Hypoxia & Hypoxemia

Mechanisms of oxygen deprivation

Hypoxia

Reduced oxygen delivery to tissues

O_2 →

Decreased cardiac output

Hypoxemia

Anemia

Carbon monoxide poisoning

Hypoxemia

Reduced partial pressure of oxygen in blood

O_2 →

Normal A-a gradient:
- Low FiO_2 (high altitudes)
- Hypoventilation

Increased A-a gradient:
- V/Q mismatch
- Right-to-left shunt
- Diffusion limitation

! PaO_2 does NOT correct with oxygen in shunt

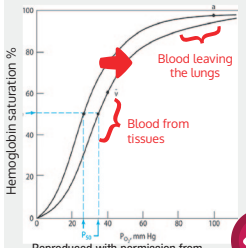
Ischemia

Reduced blood flow to tissues

Impaired arterial flow

Decreased venous drainage

Oxygen–Hemoglobin Dissociation Curve



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Rightward shift:
- ↓affinity of Hb for oxygen
- Facilitates oxygen unloading to tissues

Causes of right shift:
- ↓ pH (↑[H+])
- ↑CO_2
- Exercise (↑temperature)
- 2,3-BPG
- Altitude

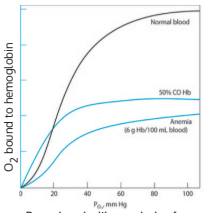
! Sigmoid shape is from positive cooperativity of Hb tetramer

O_2 Content of blood = (1.34 x [Hb] x SaO_2) + (0.003 x PaO_2)

Anemia - ↓[Hb]
- Decreased hemoglobin level
- Reduced O_2 carrying capacity

Carbon monoxide - ↓SaO_2
- CO has greater Hb affinity than O_2
- Causes left shift in Hb curve & impaired O_2 offloading to tissues
- Reduced O_2 saturation of Hb
- Normal pulse oximetry reading

Hypoxemia - ↓PaO_2
- Less dissolved O_2 for binding Hb



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Alveolar Gas Equation

$PAO_2 = PIO_2 - PaCO_2/R$

$PIO_2 = FiO_2 \times Pb$

On room air at sea level:
$PIO_2 = 0.21 \times 760$ mm Hg
$PIO_2 = \sim 150$ mm Hg

PAO_2 - alveolar PO_2
PaO_2 - arteriolar PO_2
R - respiratory quotient (0.8)
PIO_2 - PO_2 of inspired air
FiO_2 - O_2 fraction of air
Pb - barometric pressure

$PAO_2 = 150$ mm Hg $- PaCO_2/0.8$

A-a Gradient = $PAO_2 - PaCO_2$

Normal A-a gradient increases with age (< age/4 + 4)

V/Q Mismatch

Ventilation (V) & perfusion (Q) are not matched (ideal V/Q = 1)

V/Q = 0
- Perfusion without ventilation (**Shunt**)
- ie, alveolar obstruction

V/Q = ∞
- Ventilation without perfusion
- ie, pulmonary embolism