# Enzyme kinetics

Enzyme kinetics is the quantitative study of enzyme catalysis. Kinetic studies measure reaction rates and the affinity of enzymes for substrates. A useful model for the kinetics of enzyme catalyzed reaction was proposed by Leonor Michaelis and Maud Menten(1913).

During enzymatic reaction, the enzyme and substrates combine with each other to form enzyme- substrate complex (ES-complex) and this complex is then converted to product. Formation of ES-complex is a reversible process. Once ES-complex is formed, it can either go to P and E formation, or can revert back to E and S.


Here, $k_1$ is the rate constant for the formation of ES-complex,

$k_{-1}$ is the constant for the reverse reaction, dissociation of the ES-complex to free E and S.

$k_2$ is the rate constant for the conversion of the ES-complex to product(P) and release of enzyme(E).

Functions of the rate constants of three different steps can be written by one constant, called Michaelis - Menten constant ($\mathbf{K_m}$) as follows-

$$K_M = \frac{k_{-1} + k_2}{k_1}$$

In an enzyme catalyzed reaction, the rate of reaction depends on the substrate concentration(S). At a relatively low concentration of substrate(S), the initial velocity (V) increases linearly with an increase in a substrate concentration. The reaction reaches a maximum velocity ($V_{max}$) with an increase in substrate

concentration. It does not increase further by increasing concentration of substrate. **Michaelis - Menten constant ($K_m$) is defined as the substrate concentration to produce half- maximum velocity in an enzyme catalysed reaction.**

Michaelis and Menten derived an equation from examining the effect of substrate concentration for Michaelis constant. This constant was dependent on substrate concentration (S), initial (v) and maximum rate ($V_{max}$) of the enzymatic reaction. Accordingly,

$$v = \frac{V_{max}[S]}{K_m + [S]}$$

Here, v-measured velocity

$V_{max}$-maximum velocity

S- Substrate concentration

$K_m$- Michaelis constant

This equation describes how the initial rate of reaction is affected by the initial substrate concentration, [S].

When a graph of substrate concentration against rate of reaction is plotted, the initial rate of reaction increases rapidly in a linear fashion as substrate concentration increases. Rate then plateaus and increasing substrate concentration has no effect on reaction velocity as all enzyme active sites are saturated with substrate . This plot of rate of reaction against substrate concentration has the shape of a rectangular hyperbola.

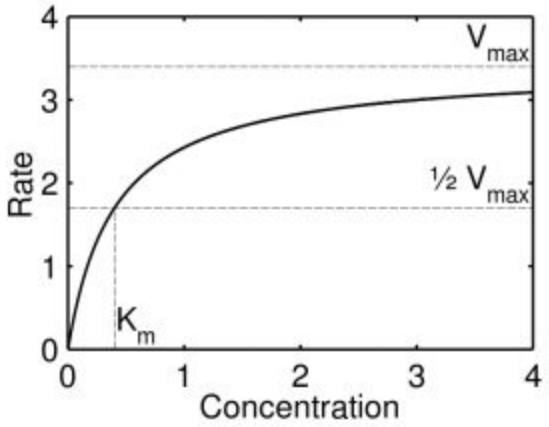


Fig – Graph of rate of reaction against substrate concentration, demonstrating Michaelis–Menten kinetics, with Vmax and Km highlighted.

Michaelis constant is an important kinetic parameter of the enzyme. It reflects the efficiency of the enzyme. **A lower $K_m$ means more efficient enzyme and higher $K_m$ means less efficient.**

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