Enzymes

TEKS and S.E.s

- B.9C identify and investigate the role of enzymes

Vocabulary

- Enzyme
- Catalyst
- Substrate
- Active site
- Substrate-enzyme complex
- Activation energy
- Inhibitor
- Catabolic
- Anabolic
- Reactant
- Product

Prerequisite Questions

- What type of biomolecule makes up an enzyme?
- What is a chemical reaction?
- What is the reactant in a chemical reaction?
- What is the product in a chemical reaction?

Essential Question

- How is an enzyme’s function connected to its structure?

WHAT is an enzyme? HOW do they work?

THE BIG IDEA:

- An **ENZYME** is a **PROTEIN** that functions as a catalyst to **SPEED UP** a **CHEMICAL REACTION** in an organism;

- Enzymes are biological catalysts.
  - Catalyst speed up reactions.
  - These reactions would take place anyway… the enzymes just speed them up!

- Catalysts are NOT used up in the chemical reaction, rather it is recycled and used over and over again

4 CHARACTERISTICS of Enzymes –

1. **Enzymes do not make anything happen** that couldn't happen on its own, just makes it happen faster.

2. **Enzymes are not used up in reactions**. They can be used over and over again!

3. **Enzymes are highly specific:** each enzyme catalyzes a specific chemical reaction, acting on a specific **substrate**

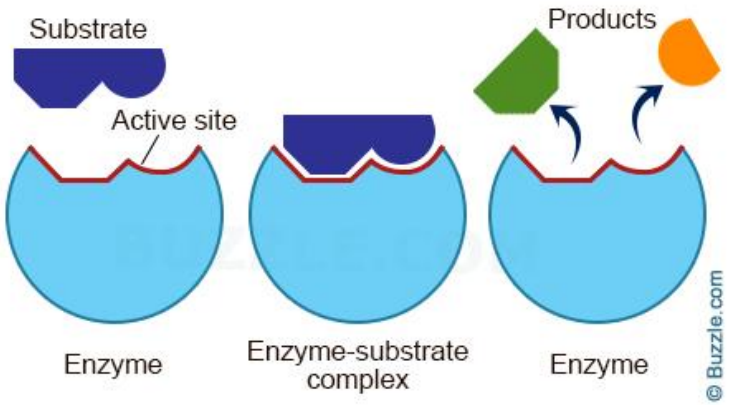
4. **Enzymes are only needed in small amounts**.

How is an enzymes shape related to its function??

THE BIG IDEA: An **enzyme's STRUCTURE DETERMINES** its **FUNCTION**!!!!

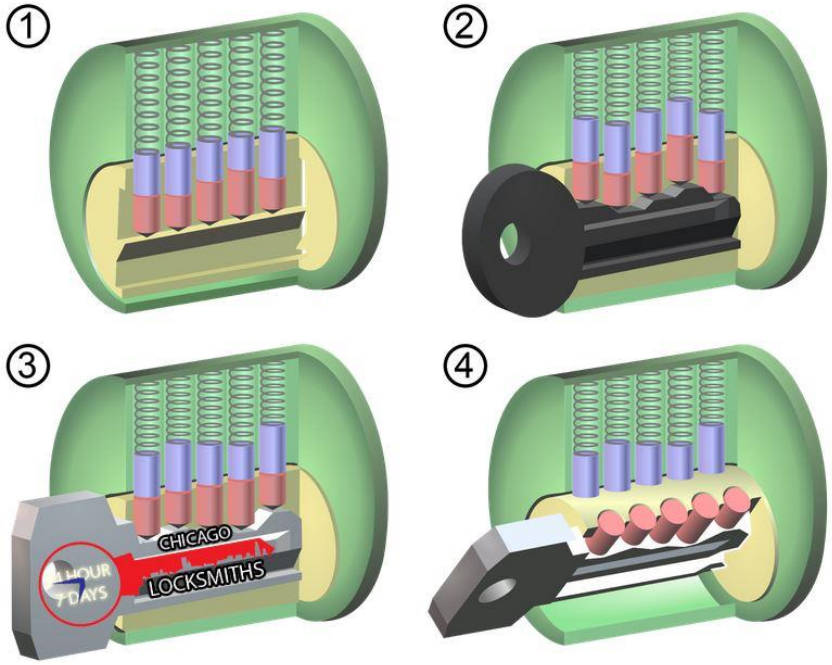
- The part of the enzyme that binds to the substrate is called the **active site**. The active site has a shape that precisely **matches** the shape of the molecule to be reacted, called the **substrate**.

- When the substrate and enzyme bind temporarily, an **enzyme-substrate complex** is formed.



“Lock and Key” Analogy

- Enzyme specificity is often described using the “**lock-and-key**” model of enzyme action:
  - The shape of the enzyme’s **active site** (the “Key’s teeth”) determines which **substrate** (which “Lock”) will “fit” with the enzyme.
  - If the **substrate** (“lock”) doesn’t match with the **active site** (“key”), the enzyme cannot catalyze the chemical reaction

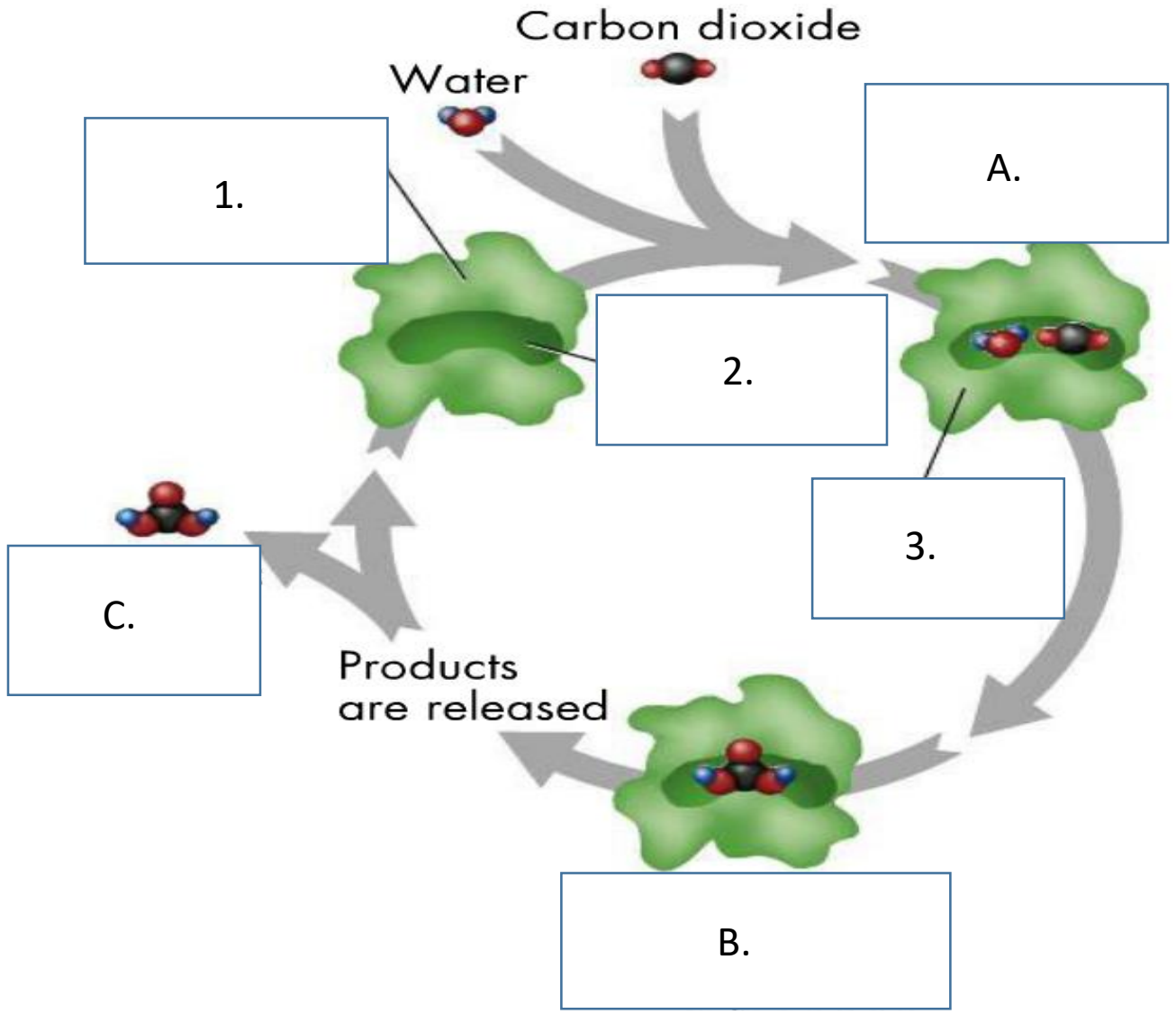


You try:

With a partner, see if you can describe what is happening at each step (letters) AND label the following parts (numbers)

Word Bank:

- **Enzyme**
- **Enzyme-Substrate Complex**
- **Active Site**
- **Substrates bind to the active site**
- **Products are released**
- **Substrates are turned into products**



Remember these **key ideas**…

- The **SUBSTRATE** is the **REACTANT** in the chemical reaction that is catalyzed by the enzyme, the substance that is CHANGED
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- The **ACTIVE SITE** is the region on the enzyme where the substrate attaches; the shape of the active site determines which substrates the enzyme can bind.
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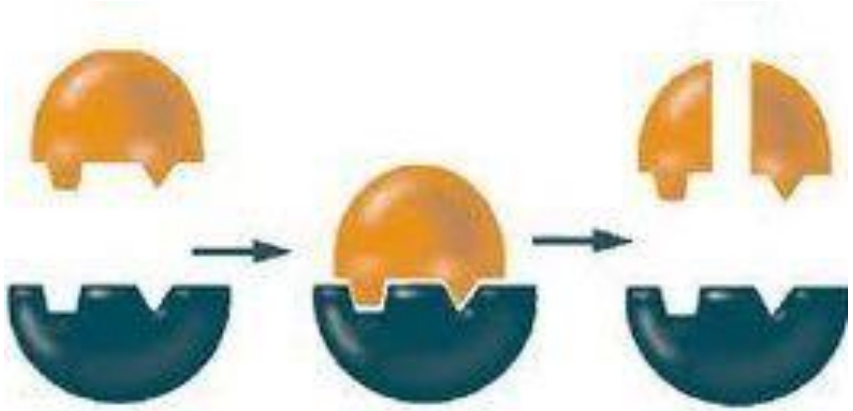
- **Imagine a KEY (the ACTIVE SITE) fitting a LOCK (the SUBSTRATE).**

- The **PRODUCT** is what you end up with after the chemical reaction has occurred.

Enzyme Classification

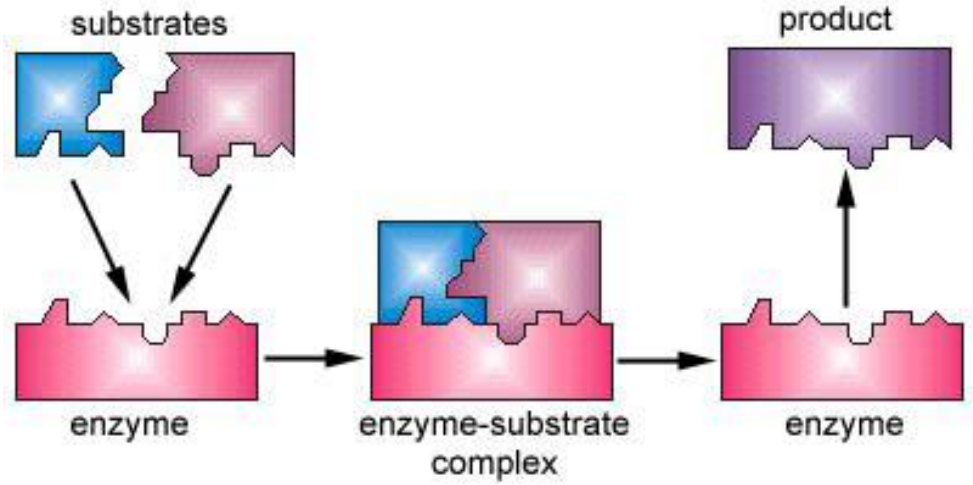


Catabolic Reaction

Bonds are being broken

Anabolic Reaction

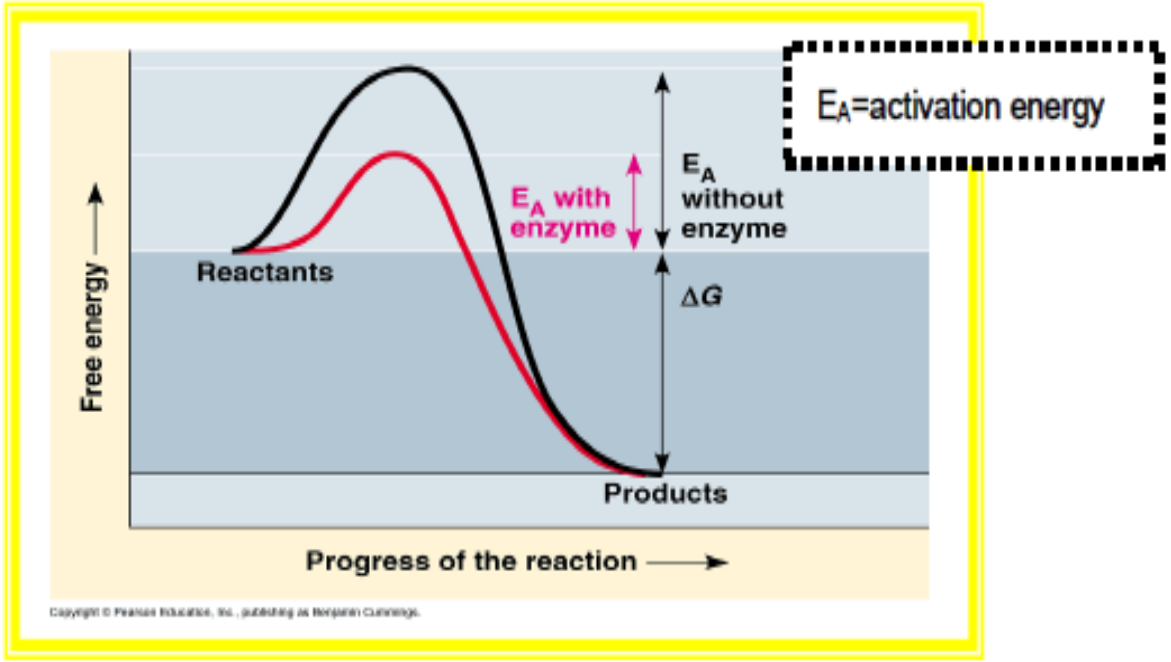
Bonds are being created

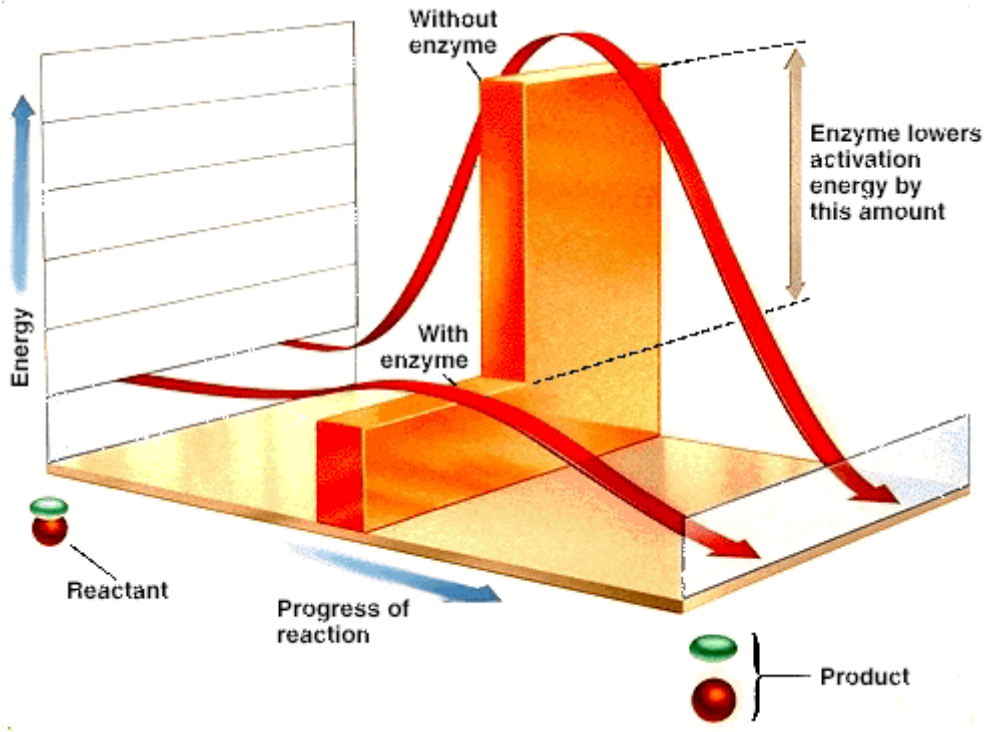


HOW do enzymes CATALYZE chemical reactions??

- Enzymes **speed up** the rate of chemical reactions by **lowering the required activation energy** (the amount of energy needed to start the reaction).

Increase rate
Decrease energy





- The **activation energy** needed for the reaction to occur is **reduced**.

- After the reaction is complete, the substrate has formed a **new product or products** and the **enzyme** is released to be **reused.**

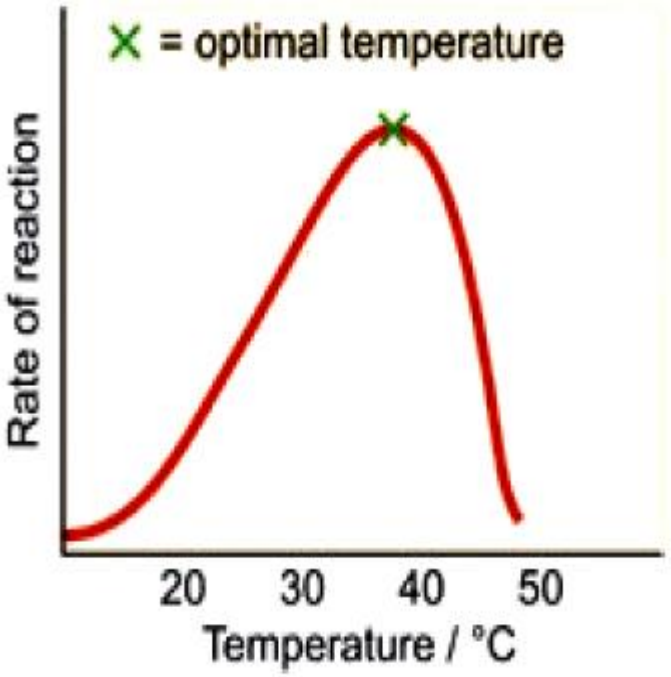
What environmental FACTORS can affect an ENZYME'S FUNCTION?

1. **Temperature:**

- **THE BIG IDEA**: Enzymes function optimally at certain temperatures.

- **BUT, if it gets TOO HOT, the enzyme becomes "DENATURED"** as the heat "cooks" the protein.

- **OPTIMAL TEMPERATURE** for an enzyme is when enzyme "works best."

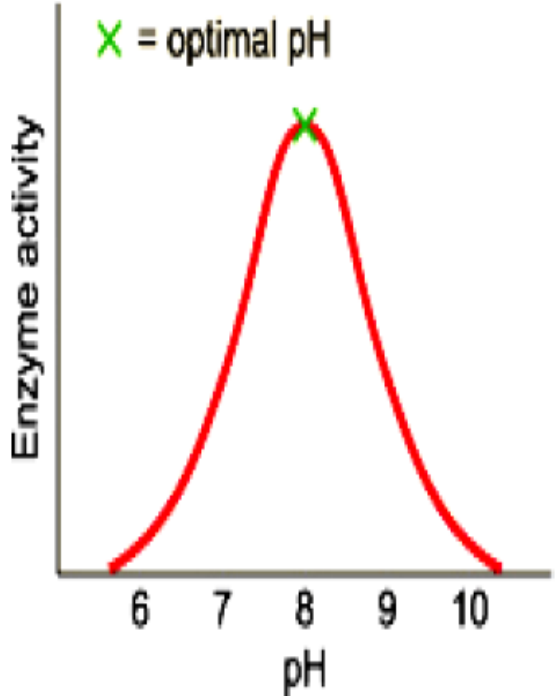


2. **pH (a measure of acidity)**

THE BIG IDEA: Enzymes function optimally at a certain pH.

- **If the pH is too low (too acidic) or too high (too basic), the enzyme becomes "DENATURED"**

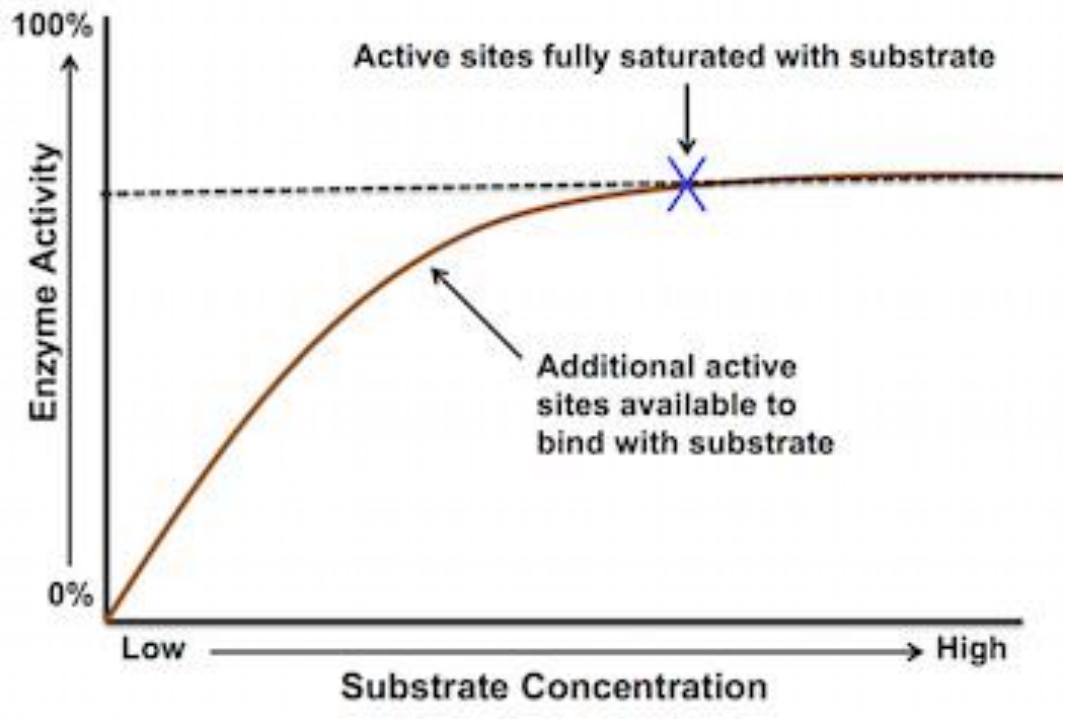
- **OPTIMAL pH** for an enzyme is the pH at which is when it "works best



3. Concentration of substrate

- Reaction rate increases as the substrate concentration increases up to a point

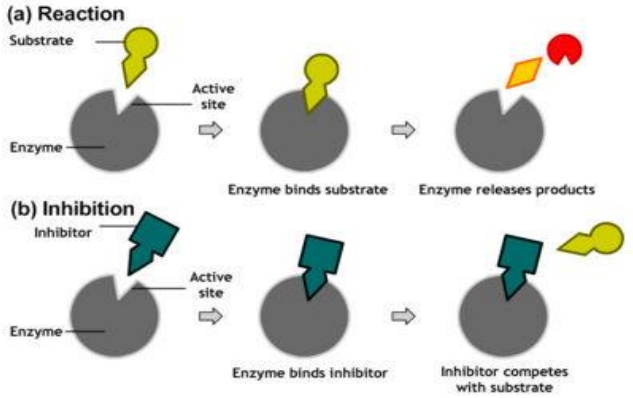
- The limiting factor in the reaction may be the amount of substrate or the amount of enzyme available



4. Inhibitor Molecules

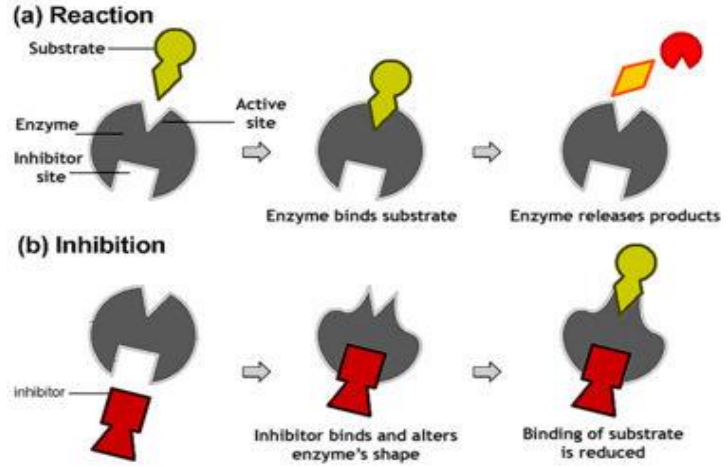
a. Competitive inhibitors

- Attach to enzyme's active site
- Shape is similar to substrate
- Compete with the substrate
- Often the end product of the reaction

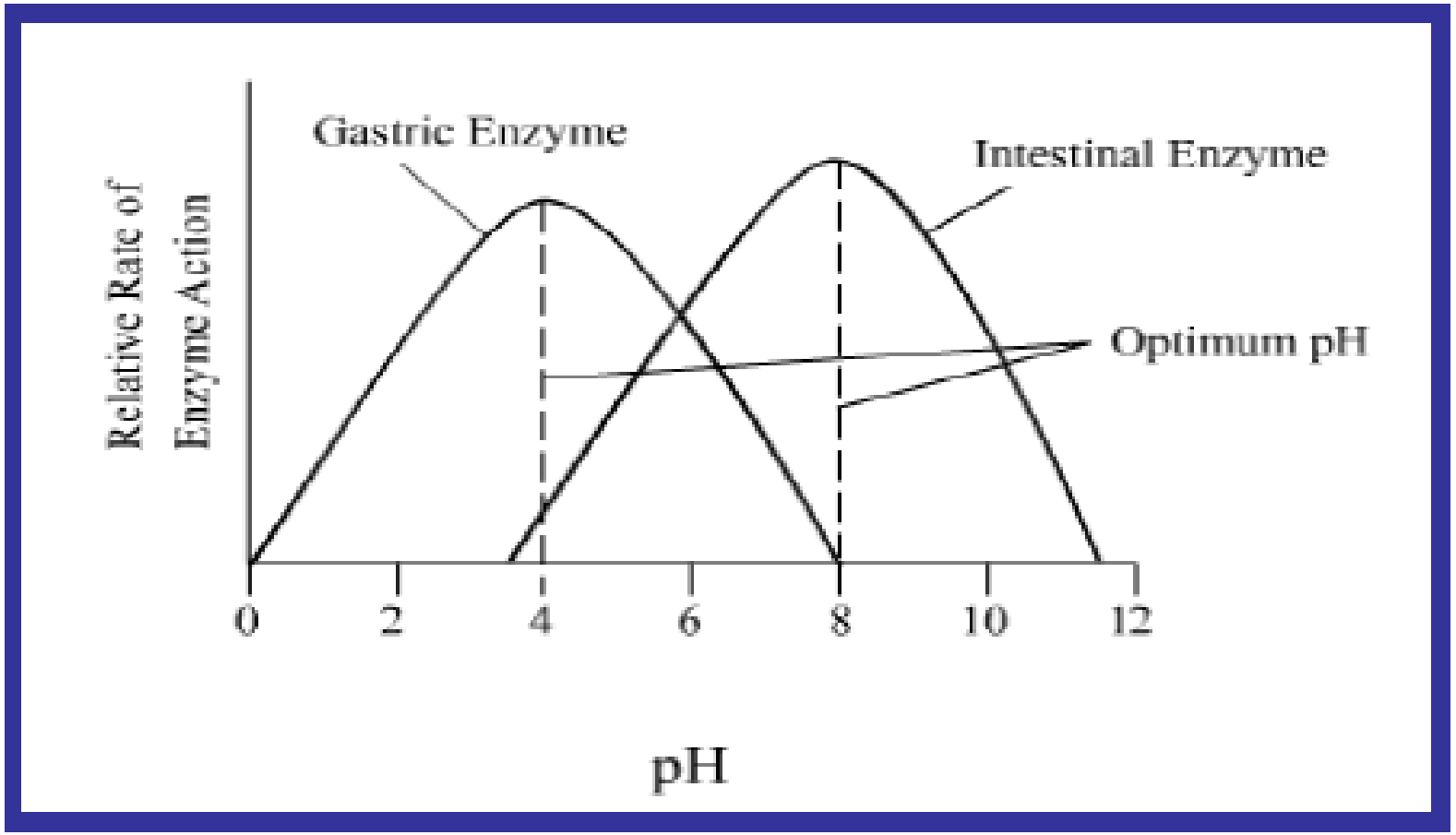


b. Non-competitive inhibitors

- Attach elsewhere on the enzyme (not the active site)
- Attachment changes the 3D shape of enzyme
- Reaction still occurs, but is inhibited

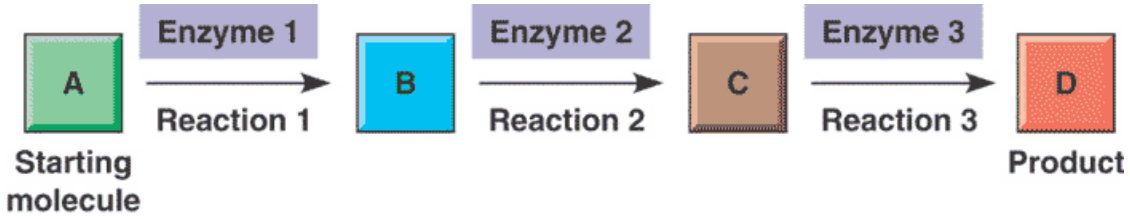


Based on the graph below, come up with two observations that are related to enzyme activity.



Concept Mastery Questions:

- Why are enzymes so specific to the reaction they mediate?
- What implications do inhibitors have on enzymatic activity?
- How do enzymes speed up chemical reactions?
- What happens to a biochemical process if one of the enzymes are denatured?



What would happen to the products (in boxes) if enzyme 2 is denatured?