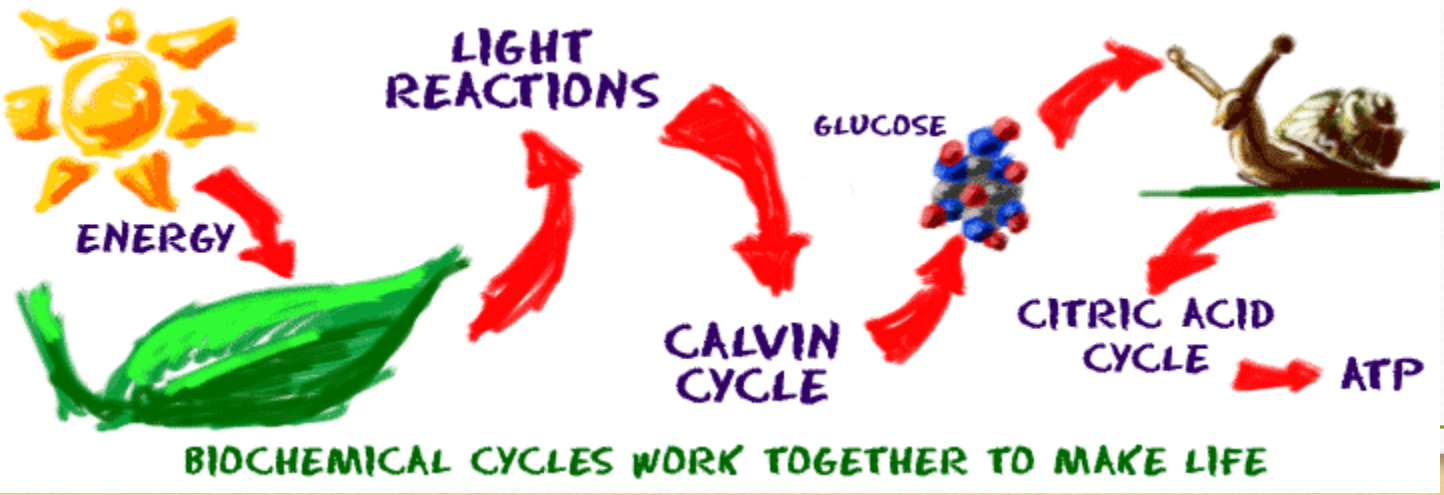
Unit 2 Topic 4: Enzymes

- By the end of this topic, students should be able to…
  1. Identify the components of a chemical reaction (products and reactants/substrates)
  2. Construct a graph detailing enzyme reaction data
  3. Describe the function of an enzyme
  4. Explain the importance of shapes in active sites on an enzyme
  5. Explain how enzymes speed up chemical reactions (act as biological catalysts)

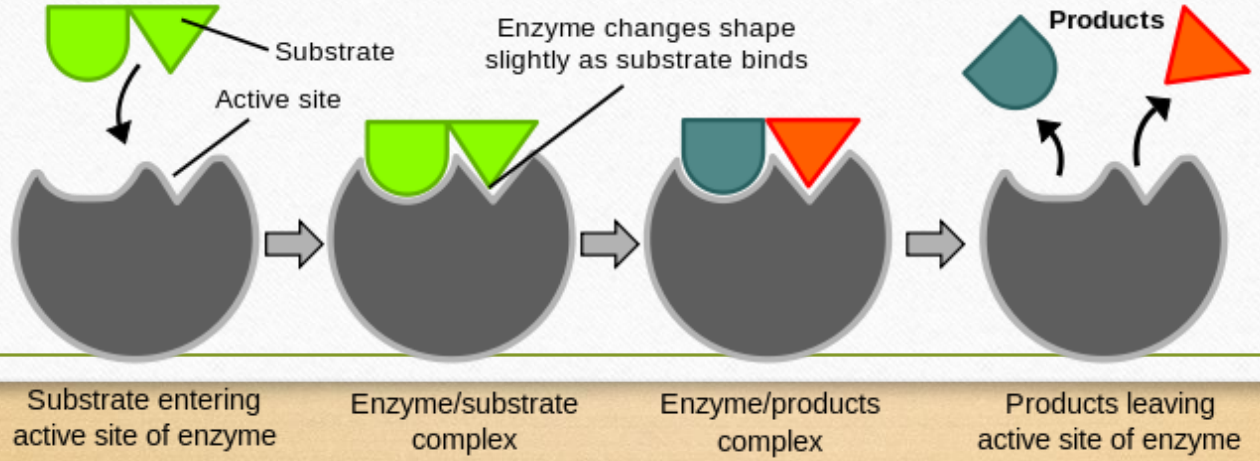
Why Study Chemistry in Biology?

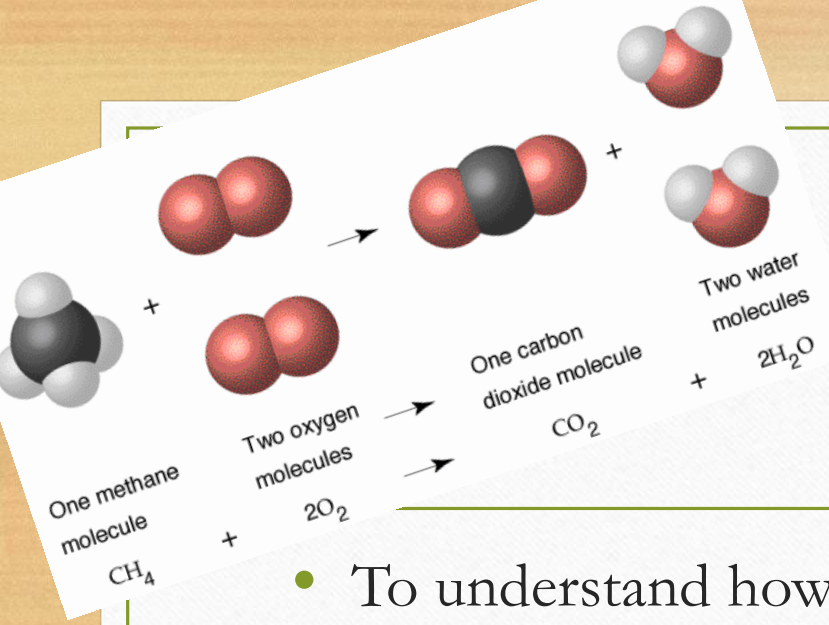
- In order to understand how an organism functions, we need to understand the reactions that take place in that organism.
  - Growth, response to stimuli, sensing, taking medicine to control regulation… all of this is chemistry!



Enzymes

- Enzymes are **proteins** that act as biological catalysts. (often end in –ase)
  - Living things produce enzymes to act as catalysts
  - Catalysts speed up chemical reactions
    - Catalysts **do not change** during a reaction… so they can be used over & over again *unless* their form/shape changes





Chemical Reactions

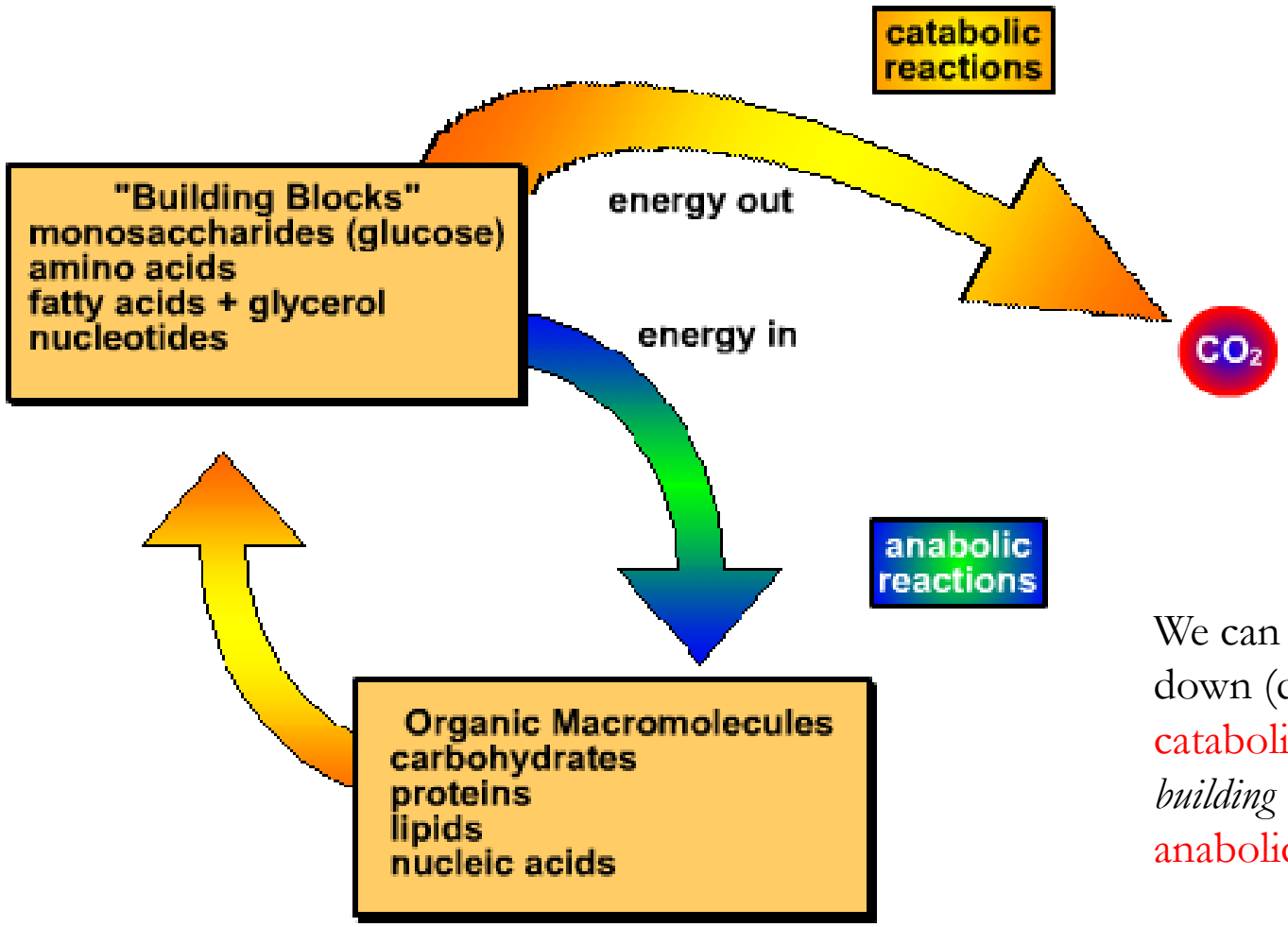
- To understand how enzymes speed up chemical reactions, we need to know what chemical reactions are.
  - Chemical reaction: process that changes **reactants** into **products** by breaking the bonds in the reactants and forming bonds in the products
    - Reactants: what you start with
    - Products: what you end with

**In chemical reactions, you can either put reactants together or break them apart. Your product can be one final product or many individual pieces.*

Energy in Reactions

- Metabolism is the sum of all chemical reactions that take place in a living thing
  - Metabolic pathways: product from one reaction is the substrate (reactant) for the next
- Catabolism: chemical reactions where complex molecules are broken down into simpler molecules
  - Usually **release energy** to drive these reactions
- Anabolism: chemical reactions where simpler molecules are combined to form more complex molecules
  - Usually **require energy**

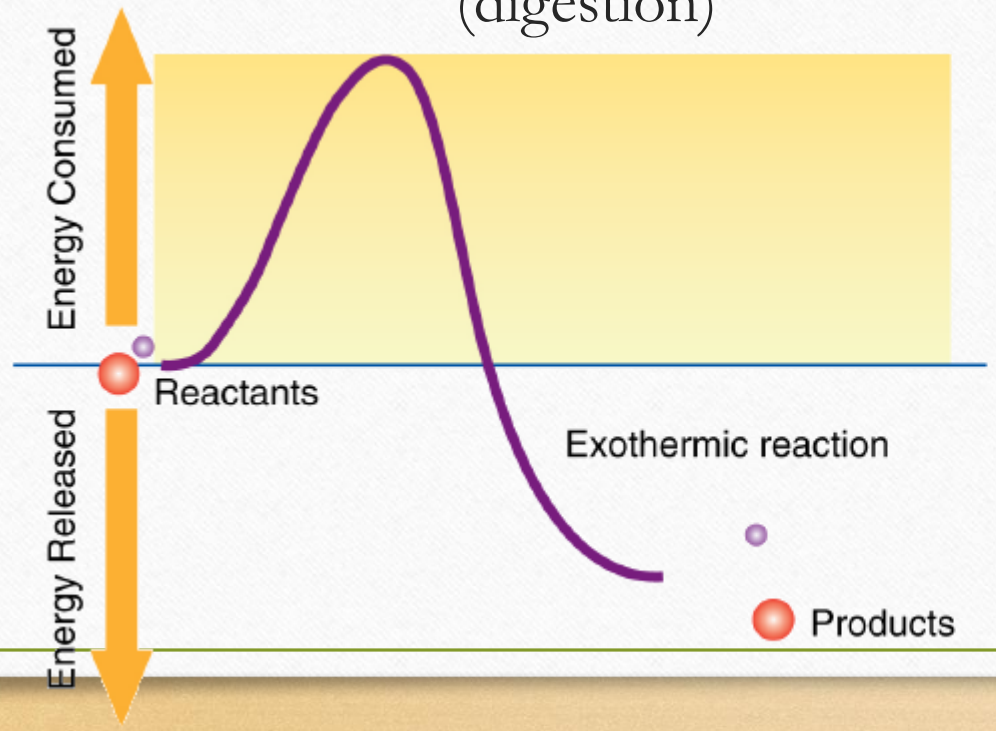
Metabolism



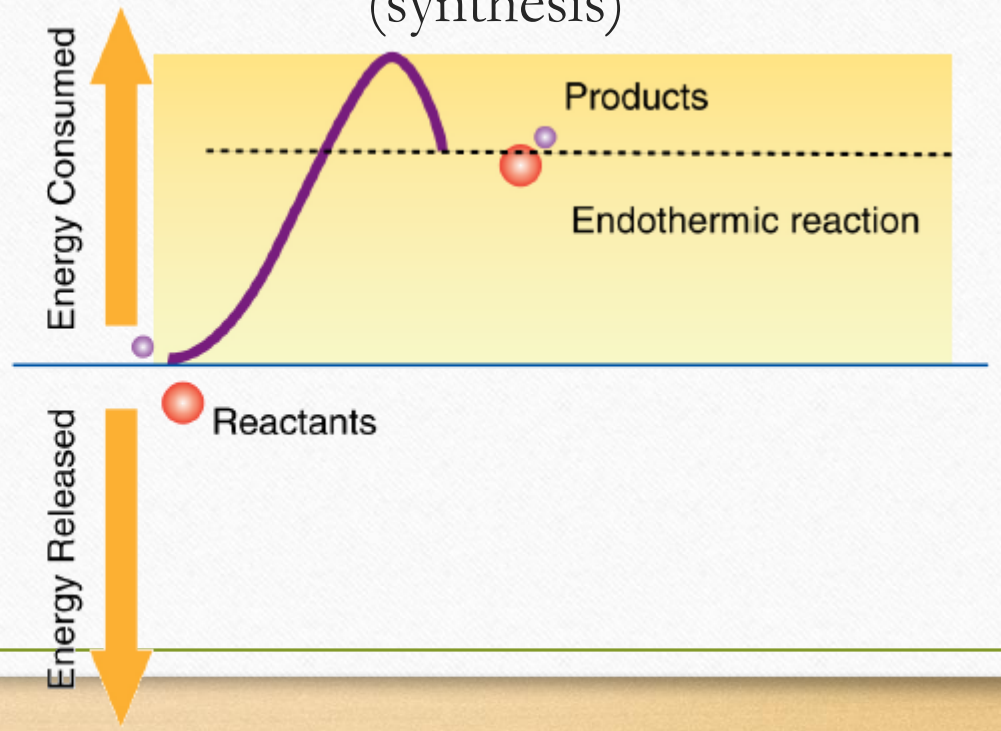
We can see that *breaking* glucose down (during respiration) is a catabolic reaction. However, *building* our macromolecules is an anabolic reaction.

Releasing V. Requiring Energy

- Exothermic: energy released (digestion)

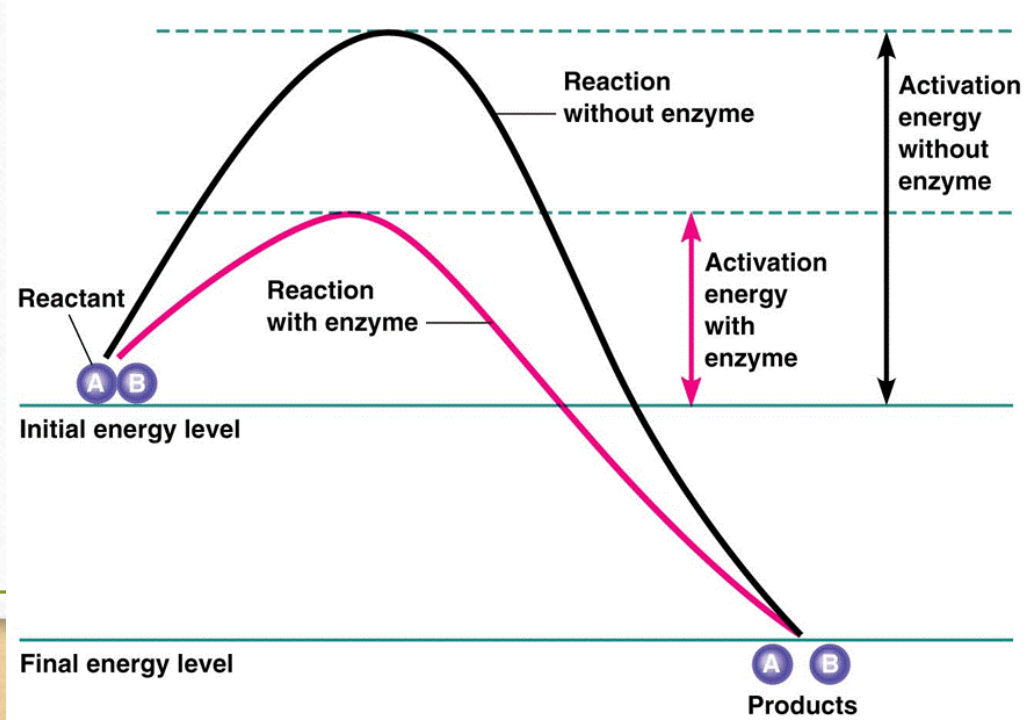


- Endothermic: energy absorbed (synthesis)



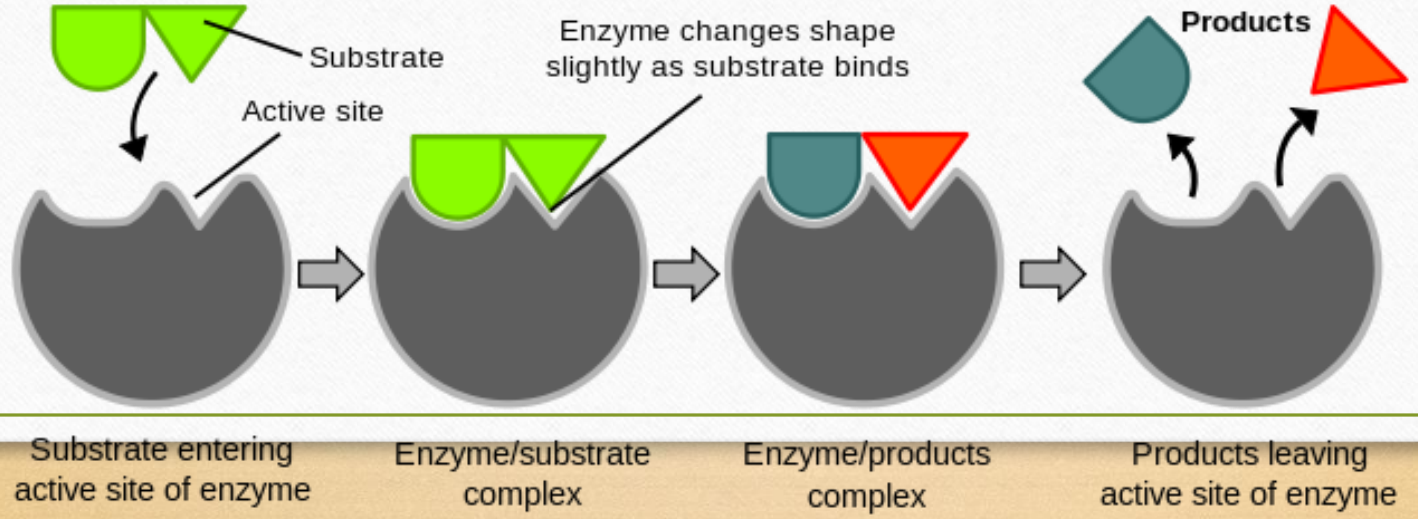
Role of Enzymes

- The role of enzymes is to <u>lower activation energy</u>!
  - Activation energy: the amount of energy required to start a reaction

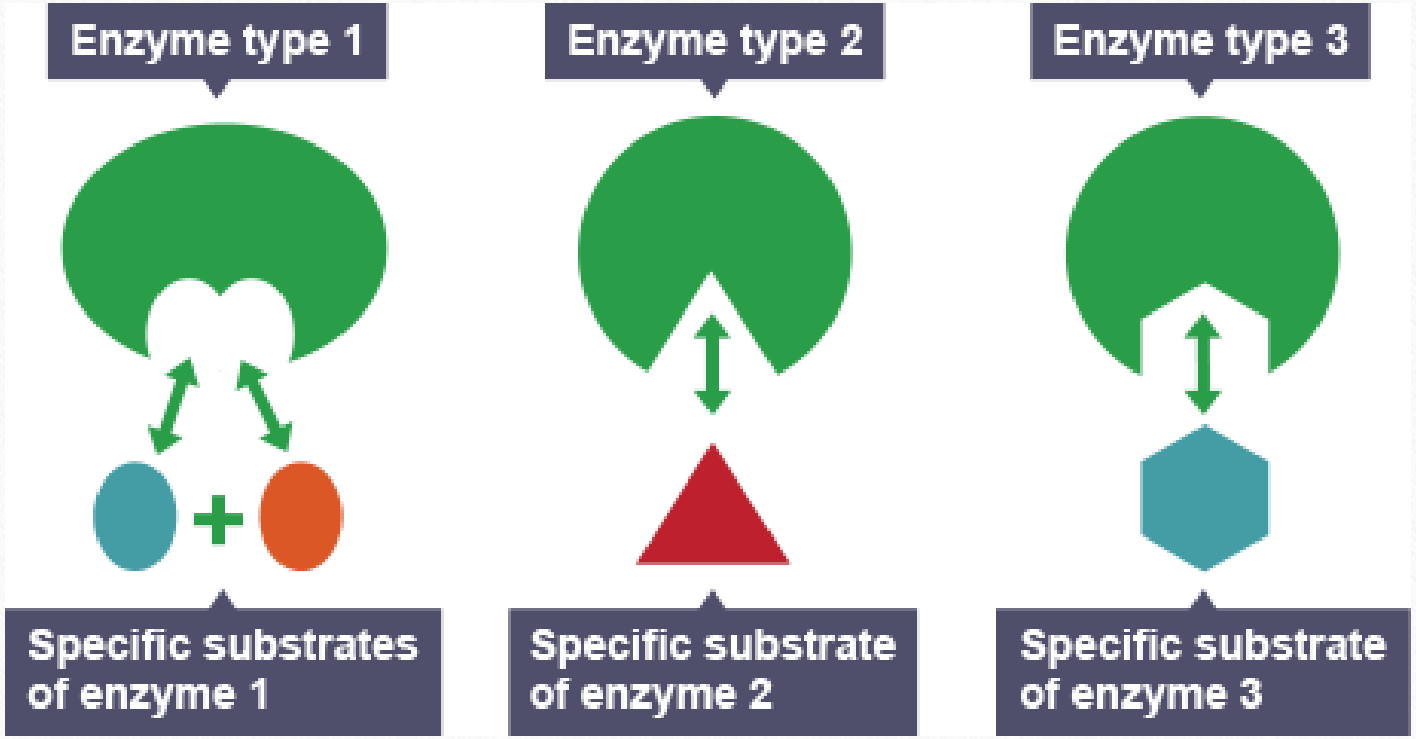


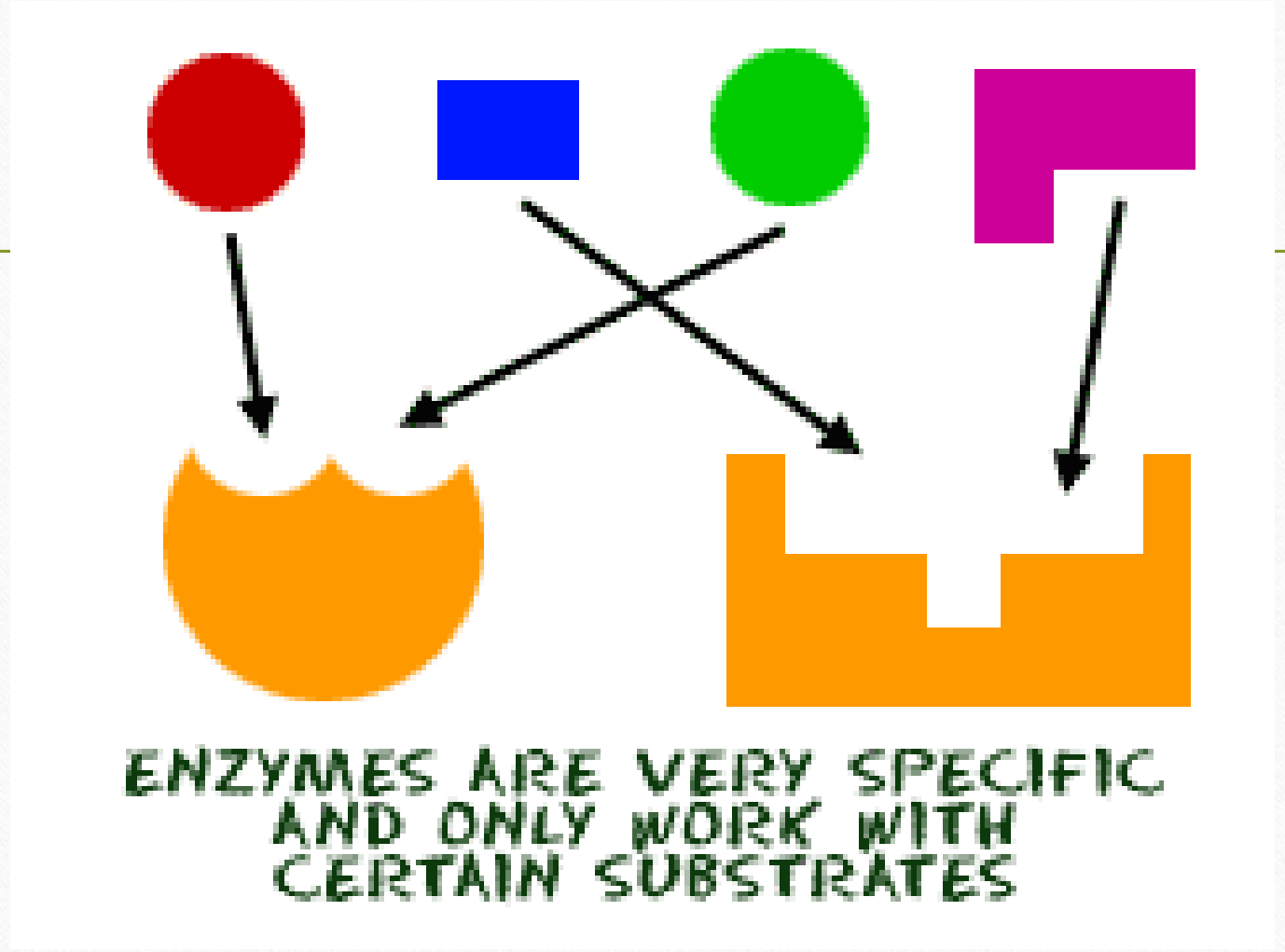
How do they do that?

- In biology, we like to say "form fits function."
  - So, the form (shape) of an enzyme impacts its role.
  - Enzymes are shape specific. They only work with certain substrates. These substrates must fit into the active site of the enzyme.



Form Fits Function

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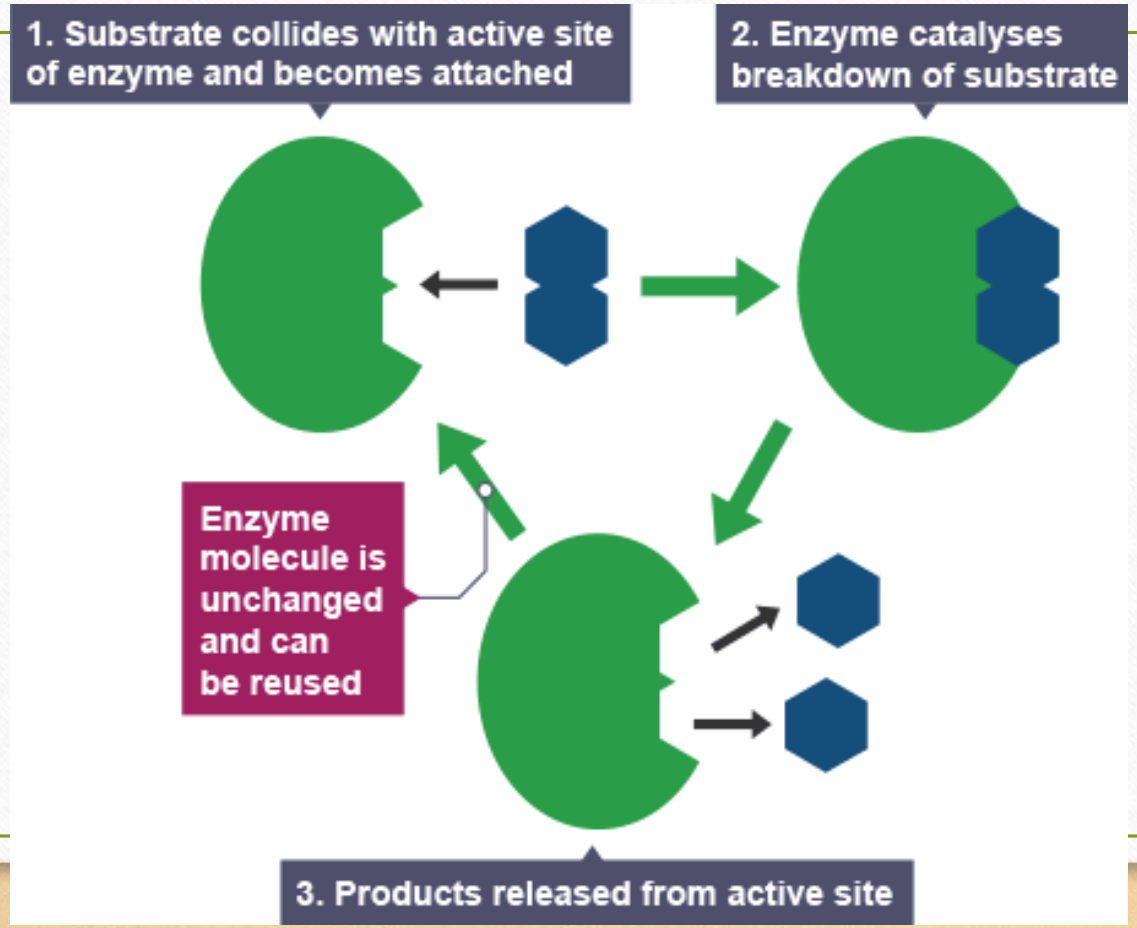
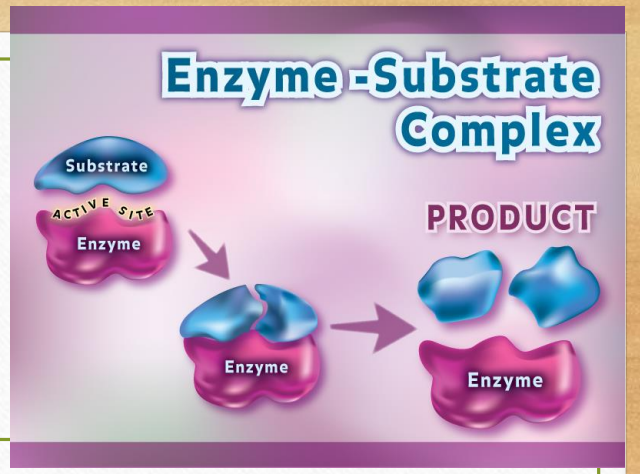
Form Fits Function

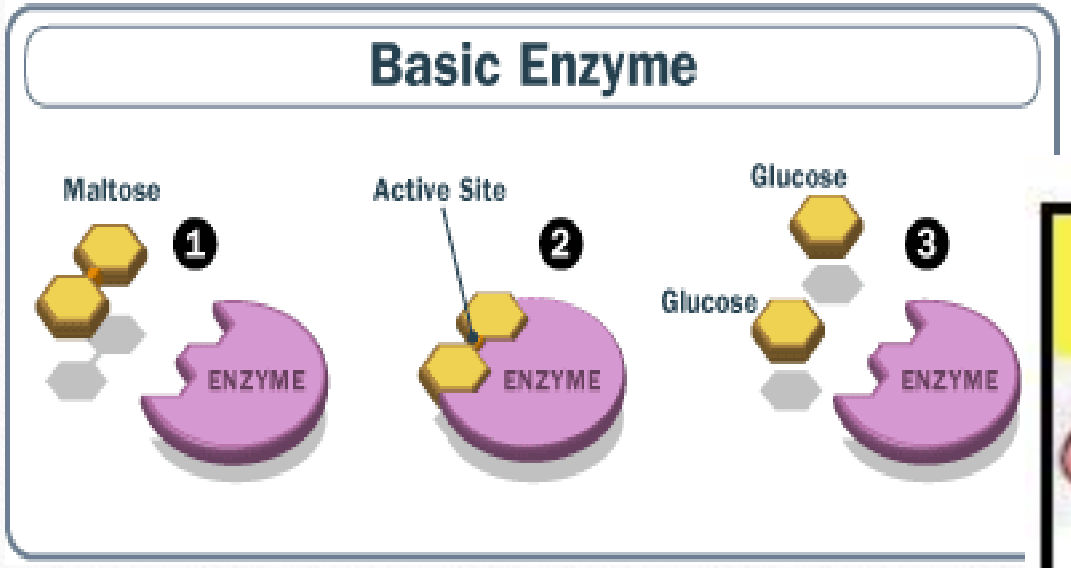


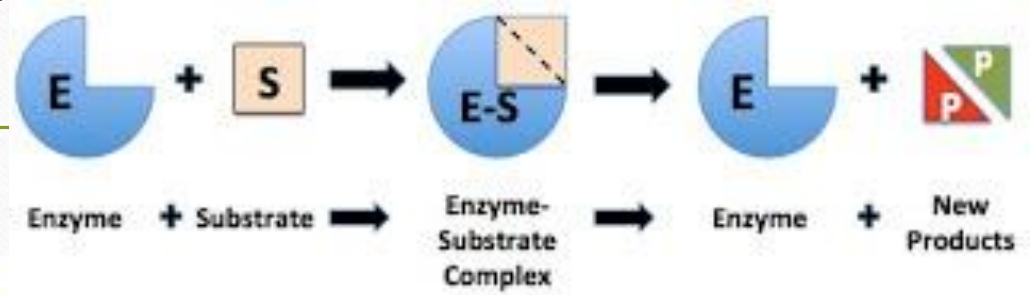
Enzyme Shape

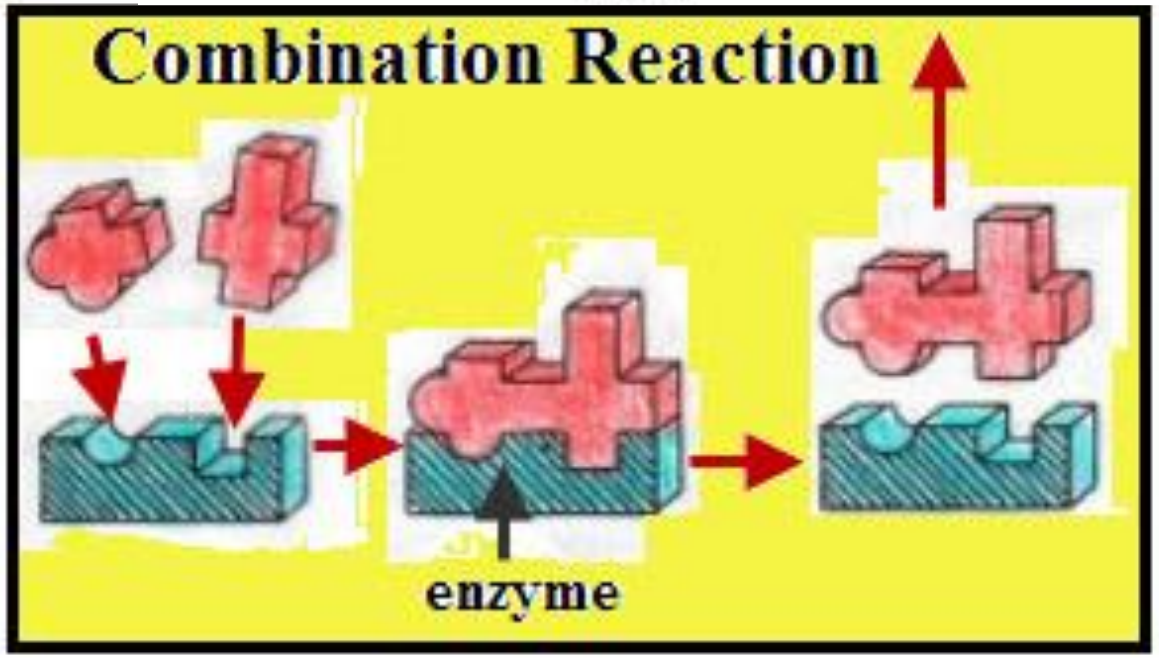


- Each enzyme has a place called the "active site." This is where the substrate(s) (reactants) bind to the enzyme.
- Once the substrate(s) has connected itself with the enzyme, the reaction takes place.
- The substrate(s) must fit exactly into the active site of the enzyme (lock & key model or induced fit).
  - Enzyme-Substrate Complex! (know this term, be able to label this!)
- Once the reaction is complete, the enzyme releases the product(s) of the reaction.

Again, enzymes can build or break

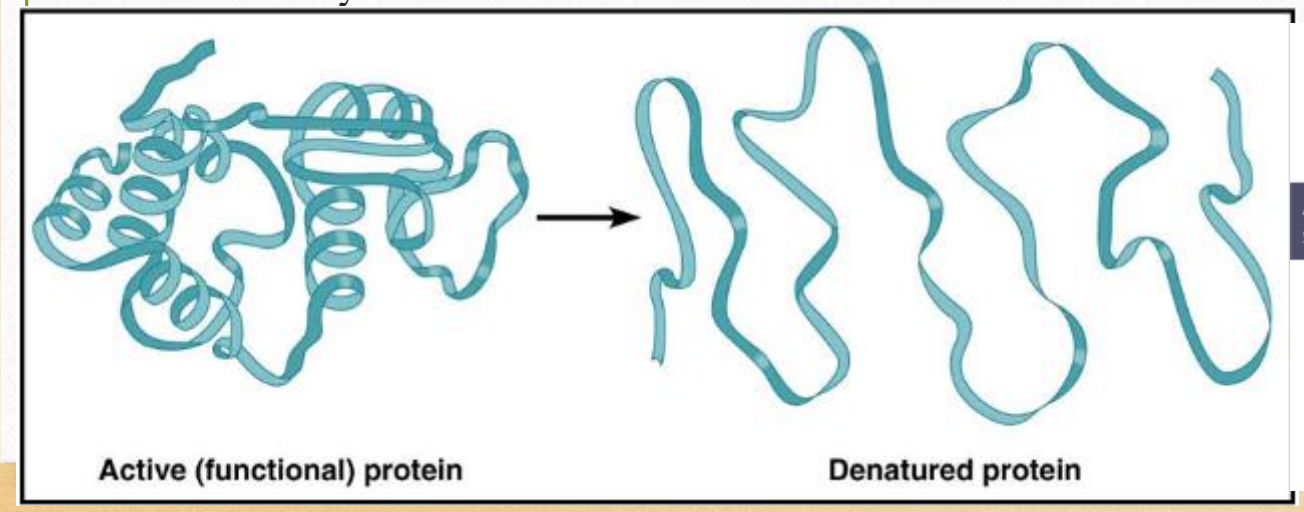


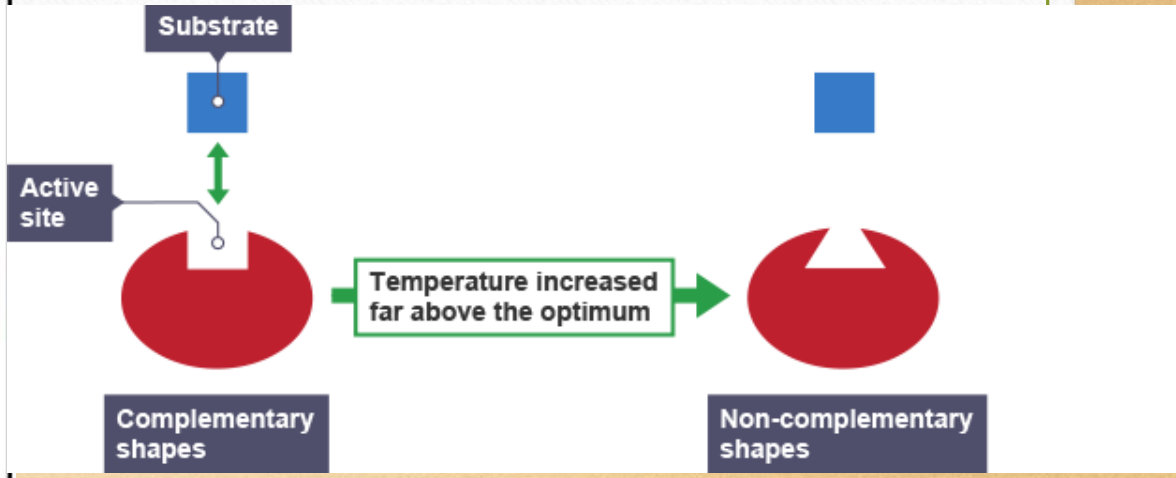




What Happens if the Enzyme Changes Shape?

- We call this a "denatured" enzyme/protein.
- When the shape changes, the substrate(s) will no longer fit in the active site, so the enzyme will no longer function. The organism needs to get rid of this enzyme.





How Can Enzymes Become Denatured?

- Enzymes work best in certain pH or temperature ranges. The best pH or temperature is said to be "optimum."
- Changing this optimum environment too much leads to enzyme denaturing.