Pre-Equilibrium Mechanism — Michaelis - Menten Mechanisim

$$E + S \underset{k_{-1}}{\overset{k_2}{\rightleftharpoons}} (ES) \xrightarrow{k_1} P + E \qquad \frac{d[P]}{dt} = k_1 [ES]$$

E = Enzyme S = Substrate P= Product

$$0 \approx \frac{d[ES]}{dt} = k_2 [E][S] - k_{-1} [ES] - k_1 [ES]$$

$$[ES] = \frac{k_2 [E][S]}{(k_{-1} + k_1)}$$

$$[E]_o = [E] + [ES] \qquad [E] = [E]_o - [ES]$$

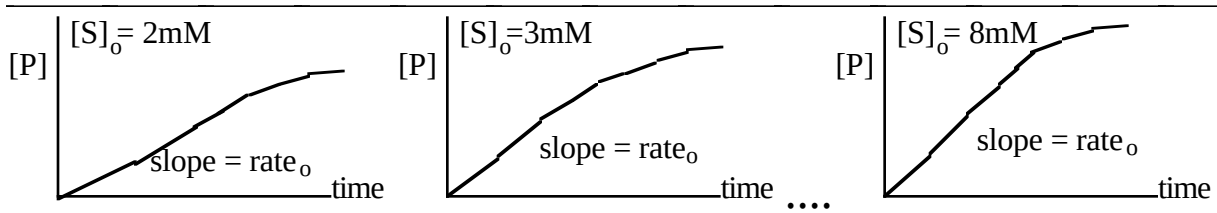
$$[ES] = \frac{k_2 ([E]_o - [ES])[S]}{(k_{-1} + k_1)} = \frac{k_2 [E]_o[S]}{(k_{-1} + k_1)} - \frac{k_2 [ES][S]}{(k_{-1} + k_1)}$$

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

$$[ES] = \frac{k_2 [E]_o[S]}{(k_{-1} + k_1 + k_2[S])}$$

$$\frac{d[P]}{dt} = k_1 [ES] = k_1 \frac{k_2 [E]_o[S]}{(k_{-1} + k_1 + k_2[S])}$$

$$\frac{d[P]}{dt} = k_1 [ES] = \frac{k_1 [E]_o[S]}{(k_M + [S])} \qquad k_M = \frac{(k_1 + k_{-1})}{k_2}$$

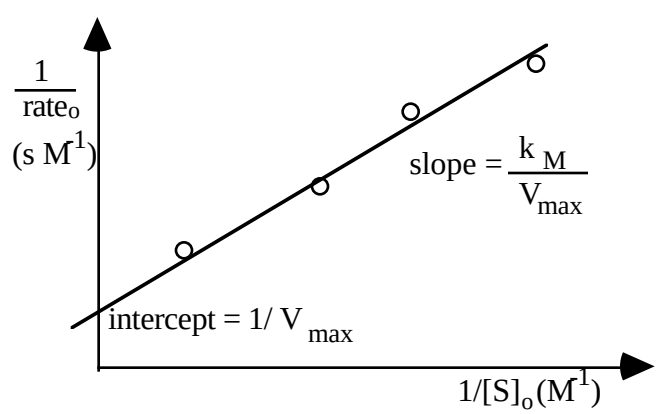


$$\frac{1}{rate} = \frac{k_M + [S]}{k_1 [E]_o[S]}$$

initial rate: $[S] \approx [S]_o$

$$\frac{1}{rate_o} = \frac{1}{k_1 [E]_o} + \frac{k_M}{k_1 [E]_o[S]_o}$$

when $[ES]=[E]_o$ get maximum rate

$$V_{max} = \frac{d[P]}{dt} = k_1 [E]_o$$

$$\frac{1}{rate_o} = \frac{1}{V_{max}} + \frac{k_M}{V_{max} [S]_o}$$