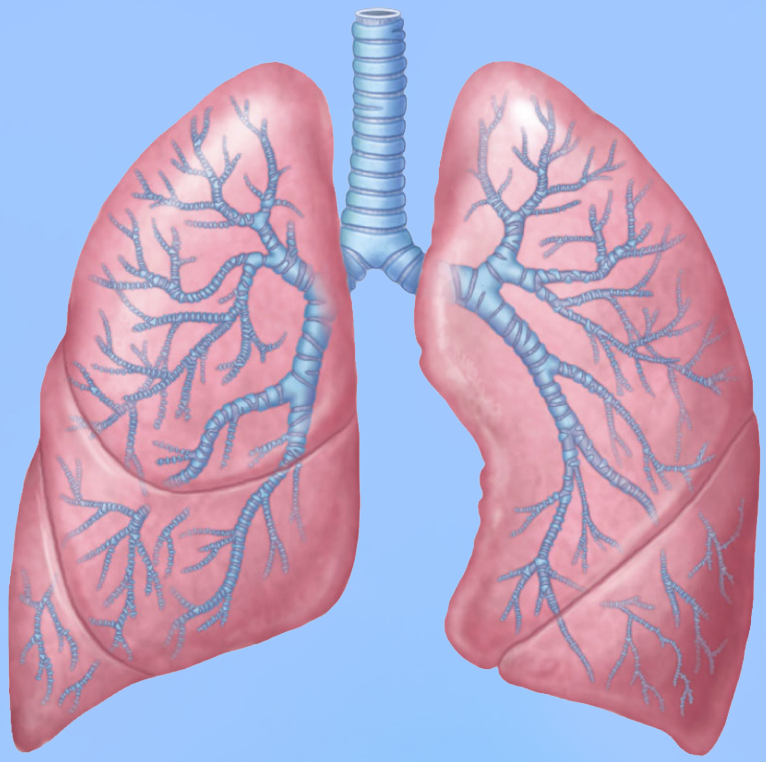
7 Hypoxia and Cyanosis



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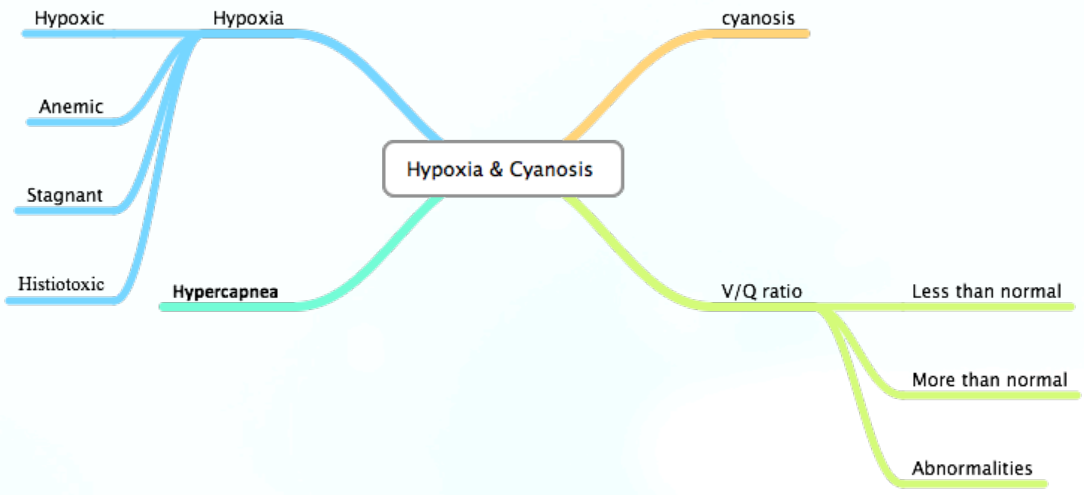
Respiratory Block

Objectives:

Define hypoxia and list it's various physiological and pathological causes
Define hypo and hyper ventilation in terms in terms of arterial PCO2 and PO2
Define cyanosis and its clinical presentation
Discuss Ventilation-Perfusion Ratio and its normal value.

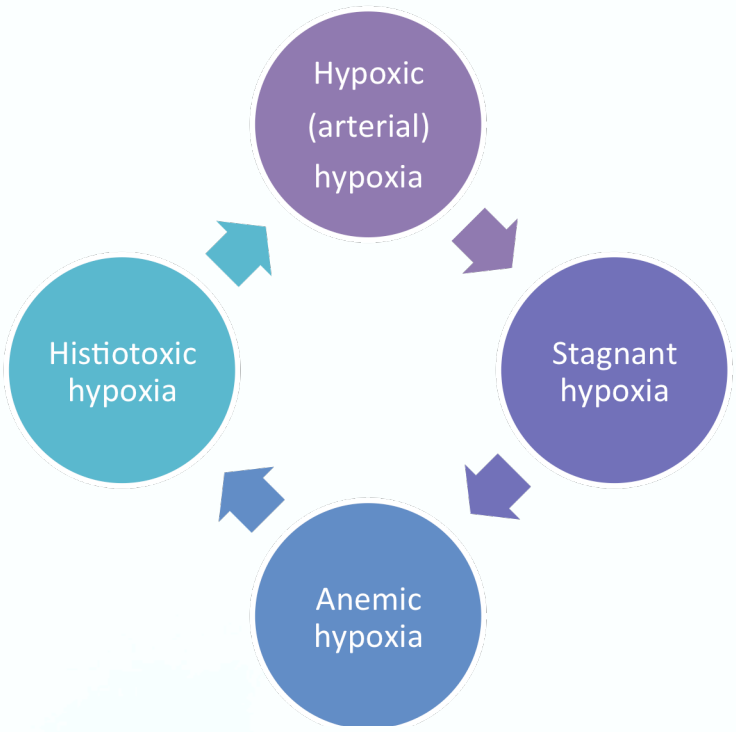
Mind map



Hypoxia

Definition: Loss f Oxygen supply to the tissues, usually due to insufficient Oxygen concentration in the blood

Types of hypoxia



What is the difference between HYPOXIA and HYPOXEMIA?

Hypoxia: decreased oxygen supply to the tissues.

Hypoxemia: low levels of dissolved oxygen in the arterial blood.

Types of hypoxia	Caused by	Notes
Hypoxic (arterial)	Reduced arterial PO_2 • Alveolar hypoventilation • Diffusion abnormalities • Right to left shunt • Ventilation perfusion imbalance • High altitude or drowning	* Diffusion abnormalities may be due to thick Resp. membrane (normally it's very thin) * pulmonary fibrosis and COPD can cause this type of hypoxia
Anemic hypoxia	It is reduction in the oxygen carrying capacity of the blood, due to • decreased amount of Hb Anemia • Abnormal type of Hb which is unable to carry oxygen Met Hb, Carboxy Hb	• The PO2 and % Hb-O2 is normal. • PO_2 is NORMAL but the *problem* is in the reduced Hb count which causes low O_2 delivery rate to the tissues (although the arterial PO_2 is normal) • The affinity between Hb and O_2 is normal and may be even increased due to the increased DPG
Stagnant hypoxia	It's reduced blood flow through the tissues, 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 hypoxia. Causes: 1-General slowing of the circulation, as in heart failure and shock 2-Local slowing in the extremities e.g. vasoconstriction, cold, arterial wall spasm.	Please note that in STAGNANT Hypoxia Hb count and the arterial PO_2 are NORMAL. Furthermore, the O2 content is NORMAL in the arterial blood. So what's the reason behind this hypoxia, although everything is in the normal range? Due to decrease blood circulation which lead to it's failure to provide adequate amount of oxygen to the tissue

Effects of hypoxia

- Impairment of judgment
- Inability to perform complex calculations
- Headache, nausea, irritability and dyspnea
- Increased heart rate
- Reduction in muscles working capacity
- Coma and death if severe

Treatment of Hypoxia

Oxygen therapy: **in a tent **high oxygen tension mask

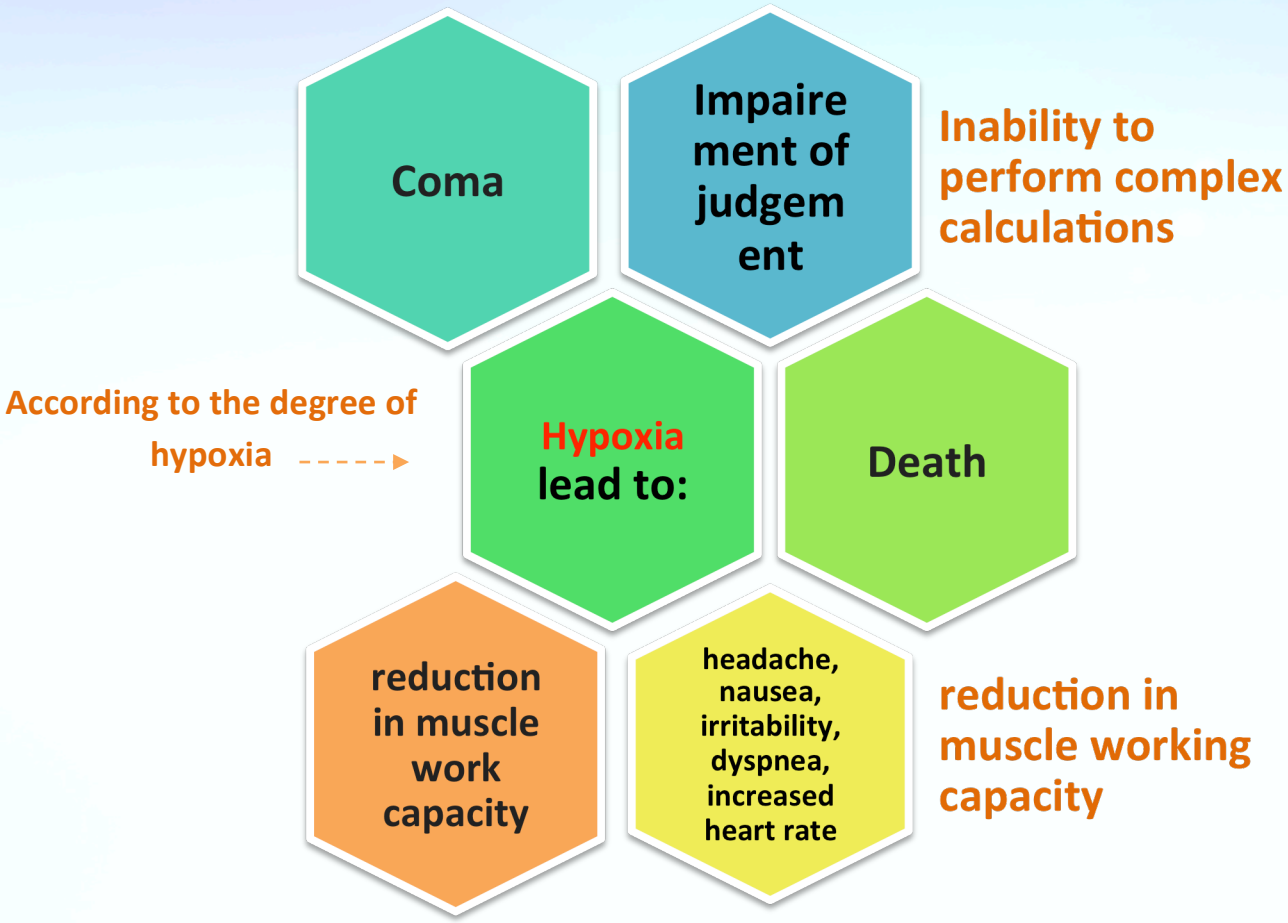
Useful	❖ Hypoxic hypoxia
Less useful	❖ Stagnant hypoxia ❖ Anemic hypoxia
Unuseful	❖ Histiotoxic hypoxia

Cyanosis

Blue discoloration of the skin and mucus membrane due to more than 5 g/dl (5g/100ml) of reduced (deoxygenated) hemoglobin in blood.

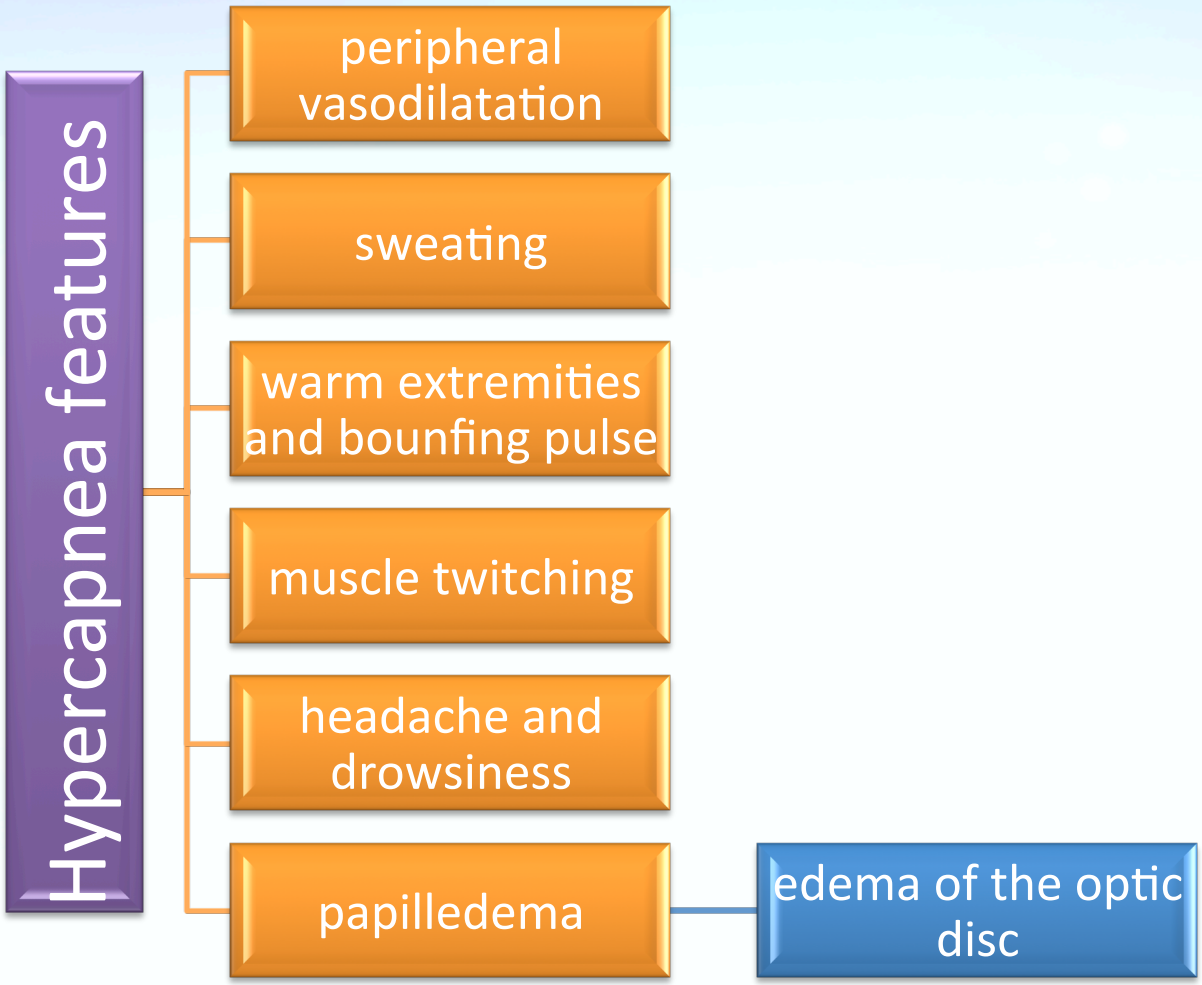
Blue discoloration of the skin and mucus membrane due to more than 5 g/dl of reduced (deoxygenated) hemoglobin in blood.

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



Hypercapnea :

Excess of co2 in body fluids, it usually occurs with hypoxia, pco2 increases above 52 mmhg, it decreases the ph



Cyanosis

Arterial blood with > 5g Hb/100ml in deoxygenated state, results in a bluish / purple discoloration of nail beds and mucous membranes.

An anemic patient may not have sufficient deoxygenated Hb to appear cyanotic (Never cyanotic)

Ventilation –perfusion ratio (V/Q)

1

Ventilation –perfusion ratio (V/Q) = $\frac{\text{ALVEOLAR VENTILATION (4.2)}}{\text{PULMONARY BLOOD FLOW RATE (5)}}$

2

What is this ratio used for?

to determine the state of oxygenation in the body.

What does a mismatched ratio result in?

Hypoxia (Hypoxic)

3

- **apex is more ventilated than perfused**
- **base is more perfused than ventilated.**
- ***During exercise the V/Q ratio becomes more homogenous among different parts of the lung***

Site of Lung	Value
Average	0.8
Apex	3.0
Base	0.6

4

When low = Physiological shunt

When high = physiological dead space

Q1: Vasoconstriction occurs in :

A- Hypoxic or arterial hypoxia
B- Anemic hypoxia
C- Stagnant hypoxia
D- Histiotoxic hypoxia

Q2: The PO2 and % Hb-O2 is normal in

A- Hypoxic or arterial hypoxia
B- Anemic hypoxia
C- Stagnant hypoxia
D- Histiotoxic hypoxia

Q3: O2 therapy will not benefit in :

A- Hypoxic or arterial hypoxia
B- Anemic hypoxia
C- Stagnant hypoxia
D- Histiotoxic hypoxia

Q4: Peripheral vasodilatation occurs in :

A- Hypoxic or arterial hypoxia
B- Hypercapnea
C- Stagnant hypoxia
D- Histiotoxic hypoxia

Q5: The alveolar ventilation at rest :

A- 4.2
B- 5
C- 0.84
D- 1.94

Q6: When the V/Q ratio is LESS than norma this is called :

A- physiologic shunt
B- Physiologic dead space
C- Anemic hypoxia
D- Stagnant hypoxia

Q7: When the V/Q ratio is MORE than normal this is called :

A- physiologic shunt
B- Physiologic dead space
C- Anemic hypoxia
D- Stagnant hypoxia

Q7: v/q ratio of the apex of the lung is:

A- 3
B- 0.6
C- 2.5
D- 3.7

Answers: 1-C 2-B 3-D 4- B 5-A 6-A 7-B 8-A

Summary

Hypoxic or arterial hypoxia	**Reduced arterial PO2**	
Anemic hypoxia	**reduction in the oxygen carrying capacity of the blood**	1- due to decreased amount of Hb or abnormal type of Hb which is unable to carry oxygen 2- The PO2 and % Hb-O2 is normal .
Stagnant hypoxia	**reduced blood flow through the tissues**	less oxygen is carried by the blood at the lung :Causes 1-General **slowing of the circulation**, as in heart failure and shock 2-Local slowing e.g **vasoconstriction**, cold, arterial wall spasm
Histiotoxic hypoxia	**inability of the tissues to use oxygen**	1-due to inhibition of the oxidative enzyme activity e.g **cyanide poisoning•** 2-**not** benefit from O2 therapy
Hypercapnea	**Excess of CO2 in body fluids**	1-PCO2 increases above 52 mmHg, it decreases the PH 2-Features of hypercapnea: Peripheral **vasodilatation**
Cyanosis	**Blue discoloration of the skin and mucus membrane**	due to more than 5 g/dl of reduced (deoxygenated) hemoglobin in blood
Ventilation – perfusion ratio (V/Q	**It is the ratio of alveolar ventilation to pulmonary blood flow per minute**	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