Semester II
CC IV : Animal Physiology
Unit 3 : Respiratory System

E-Class : 02
Topic : Dissociation Curve and Influencing Factors

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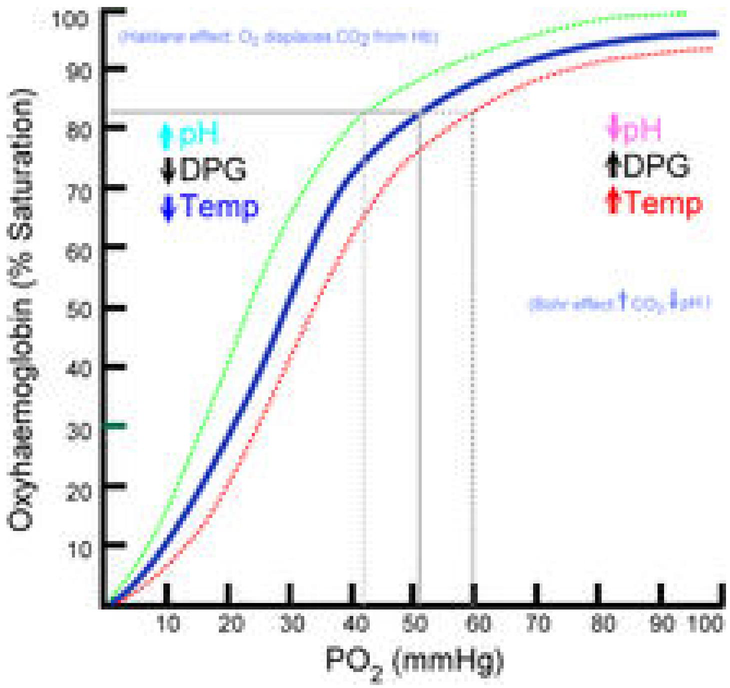
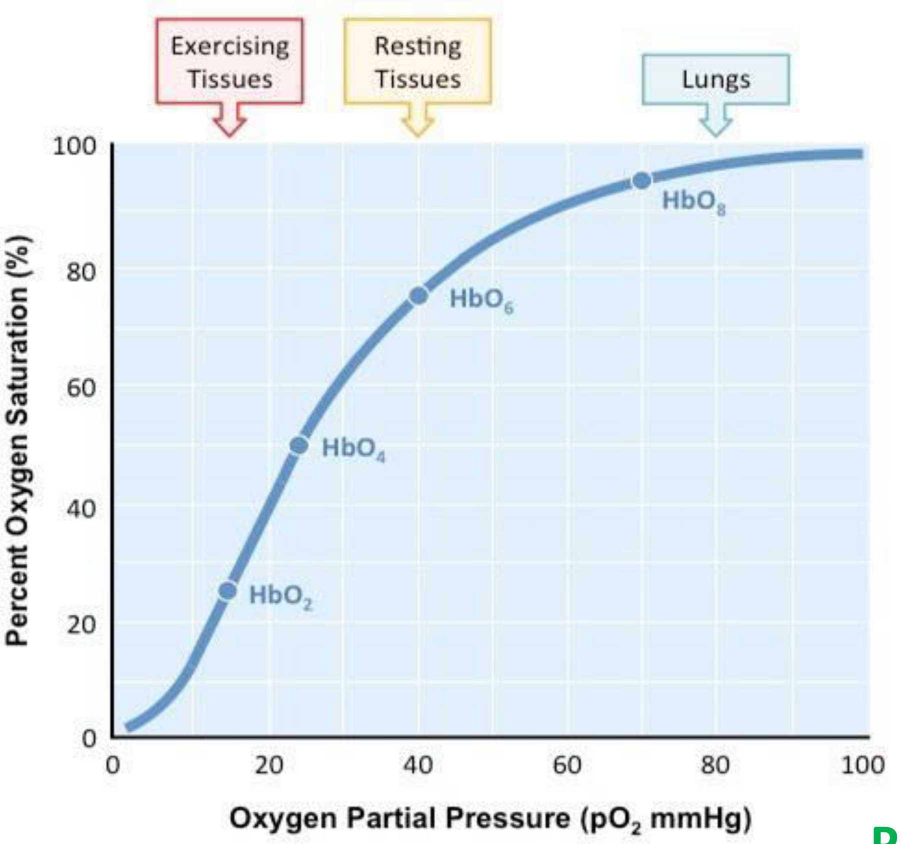
Oxyhaemoglobin Dissociation Curve



Oxyhaemoglobin Saturation Curve

Graphical presentation of oxyhaemoglobin complex formation in RBC with different pressure of O_2 at normal temperature, and pH

O_2 supply to every tissue for ATP generation



Low saturation creates hypoxia

$Hb_4 + O_2 \leftrightarrow Hb_4O_2$

$Hb_4O_2 + O_2 \leftrightarrow Hb_4O_4$

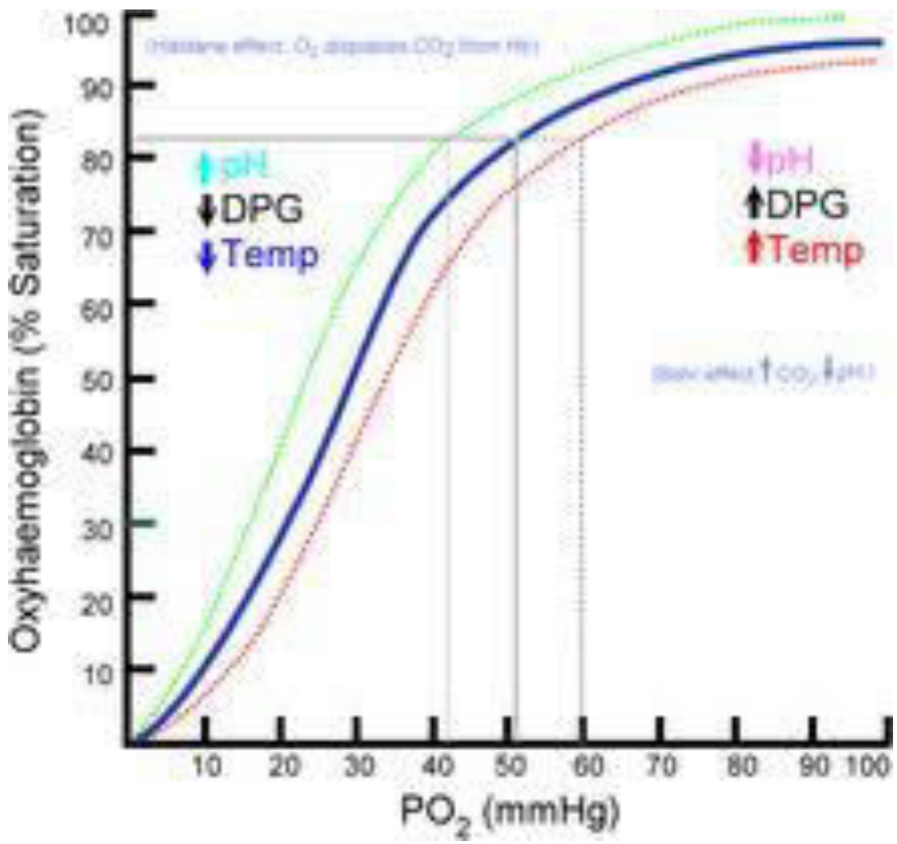
$Hb_4O_4 + O_2 \leftrightarrow Hb_4O_6$

$Hb_4O_6 + O_2 \leftrightarrow Hb_4O_8$

P_{O2} in alveoli = 100mmHg

Dissociation Curve

Graphical presentation of the dissociation of oxyhaemoglobin complex in RBC at different concentration of influencing factors under constant partial pressure of O_2



Influencing Factors

1) Temperature

2) P_{CO2}

3) P_{CO}

4) pH

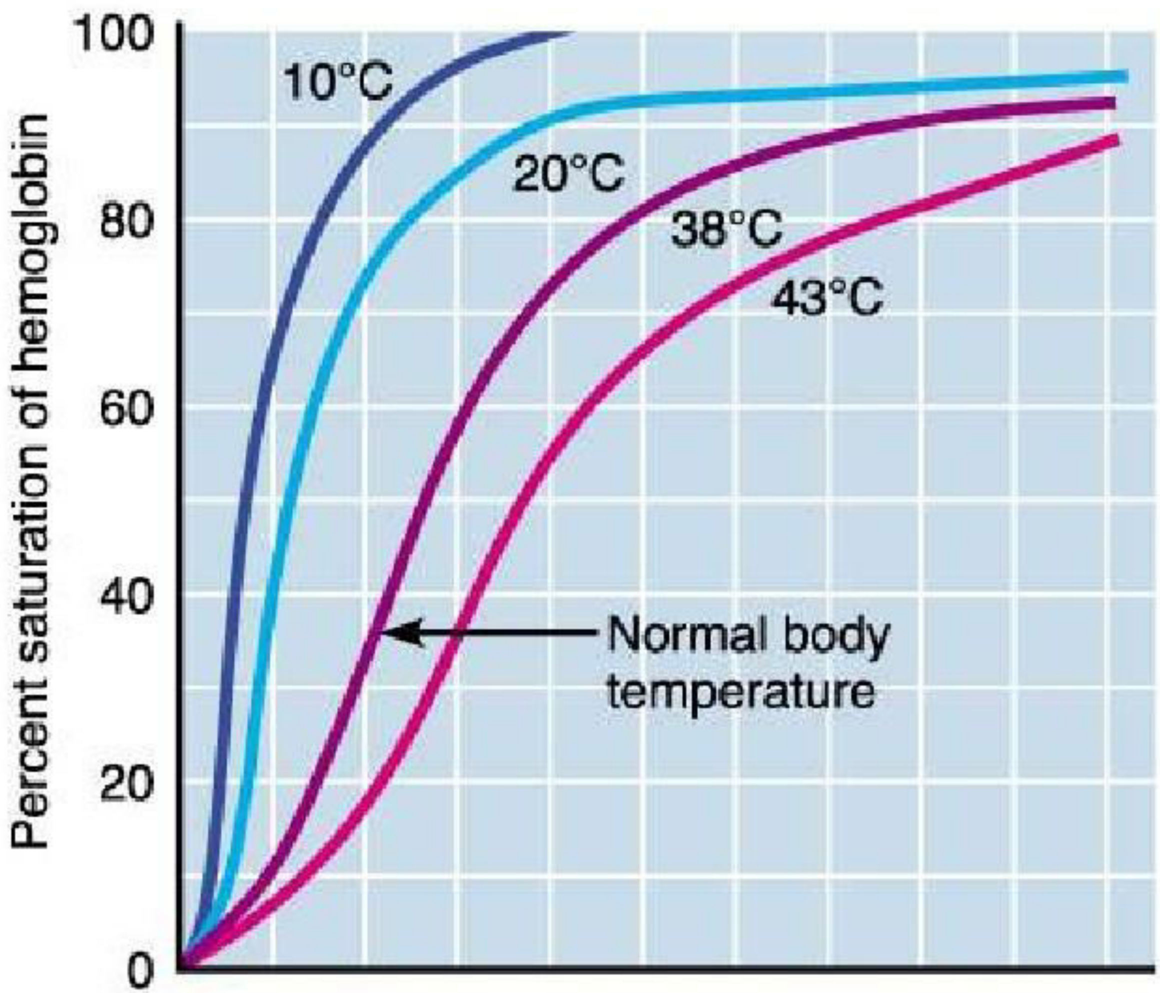
5) 2,3 DPG

6) Hb F

Body Temperature (T)

$Hb_4O_8 \rightarrow Hb_4O_6 + O_2 \rightarrow Hb_4O_4 + O_2 \rightarrow Hb_4O_2 + O_2$

At normal body temp. dissociation occurs at cephalic & systemic blood capillaries



$S_{O2} \ \alpha \ T^{-1}$

$D_{O2} \ \alpha \ T$

Higher temperature causes hypoxia

Partial pressure of CO_2 in blood (P_{CO2})

$Hb_4 + CO_2 \rightarrow Hb_4CO_2$; $Hb_4O_2 + CO_2 \rightarrow Hb_4CO_2 + O_2$; $Hb_4O_4 + CO \rightarrow Hb_4CO_2 + 2O_2$; $Hb_4O_6 + CO_2 \rightarrow Hb_4CO_2 + 3O_2$; $Hb_4O_8 + CO_2 \rightarrow Hb_4CO_2 + 4O_2$

Normally, DO_2 occurs at tissue capillaries but in higher P_{CO2}, it occurs at alveolar capillaries

High DO_2 causes hypoxia & death

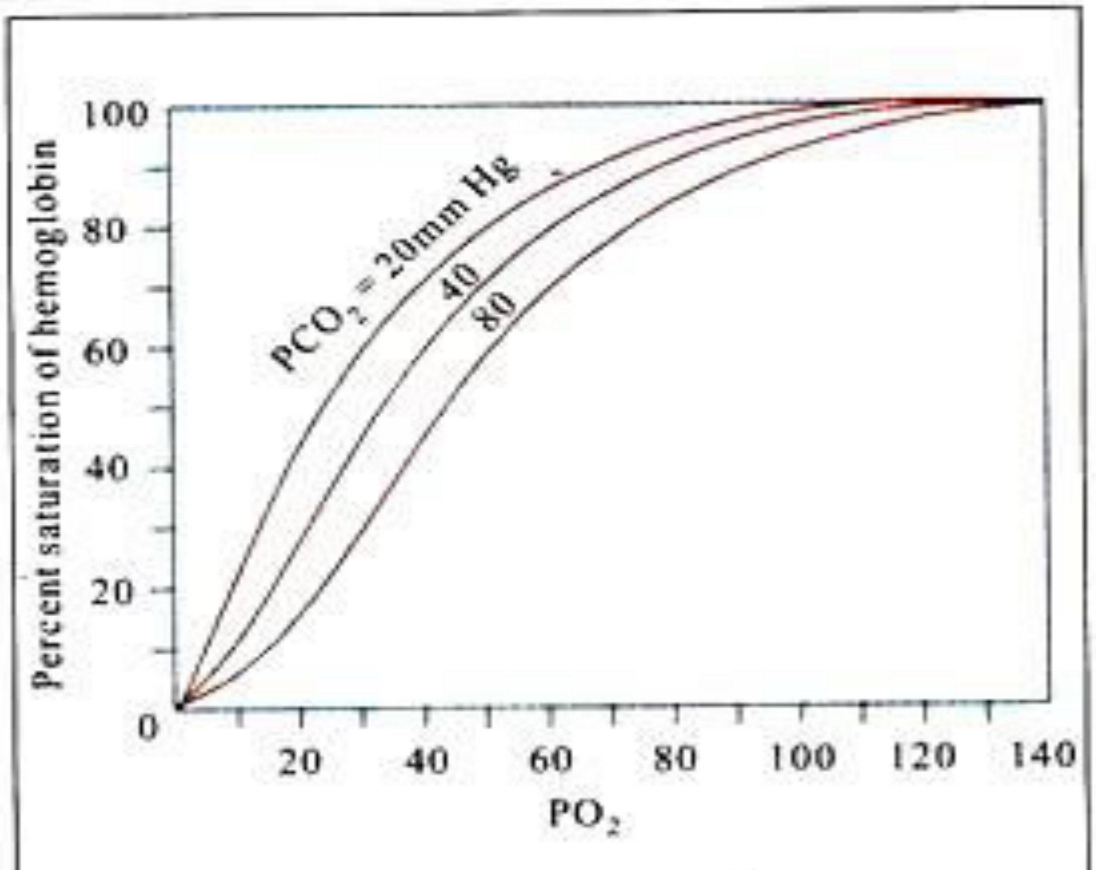


Fig. 13.1 : Dissociation of hemoglobin

P_{CO2}

Alveoli = 40 mmHg

Arterial blood = 40 mmHg

Venous blood = 45 mmHg

Tissue = 50mmHg

$DO_2 \propto P_{CO2}$

$SO_2 \propto P_{CO2}^{-1}$

Partial Pressure of CO in blood (P_{CO})

$Hb_4 + CO \rightarrow Hb_4CO$; $Hb_4O_2 + CO \rightarrow Hb_4CO + O_2$; $Hb_4O_4 + CO \rightarrow Hb_4CO + 2O_2$; $Hb_4O_6 + CO \rightarrow Hb_4CO + 3O_2$; $Hb_4O_8 + CO \rightarrow Hb_4CO + 4O_2$

Hb affinity : $CO > CO_2 > O_2$

CO causes hypoxia & death

CO is highly toxic

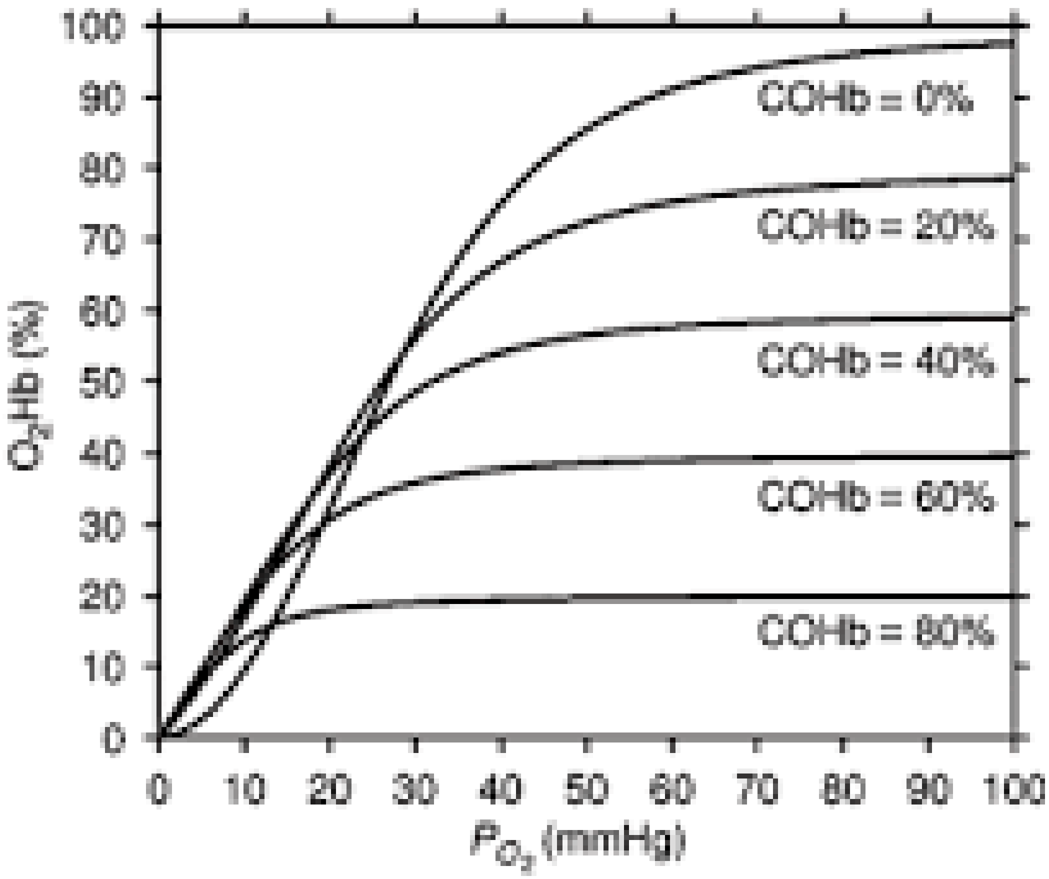


Figure 1. Dissociation curve of O_2 in the blood for several values of COHb.

$DO_2 \propto P_{CO}$

$SO_2 \propto P_{CO}^{-1}$

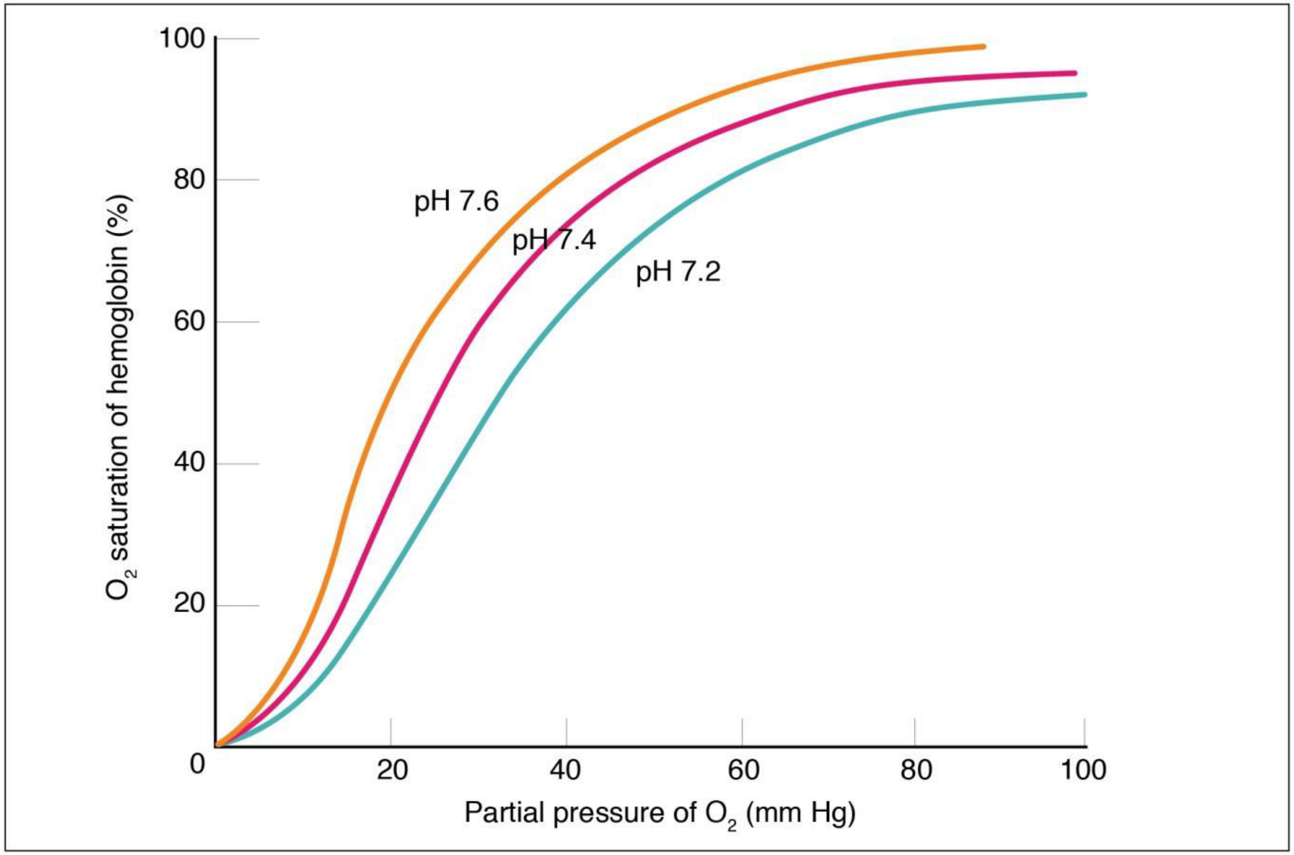
pH in Blood

$Hb_4O_8 + H^+ \rightarrow Hb_4O_6 + O_2$ $Hb_4O_6 + H^+ \rightarrow Hb_4O_4 + O_2$

$Hb_4O_4 + H^+ \rightarrow Hb_4O_2 + O_2$ $Hb_4O_2 + H^+ \rightarrow Hb_4 + O_2$

Higher pH can cause hypoxia, acidosis & death

High P_{CO2} (> 50mmHg) increases blood pH resulting in acidosis (pH < 7.35)



(b) Effect of pH

pH Blood = 7.4

Pulmonary blood = 7.2

Tissue blood = 7.6

DO_2 α $[H^+]$

Or

DO_2 α pH

SO_2 α $[H^+]^{-1}$

2,3 Diphospho glycerate (2,3 DPG) in RBC

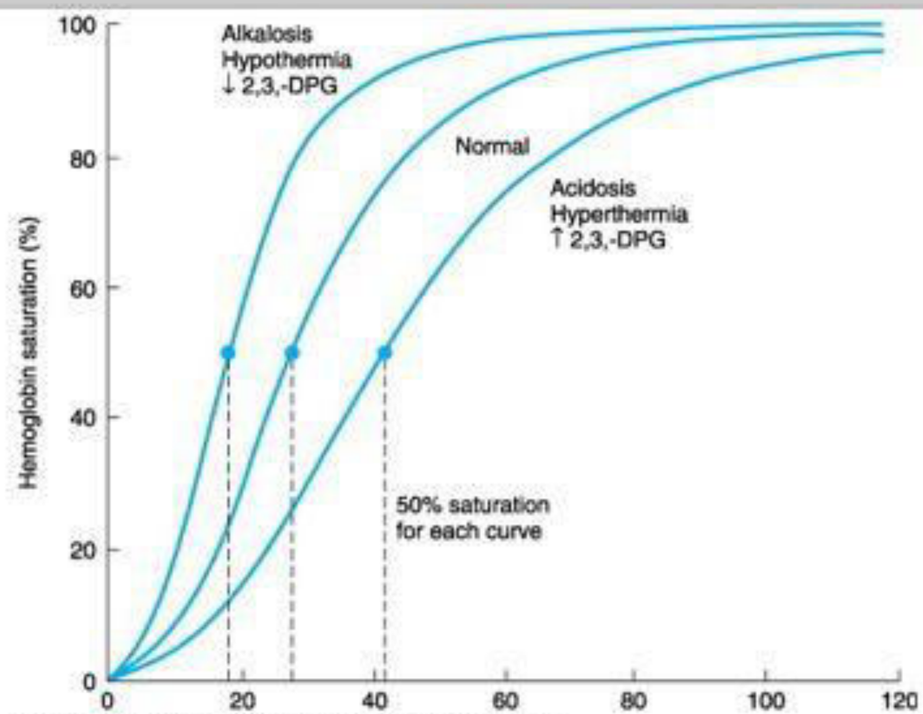
Glycolytic intermediate **Hb affinity : 2,3 DPG > O_2**

$Hb_4 + DPG \rightarrow Hb_4DPG$ $Hb_4(O_2)_x \rightarrow Hb_4DPG + xO_2$

Normal conc. in RBC : 5 mmol L^{-1}

DPG allosterically promotes RBC to release O_2 near tissue

Figure 22–23.



The effects of changes in acid-base status, body temperature, and 2,3-DPG concentration on the hemoglobin-oxygen dissociation curve.

DO_2 α DPG

SO_2 α DPG^{-1}

DPG can't influence myoglobin saturation

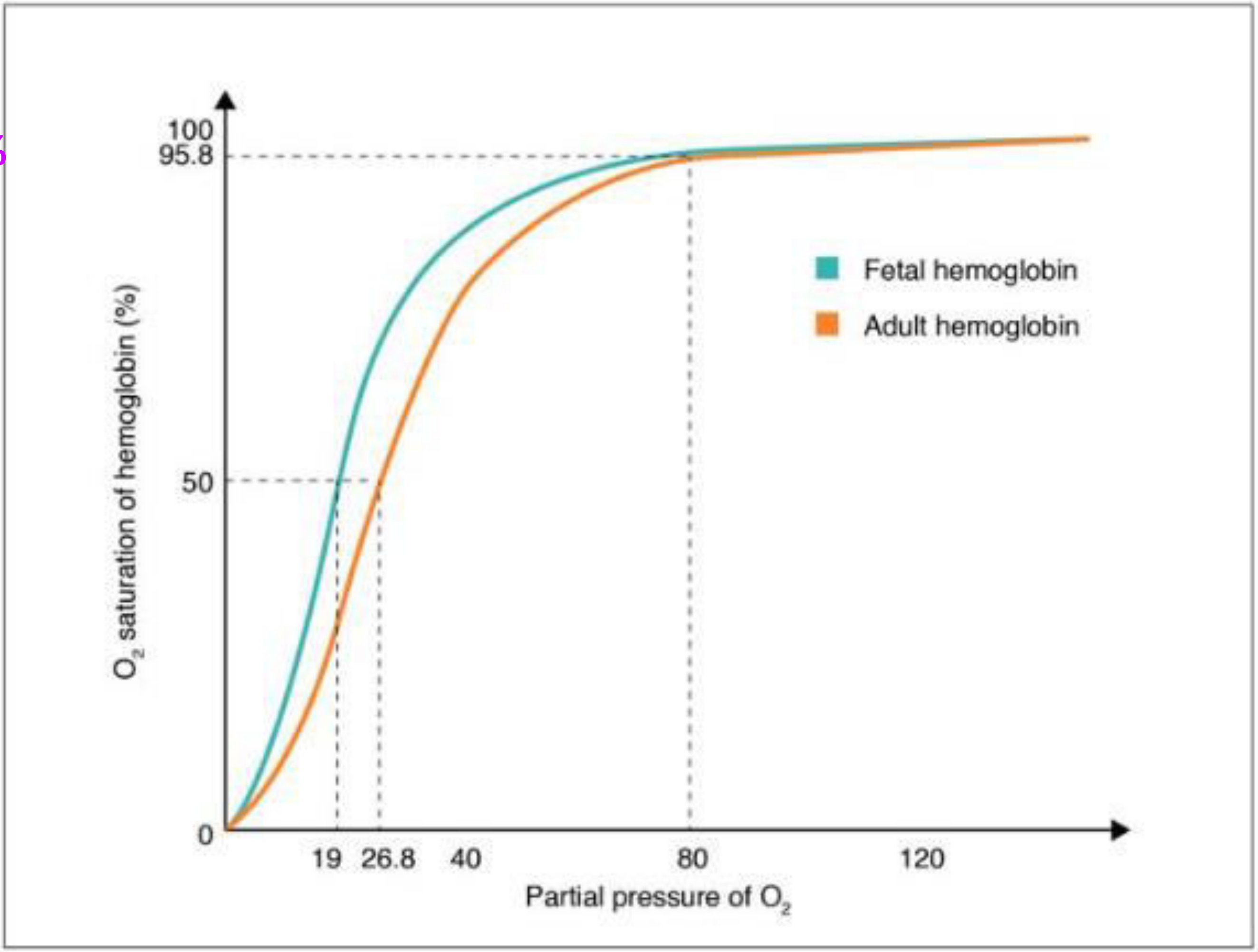
In pregnancy DPG increases by 30% resulting in hypoxia

Fetal Haemoglobin (HbF) in Blood

In healthy adult,
HbA : ~ 97%
HbF : < 1%

At P_{50}
HbF: 19 mmHg
HbA : 27 mmHg

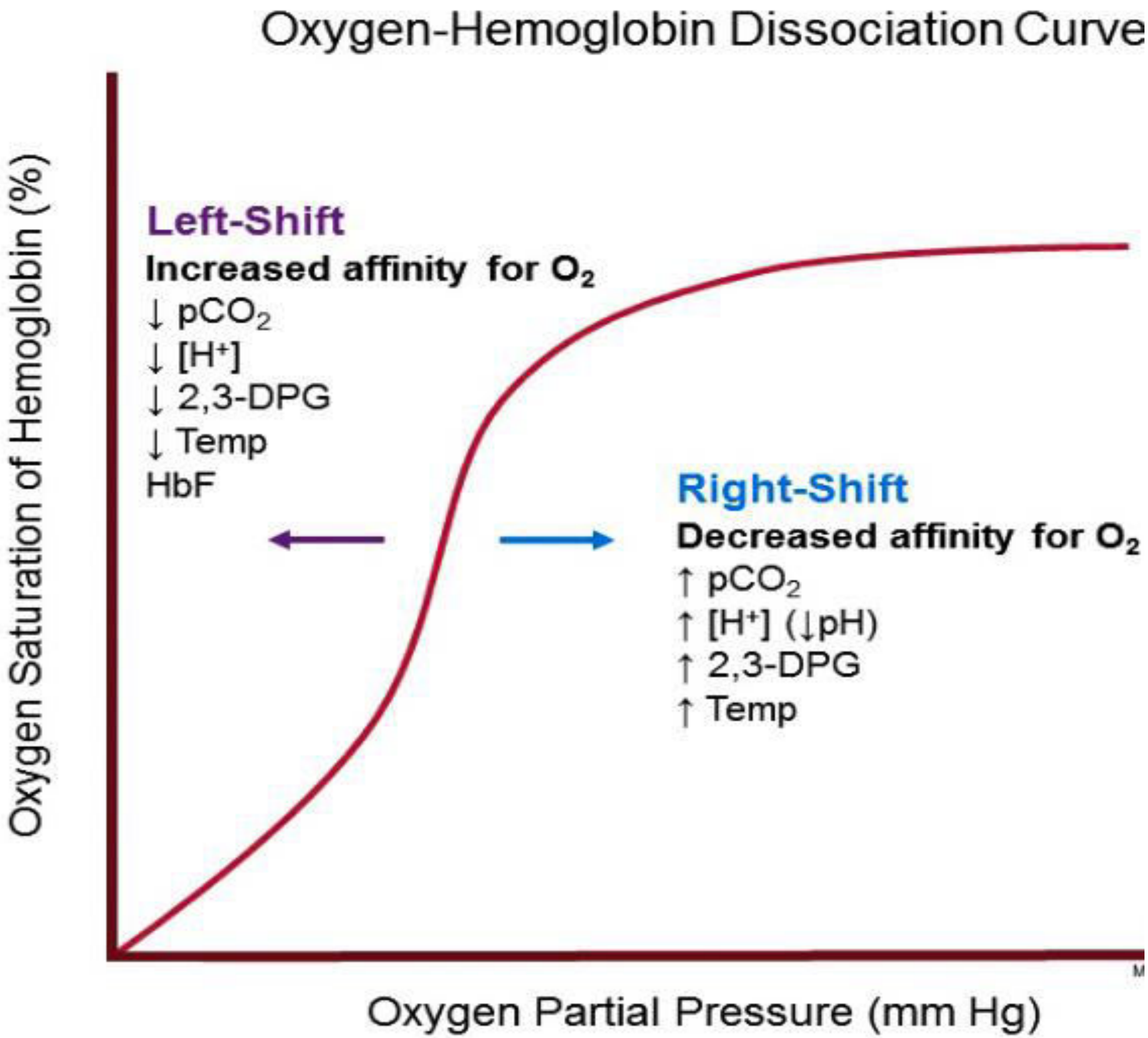
Fetal uptakes more O_2 from placenta



O_2 affinity : HbF > HbA

SO_2 α HbF
DO_2 α HbF^{-1}

Curve shift



Oxygen-Hemoglobin Dissociation Curve
Oxygen Saturation of Hemoglobin (%)
Left-Shift
Increased affinity for O_2
↓ pCO_2
↓ $[H^+]$
↓ 2,3-DPG
↓ Temp
HbF
Right-Shift
Decreased affinity for O_2
↑ pCO_2
↑ $[H^+]$ (↓pH)
↑ 2,3-DPG
↑ Temp
Oxygen Partial Pressure (mm Hg)

Model Questions

1) Define O_2 saturation curve ? Where does it occur in our body ?
2) What is oxyhaemoglobin dissociation curve ? Give importance of the curve.
3) Cite the names of influencing factors.
4) Which is allosteric factor ? Why is it called such ?
5) Mention the conditions for curve shifting.
6) How do T, CO_2,CO, [H^+] & HbF influence dissociation curve.
7) Describe the role of 2,3 DPG to influence dissociation curve.
8) Why does pregnant woman feel hypoxia?
9) What will be fate of dissociation curve in acidosis ?
10) Why is CO more toxic than CO_2 ?
11) What is P_{50} ?
12) Why do we feel hypoxia in summer ?
13) Calculate P_{50} from the dissociation curve.