5.2: Enzyme Parameters

Vmax & Kcat

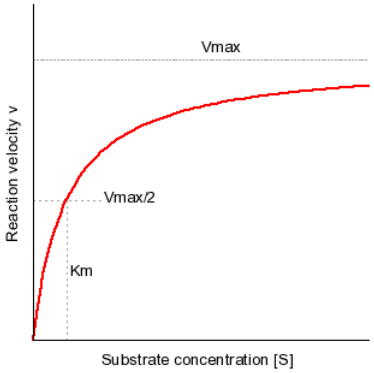

Figure 5.2.1: plot of Velocity vs Substrate Concentration (V vs. [S]).

On a plot of initial velocity vs Substrate Concentration (v vs. [S]), the maximum velocity (known as V*max*) is the value on the Y axis that the curve asymptotically approaches. It should be noted that the value of V*max* depends on the amount of enzyme used in a reaction. Double the amount of enzyme, double the V*max* . If one wanted to compare the velocities of two different enzymes, it would be necessary to use the same amounts of enzyme in the different reactions they catalyze. It is desirable to have a measure of velocity that is independent of enzyme concentration. For this, we define the value *Kcat* , also known as the turnover number. Mathematically,

$$\mathrm{Kcat} = \frac{V_{max}}{[Enzyme]}$$

To determine *Kcat*, one must obviously know the V*max* at a particular concentration of enzyme, but the beauty of the term is that **it is a measure of velocity independent of enzyme concentration**, thanks to the term in the denominator. K*cat* is thus a constant for an enzyme under given conditions. *The units of Kcat are time*$^{-1}$. An example would be 35/second. This would mean that each molecule of enzyme is catalyzing the formation of 35 molecules of product every second. While that might seem like a high value, there are enzymes known (carbonic anhydrase, for example) that have *Kcat* values of 106/second. This astonishing number illustrates clearly why enzymes seem almost magical in their action.

Km

Another parameter of an enzyme that is useful is known as *Km* , the **Michaelis constant**. What it measures, in simple terms, is the affinity an enzyme has for its substrate. Affinities of enzymes for substrates vary considerably, so knowing *Km* helps us to understand how well an enzyme is suited to the substrate being used. Measurement of *Km* depends on the measurement of V*max*. On a V vs. [S] plot, *Km* is determined as the x value that give V*max*/2. A common mistake students make in describing V*max* is saying that *Km* = Vmax/2. This is, of course not true. *Km* is a substrate concentration and is the amount of substrate it takes for an enzyme to reach V*max*/2. On the other hand V*max*/2 is a velocity and is nothing more than that. The value of *Km* is inversely related to the affinity of the enzyme for its substrate. High values of *Km* correspond to low enzyme affinity for substrate (it takes more substrate to get to V*max*). Low *Km* values for an enzyme correspond to high affinity for substrate.

Contributors

Dr. Kevin Ahern and Dr. Indira Rajagopal (Oregon State University)