Assuming rapid equilibrium and with the definition of

$$K'_m = \frac{[E][S]}{[ES]}, \qquad K_I = \frac{[E][I]}{[EI]}$$
$$[E_0] = [E] + [ES] + [EI] \quad \text{and} \quad v = k_2[ES] \tag{3.21}$$

we can develop the following equation for the rate of enzymatic conversion:

$$v = \frac{V_m[S]}{K'_m\left[1 + \frac{[I]}{K_I}\right] + [S]} \tag{3.22}$$

or

$$v = \frac{V_m[S]}{K'_{m,\text{ app}} + [S]} \tag{3.23}$$

where $K'_{m,\text{app}} = K'_m\left(1 + \frac{[I]}{K_1}\right)$.

The net effect of competitive inhibition is an increased value of $K'_{m,\text{ app}}$ and, therefore, reduced reaction rate. Competitive inhibition can be overcome by high concentrations of substrate. Figure 3.10 describes competitive enzyme inhibition in the form of a double-reciprocal plot.

Noncompetitive inhibitors are not substrate analogs. Inhibitors bind on sites other than the active site and reduce enzyme affinity to the substrate. Noncompetitive enzyme inhibition can be described as follows:

$$\begin{array}{ccccc}
E + S & \underset{K'_m}{\rightleftharpoons} & ES & \xrightarrow[k_2]{} & E + P \\
+ & & + & & \\
I & & I & & \\
K_1 \updownarrow & & \updownarrow & & \\
EI + S & \underset{K'_m}{\rightleftharpoons} & ESI & &
\end{array} \tag{3.24}$$

With the definition of

$$K'_m = \frac{[E][S]}{[ES]} = \frac{[EI][S]}{[ESI]}, \qquad K_I = \frac{[E][I]}{[EI]} = \frac{[ES][I]}{[ESI]}$$
$$[E_0] = [E] + [ES] + [EI] + [ESI] \text{ and } v = k_2[ES] \tag{3.25}$$

we can develop the following rate equation:

$$v = \frac{V_m}{\left(1 + \frac{[I]}{K_1}\right)\left(1 + \frac{K'_m}{[S]}\right)} \tag{3.26}$$