

Michaelis-Menten Kinetics

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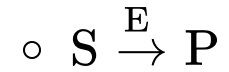
Chemical Reaction Engineering

Enzyme are proteins that speeds up biological reactions without being used up

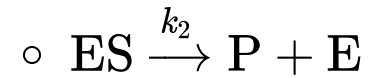
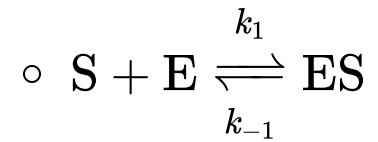
- **Catalyzer** - substances that speeds up reactions without being used up
- **Enzyme** - proteins that catalyzes reactions
 - E.g. Sucrase - digestive enzyme that breaks down sucrose into glucose

Michaelis-Menten kinetics describes simple enzymatic reactions

- Overall reaction



- Reaction mechanism



Michaelis-Menten kinetics can be derived with pseudo-steady-state approximation

Ex. Derive the rate of production r_P described by Michaelis-Menten and determine V_{\max} and K_M :

$$r_P = \frac{V_{\max} [S]}{K_M + [S]}$$

- Rate expression of rate of production
- Rate expression of rate of production of intermediate
 - **Pseudo-steady-state approximation** - intermediates are immediately consumed after production, so the net rate of intermediate is zero

Michaelis-Menten kinetics relates rate of production with substrate concentration

- Enzyme balance - total amount of enzyme is constant
- Solve for $[ES]$
- Solve for r_P

Michaelis-Menten parameters describes reaction properties

- Simplify r_P with
 - **Maximum rate** of reaction
 - $V_{\max} = k_2[E_T]$
 - **Michaelis-Menten constant** - attraction of enzyme of its substrate
 - $K_M = \frac{k_2 + k_{-1}}{k_1}$
 - **Turnover number** - # substrates converted to product per unit time on one enzyme at saturation
 - $k_{\text{cat}} = k_2$
- Given Michaelis-Menten parameters, we can know $r_P([S])$ by Michaelis-Menten eqn:

$$r_P = \frac{V_{\max}[S]}{K_M + [S]}$$

Michaelis-Menten parameters can be found by linearizing the Michaelis-Menten eqn

$$r_P = \frac{V_{\max} [S]}{K_M + [S]}$$

- **Lineweaver-Burk equation**

- $\frac{1}{r_P} = \frac{K_M}{V_{\max}} \frac{1}{[S]} + \frac{1}{V_{\max}}$

- **Eadie-Hofstee equation**

- $r_P = V_{\max} - K_M \frac{r_P}{[S]}$

- **Hanes-Woolf equation**

- $\frac{[S]}{r_P} = \frac{K_M}{V_{\max}} + \frac{1}{V_{\max}} [S]$