

Hypoxia & Cyanosis



Editing File



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-Main Text -**Important** -Notes
-Boy Slides -Girl Slides -Extra

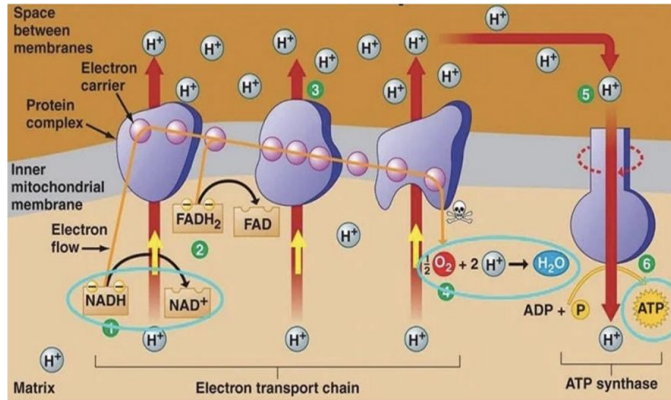
Objectives

- 01** Define **hypoxia**, **hypoxemia**, **asphyxia** and **cyanosis** and list their various physiological and pathological causes.
- 02** Outline the treatment of hypoxia
- 03** Describe the pathophysiology, features and effects of different types of hypoxia.
- 04** Define **hypercapnia** and list its causes and manifestations.
- 05** Define **hypo** and **hyperventilation** in terms of arterial PCO₂ and PO₂.
- 06** Define **cyanosis** with its clinical presentation and **explain its pathophysiology**.



Why do we need oxygen?

- O₂ is essential to produce energy on ongoing bases to make ATP



What do we need for normal oxygenation?

- Oxygen in the air (20.8%).
- Action of chest wall and diaphragm.
- Patent (**access**) respiratory passages.
- Elastic alveoli.
- Surfactant.
- Wall of alveoli and capillary.
- RBCs, hemoglobin.
- Adequate venous & arterial circulation.
- Capillary walls.
- Tissue fluid & cells. (**should be normal**)
- Mitochondria (**where electron transport chain occur to produce energy**)

Terms and Definitions

Hypoxia

A condition in which the body or a region of it is deprived of adequate oxygen supply/**deficiency of oxygen** at the **tissue** cell.

Anoxia =No O₂

Hypoxia is a result that has many causes (*Shock, Vessel Obstruction...*) one of these causes is Hypoxemia (low O₂ in blood)

Hypoxemia

When oxygen levels in the **blood** are lower than normal.

Hypercapnia

Excess carbon dioxide in the body **fluids**.

Asphyxia

Lack of oxygen or excess of carbon dioxide in the body that results in unconsciousness and often death

Cyanosis

Blueness of the skin & mucus membranes due to excessive amounts of deoxygenated hemoglobin.

Hypoxia

Types of hypoxia

Hypoxemic or Hypoxic/arterial hypoxia.

Reduced O₂ tension of arterial blood.

Anemic Hypoxia

Decreased O₂ carrying capacity of the blood.

Stagnant/Ischemic hypoxia

Decreased rate of blood flow to the tissues.

Histotoxic hypoxia

Decreased utilization of O₂ by tissues.

Cause of hypoxia	PaO ₂	Common causes	Treatment strategies
Hypoxic	Low	Altitude	Supplementary oxygen
Anaemic	Normal	Bleeding and anaemia	Blood transfusion and address underlying cause of anaemia*
Ischaemic	Normal	Embolism, thrombus	Treat underlying cause by increasing blood flow to target organ*
Histotoxic	Normal	Cyanide poisoning	Reverse or address causal agent*

*increasing FiO₂ is not beneficial

Types of hypoxia

Types	Definition	Typical cases
Hypoxic	↓ oxygen tension	High altitude – hypoventilation – V/Q mismatch.
Anemic	↓ carrying capacity	Anemia – blood loss – CO poisoning
Stagnant	↓ perfusion	Heart failure – Shock – ischemia
Histotoxic	Cellular hypoxia	Cyanide – other metabolic poisons – shifting of O ₂ -HB curve.

Respiratory failure

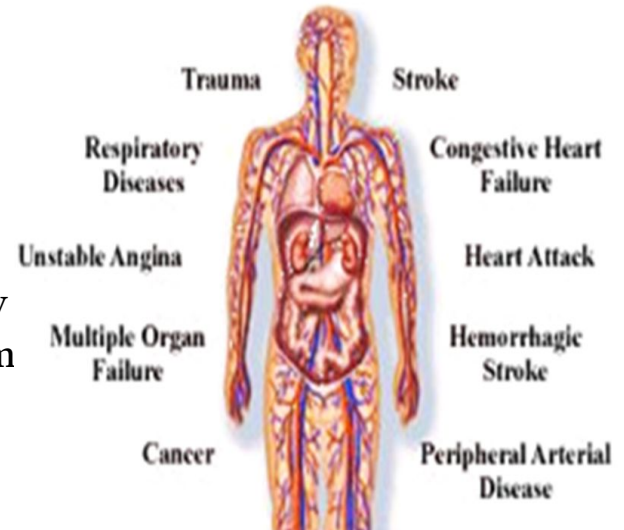
1

Type 1 respiratory failure: occurs when the respiratory system cannot adequately provide oxygen to the body, leading to **hypoxemia** ($O_2 < 75$ mmHg).
Eg; **alveolar hypoventilation in Pneumonia**

2

Type 2 respiratory failure: occurs when the respiratory system cannot adequately remove carbon dioxide from the body, leading to **hypercapnia** ($CO_2 > 50$ mmHg) & **Hypoxia** ($O_2 < 75$ mmHg).
Eg; **COPD**

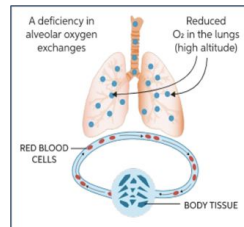
Hypoxic Conditions



Hypoxic or Arterial Hypoxia (Hypoxemia) (Altitude hypoxia)



Definition : Reduced oxygen tension (PO₂) of arterial blood.
(O₂ content and O₂ saturation is decreased)



normal		
-	Arterial	Venous
PO ₂	95	40
%Hb sat	97	75
O ₂ content	19	14
O ₂ utilized	19-14= 5ml	
A-V PO ₂ diff	95-40 = 55 mm Hg	

Hypoxic hypoxia		
-	Arterial	Venous
PO ₂	40	25
%Hb sat	75	45
O ₂ content	14	9
O ₂ utilized	14-9 = 5ml	
A-V PO ₂ diff	40-25 = 15 mm Hg	

Characteristics of hypoxic hypoxia:

1. Low arterial PO₂
2. Low % saturation of Hb
3. Low content of O₂
4. Low Arterio-venous PO₂ difference

The (A-V PO₂ diff) is a diagnostic tool and the question could come as a case so make sure that you know it, we will put an example in the QBank.

Causes of Hypoxic Hypoxia

1. Inadequate blood oxygenation in the lung:

- ❖ -O₂ deficiency (less) in the inspired air (atmosphere), eg. (high altitudes, breathing in closed space)
- ❖ Hypoventilation/Decreased pulmonary ventilation, eg. (Increase airway resistance, Decreased pulmonary compliance, asthma, paralysis of respiratory muscles, emphysema, airway obstruction, Respiratory center depression, etc)

2. Pulmonary disease:

- ❖ Alveolar hypoventilation
- ❖ Defective gas exchange and O₂ transfer due to problems/reduction in respiratory membrane diffusion, eg. Pulmonary edema
- ❖ -Defective (abnormal) ventilation-perfusion ratio due to
 - Uneven alveolar ventilation, as in asthma, emphysema, pulm. fibrosis, pneumothorax, CCF (congestive cardiac failure), increased physiological dead space or physiological shunt
 - Due to non uniform pulmonary blood flow, as in Anatomical shunts (Fallot's Tetralogy), right to left shunts causing venous admixture

Shunt: an abnormal communication between right & left sides of heart or between systemic & pulmonary vessels, allowing blood to flow directly from one circulatory system to the other.

Pathophysiology of Hypoxic Hypoxia

1

Low O₂ via peripheral chemoreceptors (located in the carotid “carotid sinus” and aortic bodies “aortic arch”)

2

Stimulates respiratory center to increase PO₂

3

Washout of CO₂ → less PCO₂

4

Shifts the O₂-Hb dissociation curve to left

5

Less release of O₂ to tissue → tissue hypoxia

Compensatory changes

1

Hypoxic stimulation of respiration

2

Alkaline urine which is due to **respiratory** alkalosis which results from PCO₂ washout by hyperventilation

3

Rise of BP (blood pressure)

4

Polycythemia with increased Hb

5

Increased 2,3 DPG in RBC (**shift to right and release O₂ to tissue**)

Anemic Hypoxia

Hemoglobin have 4 subunit, each one combine with one O₂, so 1 hemoglobin will carry 4 O₂, RBC have 260 million hemoglobin, so $260 \times 4 = 1$ billion O₂ in 1RBC

Definition : It is caused by reduction in the oxygen carrying capacity (Hemoglobin) of the blood, due to decreased/**reduced** amount of Hb or abnormal type of Hb which is unable to carry oxygen.

- The **arterial** PO₂ and % Hb-O₂ is normal

Causes :

Anemia

Hemorrhage → **normocytic anemia**

B12, folic acid deficiency → **megaloblastic anemia**

Abnormal Hb, e.g. :

Methemoglobin (MetHb) where iron is in **ferric form** instead of **ferrous form** (it's found normally in very small amount 1% but some drugs can induce the Oxidation of HB (abnormal) and will affect the ability of Hb to bind to O₂)

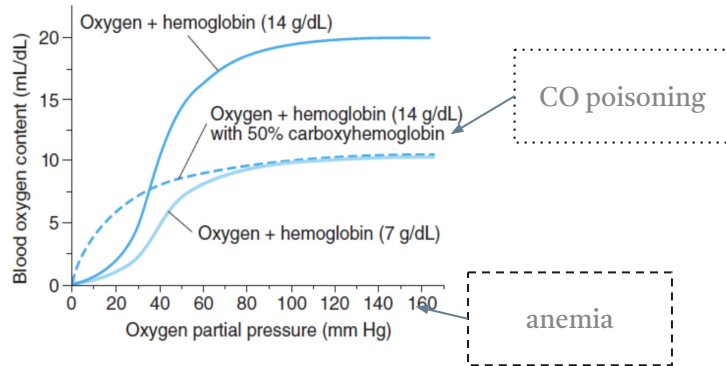
Carboxyhemoglobin (COHb)

Sickle Hemoglobin (HbS)

المشكلة هنا متعلقة الهيموجلوبين بالدم وليس الاكسجين
الذائب بالدم وليس الاكسجين المرتبط بالهيموجلوبين لذلك
يكون الضغط طبيعي في هذه الحالة

Anemic Hypoxia

Effect of anemia and CO₂ on hemoglobin binding of O₂



Normal oxyhemoglobin (14 g/dL hemoglobin) dissociation curve, compared with anemia (7 g/dL hemoglobin) and with oxyhemoglobin dissociation curves in CO poisoning (50% carboxy-hemoglobin)

Anemic hypoxia

-	Arterial	Venous
PO ₂	95	40
%Hb sat	Less	Less
O ₂ content	Less	Less
A-V PO ₂ diff	95-40 = 55ml (normal)	

Characteristics features in pathophysiology of anemic hypoxia

- Decreased O₂ carrying capacity of blood
- Here at rest hypoxia is not severe as, in anemia there is more 2,3 DPG which releases O₂ from Hb
- During exercise more O₂ demand by Tissues as more O₂ is consumed so severe hypoxia develops.

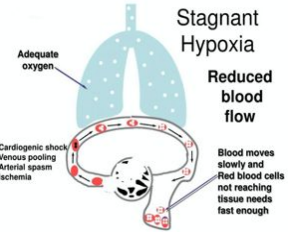
Compensatory changes

1. Hyper dynamic circulation, increased Cardiac Output and HR.
2. Increased speed of blood flow so that same Hb can be used repeatedly to transport O₂. (May cause heart failure due to increase heart work)
3. Rise of 2,3 DPG.
4. More erythropoiesis due to more erythropoietin in an attempt to correct anemia.

Stagnant/ischemic Hypoxia

People with stagnant hypoxia mostly develop edema and swelling due to blood not circulating

Definition : Caused by reduced blood flow or sluggish flow through the tissues, so more and more oxygen is extracted from the blood (inadequate O₂ supply) and due to slow circulation less oxygen is carried by the blood at the lung, leading to hypoxia. Is due to slow circulation and is a problem in organs such as the kidneys and heart during shock.



Causes :

- General slowing of the circulation, as in heart failure and shock/CCF (congestive cardiac failure), hemorrhage, Circulatory failure

المشكلة هنا تكون إما بالقلب أو بالأوعية الدموية مثل
Thrombosis

- Local slowing, eg. : vasoconstriction, cold, arterial wall spasm, Venous obstruction, coronary vasospasm

Like Raynaud syndrome



Stagnant hypoxia		
-	Arterial	Venous
PO ₂	95	25
%Hb sat	97	45
O ₂ content	19	9
O ₂ utilized	19-9 = 10ml	
A-V PO ₂ diff	95-25 = 70 mm Hg	

Due to slow speed of blood flow or stagnation blood stays for long in tissues, Venous Po₂ is less and accumulation of co₂ in tissues shifts the curve to right so more o₂ is released to tissue

Histotoxic Hypoxia

Definition : O₂ delivered to the tissues is normal but the issue is the inability of the tissues to use oxygen due to inhibition of the oxidative enzyme activity so the tissues cannot utilize O₂.

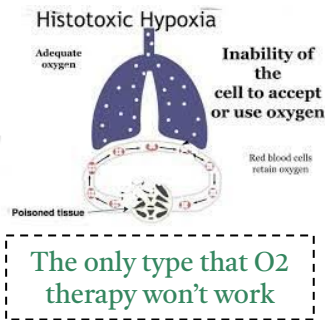
المشكلة تكون في فشل الخلية في التنفس الخلوي بسبب
تسمم في الجسم وليس نقص في الأكسجين

Causes :

1. **Cyanide poisoning** causing complete blockade of the cytochrome oxidase activity
2. Beriberi/vitamin B deficiency, in which several important steps in tissue utilization of oxygen are blocked and the formation of CO₂ are compromised
3. Deficiencies of some of the tissue cellular oxidative enzymes or of other elements in the tissue oxidative system can lead to this type of hypoxia.

Histotoxic hypoxia		
-	Arterial	Venous
PO ₂	95	90
%Hb sat	97	96
O ₂ content	19	18.5
O ₂ utilized	$19 - 18.5 = 0.5\text{ml}$	
A-V PO ₂ diff	$95 - 90 = 5 \text{ mm Hg}$	

So tissues cannot use O₂, so values at venous end are similar to arterial end.



Effects of Hypoxia on the body

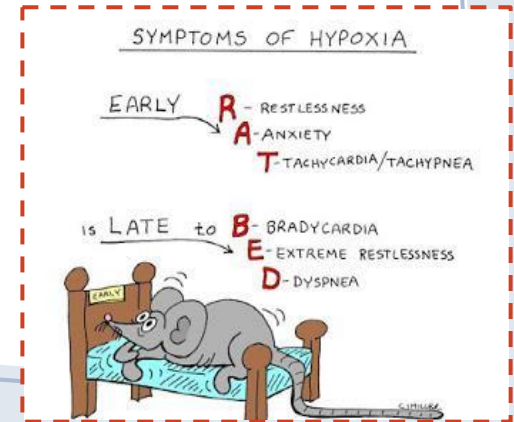
1. On respiration → All except **anemic hypoxia** stimulate peripheral chemoreceptors and thus **increase respiration**
2. On CVS → Increase in HR (heart rate) and BP (blood pressure)
3. Anorexia, nausea, vomiting
4. On CNS → **brain is affected** in all the types → Depressed mental activity, impaired judgment, drowsiness, disorientation, headache and coma.
5. **Reduced** work capacity of the muscles..

←----- Important ----->

What are the clinical effects of hypoxia?

According to the **degree of hypoxia**, it could lead to:

- Impairment of judgment
- inability to perform complex calculations.
- Headache, nausea, irritability, dyspnea, Increased heart rate
- Reduction in muscle working capacity.
- Eventually, Coma and death may occur.



Treatment of Hypoxia

Female
Slides Only

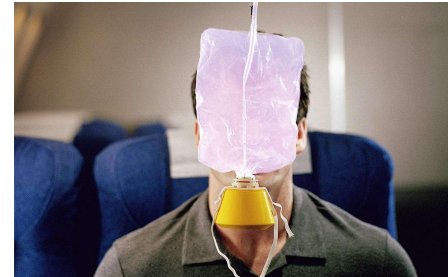
Improve the blood oxygen saturation:

- Target saturation in illness is 94-98%.
- In CO2 retainer 88-92%.
- Adjunct(مساعد) airway.
- Upright posture.
- Oxygen therapy.
- Aids to ventilation .
- Spontaneous breathers CPAP (continuous positive airway pressure), **For conscious patients only**. Ventilated PEEP (positive end expiratory pressure), **For people in coma**.



Sudden oxygen drop

- Sudden drop of oxygen to **less** than 20 mmHg (16,000 m) **causes** loss of consciousness in about 20 seconds, **death in 4-5 min.**



Treatment of Hypoxia by Oxygen

1

Allowing the patient to breathe either pure O₂ or high concentrations of O₂ from a **mask**.

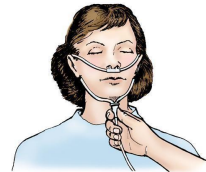
2

Placing patient's head in a **tent** that contains air fortified with O₂.

3

Intranasal tube. Preferred in **pediatrics**.

- Useful in **hypoxic hypoxia**, but of **less** value in **other types** of hypoxia.
- **Histotoxic hypoxia** will **not benefit** from O₂ therapy.



Benefit of O₂ therapy in different Types of Hypoxia :

Atmospheric hypoxia:

O₂ therapy can completely correct depressed O₂ level in inspired gases → **provides 100% effective** therapy.

Hypoventilation hypoxia:

a person breathing 100% O₂ can **move five times** as much O₂ into **alveoli** with each breath as when breathing normal air.

Therapy in this case is very effective

Anemia Hypoxia or abnormal hemoglobin:

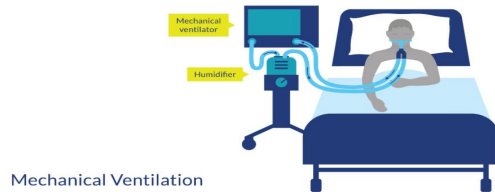
O₂ therapy is **less effective** because normal O₂ is available in alveoli but the defect is in transporting O₂ to tissues.

Histotoxic hypoxia :

O₂ therapy is of **no benefit** because O₂ is available in alveoli and no abnormality in O₂ pickup by lungs or transport to tissues but tissue enzyme are incapable of utilizing delivered O₂.

Mechanical ventilation

- A Mechanical ventilator is a machine that helps a patient breathe (ventilate) when they are having surgery or cannot breathe on their own due to a critical illness.
- The patient is connected to the ventilator with a hollow tube (artificial airway) that goes in their mouth and down into their main airway or trachea.



Should be controlled because giving too much Oxygen will lead to too much Carbon dioxide thereby causing Hypercapnia.

Indication of oxygen therapy

High O₂ concentration 15 L/min:

- Cardiac arrest or resuscitation
- Shock.
- Sepsis.
- Major trauma.
- Anaphylaxis.
- Carbon monoxide poisoning.

Moderate concentration O₂ (10-15ml/min):

- Acute asthma.
- Pneumonia.
- Lung cancer.
- Sickle cell crises.

Low oxygen:

COPD and morbid obesity.

Hypercapnia

Hypercapnia : **Excess** of CO₂ in body fluids, **PCO₂ increases above 52 mmHg**, and it decreases PH.

Hypocapnia : The result of **hyperventilation**. During voluntary hyperventilation, the **arterial PCO₂** falls from 40 mmHg to as low as 15 mmHg while the alveolar PO₂ rises to 120-140 mmHg → respiratory alkalosis and its consequences.

Hypercapnia usually occurs in association with hypoxia (only when hypoxia is caused by hypoventilation or circulatory deficiency) :

- Hypoxia caused by **hypoventilation**: **CO₂ transfer** between alveoli & atmosphere is affected as much as is O₂ transfer. Hypercapnia then occurs along with the hypoxia.
- Hypoxia caused by **Circulatory deficiency**: diminished flow of blood decreases CO₂ removal from tissues, resulting in tissue hypercapnia in addition to tissue hypoxia. However, the transport capacity of the blood for CO₂ is more than three times that for O₂ → resulting tissue hypercapnia is much less than the tissue hypoxia.

Features of Hypercapnia

When the **alveolar Pco₂ rises** above 60 to 75 mmHg – breathing becomes rapid and deep - “air hunger” - also called dyspnea, becomes severe.

Headache, drowsiness and semicoma
(If the PCO₂ rises to 80 to 100 mmHg,)

Anesthesia and death
(when the PCO₂ rises to 120 to 150 mm Hg)

At higher levels of Pco₂, the **excess CO₂** begins to **depress respiration** rather than stimulate it, thus causing a vicious circle -> **Death**.

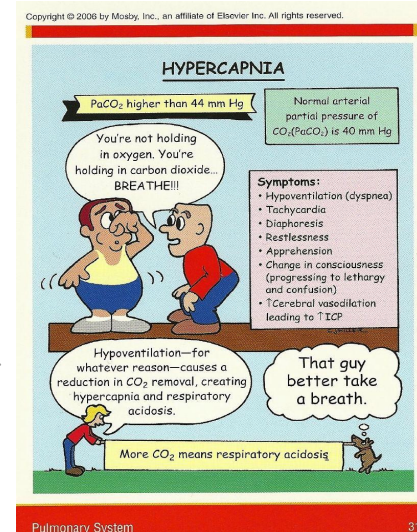
Vicious circle:
More CO₂ Further decrease in respiration, then More CO₂, and so forth culminating (come to a climax) rapidly in a respiratory death.

Warm extremities and bounding pulse
(A bounding pulse is a strong throbbing felt over one of the arteries in the body. It is due to a forceful heartbeat)

Sweating

Muscle twitching

Peripheral vasodilatation
(Peripheral vasodilation is the increase in diameter of blood vessels supplying the body's extremities.)



عند الزيادة البسيطة في CO₂ الجسم يبدأ بتحفر عثاشان يزيد ال ventilation ويحاول يتخلص من كمية CO₂ لكن عند الزيادة الكبيرة في كمية CO₂ يبدأ الجسم بدال م يتحفر عثاشان يزيد ventilation، يبدأ يتنبه الجسم وما يزيد ال ventilation مع زيادة CO₂ لكمية اكبر يشل الجهاز التنفسي

Main symptoms of Carbon dioxide toxicity

Volume % in air

- 1% - 1%
- 3% - 3%
- 5% - 5%
- 8% - 8%

Visual

- Dimmed sight

Auditory

- Reduced hearing

Central

- Drowsiness
- Mild narcosis
- Dizziness
- Confusion
- Headache
- Unconsciousness

Skin

- Sweating

Respiratory

- Shortness of breath

Muscular

- Tremor

Heart

- Increased heart rate and blood pressure

Signs and symptoms of hypercapnia

Treatment of hypercapnia

- Uncontrolled oxygen therapy, or receiving too much oxygen, can make people who usually have higher CO₂ levels retain more until it reaches dangerous levels.
 - The goal of treatment is to prevent further respiratory failure and hypoxemia of the tissues Especially the brain.
- 1 **Initial treatment** of hypercapnia is oxygen therapy with the goal of increasing the inspired oxygen volume.
 - 2 If left **untreated** or under-treated it is highly likely **hypoxia** and **hypoxaemia** will Occur.
 - 3 If **low PO₂** and **high PCO₂** continues some form of ventilation may be required: CPAP, (NIPPV) or invasive depending on the severity or risk to life.

- CPAP (continuous positive airway pressure) is a machine that uses mild air pressure to keep breathing airways open while you sleep
- Nasal intermittent positive pressure ventilation (NIPPV) is a simple, effective mode of respiratory support for older children and adults. It has been used to treat apnea in preterm infants
- Invasive ventilation air is delivered via a tube that is inserted into the windpipe through the mouth or sometimes the neck (intubation)

1. NC up to 6 LPM



3. NC + non-rebreather



5. NIPPV: CPAP



2. Venturi mask (or non-rebreather)



4. HFNC



6. Intubation



Tip

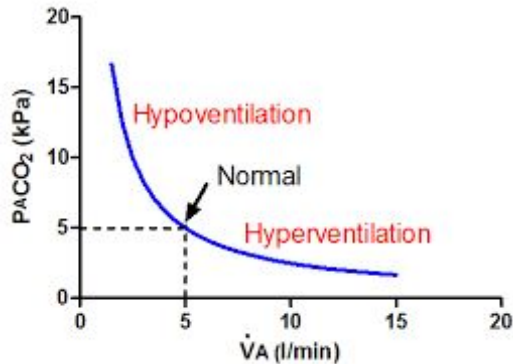
Patient repositioning
can assist

Hypoventilation and Hyperventilation :



Hypoventilation:

when you're breathing very slowly, no gas exchange is taking place at the normal rate, you'll retain too much CO₂ in your body, you'll develop Hypercapnia.



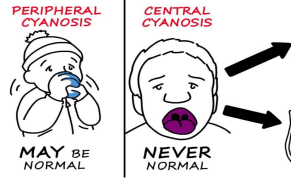
Hyperventilation :

Excessive ventilation such that too much CO₂ is blown out (washout) of the body, not breathing too quickly as the word is commonly (mis)used.

-Hyperventilation isn't about the respiratory rate it's about how much O₂ is getting inside, when the respiratory rate is very rapid the breathing becomes very shallow, and you are not taking too much O₂ and you are returning too much CO₂

Cyanosis

Cyanosis : **Blue** discoloration of the skin and mucous membrane due to **excessive** amount that's more than **5g/dl** of **reduced** (deoxygenated) **hemoglobin** in the **skin**, **blood vessels** especially the **capillaries**.



Types of Cyanosis

Central cyanosis

It is due to **hypoxic hypoxia** and all its causes.

Features:

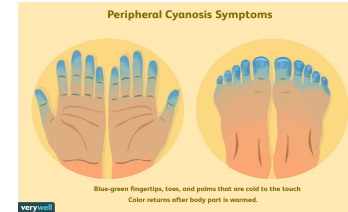
- 1-Extremities are warm and blue due to **hyperdynamic circulation** and **Hypertension**.
- 2-Cyanosis on chest, neck, lips, under tongue.

Peripheral cyanosis

It is due to **stagnant hypoxia** and all its causes.

Features:

- 1-Extremities are cold and blue due to **less blood flow** and **vasoconstriction** of vessels.
- 2-Cyanosis on nail beds, fingers, tip of nose, ears.



Male Slides
Only

Features	Central cyanosis	Peripheral Cyanosis
Mechanism	Inadequate oxygenation of systemic arterial blood (Hypoxic hypoxia).	Sluggish peripheral circulation (Stagnant hypoxia)
Sites to look	Tongue and oral mucosa-Tongue, inner aspect of lips, gum, soft palate, buccal mucosa, lower palpebral conjunctiva and sites of peripheral cyanosis	Acral - Nose tip, ear lobules, outer aspect of lips, finger tips, nail bed, extremities
Association	Clubbing, Polycythemia	-
Extremities	Warm	Cold
Warming extremities	No change	Disappears
Oxygen inhalation	Slight improvement	No change
ABG P02	Low <85%	Normal 85- 100%
Pulse volume	May be high	Usually low
Dyspnea	Often present	Usually absent

Cyanosis in (Anemia/Polycythemia/Hypoxic/Stagnant/Histotoxic)



Person with **anemia** almost **never** becomes **cyanotic** because there is **not enough hemoglobin** for 5 grams to be **deoxygenated** in 100ml of arterial blood.



Conversely, In a person with **excess RBCs**, as occurs in **polycythemia vera**, the great **excess** of available **hemoglobin** that can become **deoxygenated** leads frequently to **cyanosis**, even under otherwise normal conditions.



In **Hypoxic Hypoxia**, less arterial **PO₂**, so more **Deoxygenated Hemoglobin** and when it **exceeds** more than **5gm** cyanosis develops.



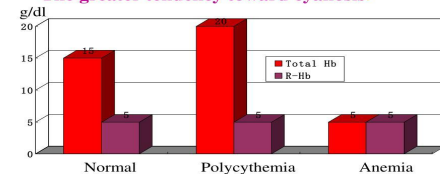
In **stagnant hypoxia** due to **slow blood flow** more **o₂ extracted** from blood so more **deoxygenated hemoglobin** so **higher** chances of **cyanosis**.



In **histotoxic hypoxia** no **O₂** used no deoxygenated hemoglobin produced so no cyanosis.

Mechanisms of Cyanosis

Caused by absolute increase of amount of reduced Hb in blood, usually **> 5g/dl (capillary)**
The higher the hemoglobin concentration,
The greater tendency toward cyanosis.



Asphyxia



 This is produced by **occlusion of Airways.**

Types:

- General asphyxia.
- Local asphyxia.

Causes:

- Suffocation.
- Strangulation.
- Drowning.
- Obliteration of blood vessels.



This result in acute hypoxia and hypercapnia

Stages:

- **Exaggerated breathing.**
- **Convulsions.**
- **Exhaustion and collapse.**

Treatment:

Artificial Respiration
CPR And O₂
Therapy.

MCQs

Q1: In which of the following there is no cyanosis?

A- Histotoxic Hypoxia

B- Stagnant Hypoxia

C- Anemic Hypoxia

D- A&C

Q2: Why are values at venous end are similar to arterial end in histotoxic hypoxia?

A-reduced Hb

B-tissue can't use **O₂**

C-reduce blood flow

D-V/Q ratio mismatch

Q3: what is the common cause of hypoxic hypoxia?

A- Deep Diving

B-Cyanide poisoning

C-Mountain Climbing

D-Anemia

MCQs

Q4: Which of the following is not a cause of hypoxemia?

A-Alveolar hypoventilation

B-Right to left shunt

C-Diffusion abnormalities

D-Abnormal circulation

Q5: what are the arterial P_{O2} and venous P_{O2} in histotoxic hypoxia?

A-95/25

B-40/25

C-95/90

D-95/40

Q6: Arterial P_{O2} = 40 and venous P_{O2} = 25 and A-V P_{O2} difference = 15 in what type of hypoxia?

A-Hypoxic Hypoxia

B-Stagnant Hypoxia

C-Anemic Hypoxia

D-Histotoxic Hypoxia

SAQs

Q1: Which type of hypoxia doesn't benefit from oxygen therapy?

Q2: Enumerate characteristics of hypoxic hypoxia?

Q3: what are the stages of asphyxia ?

A1:

- histotoxic hypoxia caused by inadequate tissue use of O₂

A2: slide 7

A3:

Exaggerated breathing

Convulsions

Exhaustion and collapse



Ahmad Addas



Ibrahim Albabtain



Leena Shagrani



Rimaz Alhammad



Abdalmohsen Alrahaimi



Omar Alattas



Marwah Fal



Basma Al-ghamdi



Abdulaziz Nasser



Khalid Alkanhal



Ghala Alyousef



Aljoharah Alyahya



Abdullah Almarwan



Samiyah Sulaiman



Saud Alsaeed



Noreen Almarabah



Abdullah Almutlaq



Aram Alzahrani



Talal Alrobaian



Lina Aljameel



Khalid Al Tameem



Layal Alkhalifah



Zyad Alshuhail



Hessa Alamer



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