ENZYMES

- Enzymes are proteins that act as catalysts for metabolic reactions, making the reaction go faster.
- Enzymes work by lowering the energy of activation.
- Each enzyme is specific for a reaction.

•Enzymes are found in all living organisms and most cells contain hundreds of types which are constantly being manufactured and replaced.

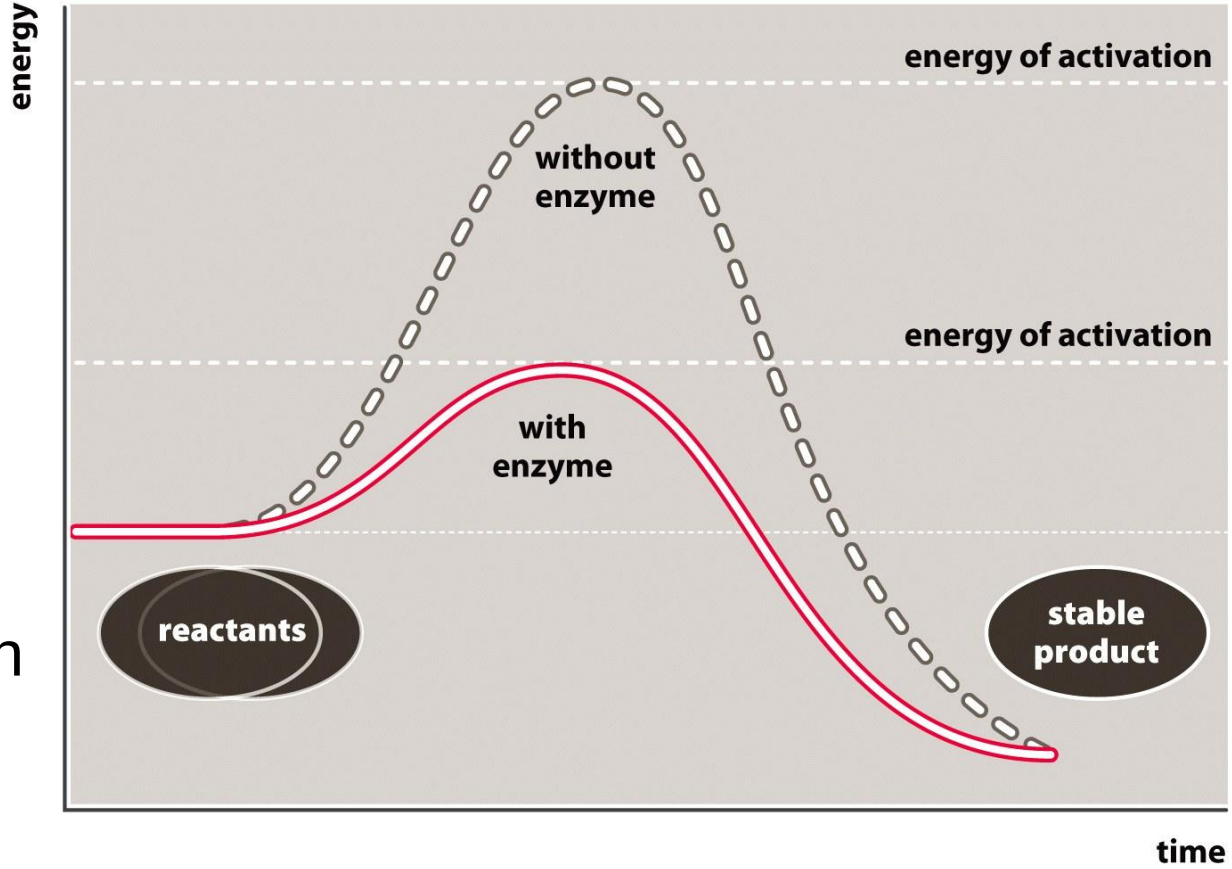


Figure 3.2 Microbiology: A Clinical Approach (© Garland Science)

PROPERTIES OF ENZYMES

- Enzymes are generally highly specific.
  - Some enzymes work with only one substrate, others work with a group of molecules.
    - Succinic dehydrogenase oxidizes only succinic acid
    - A proteolytic enzyme always degrades proteins because it reacts only with peptide bonds.
- The shape and electrical charges found at the active site allow for the reaction to work and are responsible for the enzyme's specificity.

PROPERTIES OF ENZYMES

- Enzymes have specific three dimensional shapes: if the shape changes, activity is inhibited.
- The shape of the molecule provides a importante site called the active site. It is here that:
  - The substrate fits into the enzyme's active site.
  - The enzyme and substrate interact to form the enzyme-substrate complex.
- The active site has to have the proper shape for the enzyme to work.

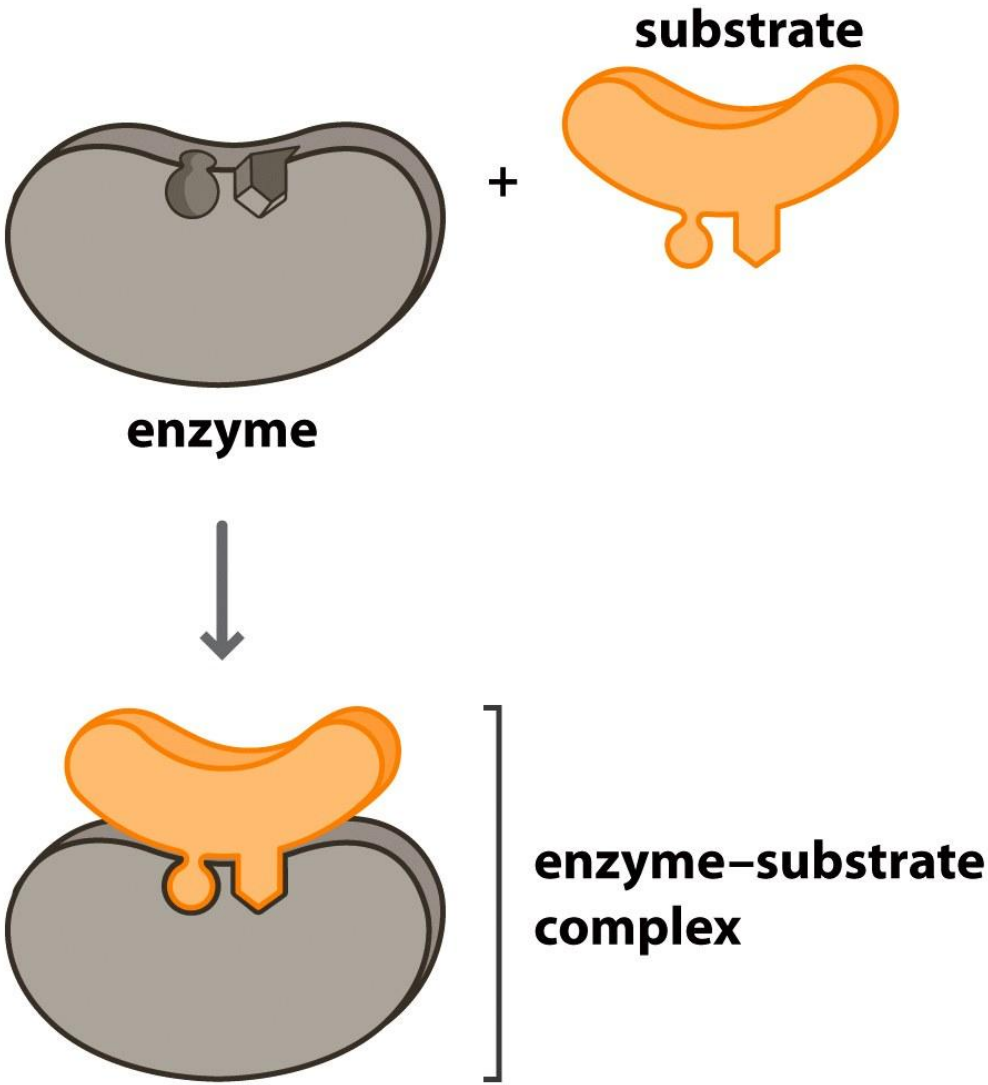


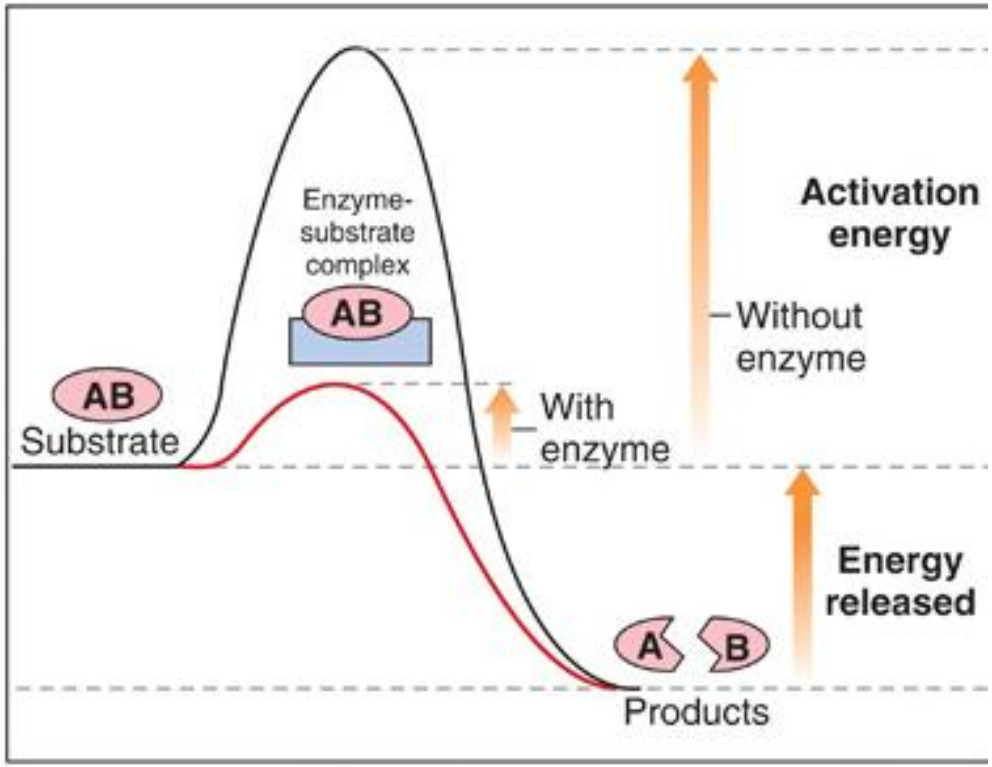
Figure 3.3 Microbiology: A Clinical Approach (© Garland Science)

Enzymes

- **Catalysts** are chemical substances that speed up a reaction without affecting the products.
- Catalysts are not used up or changed in any way during the reaction.
- **Enzymes** are important catalysts in living organisms.

Enzymes

- **Enzymes** reduce the amount of activation energy required for a reaction to proceed.
  - Enzymes are not used up or altered.
  - Products are not altered.
  - Energy released is the same.



COENZYMES AND CO-FACTORS

- Enzymes may be pure proteins or proteins plus **co-factors**
- Co-factors are helper substances that are inorganic ions such as magnesium, zinc, or manganese.
- Coenzymes are helper substances that are non-protein organic molecules.
- Co-factors or coenzymes bind to the active site and change the shape of the active site so the substrate now fits.

COENZYMES AND CO-FACTORS

- Coenzymes and co-factors can also be used as carrier molecules.
  - When a carrier molecule receives either electrons or hydrogen atoms, it becomes reduced.
  - When a carrier molecule releases electrons or hydrogen atoms, it becomes oxidized.

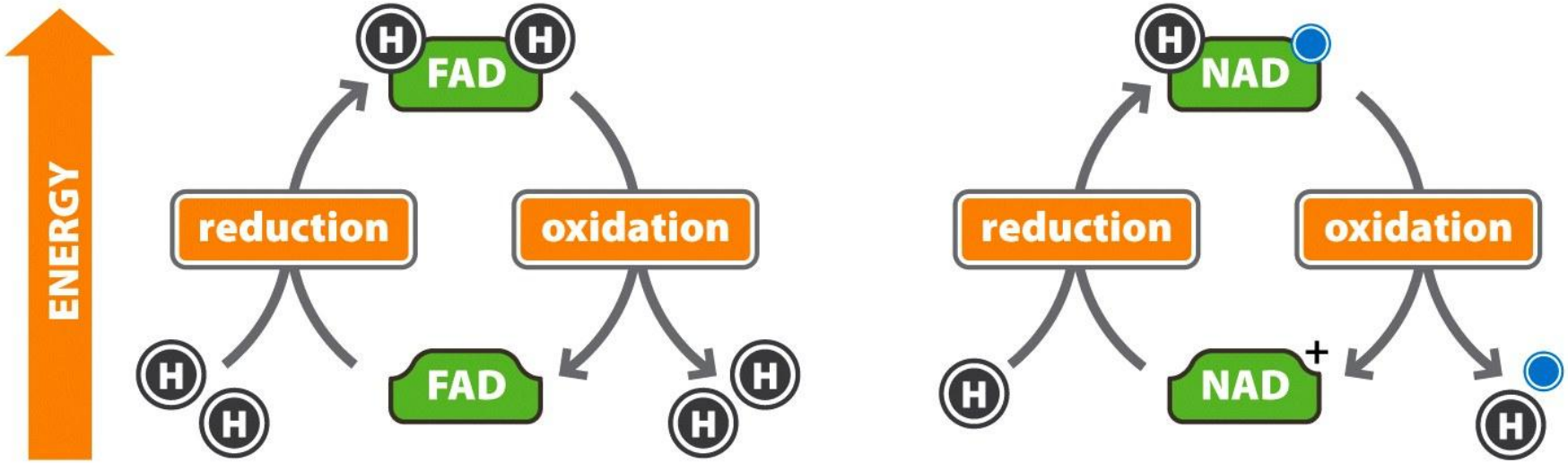


Figure 3.5 Microbiology: A Clinical Approach (© Garland Science)

COENZYMES AND CO-FACTORS

- Two coenzyme carrier molecules frequently encountered in biological reactions are:
  - NAD^+ = nicotinamide adenine dinucleotide
  - FAD = flavin adenine dinucleotide.

ENZYME INHIBITION

- Enzyme inhibition takes place in three ways:
  - Competitive inhibition
  - Allosteric inhibition
  - Feedback inhibition

COMPETITIVE INHIBITION

- The inhibitor molecule is similar in structure to the substrate and competes with the substrate to bind to the active site.
- When the inhibitor has bound to the active site, the substrate cannot bind.
- The binding dependent upon the relative numbers of inhibitor molecules and substrate molecules present.

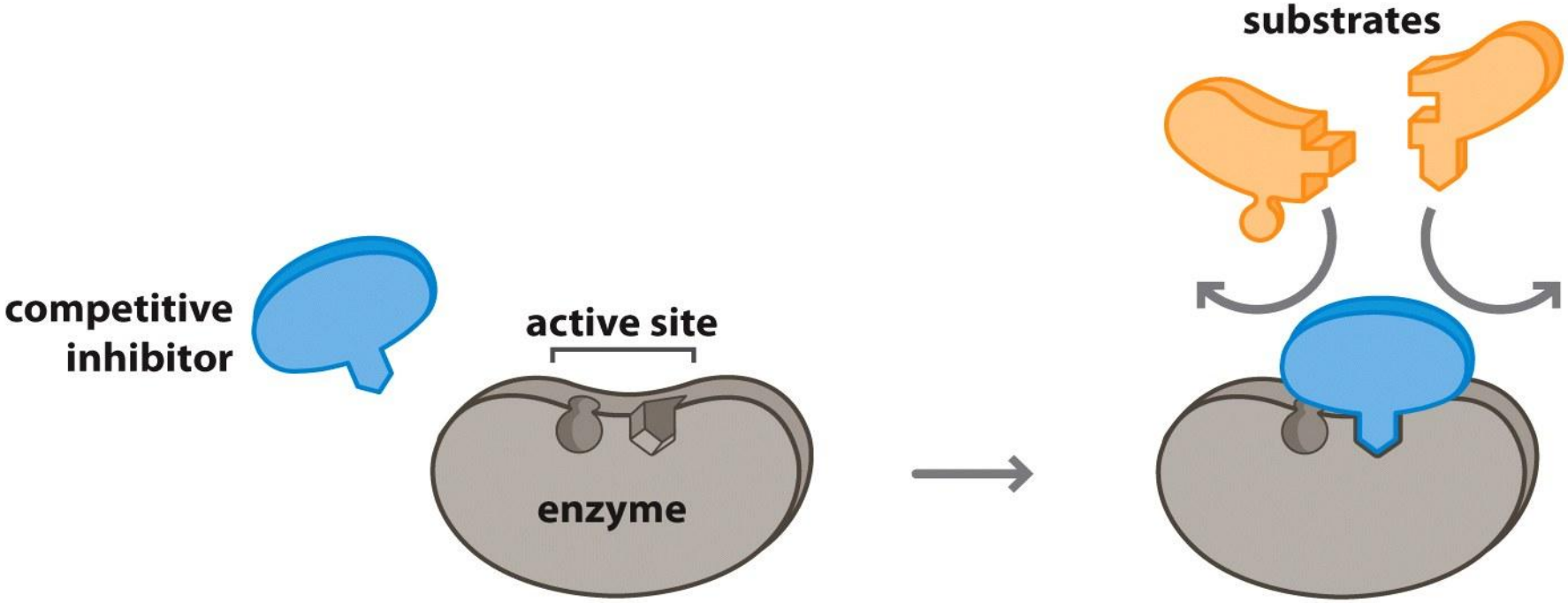


Figure 3.6 Microbiology: A Clinical Approach (© Garland Science)

ALLOSTERIC INHIBITION

- Inhibitor molecules bind to a part of the enzyme away from the active site: the allosteric site.
- This binding changes the shape of the active site in such a way that it can no longer fit properly with the substrate.

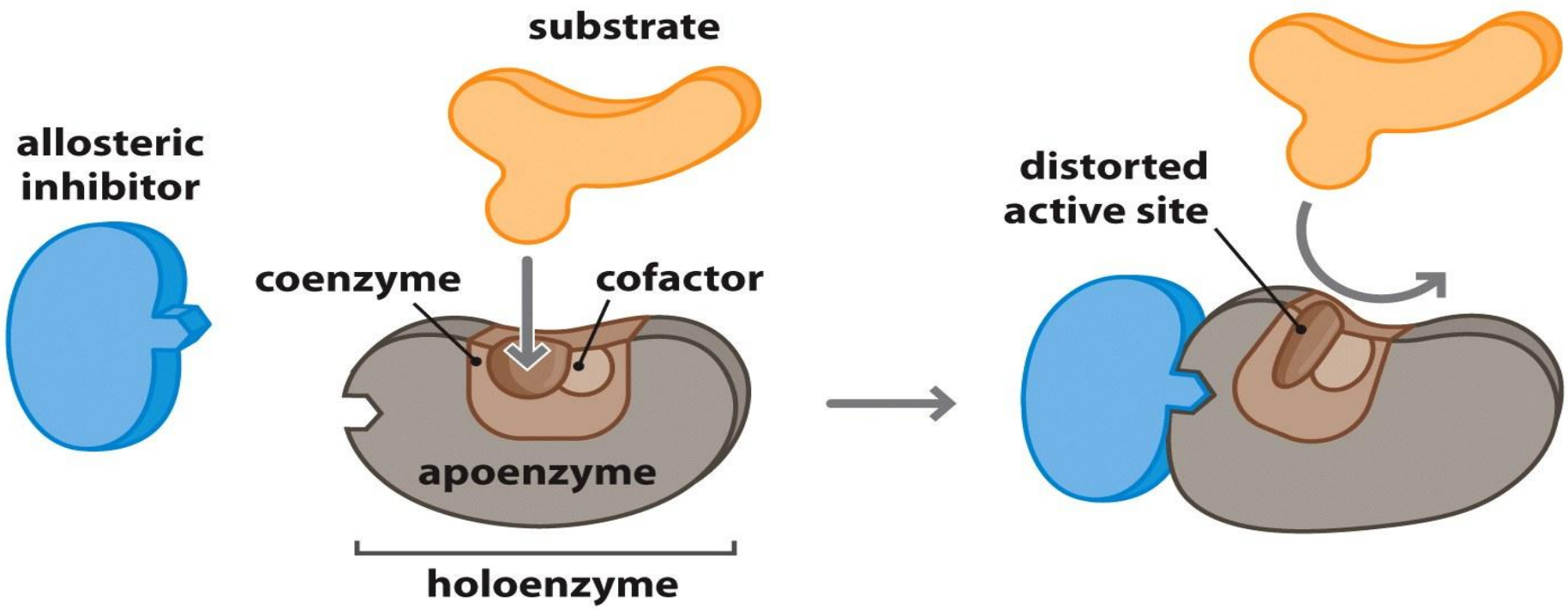


Figure 3.7 Microbiology: A Clinical Approach (© Garland Science)

FEEDBACK INHIBITION

- The final product in a pathway accumulates and begins to bind to and inactivate the enzyme

- when the level of end product decreases, the inhibition stops and the enzyme begins to function again.

Continue…

- Example: Inhibitors are often used as drugs, in many cases to prevent detrimental reactions in an organism. Aspirin, inhibits the enzymes that causes pain and inflammation.
- However, inhibitors can also be poisonous. Cyanide is a lethal toxin because it competitively inhibits cytochrome coxidase, an enzyme involved with cellular respiration.

FACTORS THAT AFFECT ENZYME REACTIONS

- Three major factors affect enzyme activity:
  - Temperature – Can break hydrogen bonds and change shape
  - pH – Can break hydrogen bonds and change shape
  - Concentration of substrate, product & enzyme – Lower numbers of substrate, product, and enzyme molecules means a lower level of activity.