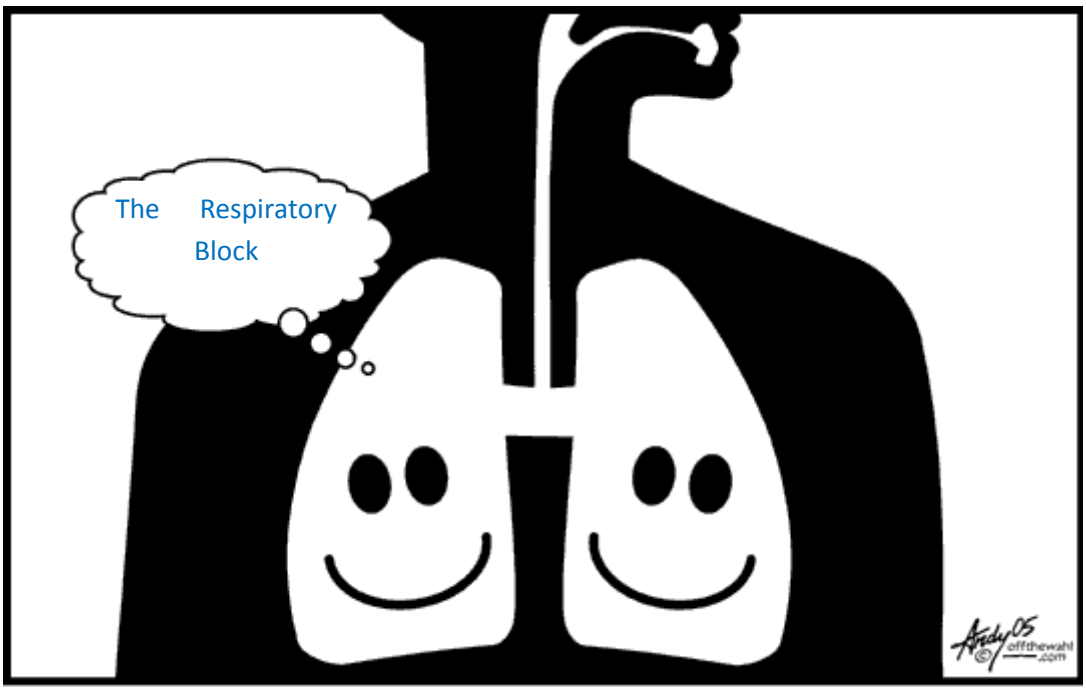
The Physiology Team



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هذه المذكرة للمذاكرة قبل الاختبار وهي تقريبا شاملة لكل شيء في المحاظرة

We did our best and I hope our best is enough

Gas Transport

PO_2 in pulmonary capillary Bl.(in lungs)

PO2 in arterial end of pulmonary capillary(deoxygenated bl.)= 40 mmHg

PO2 in venous end (oxygenated bl.) = 104 mmHg

Diffusion of oxygen from the capillary to the intestinal fluid

PO2 in arterial end of systemic capillary(oxygenated) = 95 mmHg

PO2 in venous end (deoxygenated) = 40 mmHg

Diffusion of CO2 from the cells to the tissue capillaries, an

from the pulmonary capillaries to the alveoli

PCO2 in arterial end of pulmonary capillary (deoxygenated) = 45 mmHg

PCO2 in venous end of pulmonary capillary (oxygenated)= 40 mmHg

PCO2 in arterial end of systemic capillary (oxygenated)= 40 mmHg

PCO2 in venous end of systemic capillary (deoxygenated)= 45 mmHg

When PO_2 ↑….Hb binds with O_2

" PO_2 ↓…. Hb releases O_2

- CO 2 mostly transported in blood as HCO_3^-

Less amounts of CO_2 are bound to Hb or dissolved in plasma

Terminology

-O_2 content : amount of O_2 in blood(mL O 2/100 mL blood)

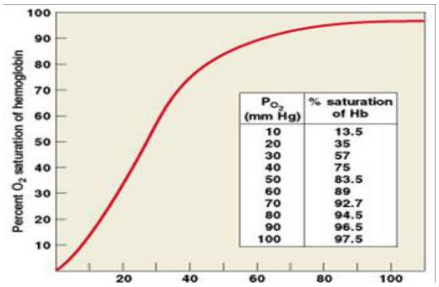
-O_2-binding capacity: Max. amt. of O_2 bound to HB (mL O 2/100 mL blood measured at 100% saturation)

-Percent saturation: % of heme groups bound to O2

-Dissolved O_2: Unbound O2 in blood (mL O2/100 ml bl.)

Oxygen transport in Blood: 3% dissolved in plasma & 97% bound to HB

Oxyhemoglobin saturation curve : ↑ PO_2 ……↑ Hb saturation



- Regarding O2 content : each ml of Hb carry 1.34 ml Of O_2

and when HB is 100% saturated with O_2 it equals 15 ml HB/100ml bl.

(15x1.34=20 ml O_2) ,but when the blood is only 97% saturated with O2

blood contains 19.4 ml O_2 ((97% x 15) x 1.34 =19.4)

- Amount of O_2 released from HB in the tissues/100 ml bl. =5 ml

so (19.4-5=14.4 ml O_2 remaining in bl.)

-During exercise: O_2 uptake by the tissue ↑ 3 folds (3x5=15 ml O_2/100 ml O_2), so 19.4 -15=4.4 ml O_2 remaining

-Tissues consume 250 ml O2 /min at rest and produce 200ml CO_2

Note that : each HB molecule (4 hemes) binds to 4 O_2 molecules

O_2 capacity : amt. of HB that combines with O_2 at a very ↑ tension(600 mmH_2O)

HB saturation % = (O_2 content/ O_2 capacity)x 100

- Notice that : O2-Hb dissociation curve is a sigmoid curve

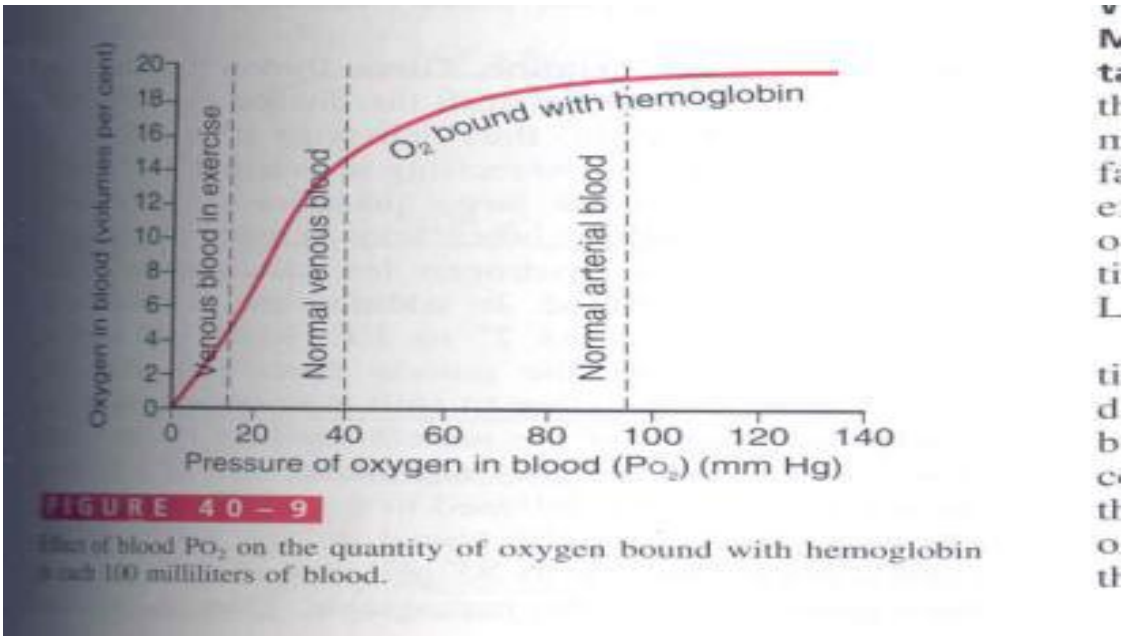


FIGURE 40–9

Effect of blood Po_2 on the quantity of oxygen bound with hemoglobin in each 100 milliliters of blood.

P50: the arterial oxygen tension at which 50% of Hb is saturated with O2, normally P50= 26.5

- ↓ P50 ……↑ affinity of Hb to O2 (shift of the curve to Left)

-↑ P50 ……↓ affinity ″ ″ ″ ″ (shift The curve to Right)

Factors that affect the Rt & Lt shifts of O2-HB dissociacion curve :

-exercise → Rt shift

-alkalosis→ Lt shift , acidosis (CO_2)→ Rt shift

- ↑Temperature→ Rt shift , ↓ Temp. → Lt shift

- ↑ 2,3 DPG in RBCs (esp. Anemia and hypoxia) → ↓ affinity→ Rt shift

- myoglobin (in Sk. Ms) → Lt shift (more affinity than HB)

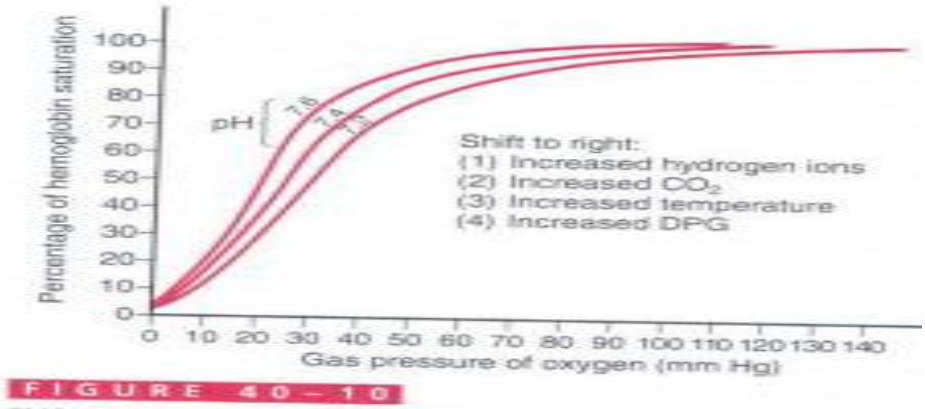


FIGURE 40–10

Shift of the oxygen-hemoglobin dissociation curve to the right by increases in (1) hydrogen ions, (2) CO_2, (3) temperature, or (4) 2,3-diphosphoglycerate (DPG).

-Fetal HB (HB f) : has a P50 = 20 in comparison to adults (P50=27)→fetal has more affinity → shifted to Lt …….this condition is called Physiological Polycythemia

-Bohr's effect : At lung: movement of CO_2 from

Bl. to alveoli ↓ bl. CO_2 &H^+ →shift the curve to Lt & ↑ O_2 affinity to Hb allowing ↑ O2 transport to tissues , at tissues: the reverse occur

-HB and CO (notice ,not CO_2) :

affinity of Hb to CO is very high , 250 x that of O2→Lt shift

Utilization Coefficient: % of blood that gives up its oxygen as it passes through the tissues capillaries

معدل الاستهلاك

=O2 delivered to the tissues/O2 content of arterial blood

Normally at rest = 5ml/20 ml= 25% , during exercise = 15 ml/20 ml= 75 % - 85%

-Only 3% of O2 is transported in the dissolved state,

at normal arterial PO2 of 95 mmHg , about 0.29 ml of oxygen is dissolved in each 100ml of blood

When the PO2 of the blood falls to 40 mmHg in tissue capillaries, only 0.12 of oxygen remains dissolve

i.e 0.17 ml of oxygen is normally transported in the dissolved state to the tissues per each 100 ml of blood

Transport of CO2 in the blood:

-Dissolved CO2= 7%

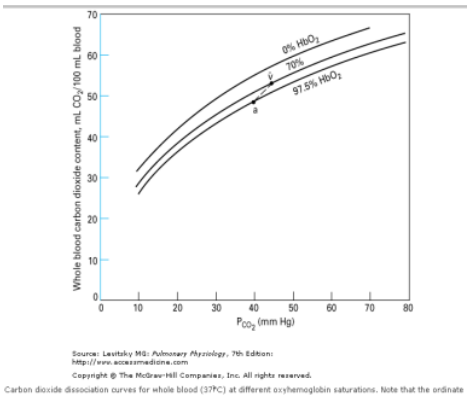
-Bicarbonate ions 70 %

-Carbaminohemoglobin(CO2 with Hb)=23-25% (in venous bl.) →75-77% is Oxyhemoglobin (w O2) (in venous bl.)

- each 100 ml of bl. carry 4 ml of CO2 from the tissues/min .

N.B. : CO2 Dissociation curve for whole blood is ***curvi-linear***

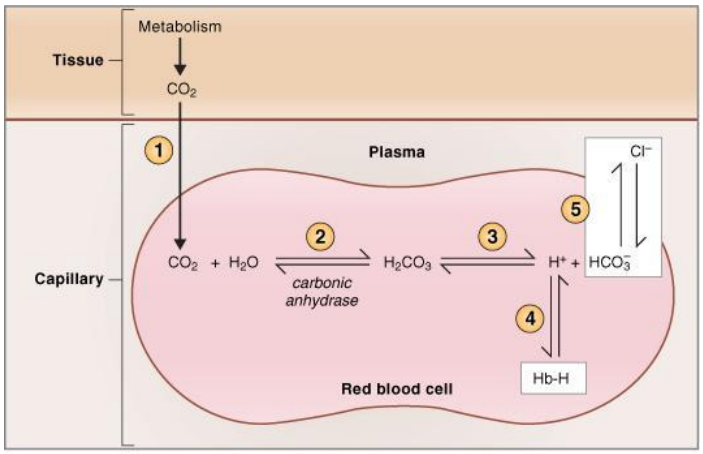
(**remember** O2 dissociation curve is *sigmoidal*→so there is a greater change in PCO2 than there is in oxygen content per mm Hg change in PO2)



Source: Lavitsky MG: *Pulmonary Physiology*, 7th Edition: http://www.accessmedicine.com

Carbon dioxide dissociation curves for whole blood (37°C) at different oxyhemoglobin saturations. Note that the ordinate

Formation of HCO3 ¯& Chloride shift inside RBC



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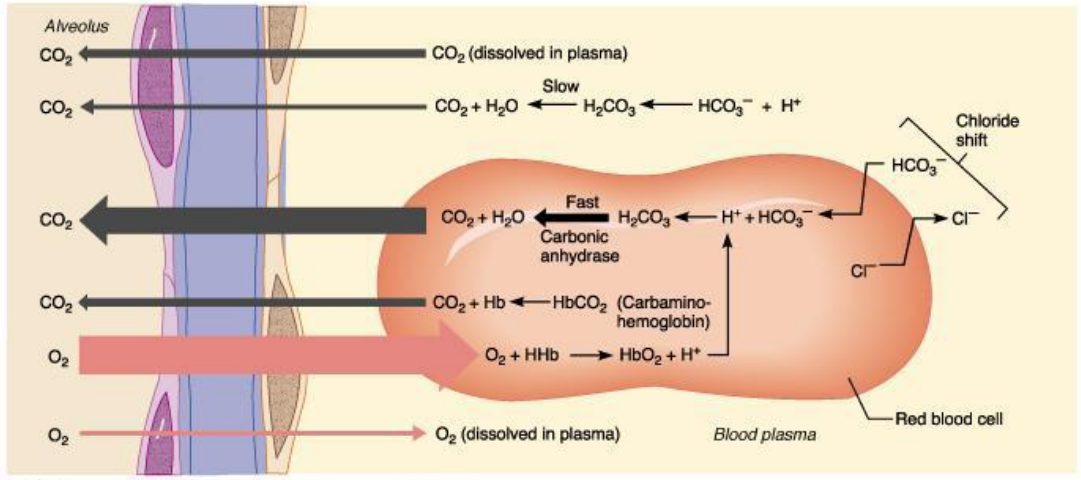
- **HB-H^+ = reduced HB (HB with H^+)**

◉H+ (الحموضة) must be buffered(نعادلها) so that the pH of RBCs (and bl.) remains within the physiologic range by binding with deoxy HB and transported in the venous bl.

Chloride shift in pulmonary capillaries



(b) Oxygen pickup and carbon dioxide release in the lungs

The Haldane effect :***When O2 binds with HB , CO2 is released→↑CO2 transport*** **to the lungs**
◉Binding of HB with O2 at the lung causes the HB to become more a stronger acid and , this in turn displaces CO2 from the blood and into the alveoli

-Arterial blood has a PH of 7.41 , venous blood with ↑ PCO2 falls to 7.37 (i.e difference of 0.04)

Respiratory Exchange ratio:

R= Rate of CO2 output/rate of O2 uptake

-Normally it is 4/5= 82% (as if for every 100% O2 uptake ,the body excreted 82 % CO2)

-When Carbohydrate diet is used R = 1

-When fats only is used R=0.7

-A person on normal diet R=0.825