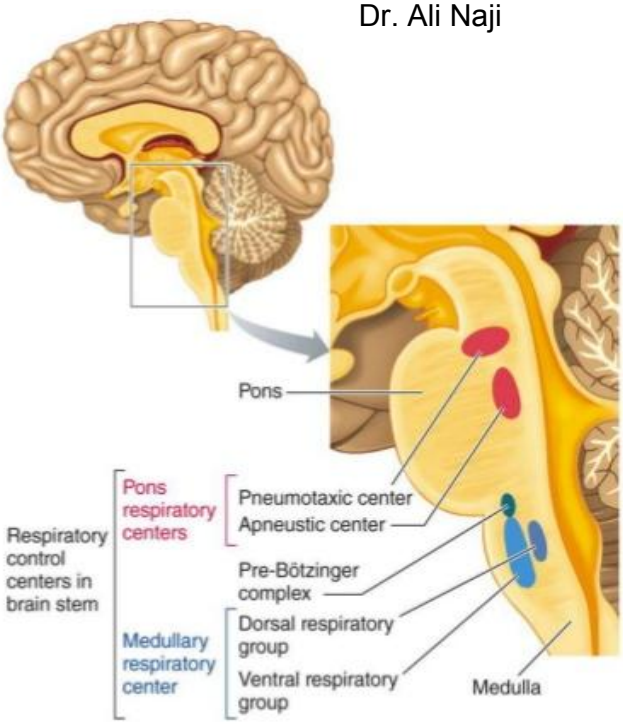


Regulation of respiration :

Breathing is regulated by two mechanisms:

- Neural regulation
- chemical regulation

Neural regulation of breathing :

I. **Voluntary control.**
II. **Automatic control**
III. **Reflex control**

Voluntary control:

- Respiration is a spontaneous process but it can be regulated by the motor cortex in the brain which send impulses to the respiratory motor neurons through corticospinal tract to the muscles of respiration → an individual can voluntarily change the pattern of breathing in talking , singing and can also stop breathing for a period of time .
- Voluntary control pathway bypasses the medullary respiratory center (automatic)
- Sometimes automatic control is damaged without loss of voluntary control (Ondine's curse) which can be caused by a pathological conditions that affect the medullary center.

Automatic control :

Is done by groups of neurons located bilaterally in the medulla oblongata and pons called **Respiratory center which can be classified into medullary and pontine center**

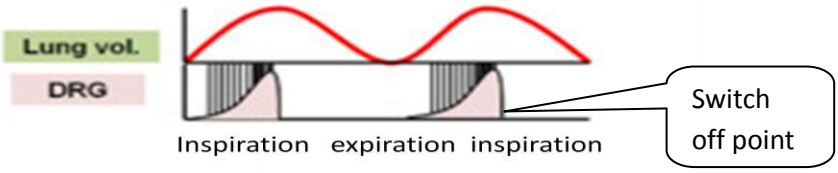
A. **medullar center** :
   - **it is the basic respiratory control** . It contains the **pre BÖtzinger complex** which is a group of pacemaker cells situated in either side of the medulla .they discharge spontaneously and rhythmically . they have two types of receptors :
     - NK1 receptors which is **stimulated** by P substance (associated with pain)

- μ –opioid receptors : opioids inhibit respiration through these receptors → opioid drugs side effect →cause respiratory depression

➢ medullary center contains two other groups of neuron (dorsal respiratory group and ventral respiratory group). impulses from these cells activate respiratory motor neurons in the spinal cord.

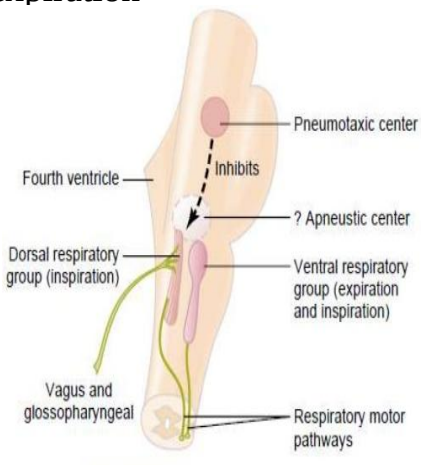
1) **Dorsal respiratory group :**

- they contain **I** neurons (**I**nspiration)
- they are active during quite inspiration and is controlled by pre Botzinger complex
- they receive sensory signals which are transmitted through Vagus (CN 10) and glosopharyngeal nerve (CN 9) from Peripheral chemoreceptores , Baroreceptores and pulmonary receptors in the lung (ex: stretch receptors)
- send impulses to **inspiratory** motor neuron .
- **Inspiratory ramp signal** : is the pattern of the action potential produced by DRG to the inspiratory muscles. it begins weakly and increases gradually in a ramp like manner for 2 second then stops for 3 seconds →gradual increase in lung volume during inspiration rather than inspiratory gasps and allow the elastic recoil of the chest and the lung to cause expiration in between



2) **Ventral respiratory group:**

- Has neurons for inspiration (type I neurons) and for expiration (type E neurons). →these neurons contribute to both inspiration and expiration
- They are **inactive** during normal quiet respiration.
- When the respiratory drive ↑→ respiratory signals pass to the ventral respiratory neurons → extra respiratory drive.
- Send impulses to **inspiratory and expiratory** motor neuron
- They are important in providing an overdrive mechanism When high levels of pulmonary ventilation are required (exercise).



B. Pontine center : modifies the activity of the medullary center :

1. Apneustic center 2. Pneumotaxic center

Apneustic center : (enhance inspiration)

- Locates in the lower pons.
- send **excitatory impulses** to the dorsal neurons to increase depth of breathing

Pneumotaxic center : (limit inspiration)

- Locates dorsally in the upper portion of the pons
- **Transmits inhibitory** impulses to the dorsal respiratory group by inhibiting Apneustic center to→decrease depth of inspiration and secondary effect causes increase in the rate .
  - **The apneustic and pnuemotaxic centers work against each other together to control the respiratory rate and depth of inspiration .**

<u>Effect of different brain stem and vagus nerve lesions on respiratory center activity :</u>

A. above the pons :
   - Vagus intact → normal breathing (respiratory center is intact)
   - After Vagatomy → loss of inhibitory impulse of lung stretching →↑depth ,↓ rate

B. Below pneumotaxic center (mid pons) :
   - Vagus intact : ↑ depth and ↓ rate
   - After vagatomy : apneusis (prolong inspiratory spasm that resemble breath holding).

C. Pontomedullary junction : irregular breathing

D. Below medulla : stop breathing (Fatal)