Mathematics 172

Quiz 35 Name: Key

You must show your work to get full credit.

A cell has a volume of $V = 5.2 \times 10^{-6}\text{mm}^3$ and a surface area of $A = 7.5 \times 10^{-3}\text{mm}^2$. Assume that oxygen, 0_2, passes through the cell membrance at a rate of $.38(\text{mg/mm}^2)/\text{hr}$.

1. What is the total amount of O_2 coming into the cell per hour?

Amount = (Amount/Area) Area
= (rate)(Area)
$= (.38)(7.5 \times 10^{-3})((\text{mg/mm}^2)/\text{hr})\,\text{mm}^2$
$= .00285\ \text{mg/hr}$

Amount of O_2/hour is $.00285\ \text{mg/hr} = 2.85 \times 10^{-3}\ \text{mg/hr}$

2. What is the amunt of O_2 per volume comming into the cell per hour?

Amount of O_2 per volume per hour is $548.1\ (\text{mg/hr})/\text{mm}^3$

This is $(\text{Amount/volume}) = \frac{.0285}{5.2 \times 10^{-6}} \frac{\text{mg}}{\text{hr}} \frac{1}{\text{mm}^3}$
$= 548.1\ (\text{mg/hr})/\text{mm}^3$

3. If the cell needs $58(\text{mg/mm}^3)/\text{hr})$ of $)_2$ to survive, then how much can it be magnified before it dies from lack of oxygen?

Let λ = magnifuction factor
= scale factor

Magnification factor is 9.45

magnified volume $= 5.2 \times 10^{-6} \lambda^3\ \text{mm}^3$
magnified area $= 7.5 \times 10^{-3} \lambda^2\ \text{mm}^2$
Amount of O_2/hr $= (.38)(7.5 \times 10^{-3}\lambda^2) = .00285\lambda^2\ \text{mg/hr}$
(Amount of O_2/hr)/volume $= \frac{.00285\lambda^2}{5.2 \times 10^{-6}\lambda^3} = \frac{548.1}{\lambda}\ (\text{mg/mm}^3)/\text{hr}$

So we need to solve

$$\frac{548.1}{\lambda} = 58$$

$$\lambda = \frac{548.1}{58} = 9.45$$