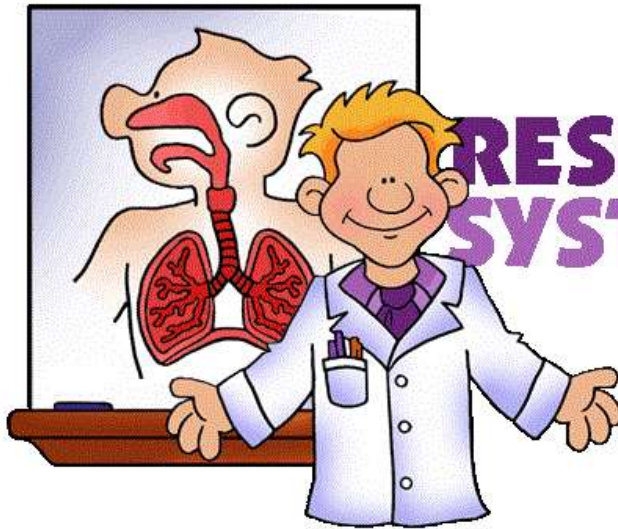




Physiology Team 432



## RESPIRATORY SYSTEM

7<sup>th</sup> Lecture

# Hypoxia and Cyanosis

**DONE AND REVIEWED BY:**

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# Objectives

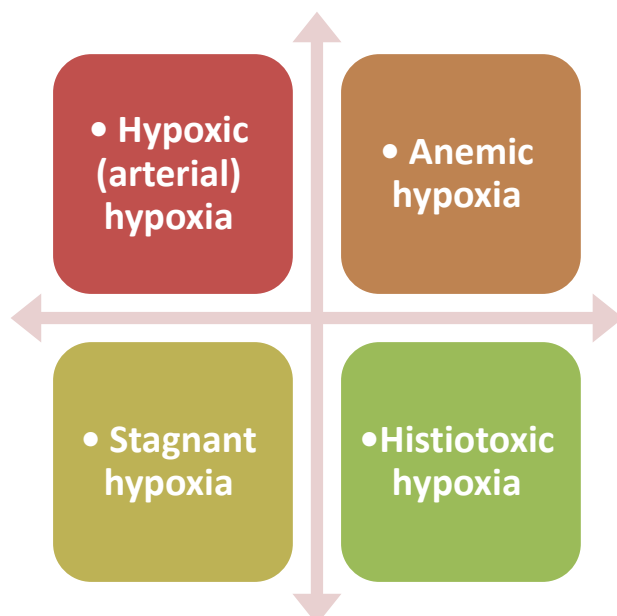
By the End of this lecture you should be able to:

- Define **hypoxia** and list its various physiological and pathological causes.
- Define **hypo and hyper-ventilation** in terms of arterial PCO<sub>2</sub> and PO<sub>2</sub>.
- Define **cyanosis** and its clinical presentation
- Define **ventilation/perfusion (V/Q) ratio** and its normal values.

## What is Hypoxia ?!

"Deficiency of oxygen in the tissue cells"

Can be classified into the following groups:



### Hypoxic Conditions

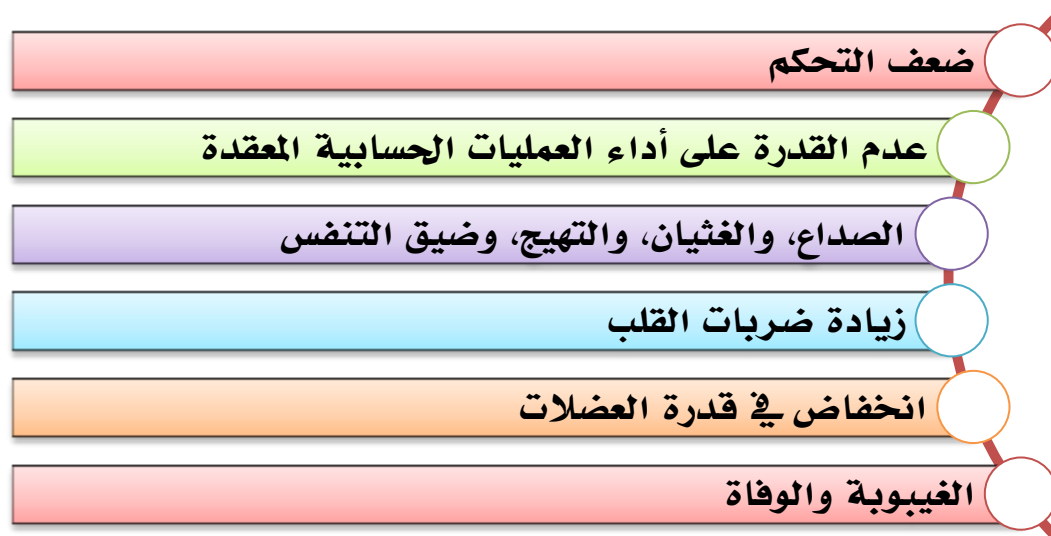
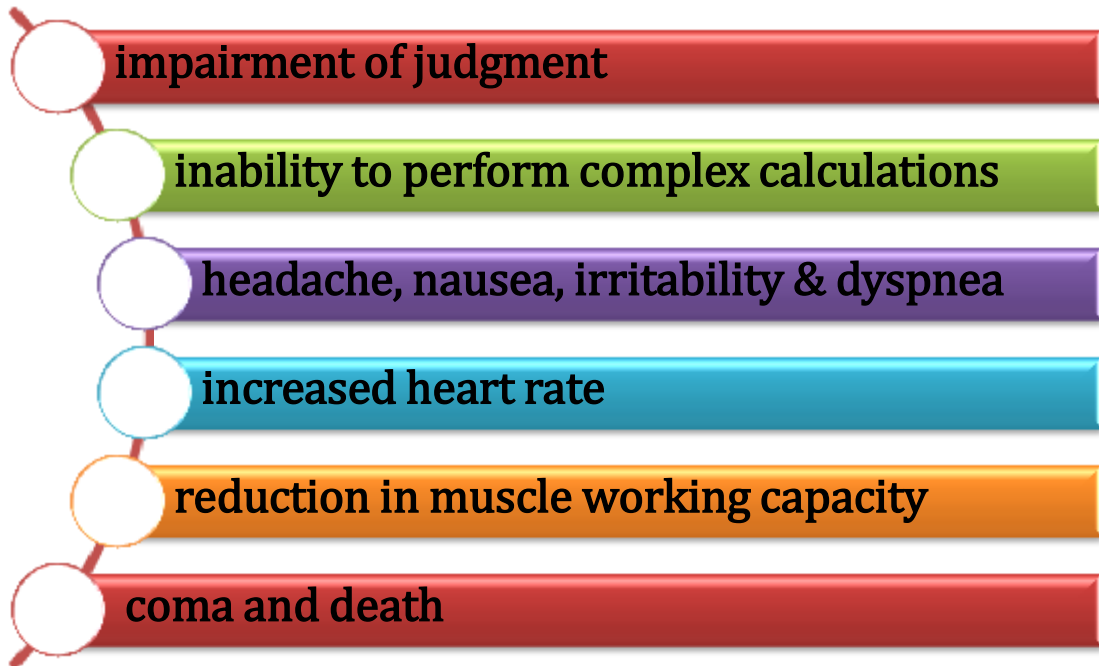


Type of Hypoxia	Due to	Notes
<b>Hypoxic (arterial) hypoxia</b>	<p><b>Reduced arterial PO<sub>2</sub></b></p> <ul style="list-style-type: none"> <li>Alveolar hypoventilation</li> <li>Diffusion abnormalities</li> <li>Right to left Shunt</li> <li>Ventilation-perfusion imbalance.</li> </ul>	<p>Ventilation-perfusion imbalance (including increased physiological dead space and physiological shunt)</p>
<b>Anemic hypoxia</b>	<p><b>Decreased amount of Hb or abnormal type of Hb which is unable to carry oxygen → Reduction in the oxygen carrying capacity of the blood</b></p> <p><b>Causes:</b></p> <ul style="list-style-type: none"> <li>Anemia.</li> <li>Abnormal Hb e.g. met-Hb, carboxyhemoglobin.</li> </ul>	<p>The PO<sub>2</sub> and Hb-O<sub>2</sub> % is normal.</p>
<b>Stagnant hypoxia</b>	<p><b>Reduced blood flow through the tissues</b></p> <p><b>Causes:</b></p> <ul style="list-style-type: none"> <li>General slowing of the circulation, as in heart failure and shock</li> <li>Local slowing (vasoconstriction, cold, arterial wall spasm).</li> </ul>	<p>So more and more oxygen is extracted from the blood, and due to slow circulation less oxygen is carried by the blood at the lung, leading to <b>hypoxia</b></p>
<b>Histiotoxic hypoxia</b>	<p><b>inability of the tissues to use O<sub>2</sub></b></p> <ul style="list-style-type: none"> <li>Inhibition of the oxidative enzyme activity e.g. cyanide poisoning causing blockade of the cytochrome oxidase activity</li> </ul>	<p><b>Cyanide</b>  مادة الزرنيخ الموجودة في ظروف الرسائل</p>

## Asphyxia:

Respiratory airway is blocked and that's lead to **hypoxia** and **hypercapnia co2** ↑

## Effects of Hypoxia



# Treatment of Hypoxia

Oxygen therapy in a tent or high oxygen tension mask.









<b>Useful</b>	<ul style="list-style-type: none"><li>• hypoxic hypoxia</li></ul>
<b>less</b>	<ul style="list-style-type: none"><li>• Stagnant hypoxia</li><li>• Histiotoxic hypoxia</li></ul>
<b>Unuseful</b>	<ul style="list-style-type: none"><li>• Histiotoxic hypoxia</li></ul>

## Hypercapnea ( $\uparrow$ $\text{CO}_2$ )

- Excess of  $\text{CO}_2$  in body fluids.
- It usually occurs with **hypoxia**.
- When  $\text{PCO}_2$  increases above 52 mmHg, it decreases the **PH**

## Features of Hypercapnea

 Peripheral vasodilatation	 Warm extremities and bounding pulse	 Headache, coma and drowsiness
 Sweating	 Muscle twitching	 Papilledema (swelling of optic disc)

# Cyanosis



## Defination:

Blue discoloration of the skin and mucus membrane and found in hypoxic and stagnant hypoxia.

## Reason:

More than 5 g/dl of reduced (deoxygenated) Hb in blood.

## Note:

A person with anemia almost **never** develops cyanosis due to low amount of Hb for 5 grams to be deoxygenated /100ml blood.

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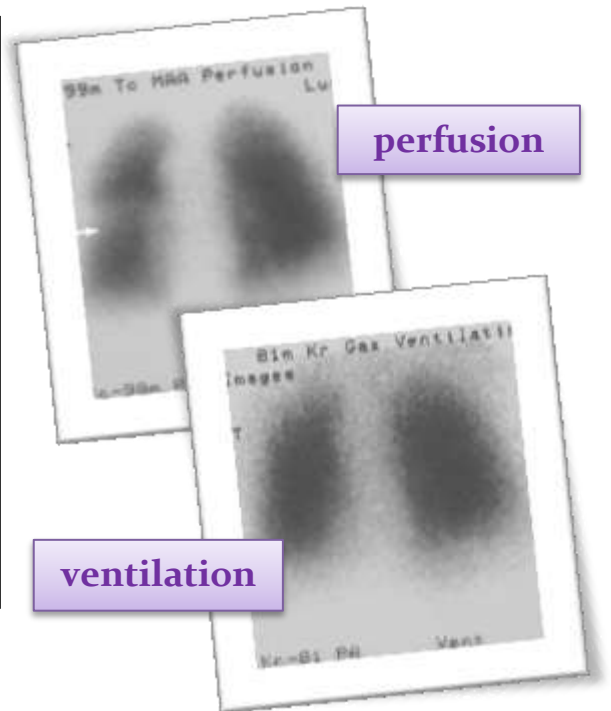
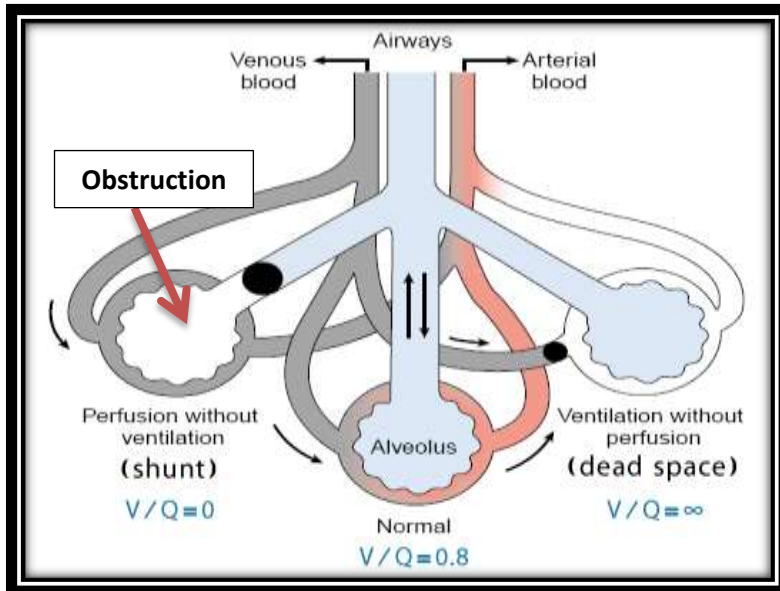
## Ventilation–Perfusion Ratio (V/Q)

- It is the ratio of alveolar ventilation to pulmonary blood flow per minute.
- The alveolar ventilation **at rest** (4.2 L/min)
- The pulmonary blood flow is equal to **right ventricular output** per minute (5L/min)

$$V/Q \text{ ratio} = \frac{4.2}{5} = 0.84$$

- ✓ Average V/Q ratio across the lung is 0.8
- ✓ At the apex V/Q ratio = 3
- ✓ At the base V/Q ratio = 0.6
- ✓ During exercise the V/Q ratio becomes more homogenous among different parts of the lung.

The **apex** is **more ventilated** than perfused and the **base** is **more perfused** than ventilated.



- ✓ The main function of this ratio is to determine the **state of oxygenation** in the body.
- ✓ Any mismatch in the ratio can result in **hypoxia**.
- ✓ When the  $V/Q$  ratio is **less** than normal this is called **physiologic shunt**  
(A certain fraction of the venous blood is passing through the pulmonary capillaries without being oxygenated i.e. shunted blood).
- ✓ When  $V/Q$  is **more** than normal this is called **Physiologic dead space**  
(When the ventilation of some of the alveoli is great but the alveolar blood flow is low, ventilation of these alveoli is wasted).

## **Abnormalities of the $V/Q$ ratio**

- In the Upper and Lower normal lung:  
**Apex  $V/Q$  ratio = 3** (moderate degree of **physiologic dead space**)  
**Base  $V/Q$  ratio = 0.6** (represent a **physiologic shunt**).
- In Chronic Obstructive Lung disease COPD:  
 Because of **bronchial obstruction** in some areas and **destruction of the alveolar septa** in other areas with patent alveoli, those people have some areas of the lung exhibit serious **physiologic shunt** and other areas serious **physiologic dead space**.
- COPD is the most prevalent cause of **pulmonary disability** today, lung effectiveness as a gas exchange organ may **decrease to 10%**.

# Notes from Dr. Ashraf

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- ❖ To **diagnose hypoxia** use **ABG**: arterial blood gas analysis.
- ❖ There is two **types of shunt** that can cause arterial hypoxia or (**hypoxic hypoxia**):

## 1- Central shunt :

In the heart like **patent ductus arteriosus** (opening between the aorta and pulmonary trunk).

## 2- Peripheral ( vascular ) :

In Arterio-venous blood.

- ❖ **Respiratory center** is in the **brainstem**.

- ❖ **Cyanosis** can be :

1 – **Central** (**blue tongue**):

That's mean shunt in the heart.

2 – **Peripheral**:

Blue color in the fingers and lips.

**GOOD LUCK**