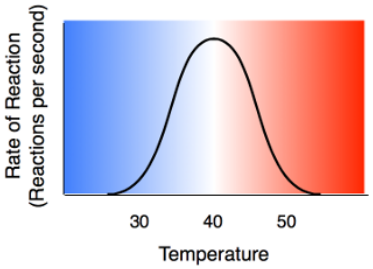
5.5: Temperature, pH, and enzyme concentration on the rate of a reaction

Temperature

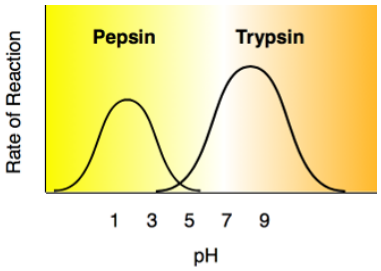
Higher temperature generally causes more collisions among the molecules and therefore increases the rate of a reaction. More collisions increase the likelihood that substrate will collide with the active site of the enzyme, thus increasing the rate of an enzyme-catalyzed reaction. Above a certain temperature, activity begins to decline because the enzyme begins to denature. The rate of chemical reactions therefore increases with temperature but then decreases as enzymes denature.



pH

Each enzyme has an optimal pH. A change in pH can alter the ionization of the R groups of the amino acids. When the charges on the amino acids change, hydrogen bonding within the protein molecule change and the molecule changes shape. The new shape may not be effective.

The diagram below shows that pepsin functions best in an acid environment. This makes sense because pepsin is an enzyme that is normally found in the stomach where the pH is low due to the presence of hydrochloric acid. Trypsin is found in the duodenum, and therefore, its optimum pH is in the neutral range to match the pH of the duodenum.



Most cells form hydrogen peroxide (H_2O_2) as a waste product of aerobic respiration. Hydrogen peroxide is toxic and must be converted to water and oxygen by the enzyme catalase.

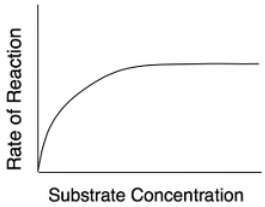
$$2\,H_2O \xrightarrow{catalase} 2\,H_2O + O_2 \tag{5.5.1}$$

Hydrogen peroxide is also commonly used as a household disinfectant. It bubbles when it is applied to cuts and scrapes because **catalase** is present in the fluids of the broken cells. As the equation above shows, the bubbles are oxygen gas (O_2).

Substrate Concentration

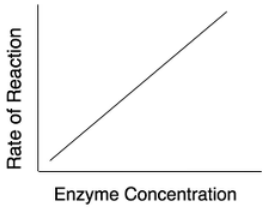
At lower concentrations, the active sites on most of the enzyme molecules are not filled because there is not much substrate. Higher concentrations cause more collisions between the molecules. With more molecules and more collisions, enzymes are more likely to encounter molecules of reactant.

The maximum velocity of a reaction is reached when the active sites are almost continuously filled. Increased substrate concentration after this point will not increase the rate. *Reaction rate therefore increases as substrate concentration is increased but it levels off.*



Enzyme Concentration

If there is insufficient enzyme present, the reaction will not proceed as fast as it otherwise would because all of the active sites are occupied with the reaction. Additional active sites could speed up the reaction. *As the amount of enzyme is increased, the rate of reaction increases.*



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