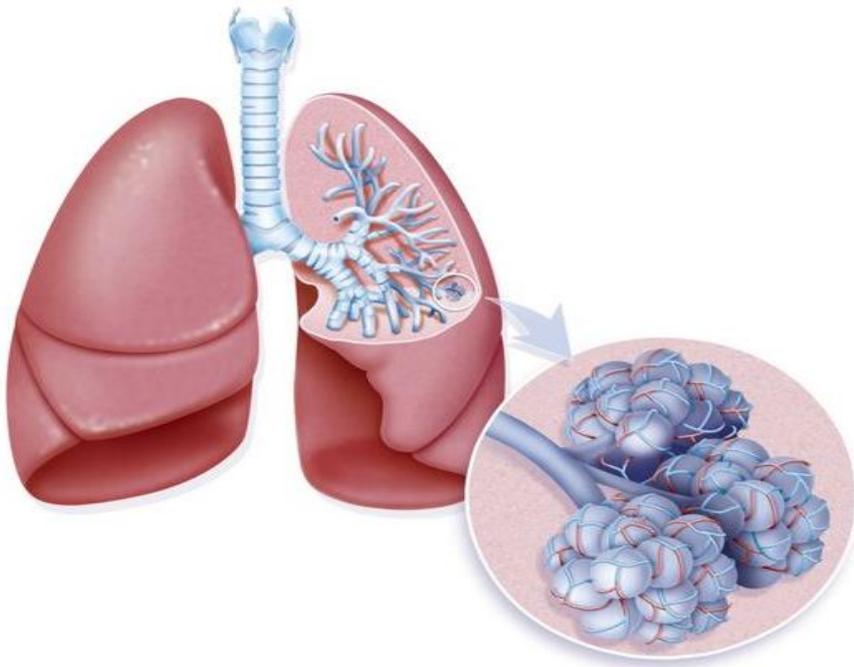




# Respiratory



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***Number***

*1*

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➔ **The human respiratory system** is a series of organs responsible for taking in **oxygen** and expelling **carbon dioxide**. The primary organs of the respiratory system are lungs, which carry out this exchange of gases as we breathe.

➔ To perform this function, there should be harmonically working components which include:

1. **The lungs** -> the main organ.

2. **Conductive system** -> airways including nasal openings, larynx, pharynx and main bronchi + alveoli of the lungs.

3. **Pump system** -> rib cage + spine + respiratory ( inspiratory and expiratory) muscles ( diaphragm mainly and intercostal muscles)  
It is important for keeping a pressure gradient.

\*Bilateral diaphragmatic paralyses is incompatible with life.

4. **Control system** -> respiratory centers in the CNS and chemoreceptors. Chemoreceptors detect changes in  $pO_2$ ,  $pCO_2$  and pH which is dependent on  $CO_2$ .

Respiratory centers get signals from the chemoreceptors and give orders to control the breathing rate to have normal breathing act, but if these centers fail to send orders hypoventilation will occur ( abnormal levels of  $O_2$  and  $CO_2$  )

\*Hypoventilation may lead to respiratory failure

✓ All these components work together by **pumping** gases from the atmospheric air to the lungs through the **conductive** system to reach the alveoli

✓ All these components are needed for us to breathe, and any abnormality in one of them may lead to **respiratory failure**.

## Respiratory Failure

A syndrome in which the respiratory system fails in one or both of the gas exchange functions (O<sub>2</sub> and CO<sub>2</sub>), it's of two types:

<b>Hypoxemic</b>	<b>Hypercapnic</b>
<ul style="list-style-type: none"><li>○ <b>Type I</b> respiratory failure.</li><li>○ Due to severe hypoxemia ( low pO<sub>2</sub>) with normal or low pCO<sub>2</sub></li><li>○ We consider the person hypoxemic if pO<sub>2</sub> is under 60mmHg based on the O<sub>2</sub>-Hb dissociation curve (when pO<sub>2</sub> is 60mmHg, oxygen saturation is %90).</li><li>○ Caused when the oxygen concentration in the air is low such as in high altitudes, and in lung diseases that affect alveolar parenchyma (pneumonia, pulmonary edema, lung fibrosis ) that prevents gas exchange through diffusion.</li></ul>	<ul style="list-style-type: none"><li>○ <b>Type II</b> respiratory failure.</li><li>○ Due to hypercapnia (high pCO<sub>2</sub>).</li><li>○ pCO<sub>2</sub> is above 50 mmHg.</li><li>○ Accompanies problems in the control and pump systems (multifocal fibrosclerosis, rib fractures...)</li></ul>

- ❖ **Hypercapnia** depends on the **alveolar ventilation rate**.
- ❖ **Alveolar ventilation's rate** = tidal volume \* respiratory rate \* **Tidal volume**-> the exhaled air volume in a respiration cycle. Tidal volume will be reduced if the patient doesn't have normal functioning respiratory muscles.
- ❖ **Control** system problems will cause **hypoventilation** due to **apneas** (*inability to breathe*).

- ❖ **Pump system** problems will cause **hypercapnia** and **decreased ventilation** because of **low tidal volume**.

**Low tidal volume**-> **Low alveolar ventilation rate** -> **Hypercapnia**

\*abnormal breathing rate doesn't necessarily mean respiratory failure.

- ❖ Not every hypoxia is respiratory failure, it has to be severe (  $pO_2 < 60$  mmHg)
- ❖ **Normal  $pO_2 = (101 - (1/3) * \text{patient's age}) \pm 5$**   
Example: if the patient is 21 years old then its  $101 - (1/3) * 21 = 94$   
So the normal range for this patient is 89-99
- ❖ Oxygen **saturation** is measured by the **pulsoximeter** while  **$pO_2$**  is measured by arterial blood gas **analysis**

## **Respiratory Diseases**

### **1) Control system problems**

- Either in the **chemoreceptors** or **respiratory centers**.
- Congenital abnormalities in the chemoreceptors causes **primary hypoventilation syndrome**.
- Most common cause of suppression of the respiratory centers is **drug overdose**, mainly **morphine**, which is used as a post-operative pain killer and palliative treatment for cancer patients.
- Other things that affect the respiratory centers include **tumors, strokes, cerebral hemorrhages, trauma,...**

**Remember:** all of the above will lead to **hypoventilation** and **hypercapnic respiratory failure**.

### **2) Pump system problems**

- For respiratory failure to occur, bilateral diaphragmatic paralysis should be present such as in diaphragmatic fatigue which is caused by tetanus.

\*Weakening of the respiratory muscles occurs when there is muscular diseases ( myopathies ) such as neuromotor diseases, myasthenia gravis, COPD secondary to muscle wasting and cachexia, duchenne muscular dystrophy in addition to problems in the ribs such as scoliosis.

**Remember:** all of the above will lead to **hypercapnic** respiratory failure.

### **3) Lung diseases**

- Cause **hypoxemic** respiratory failure
- They include pulmonary edema, emphysema, fibrosis, pneumonia, acute respiratory distress syndrome (ARDS)
- **ARDS** is a very common cause of **severe hypoxemic** respiratory failure.

It's a secondary disease to **sepsis** and **multiple trauma** characterized by **diffuse lung infiltrate**.

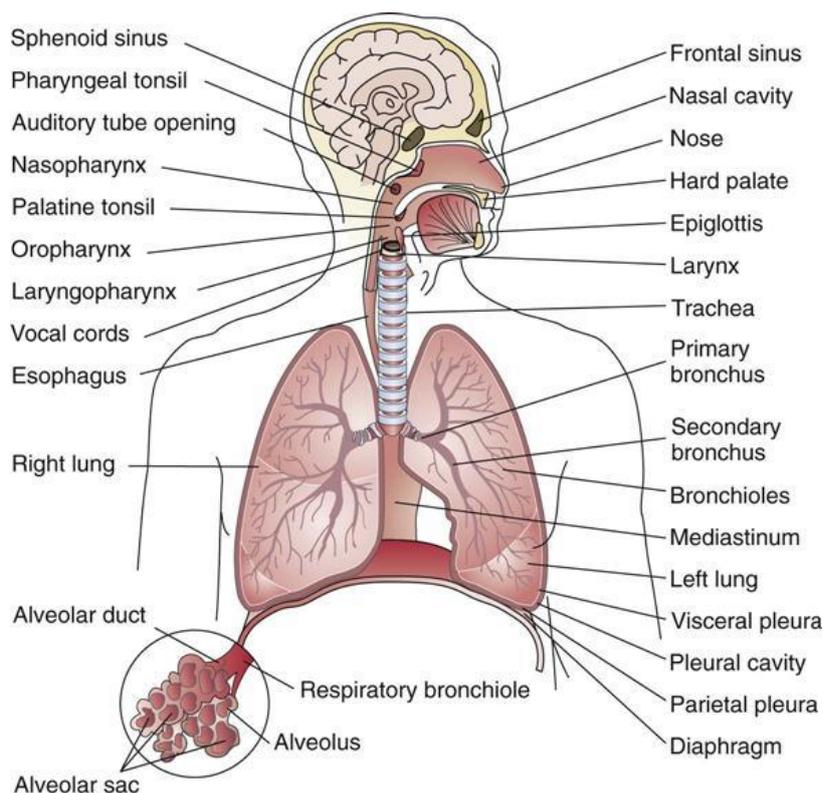
Patients are resistant to oxygen therapy meaning that they can never reach  $pO_2$  of 60 mmHg in spite of getting high concentrations of  $O_2$  (100% saturated)

### **Common Respiratory Symptoms**

- 1) **Cough** (usually a sign of airways problems)
- 2) **Dyspnea** ( shortness of breath/SOB)
- 3) **Cyanosis** (due to lack of oxygen)
- 4) **Chest pain asthma, COPD , bronchitis.**
- 5) **Sputum.**
- 6) Can be associated with **fatigue.**

## Notes:

- Tachypnea is a sign rather than a symptom
- If a patient comes to you with a chest pain, first think of **cardiac problems**, such as angina ( central chest pain with typical radiation to the left arm , left neck and jaw ) ,then respiratory problems such as pneumonia (pain is caused when the pleura is affected since it is full of receptors).
- Lungs parenchyma have no pain receptors , and the patients feel the pain when their plural nerves get involved ( pneumonia , pneumothorax, pleurisy ), They cause pleuritic chest pain ( pain with breathing).
- Wheezing indicates narrowing of the airways ( asthma, COPD ).
- The major disease to cause sputum secretion is bronchiectasis.



*The End*