

FIGURE 3.12 (a) Emil Fischer's 1894 theory that enzymes and substrates (S) must have complimentary shapes in order for catalysis of a reaction to form the product (P) forms the basis of modern understanding of enzymatic reactions. The concept of the formation of a transient enzyme/substrate complex as a reaction intermediate was later suggested by Brown and Henri. (b) "Induced fit," the theory that binding of a substrate to an enzyme could cause changes in the overall configuration of the enzyme to produce a structure capable of supporting reaction catalysis, was introduced by Koshland in 1958.

Enzymes act to increase the rate at which a preexisting reaction reaches its equilibrium by lowering the activation energy required for the reaction to proceed (Figure 3.13). Human carbonic anhydrase, for example, catalyzes

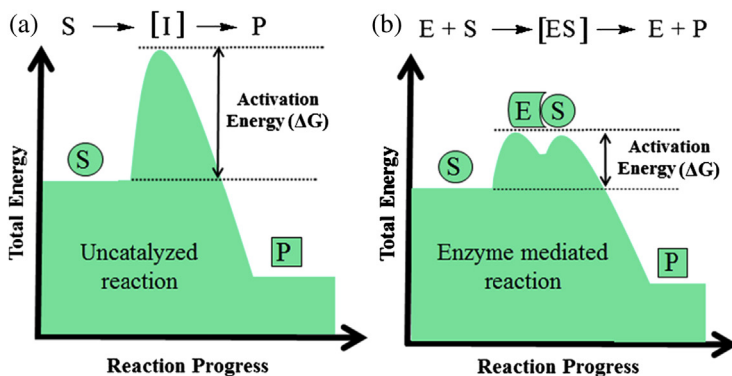


FIGURE 3.13 (a) In the absence of a catalyst, a given reaction will proceed from starting material (S) to product (P) by way of a transition state intermediate (I) that is higher in energy than the starting material. The energy required to reach the transition state is referred to as the activation energy (ΔG). In general, lowering the activation energy of a reaction leads to higher reaction rate. (b) An enzyme acts as a catalyst for a reaction, lowering the activation energy of a reaction by forming lower energy intermediates (an enzyme/substrate complex, ES). Binding interactions between the substrate and the enzyme decrease the energy requirements, in some cases forming multiple lower energy intermediates that lower the overall activation energy of a reaction.