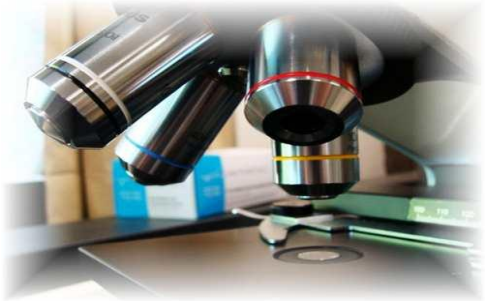

About Science Prof Online PowerPoint Resources

• Science Prof Online (SPO) is a free science education website that provides fully-developed Virtual Science Classrooms, science-related PowerPoints, articles and images. The site is designed to be a helpful resource for students, educators, and anyone interested in learning about science.

• The SPO Virtual Classrooms offer many educational resources, including practice test questions, review questions, lecture PowerPoints, video tutorials, sample assignments and course syllabi. New materials are continually being developed, so check back frequently, or follow us on Facebook (Science Prof Online) or Twitter (ScienceProfSPO) for updates.

• Many SPO PowerPoints are available in a variety of formats, such as fully editable PowerPoint files, as well as uneditable versions in smaller file sizes, such as PowerPoint Shows and Portable Document Format (.pdf), for ease of printing.

• Images used on this resource, and on the SPO website are, wherever possible, credited and linked to their source. Any words underlined and appearing in blue are links that can be clicked on for more information. PowerPoints must be viewed in *slide show mode* to use the hyperlinks directly.

• Several helpful links to fun and interactive learning tools are included throughout the PPT and on the Smart Links slide, near the end of each presentation. You must be in *slide show mode* to utilize hyperlinks and animations.

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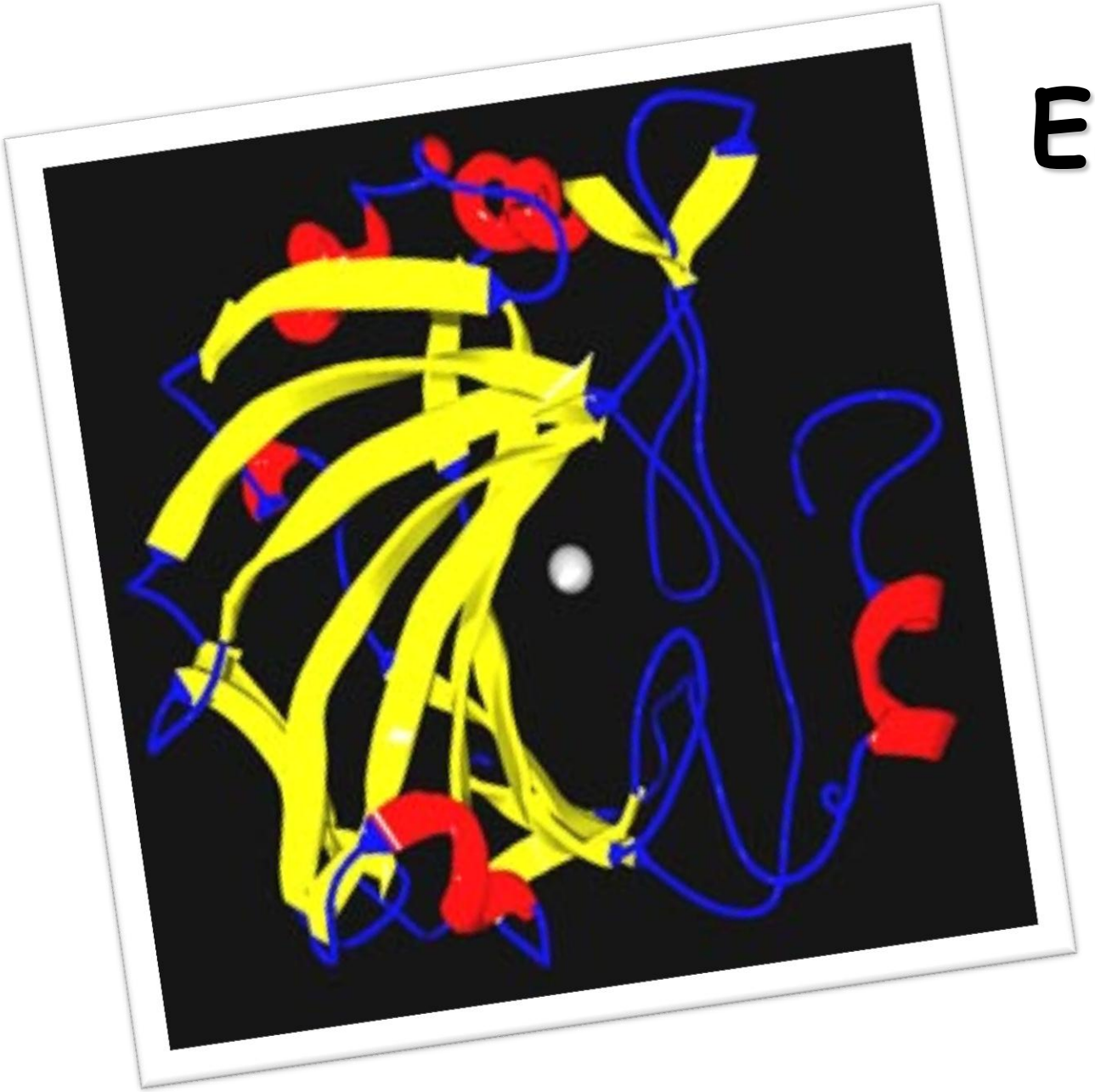
Image: Compound microscope objectives, T. Port



Enzymes

Image: Enzyme Carbonic Anhydrase, Labrador2

From the Virtual Cell Biology Classroom on ScienceProfOnline.com

Apple Experiment

Come down and get an apple and a slice of lemon.

When you get back to your seat:

1. Take a big bite of your delicious apple.

2. Immediately squeeze lemon juice over the apple flesh that is now exposed from the bite.

3. IMPORTANT! Don't get lemon juice all over the apple. Make sure that it is ONLY on the area that you just bit!

4. Set the lemon aside and wipe any lemon juice off of your hands with a napkin.

5. Take another bite from the opposite side of your apple.

6. Set your apple aside.

What are enzymes?

Enzymes are _____ (tertiary and quaternary structures).

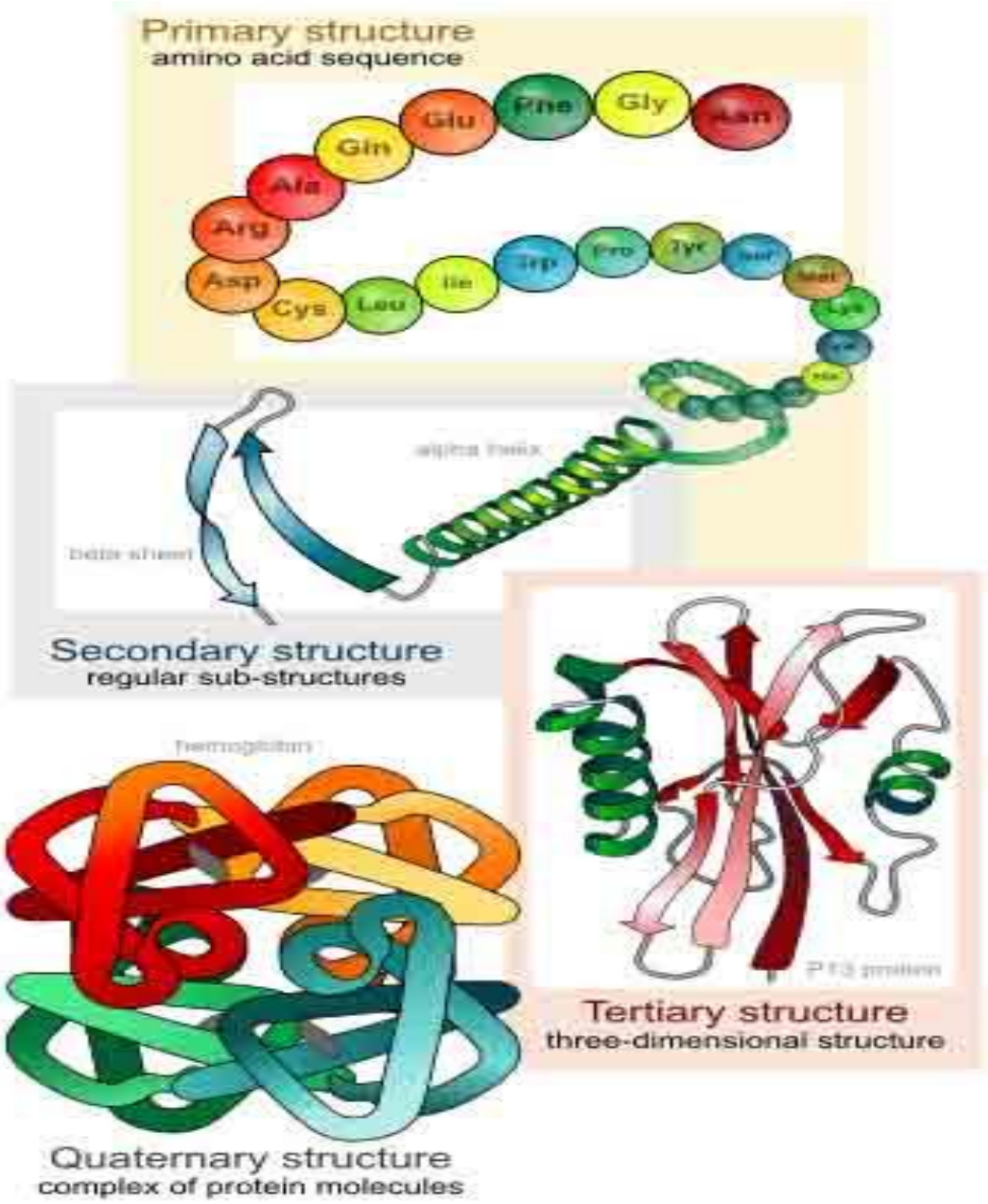
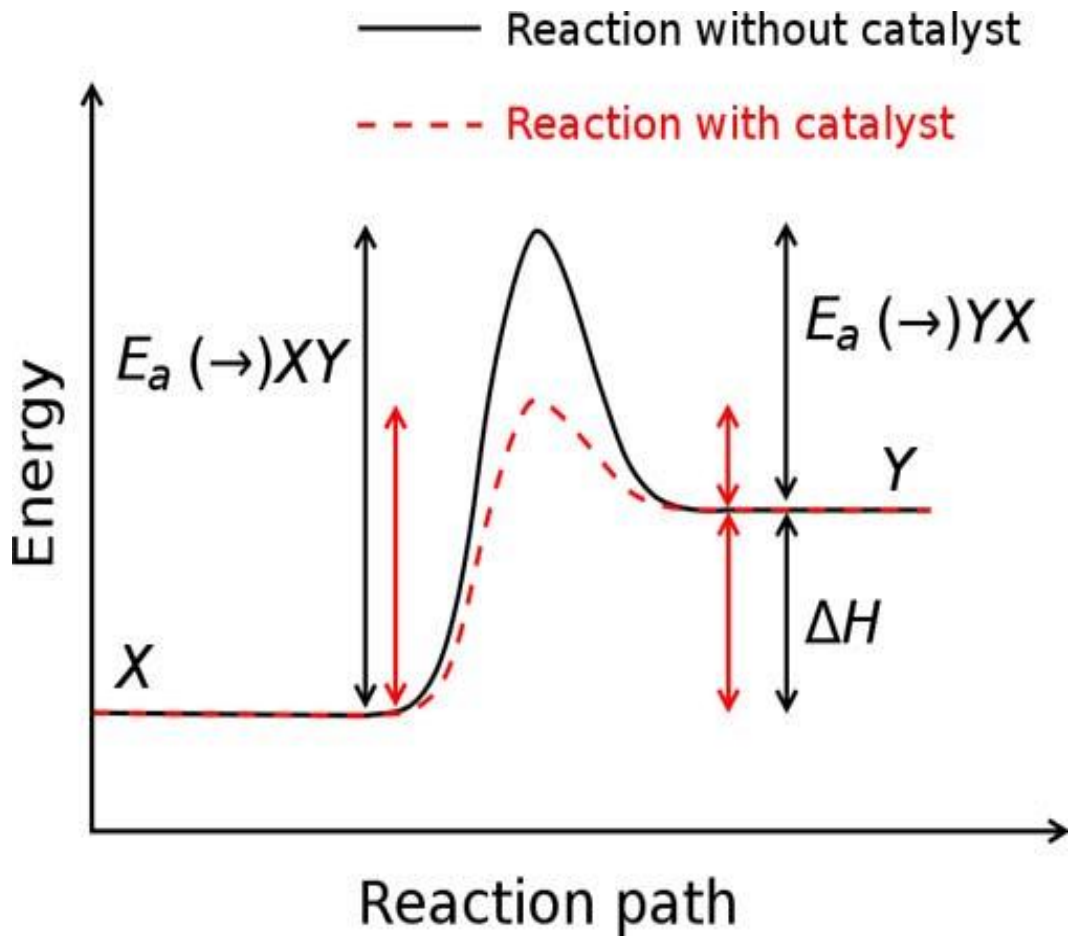


Image: Levels of protein structure, M Ruiz

What do enzymes do?

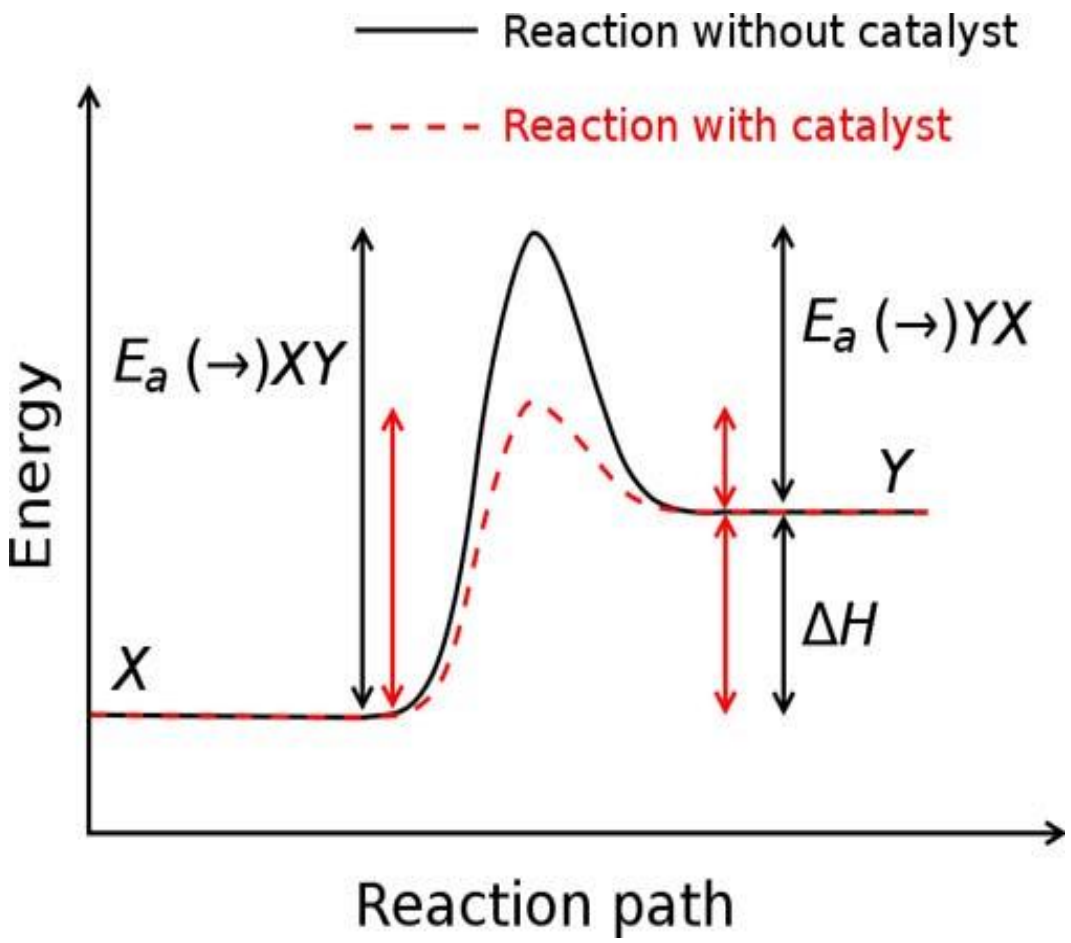
- Enzymes act as _____ in cellular reactions.

- ***Q**: What does a catalyst do?*



Images: Activation energy graph, Wiki

How do enzymes work?



Enzymes catalyze reactions by weakening chemical bonds, which _____ activation energy.

Image: Activation energy graph, Wiki

How do enzymes work?

- Each enzyme has a unique 3-D shape, including a surface groove called an _____ _____.
- The enzyme works by binding a specific chemical reactant (_____) to its active site, causing the substrate to become unstable and react.
- The resulting _____ (s) is then released from the active site.

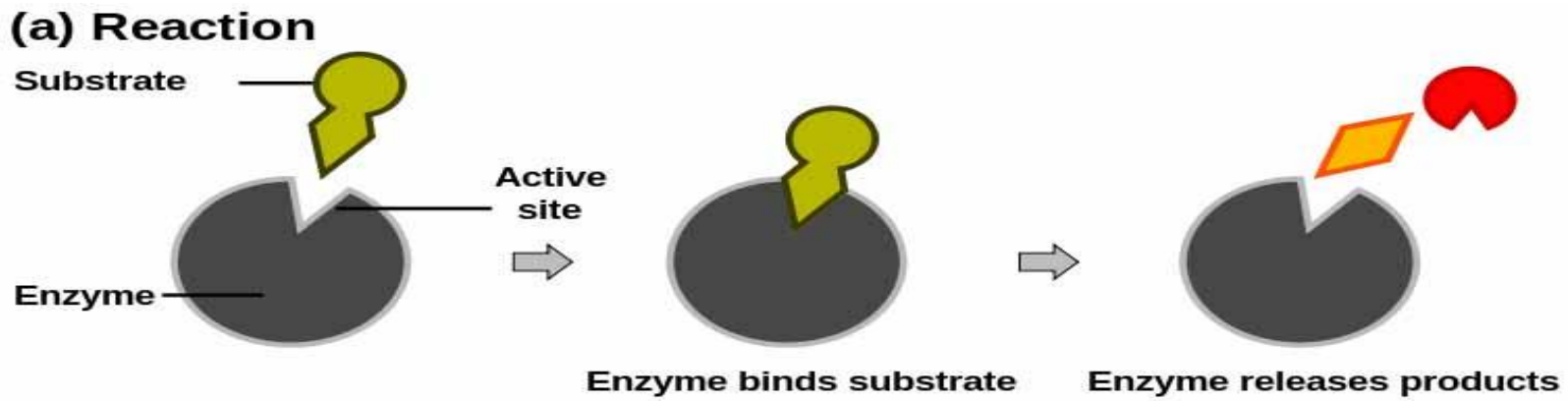


Image: Enzymatic reaction, Jerry Crimson Manni

Enzymes…

- are _____ for what they will **catalyze**.

- fit with substrate like a ____ and ____.

When an enzyme is interacting with it's substrate, during the chemical reaction, together they are referred to as the …

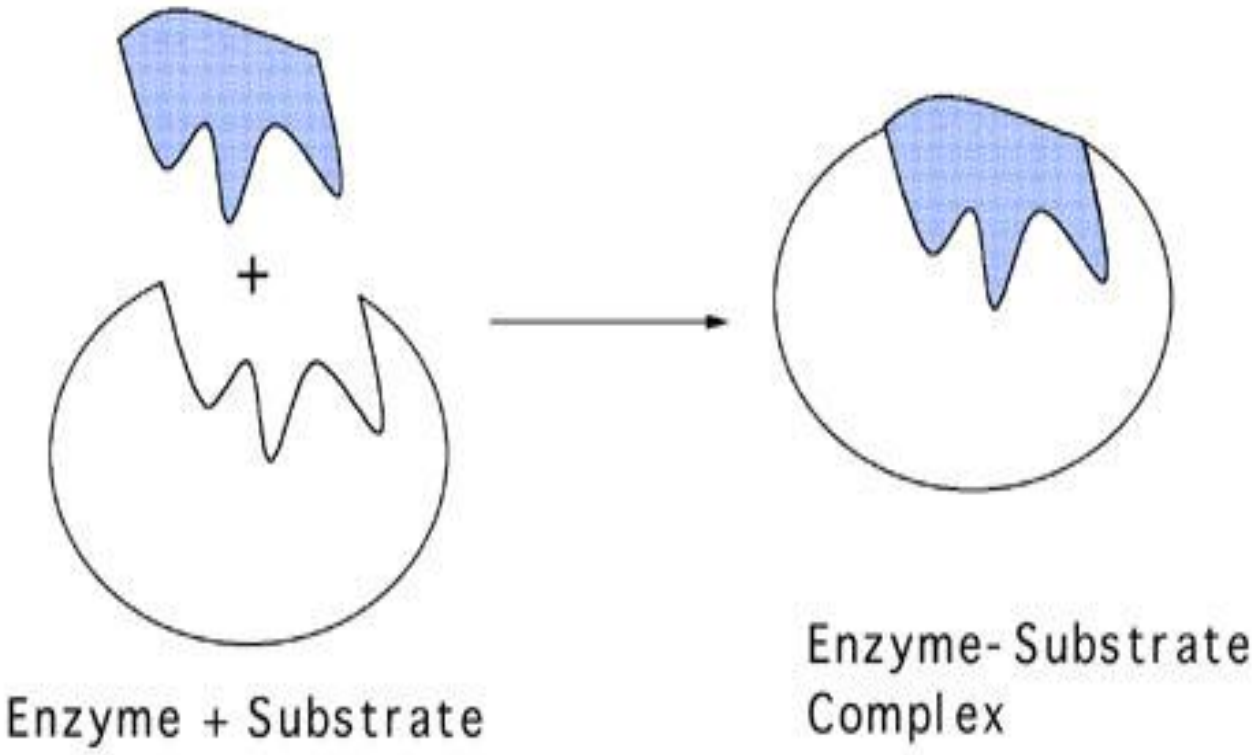


Image: Enzyme –substrate complex, UC Davis

Enzymes…

…are _____.

They are not consumed (used up) in the reactions they catalyze.

Enzymes are like tiny machines within living things.

The more cans (substrate), the more $ (product).
The more recycling machines (enzymes), the faster the cans turn into $.

Enzymes…

- Have names that usually end in -_____.

  -Sucrase

  -Lactase

  -Maltase

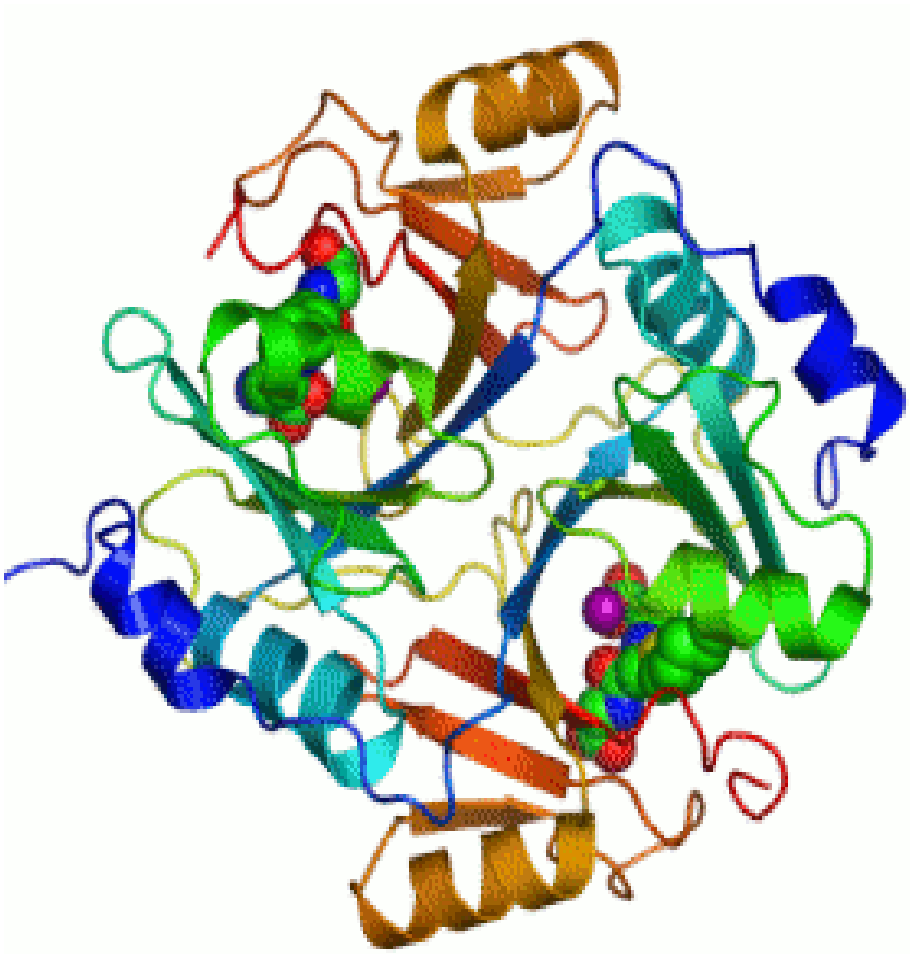


Image: Animation of Enzyme, Wiki

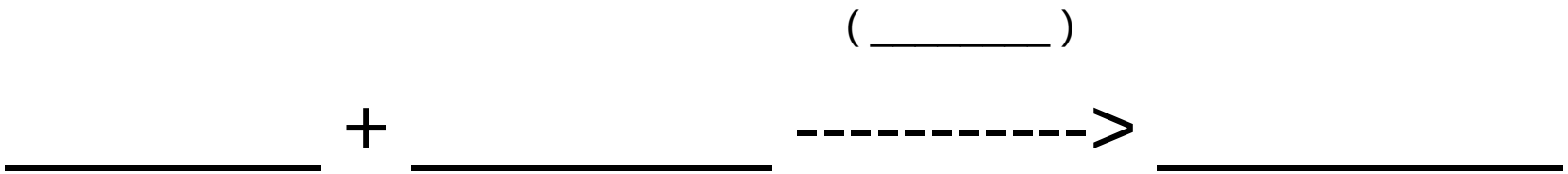
Why Are Enzymes So Important?

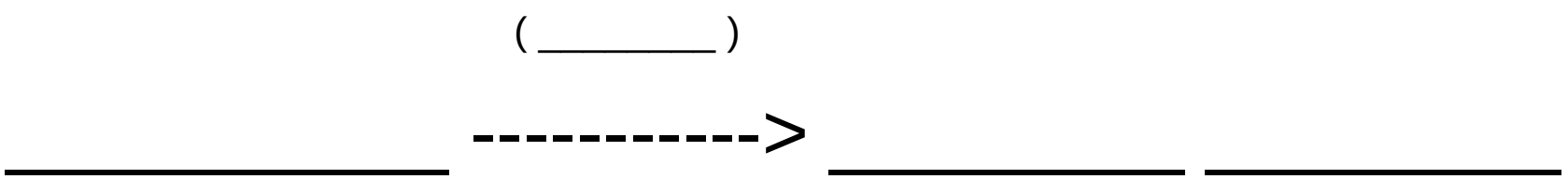
Why are we devoting one whole lecture topic to a protein molecule?

Nearly all chemical reactions in biological cells need enzymes to make the reaction occur fast enough to support life.

Image: Jumping rope, Meagan E. Klein

Formats for writing a enzymatic reaction.





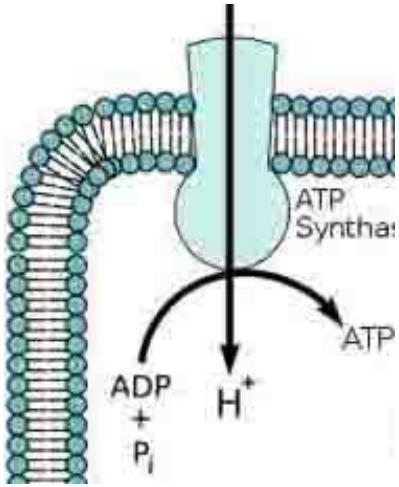
Meet the Enzyme: _____ _____

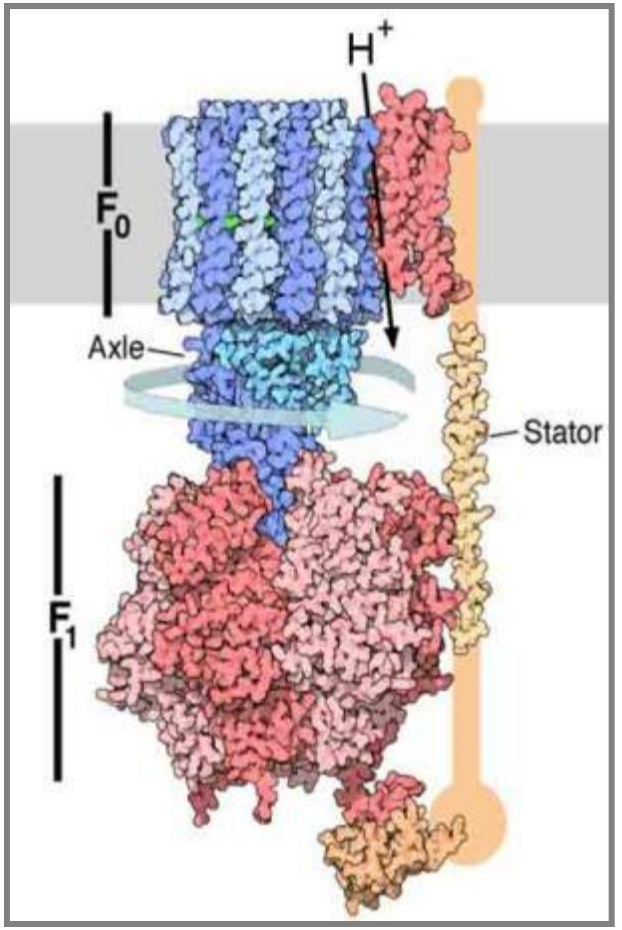
Important metabolic enzyme that harnesses energy for biological cells to use.

Involved in **synthesis** of adenosine triphosphate (ATP), from:

- adenosine diphosphate (ADP)
- a phosphate group and
- energy from H+ ion gradient

ATP is the most commonly used "energy currency" of cells.





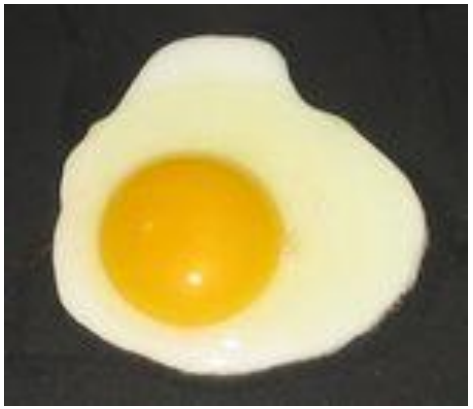
Reaction:

$$ADP + Pi \xrightarrow{\text{(ATP synthase)}} ATP$$

substrate substrate product

Images: ATP synthase diagram, Tim Vickers

How do you stop an enzyme?



_____ _____!

- Alteration of a protein shape through some form of external stress

- Example, by applying heat or changing pH.

- Denatured protein can't carry out its cellular function .

Irreversible egg protein denaturation caused by high temperature (while cooking it).

Factors That Influence Enzyme Activity

- Temperature
- pH
- Cofactors & Coenzymes
- Inhibitors

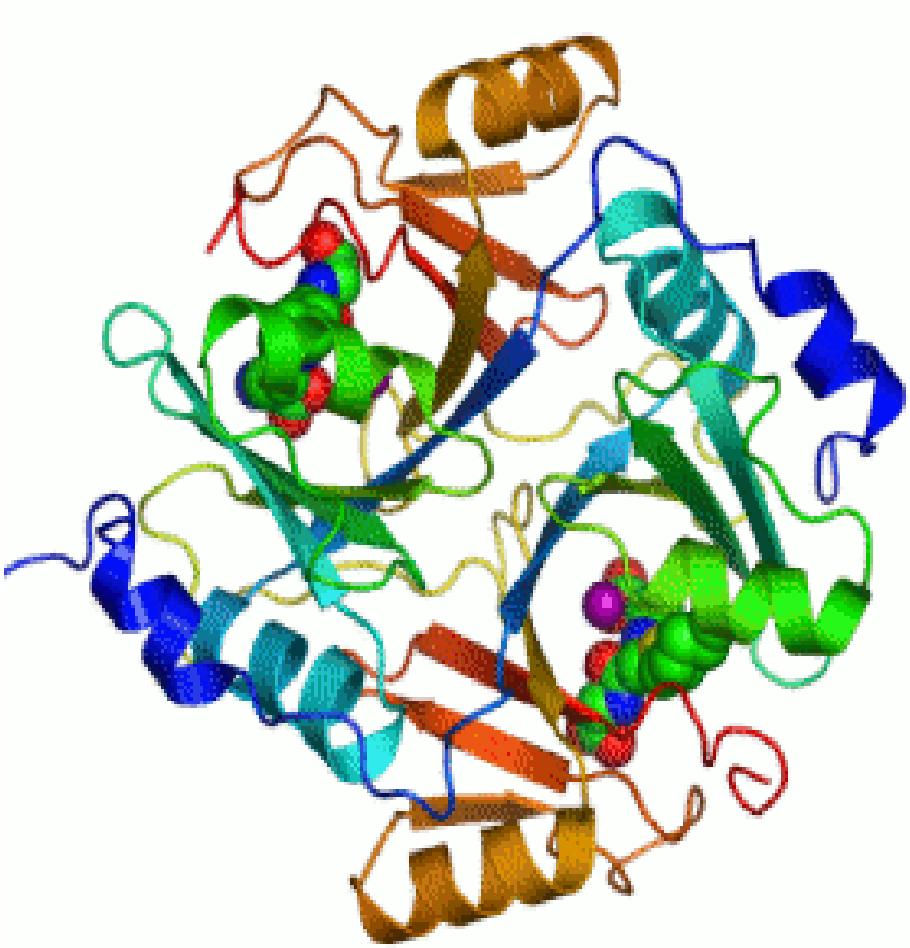
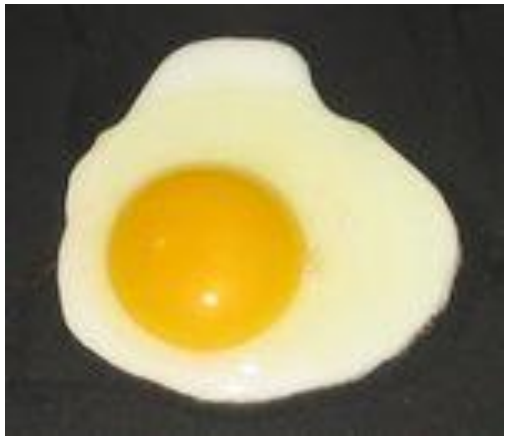


Image: Animation of Enzyme, Wiki

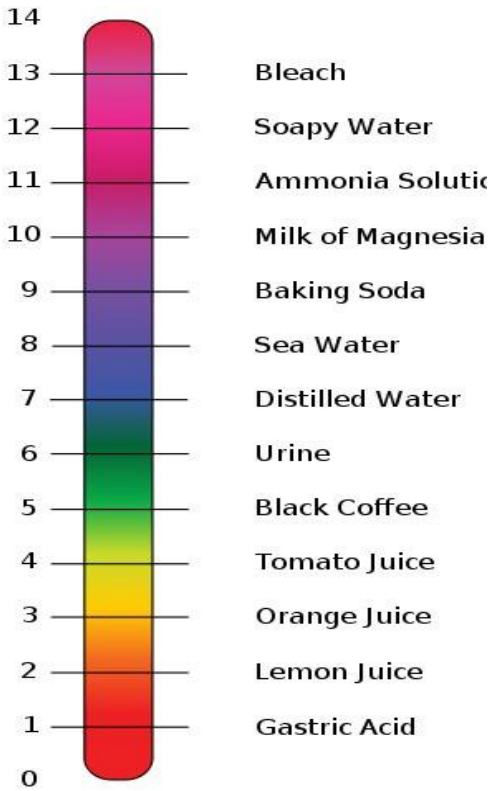
Temperature & pH



- Think about what kind of cell or organism an enzyme may work in…

- Temperatures far above the normal range _____ enzymes. (This is why very high fevers are so dangerous. They can cook the body's proteins.)

- Most enzymes work best near _____ pH (6 to 8).



Images: pH scale, Edward Stevens, Wiki

Factors That Influence Enzyme Activity

- Temperature
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- **Cofactors & Coenzymes**
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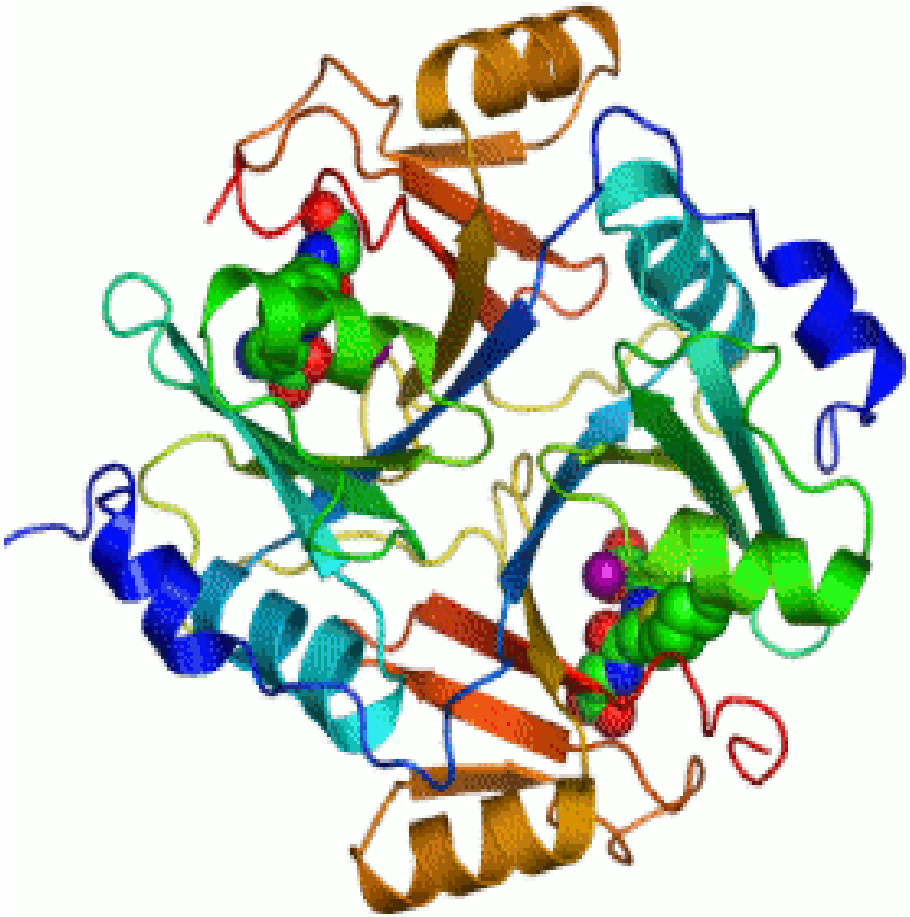


Image: Animation of Enzyme, Wiki

Cofactors & Coenzymes

- **Non-protein** substances (zinc, iron, copper, vitamins) are sometimes need for proper enzymatic activity.

- **Coenzyme vs Cofactor:** What's the difference?

  _____ more general term. Includes inorganic and organic molecules.

  _____ type of cofactor, But specifically organic molecules.

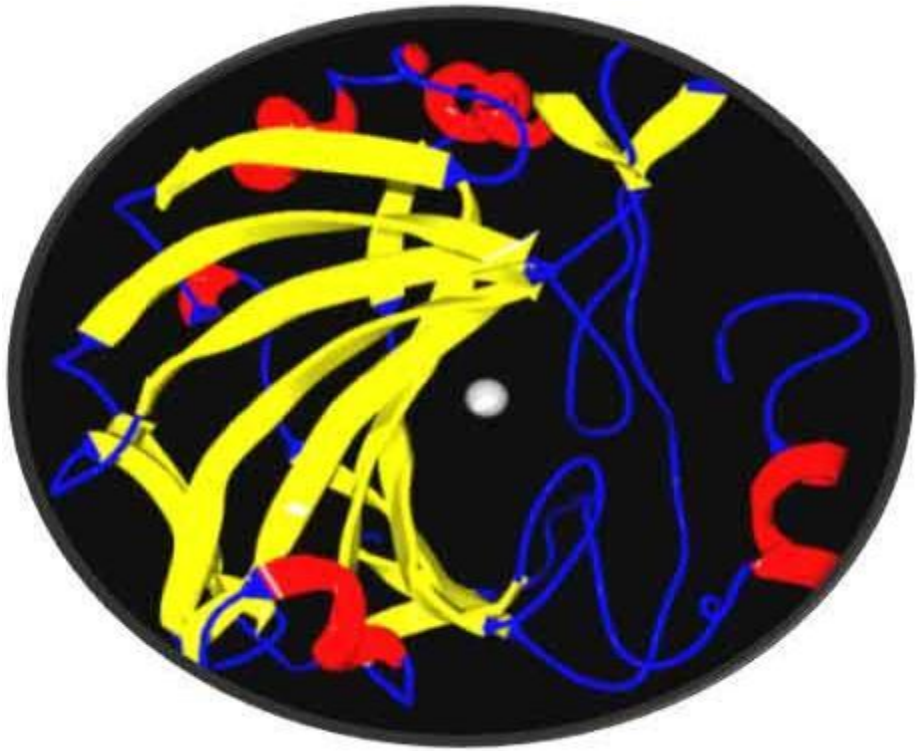
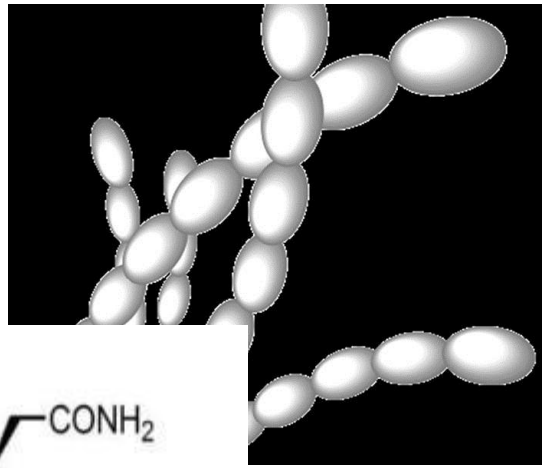
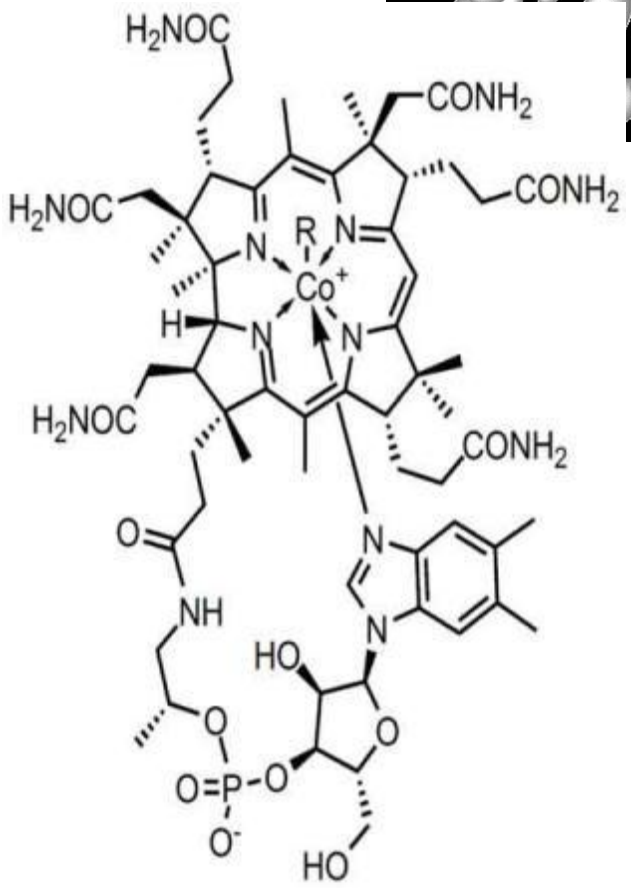


Image: Enzyme with Cofactor, Wiki. Ribbon-diagram showing carbonic anhydrase II. The grey sphere is the zinc cofactor in the active site.

Coenzyme: Vitamin B12



- Most _____ are coenzymes essential in helping move atoms between molecules in the formation of carbohydrates, fats, and proteins.
- Exclusively synthesized by _____.
- Dietary sources include meat, eggs, dairy products and supplements.



Images: *Streptomyces* spores, Wiki; Vitamin B12 chemical structure, Wiki

Factors That Influence Enzyme Activity

- Temperature
- pH
- Cofactors & Coenzymes
- **Inhibitors**

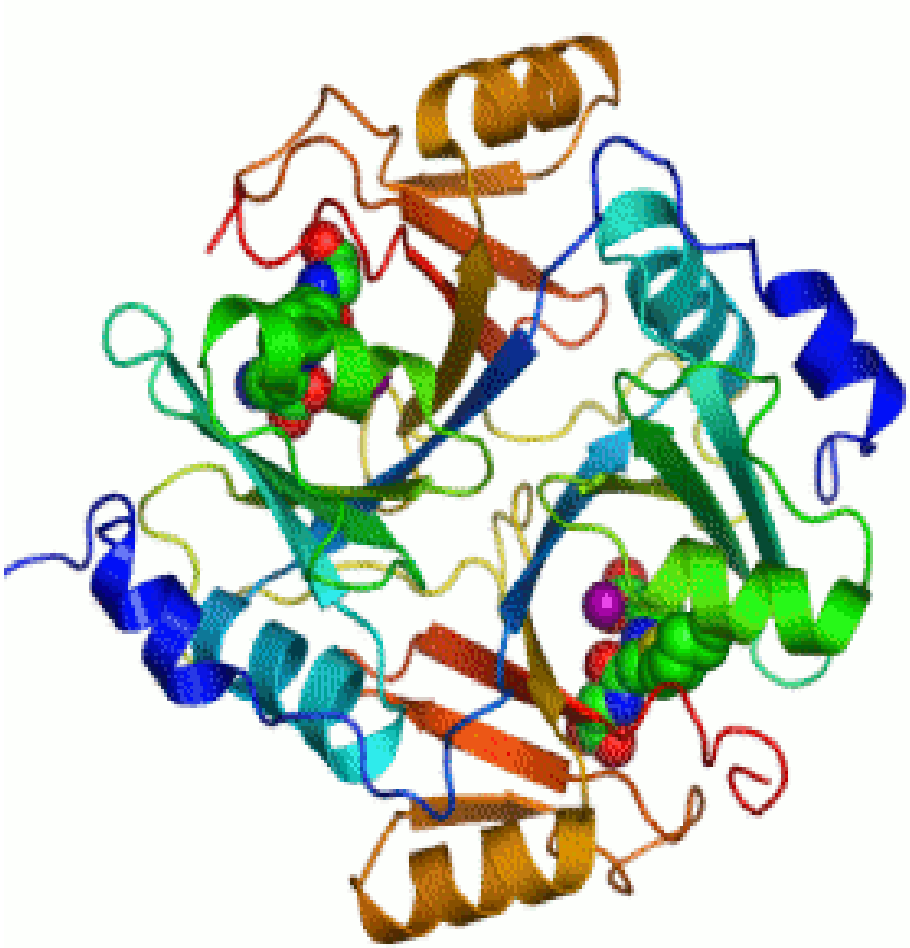


Image: Animation of Enzyme, Wiki

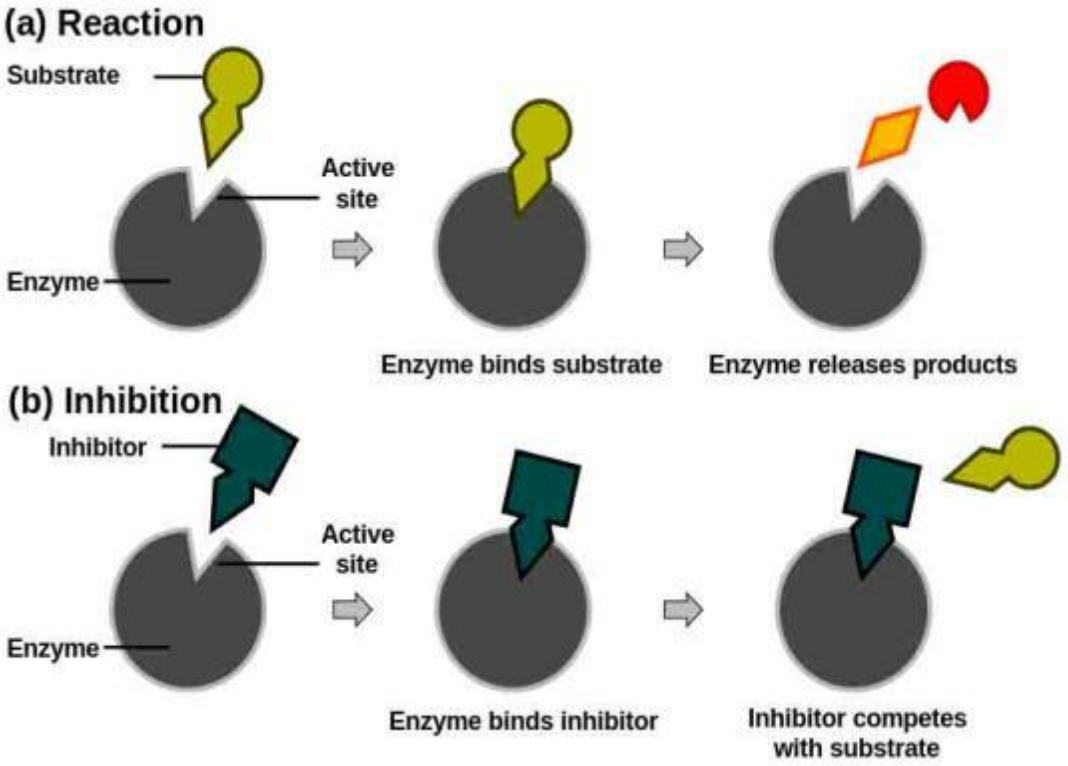
Two Types of Enzyme Inhibitors

1. _____

_____

Chemicals that resemble an enzyme's normal substrate and compete with it for the active site.

Reversible depending on concentration of inhibitor and substrate.



EXAMPLE: The drug **Antabuse** is used to help alcoholics quit drinking. Antabuse ***inhibits aldehyde oxidase***, resulting in the accumulation of acetaldehyde (say a-si-'tell-de-hide) during the metabolism of alcohol. Elevated acetaldehyde levels cause symptoms of nausea and vomiting.

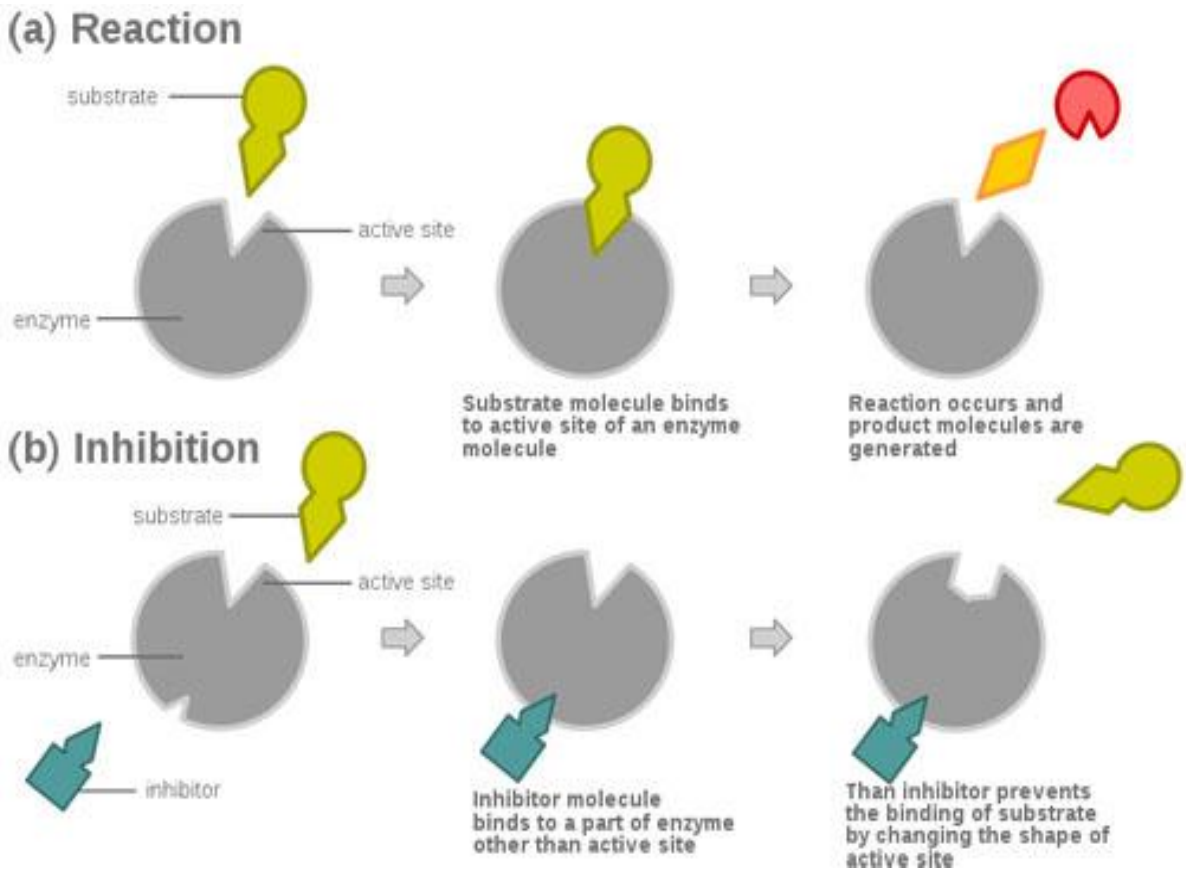
Image: Competitive inhibition of enzyme, Jerry Crimson Mann

Two Types of Enzyme Inhibitors

2. _____
_____

Do not enter active site, but bind to another part of the enzyme, causing the enzyme & active site to change shape.

Usually reversible, depending on concentration of inhibitor & substrate.



EXAMPLE: You may know that compounds containing **heavy metals** such as lead, mercury, copper or silver are **poisonous**. This is because ions of these metals are non-competitive inhibitors for several enzymes.

Image: Pouring liquid mercury, Bionerd

Enzyme Inhibitors

Blocking an enzyme's activity can kill a pathogen or correct a metabolic imbalance.

Many _____ are enzyme inhibitors.

Enzyme inhibitors are also used as _____ and _____.

EXAMPLE:

- Another example of competitive inhibition is **protease inhibitors**.
- They are a class of **anti-retroviral drugs** used to treat HIV.
- The structure of the drug ritonavir *(say ri-TAHN-a-veer)* **resembles the substrate of HIV protease**, an enzyme required for HIV to be made.

Images: Prescription bottle, T. Port; Dead cockroach, Wiki

Meet the Enzyme: Catecholase

- Catecholase is present in most _____ and _____.

- It is the enzyme that facilitates the _____ of cut or bruised fruits and vegetables by **catalyzing** the following reaction:

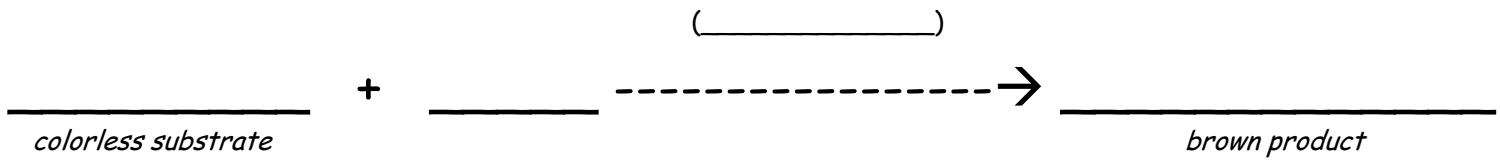


Image: Bananas T. Port

Meet the Enzyme: **Catecholase**

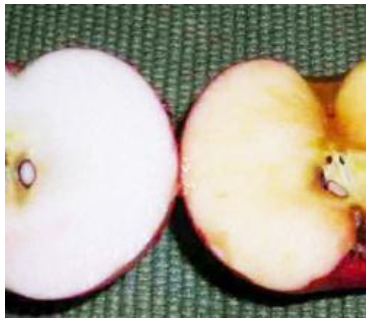
_____ juice and other acids are used to preserve color in fruit, particularly apples, by lowering the ____ and removing the **copper** (cofactor) necessary for the enzyme to function.

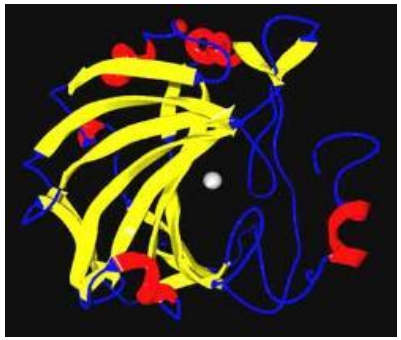
Reaction:

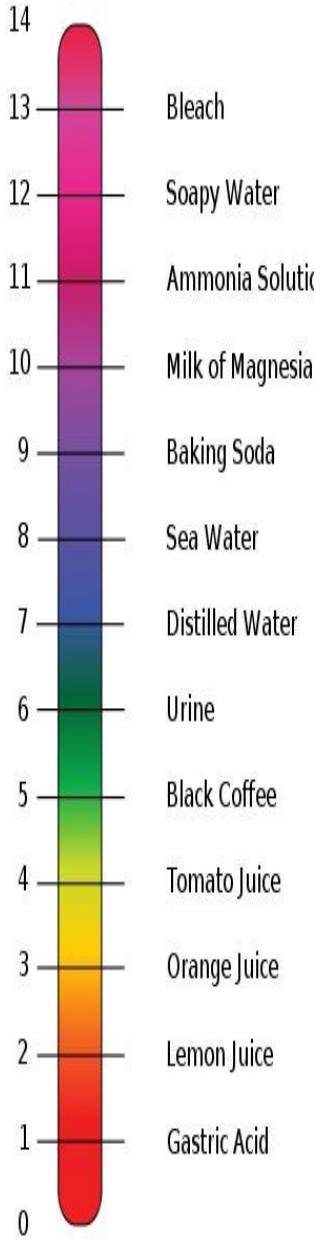
catecholase

catechol + O_2 ----------→ polyphenol

colorless substrate *brown product*







Images: Apples, T. Port; Lemons, André Karwath; Enzyme with Cofactor, Wiki; pH scale, Edward Stevens, Wiki

Meet the Enzyme: Bromelain

- Pineapple contains enzyme **bromelain**, which can _____ _____.
- Jell-O® is made of *gelatin*, a processed version of a **structural protein** called _____ found in many animals, including humans.
- Collagen = big, fibrous molecule makes skin, bones, and tendons both strong and elastic.
- Gelatin you eat in Jell-O ® comes from the collagen in cow or pig bones, hooves, and connective tissues. (Yummie!)
- Examine 2 containers:

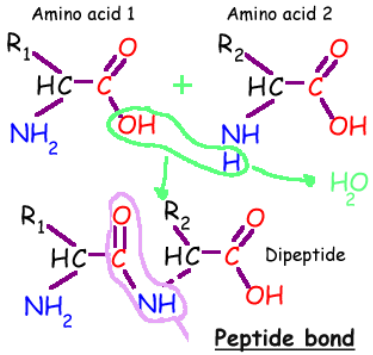
  a. In one, canned pineapple was used to make Jell-O® .

  b. The other, fresh pineapple was used.

  Q: Why is one Jell-O solid and the other liquid?

Image: Pineapple, Whaldener Endo

Meet the Enzyme: Bromelain



Bromelain is a _____ enzyme that facilitates hydrolysis of protein.

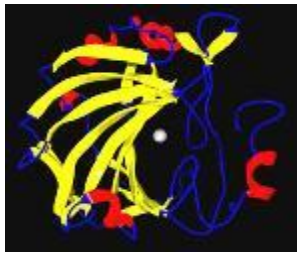
Remember, hydrolysis cuts molecule by adding water…the reverse of the hydration synthesis pictured to the left.

(bromelain)

collagen protein + H_2O ----------→ amino acids

substrate products

FYI: Bromelain is used as a meat tenderizer. Breaks down the collagen in meat. So what do you think could happen to your tongue when you eat fresh pineapple?



"Goodtimes with Enzymes"

(to the tune of "Goodtimes" by Chic)

by Annette M. Parrott, PhD

CHORUS:

Enzymes, These are the enzymes
With substrates combine
Leave products behind

Enzymes, Reduce reaction time
With substrates combine
These are the enzymes

Enzymes are proteins usually ending in "-ase"
They change but are not changed, the definition of a catalase
Combine with substrates to break them apart
Their specific activation site makes sure they hit the mark

There's a reaction that you want to go
Without an enzyme it'll move too slow
Enzymes lower activation energy
And once that's lowered you're home free

CHORUS

Amino acids are the monomers
of a polypeptide a protein polymer
They require a specific temperature
And if it's not exact they can be denatured

They are specific, my lock to your key
Unlocks the active site so we can proceed
Now you know enzyme you can sing it with me
On the count of three…1…2…3.

CHORUS

Image: Enzyme with Cofactor, Wiki

Confused?

Here are some links to fun resources that further explain enzymes:

Smart Links

- Enzymes Main Page on the Virtual Cell Biology Classroom of Science Prof Online.
- "How Enzymes Work" an animation from McGraw-Hill.
- Interactive Enzyme Tutorial and quiz from *Life: The Science of Biology.*
- "The Role Enzymes Play in the Body" from Enzymedica. These guys are selling supplements. I don't endorse the supplement, but their video is very instructive regarding enzymes and digestion.
- "Assignment Discovery: Enzyme Catalysts" from HowStuffWorks, a Discovery Company.
- "Enzymes and Digestion" from About.com.
- "Bio Rad GTCA Song" musical advertisement for SsoFast™.
- And why not sing "Goodtimes with Enzymes" to the Chic song "Goodtimes." See next slide for lyrics.

(You must be in PPT slideshow view to click on links.)

Assignment

See the ScienceProfOnline Virtual Cell Biology Classroom: **Enzymes Lecture** for a printable Word .doc of this assignment.

- At the end of most lectures, I will give you some type of in-class assignment or homework to evaluate your understanding of today's topic.
- This assignment will always be open-book.
- Today you may be completing an *experiment* on the topic of **Enzymes**.

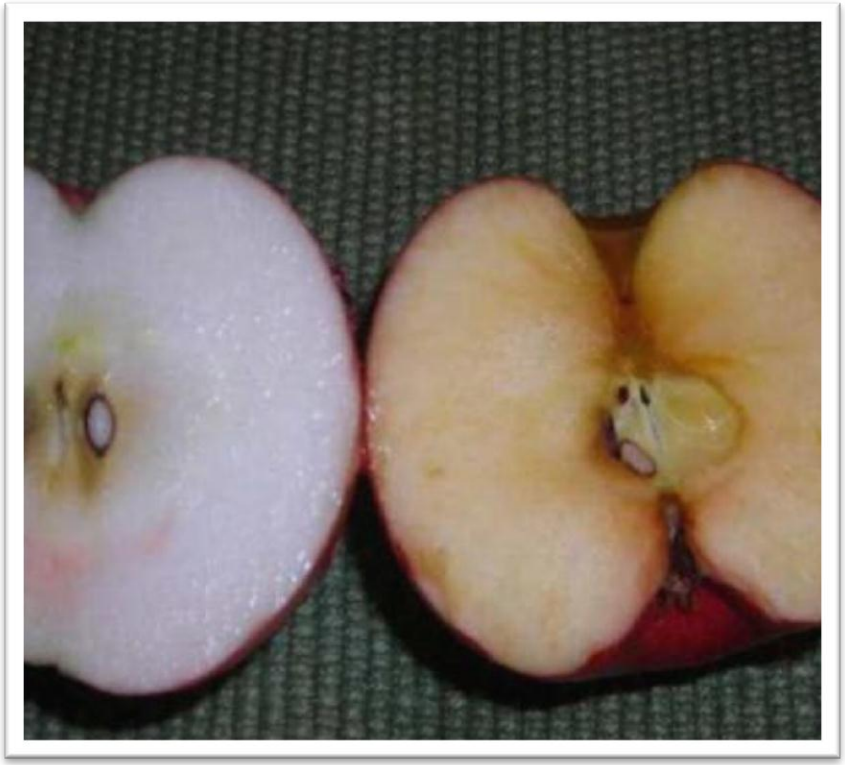
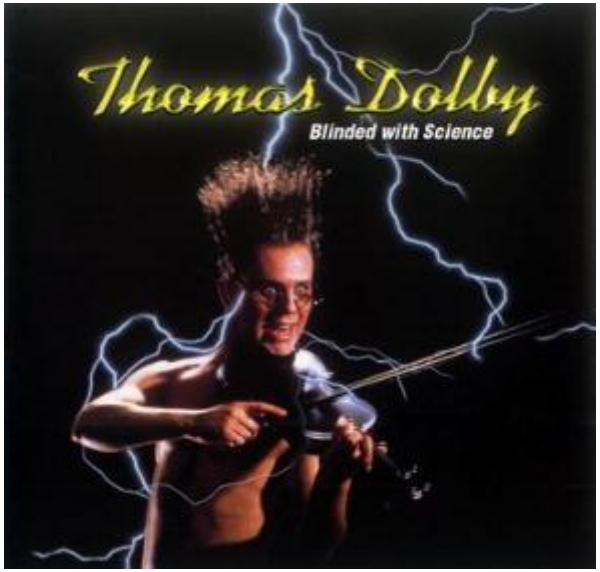


Image: Accumulation of polyphenol in apple, T. Port



Are you feeling blinded by science?

Do yourself a favor. Use the…

Virtual Cell Biology Classroom *(VCBC)*!

The VCBC is full of resources to help you succeed, including:

- practice test questions
- review questions
- study guides and learning objectives
- PowerPoints on other topics

You can access the VCBC by going to the Science Prof Online website
www.ScienceProfOnline.com

Images: Blinded With Science album, Thomas Dolby; Endomembrane system, Mariana Ruiz, Wiki