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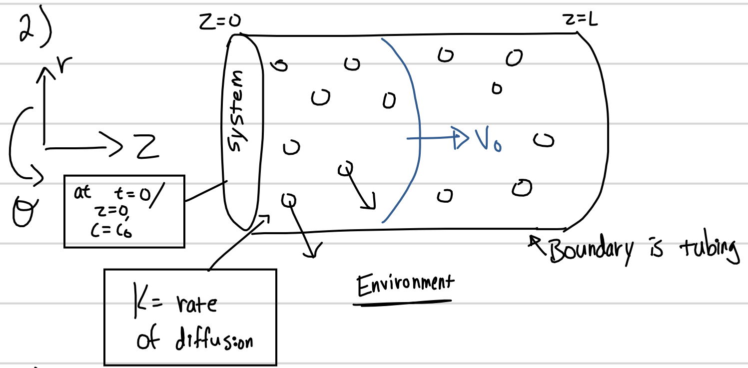
BIOE 340
Sect: 0102

Laboratory Assignment #1

Par A: Model Design

1) We only need to consider the permeability of the tube using K, the initial concentration, and the position of the analysis given by z.

2)



3) We can assume that the concentration doesn't change based on time and that the concentration is in steady state. This means that at the same length the concentration will always be constant. The system is axis symmetric as the rate of diffusion is the same no matter what slice of tube is analyzed. Lastly the radius won't affect the concentration because the concentration can be assumed to be uniform within the boundaries of the system.

4) The time period is only the time for the blood to flow through the tube (i.e. $t = L/V_0$).

5) Using Fick's 2nd Law:

$$\frac{dC_A}{dt} = D\nabla^2 C_A$$

$$\cancel{\frac{dC_A}{dt}} = D\left[\frac{1}{r}\cancel{\frac{\delta}{\delta r}}\left(r\cancel{\frac{\delta C_A}{\delta r}}\right) + \frac{1}{r^2}\cancel{\frac{\delta^2 C_A}{\delta \theta^2}} + \frac{\delta^2 C_A}{\delta z^2}\right]$$

$$0 = \frac{\delta^2 C_A}{\delta z^2}$$

$$\int 0\, dz = \int \frac{\delta^2 C_A}{\delta z^2}\, dz$$

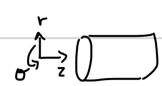
$$\int C_1\, dz = \int \frac{\delta C_A}{\delta z}\, dz \qquad \underline{BC\#1} \quad C_2 = C_0$$

$$C_1 z + C_2 = C_A \qquad \underline{BC\#2} \quad C_1 = K$$

$$\boxed{C_A = Kz + C_0}$$

Assume

1 Axis Symmetric



2 Uniform Concentration regardless of r

3 SS

$BC\#1 \rightarrow$ at $z=0$, $C_A = C_0$

$BC\#2 \rightarrow$ at $z=L$, $C_A = C_0 + KL$