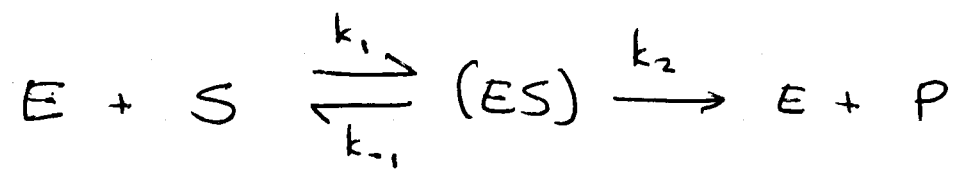


Simple derivation of Michaelis - Menden enzyme kinetic rate expression



Mass conservation eqns

dS/dt = -k1 ES + k-1 (ES)

dP/dt = k2 (ES)

d(ES)/dt = k1 ES - k-1 (ES) - k2 (ES)

dE/dt = -k1 ES + k-1 (ES) + k2 (ES)

Sum (ES) + E eqns

d/dt [(ES) + E] = 0 => E + (ES) = E\_Total

Apply quasi-steady-state assumption

d[ES]/dt << dS/dt, dP/dt, generally justified by Et << S

=> d(ES)/dt ≈ 0

$$\therefore 0 = k_1 [E_T - (ES)] S - (k_{-1} + k_2) (ES)$$

$$\Rightarrow (ES) = \frac{E_T S}{\left[\frac{k_{-1} + k_2}{k_1}\right] + S}$$

$$\therefore \frac{dP}{dt} = - \frac{dS}{dt} = \frac{[k_2 E_T] S}{\left[\frac{k_{-1} + k_2}{k_1}\right] + S}$$

$$= \frac{V_{max} S}{K_m + S}$$

$V_{max}$  (maximum reaction velocity)  $\equiv k_2 E_T$

$K_m$  (Michaelis-Menten constant)  $\equiv \frac{k_{-1} + k_2}{k_1}$

This expression is often valid for in vitro situations, but less often for in vivo; in the latter, the substrate concentration may not necessarily overwhelm the enzyme concentration.

Another caveat is that even when it is valid for individual reactions, if those reactions are coupled it can become invalid.