CBE 30357

8/24/17

O_2 SOLUBILITY IN BLOOD

- IMPLICATIONS

O_2 SOLUBILITY IN BLOOD

PHYSICAL SOLUBILITY

"HENRY'S LAW"

$$C_{O_2} = H_{O_2} P_{O_2}$$

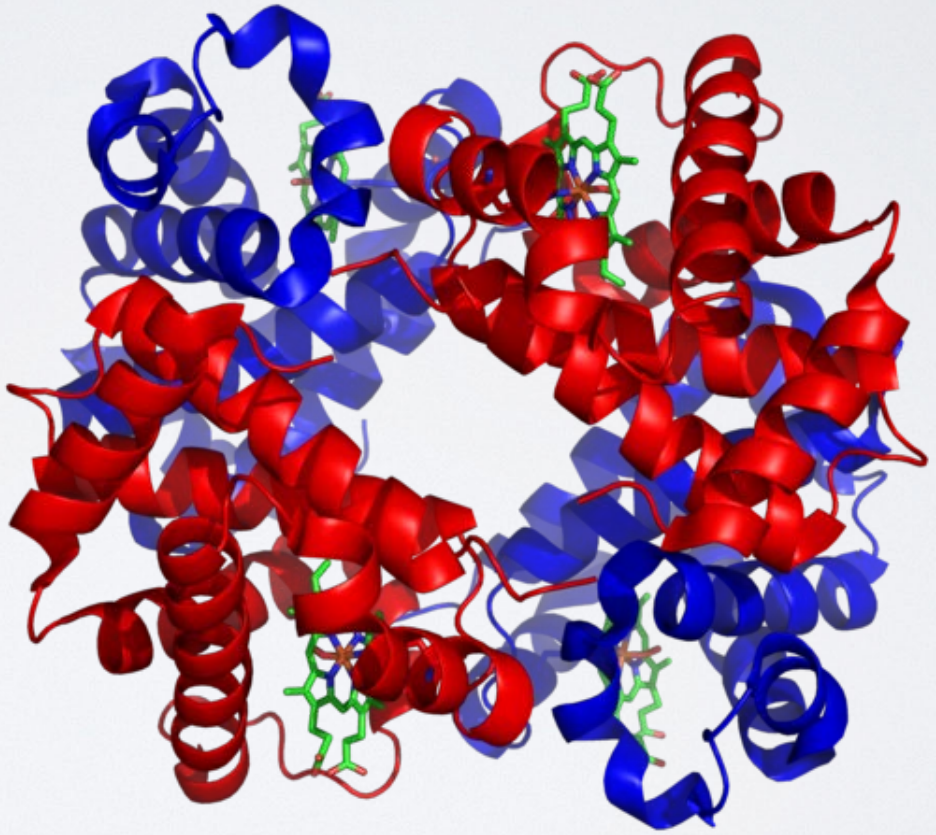
↑ HENRY'S CONSTANT

↑ PARTIAL PRESSURE

LIMITED TO LOW CONCENTRATION ~ PPM, "FLAT EARTH", FIRST TERM IN TAYLOR SERIES..

HEMOGLOBIN

- O2: Cooperative binding



TO SUSTAIN ROBUST LIFE

O_2 SOLUBILITY MUCH HIGHER THAN HENRY'S LAW RANGE IS NEEDED

- CHEMICAL COMPLEXATION

A.K.A.: HEMOGLOBIN

THE EQUATION O_2 IN BLOOD IS

$$C_{O_2} = H_{O_2} P_{O_2} (1 - H_{ct}) + \left(4 C_{Hb} \bar{S} + H_{Hb} P_{O_2}\right) H_{ct}$$

PHYSICAL SOLUBILITY

↑ FRACTION OF BLOOD THAT IS RED BLOOD CELLS

CHEMICAL COMPLEXATION

$\bar{S}$ FRACTIONAL LOADING OF O_2 ONTO HEMOGLOBIN BINDING SITES

OXYGEN CAPACITY OF BLOOD

$$C_{O_2} == H_{O_2} P_{O_2} (1 - Hct) + (4 C_{Hb} \overline{S} + H_{Hb} P_{O_2}) Hct$$

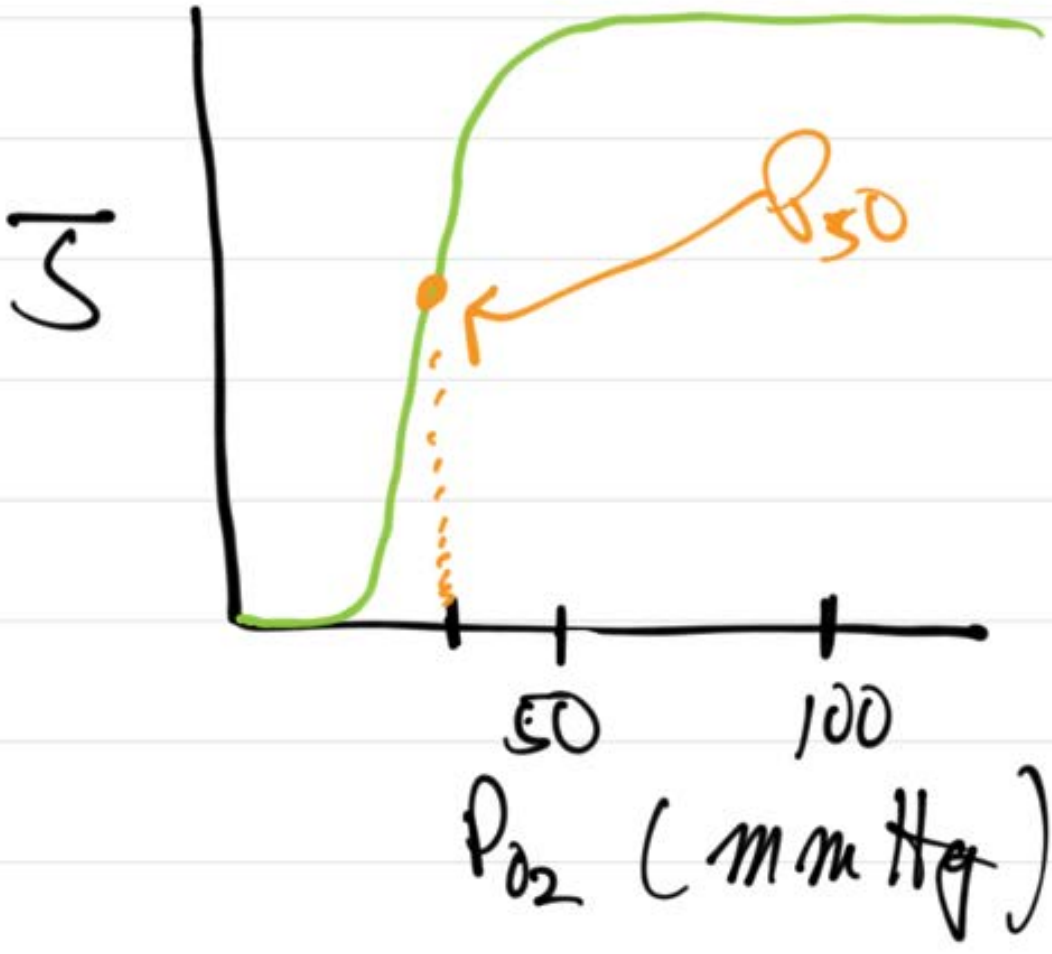
C_{O_2}, C_{Hb} == Concentrations of O2 and hemoglobin

H_{O_2}, H_{Hb} == "Henry's" constants for oxygen in plasma and hemoglobin

P_{O_2} == partial pressure of oxygen

Hct == "hematocrit", the volume fraction of red blood cells

$\overline{S}$ == The fractional saturation of oxygen on the hemoglobir



$$\overline{S} = \frac{(P_{O_2}/P_{50})^{2.6}}{(1 + P_{O_2}/P_{50})^{2.6}}$$

Figure 1.14 Oxygen–hemoglobin and oxygen–myoglobin dissociation curves. The fractional saturation is the relative amount of heme groups bound to molecular oxygen.

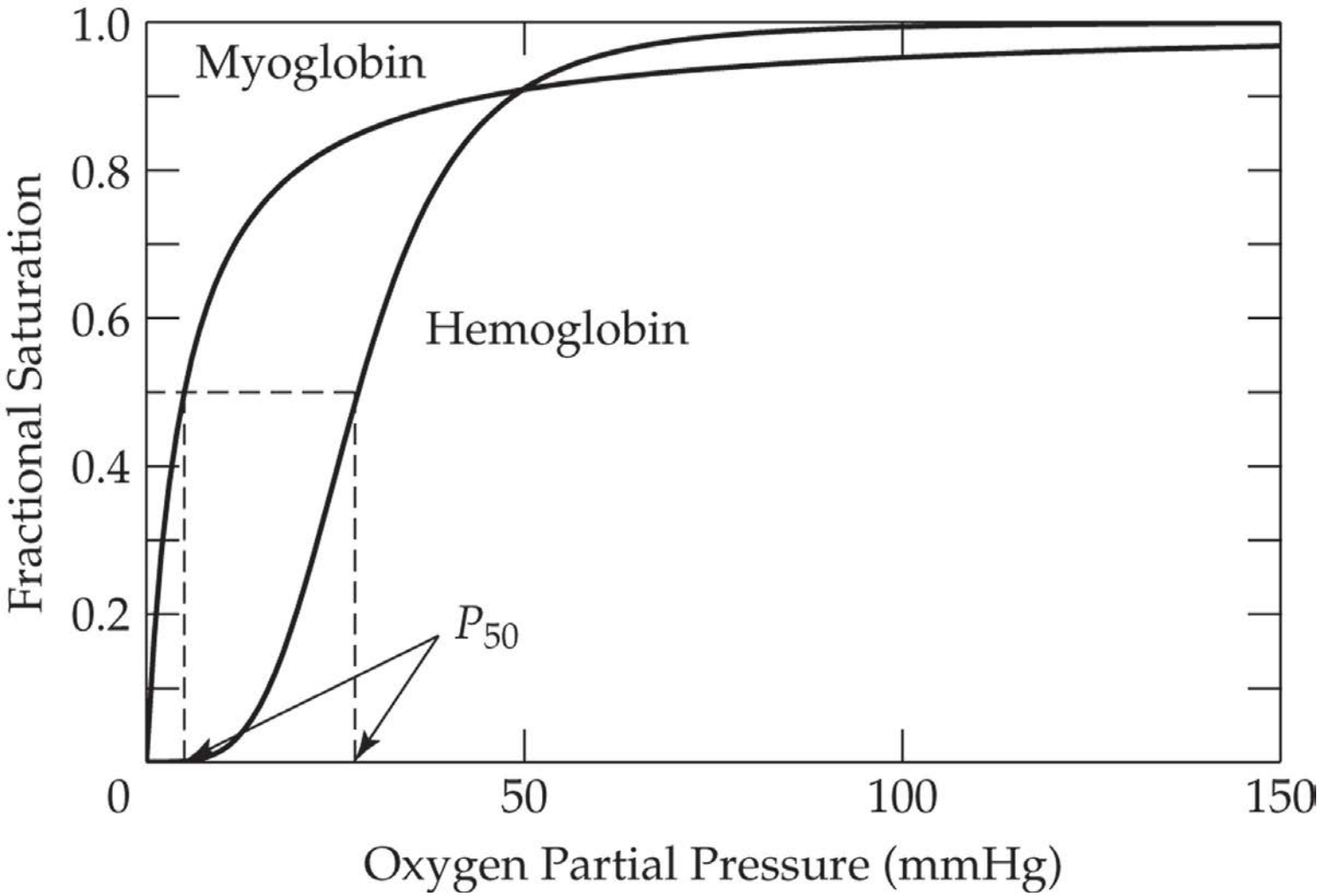


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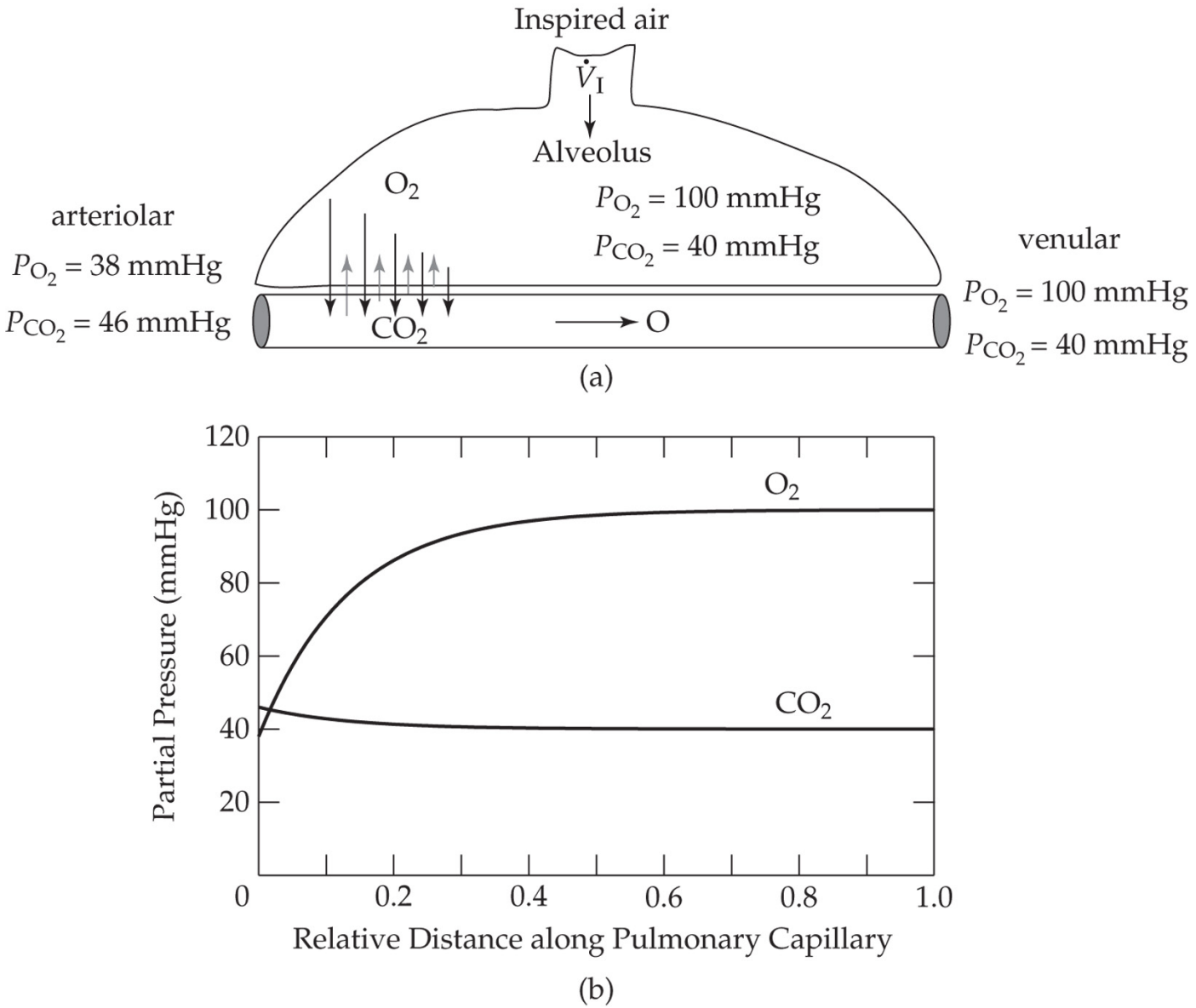
Figure 1.16 Oxygen and carbon dioxide exchange across the alveolar capillaries.



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WHILE YOU MAY (AT LEAST NOW)

NOT LOVE TO "WALLOW"

IN EQUATIONS AS MUCH

AS I DO...

LET'S !!

EX: WHEN IS PURE O_2 AN EFFECTIVE MEDICAL TREATMENT?

WE SEE THE 3 TERMS

$$H_{O_2} P_{O_2} (1 - H_{ct})$$

$$H_{O_2} = 1.4 \times 10^{-6} \frac{mol}{L - mmHg}$$

$$P_{O_2} \sim .21 * 760$$

$$= 160 \text{ mmHg}$$

$$H_{ct} \sim .45 \text{ OR } .4$$

$$= .00012 \frac{mol}{LITER}$$

$$= \sim 3 \text{ PPM (MASS)}$$

LOOK AT LAST TERM

$$H_{Hb} \; P_{O_2} \; H_{Ct}$$

$$1 \times 10^{-6} \; (160) \; .45$$

$$= .00007 \; \frac{mol}{L}$$

MIDDLE TERM

$$4 \; C_{Hb} \; \overline{S} \; H_{Ct}$$

C_{Hb} ≈ .45

$\overline{S}$ ↑ ≈ 1

O_2 ON

Hb

$= .0203 \; m/L$ $= .009$

CHEMICAL COMPLEXATION

.009 MOL/L.

PHYSICAL SOLUBILITY

= .00012 + .00007

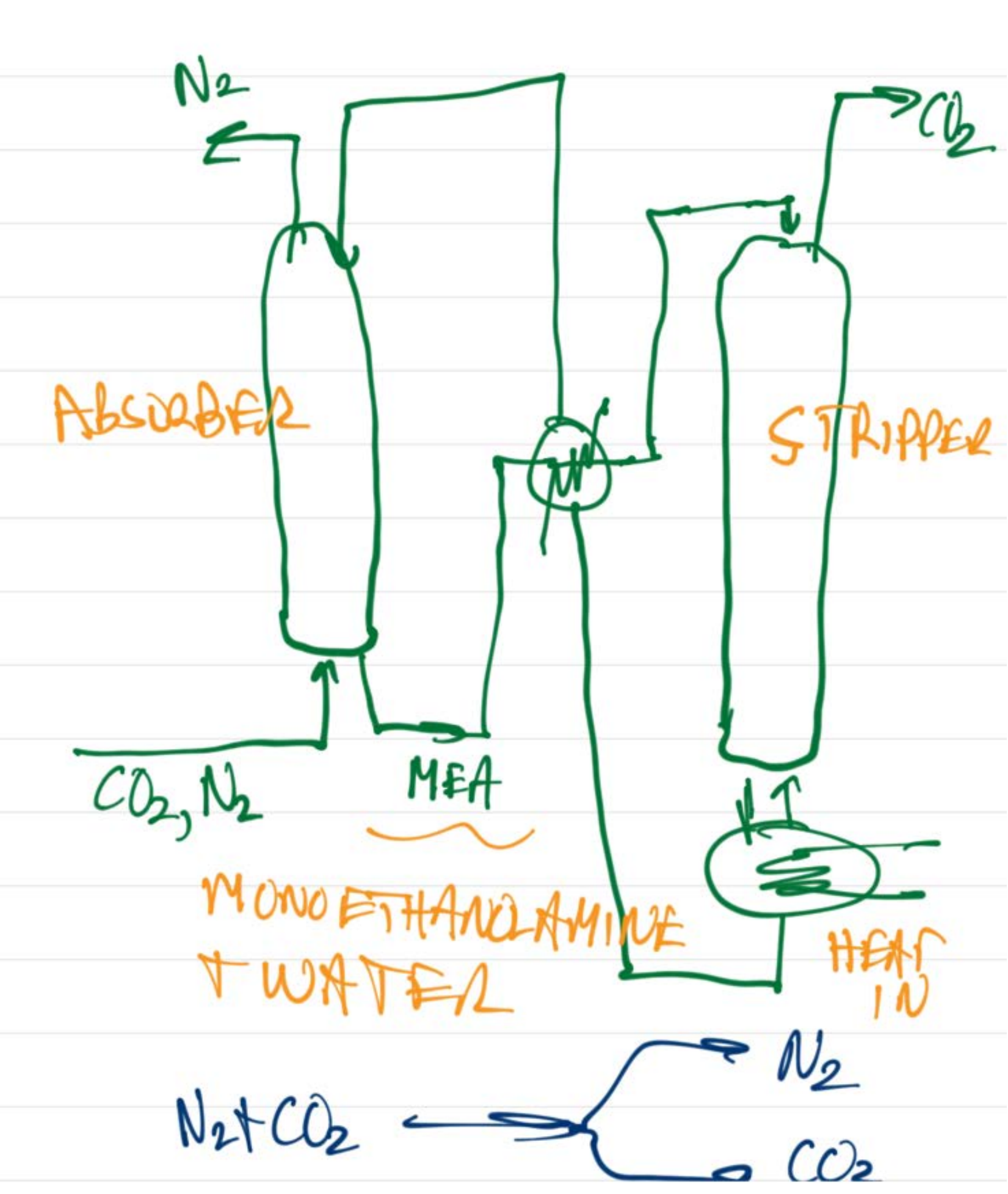
RATIO: $\frac{.009}{.00019} = 47$

HW PROBLEM GIVES A CHANCE TO TRY TO SEE WHAT LEVEL OF LIFE IS POSSIBLE WITH ONLY PHYSICAL SOLUBILITY

ALSO, THIS IS

"JUST LIKE" ...

??


N_2
CO_2
ABSORBER
STRIPPER
CO_2, N_2
MEA
MONOETHANOLAMINE
+ WATER
HEAT
IN
$N_2 + CO_2$
N_2
CO_2

THIS EQUATION ALSO "INFORMS" M.O.N.A.

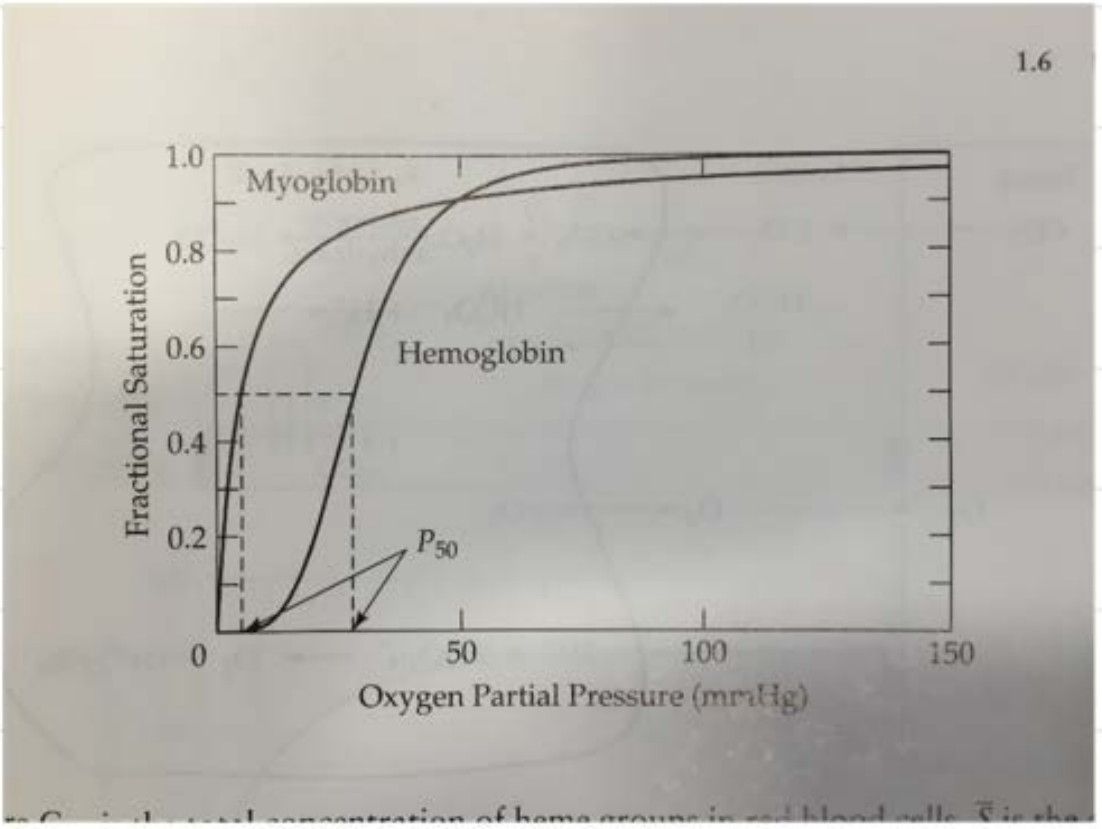
M: MORPHINE

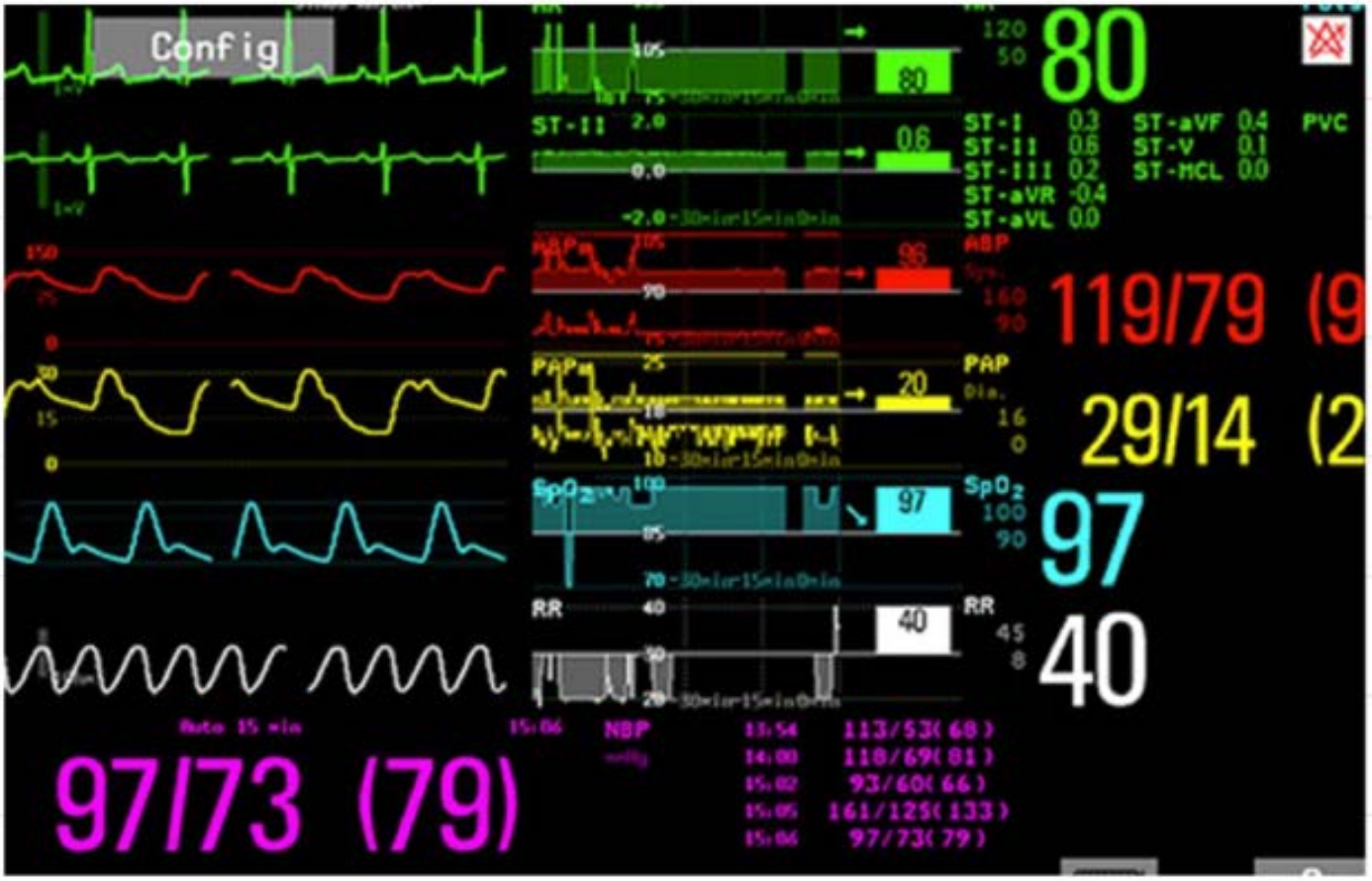
O: OXYGEN ??

N: NITROGLYCERINE

A: ASPIRIN

WILL IT HELP?


1.6
1.0
0.8
0.6
0.4
0.2
0
Myoglobin
Hemoglobin
P_{50}
Fractional Saturation
50
100
150
Oxygen Partial Pressure (mmHg)


Config
80
ST-I 0.3
ST-II 0.6
ST-III 0.2
ST-aVR -0.4
ST-aVL 0.0
ST-aVF 0.4
ST-V 0.1
ST-MCL 0.0
PVC
119/79 (9
29/14 (2
97
40
97/73 (79)
NBP
13:54 113/53(68)
14:00 110/69(81)
15:02 93/60(66)
15:05 161/125(133)
15:06 97/73(79)