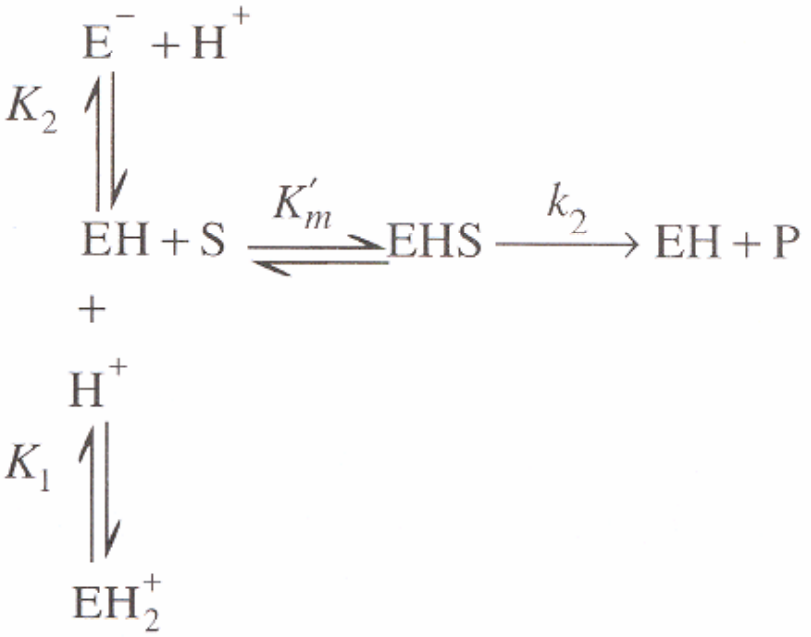
Effect of pH

3.3.5.1. pH effects. Certain enzymes have ionic groups on their active sites, and these ionic groups must be in a suitable form (acid or base) to function. Variations in the pH of the medium result in changes in the ionic form of the active site and changes in the activity of the enzyme and hence the reaction rate. Changes in pH may also alter the three-dimensional shape of the enzyme. For these reasons, enzymes are only active over a certain pH range. The pH of the medium may affect the maximum reaction rate, K_m, and the stability of the enzyme. In some cases, the substrate may contain ionic groups, and the pH of the medium affects the affinity of the substrate to the enzyme.

Effect of pH



$$K_m' = \frac{[EH][S]}{[EHS]}$$

$$K_1 = \frac{[EH][H^+]}{[EH_2^+]}$$

$$K_2 = \frac{[E^-][H^+]}{[EH]}$$

$$[E_0] = [E^-] + [EH] + [EH_2^+] + [EHS],$$

$$v = k_2[EHS]$$

Effect of pH

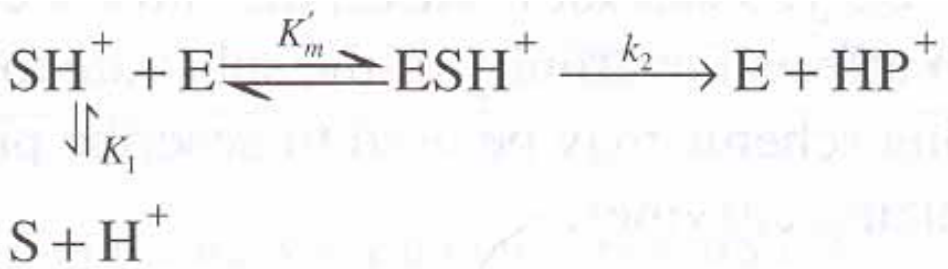
$$v = \frac{V_m[\mathrm{S}]}{K_m'\left[1 + \frac{K_2}{[\mathrm{H}^+]} + \frac{[\mathrm{H}^+]}{K_1}\right] + [\mathrm{S}]}$$

$$v = \frac{V_m[\mathrm{S}]}{K_{m,\mathrm{app}}' + [\mathrm{S}]}$$

where $K_{m,\mathrm{app}}' = K_m'\left[1 + \frac{K_2}{[\mathrm{H}^+]} + \frac{[\mathrm{H}^+]}{K_1}\right]$

Effect of pH

For the case of ionizing substrate,



$$v = \frac{V_m[S]}{K_m' \frac{K_1}{[H^+]} + [S]}$$

Effect of pH

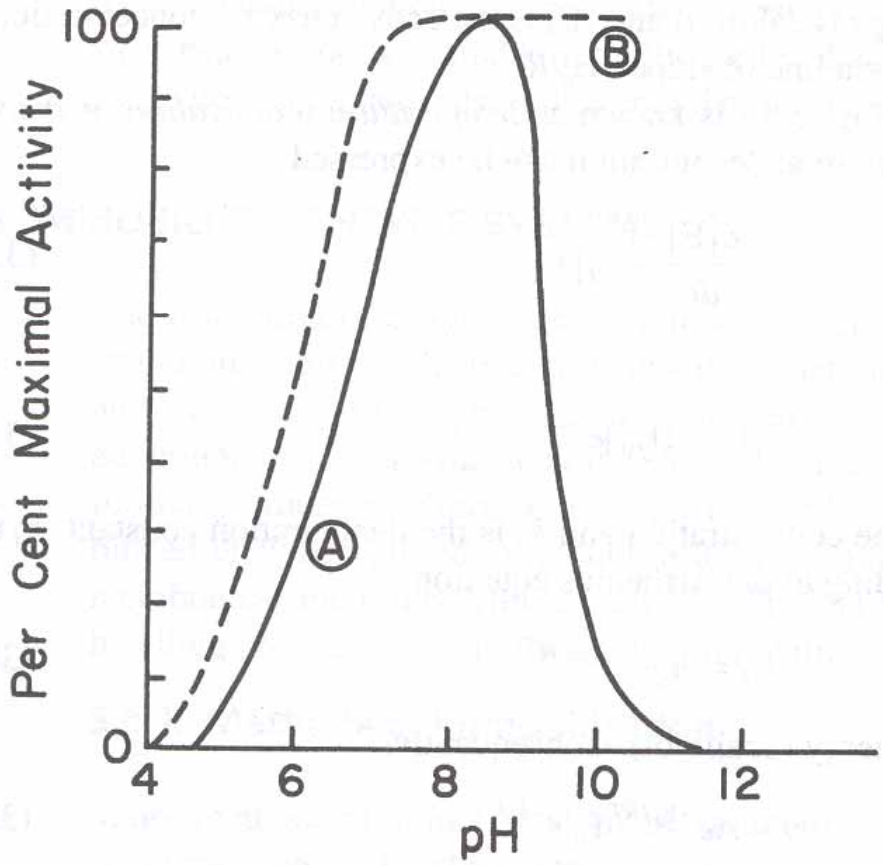
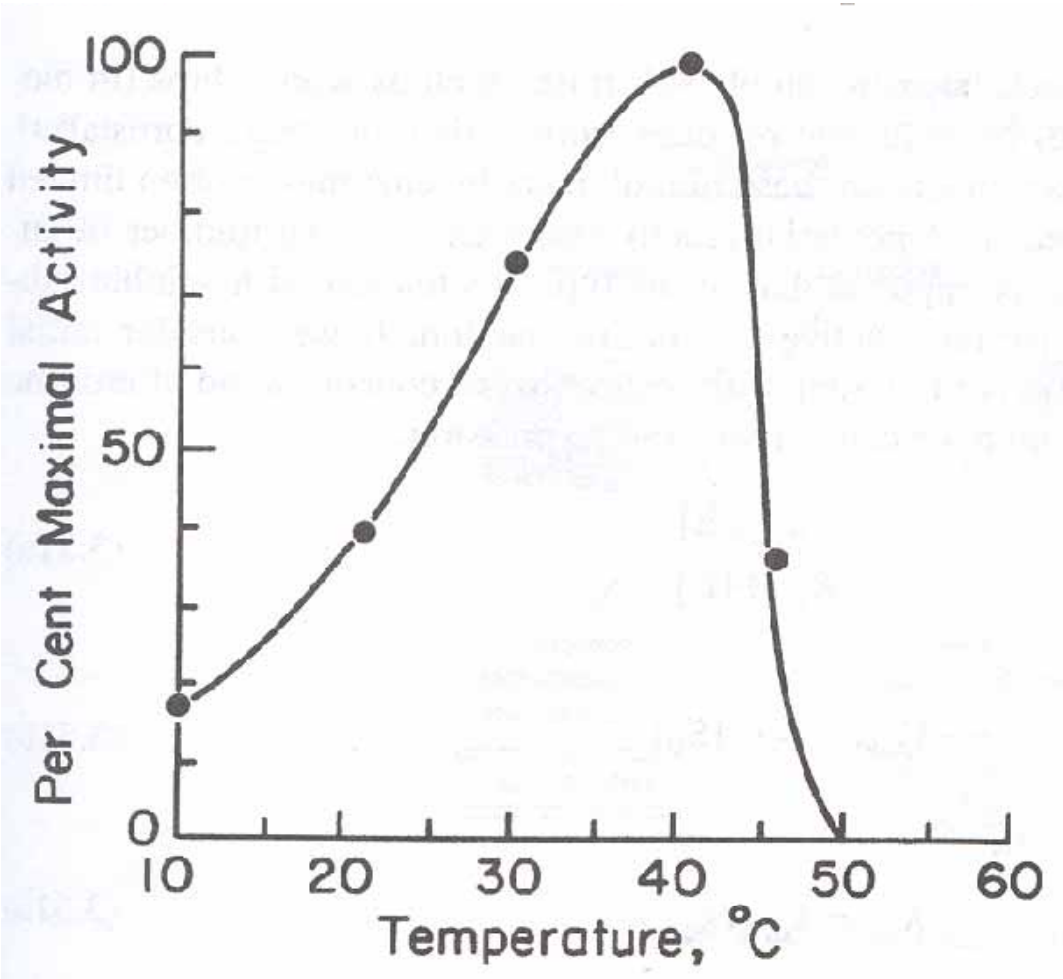


Figure 3.14. The pH-activity profiles of two enzymes. (A) approximate activity for trypsin; (B) approximate activity for cholinesterase.

Effect of Temperature



Effect of Temperature

$$v = k_2[E]$$

Temperature Activation

$$k_2 = Ae^{-E_a/RT}$$

Temperature Deactivation

$$-\frac{d[\mathrm{E}]}{dt} = k_d[\mathrm{E}]$$

$$[\mathrm{E}] = [\mathrm{E}_0]e^{-k_d t}$$

where $k_d = A_d e^{-E_d/RT}$

$$v = Ae^{-E_a/RT}\mathrm{E}_0 e^{-k_d t}$$

Insoluble Substrates

$$v = \frac{V_{max,S}[E]}{K_{eq} + [E]}$$

where $V_{max,S} = k_2[S_0]$

$$K_{eq}' = k_{des}/k_{ads}$$