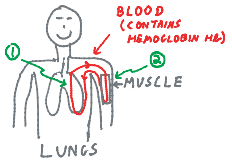
HEMOGLOBIN SCENARIO, PART 3



$Hb + 4O_2 \rightleftharpoons Hb(O_2)_4 \quad K = 2.4 \times 10^{-6}$

$Q = \frac{[Hb(O_2)_4]}{[Hb][O_2]^4}$ (M; TORR (OR mm Hg))

TOTAL CONCENTRATION OF HEMOGLOBIN $[Hb] + [Hb(O_2)_4] = 240\ \mu M$

$1\ \mu M = 10^{-6} M$

① BLOOD IN LUNGS

	Hb	+	$4O_2$	⇌	$Hb(O_2)_4$
I	240×10^{-6}		100		0
C	$-x$				$+x$
E	$240 \times 10^{-6} - x$		100		$+x$

THE PERSON IS BREATHING FRESH AIR

$K = \frac{[Hb(O_2)_4]}{[Hb][O_2]^4}$

$2.4 \times 10^{-6} = \frac{x}{(240 \times 10^{-6} - x)(100)^4}$

$x = 239.004 \times 10^{-6}$

$[Hb(O_2)_4] = 239\ \mu M$

$[Hb] = 240 \times 10^{-6} - 239.004 \times 10^{-6} = 1\ \mu M$

$[O_2] = 100$ TORR

USING MINORITY SPECIES APPROXIMATION

STEP 1 DETERMINE MAJORITY SPECIES

	LIMITING REAGENT → Hb	+	$4O_2$ ← IN CONSTANT SUPPLY	⇌	$Hb(O_2)_4$
I	240×10^{-6}		100		0
C	-240×10^{-6}		↓		$+240 \times 10^{-6}$
K=∞	0		100		240×10^{-6}

TRY ASSUMING $K = \infty$

MINORITY SPECIES [ ] IS ONLY ≈ 0

MAJORITY SPECIES [ ]'s ARE NOW KNOWN

STEP 2 USE K = Q TO DETERMINE MINORITY [ ]'s

$K = 2.4 \times 10^{-6} = \frac{[Hb(O_2)_4]}{[Hb][O_2]^4} = \frac{240 \times 10^{-6}}{[Hb](100)^4} \rightarrow [Hb] = 1.0\ \mu M$

$[Hb(O_2)_4] = 240\ \mu M$

$[Hb] = 1\ \mu M$

$[O_2] = 100$ TORR

CHECK <5%

$\frac{1}{240} = 0.0042 = 0.42\%$ < 5% ✓

② BLOOD IN MUSCLES

	Hb	+	$4O_2$	⇌	$Hb(O_2)_4$
I	240×10^{-6}		5		0
C	$-x$				$+x$
E	$240 \times 10^{-6} - x$		5		$+x$

MUSCLES CONSUMPTION FIXES THIS

$K = \frac{[Hb(O_2)_4]}{[Hb][O_2]^4}$

$2.4 \times 10^{-6} = \frac{x}{(240 \times 10^{-6} - x)(5)^4}$

$x = 3.59 \times 10^{-7}$

$[Hb(O_2)_4] = 240\ \mu M$

$[Hb] = 0.36\ \mu M$

$[O_2] = 5$ TORR

USING MINORITY SPECIES APPROXIMATION

STEP 1 DETERMINE MAJORITY SPECIES (ASSUME K=0)

	Hb	+	$4O_2$	⇌	$Hb(O_2)_4$ ← LIMITING REAGENT
I	240×10^{-6}		5		0
C	0		↓		0
K=0	240×10^{-6}		5		0

MAJORITY SPECIES [ ]'s ARE NOW KNOWN

MINORITY SPECIES [ ] IS ONLY ≈ 0

STEP 2 USE K = Q TO DETERMINE MINORITY [ ]'s

$K = 2.4 \times 10^{-6} = \frac{[Hb(O_2)_4]}{[Hb][O_2]^4} = \frac{[Hb(O_2)_4]}{240 \times 10^{-6}(5)^4} \rightarrow [Hb(O_2)_4] = 0.36\ \mu M$

$[Hb(O_2)_4] = 240\ \mu M$

$[Hb] = 0.36\ \mu M$

$[O_2] = 5$ TORR

CHECK <5%

$\frac{0.36}{240} = 0.0015 = 0.15\%$ < 5% ✓