Reflex control :

Receptors are classified into two types:

- Receptors inside respiratory system
- Receptors outside respiratory system

Receptors inside respiratory system : three types

- Slowly adapting receptors (stretch receptors)
- Rapidly adapting receptors (irritant receptors)
  Both are innervated by myelinated vagal nerve

  Note Slowly or rapidly adapting receptors basis on whether sustained stimulation leads to prolong or transient discharge in their afferent nerve ending .

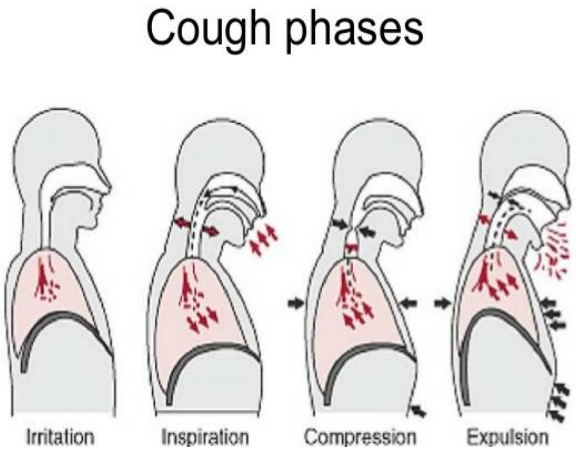
- (Juxtacapillary receptors) or J receptors which is Unmyelinated C fiber ending . They are present in the alveolar interstitium adjacent to pulmonary capillaries and are innervated by vagal fibers. They are stimulated by an increase in the alveolar interstitial fluid volume

1- Stretch receptors :

- **Hering –Breuer inflation reflex** : Is an inhibitory reflex transmitted from **stretch receptors** in the muscular wall of bronchi and bronchioles through vagus nerve when the lung stretched three times the normal tidal volume (1.5L) →↓depth of breathing and ↑RR (like pneumotaxic ceneter) .Importance of Hering-breuer reflex is it prevents excessive inflation of the lung
- **Hering –Breuer deflation reflex:** sever deflation of the lung →no inhibitory signal from stretch receptors →inspiratory signals will prolong and ↑filling volume (bring lung volume back to normal)

2- **Irritant receptors** : are located between epithelial cell of the tracheobronchial tree . they produce protective reflexes , irritant receptors stimulated by dust ,cold air, histamine and irritant gas → bronchospasm , mucous secretion , cough and sneezing :

- Cough reflex :(afferent nerve is vagus →medullary center) stimulation of irritant receptors →stimulation of respiratory center →deep inspiration (2.5 L) → then glottis is closed and followed by forceful contraction of abdominal and expiratory muscles → forceful expiration against closed glottis →↑ pressure inside the lung to 100 mmHg →glottis open suddenly →explosive out flow of air



- Sneezing reflex :mechanism is similar to the cough reflex with these differences :
    - ✓ Irritant receptors in the nasal passages
    - ✓ Afferent nerve is the fifth cranial nerve
    - ✓ Glottis is continuously open and the Uvula is depressed downward→ most of flow pass through the nose .

Other visceral reflexes:

Hiccup : is a spasmodic contraction of the diaphragm and other inspiratory muscles accompanied by suddenly closure of glottis which is responsible for the characteristic sensation and sound.

- Pathophysiological significance is unknown
- Although it can results from conditions such as nerve irritation (phrinic and vagus), indigestion and central nervous system abnormality like brain tumor , most of the time it is harmless and temporary and attacks are usually of short duration.
- Often respond to breathe holding or other measures that ↑ arterial PCo2.

Yawning: is a reflex respiratory act characterized by deep inspiration and typical prolonged musical sound .It is often infectious .The exact mechanism is unknown and the probable functions are :

1. Remove excess CO2 from blood and improve oxygenation of tissue .it usually occur in people are fatigue or tired
2. Improve lung expansion and prevent collapse of alveoli
3. Improve venous return
4. Nonverbal communication.

Receptors outside the respiratory system : two types

1. Stimulate respiration :
   - **Proprioreceptors** :present in muscles ,tendon and joints → when stimulated (ex : excesice)→stimulates respiratory center→↑ventilation even before changes in PO2, PCO2 ,and pH
   - **Nociceptors** : pain →stimulate respiratory center .
   - **Thermoreceptors** : present in the hypothalamus →stimulate respiratory center when temp ↑
   - **Emotional stimuli** from hypothalamus and limbic system →alter respiration during : crying , laughing .

2. Inhibit respiration :
   - **Visceroreceptores** : (deglutition apnea) :is an inhibitory reflex that occurs during swallowing → prevents entry of food into respiratory passages .
   - **Baroreceptors**

Chemical regulation of respiratory center

The aim is to maintain a proper concentration of O2,CO2 and H ion in the blood through two types of chemical receptors :

1- Central chemoreceptors
2- Peripheral chemoreceptors

Central chemoreceptors :

- They are located bilaterally in the medulla in the **chemosensetive area .**
- They are stimulated indirectly by CO2 through H ion in brain interstitial fluid and CSF (cerebrospinal fluid)
- H ion and HCO3 penetrate Blood brain barrier (BBB)very slowly while CO2 is easly pass through it .when CO2 in blood ↑→ pass BBB and reacts with H2O↔ H2CO3 →H + HCO3 . ↑H ion in both interstitial fluid of the medulla and the cerebrospinal fluid → potent stimulant to the central chemoreceptors.
- CO2 is a potent **acute controller** of the respiratory drive but a weak **chronic controller** (after 1-2 days the effect of CO2 on chemoreceptors decreases to 1/5 its initial effect) why ?
    - Initially: CSF has a fewer buffers than blood →↑H ion in CSF has a potent action on Central chemoreceptors.
    - over hours of initial stimulation the HCO3 slowly diffuse through the BBB→ combine with H ion and ↓ its concentration and ↓ its effect .
- Central chemoreceptors are not affected by changing in blood O2 and H concentration.
- CCR are inhibited by anesthesia.