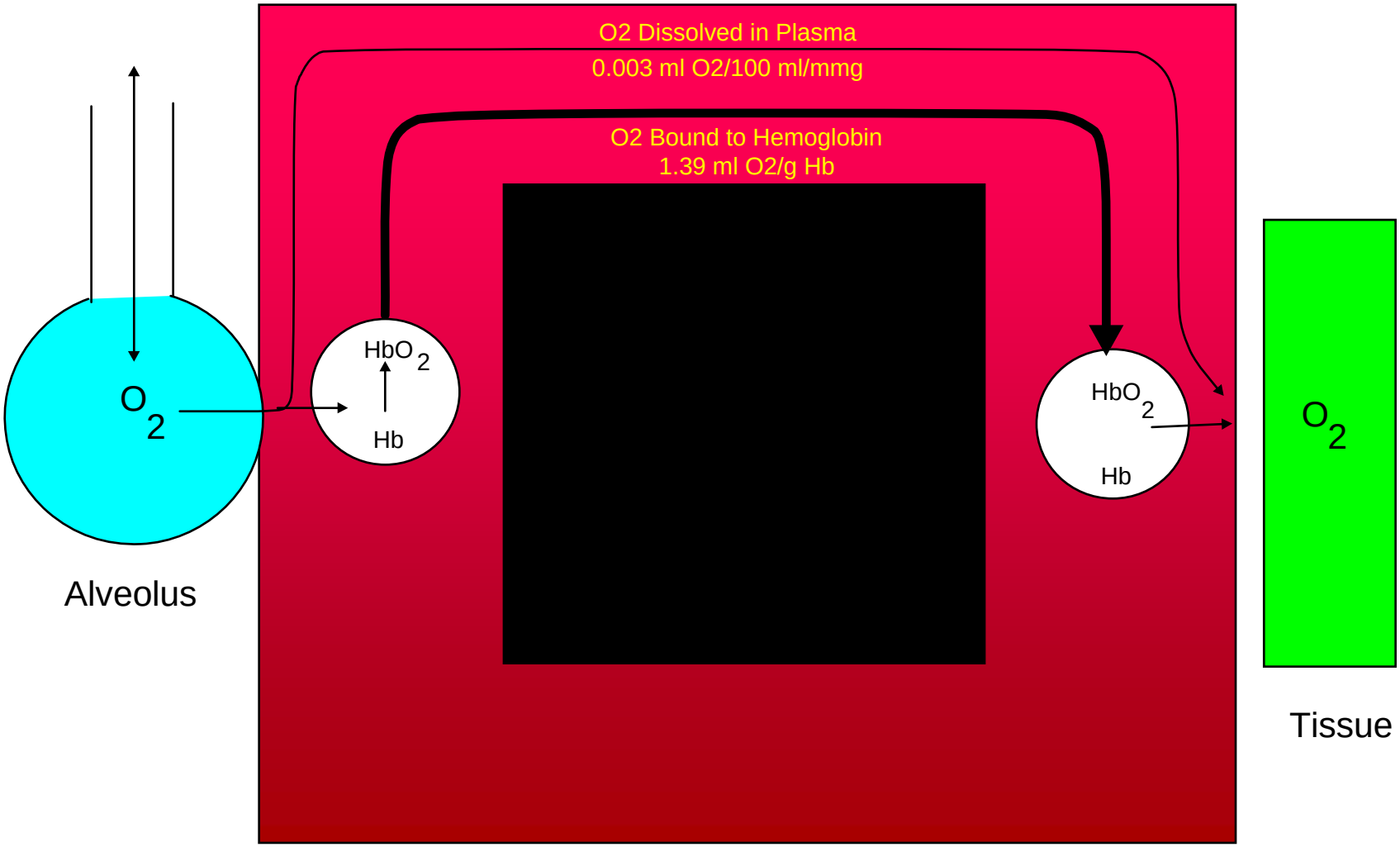
Gas Transport by the Blood

Oxygen Transport



Transport of Dissolved Oxygen

C_{O2} This is the term for oxygen content.

Oxygen solubility = 0.003 $mlO_2/dL/mmHgO_2$ * P_{O2}

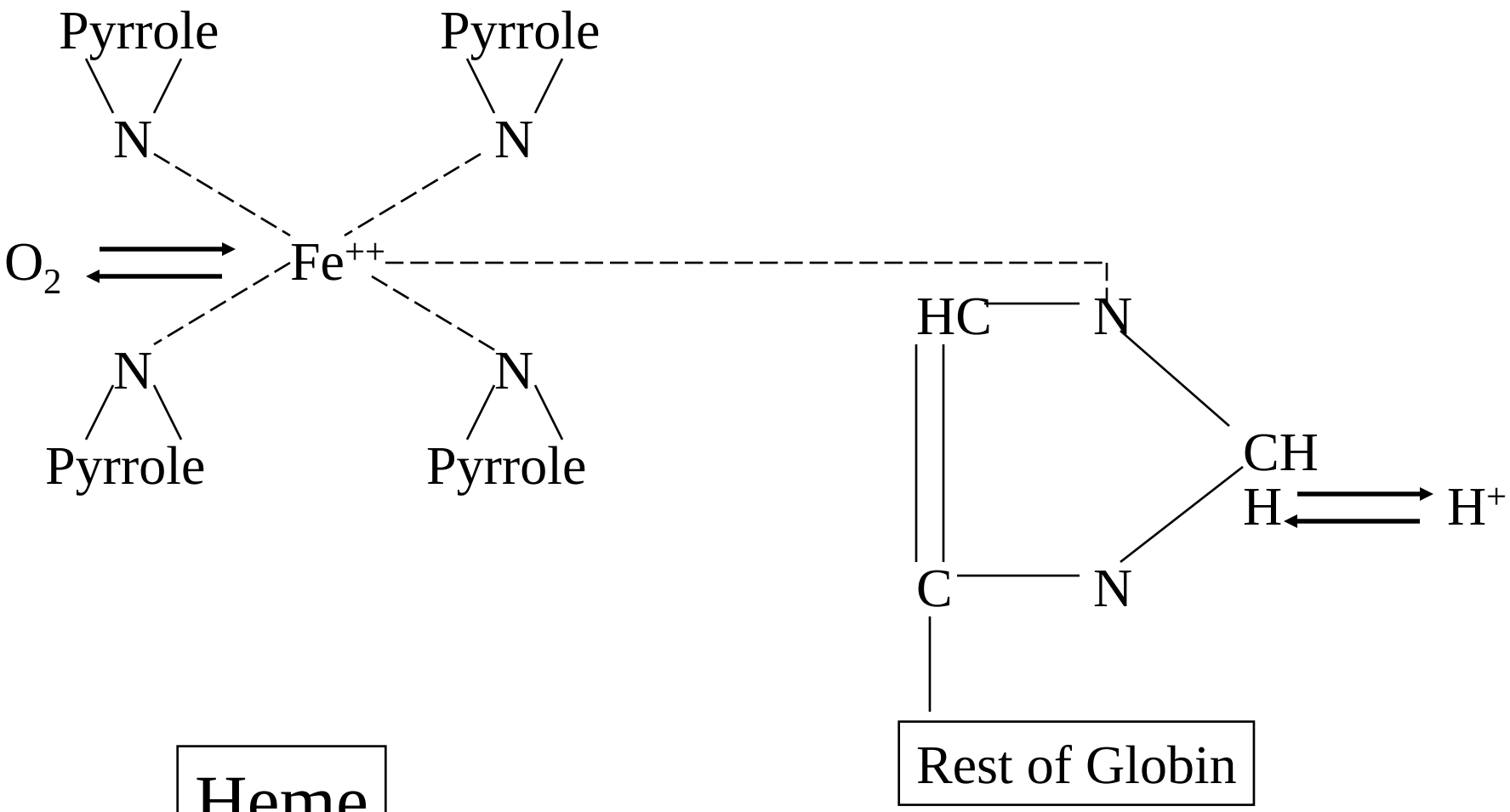
Dissolved oxygen content:

Pa_{O2} = 100 mmHg

Pv_{O2} = 40 mmHg

C_{aO2} = 0.003 $mlO_2/dL/mmHgO_2$ * 100 mmHg

C_{aO2} = 0.3 mlO_2/dL blood



Heme

Imidazole group on Histidine residue of globin

Hemoglobin Bound Oxygen Content

1 gram HB binds 1.39 mlO_2/dl blood

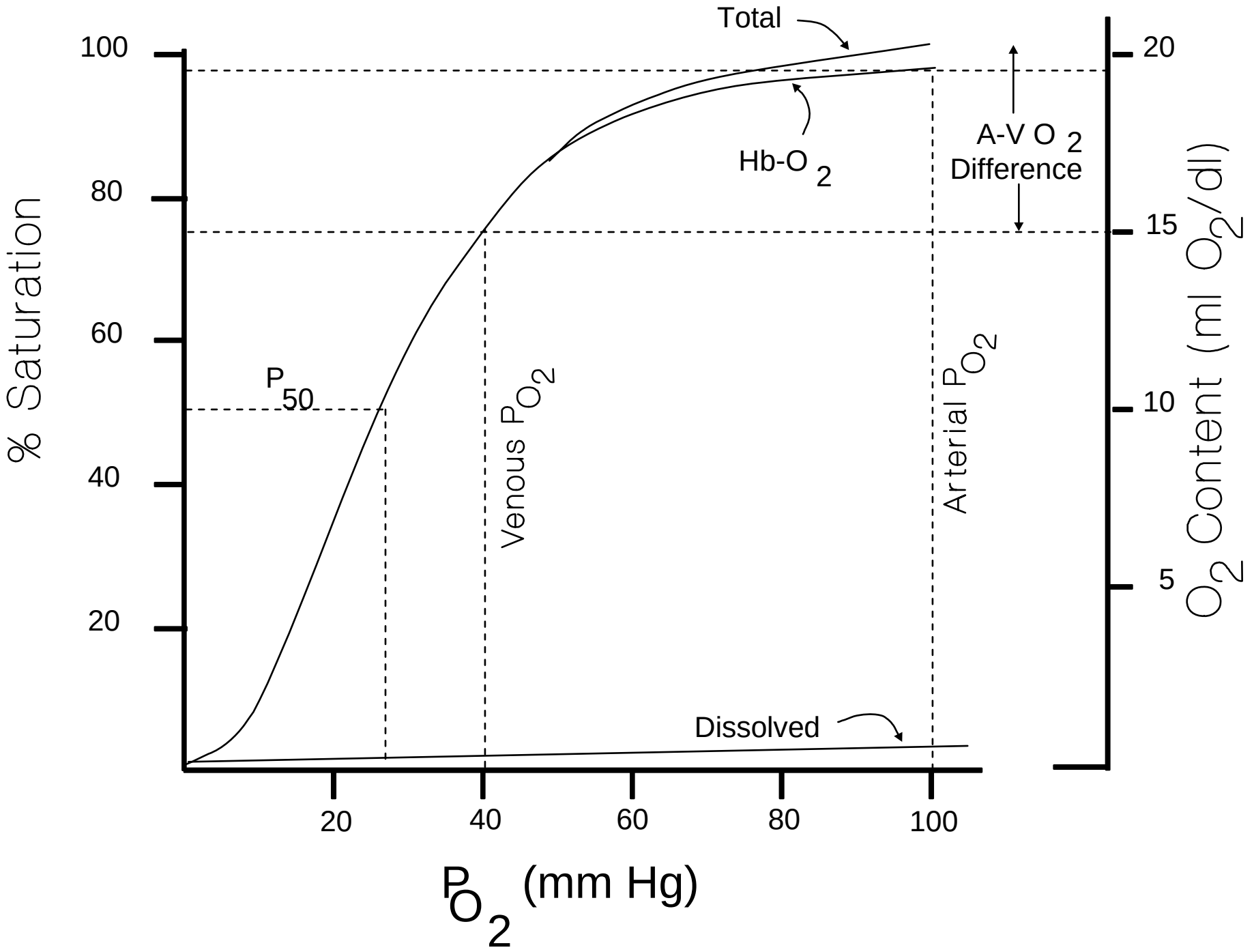
Normal blood [HB] = 15 gm/dL

HB bound oxygen content:

C_{O2} = 1.39 ml O_2/gm * [HB]

C_{O2} = 1.39 ml O_2/gm * 15 gm/dL

C_{O2} = 20.85 ml O_2/dL blood


Total
Hb-O 2
A-V O 2
Difference
100
80
60
40
20
% Saturation
P 50
Venous P O2
Arterial P O2
Dissolved
20
15
10
5
O2 Content (ml O2/dl)
20
40
60
80
100
P O2 (mm Hg)

Total Blood Oxygen Content

Normal blood [HB] = 15 gm/dL

Pa_{O2} = 100 mmHg

Pv_{O2} = 40 mmHg

Oxygen solubility = 0.003 $mlO_2/dL/mmHgO_2$ * P_{O2}

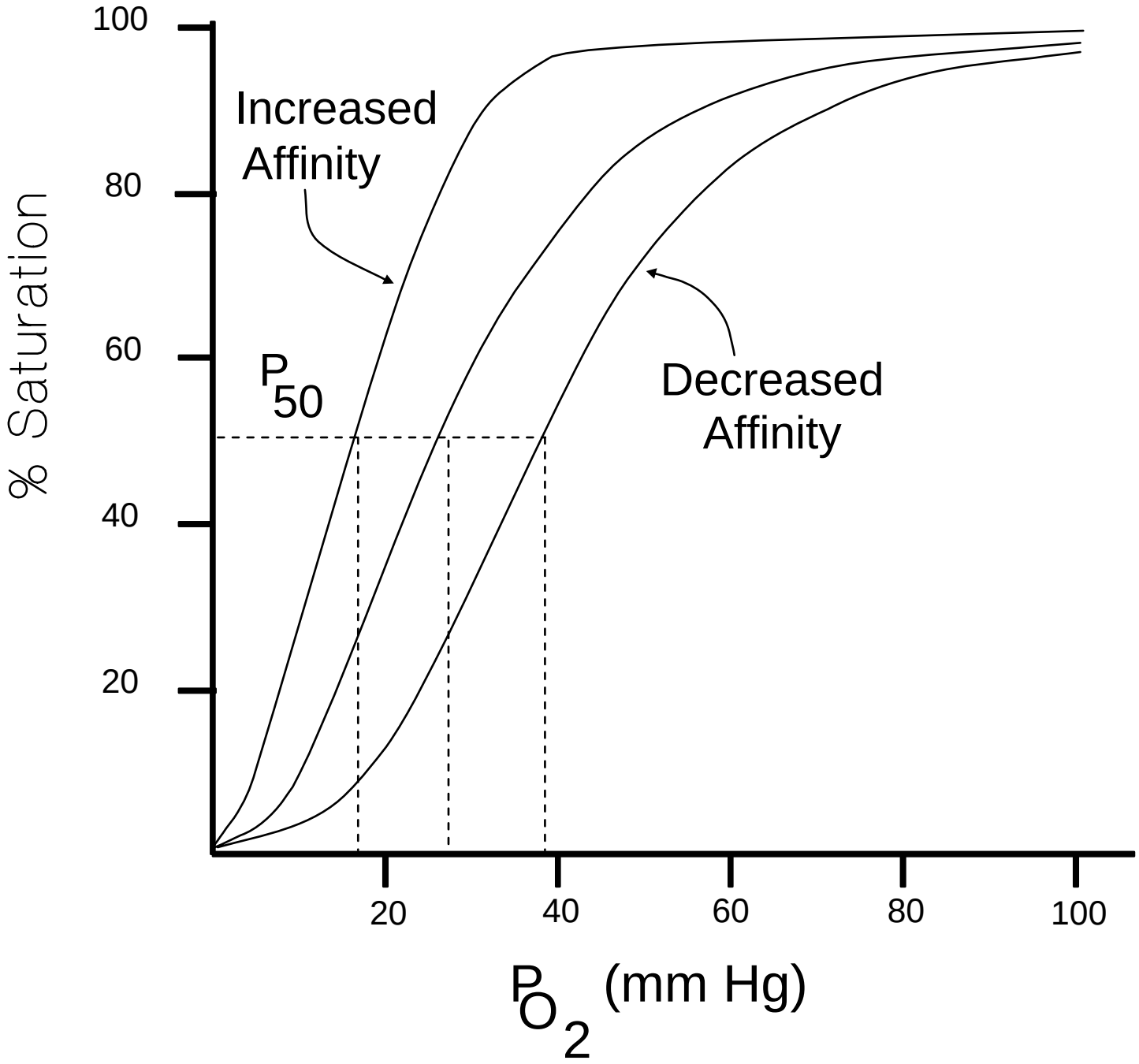
Total blood oxygen content is the sum of HB bound and dissolved:

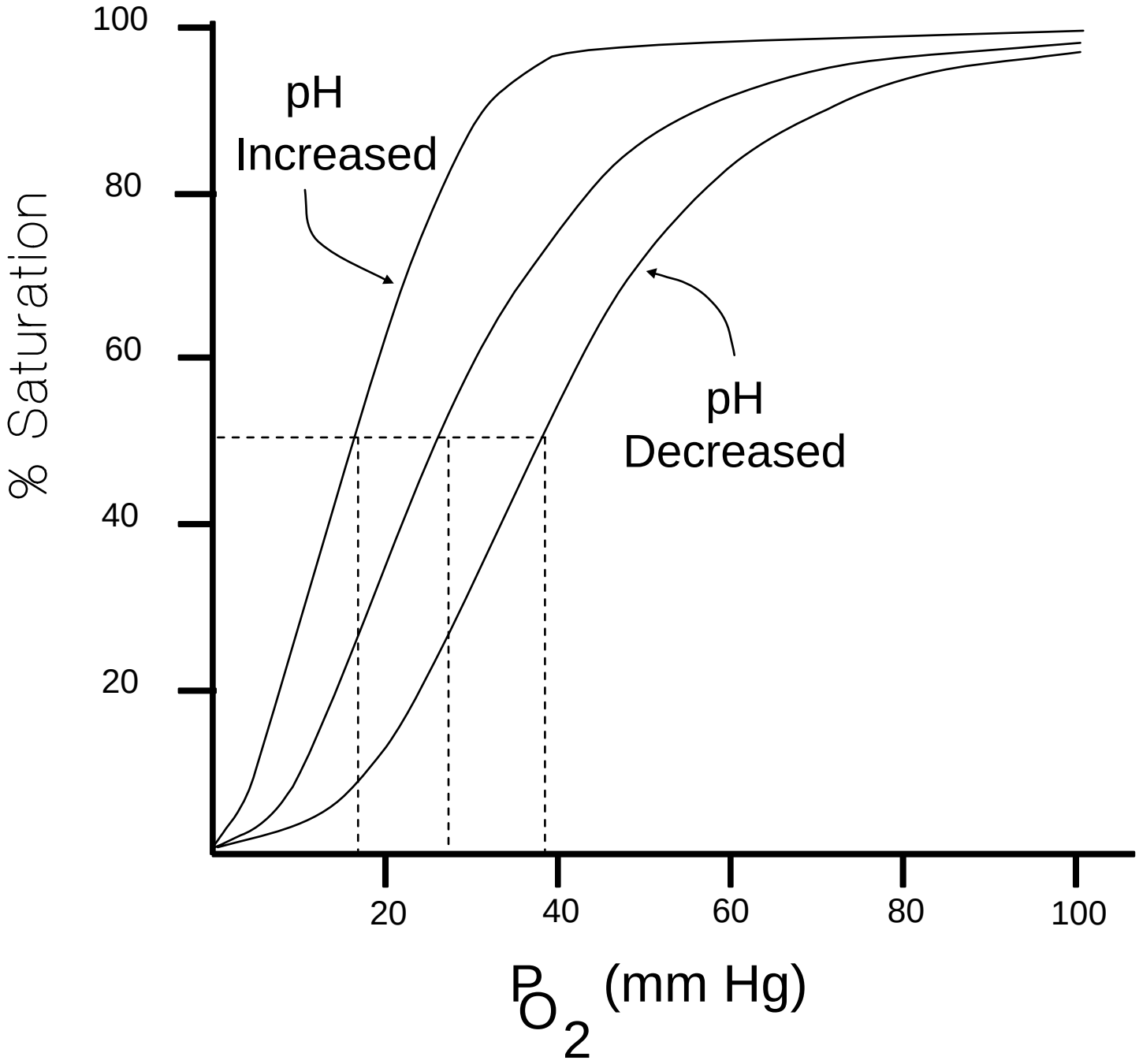
C_{O2} = (1.39 ml O_2/gm * [HB] * % Sat) + (0.003 $mlO_2/dL/mmHgO_2$ * PO_2)

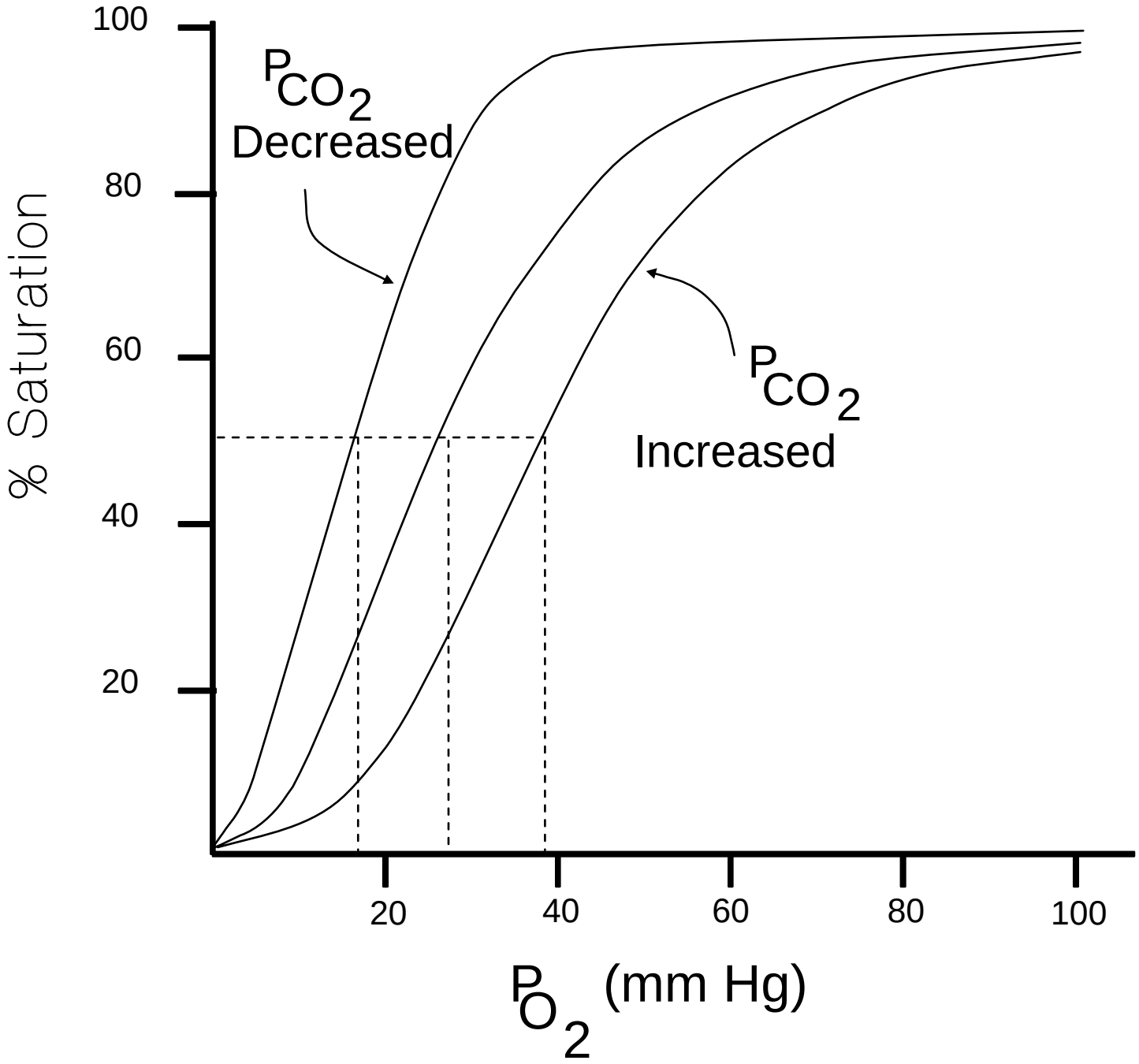
C_{aO2} = (1.39 ml O_2/gm * 15 gm/dL * 0.97) + (0.003 $mlO_2/dL/mmHgO_2$ * 100 mmHg)

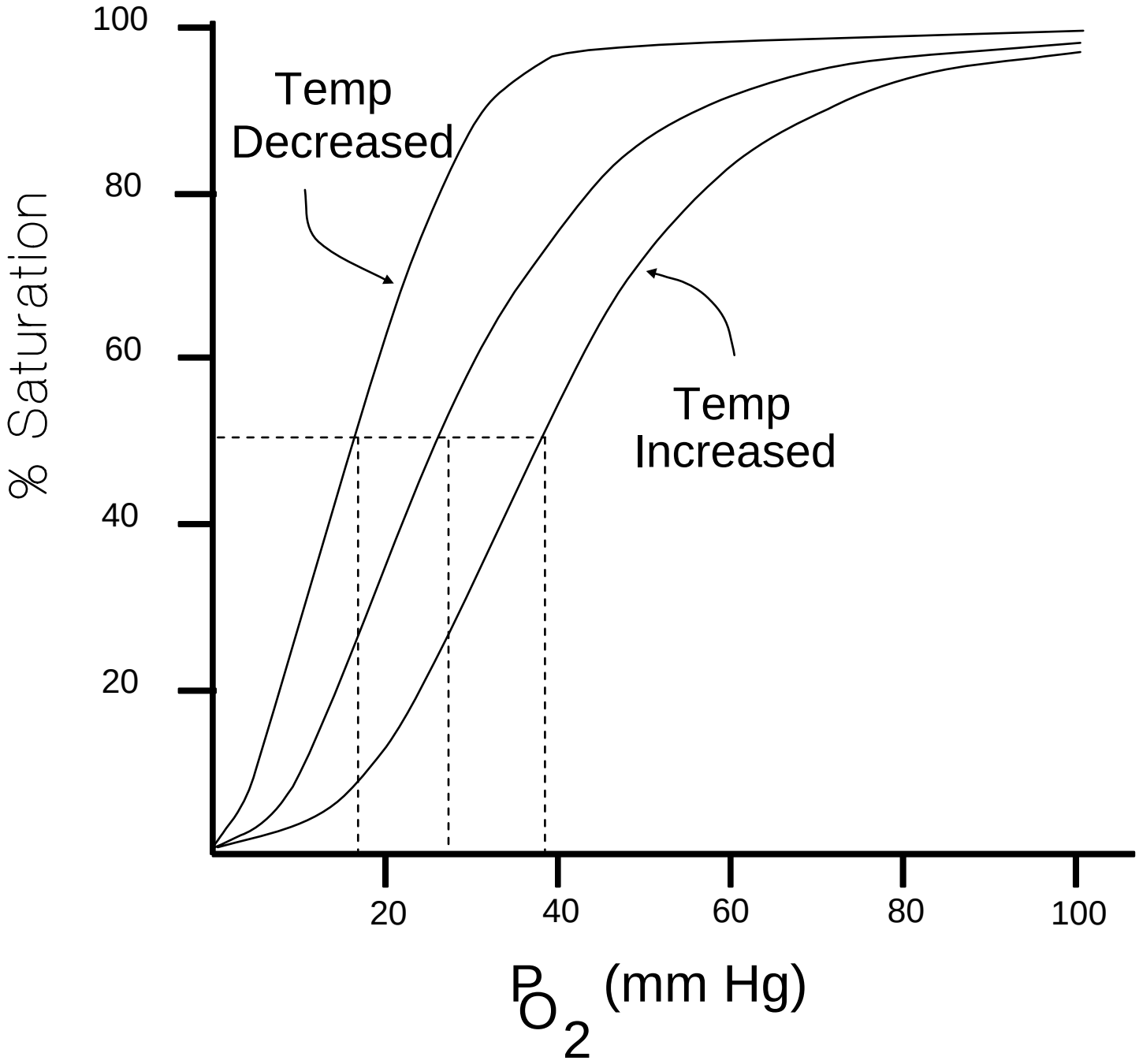
C_{aO2} = 20.22 ml O_2/dL blood + 0.3 ml O2/dL blood

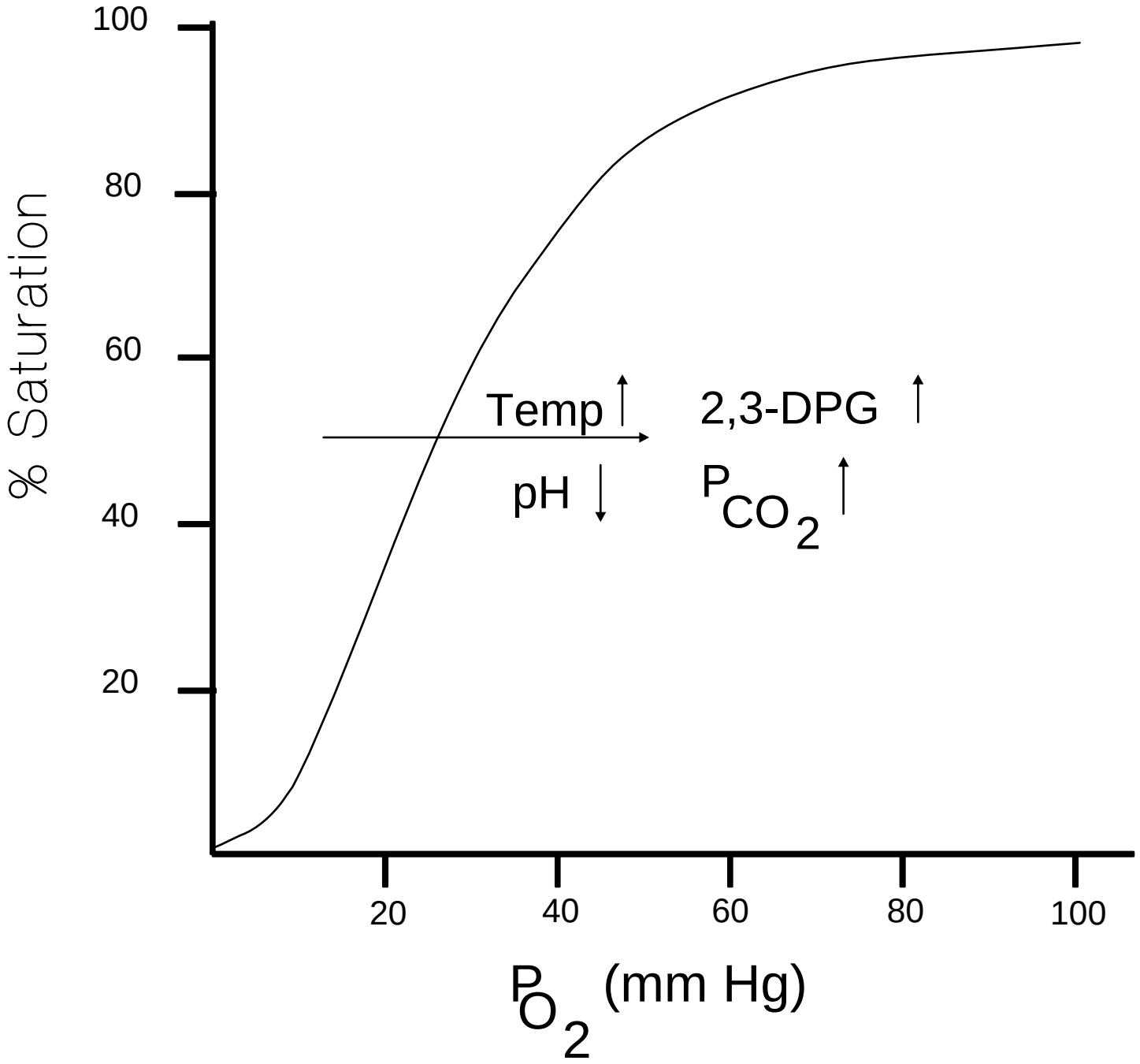
C_{aO2} = 20.52 ml O_2/dL blood

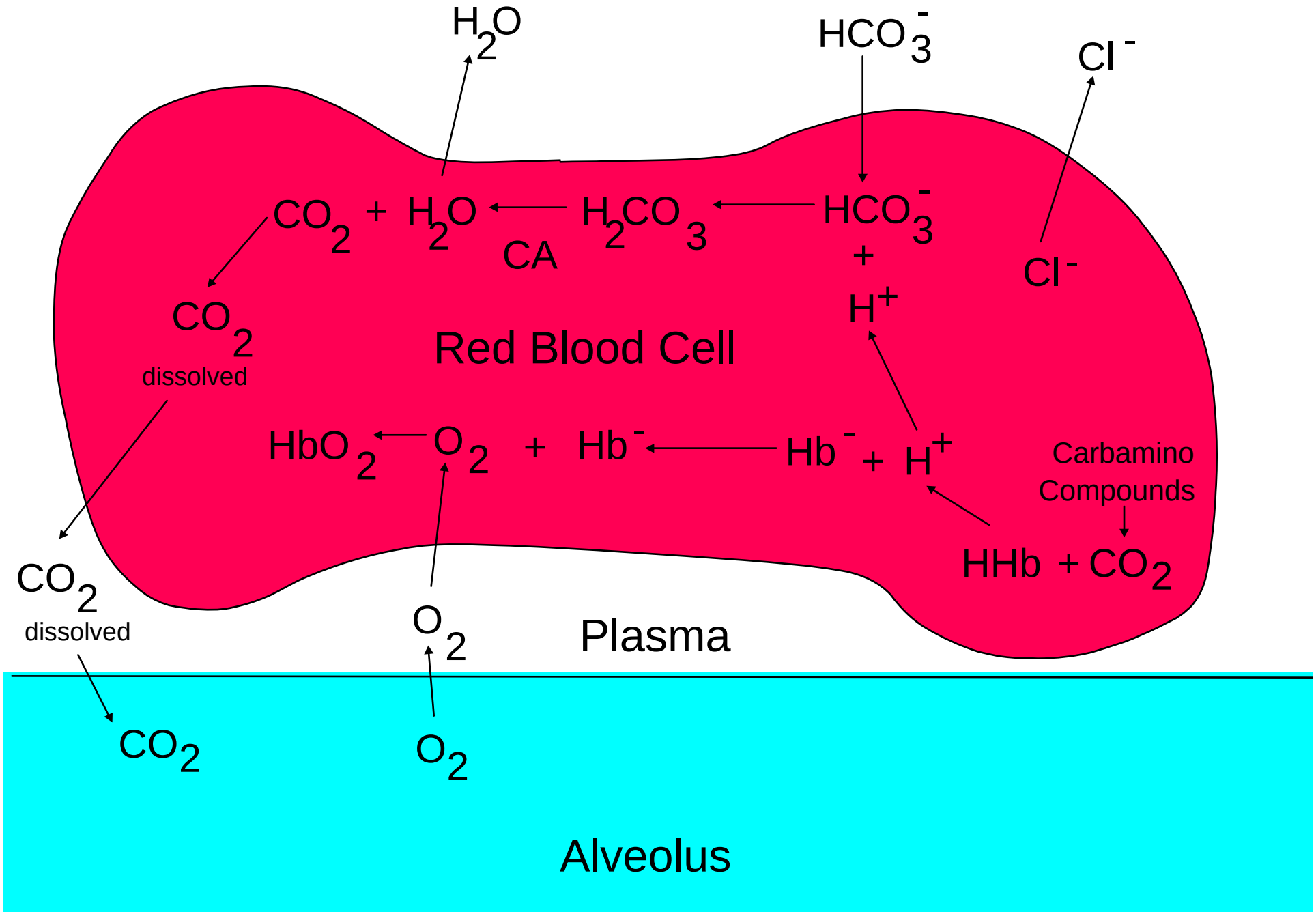

100
80
60
40
20
% Saturation
Increased
Affinity
P50
Decreased
Affinity
20
40
60
80
100
PO2 (mm Hg)

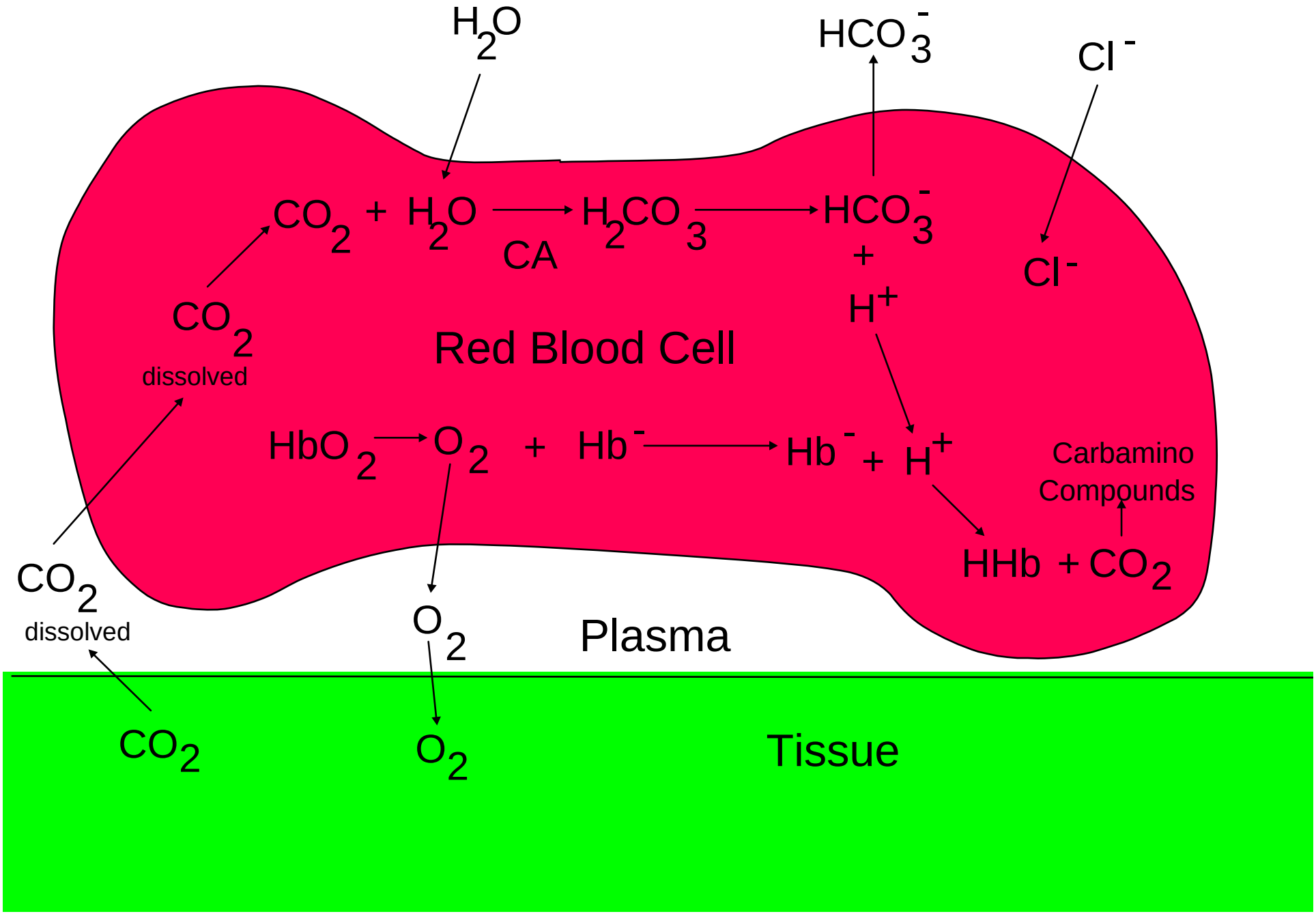

100
80
60
40
20
% Saturation
pH
Increased
pH
Decreased
20
40
60
80
100
P_{O_2} (mm Hg)

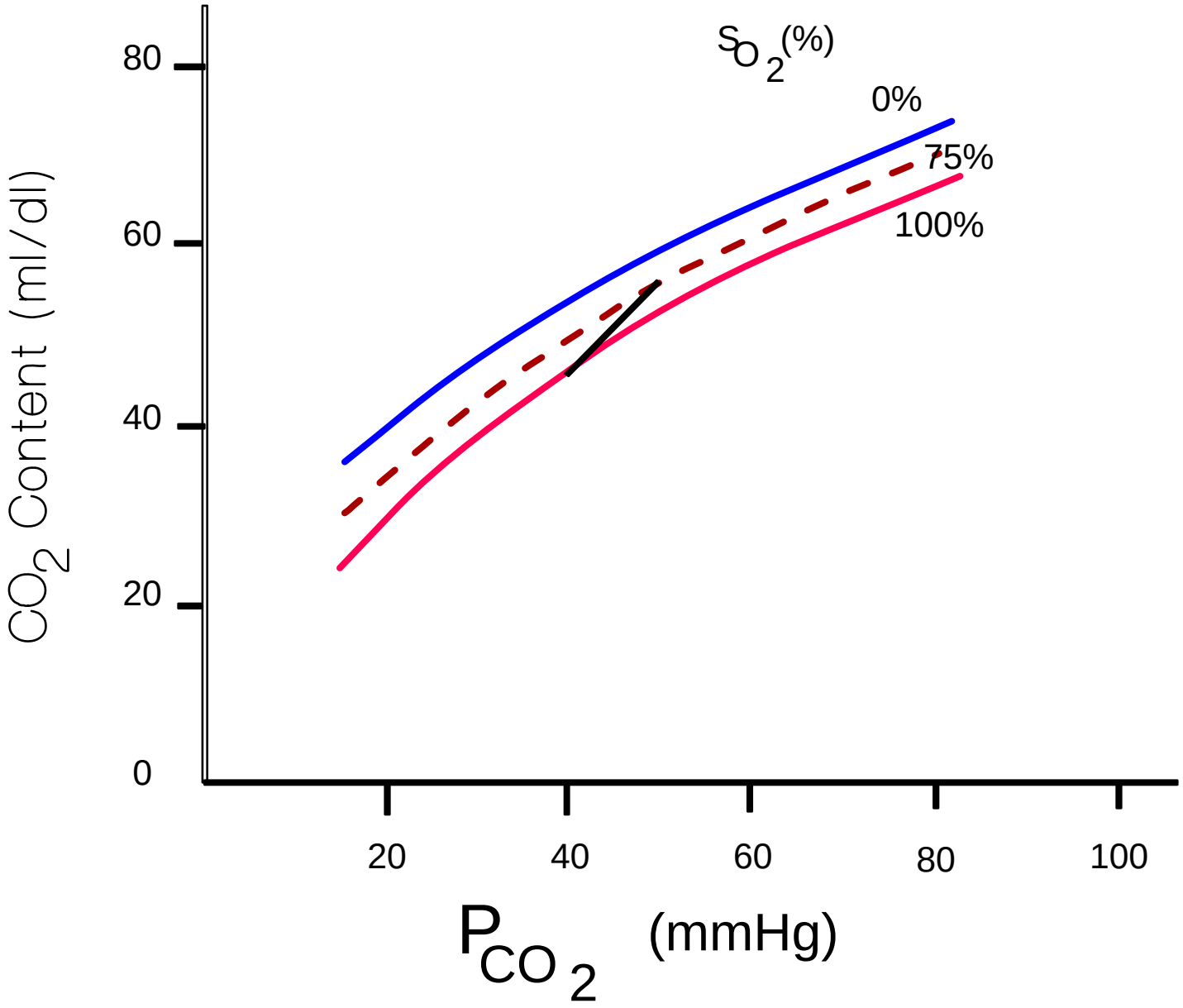

100
80
60
40
20
% Saturation
P_{CO_2}
Decreased
P_{CO_2}
Increased
20
40
60
80
100
P_{O_2} (mm Hg)

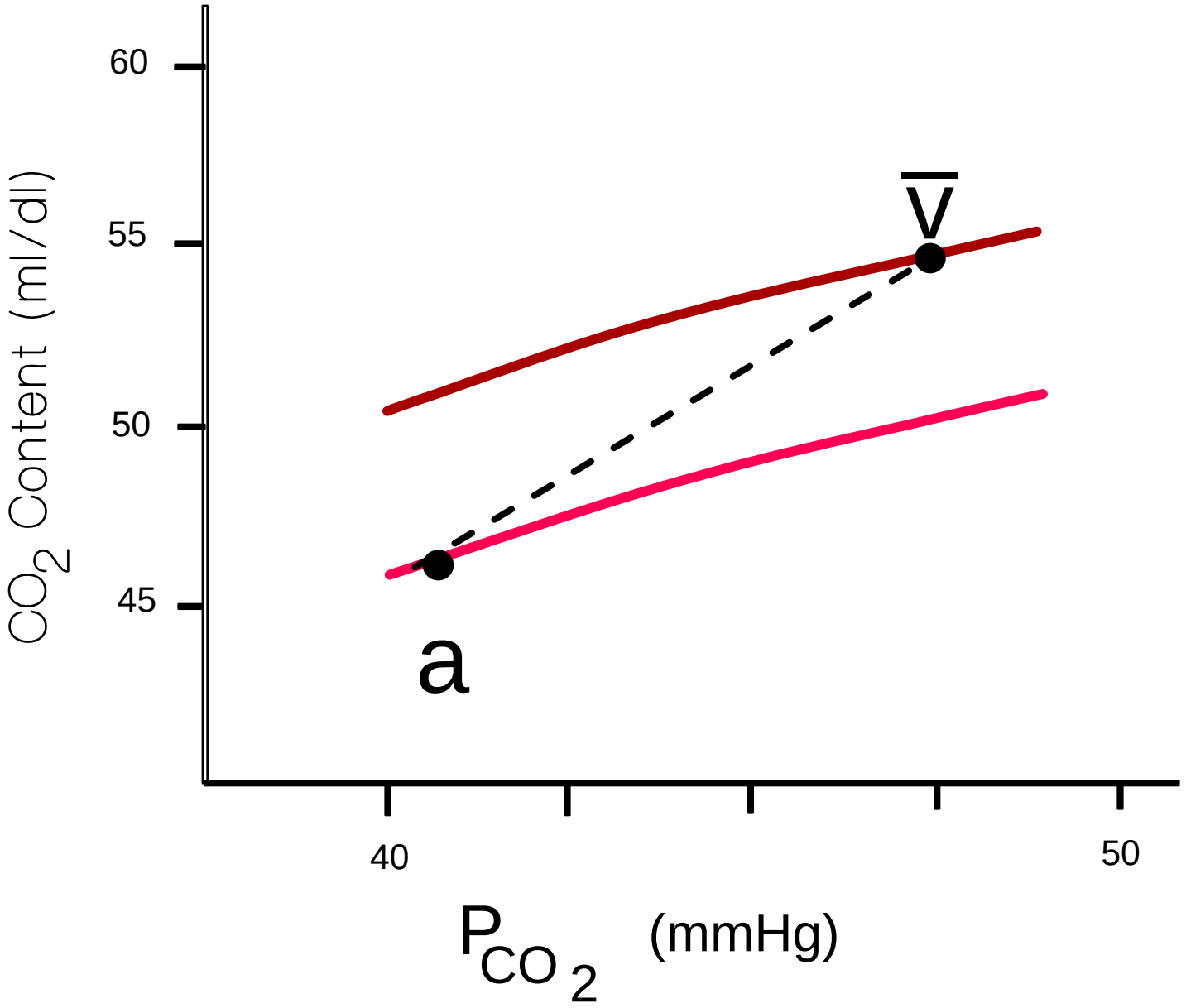

100
80
60
40
20
% Saturation
Temp
Decreased
Temp
Increased
20
40
60
80
100
P_{O_2} (mm Hg)


100
80
60
40
20
% Saturation
Temp ↑
2,3-DPG ↑
pH ↓
P_{CO_2} ↑
20
40
60
80
100
P_{O_2} (mm Hg)


H_2O
HCO_3^-
Cl^-
$CO_2 + H_2O \leftarrow H_2CO_3 \leftarrow HCO_3^-$
CA
+
H^+
Cl^-
CO_2
dissolved
Red Blood Cell
$HbO_2 \leftarrow O_2 + Hb^- \leftarrow Hb^- + H^+$
Carbamino
Compounds
$HHb + CO_2$
CO_2
dissolved
O_2
Plasma
CO_2
O_2
Alveolus


H_2O
HCO_3^-
Cl^-
$CO_2 + H_2O \xrightarrow{CA} H_2CO_3 \rightarrow HCO_3^- + H^+$
Cl^-
CO_2 dissolved
Red Blood Cell
$HbO_2 \rightarrow O_2 + Hb^- \rightarrow Hb^- + H^+$
Carbamino Compounds
$HHb + CO_2$
CO_2 dissolved
O_2
Plasma
CO_2
O_2
Tissue


S_{O_2}(%)
0%
75%
100%
80
60
40
20
0
CO_2 Content (ml/dl)
20
40
60
80
100
P_{CO_2} (mmHg)


60
55
50
45
CO_2 Content (ml/dl)
$\bar{v}$
a
40
50
P_{CO_2} (mmHg)