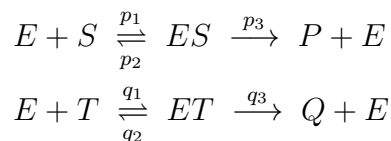
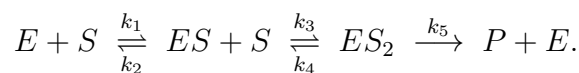


Read: Chapter 2: Bistability in the lactose operon of *Escherichia coli*: A comparison of differential equation and Boolean network models, by R. Robeva, and N. Yildirim. pages 37–57.

1. Consider the reactions where two substrates S and T compete for binding to an enzyme E to produce two different products P and Q :



- (a) Assuming that each reaction follows the Michaelis-Menten kinetics, derive rate equations for P and Q in this system. That is, determine $d[P]/dt$ and $d[Q]/dt$.
 - (b) Explain the effects of the competition occurring.
2. The Hill equation is an approximation for multi-molecule binding and it assumes simultaneous binding of n -molecules of a substrate S to the enzyme E . Suppose that two molecules of the substrate S are undergoing a reaction with an enzyme in an ordered manner as follows:



- (a) Derive a rate equation under the steady state assumption and compare it with the Hill equation with Hill coefficient $n = 2$:

$$\frac{d[P]}{dt} = \frac{V_{\max}[S]^2}{K_m + [S]^2}.$$

- (b) When do these two equations become roughly the same?