MICHAELIS-MENTEN EQUATION

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By

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MICHAELIS-MENTEN EQUATION

- Michaelis–Menten kinetics is one of the simplest and best-known models of enzyme kinetics

- It is named after German biochemist **Leonor Michaelis** and Canadian physician **Maud Menten**

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- The Michaelis-Menten equation arises from the general equation for an enzymatic reaction:

- $E + S \leftrightarrow ES \leftrightarrow E + P$

- (E is the enzyme, S is the substrate, ES is the enzyme-substrate complex, and P is the product)

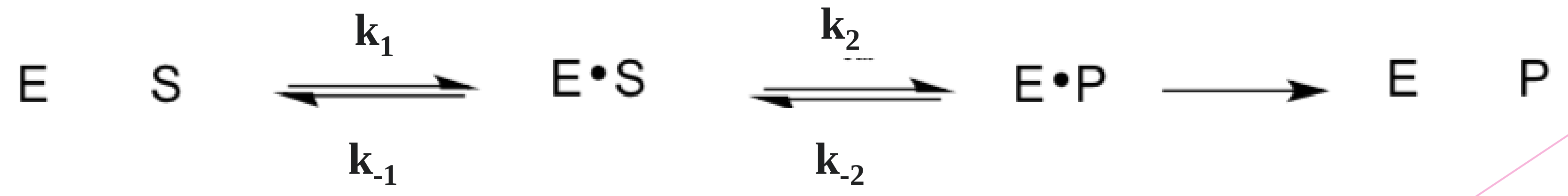
- The enzyme combines with the substrate in order to form the ES complex, which in turn converts to product while preserving the enzyme

- The rate of the forward reaction from E + S to ES may be termed k_1 and the reverse reaction as k_{-1}

Continue…..

- For the reaction from the ES complex to E and P, the forward reaction rate is k_2, and the reverse is k_{-2}

- The ES complex may dissolve back into the enzyme and substrate, or move forward to form product.



Continue…..

- At initial reaction time, when $t \approx 0$, little product formation occurs, therefore the backward reaction rate of k_{-2} may be neglected
- The new reaction becomes

$$E + S \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} ES \xrightarrow{k_2} E + P$$

Continue…..

- Assuming steady state, the following rate equations may be written as:

Rate of formation of **ES** = $k_1[E][S]$

Rate of breakdown of **ES** = $(k_{-1} + k_2)\ [ES]$

Set equal to each other (brackets represent concentrations)

Therefore:

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

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

Continue…..

- $[E][S]/[ES] = (k_{-1} + k_2)/k_1$
- $[E]total = [E] + [ES]$, where $[E]total$ is the total enzyme concentration
- $[E] = [E]total - [ES]$ Substitute **[E]** in the above equation
- $([E]total - [ES])\ [S]/[ES] = (k_{-1} + k_2)/k_1$
- $[E]total\ [S] - [ES]\ [S]\ /\ [ES] = (k_{-1} + k_2)/k_1$ $(k_{-1} + k_2)/k_1 = K_M$ (Michaelis Constant)
- $[E]total\ [S] - [ES]\ [S]\ /\ [ES] = K_M$
- $[E]total\ [S] - [ES]\ [S] = [ES]\ K_M$ Rearranging terms,
- $[E]total\ [S] = [ES]\ (K_M + [S])$

Continue…..

- $[E]total\ [S] = [ES]\ (K_{M} + [S])$

- $[ES] = \dfrac{[E]total\ [S]}{K_{M} + [S]}$

- $V_o = k_2\ [ES]$

- $V_o = k_2 \dfrac{[E]total\ [S]}{K_{M} + [S]}$

- $k_2\ [E]total = V_{max}$

- $V_o = \dfrac{V_{max}[S]}{K_{M} + [S]}$ ⟶ **Michaelis-Menten equation**

Continue…..

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

V_0 is the initial velocity of the reaction

V_{max} = maximum velocity or maximal reaction rate

S = Substrate concentration

K_M = Michaelis constant

Thank You