



- In response to metabolic acidosis:  $\uparrow$  ventilation  $\rightarrow$   $\downarrow$  Pco 2 (ex: PCO<sub>2</sub>  $\downarrow$  from 40 mm Hg to 20 mm Hg)  $\rightarrow$  shift the equilibrium of carbonic acid bicarbonate to lower H ion conc.  $\rightarrow$   $\uparrow$  pH toward normal
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## Disturbance of respiration

**Hypoxia** :Is oxygen deficiency at the tissue level : 4 types :

- 1. Hypoxic hypoxia ( hypoxemia)** :  $\downarrow$  PO<sub>2</sub> of the arterial blood , is the most common cause of hypoxia .Causes :
  - I. Inadequate oxygenation of the blood in the lung because of extrinsic causes ex:  $\downarrow$  O<sub>2</sub> in the atmosphere ex: high altitude
  - II. Pulmonary disease ex: ex: decrease ventilation in bronchial obstruction ,pulmonary fibrosis , respiratory center depression
  - III. Venous to arterial shunt ( Rt to Lt shunt) .
- 2. Anemic hypoxia** : arterial PO<sub>2</sub> is normal but the amount of hemoglobin available to carry O<sub>2</sub> is reduced .ex: anemia and CO poisoning (as it decreases the amount of O<sub>2</sub> that can be carried by Hb).
- 3. Ischemic (stagnant hypoxia)** low blood flow to the tissue  $\rightarrow$ inadequate O<sub>2</sub> is delivered to it despite a normal PO<sub>2</sub> and Hb concentration .causes:
  - a) Generalized : ex : shock , polycythemia, congestive heart failure
  - b) Localized ex: thrombosis , embolism
- 4. Histotoxic hypoxia** : the amount of O<sub>2</sub> delivered to the tissue is adequate but because of the toxic substance ,the tissue cell cannot use O<sub>2</sub> supplied to them .ex: cyanide poisoning inhibits **cytochrome oxidase**  $\rightarrow$ inhibits tissue oxidative process .

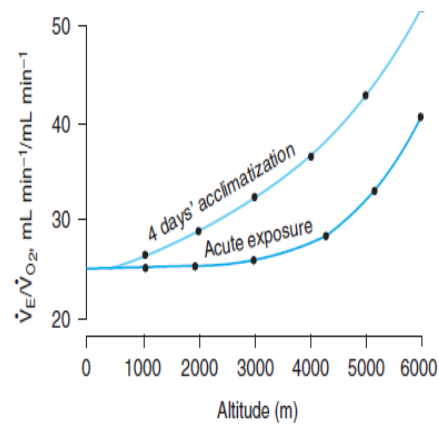
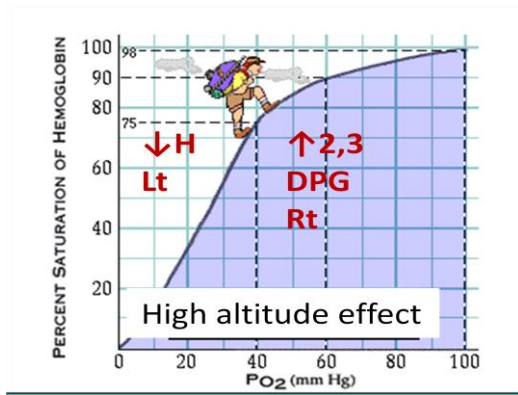
**Examples of hypoxic hypoxia : Effect of decrease barometric pressure ( high altitude):**

- ❑ The composition of air stays the same, but the total barometric pressure ↓ with increasing altitude → ↓ $P_{O_2}$ .
- ❑ **At 3000 m** above sea level, the alveolar  $P_{O_2}$  is about 60 mm Hg and there is enough hypoxic stimulation of the chemoreceptors → ↑ ventilation.
- ❑ in **unacclimatized** person at altitudes above 6000 m ,consciousness is usually lost
- ❑ the lowest atmospheric pressure at which a normal alveolar  $PO_2$  of 100 mm Hg with 100%  $O_2$  is at **187 mm Hg , at about 10,400 m (34,000 ft ) because**  $PH_2O$  in the alveolar air is constant (47 mm Hg) , and that of  $PCO_2$  is 40 mm Hg, so that ( **100+ 47+40**)

**Acclimatization** Is the adaptations or the adjustments by the body in high altitude. →hypoxic effects are reduced.

**Changes during acclimatization :**

1. Initially ↑ ventilation : →↑ $P_{O_2}$  but also it causes  $PCO_2$  ↓→depressed respiration and also **cause respiratory alkalosis** which leads to a shift  $O_2$  Hb dissociation curve to the Lt (less oxygen delivery )
2. 2,3 DPG ↑(12-24 hr) → shift of  $O_2$  HB dissociation curve to the Rt →↓affinty for  $O_2$  →↑  $O_2$  delivery to the tissue
3. Erythropoietin secretion ↑→ ↑ RBC in 2–3 day and continue weeks to month
4. Ventilation ↑over next 4 days : active transport of H ion and developing of lactic acidosis in the brain, →↓CSF pH →↑the response to hypoxia.
5. Increase vascularity of tissue :cardiac output increase 20-30%
6. ↑Diffusion capacity :due to increase ventilation and pulmonary blood flow and increase surface area
7. At tissues level . ↑mitochondria, ↑myoglobin, ( more oxygen store and delivery to muscle), ↑tissue capillaries and ↑The tissue content of cytochrome oxidase .



## Cyanosis:

- Is a bluish discoloration of the skin and mucous membrane by  $\uparrow$ deoxygenated Hb > 5 g/dl . Could be central or peripheral cyanosis.
- Causes :
  1. Hypoxic hypoxia : ex : cyanotic congenital Heart disease , respiratory disease ex: chronic obstructive lung disease .
  2. Stagnant hypoxia ex: polycythemia : slow blood flow by high blood viscosity and there is excess of available Hb that can be deoxygenated

Cyanosis also occurs in exposure to sever cold where there is sever vasoconstriction

## **Cyanosis does not occur in**

- Anemic hypoxia as hemoglobin content is low ,CO poisoning: give cherry red color , histotoxic hypoxia : tissue unable to use oxygen

**Asphyxia** : a condition in which hypoxia ( $\downarrow$ PO<sub>2</sub>) is associated with hypercapnia ( $\uparrow$ PCO<sub>2</sub>) ex : in drowning , acute tracheal obstruction ,foreign body inoculation in the trachea, traumatic compression of the chest. .

## **Stages:**

1. **Stage of exaggerated breathing** : hypoxia and hypercapnia causes strong stimulation with violent respiratory effort. it ends with loss consciousness because of hypoxia.
2. **Stage of convulsion** :  $\uparrow$  heart rate ,blood pressure ,Acidosis and convulsion (increase catecholamine and sympathetic activity)
3. **Stage of exhaustion:** if no artificial respiration Is started ,respiratory movement becomes sluggish then coma , death occurs due to respiratory center depression and cardiac arrest within 5-6 min .