Enzymes and Metabolism

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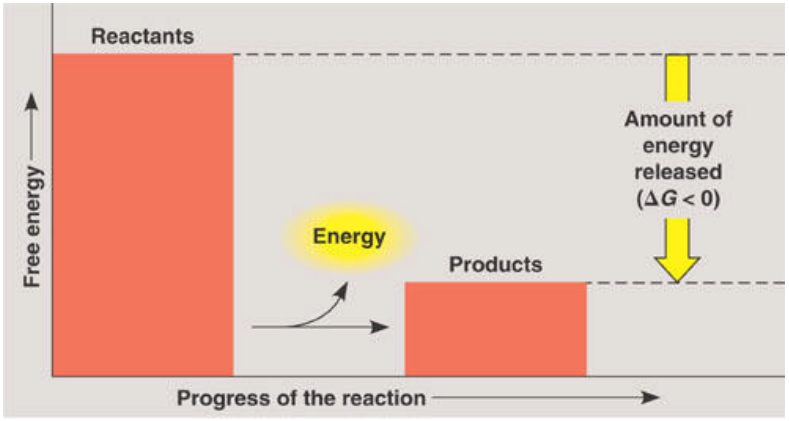
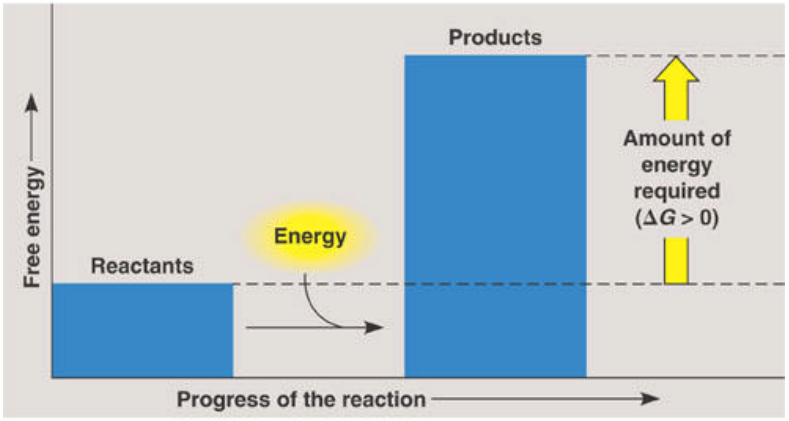
Metabolism: Exergonic and Endergonic Reactions



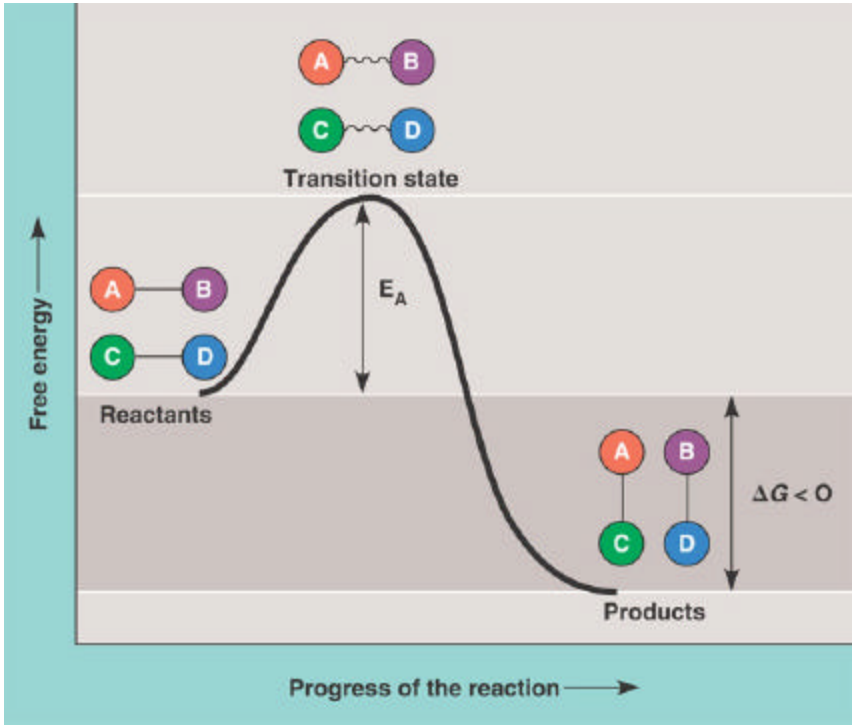
(a) Exergonic reaction: energy released



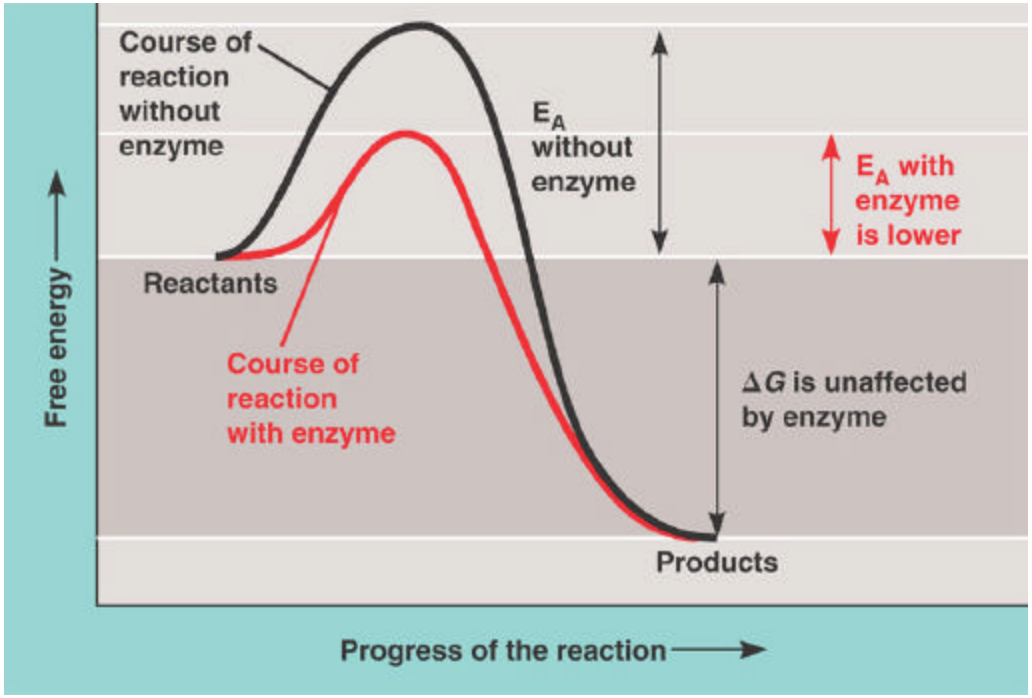
(b) Endergonic reaction: energy required

Chemical Reactions: Activation Energy (E_A)

- Every chemical reaction involves bond breaking and bond forming
- A chemical reaction generally involves the transformation of a molecule (*reactant*) into another (*product*) after the *transition state* has been overcome
- *Activation energy* is the energy required for such transformation

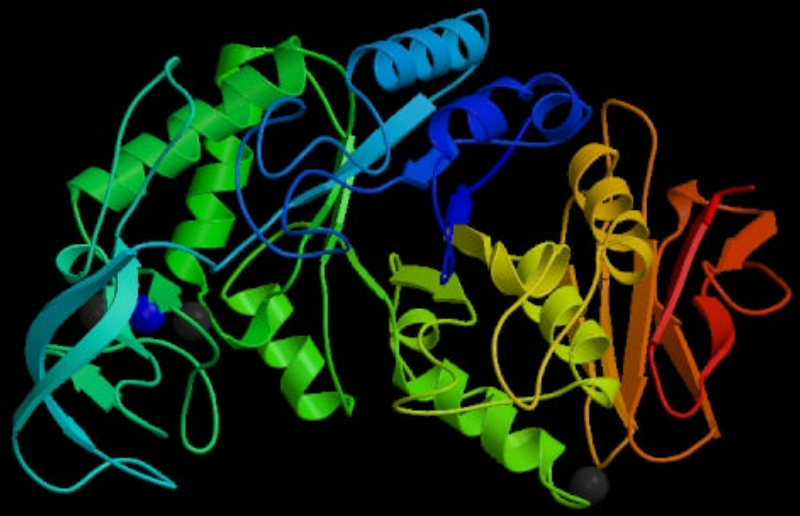


Chemical Reactions: Enzymes Lower the Activation Energy Barrier



Enzymes: What Are They?

- Enzymes are catalysts, molecules that lower the activation energy barrier required for a reaction to occur. Thus, catalysts speed up chemical reactions
- Enzymes are proteins or nucleic acids (RNA). Enzymes made of RNA are called *ribozymes*
- Enzymes carry the suffix *ase*
- Enzymes are substrate specific

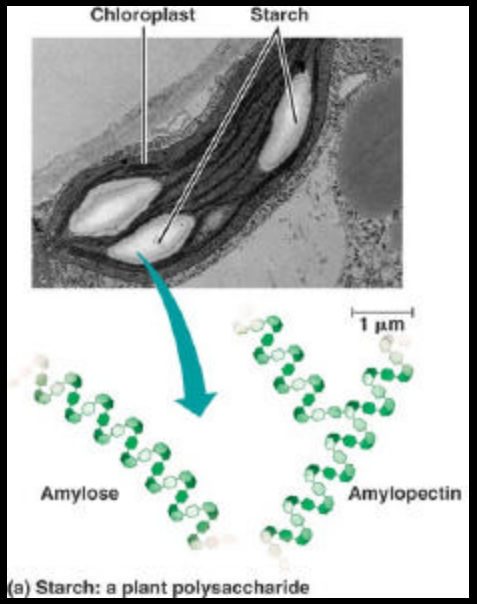


Bacillus licheniformis a-amylase (1BLI)

Enzymes: Specificity of Substrate

- The reactant an enzyme acts on is referred to as the enzyme's *substrate*
- The enzyme binds to the substrate, thus forming the *enzyme-substrate complex*
- The reaction catalyzed by the enzyme produces *end products*

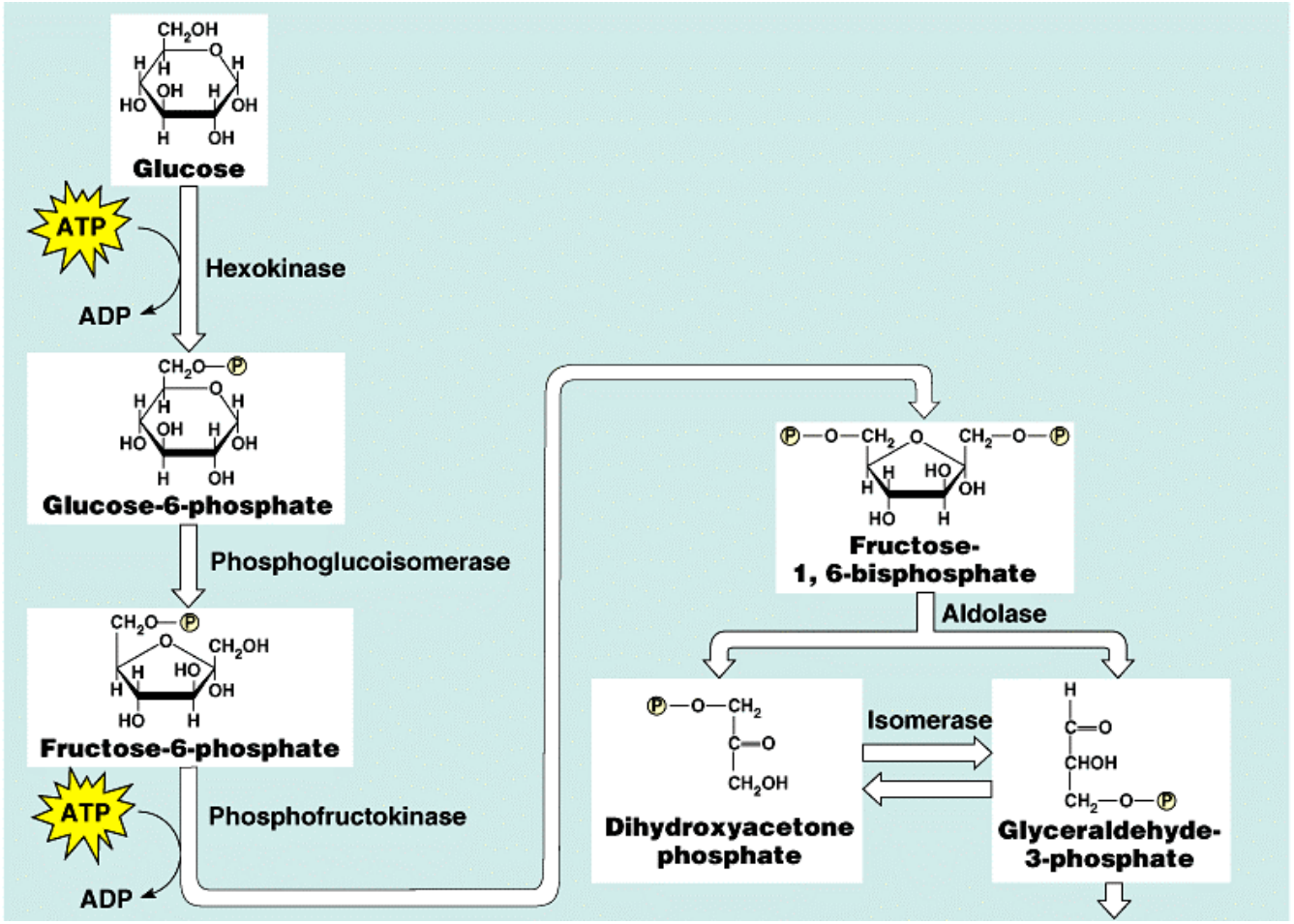
a-amylase



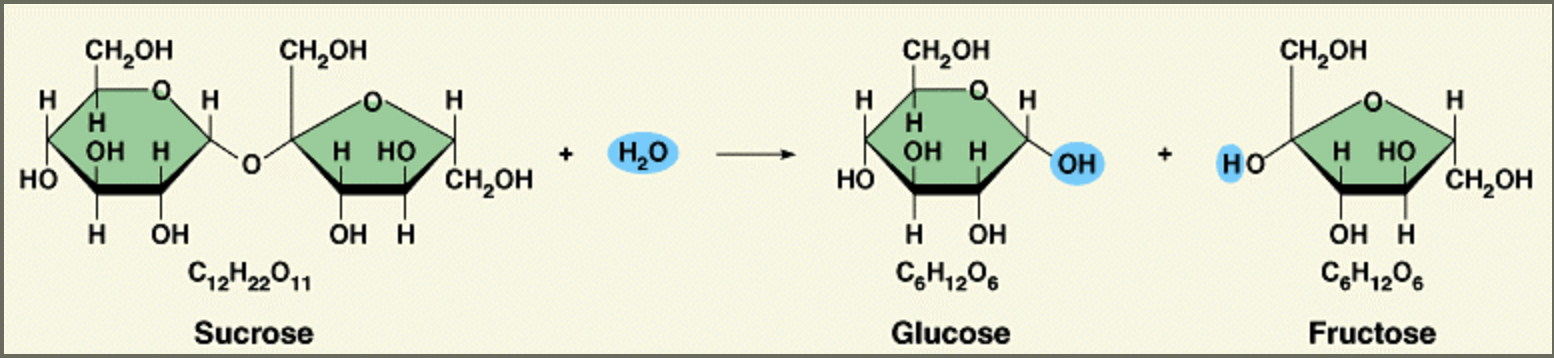
starch

Substrate + Enzyme → End Product (s)

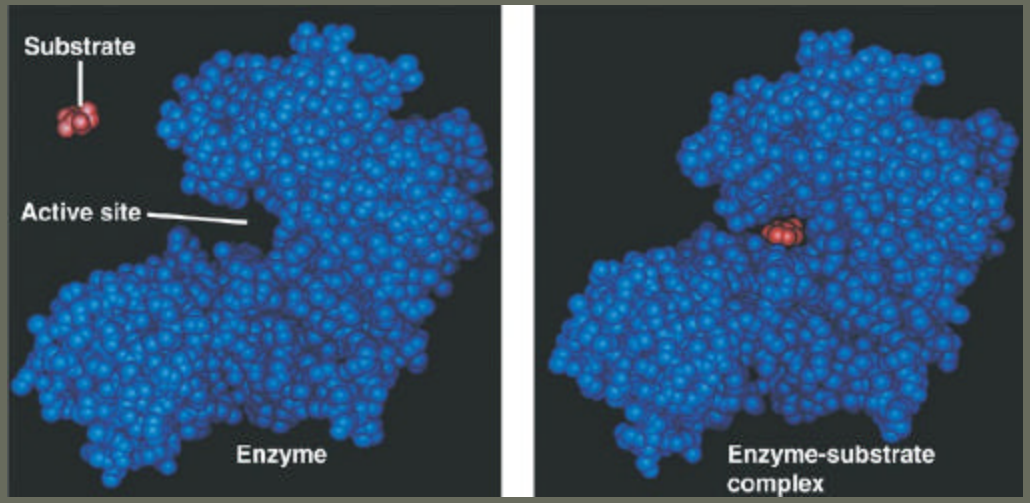
Enzymes: Specificity of Substrate



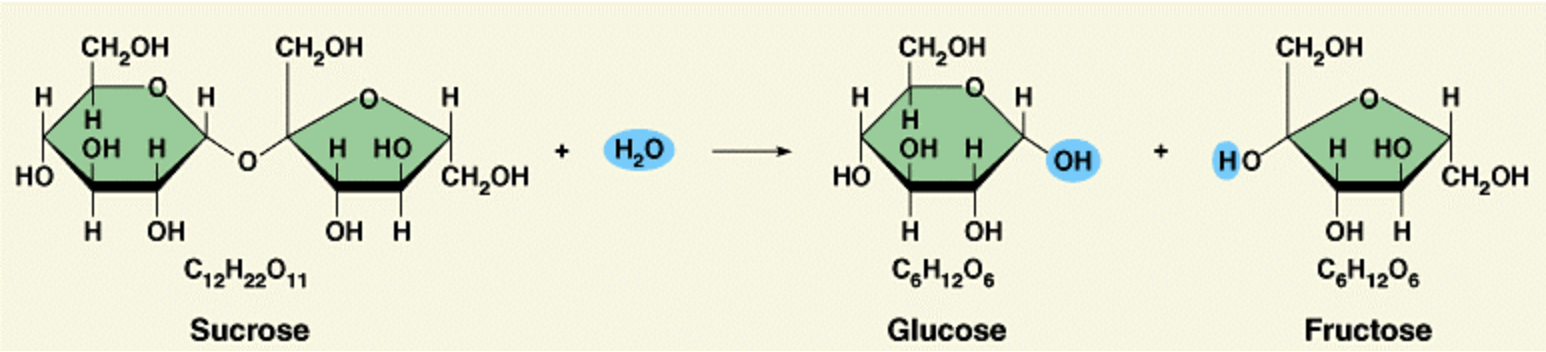
Enzymes: Specificity of Substrate



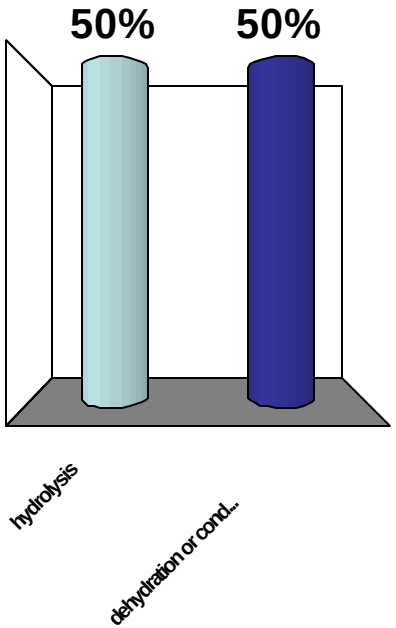
***Sucrase* catalyzes the hydrolysis of sucrose into glucose and fructose**



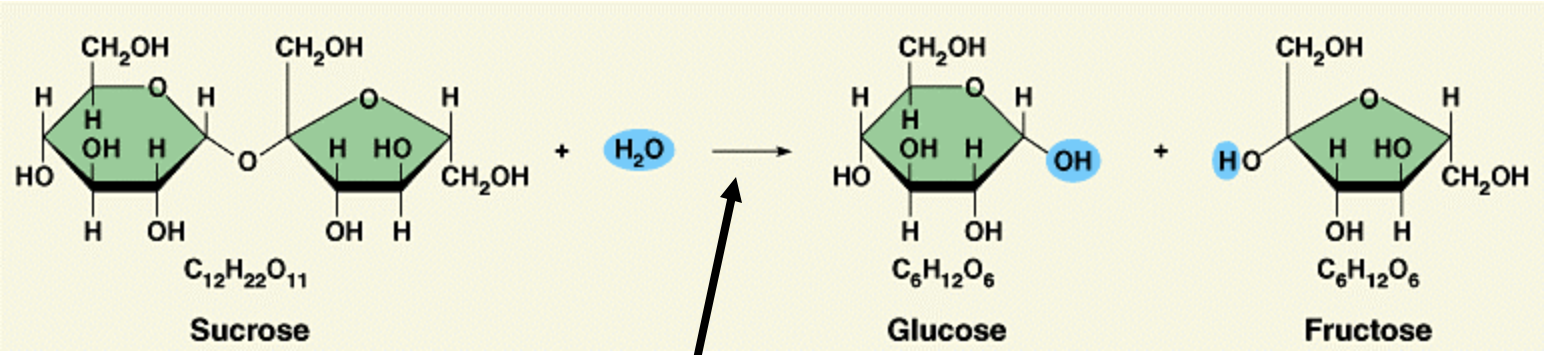
A ___ reaction is shown below.



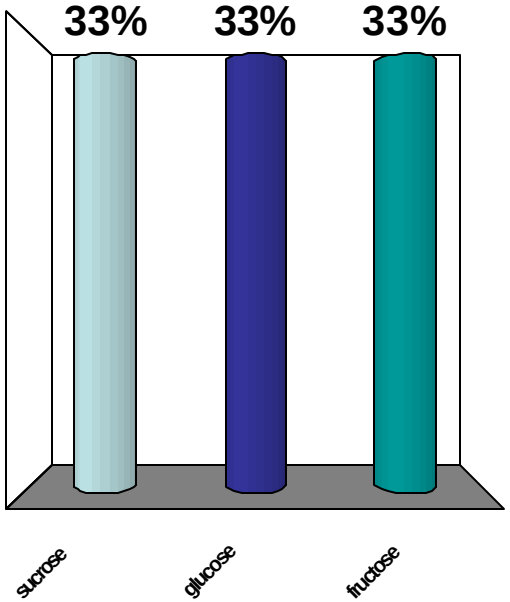
1. hydrolysis
2. dehydration or condensation



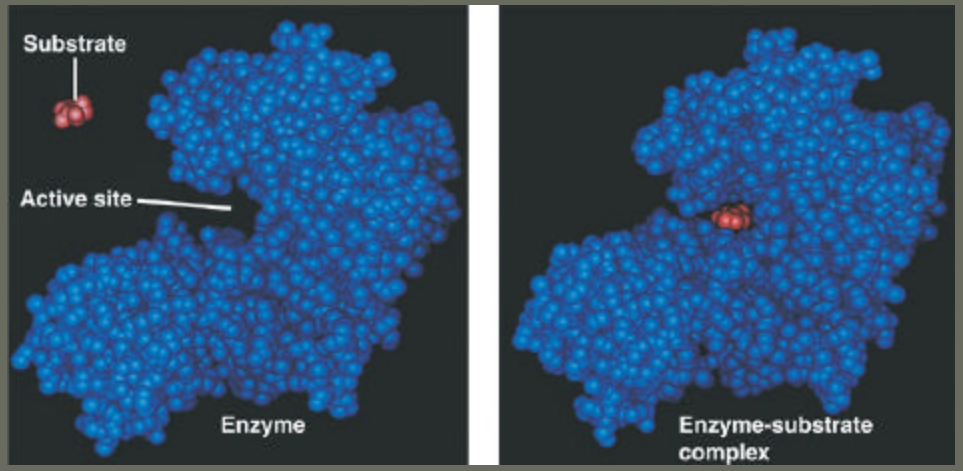
In the reaction below, ___ is sucrase's substrate.



1. sucrose
2. glucose
3. fructose

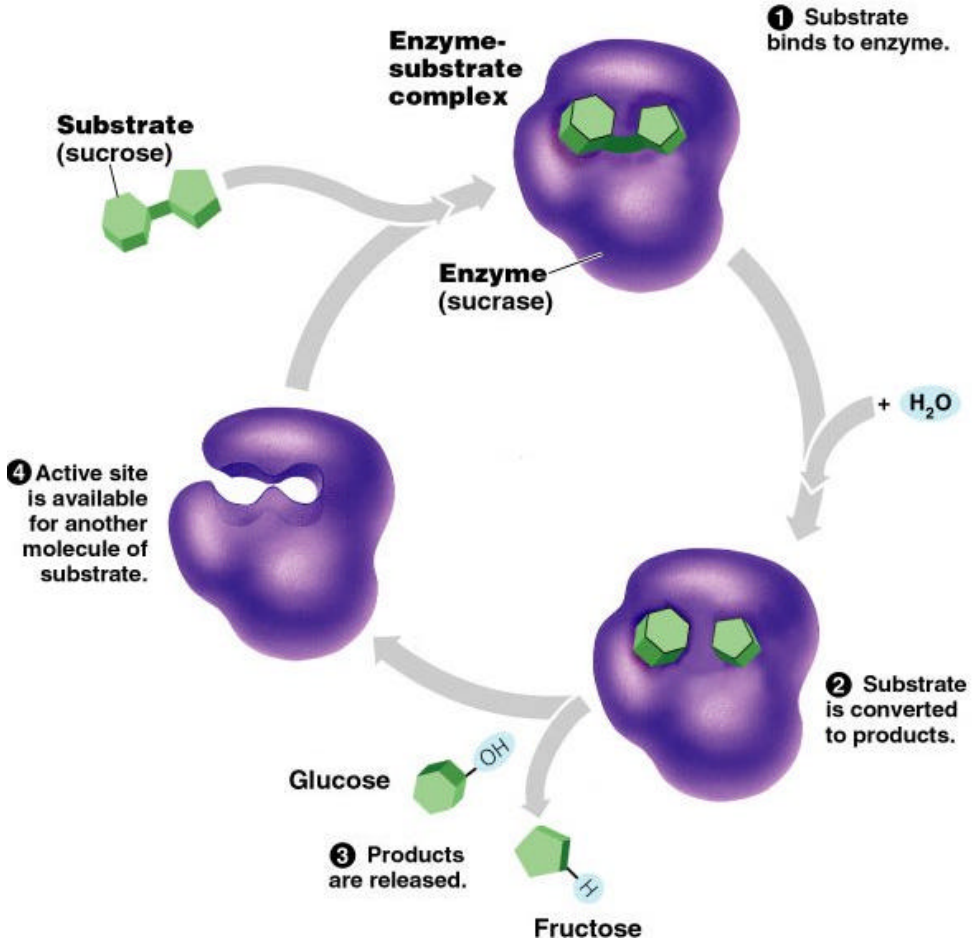


How Enzymes Work: The Active Site



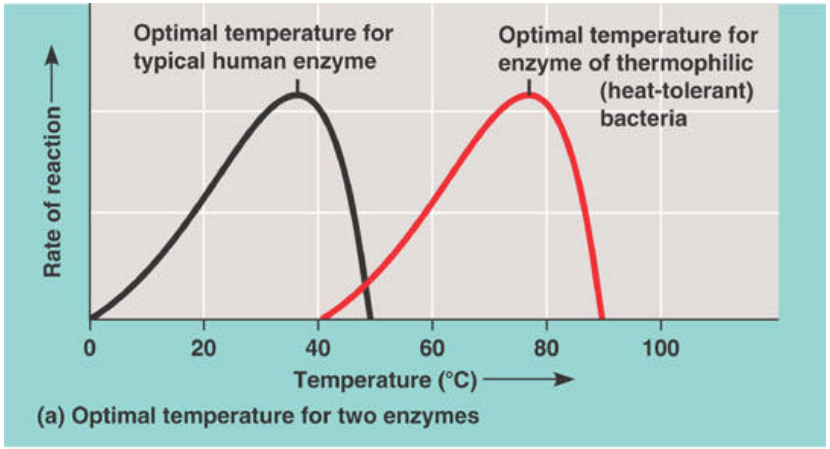
- An enzyme recognizes its substrate through a restricted region of its molecular structure, the *active site*
- The active site fits tightly the substrate's conformation. After fitting, the enzyme-substrate complex forms
- Disrupting the active site's molecular composition or conformation results in the enzyme's inactivation

How Enzymes Work: An Enzymatic Reaction

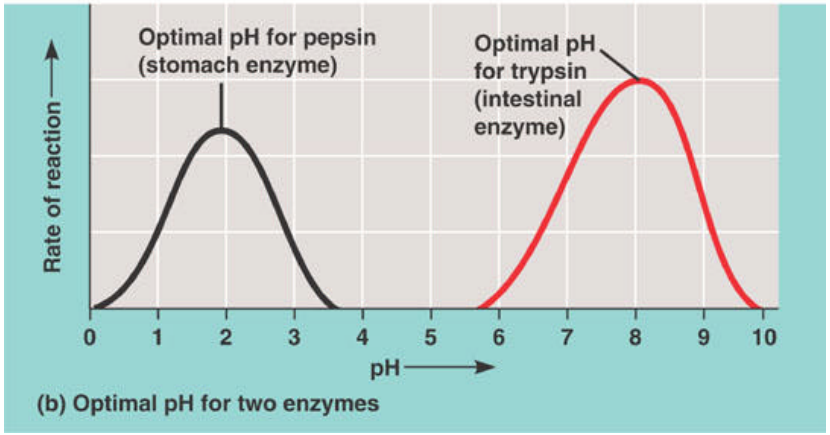


Factors Influencing Enzyme Activity

- **Concentration:** In general, the more concentration of substrate, the more frequently the enzyme's active site interact. However, high concentrations of substrate can saturate the enzyme
- **Temperature and pH:** Enzymes are very sensitive to slight changes of pH and temperature. Each enzyme has an optimal value of pH and temperature to which is most active
- **Enzyme regulation**



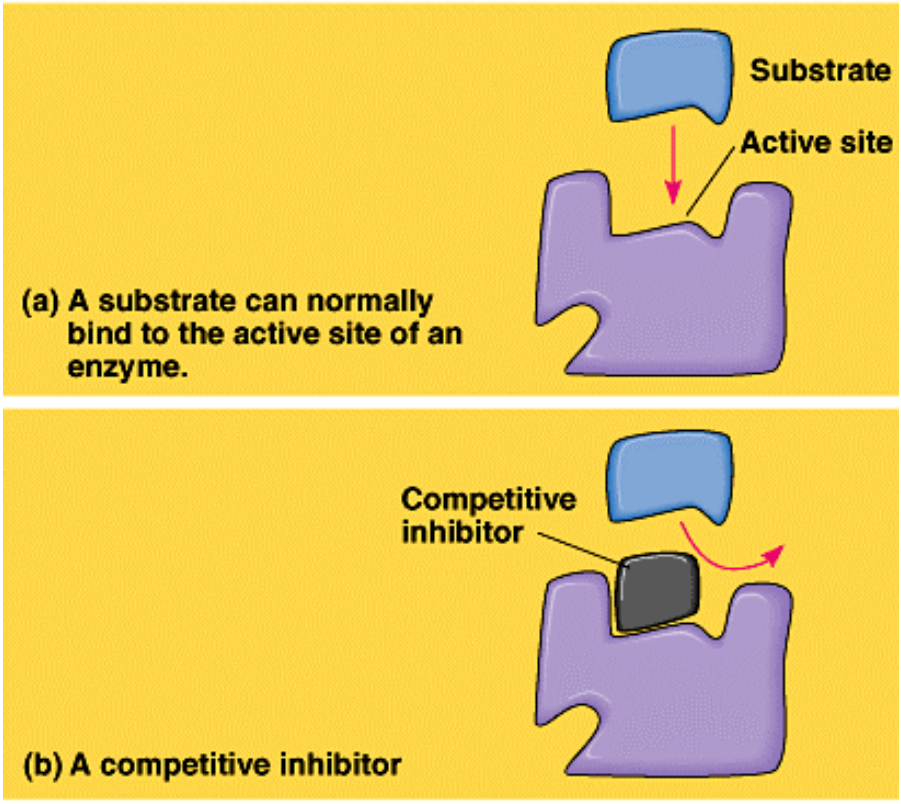
(a) Optimal temperature for two enzymes



(b) Optimal pH for two enzymes

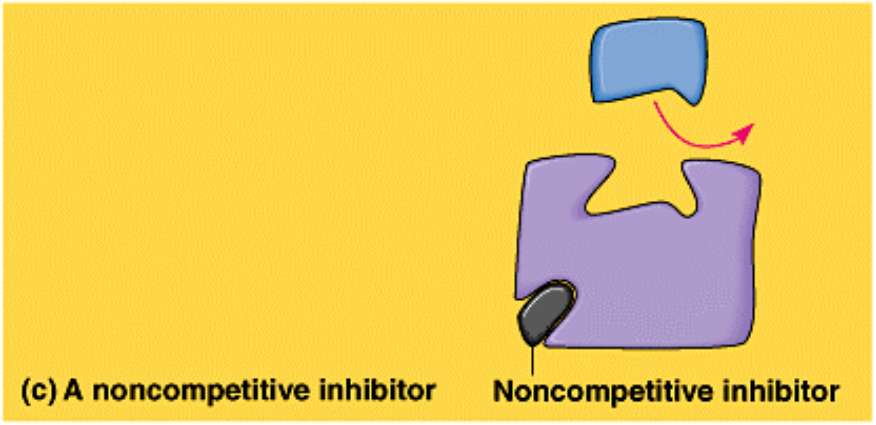
Enzyme Regulation
Competitive Regulation

- Competitive Inhibition of enzyme activity is carried out by a *competitive inhibitor* that binds to the active site, thus blocking the access of the substrate to it



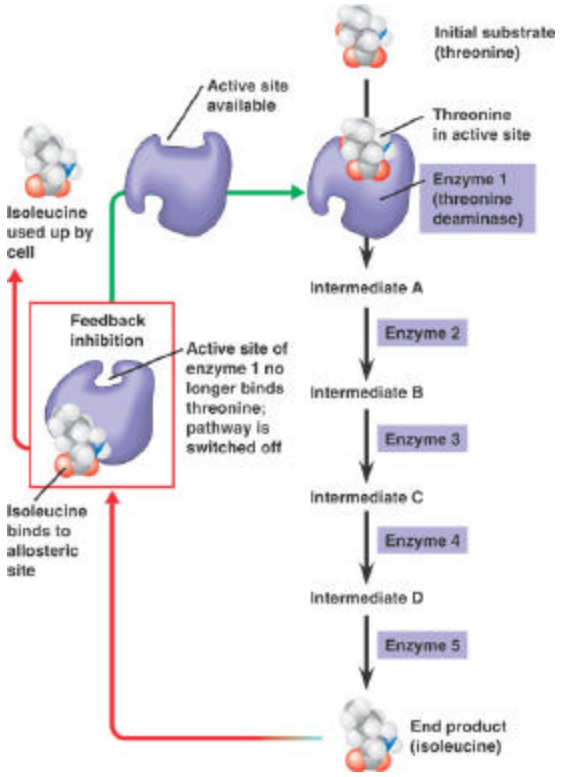
Enzyme Regulation
Non- Competitive or Allosteric Regulation

- Non-competitive or allosteric regulation is carried out by a *non-competitive inhibitor* that binds to a site in the enzyme other than the active site, the so called *allosteric site*
- Non-competitive or allosteric regulators do not compete with the substrate for the active site. They alter the enzyme's conformation
- Allosteric regulation can render rearrangement of the active site (end products are produced), or change of the active site's conformation (blocking of enzyme activity; release of end products ceases)



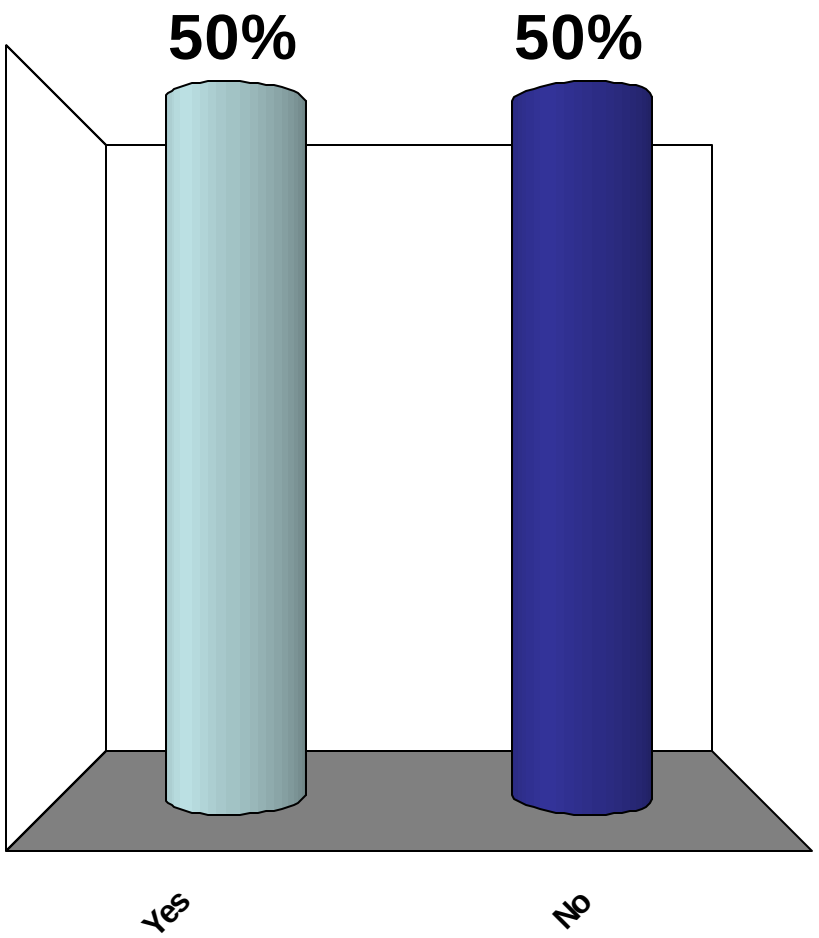
Enzyme Regulation
Feedback Inhibition

- In feedback inhibition, a metabolic pathway is switched off by molecules that regulate the activity of the enzyme or enzymes intervening in the pattern.
- In feedback inhibition, the regulatory molecules are the *end product(s).* They can perform competitive or allosteric inhibition upon the enzyme



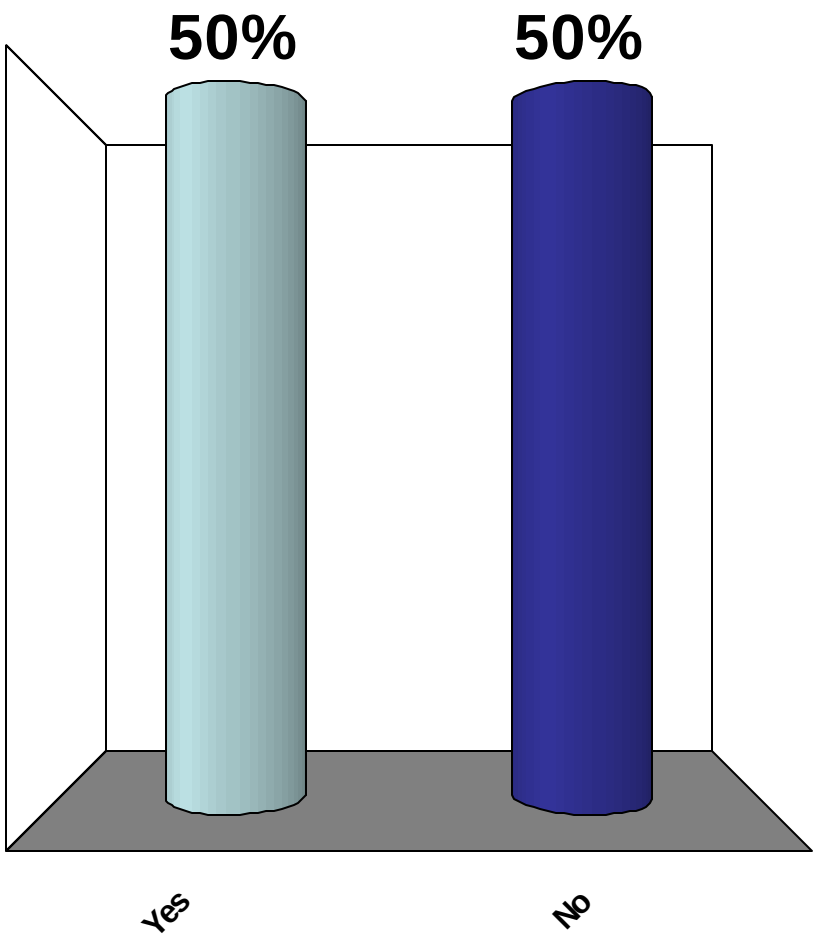
A competitive inhibitor binds to the enzyme's active site. Do you agree?

1. Yes
2. No

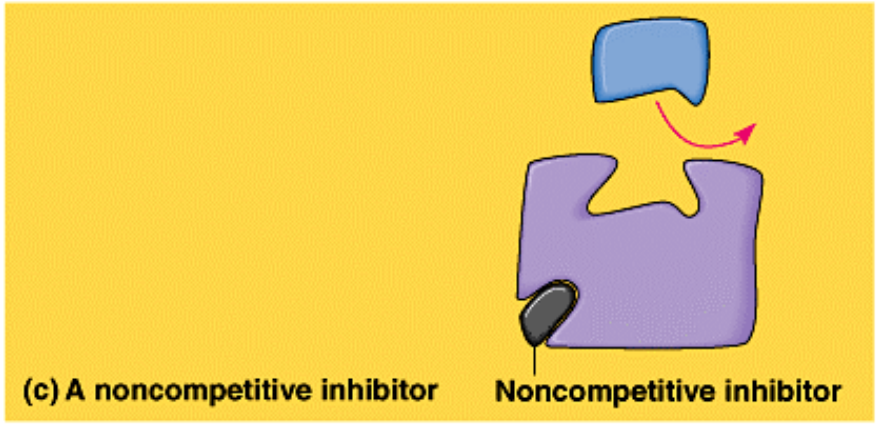


A non-competitive inhibitor binds to the enzyme's active site. Do you agree?

1. Yes
2. No



Allosteric regulation involves a non-competitive inhibitor. Do you agree?



1. Yes
2. No