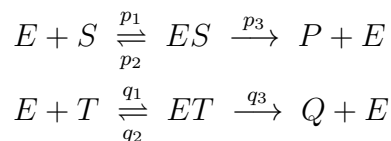
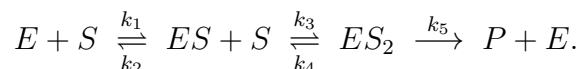


*Read:* Chapter 2.3: Modeling biochemical reactions with differential equations, by R. Robeva, and N. Yildirim. pages 40–46.

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?