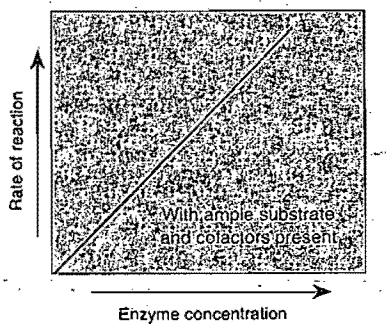
Enzyme Reaction Rates

Enzymes are sensitive molecules. They often have a narrow range of conditions under which they operate properly. For most of the enzymes associated with plant and animal metabolism, there is little activity at low temperatures. As the temperature increases, so too does the enzyme activity, until the point is reached where the temperature is high enough to damage the enzyme's structure. At this point, the enzyme ceases to function; a phenomenon called enzyme or protein **denaturation**.

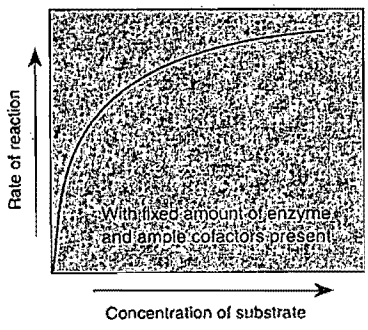
Extremes in acidity (pH) can also cause the protein structure of enzymes to denature. Poisons often work by denaturing enzymes or occupying the enzyme's active site so that it does not function. In some cases, enzymes will not function without cofactors, such as vitamins or trace elements. In the four graphs below, the rate of reaction or degree of enzyme activity is plotted against each of four factors that affect enzyme performance. Answer the questions relating to each graph:



1. **Enzyme concentration**

   a). Describe the change in the rate of reaction when the enzyme concentration is increased (assuming that substrate and cofactors are not limiting):

   more enzymes ~~part~~ faster rate



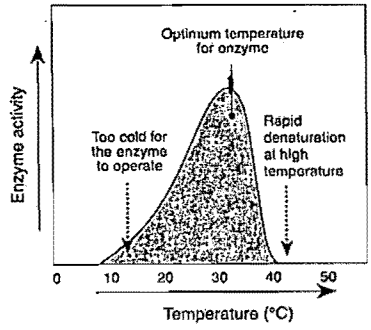
2. **Substrate concentration**

   a). Describe the change in the rate of reaction when the substrate concentration is **increased** (assuming a fixed amount of enzyme and ample cofactors):

   more substrate faster to certain point

   b). Explain why the rate changes the way it does:

   all enzymes are being used



3. **Temperature**

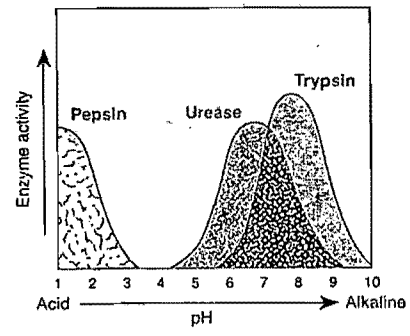
   Higher temperatures speed up all reactions, but few enzymes can tolerate temperatures higher than 50-60°C. The rate at which enzymes are **denatured** (change their shape and become inactive) increases with higher temperatures.

   a). Describe what is meant by an optimum temperature for enzyme activity:

   30° - temperature where it works the best

   b). Explain why most enzymes perform poorly at low temperatures:

   no liquid water
   objects moving slowly



4. **pH (acidity/alkalinity)**

   Like all proteins, enzymes and **denatured** by extremes of **pH** (very acid or alkaline). Within these extremes, most enzymes are still influenced by pH. Each enzyme has a preferred pH range for optimum activity.

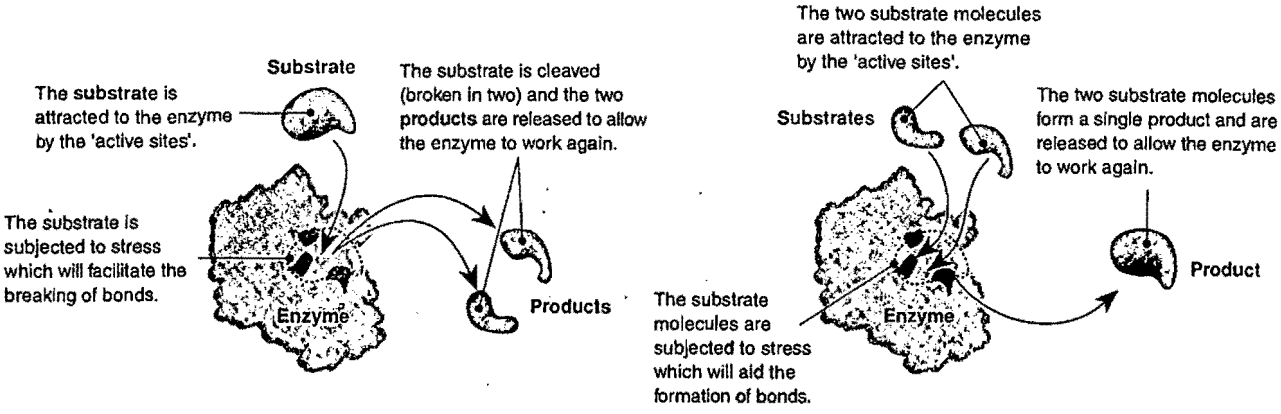
   a). State the optimum pH for each of the enzymes:

   Pepsin: 1 Trypsin: 8 Urease: 6

   b). Pepsin acts on proteins in the stomach. Explain how its optimum pH is suited to its working environment:

   Stomach is highly acidic

Enzyme Review Sheet



Catabolic reactions

Some enzymes can cause a single substrate molecule to be drawn into the active site. Chemical bonds are broken, causing the substrate molecule to break apart to become two separate molecules. **Examples:** *digestion, cellular respiration.*

Anabolic reactions

Some enzymes can cause two substrate molecules to be drawn into the active site. Chemical bonds are formed, causing the two substrate molecules to form bonds and become a single molecule. **Examples:** *protein synthesis, photosynthesis.*

1. Give a brief account of enzymes as **biological catalysts**, including reference to the role of the **active site**:
Biological catalysts are going to lower the activation energy needed speeding up the reaction. when a substrate fits into the active site, the enzyme creats stress on the bonds making reactions favor.
2. Distinguish between **catabolism** and **anabolism**, giving an example of each and identifying each reaction as **endergonic** or **exergonic**:
catabolic breaks it into 2 pieces - exergonic
anabolic combines smaller pieces - endergonic
3. Outline the key features of the '**lock and key**' model of enzyme action:
The enzyme's active site is the perfect shape for the substrate
4. Outline the '**induced fit**' model of enzyme action, explaining how it differs from the lock and key model:
as the substrate attaches to the protein, the protein fits around the substrate creating the perfect shape that wasn't always there.
5. Identify two factors that could cause enzyme denaturation, explaining how they exert their effects (see the next activity):
a). High temperature } breaks bonds, changes shapes
b). changes in pH }