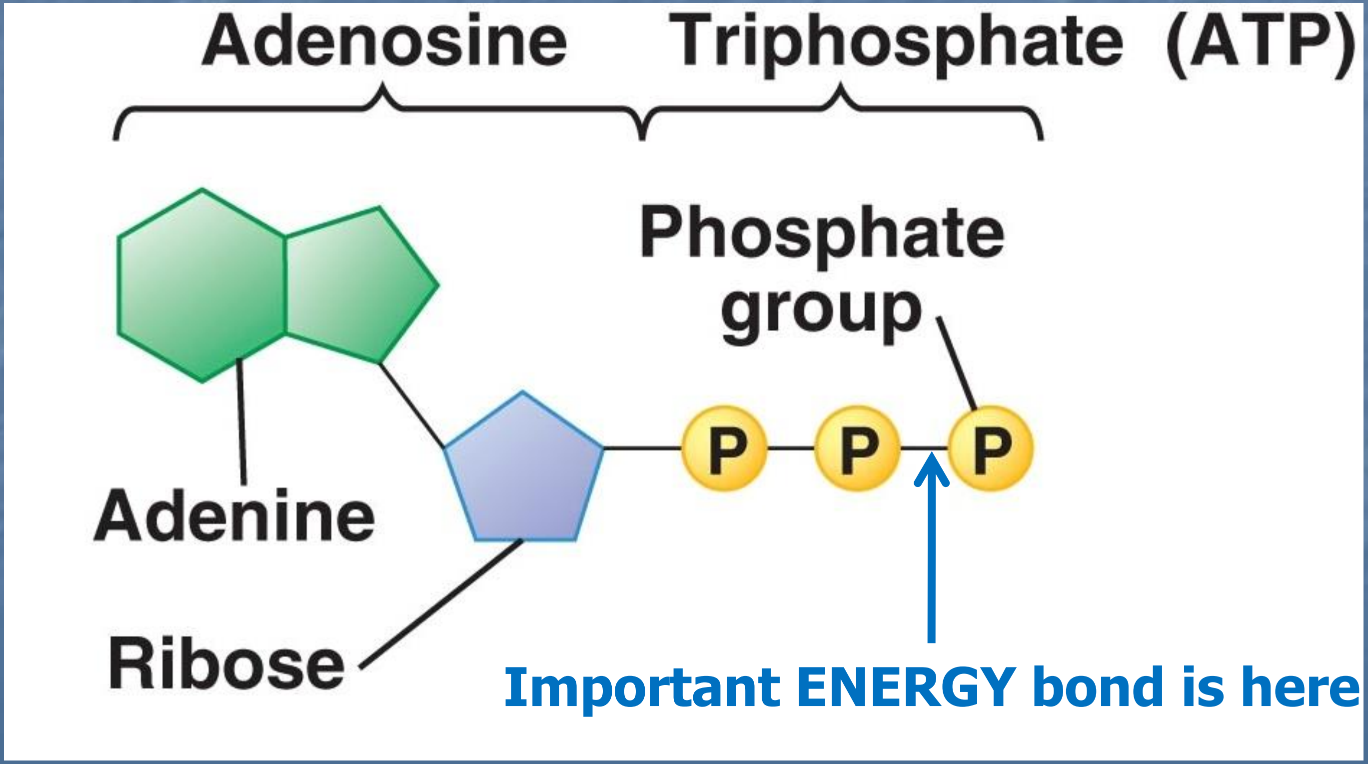
- Fun Enzyme Intro Video

# ATP (adenosine tri-phosphate)

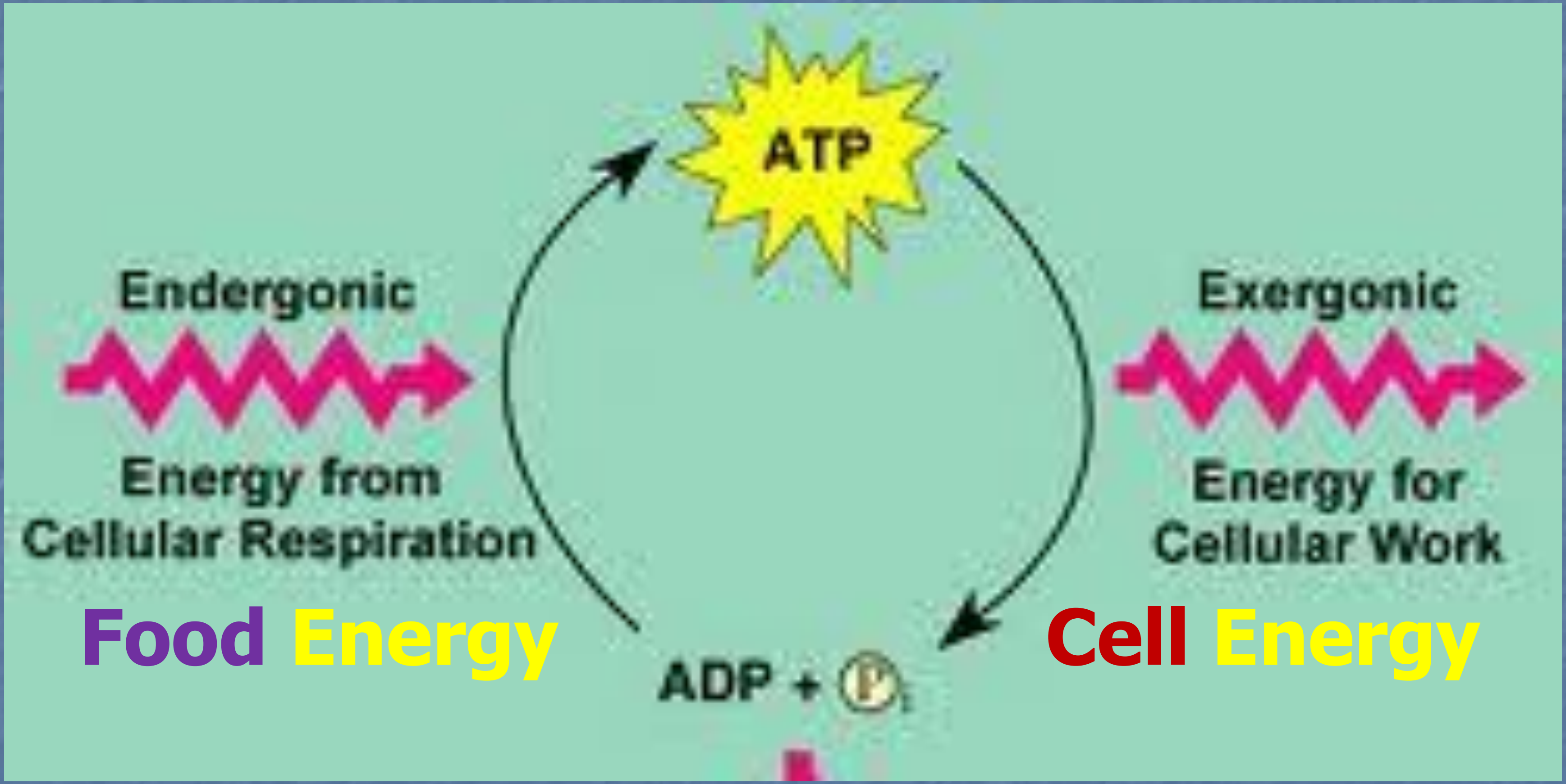
- BUILDING BLOCK: a single nucleotide + 2 extra phosphate groups



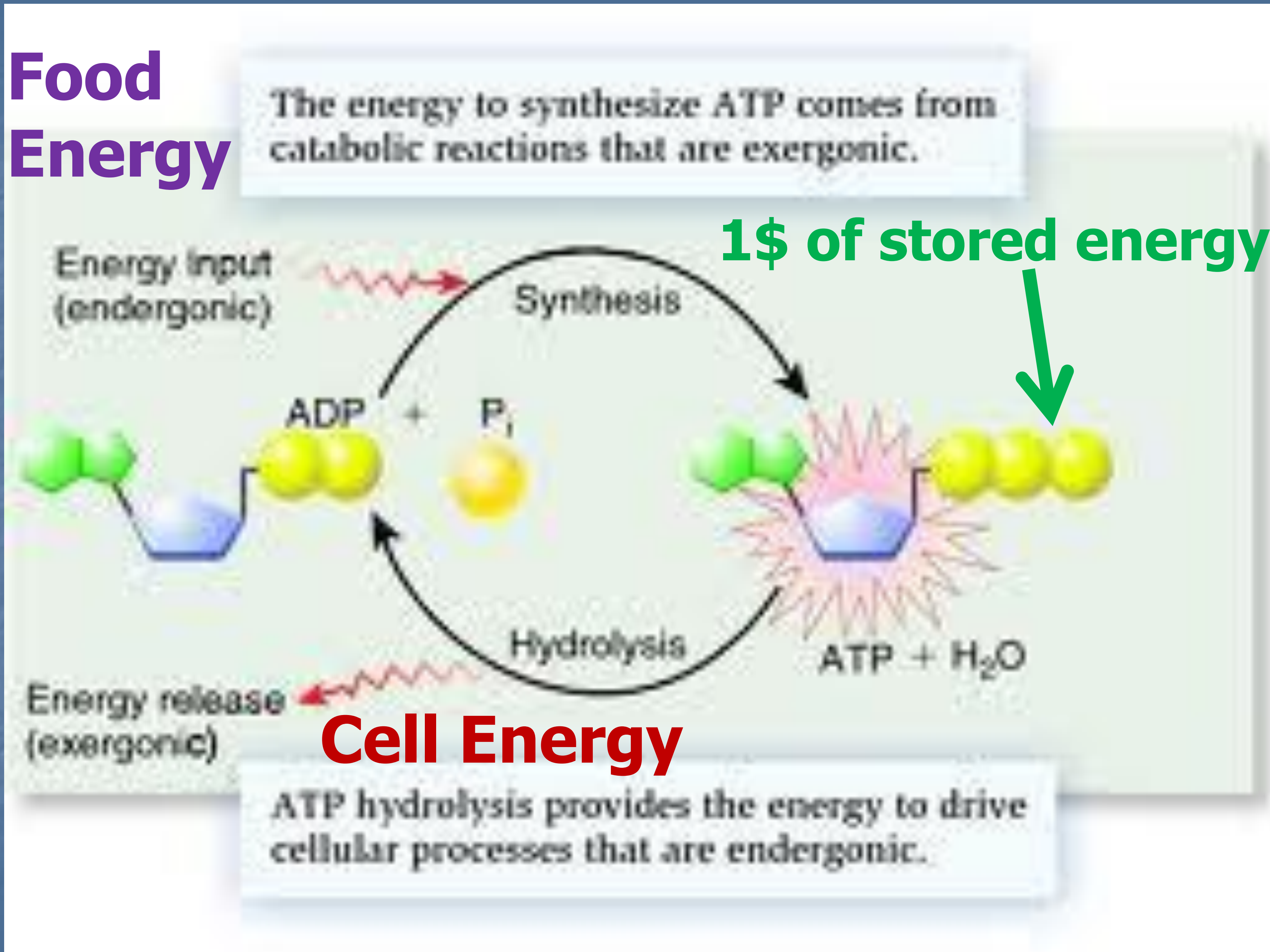
# Important things to know about **ATP**:

- Chemical Energy is stored in covalent bonds between **phosphate** groups
  - When the bond breaks, **energy is released**
- FUNCTION
  - carries Energy in cells
  - fuels most cellular activities (like $1 of energy)

There are also molecules known as **AMP molecules** (adenosine **mono**phosphate) and **ADP molecules** (adenosine **di**phosphate).




ATP video


Food Energy
The energy to synthesize ATP comes from catabolic reactions that are exergonic.
Energy input (endergonic)
Synthesis
1$ of stored energy
ADP + $P_i$
ATP + $H_2O$
Hydrolysis
Energy release (exergonic)
Cell Energy
ATP hydrolysis provides the energy to drive cellular processes that are endergonic.

# Cells need **ENERGY** to function

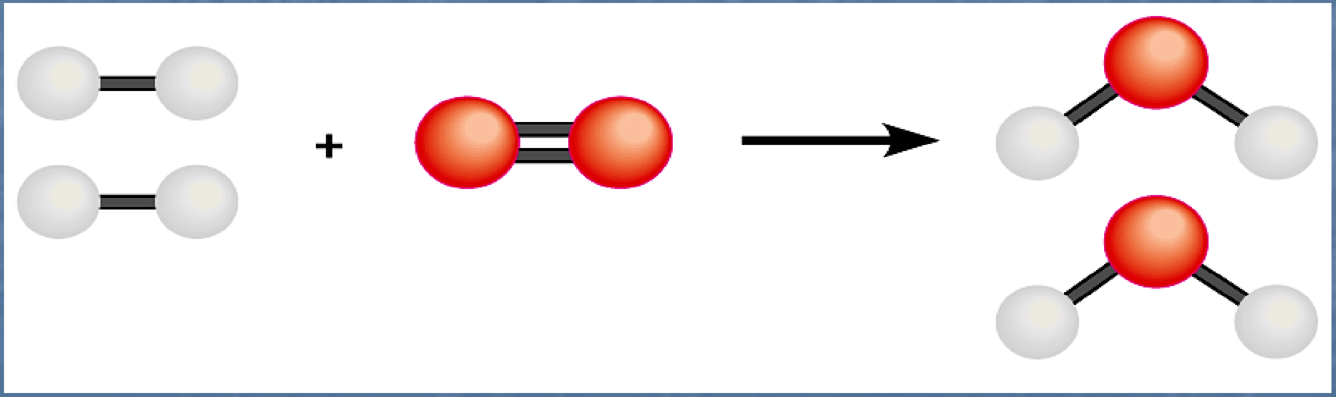
- Energy: <u>the ability to move or change matter</u>
- Energy comes in different **forms**
  - Ex.
- LAW OF CONSERVATION OF ENERGY:
  - Energy cannot be <u>created</u> or <u>destroyed</u> only **CHANGE forms**

- Energy can be **<u>stored</u>** (in bonds) or **<u>released</u>** (breaking bonds) by chemical reactions
  - Chemical reaction: reactants → products

    Ex. $NaCl \rightarrow Na^{+} + Cl^{-}$
  - Reactants = **<u>starting materials</u>**
  - Products = **<u>newly formed substances after the reaction</u>**

# Let's review

- **In a chemical reaction:**
  - __**Energy**__ is added to "jumpstart" the reaction
  - Bonds are broken and __**reactants**__ interact
  - Atoms __**rearrange**__
  - New bonds form and __**products**__ result



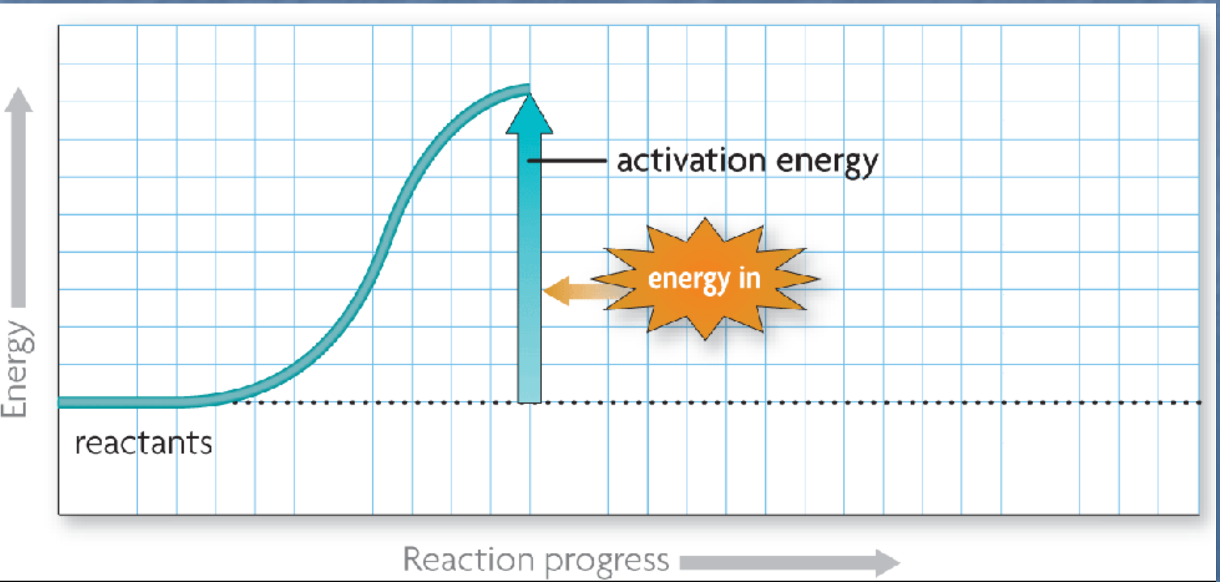

$2\ H_2 \quad + \quad O_2 \quad \rightarrow \quad 2\ H_2O$

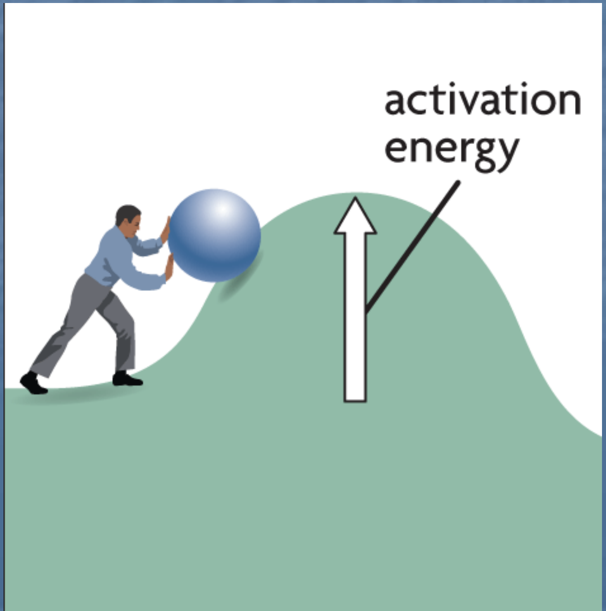
# Prefix Preview:

Identify the Latin "root word" that matches each prefix

| Prefix | Greek "Root Word" |
|---|---|
| OUT | **Exo** |
| IN | **Endo** |

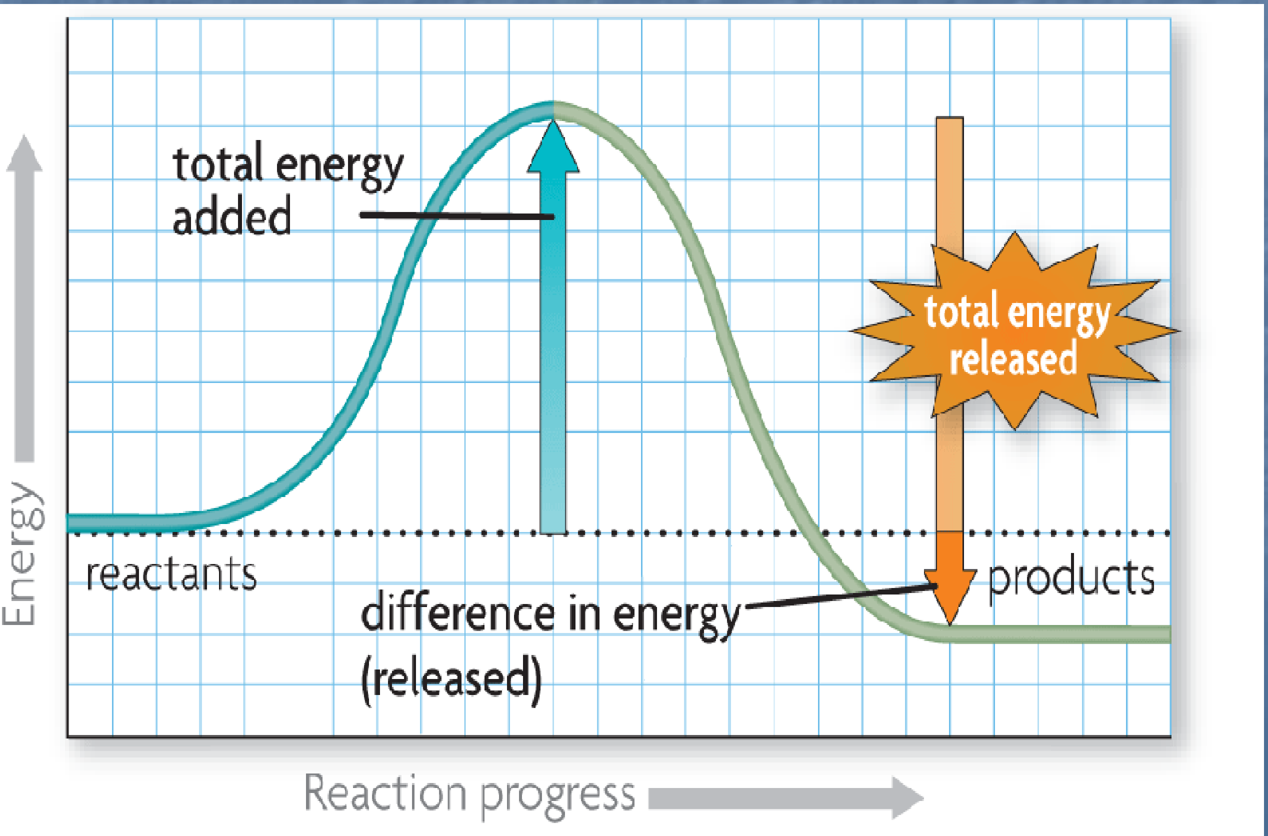
- Chemical reactions will NOT start until some **energy** is **absorbed** by the reactants.
- This energy is called the **Activation Energy**
- When enough Activation Energy is absorbed to **break** the chemical bonds in the reactants, a reaction will begin
- Activation Energy is like a "**spark**" that **jumpstarts** a chemical reaction

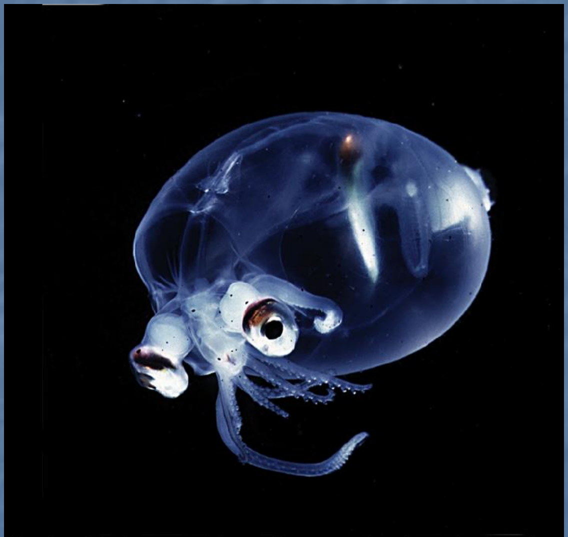


- Chemistry in real-life:
- Think of a spark that starts a fire. What is this “spark” providing in this situation?
  - A: Activation Energy
  - Energy required to start a chemical reaction.

- Chemical reactions either ___absorb___ or ___release___ energy
  - An **Exergonic** reaction ___releases___ more energy than it absorbs
    - Everyday Examples:

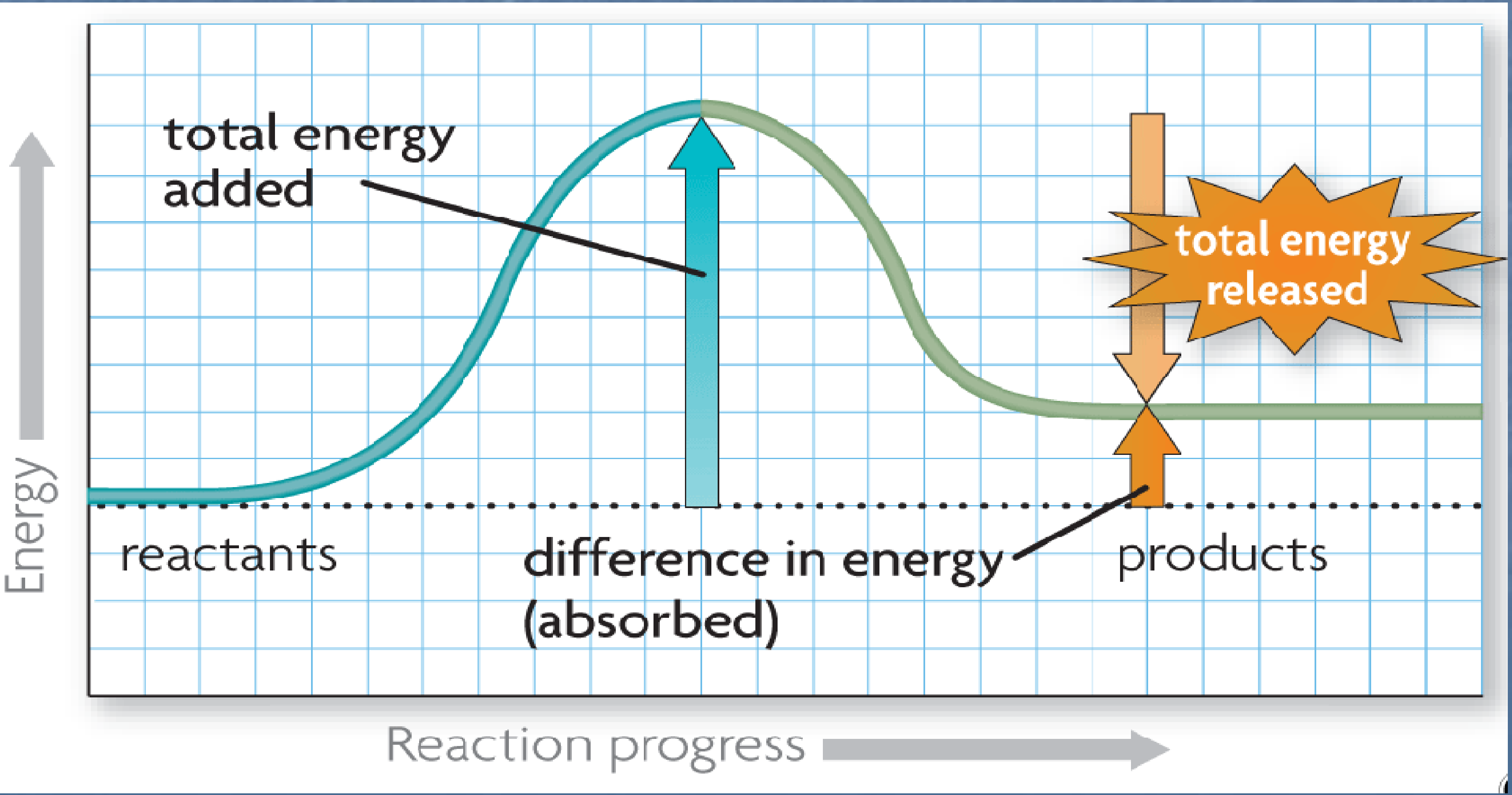


The glow of the bugeye squid comes from an exothermic reaction that release

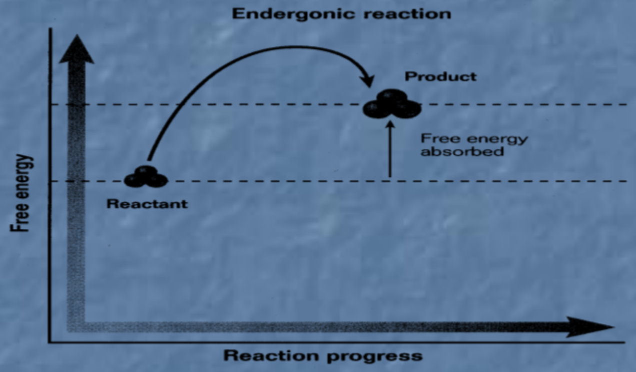
- An **Endergonic** reaction **absorbs**________ more energy than it **releases**.
  - Everyday Examples:

Endo video 1

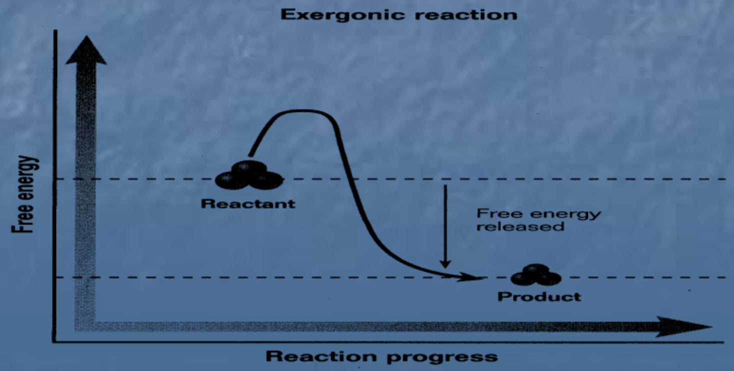


# A Closer Look at the 2 Reaction Types

- **Endergonic**: energy is absorbed **IN**.
  - <u>sunlight</u> energy (IN) + $6CO_2$ + $6H_2O$ → $C_6H_{12}O_6$ + $6O_2$
  - **photosynthesis**




- **Exergonic**: energy is released **OUT**.
  - burn wood → $CO_2$ + $H_2O$ + <u>Heat</u> E (OUT) + <u>light</u> E (OUT)
  - **Combustion**
  - **Cellular respiration**



# Let's Review: Which process (Exergonic or Endergonic) is most similar to each action below:

1. You boil a pot of water on the stove?

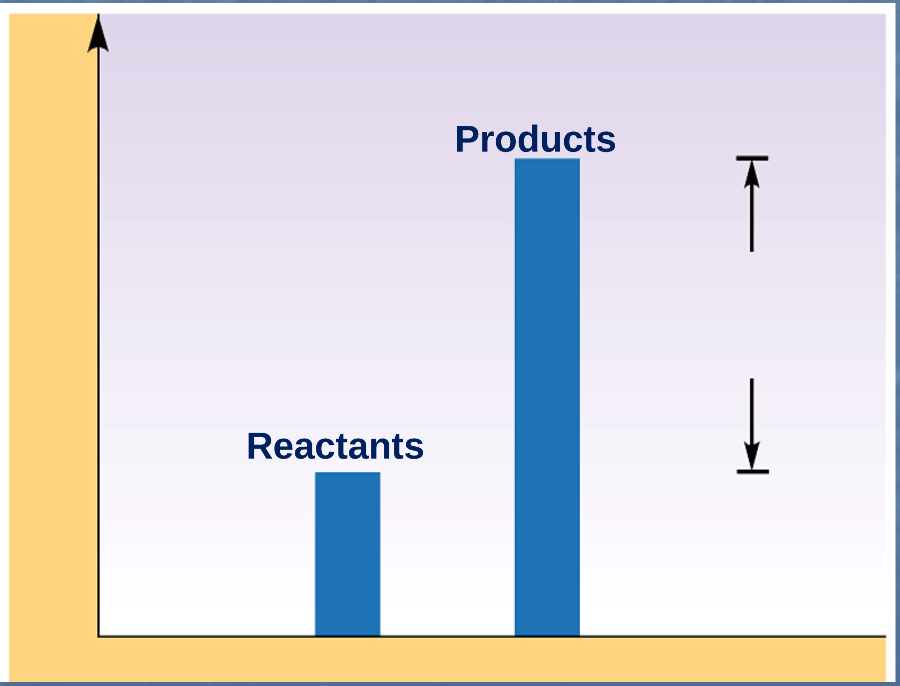
2. Your ice cubes melt in your drink on a hot day?

3. You mix two chemicals together to make epoxy glue and notice the glue gets warm?

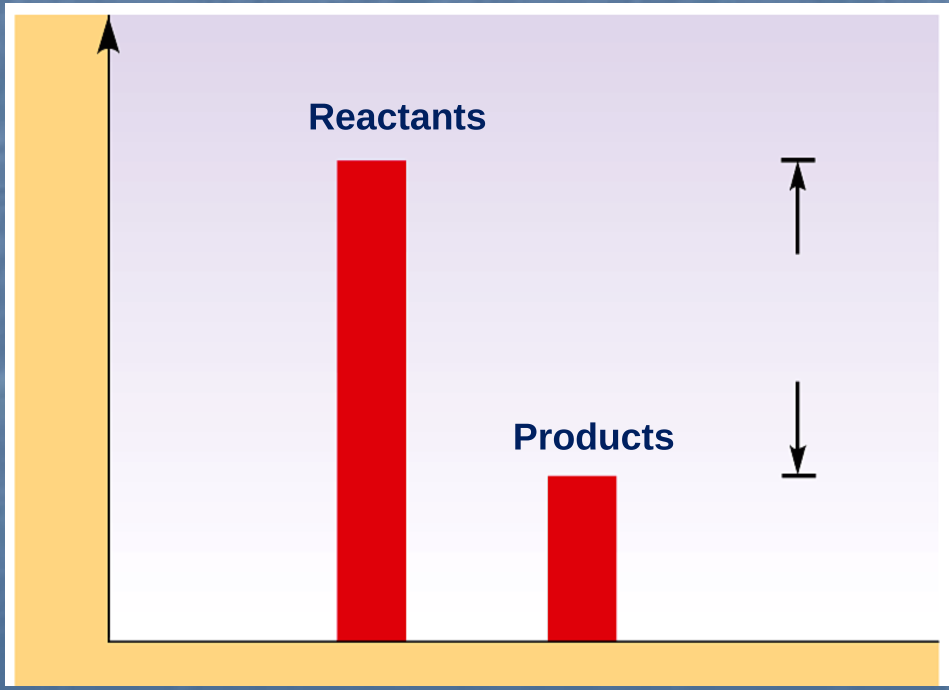
4. Liquid water turns into an ice cube in the freezer?

# Let's Review: Which process (Exergonic or Endergonic) is most similar to each action below:

5.




6.



# Let's Review: Which process (Exergonic or Endergonic) is most similar to each action below:

1. You boil a pot of water on the stove?

**Endergonic**

2. Your ice cubes melt in your drink on a hot day?

**Endergonic**

3. You mix two chemicals together to make epoxy glue and notice the glue gets warm?

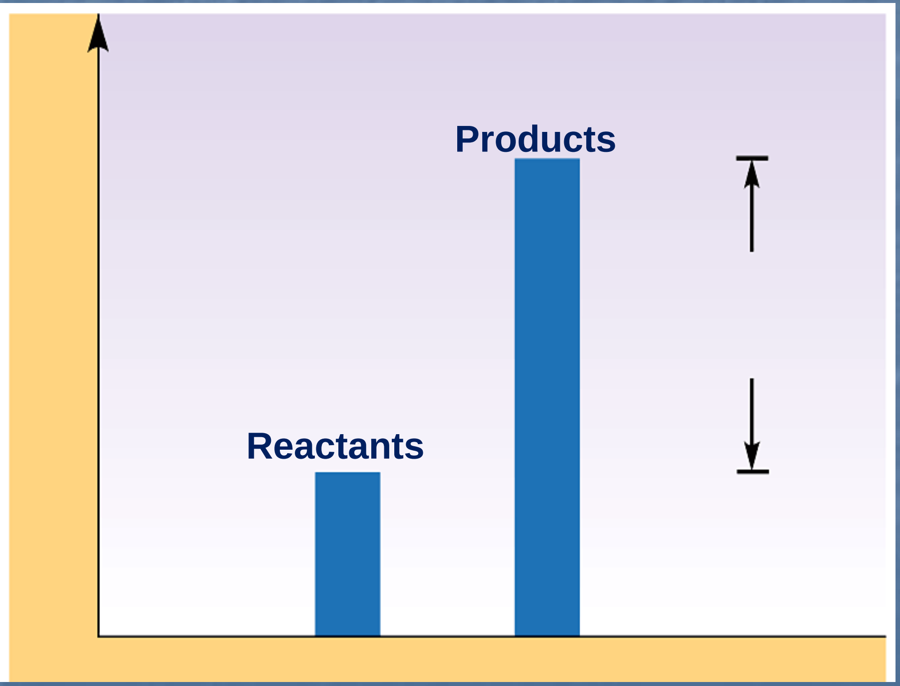
**Exergonic**

4. Liquid water turns into an ice cube in the freezer?

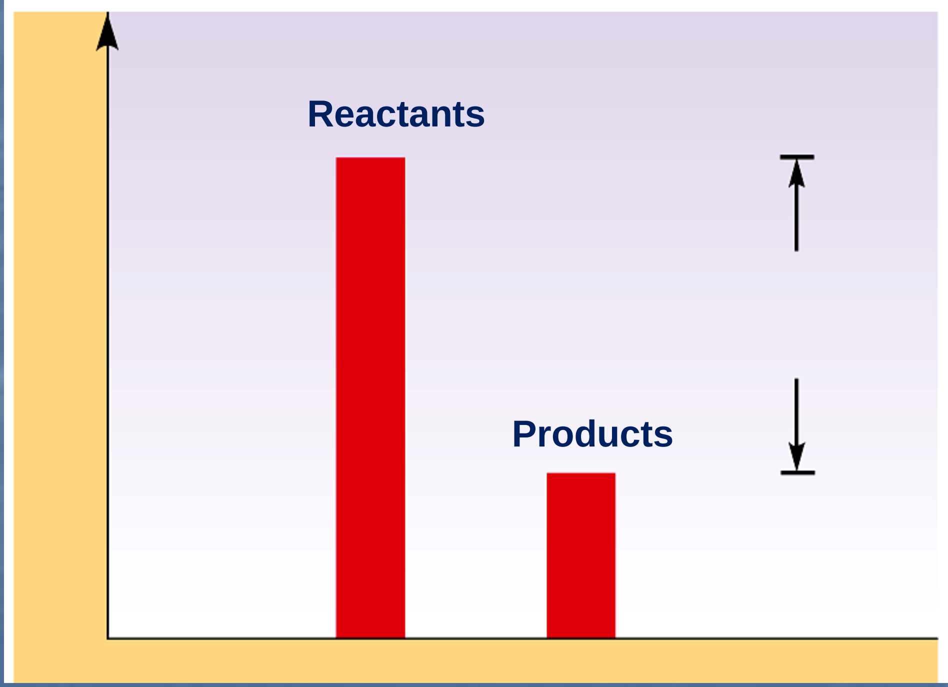
**Exergonic**

# Let's Review: Which process (Exergonic or Endergonic) is most similar to each action below:

5. Endergonic




6. Exergonic

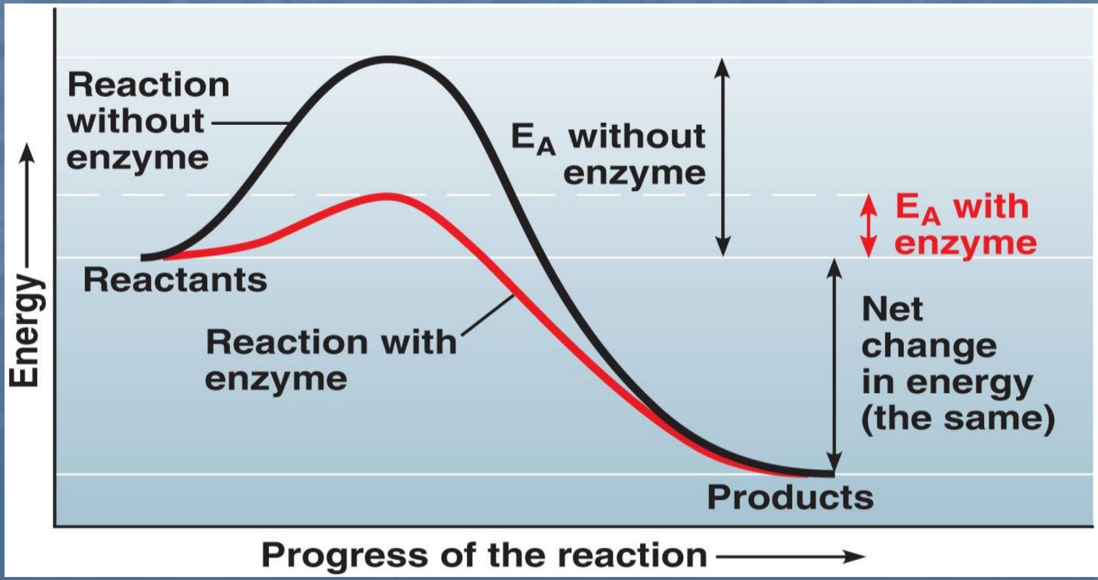


- Fun Enzyme Intro Video

# ENZYMES

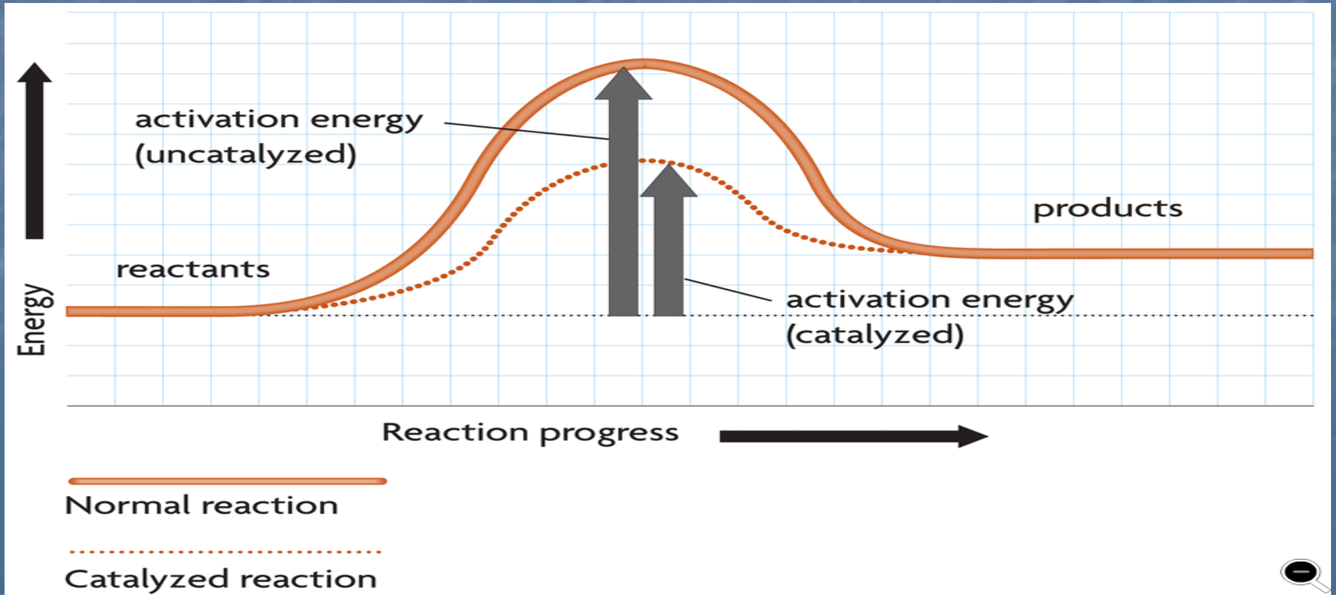
- Made of _Protein________
- End in "_ASE__".
  - Catalase, lactase, sucrase, lipase
- FUNCTION
  - __Speed UP______a chemical reaction by _lowering_ the activation energy needed to start the reaction

(biological catalyst)

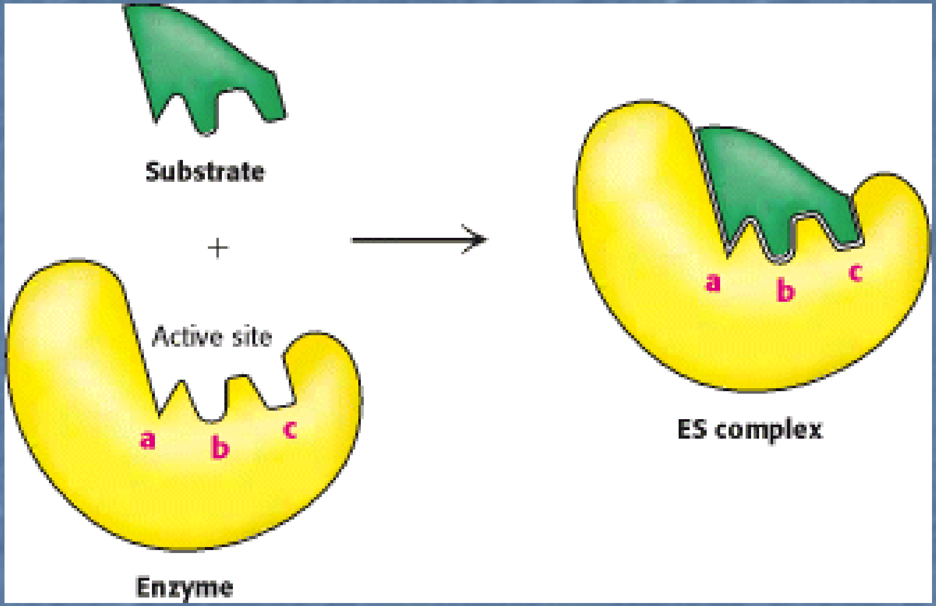


# Another look at the "**magic**" of **Enzymes**

- Enzymes act like __**catalysts**__ inside of cells
- This means they not only speed up the rate of chemical reactions, but they also allow reactions in a cell to **get started more easily** (**i.e.,** You DO NOT have to **heat** the cell up to 500 degrees F to get the reaction started )

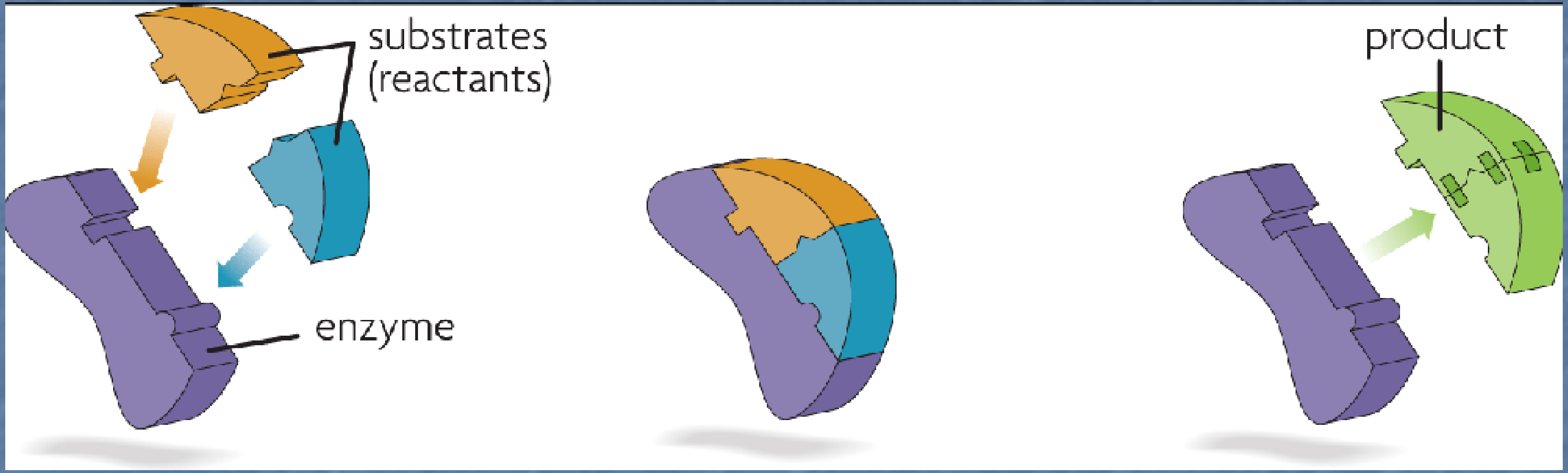


- Enzymes are _specific____: they only react with ONE kind of substrate
- The substrate fits into the enzyme's uniquely shaped _Active site_____(folds and pockets on the enzyme surface)



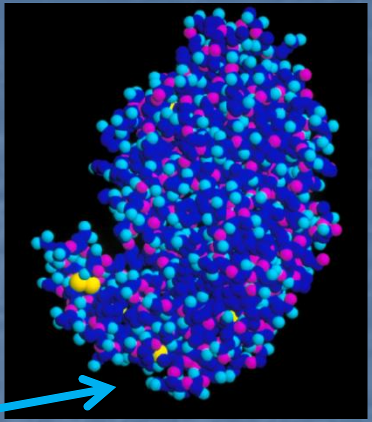

- Enzymes are _reusable__ …one enzyme can perform the same job over and over again, millions of times, without being consumed in the process

- Enzymes work somewhat like a **Lock-n-Key**
- After the substrates temporarily bind to the enzyme, the enzyme helps the substrates react together as it slightly **bends n wiggles**




- Some things cause cell reactions to **Speed UP**
  - **Warm** the cell temperature …. to a point !!!
  - **Increase** the number of enzymes in the cell
  - **Increase** the amount of substrate in the cell

- Some things cause cell reactions to **SLOW DOWN**
  - **Cool** the cell temperature
  - Lower the number of **enzymes** in the cell
  - Lower the amount of **substrates** in the cell
  - Add **salt** to the cell environment
  - Change the **pH** of the cell environment



- Enzymes only work when they fold up using their H-bonds into the **correct 3-D shape**
- Various things in a cell can interfere with the **shape** of an enzyme and can cause it to stop working
  - Example 1: **high** temperatures can **denature** an enzyme causing it not to function.
  - Example 2: Changing the cell's **pH** (acid or base) can **denature** an enzyme
  - Example 3: Some pesticides and antibiotics can **denature** enzymes … **Penicillin** blocks an enzyme that germs use

# How does the herbicide Roundup work?

- Roundup® (a trade name used by Monsanto) and other herbicides based on **glyphosate** all work on the same biochemical principle -- they inhibit a specific **enzyme** that plants need in order to grow. The specific enzyme is called **EPSP synthase**. Without that enzyme, plants are unable to produce other proteins essential to growth, so they yellow and die over the course of several days or weeks.

# How does the herbicide **Roundup** work?

- A majority of plants use this same enzyme, so almost <u>all plants succumb to Roundup</u>.
- If you've been following farming news or the <u>genetically modified food</u> debate, you know that glyphosate-tolerant seeds are now available -- you can buy genetically modified corn, soybeans, etc. that are immune to glyphosate. These plants produce an enzyme that performs the same function as EPSP synthase but is not inhibited by glyphosate.

- Enzyme Video 1 with C & NC Inhibition
- Enzyme video 2 (old intro)
- Enzyme lower Ea
- Enzyme song Mr W
- Enzyme Song 2
- Roundup work?
- Roundup work2??

# Enzyme Demos #1
## PSP = **P**uffN **S**tarch **P**ellet

1) Starch dissolved in Water (Neutral)
2) Starch dissolved in Saliva **Enzyme** (Neutral)
3) Starch dissolved in Saliva **Enzyme** (**Acid**)
4) Starch dissolved in Saliva **Enzyme** (**Base**)

# Starch Testing with **Iodine**

| Test Tube # | Materials Tested | Indicator | Observations |
|---|---|---|---|
| 1 | Starch in water | Iodine | |
| 2 | Starch in Enzyme (Neutral) | Iodine | |
| 3 | Starch in Enzyme (Acid) | Iodine | |
| 4 | Starch in Enzyme (Base) | Iodine | |

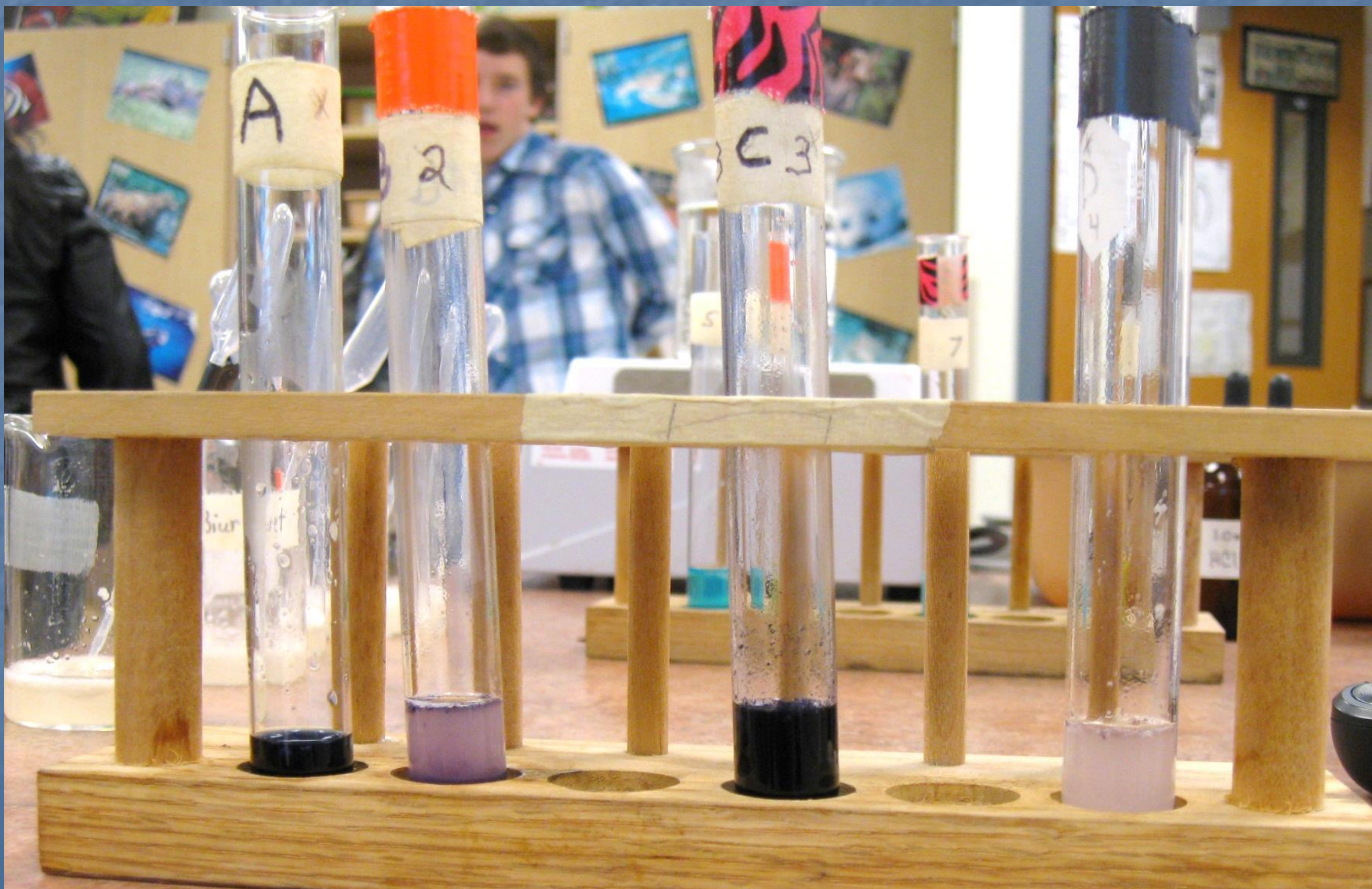
# Glucose Testing with **Benedict's solution**

| Test Tube # | Materials Tested | Indicator | Observations |
|---|---|---|---|
| 5 | Starch in water | Ben S | |
| 6 | Starch in Enzyme (Neutral) | Ben S | |
| 7 | Starch in Enzyme (Acid) | Ben S | |
| 8 | Starch in Enzyme (Base) | Ben S | |

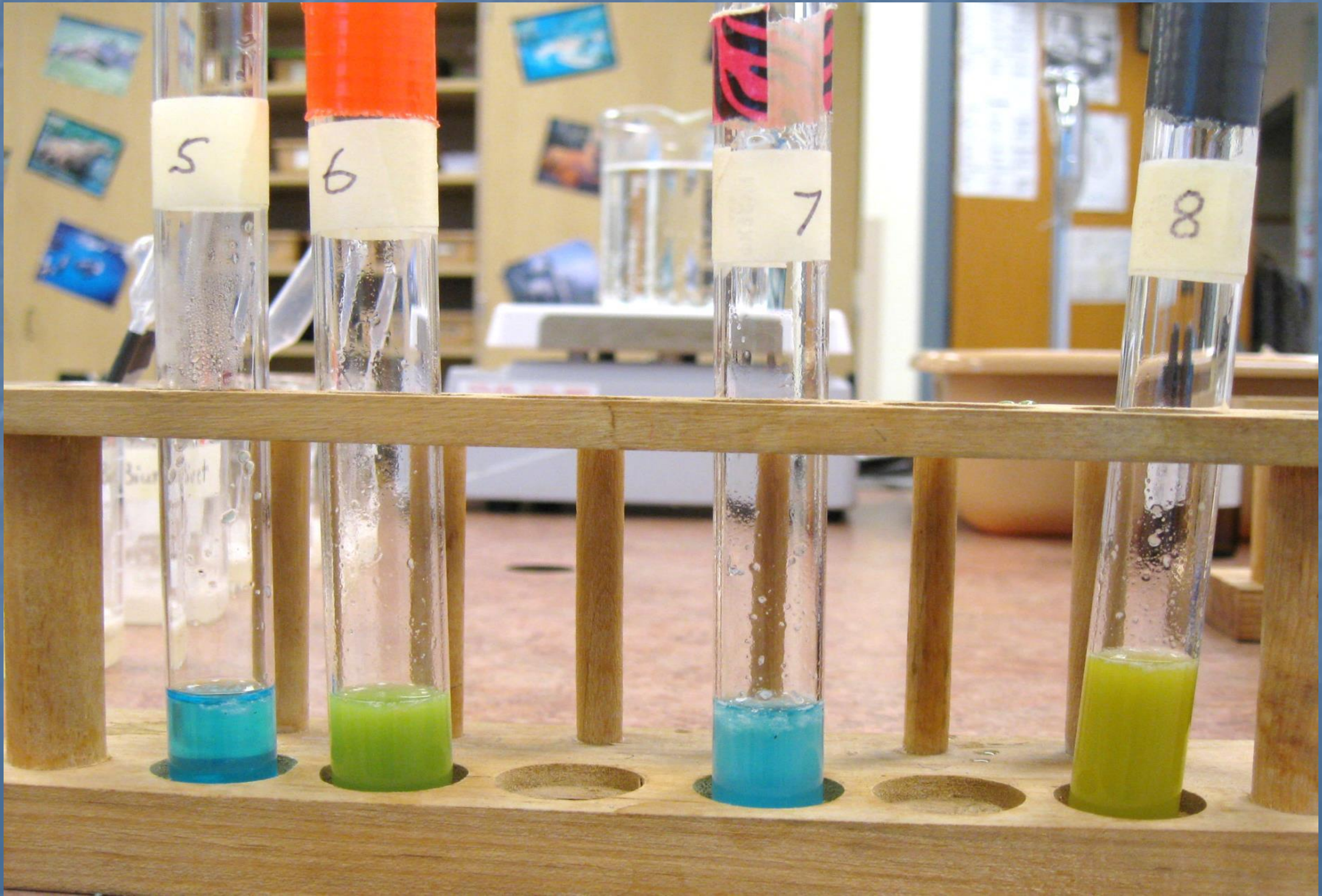
# Enzyme Demos #1

**Starch** $\longrightarrow$ **Glucose**

# **Starch** Testing with **Iodine**



# Glucose Testing with Benedict's solution




Royals

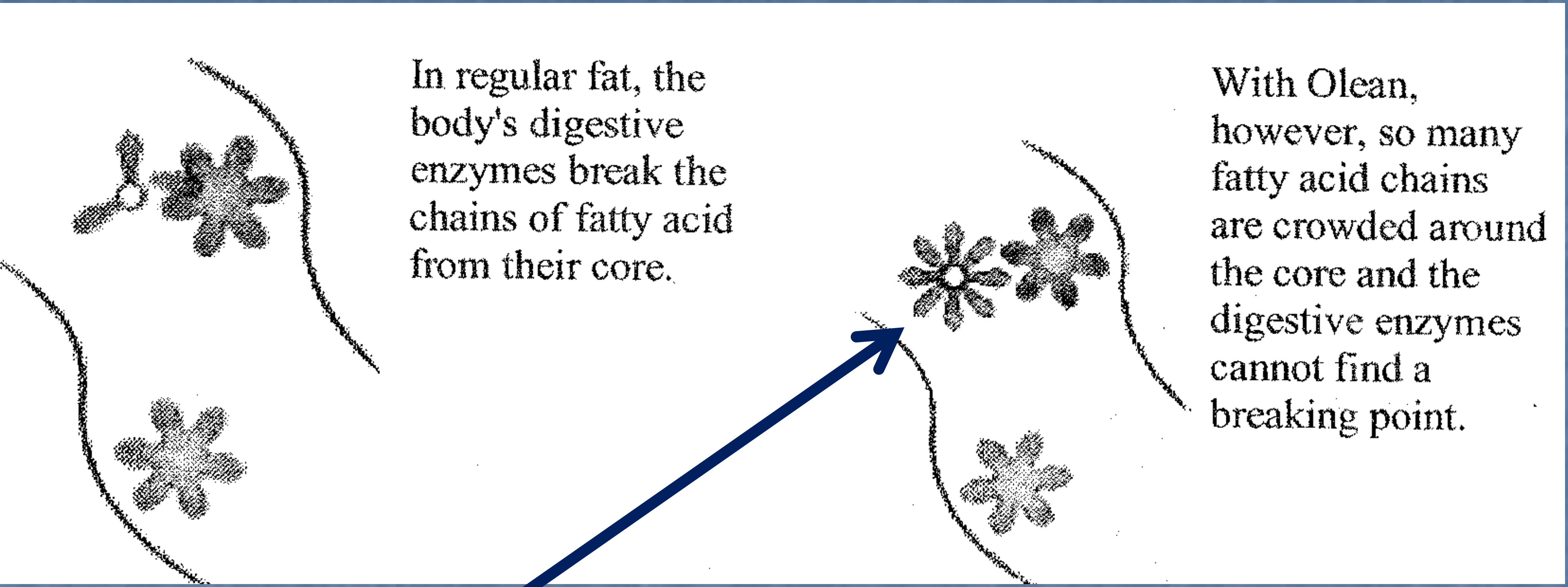

MADE WITH
Olean
BRAND FAT REPLACER

Ruffles
ALL THE TASTE
Light
1/2 the CALORIES
ORIGINAL
FAT FREE

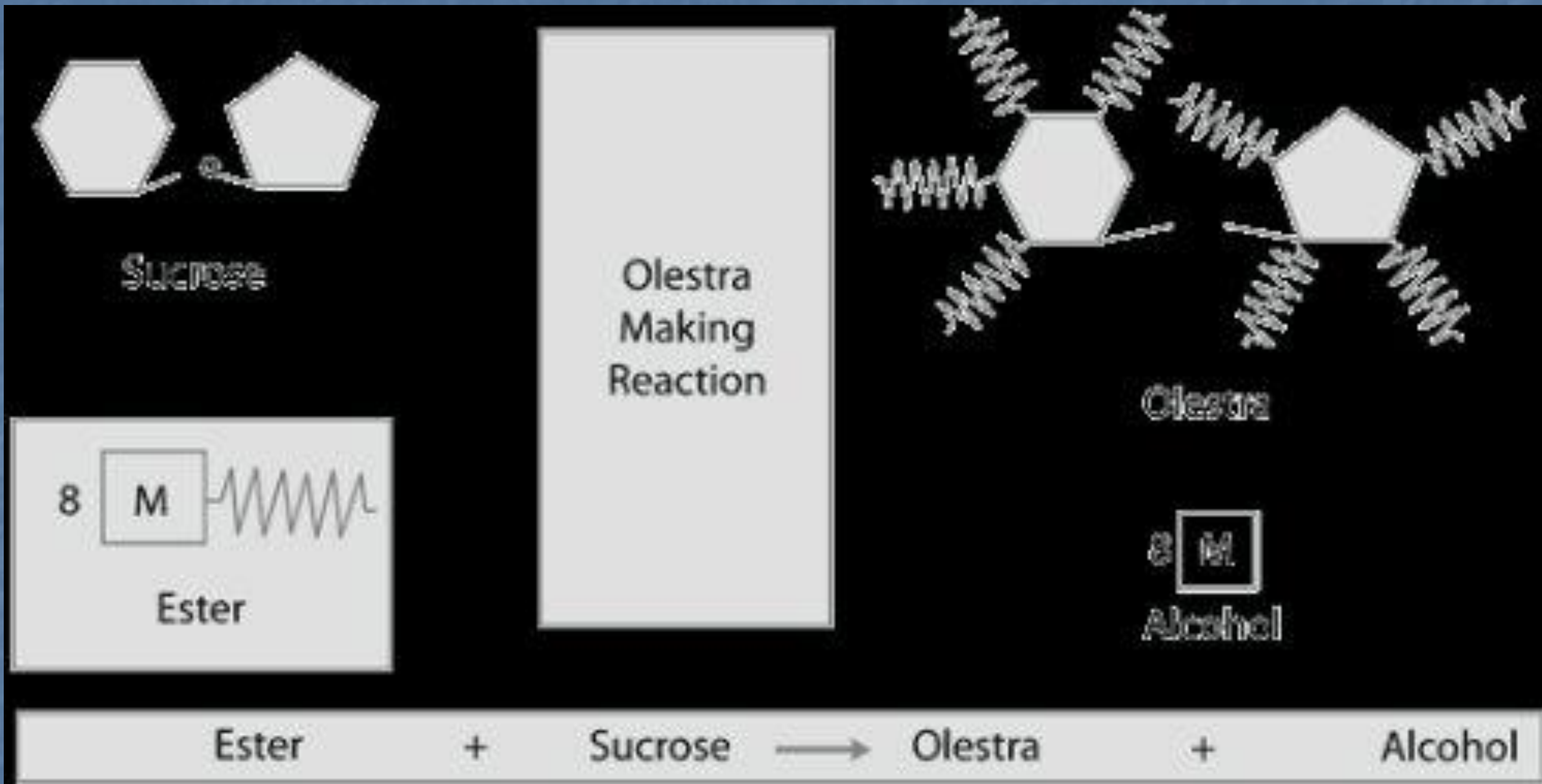
Ruffles
WOW
ALL THE TASTE
FAT FREE
Cheddar &
Sour Cream
99¢

Lay's
WOW
FAT FREE
Original
Doritos
WOW
Nacho
Cheesier
Ruffles
WOW
FAT FREE
Original

# How Olean works




**Olean = 1 sugar + 6-8 Fatty Acids**


Sucrose
Olestra
Making
Reaction
Olestra
8
M
Ester
8
M
Alcohol
Ester + Sucrose → Olestra + Alcohol

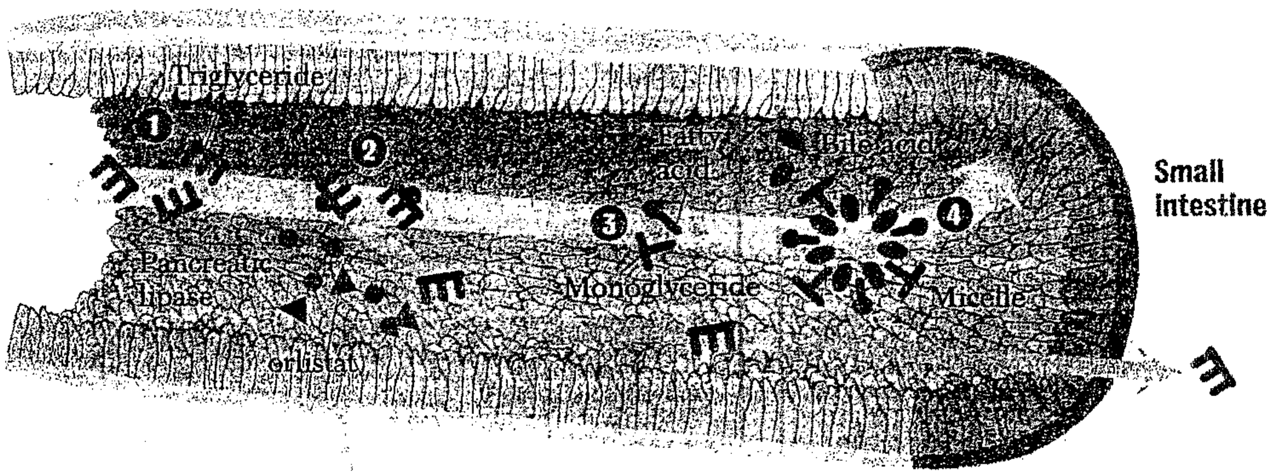
# Ever seen a food with a **warning label**?

# Alli = Orlistat

HEALTH

## Finally, the Free Lunch?

A new drug blocks absorption of dietary fat




**How fat gets digested—or not:**

❶ Triglycerides (fat molecules) enter the intestine.

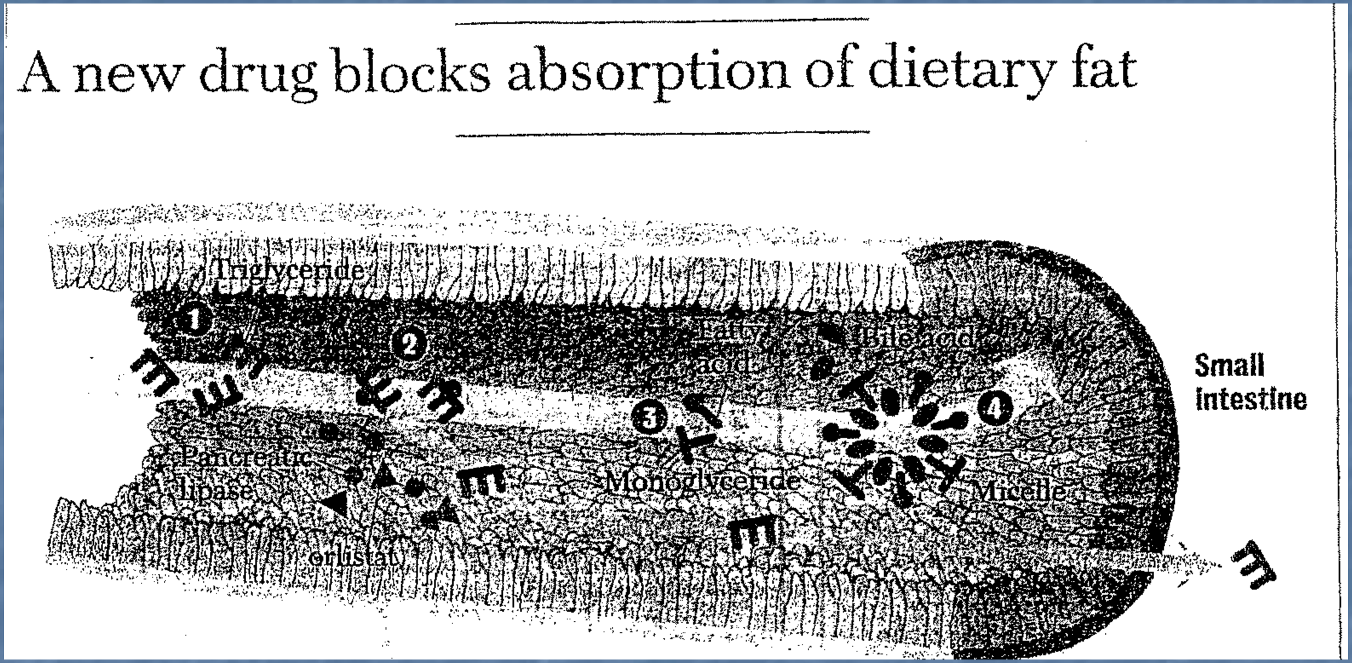
❷ Fat molecules bind with pancreatic lipase enzymes. (Orlistat blocks this process by binding with some of the enzymes instead. Thirty percent of the fat molecules are excreted.)

❸ Without orlistat, the triglyceride separates into a fatty acid and a monoglyceride, a fat fragment.

❹ They bind with bile acid. The resulting complex (a micelle) carries the fat pieces into the intestinal wall. The fat enters the bloodstream.

SOURCE: HOFFMANN-LA ROCHE, INC. GRAPHIC BY STANFORD KAY—NEWSWEEK

# Alli = Orlistat




These early **alli** users are providing honest and candid feedback on their experiences with **alli** in an effort to help others succeed on the program. "**In beginning of the alli program, I learned that there are treatment effects, so if you cheat** (by eating foods that are high in fat), **<u>you will pay the price</u>**," says Caryn Eyring, an **alli** First Team Community member. "Luckily, I've stayed within the plan so I have

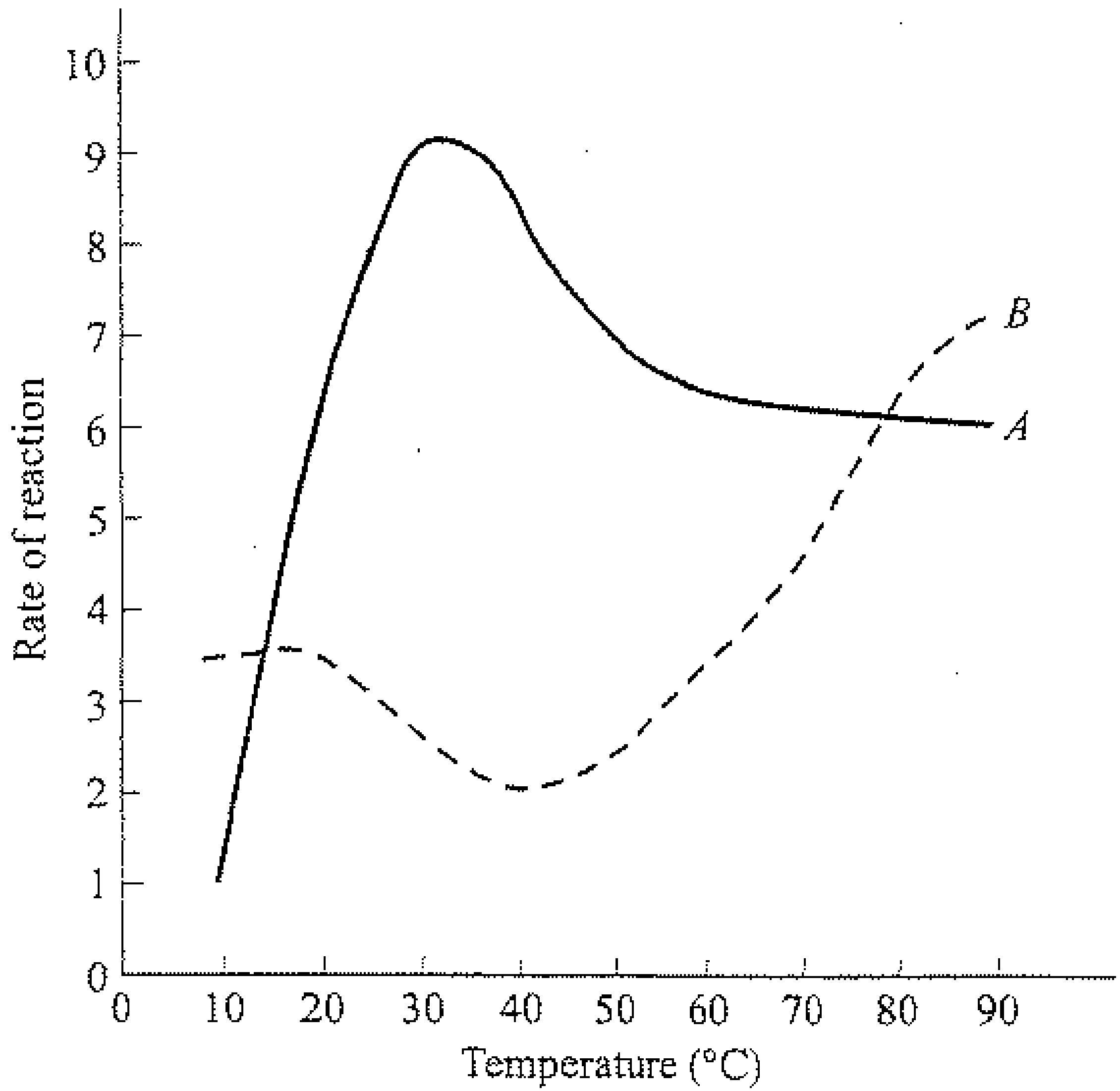
not had any treatment effects. However, I pushed the envelope once."

# Alli = Orlistat

**4. what should I do if I experience treatment effects?**

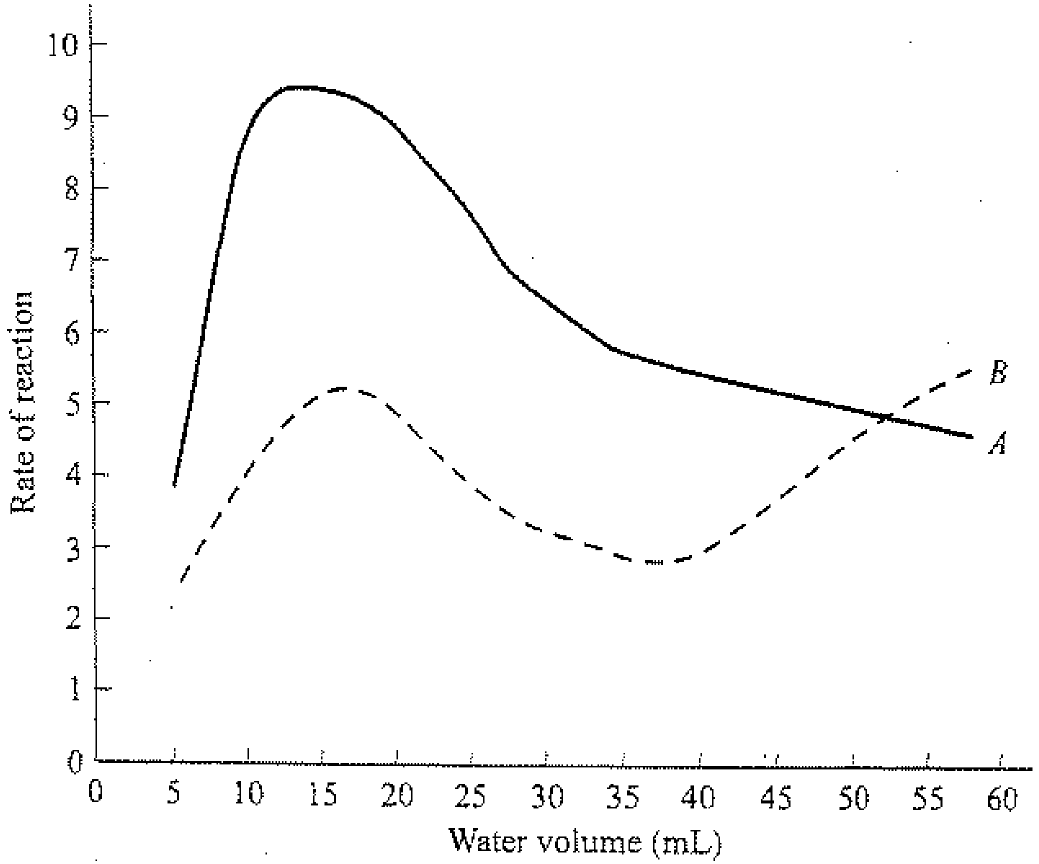
The most common treatment effects come from eating meals with too much fat while using alli capsules. Undigested fat cannot be absorbed and passes through the body naturally. The excess fat is not harmful. In fact, you may recognize it in the toilet as something that looks like the oil on top of a pizza.

The treatment effects may include gas with oily spotting, loose stools, and more frequent stools that may be hard to control. Eating a low-fat diet with 15 grams of fat per meal on average can lower the chance of experiencing these treatment effects.



Rate of reaction
10
9
8
7
6
5
4
3
2
1
0
0
10
20
30
40
50
60
70
80
90
Temperature (°C)
A
B

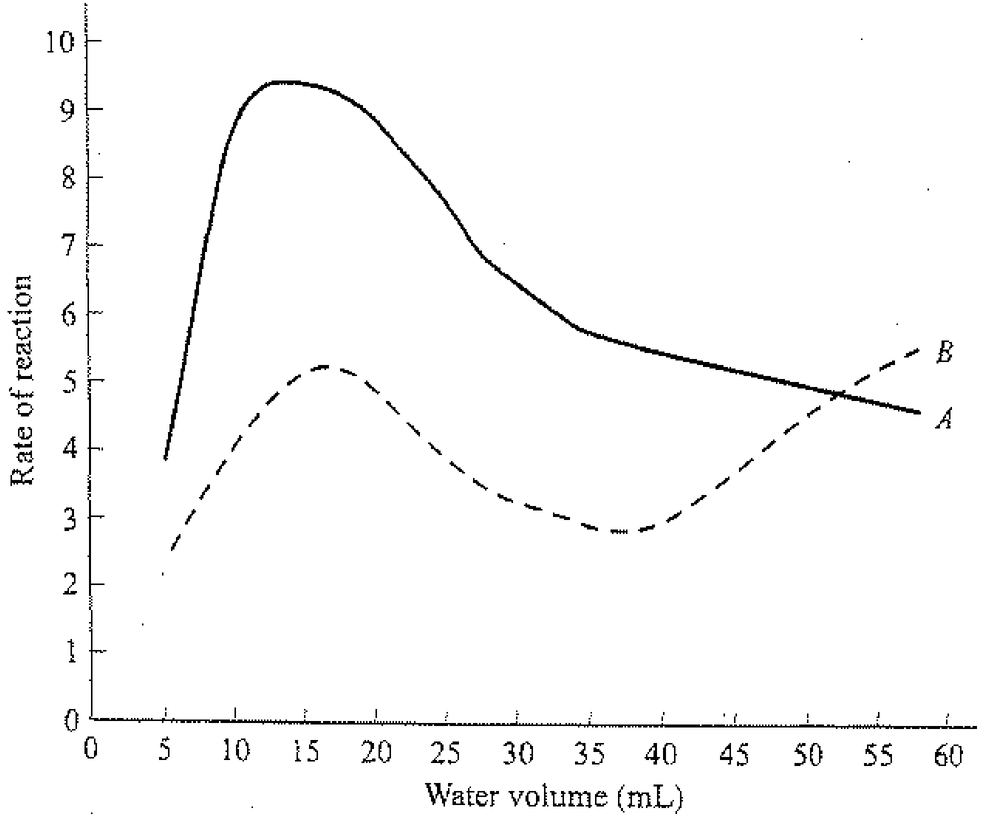

**Figure 1**




Note: The amount of amino acid is held constant.

**Figure 2**

1. According to Figure 2, Amino Acid A has the highest reaction rate at a water volume closest to:
   **A.** 0 mL.
   **B.** 4 mL.
   **C.** 12 mL.
   **D.** 20 mL.




Note: The amount of amino acid is held constant.

**Figure 2**

2. Based on the data presented in Figure 2, at approximately which of the following water volumes does Amino Acid A have the same reaction rate as Amino Acid B?

F. 30 mL
G. 40 mL
H. 50 mL
J. 60 mL

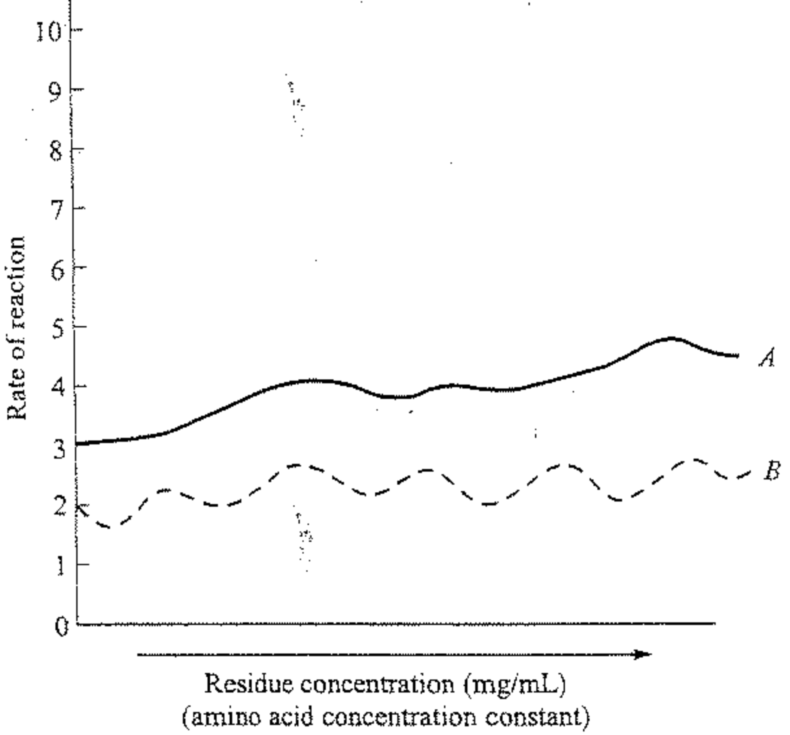



**Figure 3**

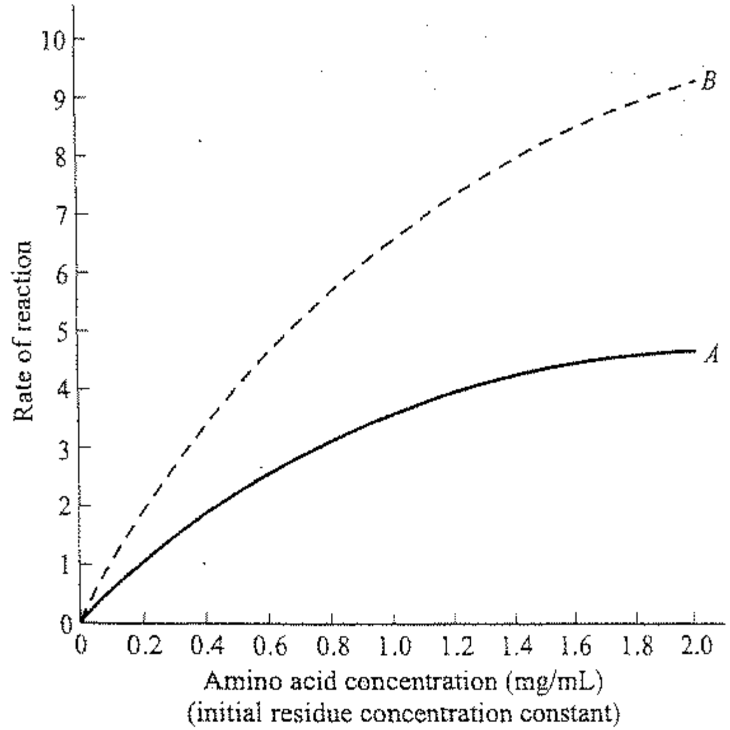



**Figure 4**

3. A researcher claims that the reaction rate of Amino Acid B is dependent on both residue concentration and amino acid concentration. Do the data in Figures 3 and 4 support this claim?
   **A.** No, the reaction rate is dependent on the amino acid concentration, but not on the residue concentration.
   **B.** No, the reaction rate is not dependent on either the residue concentration or the amino acid concentration.
   **C.** Yes, the reaction rate is dependent on both the residue concentration and the amino acid concentration.
   **D.** Yes, the reaction rate is dependent on the residue concentration, but not on the amino acid concentration.

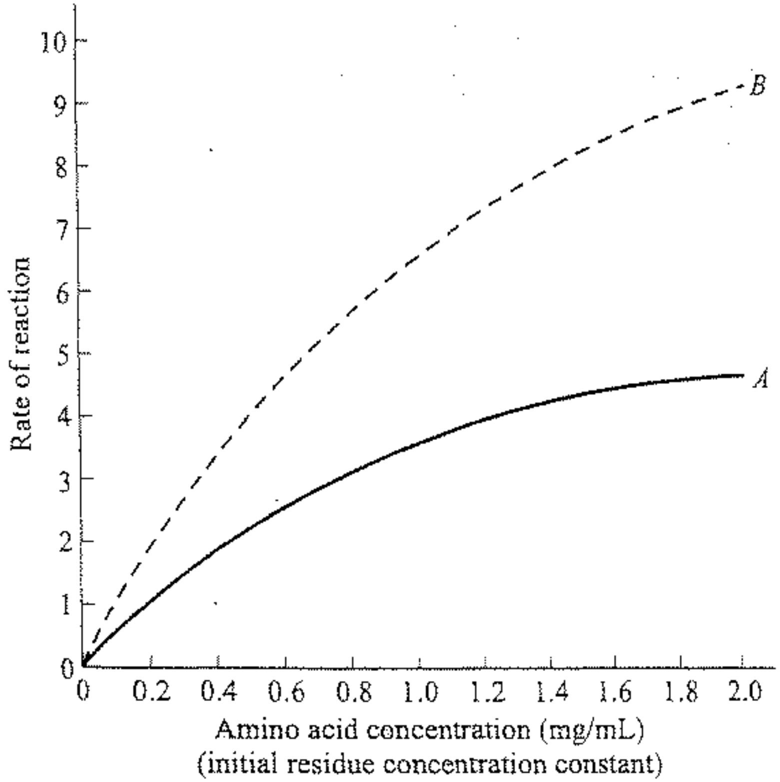



**Figure 4**

4. A researcher claims that under the conditions used to determine the data for Figure 4, the reaction rate for Amino Acid A at any given concentration will always be greater than the reaction rate for Amino Acid B at the same concentration. Do the data support this conclusion?

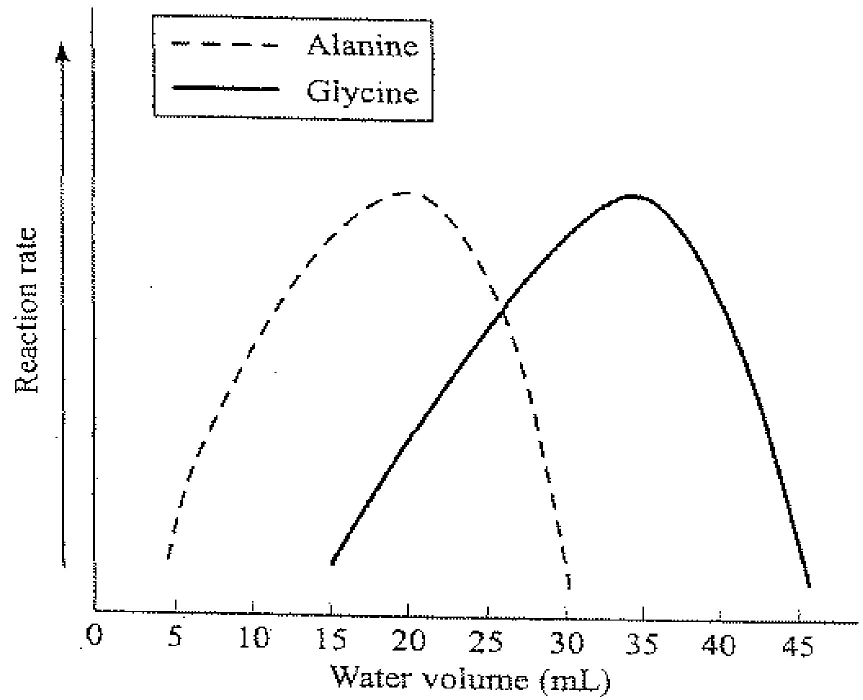
   F. No, Amino Acid A has a lower reaction rate at all given residue concentrations tested.

   G. No, Amino Acid A has a lower reaction rate at all given amino acid concentrations tested.

   H. Yes, Amino Acid A has a higher reaction rate at all given residue concentrations tested.

   J. Yes, Amino Acid A has a higher reaction rate at all given amino acid concentrations tested.

5. The figure below shows the relative reaction rates for *alanine*, an amino acid found in DNA, and *glycine* an amino acid found in the muscles.




Note: The amount of amino acid is held constant.

Based on this figure, one would best conclude that compared to the water volume at the peak reaction rate of amino acids in DNA, the water volume at the peak reaction rate of amino acids in the muscles:

**A.** is higher.
**B.** is lower.
**C.** is the same.
**D.** cannot be measured.