

Sept 25, 2008

1 Membrane Transport

In this section I want to briefly consider the kinetics of simple membrane diffusion. Consider two compartments, A and B as shown in figure ?? connected by a thin membrane that allows diffusion of substance from one compartment to another. A membrane that separates two compartments is a two dimensional surface and for this reason the kinetic formulation is slightly different from bulk solution reaction kinetics. Whereas concentration changes in the bulk solution are often expressed in terms of moles of substance transformed per unit *volume* per unit time (moles $V^{-1} t^{-1}$), transport across a membrane is expressed in units of moles per unit *area* per unit time (moles $A^{-1} t^{-1}$) and is called the flux, J .

By Fick's law of diffusion, the flux is proportional to the concentration gradient across the membrane:

$$J_A = D_A \frac{dS}{dx}$$

where S is concentration and D_A the diffusivity coefficient ($A t^{-1}$). If the zone of diffusion has a width δ , we can approximate Fick's law with

$$J_A = D_A \frac{S_{out} - S_{in}}{\delta}$$

or

$$J_A = P_A(S_{out} - S_{in})$$

where P_A is the permeability coefficient and has units of length per unit time (often $l t^{-1}$). The units of flux at this stage are moles per unit area per unit time (*moles* $l^{-2} t^{-1}$). To obtain the total amount of mass that moves from one compartment to another we must multiply the flux by the cross-sectional area of the membrane (A), thus:

$$\frac{dq}{dt} = AJ$$

where q is the amount of substance and A the area of the membrane. If this substance is moving into a volume V , then the rate of change of concentration in the compartment is given by:

$$\frac{dS}{dt} = \frac{A}{V} J$$

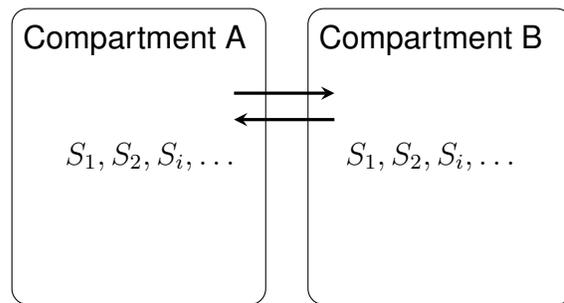


Figure 1: Compartmental Analysis. Two compartment, A and B with volumes V_A and V_B exchange mass across a membrane.