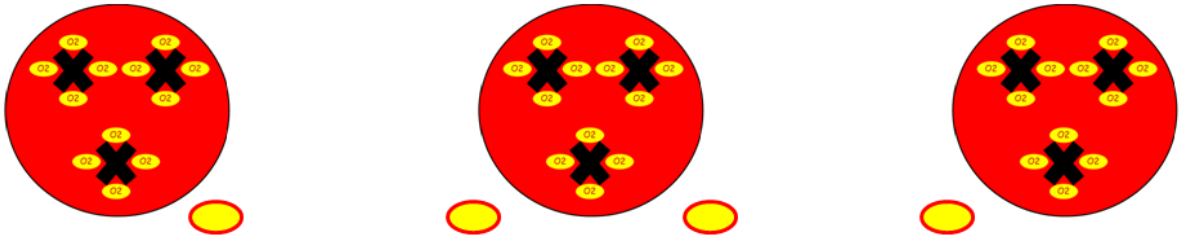
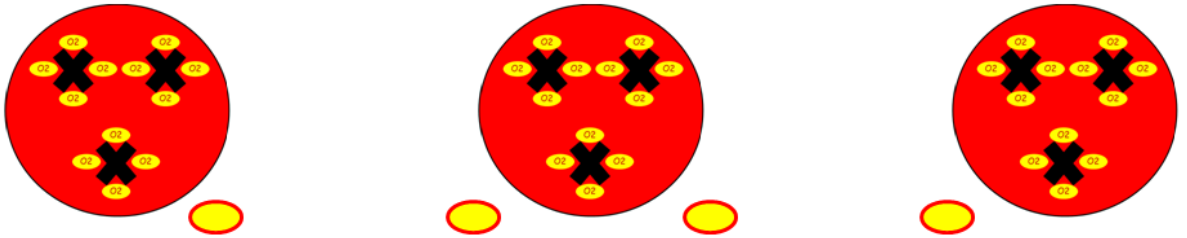
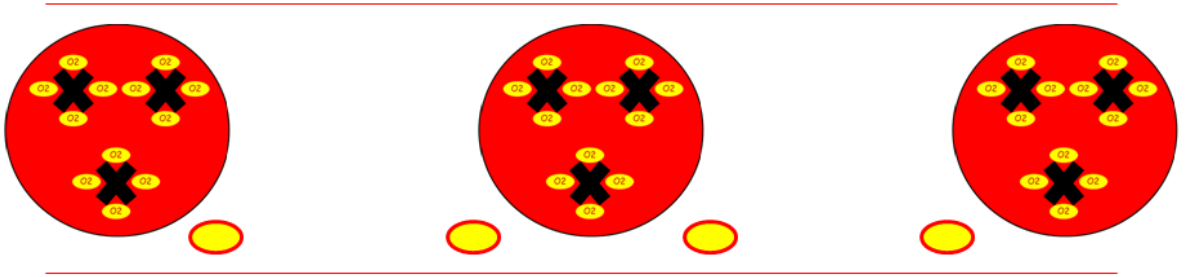


Cardiovascular Response to Anemia?

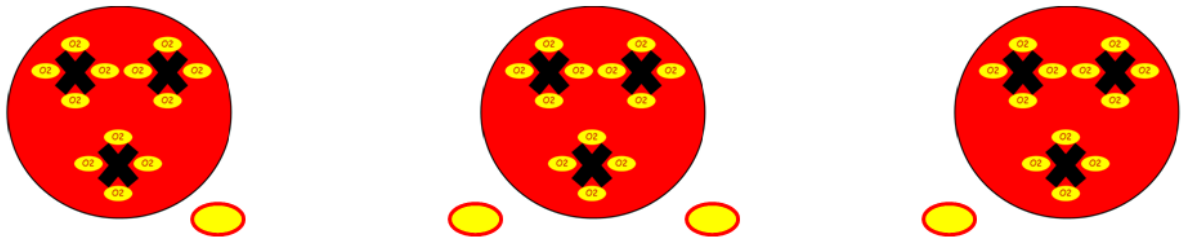


Cardiovascular Response to Hypoxia?

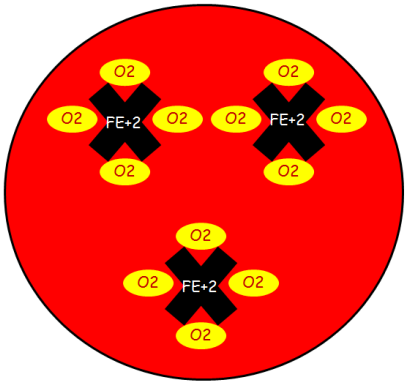


Cardiovascular Response to Hypoxia?

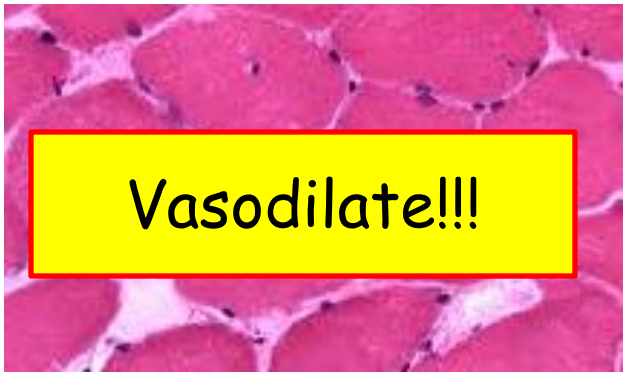
Anemia = Low CaO_2 = Tissue Hypoxia



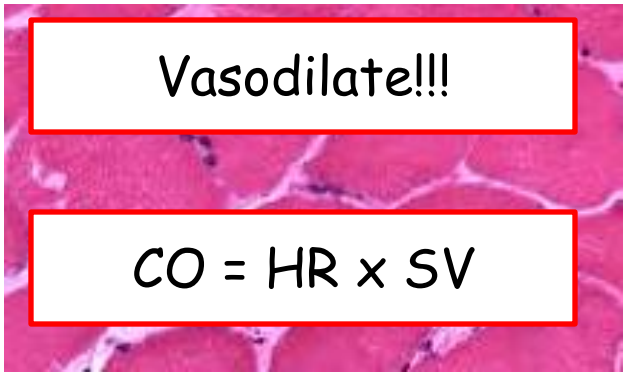
Cardiovascular Response to Anemia?



If the purpose of RBCs are to deliver oxygen, how will oxygen-deprived tissues respond?



Cardiovascular Response to Anemia?



Vasodilate!!!

CO = HR x SV

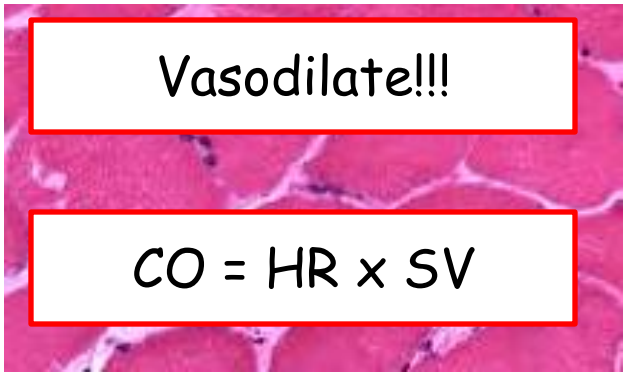
If you vasodilate, what happens to afterload?

If afterload decreases, what happens to SV?

If SV increases, what happens to CO?

If SV increases, what happens to pulse pressure?

Cardiovascular Response to Anemia?



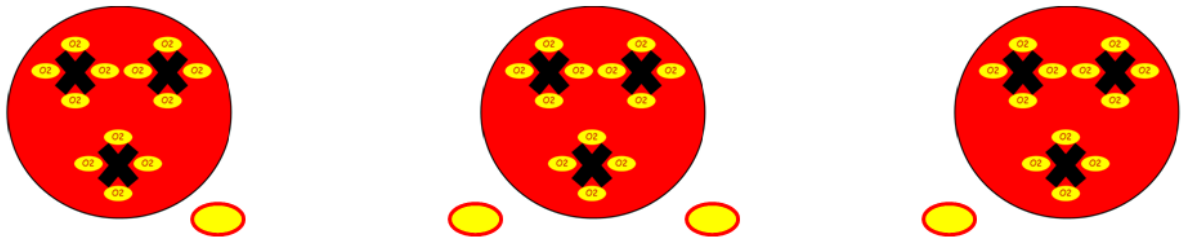
Vasodilate!!!

CO = HR x SV

Pulse Pressure

1. Systolic - Diastolic
2. Compliance (aortic) x SV

If SV increases, what happens to pulse pressure?



Cardiac Response to Anemia

Low oxygen delivery to tissue/periphery:

Vasodilation → ↓ Afterload
SV ↑ due to ↓ Afterload (and ↓ blood viscosity)
CO ↑ due to ↑ SV (and HR via SNS)
Pulse Pressure ↑: SV x Compliance (aortic)

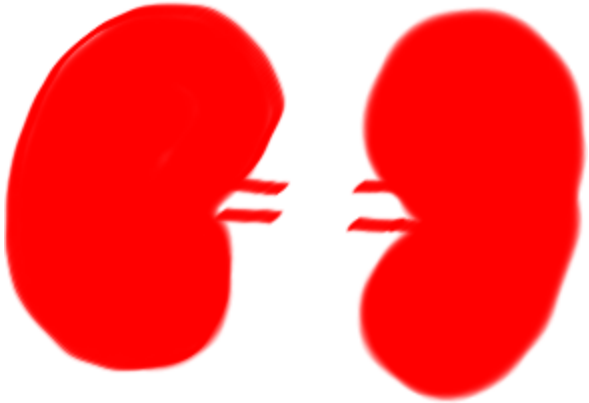
CV Response to ↓ O2 Content:
↑CO, SV, PP (pulse pressure)

FYI…example of 'hi output failure'

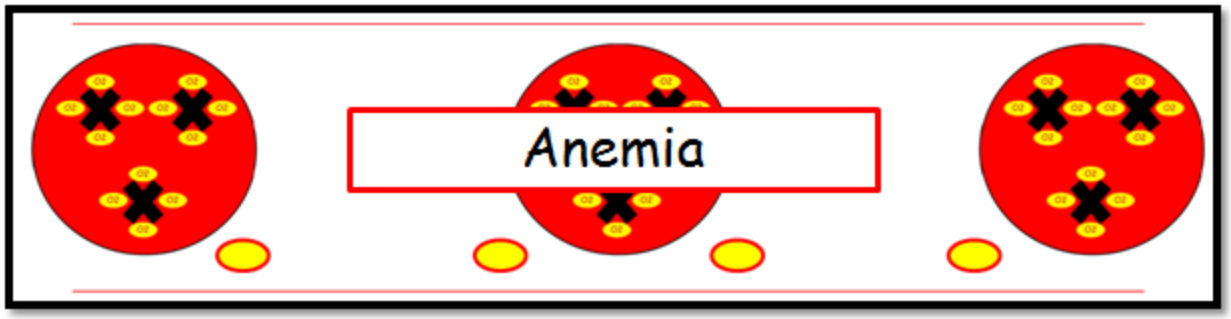
Patient with Hgb 10 (12-15) and HCT of 30% (40-45)

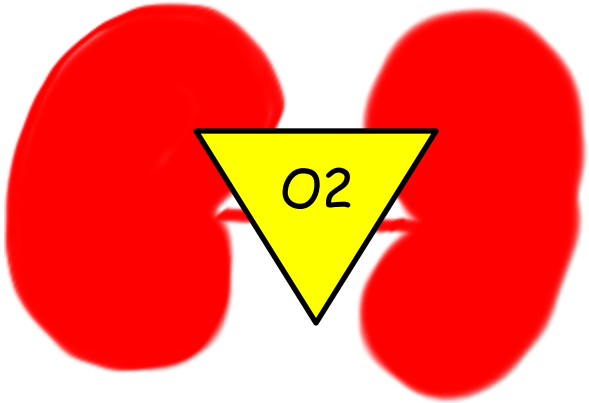
	PaO2	SaO2	CaO2	SV, CO, PP
A.	⇩	⇩	⇔	⇔
B.	⇧	⇧	⇧	⇩
C.	⇔	⇔	⇩	⇧

Q. Stimulus to EPO: GFR or Anemia?



Hello Kidneys!

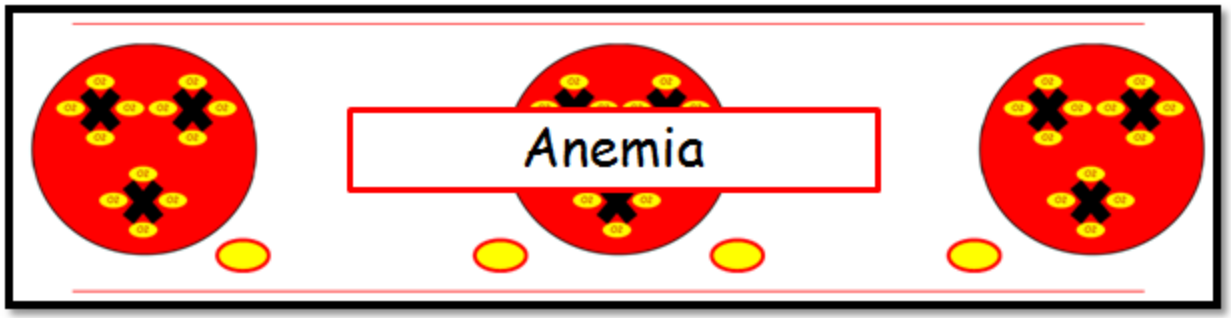




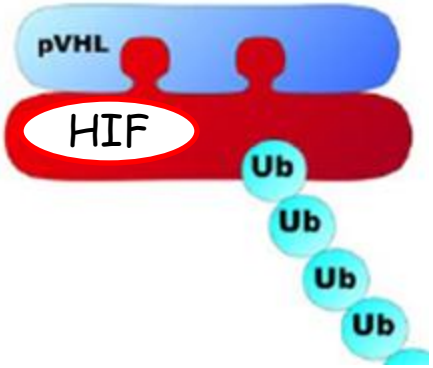
Erythropoietin production (interstitial cells) driven by:

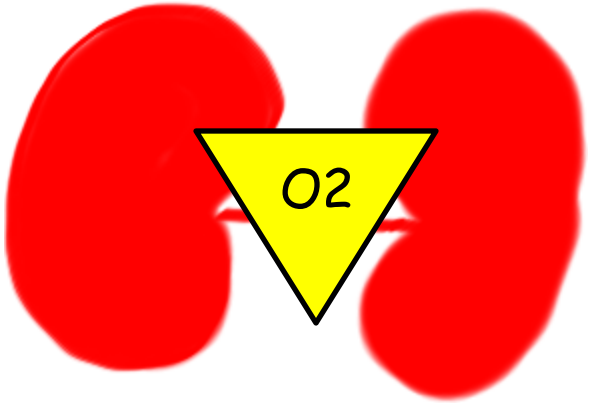
OXYGEN CONTENT

(Hb 9 x 1.34) x 95-100% SaO2 + 0.3 = 12 ml O2/dl



Normoxia





Hypoxia

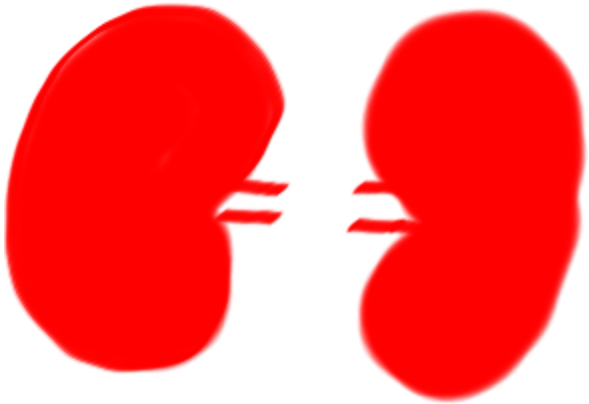
Erythropoietin production (interstitial cells) driven by:

OXYGEN CONTENT

Transcription of hypoxia inducible genes

(Hb 9 x 1.34) x 95-100% SaO2 + 0.3 = 12 ml O2/dl

Q. Stimulus to EPO: GFR or Anemia?



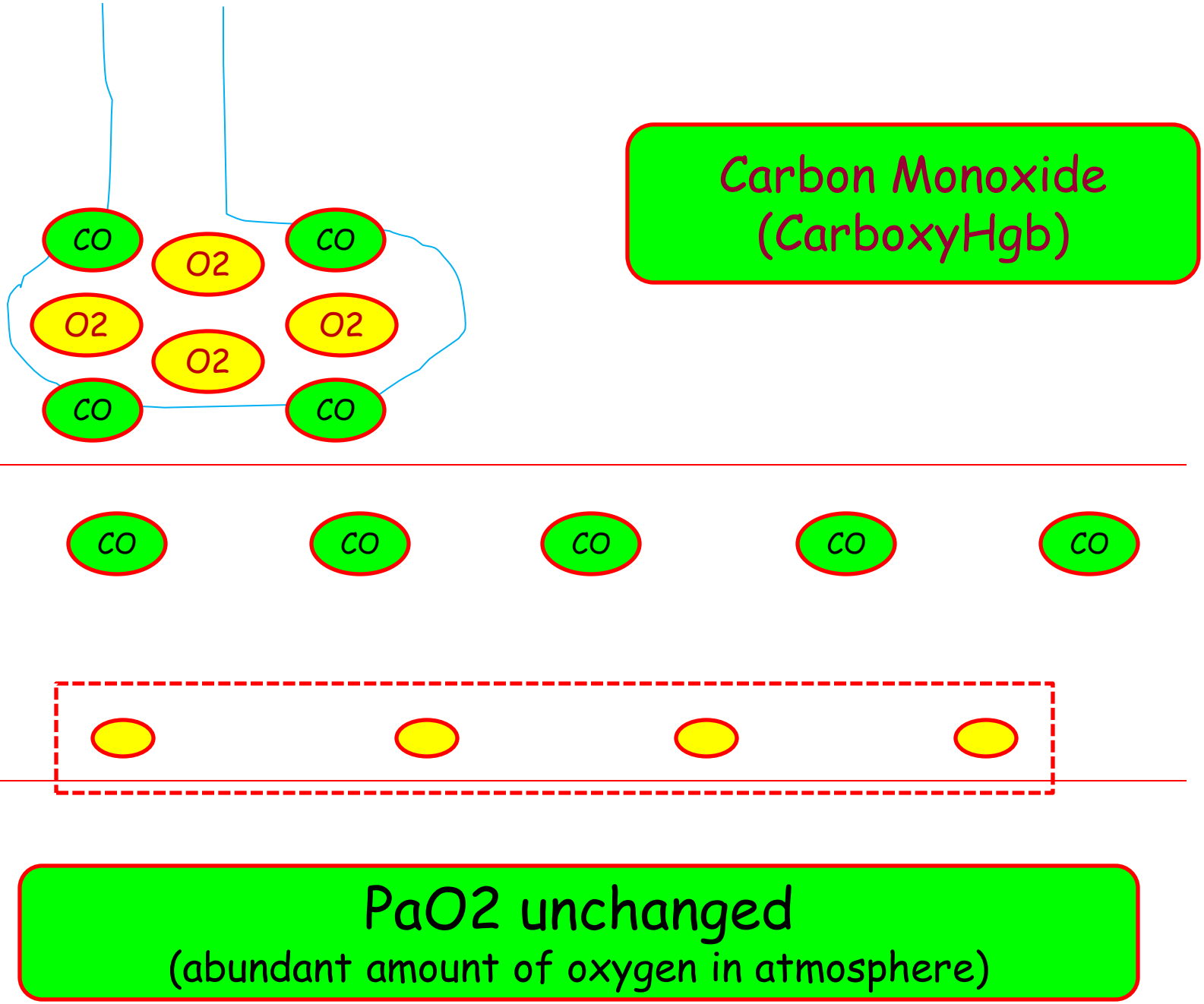
Yes, oxygen content drives EPO, not GFR (they are dissociated)

This concept also explains the physiologic erythrocytosis seen in patients with chronic lung disease.

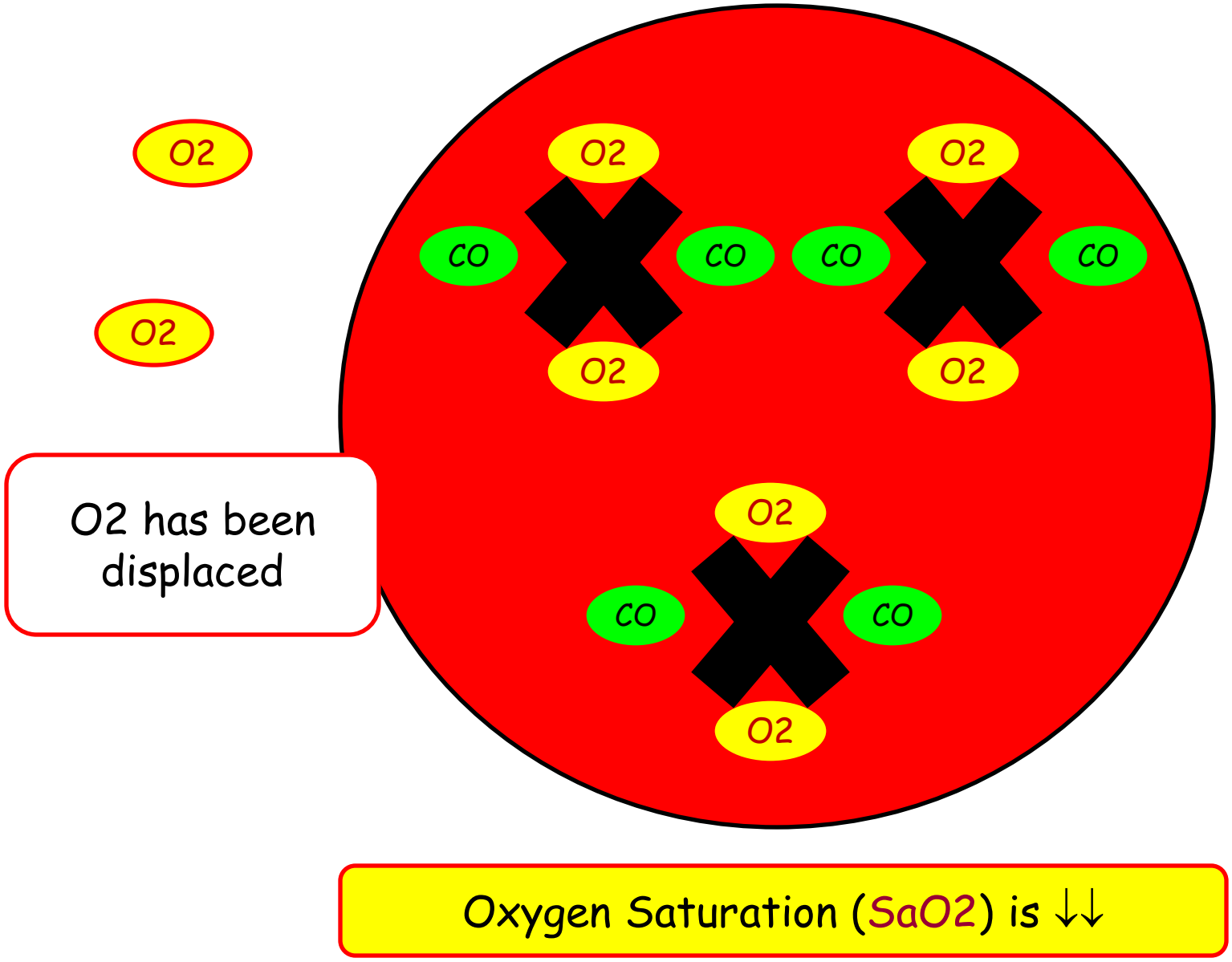
Covered Material

- Measures of Oxygen Transport
  - PaO2 (mm Hg)
  - SaO2 (%)
  - CaO2 (ml O2/dL)
- Reviewed how anemia effects those measures
- Reviewed cardiovascular response to anemia
- Reviewed renal/erythropoietin response to ↓ CaO2

- Let's review how abnormal oxygen binding (CO) and abnormal iron (Fe+3) impacts these measures.


CO
O2
CO
O2
O2
O2
CO
CO
Carbon Monoxide
(CarboxyHgb)
CO
CO
CO
CO
CO
PaO2 unchanged
(abundant amount of oxygen in atmosphere)

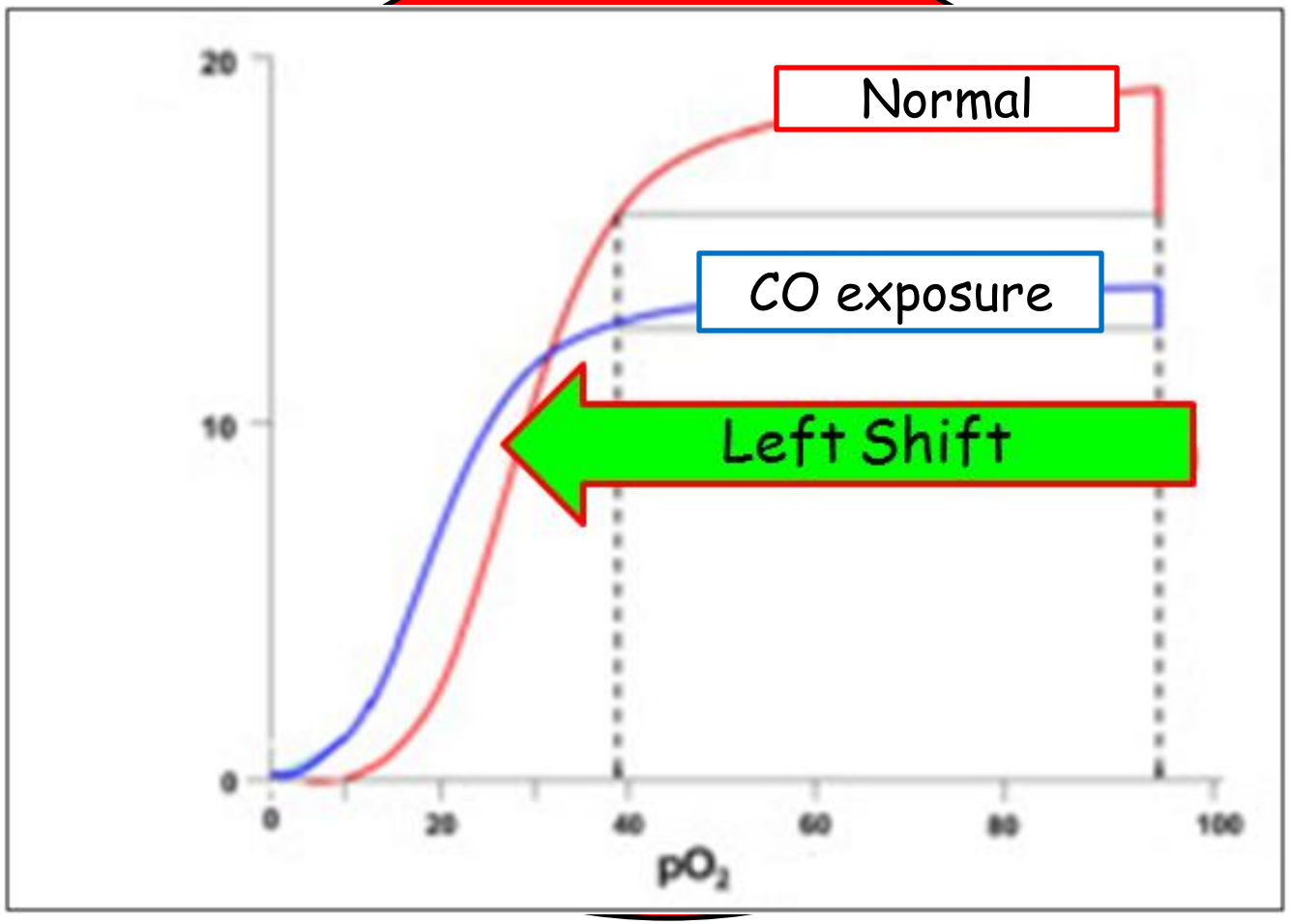
CO >>> O2 Binding Affinity



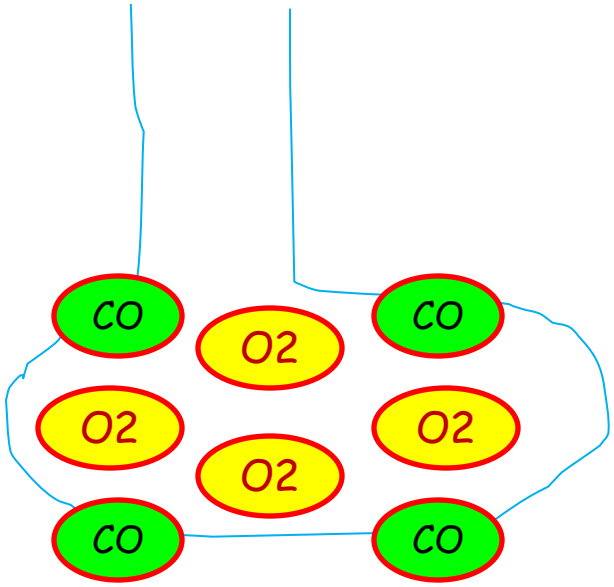
O2 has been displaced

Oxygen Saturation (SaO2) is ↓↓

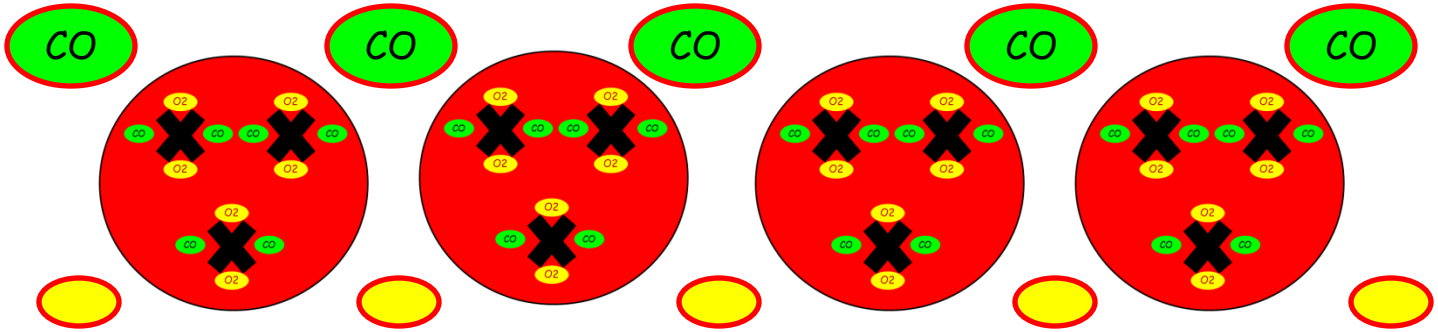
CO >>> O2 Binding Affinity



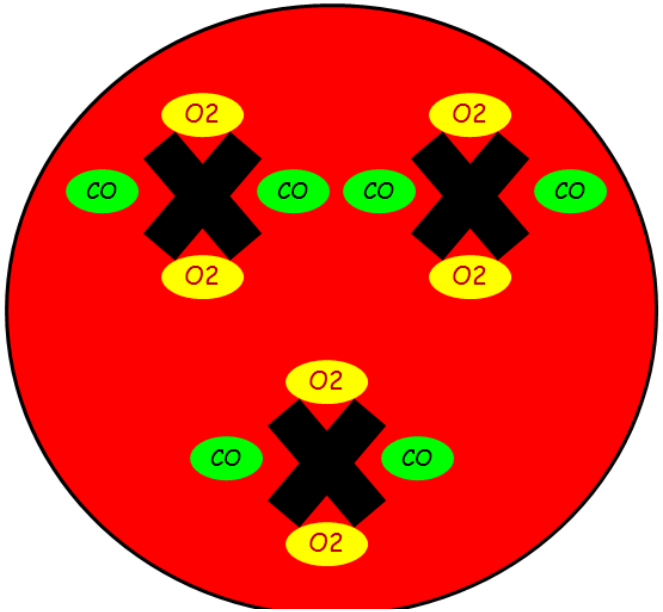
Oxygen Saturation (SaO2) is ↓↓



Carbon Monoxide
(CarboxyHgb)



Oxygen Content:
[Hgb x 1.34 (no change)] x SaO2 ↓↓ + 0.3



Carbon Monoxide

200x affinity for Hgb

O2 dissociation curve → left

History: Exposure

PE: CNS depression

Skin color: cyanotic or cherry red???

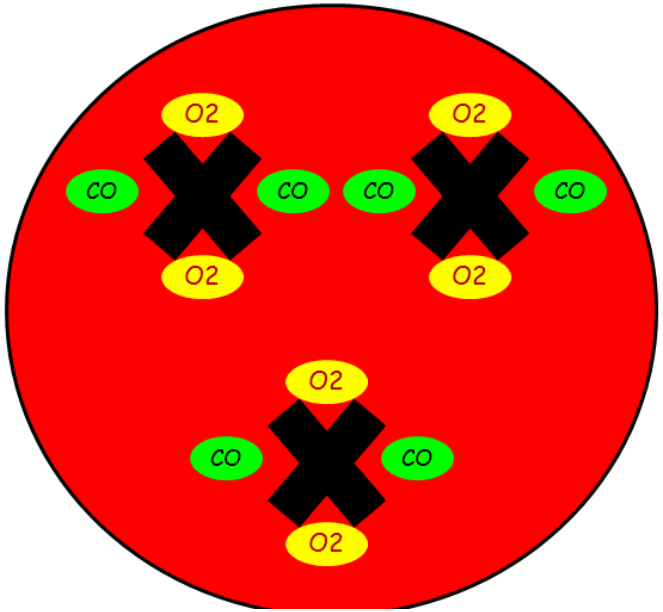
Exposure/Presentation:

Working in a garage with heater running.

Bought to ER by friend.

Appears Cherry Red.

carbon monOXIDE



PaO2: no change
SaO2: decreased
CaO2: decreased

Carbon Monoxide

200x affinity for Hgb

O2 dissociation curve → left

History: Exposure

PE: CNS depression

Skin color: cyanotic or cherry red???

Clinical Dx: CarboxyHgb level

USMLE Dx: Oxygen Content

Rx: Oxygen

Covered

- Measures of Oxygen Transport
  - PaO2
  - SaO2
  - CaO2
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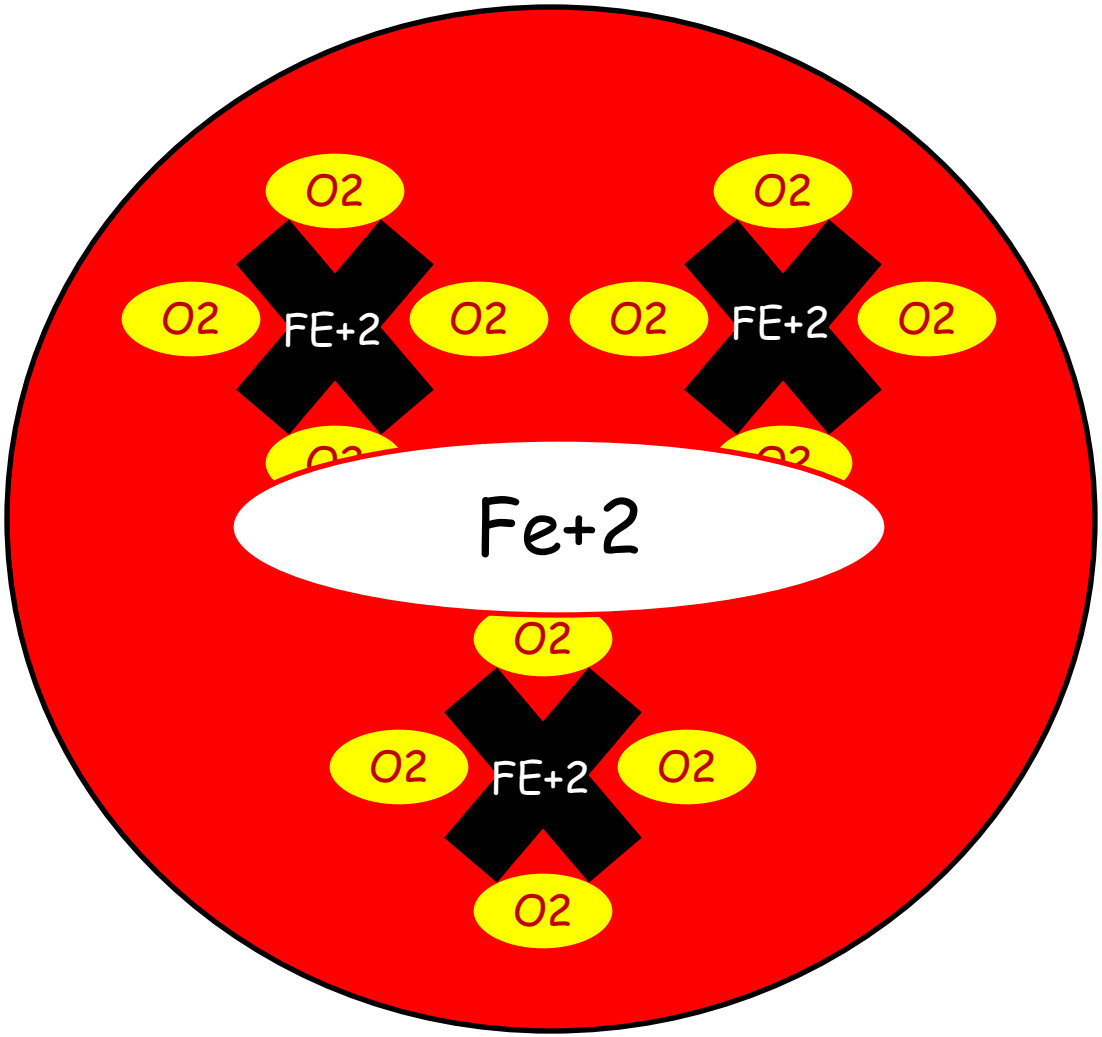
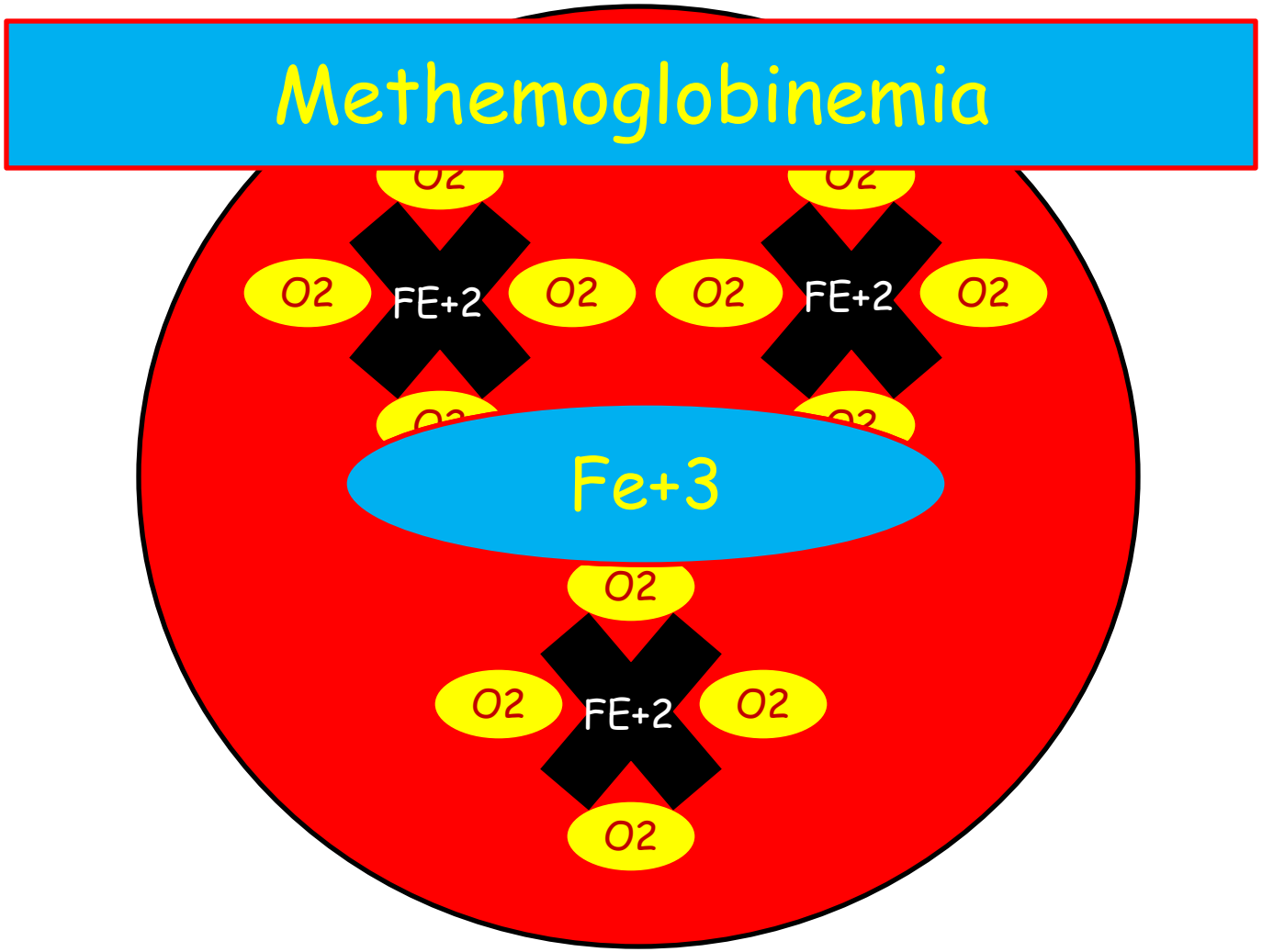
Oxygen freely diffuses into RBCs
SaO2 measures Hgb binding sites bound to oxygen

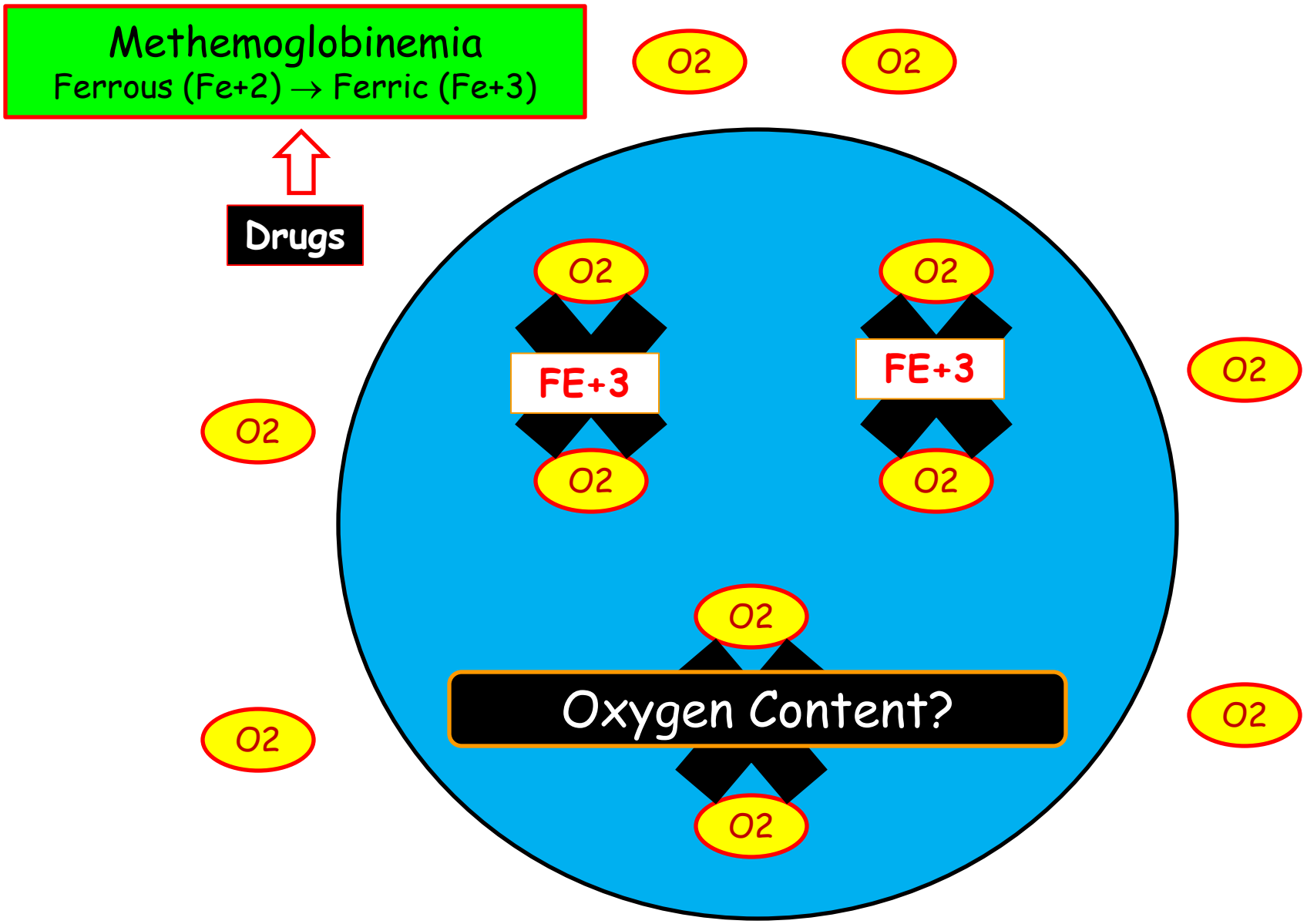


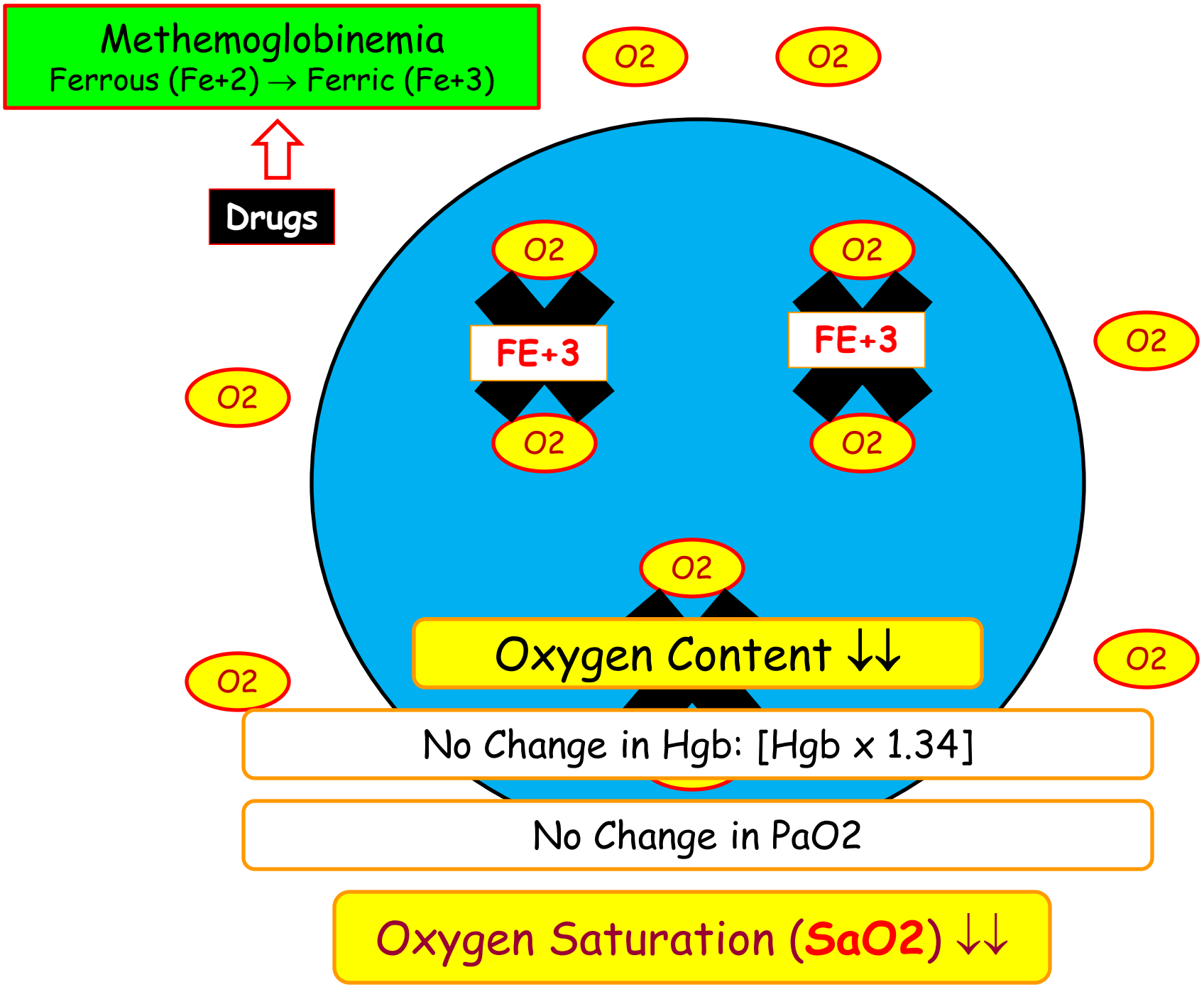
Oxygen Saturation (SaO2)

Oxygen freely diffuses into RBCs
SaO2 measures Hgb binding sites bound to oxygen



Oxygen Saturation (SaO2)


Methemoglobinemia
Ferrous (Fe+2) → Ferric (Fe+3)
Drugs
O2
O2
O2
O2
FE+3
FE+3
O2
O2
O2
O2
O2
Oxygen Content?
O2
O2
O2


Methemoglobinemia
Ferrous (Fe+2) → Ferric (Fe+3)
Drugs
O2
O2
O2
O2
FE+3
FE+3
O2
O2
O2
O2
O2
O2
O2
Oxygen Content ↓↓
No Change in Hgb: [Hgb x 1.34]
No Change in PaO2
Oxygen Saturation (SaO2) ↓↓

PABA

⇩

DHF

Methemoglobinemia
Ferrous (Fe+2) → Ferric (Fe+3)

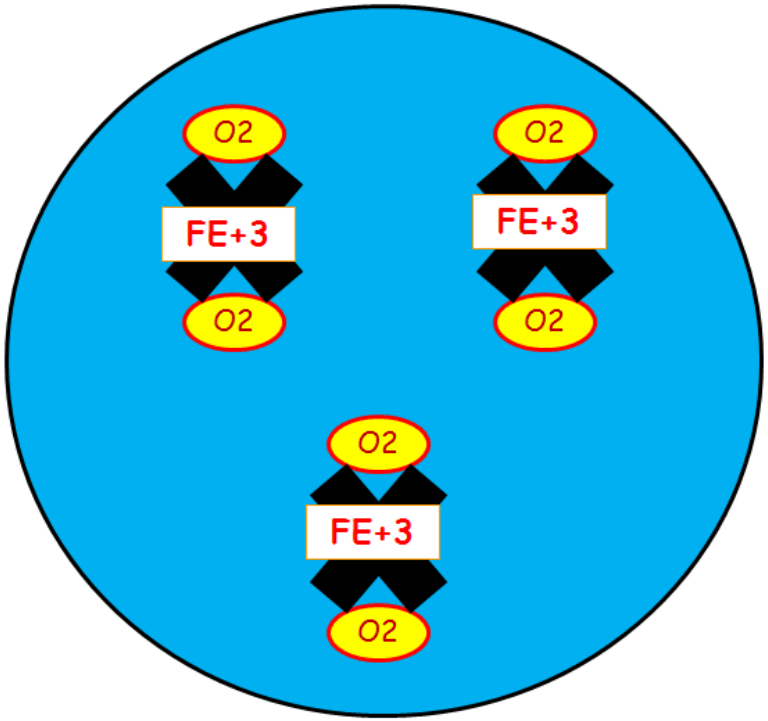
⇧

Drugs

Dapsone
Antifolate (PABA antagonist)
Indication: Leprosy, PCP ppx, DH
AE (>10%): MetHgb, hemolysis (G6PD)

Leprosy
Bug: mycobacterium leprae
Painless, nonhealing skin lesions
Rx: Dapsone and Rifampin

Q. Patient is given a drug for nonhealing skin lesions and…



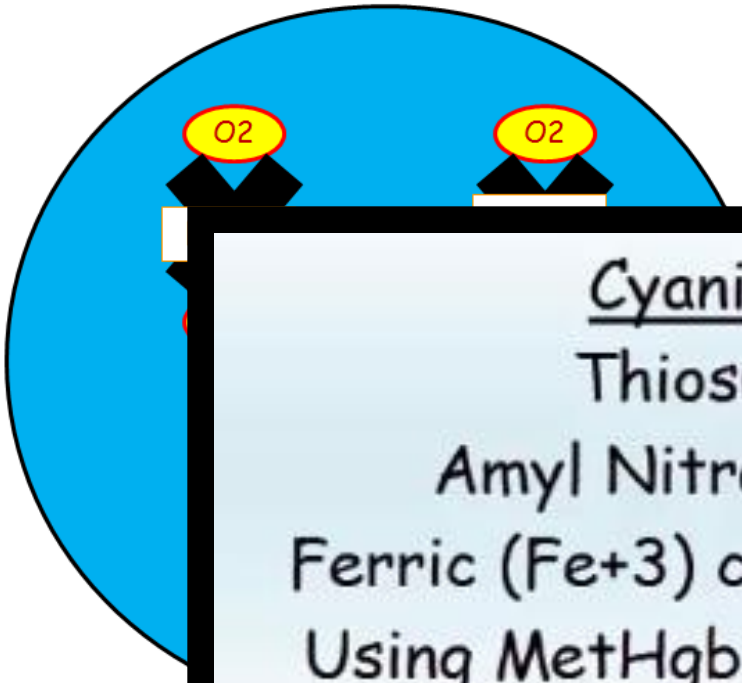
PaO2 unchanged
SaO2 ↓↓
Oxygen Content ↓↓
MetHgb level ↑

<u>Methemoglobinemia</u>
Fe^{+3} is unable to bind oxygen
Remaining Fe+2 has increased affinity (shift curve → left)

<u>History</u>: Offending drug (esp dapsone/sulfa, nitrates, topical anesthetics)
<u>PE</u>: cyanosis/'dusky'
'chocolate brown blood' (in OR)
<u>Data</u>: (in box)

<u>Rx</u>: Methylene blue
(electron acceptor)

<u>Special Notes</u>:
Cyanide poisoning and nitroprusside



Cyanide Toxicity Rx:
Thiosulfate is classic.
Amyl Nitrate induces MetHgb.
Ferric (Fe+3) can bind cyanide molecule.
Using MetHgb for good instead of evil!

Methemoglobinemia
Fe^{+3} is unable to bind oxygen
...sed
...eft)
...g
... topical
... OR)
Data: (in box)

PaO2 unchanged
SaO2 ↓↓
Oxygen Content ↓↓
MetHgb level ↑

Rx: Methylene blue
(electron acceptor)

Special Notes:
Cyanide poisoning and nitroprusside

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- Let's review how abnormal oxygen binding (CO) and abnormal iron (Fe+3) impacts these measures.

Material Covered

Don't be stubborn!

Howard@12daysinmarch.com