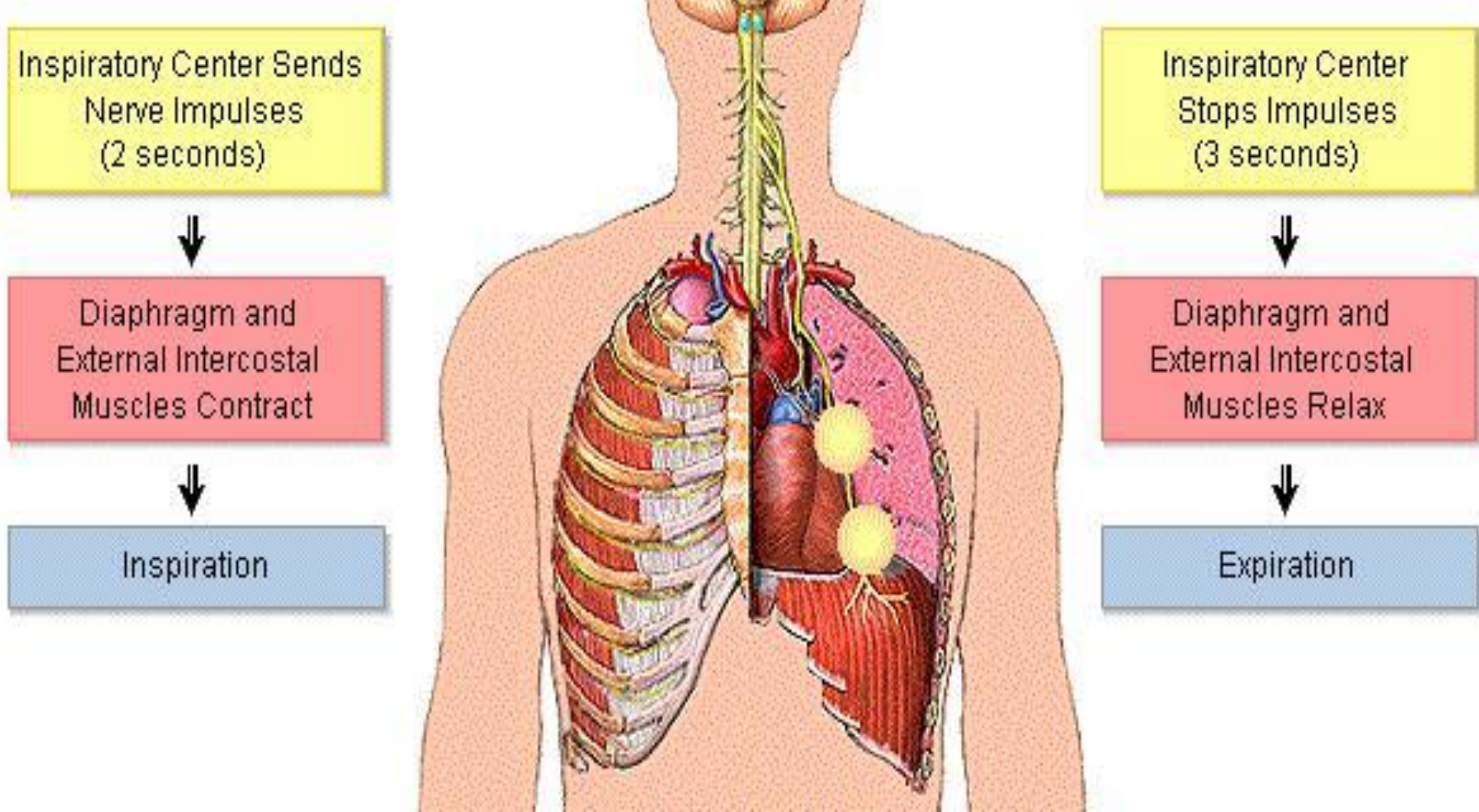




# INSPIRATORY CENTER

The normal resting breathing rate is between 12 - 15 breaths per minute.

The inspiratory ramp signal impulses from the **inspiratory centre** to the inspiratory muscles begins **very weak** then gradual increase for about **2 seconds** then it stop for another **3 seconds** (expiration).

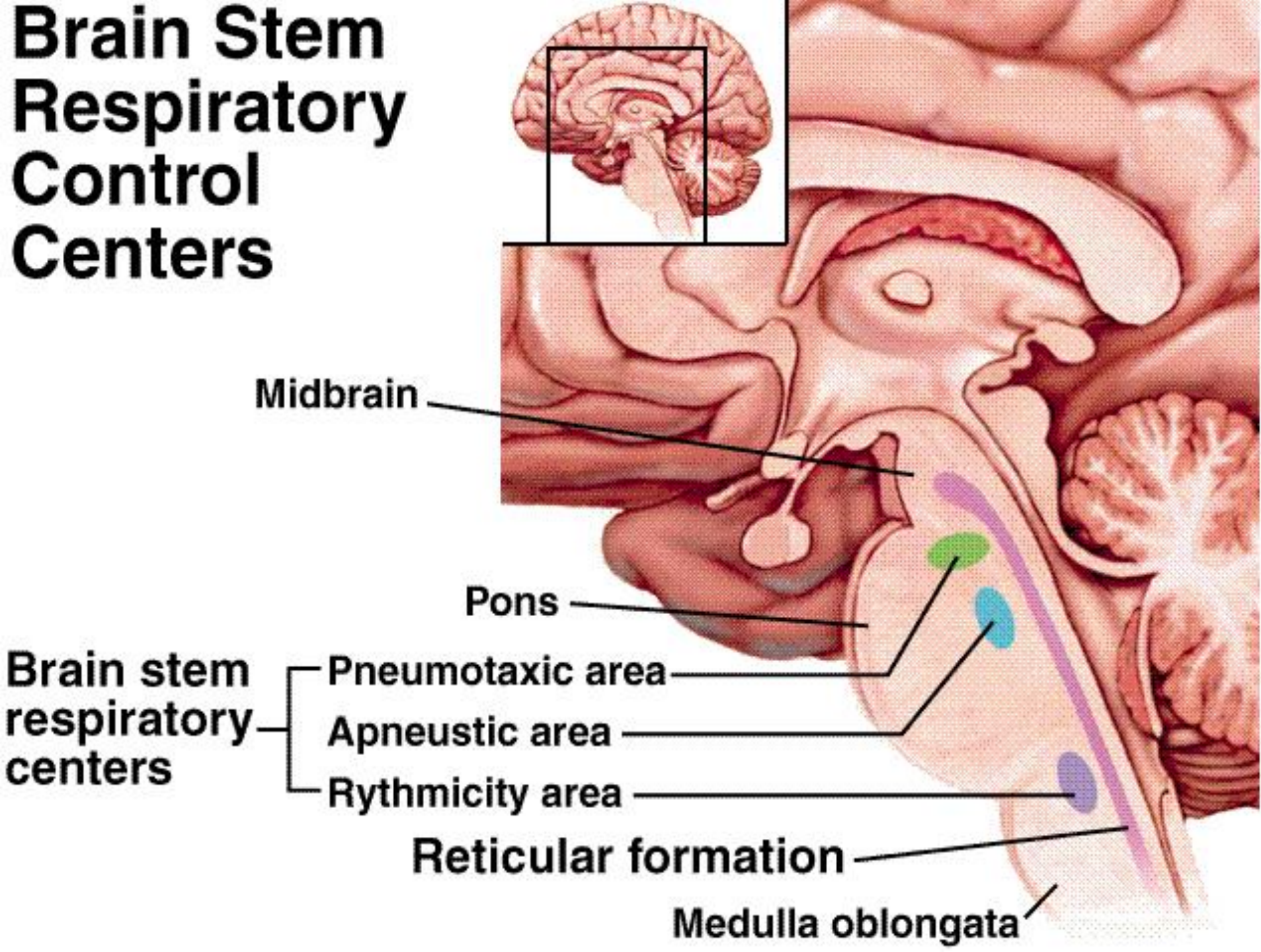


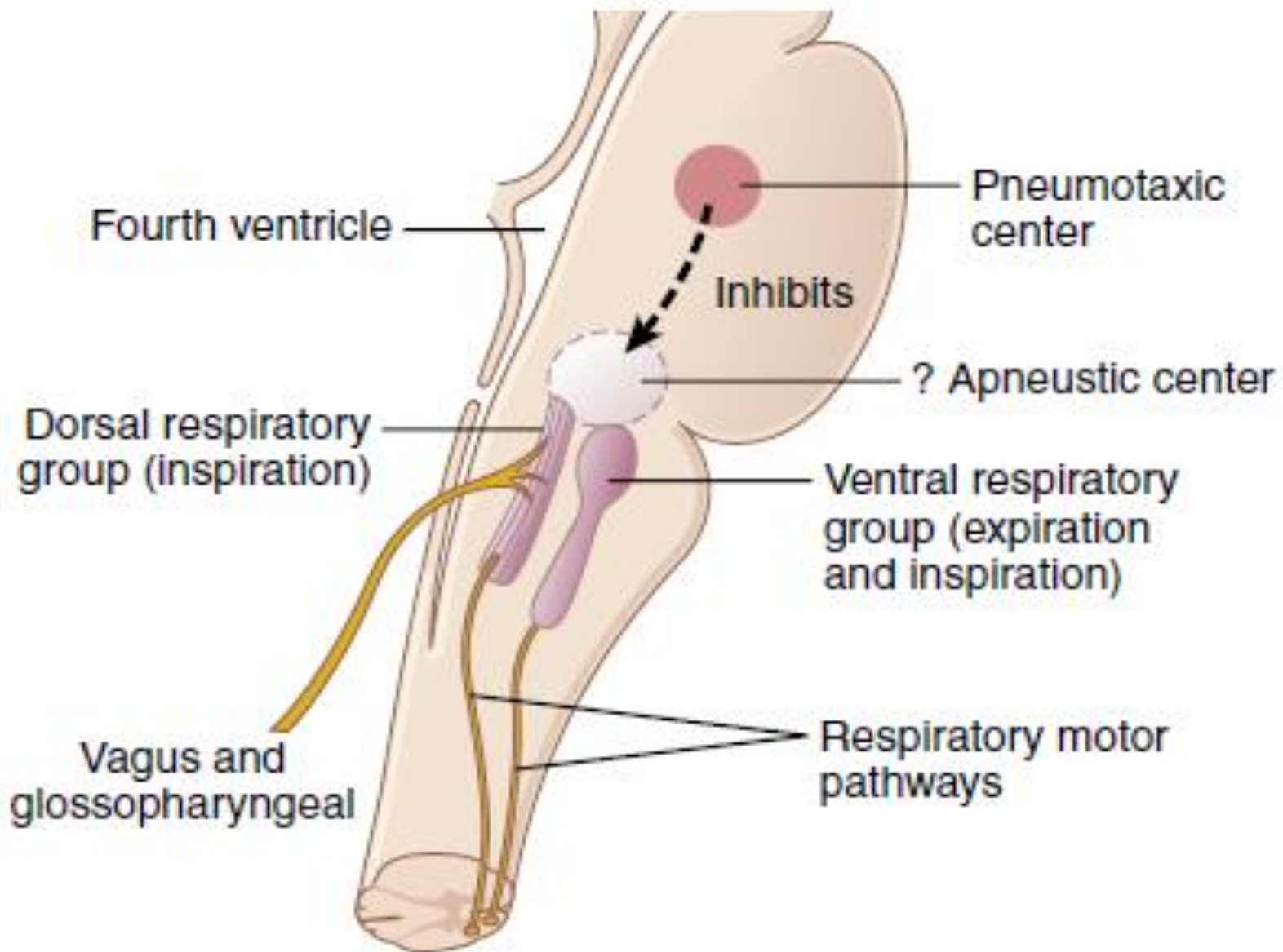
# Respiratory Areas in Brainstem

- These centers responsible for **automatic basic rhythm** of respiration, located bilaterally in the brain stem composed of two groups of neurons (inspiratory, expiratory)
- **Medullary respiratory centers**
  - Dorsal groups stimulate the diaphragm (insp. center)
  - Ventral groups (exp. center) stimulate the internal intercostal and abdominal muscles
- **Pontine respiratory centers**
  - Involved with switching between inspiration and expiration
  - **Pneumotaxic** and **apneustic** centers



# Brain Stem Respiratory Control Centers







# A. Medulla Respiratory Centers

- Regulates the rate and pattern of breathing.
- Accelerates or slows down breathing rates

## 1. Inspiratory Center or Dorsal Resp Group (DRG)

- Basic rhythmic breathing

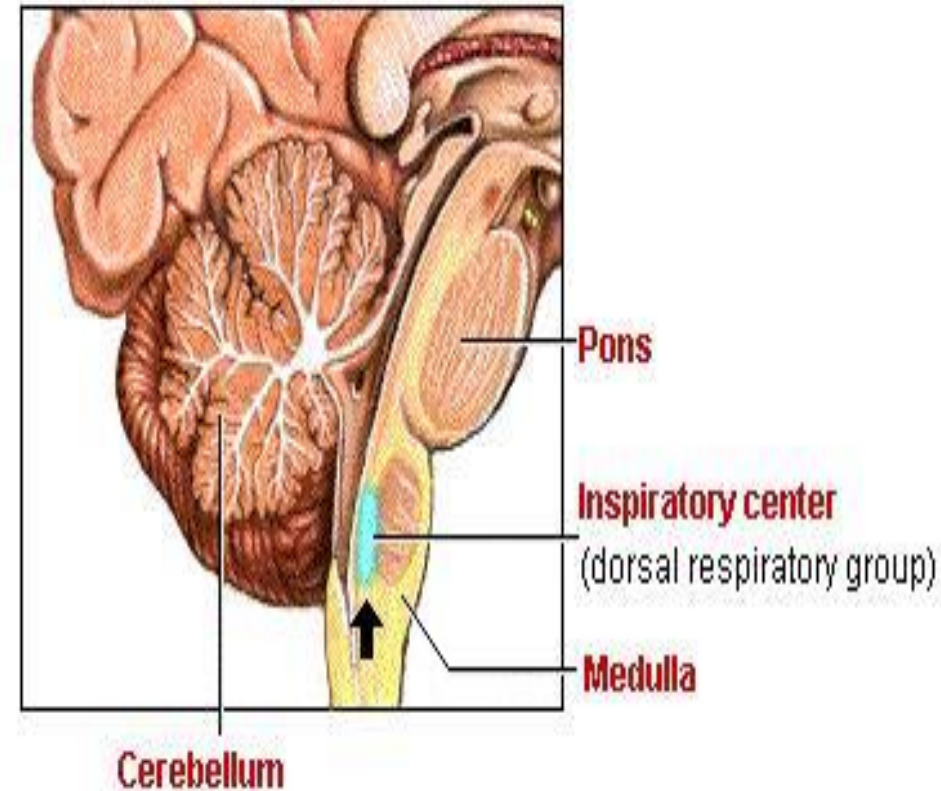
Phrenic nerve ---->

Intercostal nerves --->

Diaphragm + external intercostals

- **Containing Insp. neurons**

## INSPIRATORY CENTER



The basic rhythm of breathing is controlled by respiratory centers located in the medulla and pons of the **brainstem**.

The inspiratory center (dorsal respiratory group) sets this rhythm by automatically initiating inspiration.

# A. Medulla Respiratory Centers

## 2. Expiratory Center or Ventral Resp Group (VRG)

Forced expiration) ---->

Phrenic nerve ---->

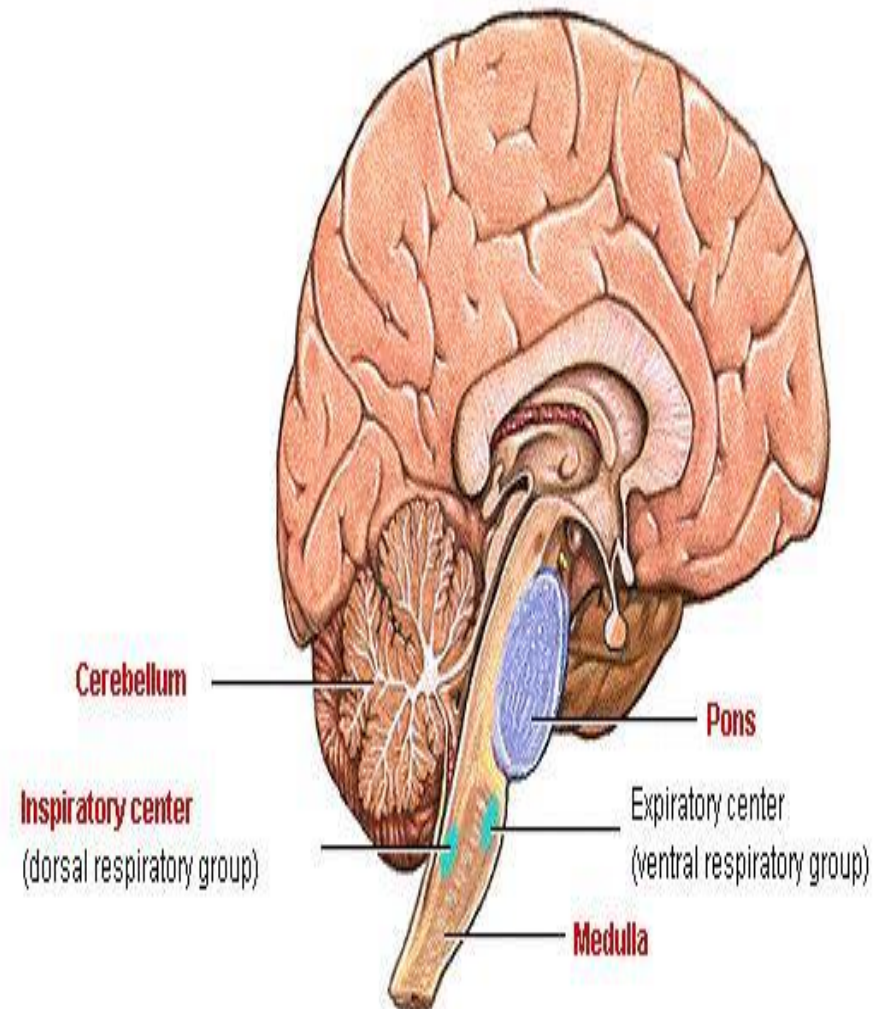
Intercostal nerves --->  
internal intercostals +  
abdominals  
(expiration)

- **Containing Exp. neurons**

## OTHER RESPIRATORY CONTROL CENTERS

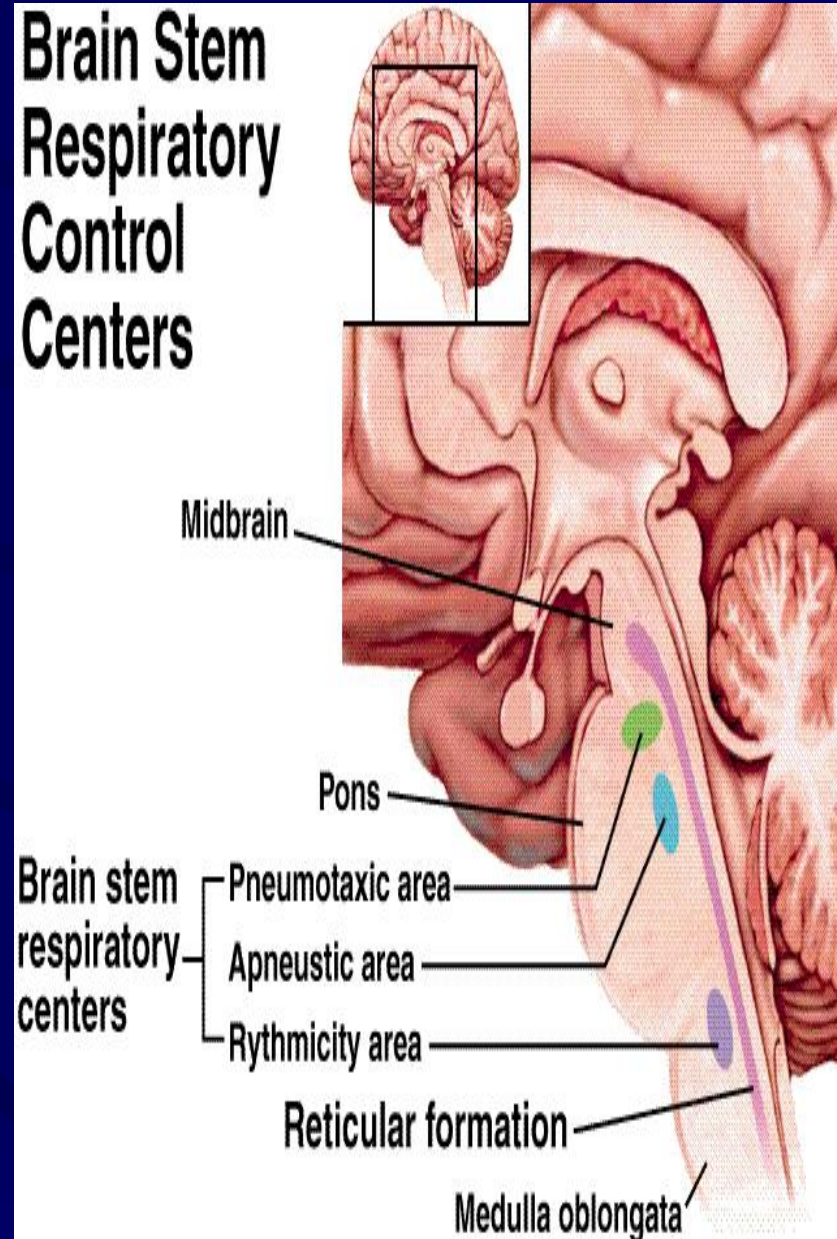
The **expiratory** center in the medulla appears to function during forced expiration, stimulating the internal intercostal and abdominal muscles.

Other respiratory centers in the pons modify inspiration and allow for smooth transitions between inspiration and expiration. Their precise roles are not fully understood.



# B. Pons Respiratory Centers

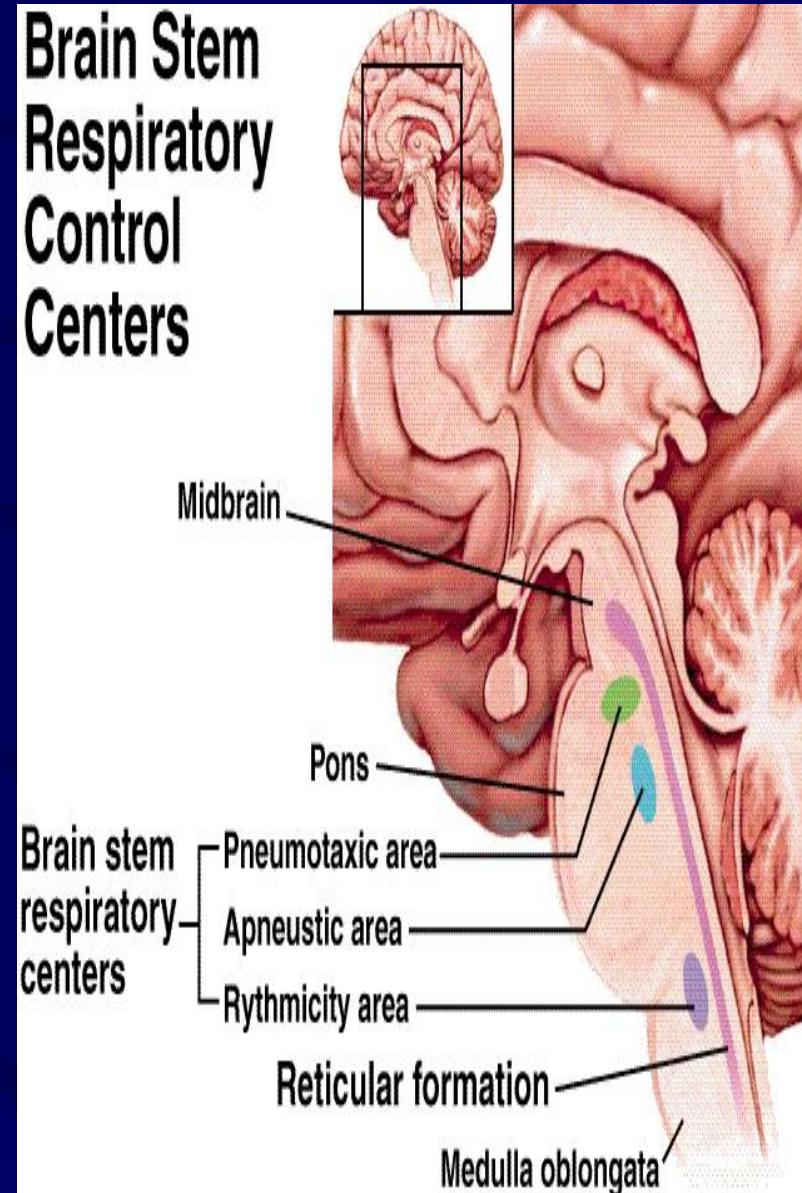
- **Pneumotaxic center**
  - Located in upper part of the pons
  - **Slightly inhibits medulla, causes shorter, shallower, quicker breaths**
  - Inhibitory effect on inspiration
  - Its function is to modulate the activity by apneustic center on and off to create the normal rhythm of respiration
  - when activity of inspiration center stops, inhibitory impulses cease from pneumotaxic center and inspiratory impulses initiated





# B. Pons Respiratory Centers

- **Apneustic center**
  - Located in lower portion of pons
  - **Stimulates the medulla, causes longer, deeper, slower breaths (prevent switch off)**
  - Stimulatory effect on Insp. center
  - Its activity is modulated on and off by pneumotaxic center
  - It is intermittently **inhibited by vagal discharge (Herring-Breuer Reflex)** arise from lung which appear during inflation of the lung and disappear during deflation of the lung



# Genesis of normal rhythmic respiration

1) The apneustic center stimulates the inspiratory center so inspiration is **switch on**.

2) The inspiratory center sends gradual impulses to inspiratory muscles → gradual inspiration (inspiratory ramp signal).

3) This inspiratory signal is **switch off** by:

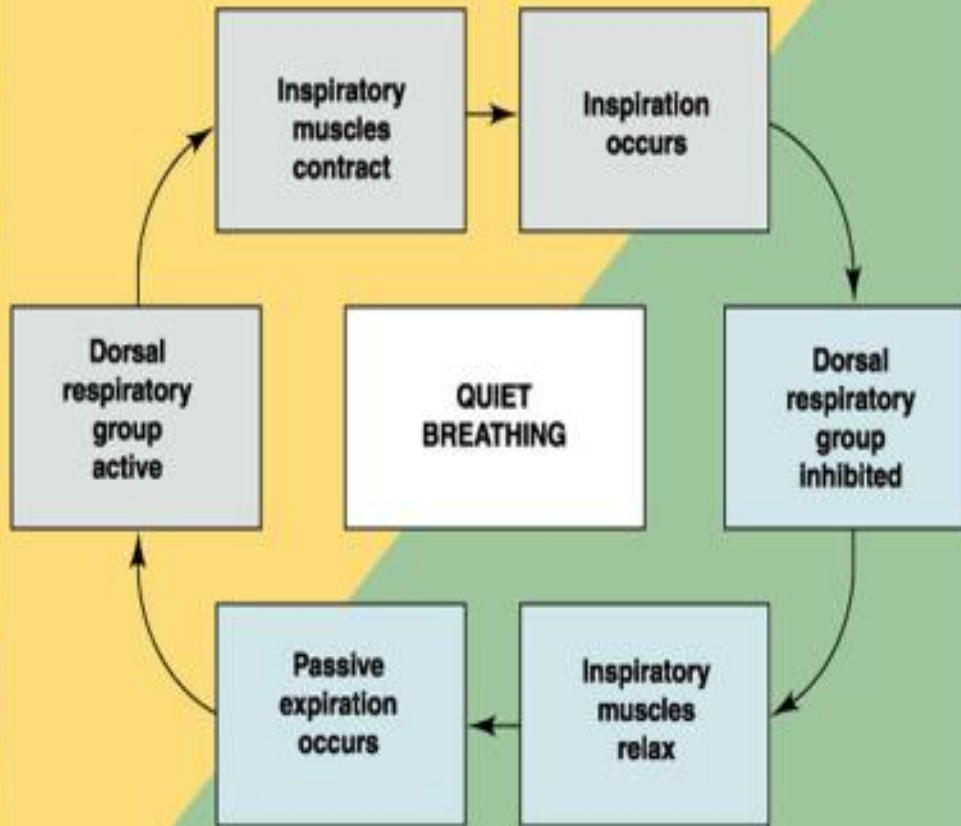
(a) **Vagi**: as a result of stimulation of stretch receptors in smooth muscle of bronchioles (Hering Breuer reflex).

(b) **Pneumotaxic center**: but slow in action than vagal inhibition both (a) & (b) inhibition of apneustic and inspiratory centers.

4) Once inspiration is inhibited expiration follows passively. Expiratory Centre is active in forced expiration.

**N.B Pre-Bottzinger complex**: It is the *pace maker* neurons present bilaterally in medulla oblongata and give *rhythmic discharge* to phrenic nerve.

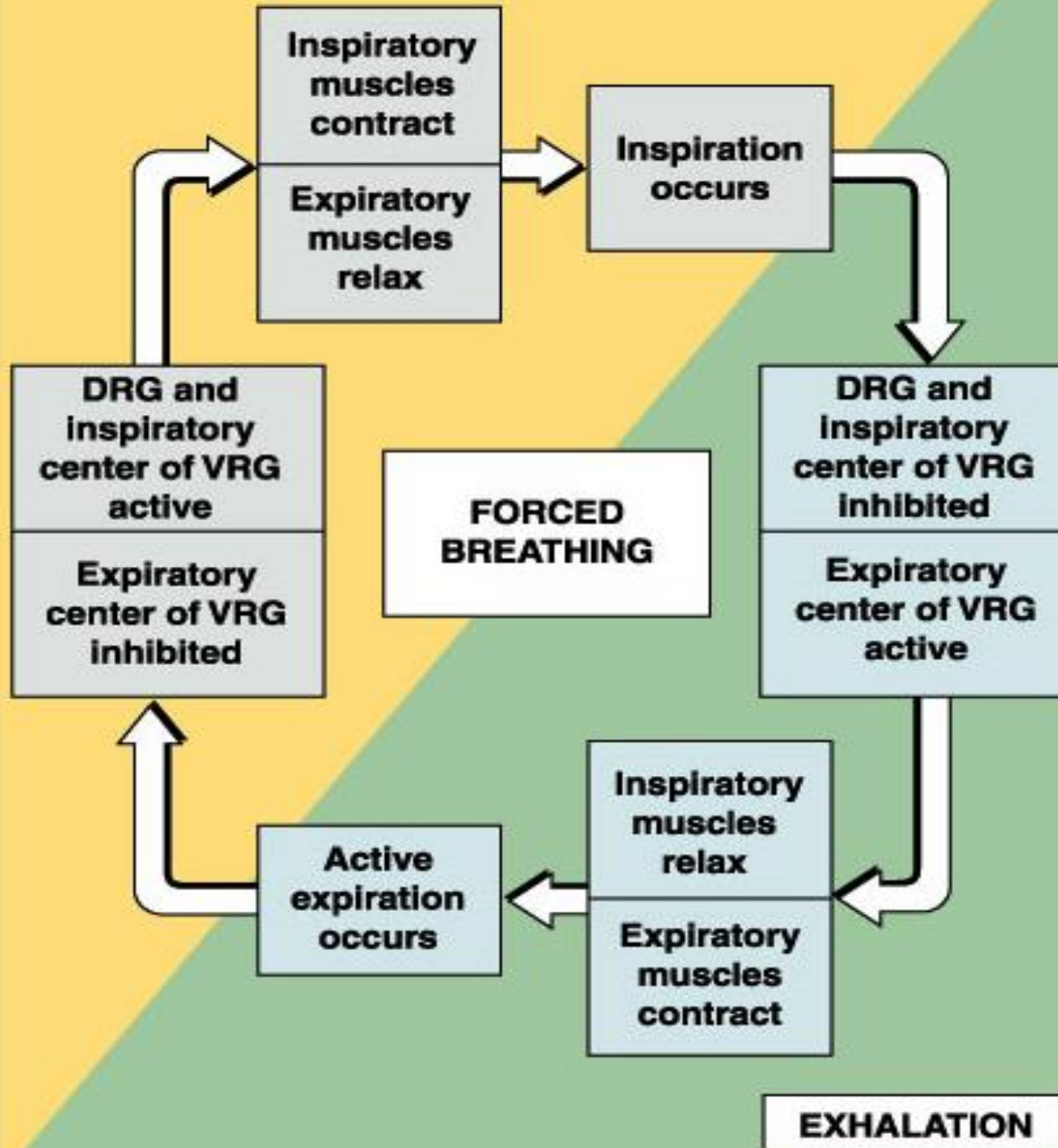
**INHALATION  
(2 seconds)**



**EXHALATION  
(3 seconds)**



**INHALATION**

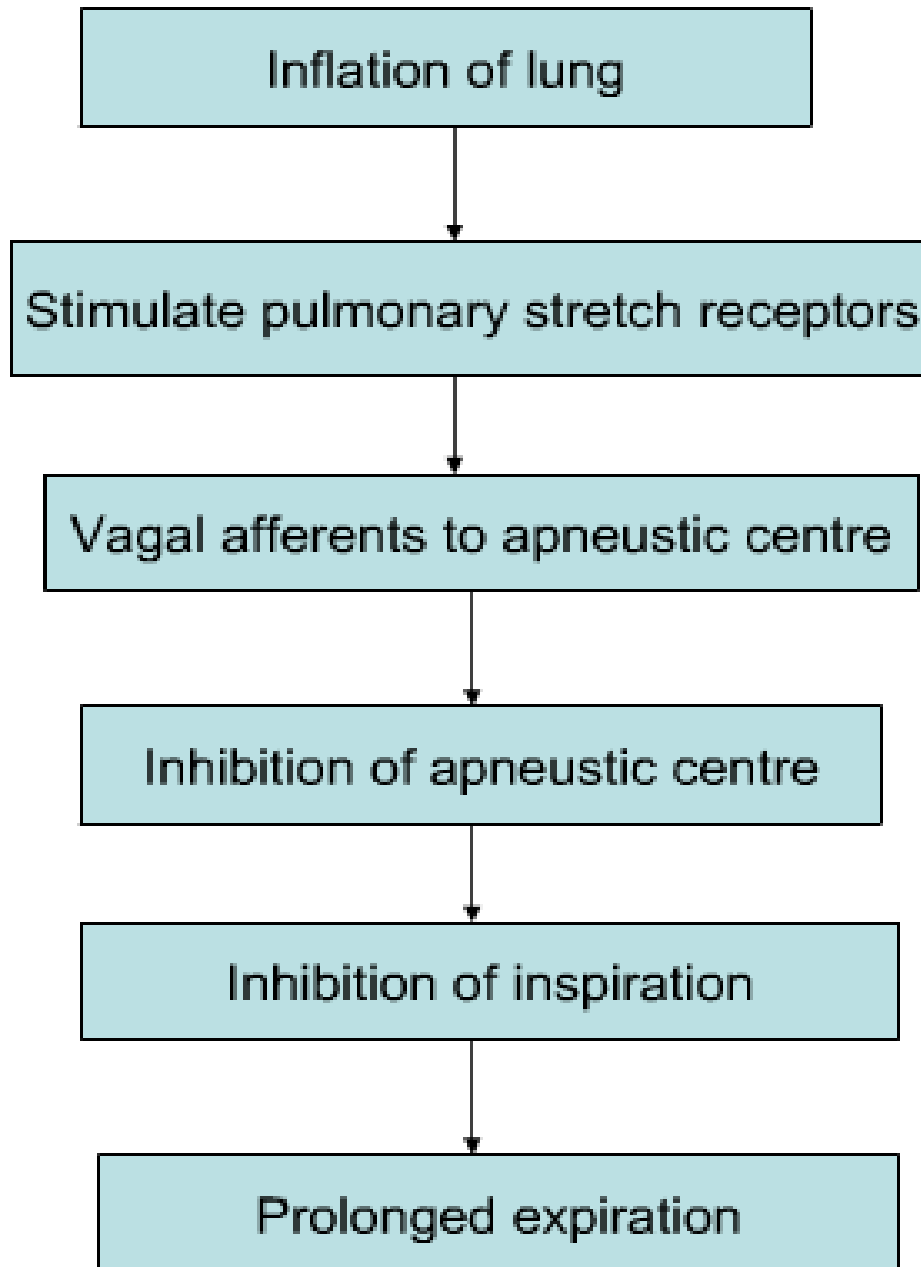


**EXHALATION**

# Vagal (inflation) reflex (Herring- Breuer reflex)

- Stretch or inflation endings of Vagus nerve (X) in bronchi, bronchioles, lungs to medulla
- Discharges inhibitory impulses causing inspiration to stop
- Expiration occurs, lungs deflate and stretch receptors are no longer stimulated
- **Limits inspiration and prevents over inflation**

# 1. Hering-Breuer inflation reflex:



## **Significance:**

Absent at normal tidal volume.

Threshold at 1-1.5lts of tidal volume.



# Experimental evidence of respiratory centers

Complete section of brain stem above pons	normal <u>A</u> utomatic respiration without voluntary control
Section at lower medulla or upper cervical	<u>d</u> eath (as in Hanging)
Section of lower cervical	<u>d</u> iaphragmatic respiration
Bilateral vagotomy	<u>d</u> eep & slow respiration
Bilateral vagotomy + Damage of pneumotaxic center	<u>A</u> pneusis (inspiratory spasm interrupted by short expiration by fatigue of muscles).

**Thank You**

