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Metabolismul oxigenului.Oximetria.

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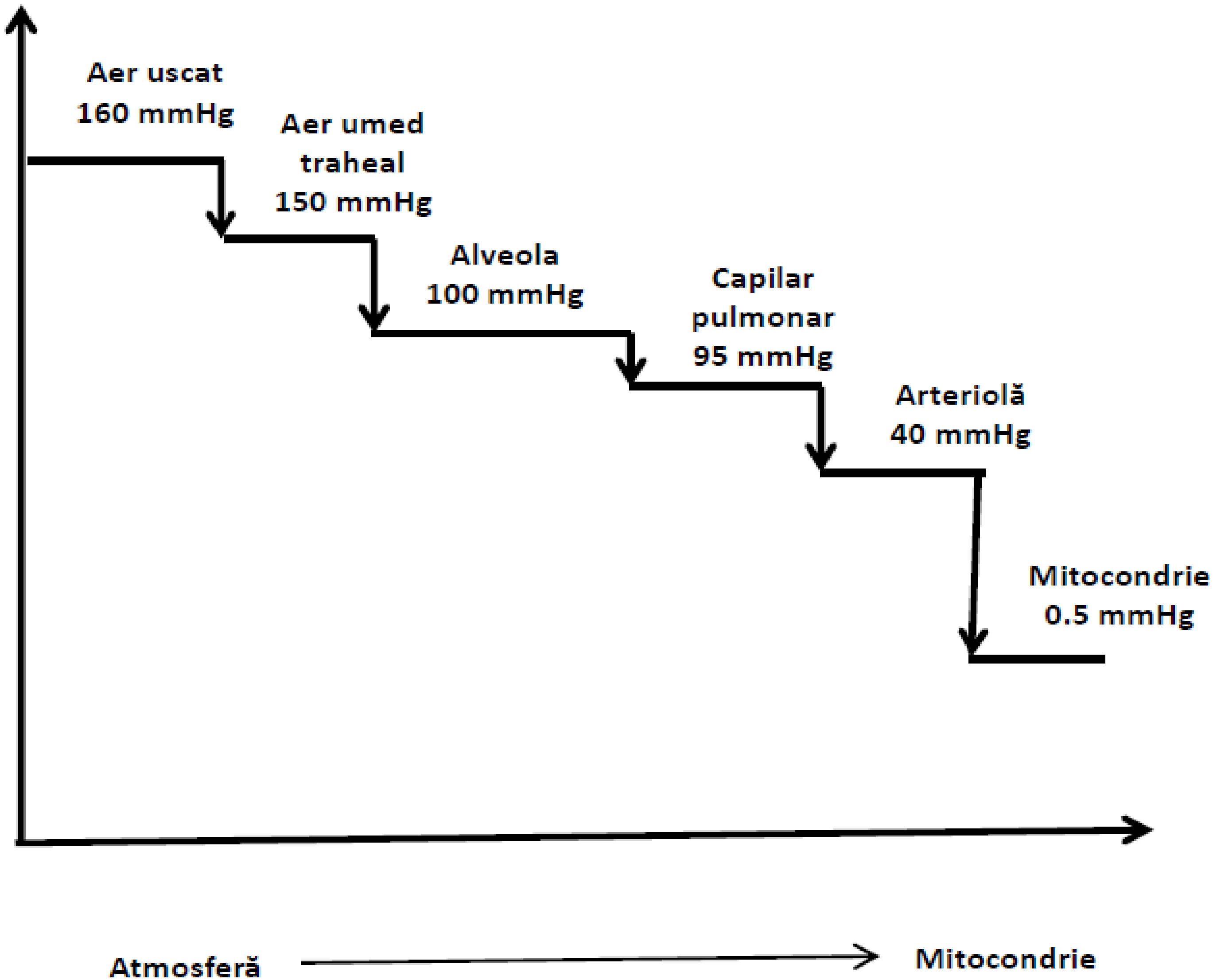
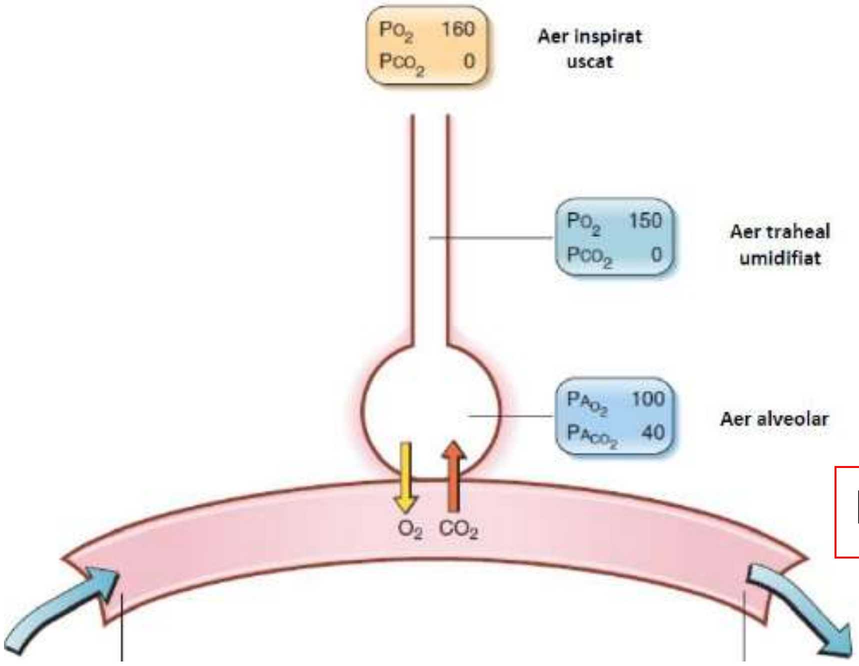
Cascada oxigenului



Captarea oxigenului la nivel pulmonar



Legea lui Dalton:

$PO_2 = \% O_2 \times Ptotala\ aer$

$$PAO_2 = FiO_2 \times (P_B - P_{H20}) - \frac{PACO_2}{RQ}$$

P_B = presiunea barometrica =760 mmHg

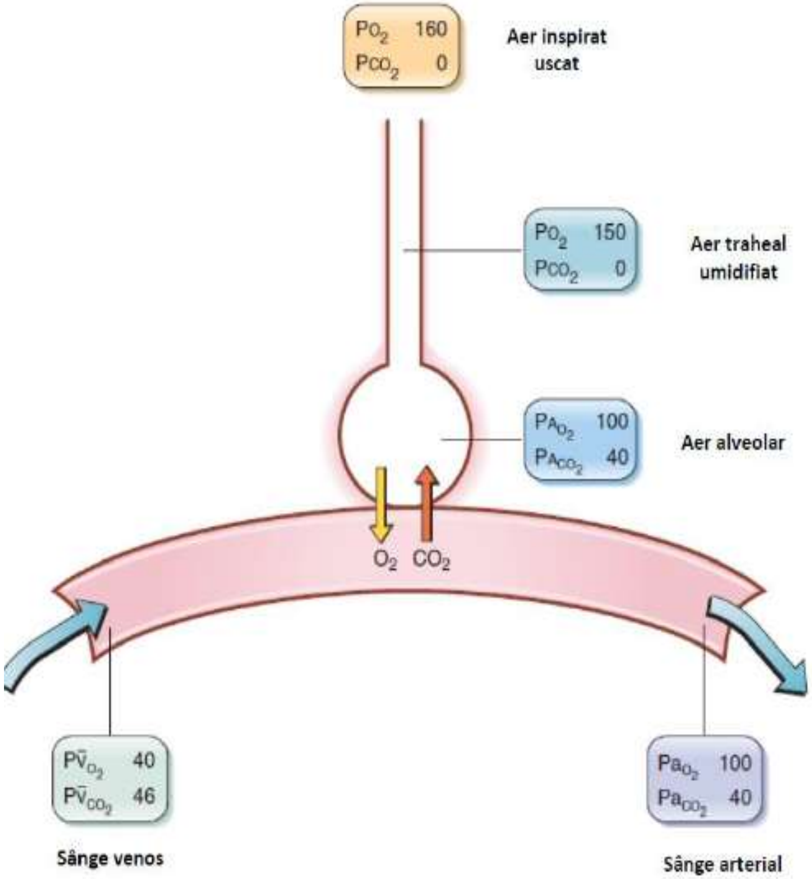
$RQ = CO_{2\ eliminat} / O_{2\ consumat}$

$PO_{2\ aer\ uscat}$ = 0,2093 x 760 mmHg = 159 mmHg

PO_2 cai respiratorii = 0,2093 x 760 -47 mmHg = 149,24 mmHg

PAO_2 = 0,2093 x (760-47) - 40/0.8 = 99,23 mmHg

Difuziunea alveolocapilara a O_2



Transfer O_2 in 0,25 secunde

Membrana alveolo-capilara= 12 straturi

Transfer O_2 "perfuzie limitat" (fiziologic)

Transfer O_2 "difuzie limitat" (hipoxie severa)

Gradient alveolo(A)-arterial(a) = 5-10 mmHg

Transportul O_2 in singe

2 forme de transport:

1. O_2 dizolvat in plasma (2%)

2. O_2 legat de hemoglobina (98%)

O2 dizolvat in plasma

Legea Henry: cantitatea dizolvata dependenta de pp a O_2

1 mmHg se dizolva 0.003mL O_2/100 mL singe

100 mmHg: 100mL singe contin 0.3 mL O_2 $\Leftrightarrow$ 3 mL O_2/L

O2 dizolvat nu satisface necesitatile fiziologice!

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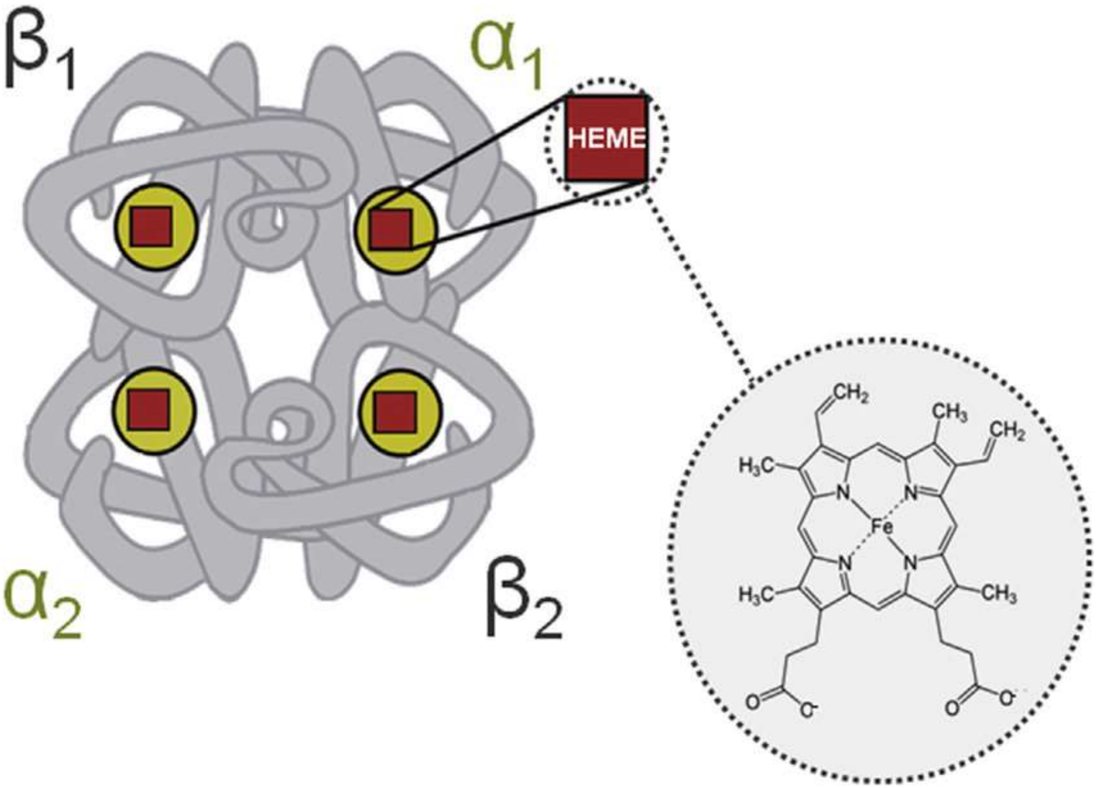
Transportul O_2 in singe

O_2 legat de hemoglobina



Fe - protoporphyrin IX

Globina:

2α +2 ß = HbA

2α +2γ = HbF

Hem:

4 protoporfirine

4 atomi Fe^{2+}

4 O2

"legare cooperativa pozitiva": O_2-Fe^{2+}

1 g Hb incarca 1,34 mL O_2, la 15 g/dL incarca 20 mL O_2

Transportul O_2 in singe

O_2 legat de hemoglobina

Conținutul de O_2 %= (Cantitatea legată × Saturația %) + Cantitatea dizolvată

CaO_2 = (1,34 x 15 x 0.97) + (0.003 x 95) = 19,5 + 0,285 = 19,785 ≈20 ml

CvO_2 = (1,34 x 15 x 0.75) = (0.003 x 40) = 15,075 + 0,12 =15,195 ≈ 15 ml

Rata de extracție tisulară O_2 = CaO_2-CvO_2 = 20mL-15mL= 5 mL/dL

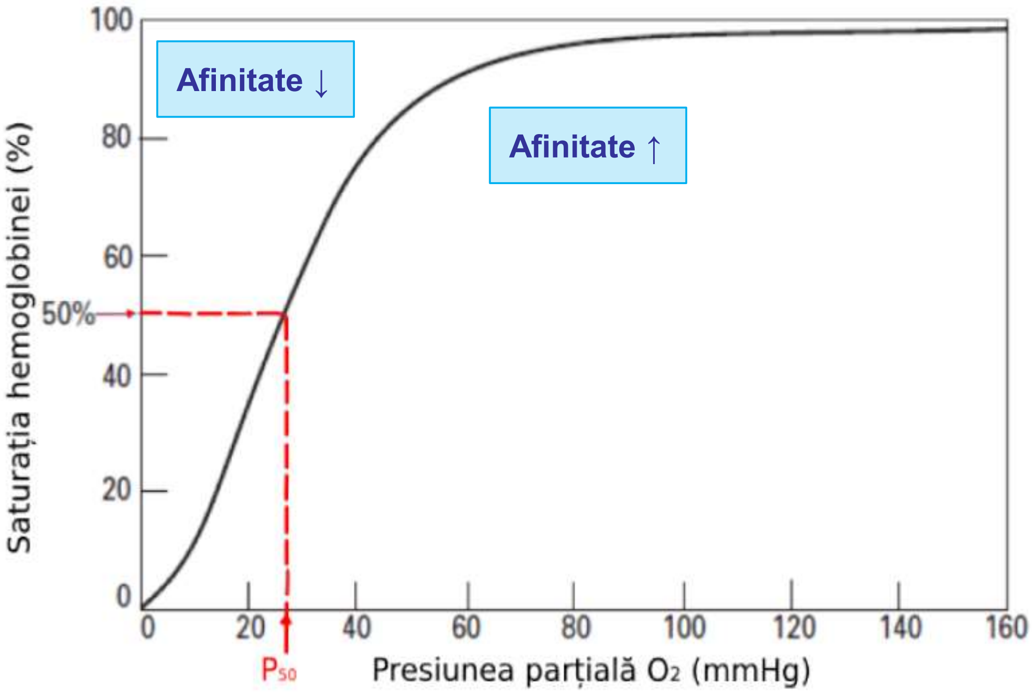
(1) CaO_2= (5 g/dL) (1.34 mL/g) (1.00) = 6.7 mL/dL
(105 mm Hg x 0.003mL/dL/mmHg) = 0.3 mL/dL } 7.0 mL/dL

(2) CaO_2= (5 g/dL) (1.34 mL/g) (1.00) = 6.7 mL/dL
(500 mm Hg x 0.003mL/dL/mmHg) = 1.5 mL/dL } 7.2 mL/dL

(3) CaO_2= (8 g/dL) (1.34 mL/g) (1.00) = 10.7 mL/dL
(500 mm Hg x 0.003mL/dL/mmHg) = 1.5 mL/dL } 12.2 mL/dL

Transportul O_2 in singe

Relatia PaO_2-Oxihemoglobina



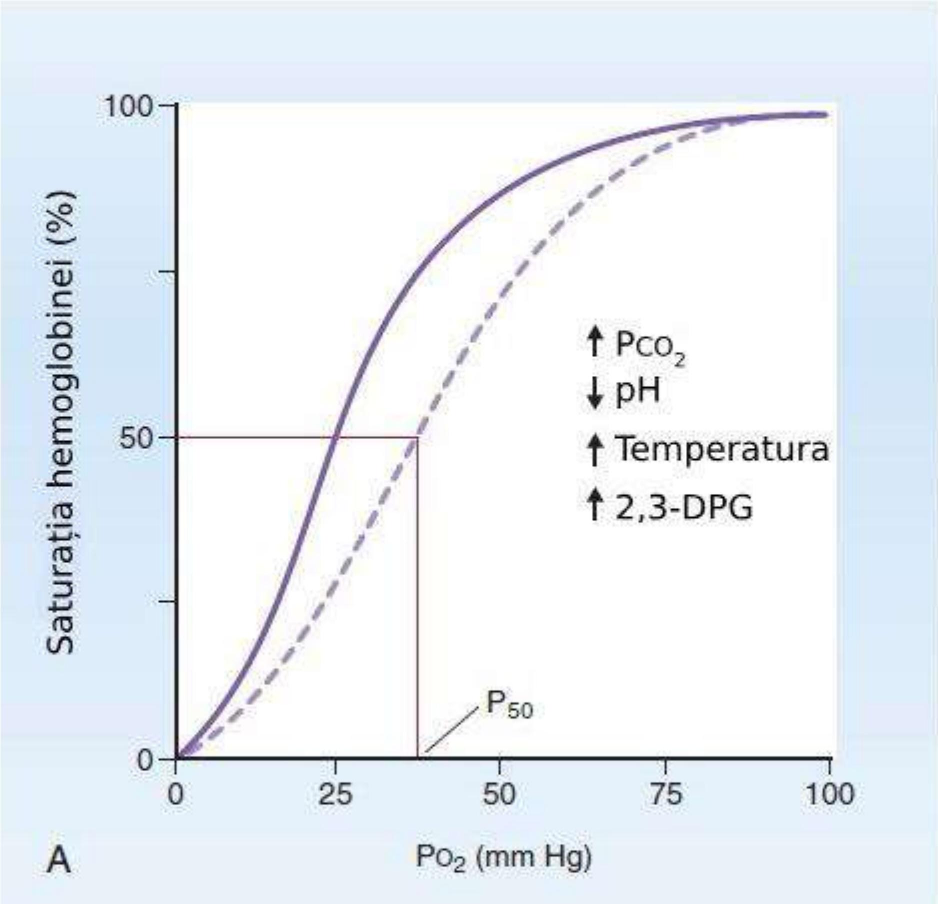
Curba sinusoidala

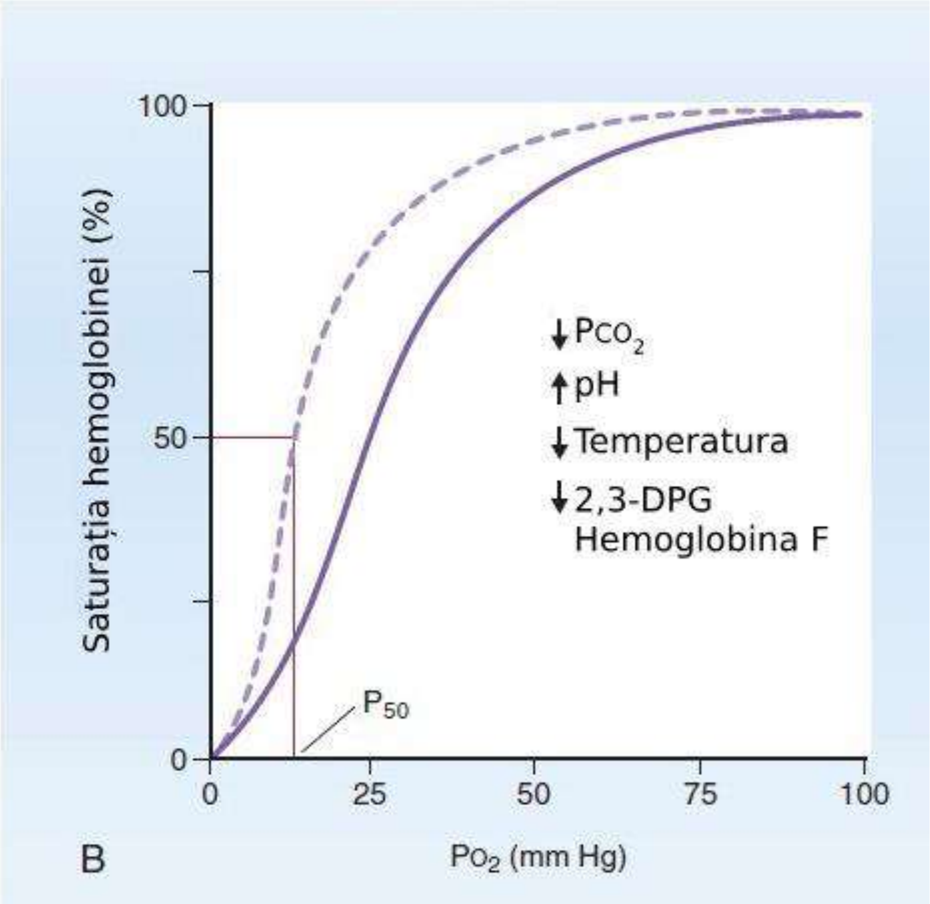
PaO_2 = 26 mmHg =P_{50}

PvO_2 = 29 mmHg =P_{50}

Transportul O_2 in singe

Relatia PaO_2-Oxihemoglobina

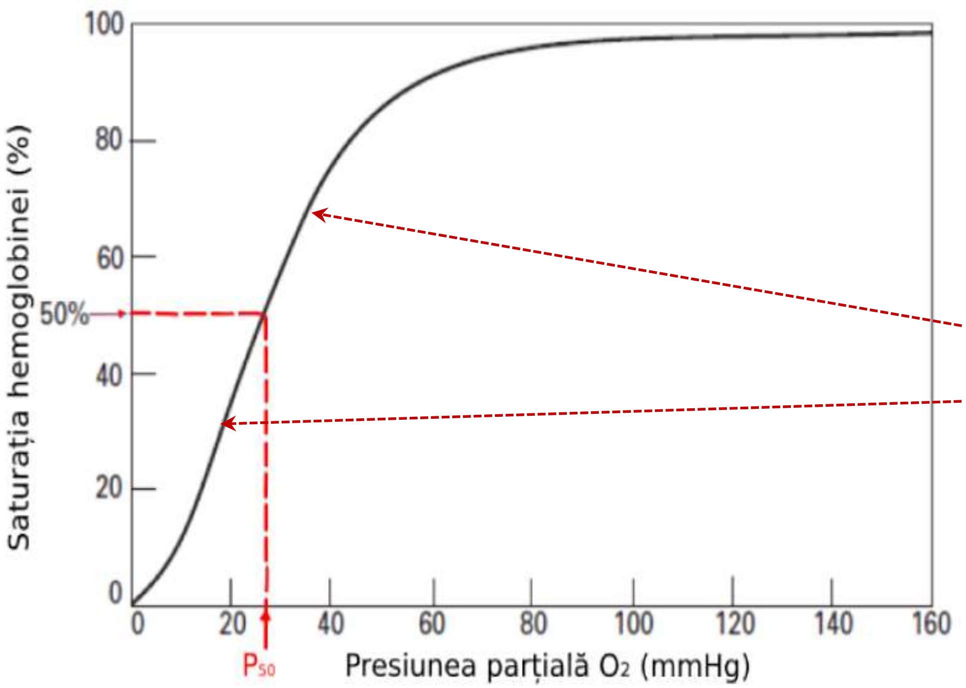




P_{50} spre dreapta

P_{50} spre stinga

Difuziunea tisulara a O_2



PaO_2 variabil de la un organ la altul

Scaderi dramatice SaO_2 (CaO_2)

PaO_2 = 40mmHg (SaO_2=75%) CaO_2 = 15mL/dL

PaO_2 = 20mmHg (SaO_2=32%) CaO_2 = 6,5mL/dL

Efectul Bohr + 2,3 DPG ↓

fundamentale

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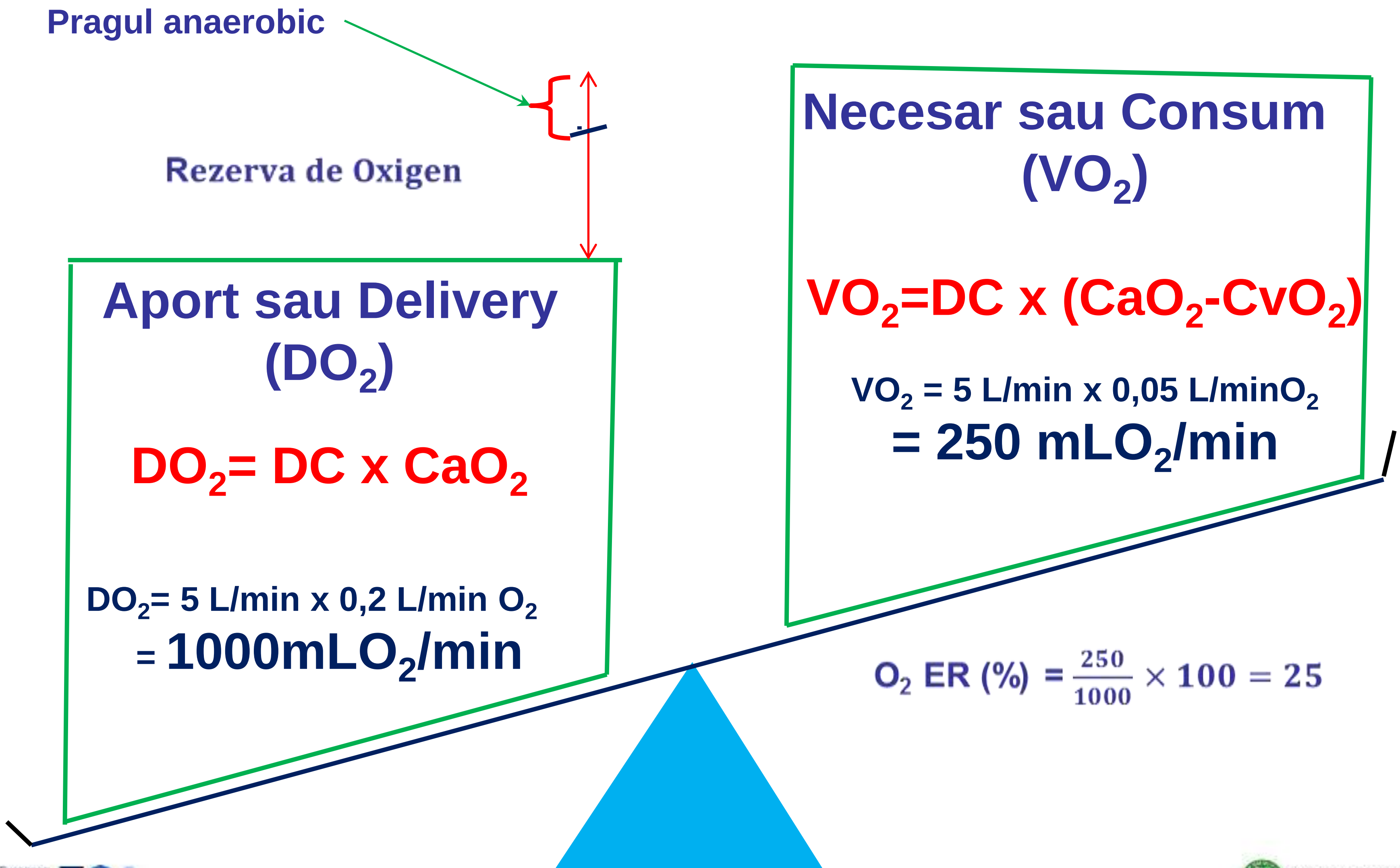
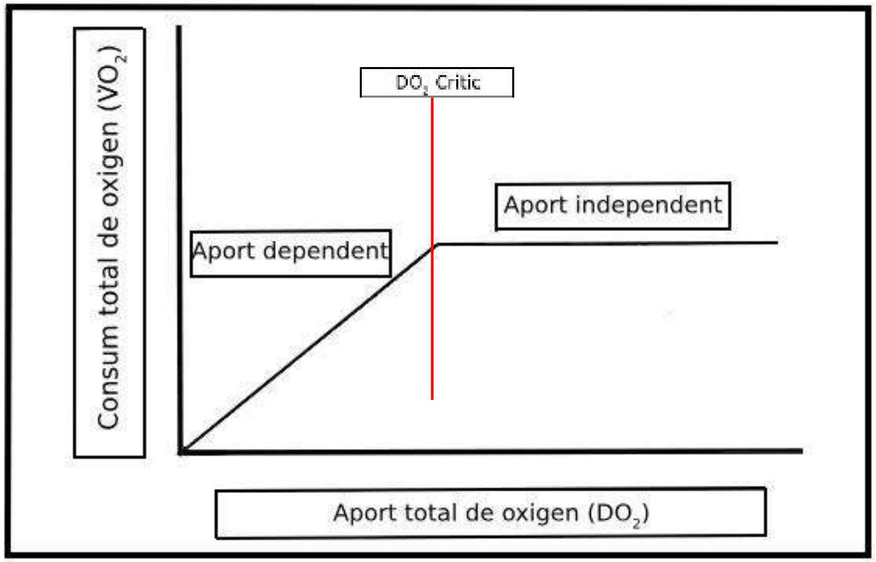
Balanta tisulara de O_2



$$O_2\ ER\ (\%) = \frac{250}{1000} \times 100 = 25$$

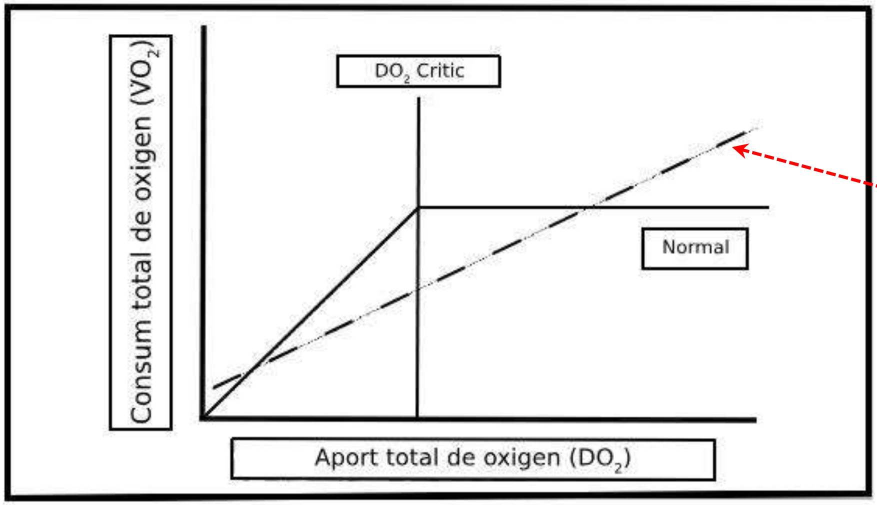
Balanta tisulara de O2



Raportul DO_2/VO_2

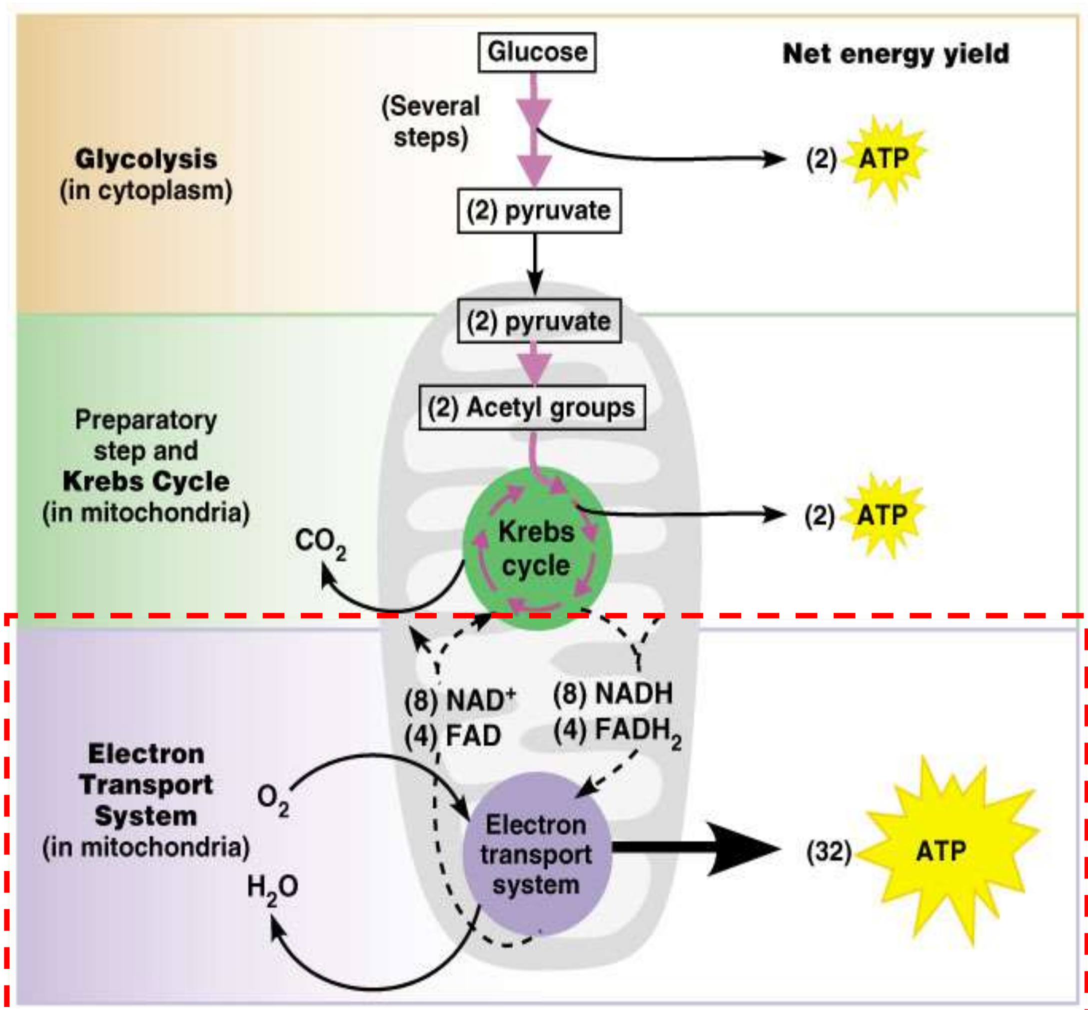
consum independent de DO_2 = rezerva suficienta = **VO2 aport independent**

Atingerea DO2 critic → **VO2 aport dependent**



VO2 aport dependent permanent

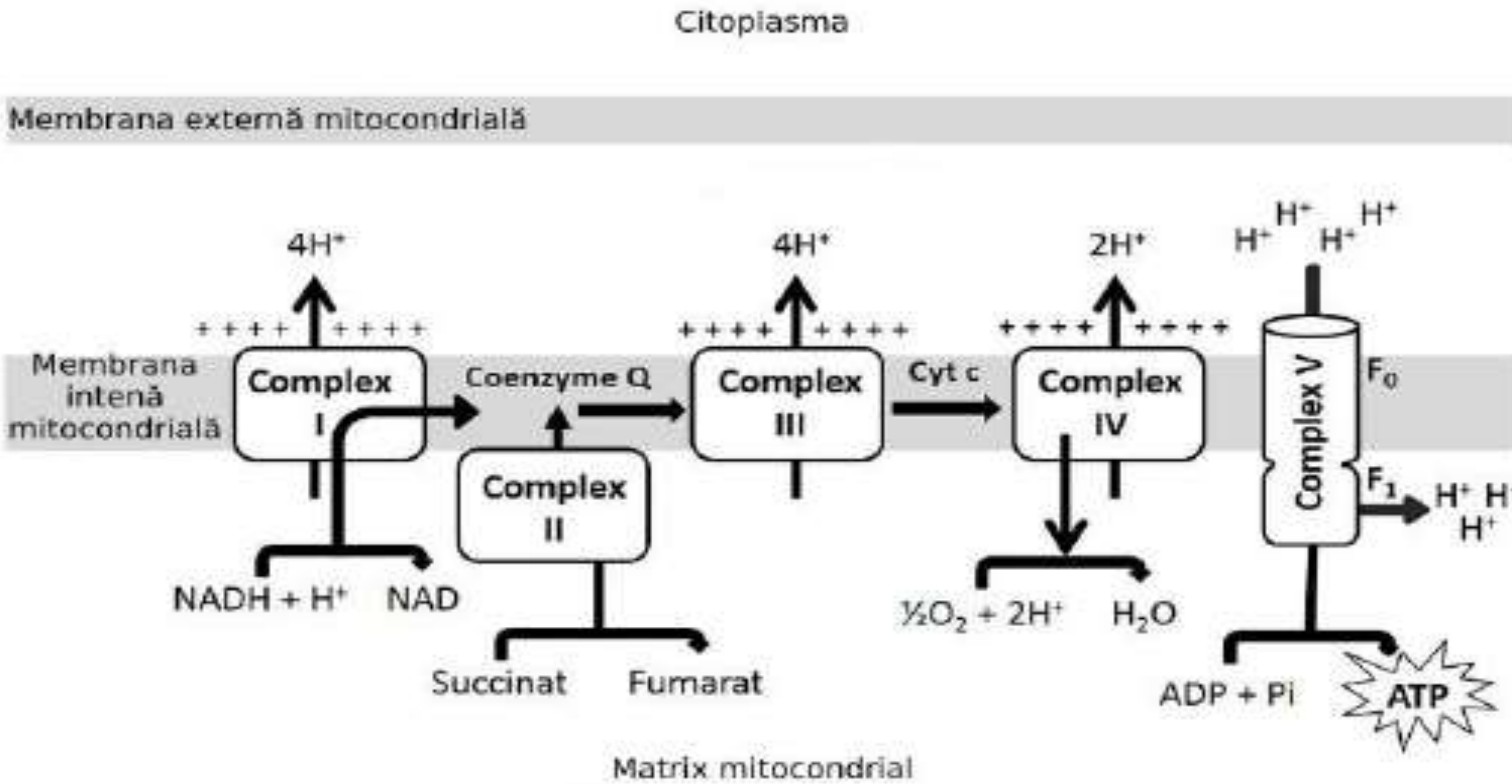
Utilizarea O2 in metabolism aerobic si productie de ATP



Fermentatie

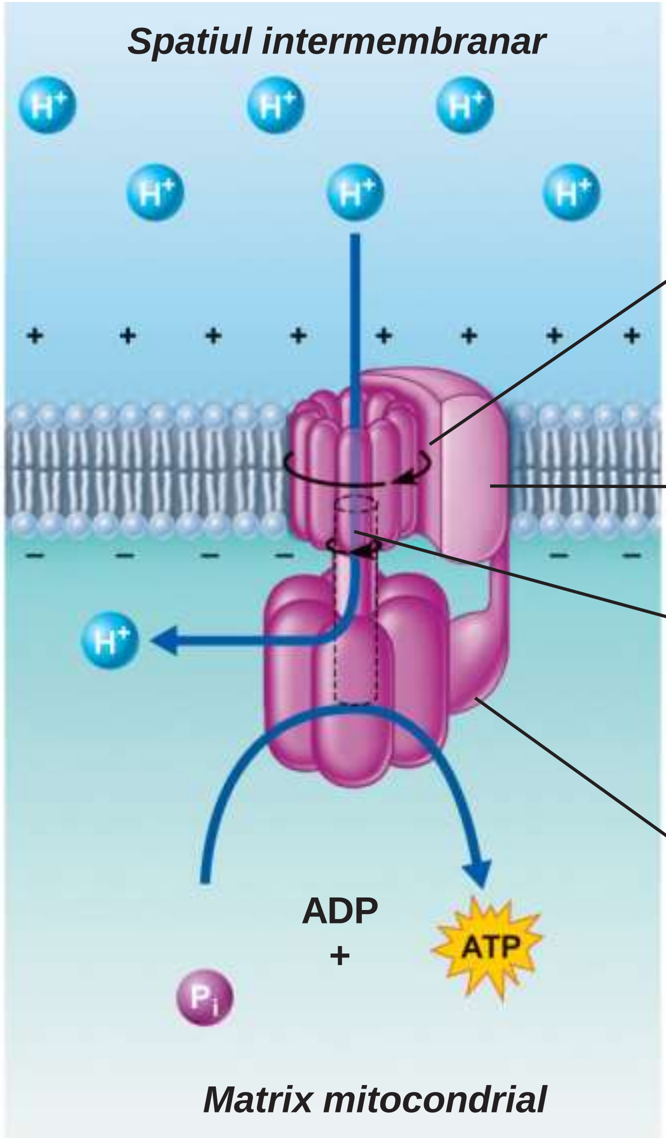
Glicoliza anaeroba = 2 ATP

Fosforilarea oxidativa



1. Complex I: NADH dehidrogenaza
2. Complex II: succinat dehidrogenaza
3. Citocrom c
4. Complex IV: citocrom c oxydaza (formeaza H_2O)
5. Complexul V ATP-aza

Fosforilarea oxidativa



Un **rotor** in membrana se invirte orar cind H^+ curge in virtutea gradientului H^+ .

Un **stator** ancorat in membrana mentine nodul sau capatul stationar

Cind rototrul se invirte **Tija care leaga rotorul de nod se invirte de asemenea**

Nodul stationar contine trei site-uri catalitice care leaga fosfatul anorganic de ADP pentru a sintetiza ATP atunci cind tija se roteste.

Oximetria

Masurarea nivelului de oxigenare:
(spectrofotometrie cu co-oximetrie de absorbtie)

1.Direct in singe (arterial,venos,capilar)

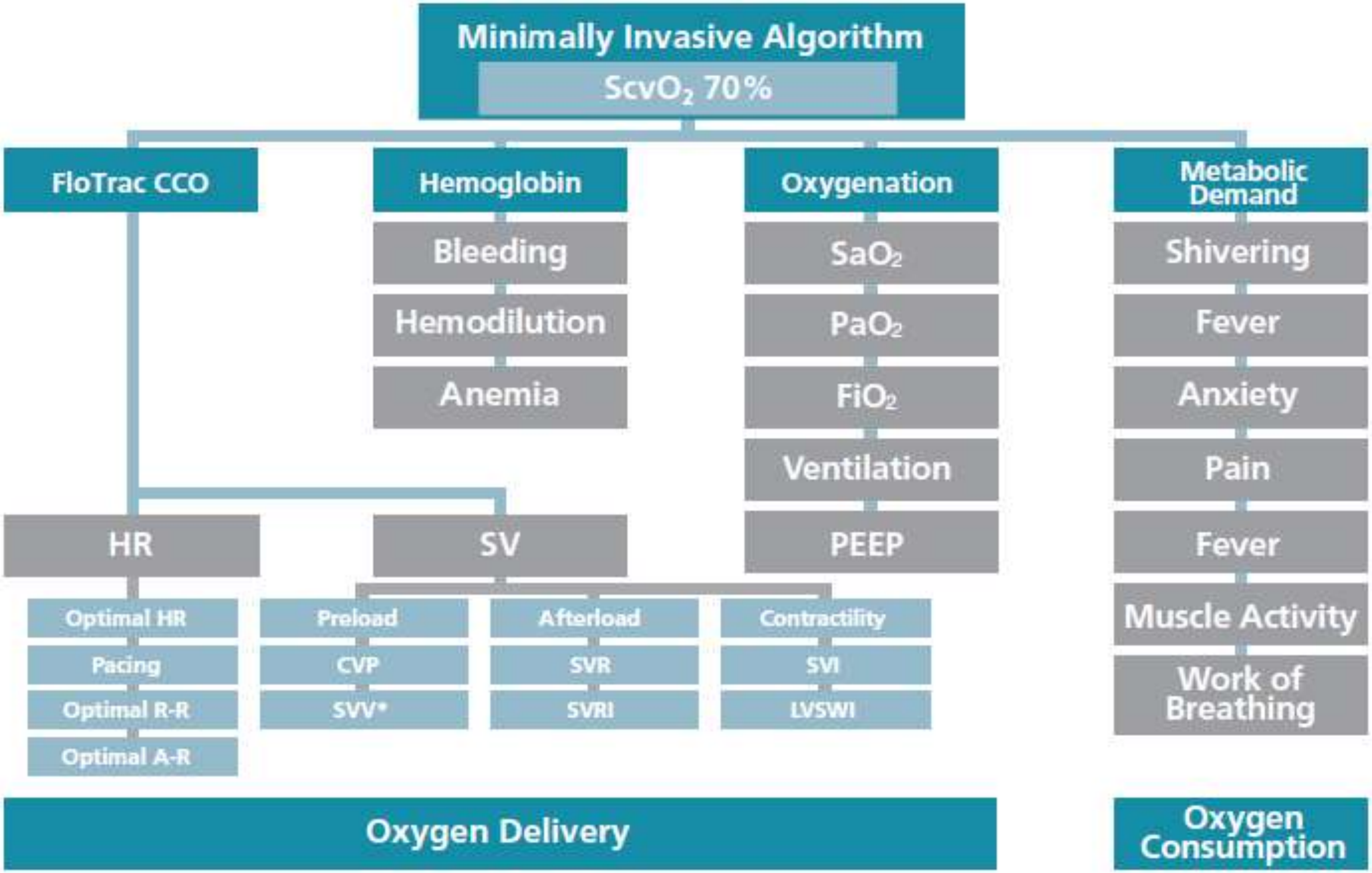
PaO_2, PvO_2, SaO_2, SvO_2, $ScvO_2$, $SpvO_2$, $SjvO_2$, $ShvO_2$, $ScsO_2$.

$ScvO_2 \leq SvO_2$ (in conditii normale)

$ScvO_2 \geq SvO_2$ (in stari de hipoperfuzie si soc)

2. Indirect (pulsoximetrie, oximetrie cerebrala)

Oximetria


Minimally Invasive Algorithm
ScvO2 70%
FloTrac CCO
Hemoglobin
Oxygenation
Metabolic Demand
Bleeding
Hemodilution
Anemia
SaO2
PaO2
FiO2
Ventilation
PEEP
Shivering
Fever
Anxiety
Pain
Fever
Muscle Activity
Work of Breathing
HR
SV
Optimal HR
Pacing
Optimal R-R
Optimal A-R
Preload
CVP
SVV*
Afterload
SVR
SVRI
Contractility
SVI
LVSWI
Oxygen Delivery
Oxygen Consumption

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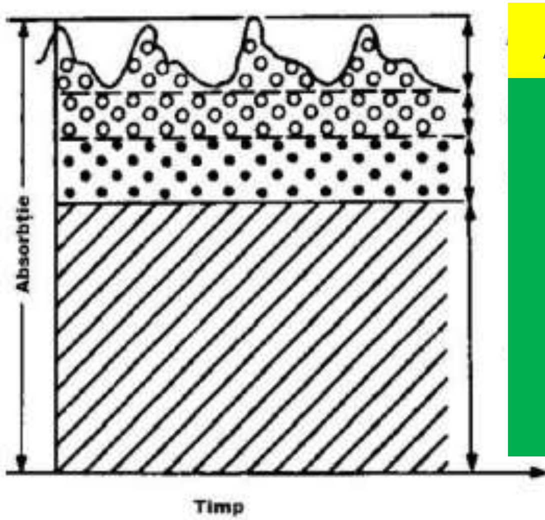
Pulsoximetria

Standard de baza in anestezie, ICU, sedare , urgente
Spectrofotometrie + pletismografie
Legea Beer Lambert: intensitatea luminii transmisa prin tesuturi este fct log. a saturatiei in O_2.
HbH absoarbe lumina ≠ fata de O_2Hb (sau alte Hb)
Masurare si comparare a luminii emise de 2 fotodiode in spectrul R (660nm) si IR (940 nm).

SaO_2 funcţională = O_2Hb / (O_2Hb+HbH) × 100



Absorbtia variabila

Absorbtia non variabila

Pulsoximetria

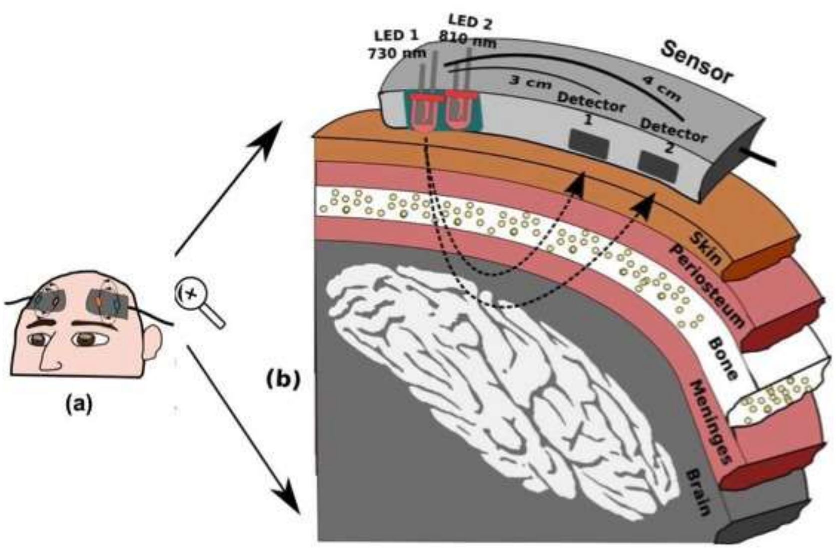
Influente in masurarea acurata:

1. miscarile pacientului
2. pozitionarea si lumina ambientala
3. lacul de unghii
4. hemoglobinele patologice (carboxiHb confunda cu O_2Hb, Met Hb valori fals scazuta la SpO_2 >85% si fals crescuta la SpO_2<85%.
5. efectul de penumbra subapreciaza saturatia
6. lipsa de rezolutie la PaO_2 > 100 mmHg
7. acuratete ± 3% intre 70-100%
8. timp de raspuns : 15-35 sec.
9. low flow conditii

Regula 40, 50, 60 (mmHg): 70, 80, 90 (%) SpO_2

Oximetria cerebrala

Monitorizeaza rSO_2 cerebral
NIRS: principiu legii Beer Lambert
Singe venos amestecat cu arterial si nepulsatil
Imbalanta aport O_2/consum O_2 cerebral
VN: rSO_2=50% sau scadere de maximum 20%



Utila in chirurgia vasculara, CPR, neurochirugie, trauma

Mesaje de luat acasa

1. La nivel pulmonar, principalele cauze generatoare de hipoxemie sunt alterarea raportului ventilatie/perfuzie (cresterea spatiului mort functional si suntul dreapta-stinga) si tulburarile de difuziune.

2. Hemoglobina este principalul transportator al oxigenului, iar performanta cardiaca optimala (cu toti determinantii sai), cureaua de transmisie a acesteia intre plamini si tesuturi.

Mesaj de luat acasa

3.Cauzele de imbalanta in cererea si oferta de oxigen trebuie identificate si corectate cit mai precoce, in scopul mentinerii metabolismului tisular in regim de aerobioza, cu productie fiziologica de ATP, generat prin proces de fosforilare oxidativa. Metabolismul anaerob trebuie evitat, fiind cauzator de suferinta celulara si disfunctii severe de organ.

Mesaj de luat acasa

4. **Monitorizarea continutului de O2 in singe ofera date cruciale despre functionalitatea aparatului respirator, valoarea performantei cardiace (debitului cardiac), a macro- si microcirculatiei sistemice regionale sau locale, valorii hemoglobinei, a statusului volemic, despre performanta metabolismului tisular si prezenta suferintei de organ si celulara.**


Merry
Christmas
Ho Ho