over the period of the study. Significant depletion of solute in the donor vehicle or an inadequate receptor sink requires more complex modeling, as discussed later. If transport through the SC is rate limiting, the steady-state approximation of amount of solute absorbed (Q) when concentration Cv is applied to an area of application (A) for an exposure time (T) is given in Equation (2.1) (see Ref. 2):

$$Q = k_{\mathrm{p}} A C_{\mathrm{v}} (T - lag) \tag{2.1}$$

where k_{p} is the permeability coefficient (unit: cm/h) of the SC. In reality, absorption does not cease after removal of the vehicle, so that the overall absorption is slightly over $k_{\mathrm{p}}AC_{\mathrm{v}}T$. The permeability coefficient in Equation (2.1) is normally defined in terms of the dimensionless partition coefficient between the SC and vehicle (K_{m}) and D_m, the diffusivity of a solute in SC over a diffusion path length h_{m}:

$$k_{\mathrm{p}} = \frac{K_{\mathrm{m}} D_{\mathrm{m}}}{h_{\mathrm{m}}} \tag{2.2}$$

K_{m} is defined as the ratio of solute concentrations in the SC (C_{m}) and vehicle (C_{v}) under equilibrium i.e., $K_{\mathrm{m}} = C_{\mathrm{m}}/C_{\mathrm{v}}$.

In practice, the permeability coefficient k_{p} is a composite parameter. When solute transport occurs via both a lipid pathway of permeability coefficient $k_{\mathrm{p.lipid}}$ and a polar pathway of permeability coefficient $k_{\mathrm{p.polar}}$, an aqueous boundary layer of the epidermis provides a rate-limiting permeability coefficient $k_{\mathrm{p.aqueous}}$ and k_{p} is more properly expressed as:

$$k_{\mathrm{p}} = \left(\frac{1}{k_{\mathrm{p.lipid}} + k_{\mathrm{p.polar}}} + \frac{1}{k_{\mathrm{p.aqueous}}} \right)^{-1} \tag{2.3}$$

As discussed by Roberts and Walters [2], for most solutes, $k_{\mathrm{p}} \approx k_{\mathrm{p.lipid}}$.

Absorption is more commonly expressed in terms of the steady state flux J_{ss} or the absorption rate per unit area:

$$J_{\mathrm{ss}} = \frac{Q}{A(T - lag)} = k_{\mathrm{p}} C_{\mathrm{v}} \tag{2.4}$$

Equations (2.1) and (2.4) are the simplified forms of a more complex expression based on the solution of the diffusion equation for transport of solute in the skin:

$$\frac{\partial C_{\mathrm{m}}}{\partial t} = D_{\mathrm{m}} \frac{\partial^2 C_{\mathrm{m}}}{\partial x^2} \tag{2.5}$$

the initial condition:

$$C_{\mathrm{m}}(x, 0) = 0 \tag{2.6}$$

and boundary conditions:

$$C_{\mathrm{m}}(0, t) = K_{\mathrm{m}} C_{\mathrm{v}} \tag{2.7}$$

$$C_{\mathrm{m}}(h_{\mathrm{m}}, t) = 0 \tag{2.8}$$

Traditionally Equation (2.5) is solved in terms of the amount of solute $Q(t)$ exiting from the membrane in time t and expressed as a series solution [3]:

$$Q(t) = -D_{\mathrm{m}} A \int_0^t \left. \frac{\partial C_{\mathrm{m}}}{\partial x} \right|_{x = h_{\mathrm{m}}} \mathrm{d}t = K_{\mathrm{m}} A C_{\mathrm{v}} h_{\mathrm{m}} \left(\frac{t}{t_{\mathrm{d}}} - \frac{1}{6} - \frac{2}{\pi^2} \sum_{n=1}^{\infty} \frac{(-1)^n}{n^2} \exp\left(-\frac{t}{t_{\mathrm{d}}} \pi^2 n^2 \right) \right) \tag{2.9}$$