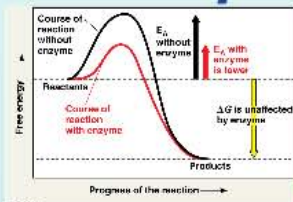


Cellular Energetics

Practice Enzymes!

"-ase"

A common nomenclature suffix for enzymes. Usually refers to enzyme's substrate.



Biological catalysts.

Proteins and some RNA molecules (examples?)

How do they do it?

Induced Fit

The shape of the active site of an enzyme is shape-specific for a particular substrate.

The binding of a substrate to the active site induces the necessary conformational change of the enzyme to catalyze the reaction.



The active site is localized to a small area of the enzyme.

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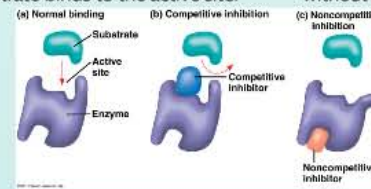
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Competitive Interactions

A molecule other than the substrate binds to the active site.



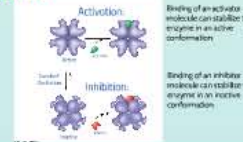
Non-Competitive Interactions

Regulation is accomplished without occupying the active site.

Allosteric Interactions

"Other-site"

Stimulate or inhibit enzyme activity by causing a conformational change in the enzyme.



Binding of a substrate molecule to an active subunit of an enzyme can also trigger stabilizations of the active conformation in all subunits ("cooperativity").



Organization:

Compartmentalization

Localization of specific enzymes into the reactions they mediate within compartments of the cell allow for more control over when and where particular metabolic reactions occur in eukaryotes.



Environmental Influence:

Local proteins, enzyme structure and therefore reaction rate can be affected by the conditions of the organism's environment.

These are their major environmental conditions that affect enzyme structure and function.



Feedback:

Many metabolic pathways are regulated by feedback inhibition that stabilize the metabolic pathway that result in the production of those molecules.



Cellular Energetics

Practice

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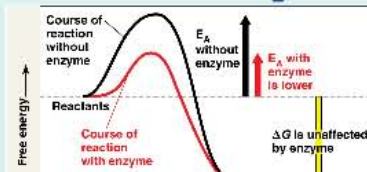
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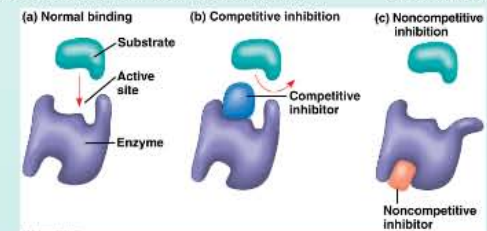
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Binding of a substrate molecule to an active site



Big Questions:

How do living systems control their metabolism?

How do living systems carry out a wide variety of specific chemical reactions?

Cellular Energetics

Big Question:
How do enzymes control the reaction?
How does the cell control the activity of enzymes?

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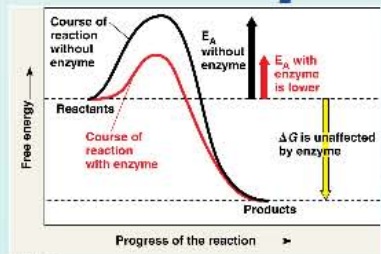
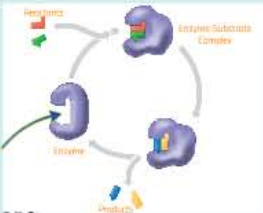
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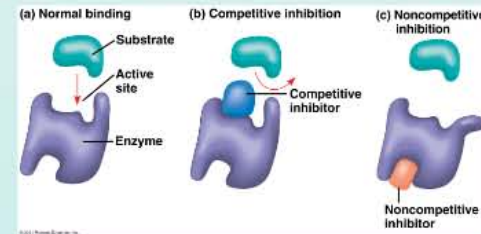
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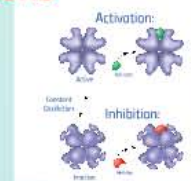
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Allosteric Interactions

"Other-site"

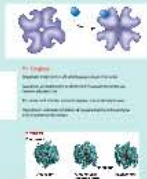
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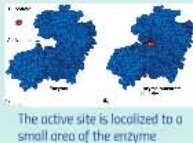
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Feedback:

Many metabolites have regulatory effects on enzymes that catalyze the metabolic pathways that result in the production of those metabolites.



How does the cell regulate enzyme activity?
Enzymes are regulated by various factors including allosteric regulation, covalent modification, and gene expression control.



Enzymes!

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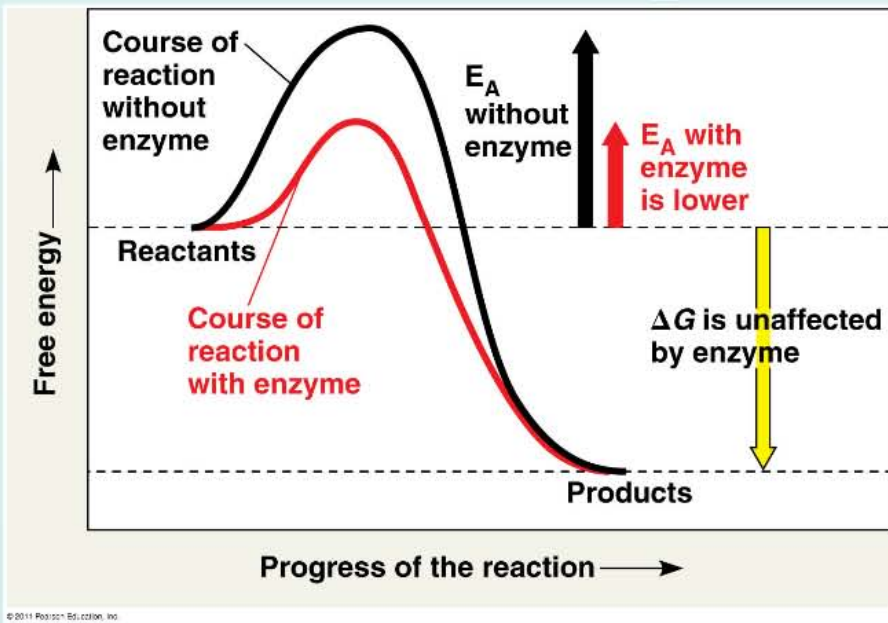
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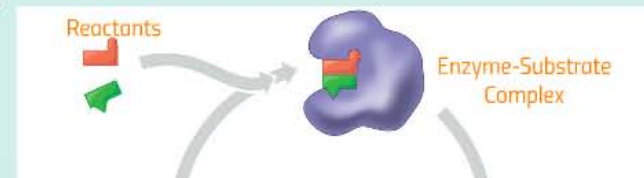
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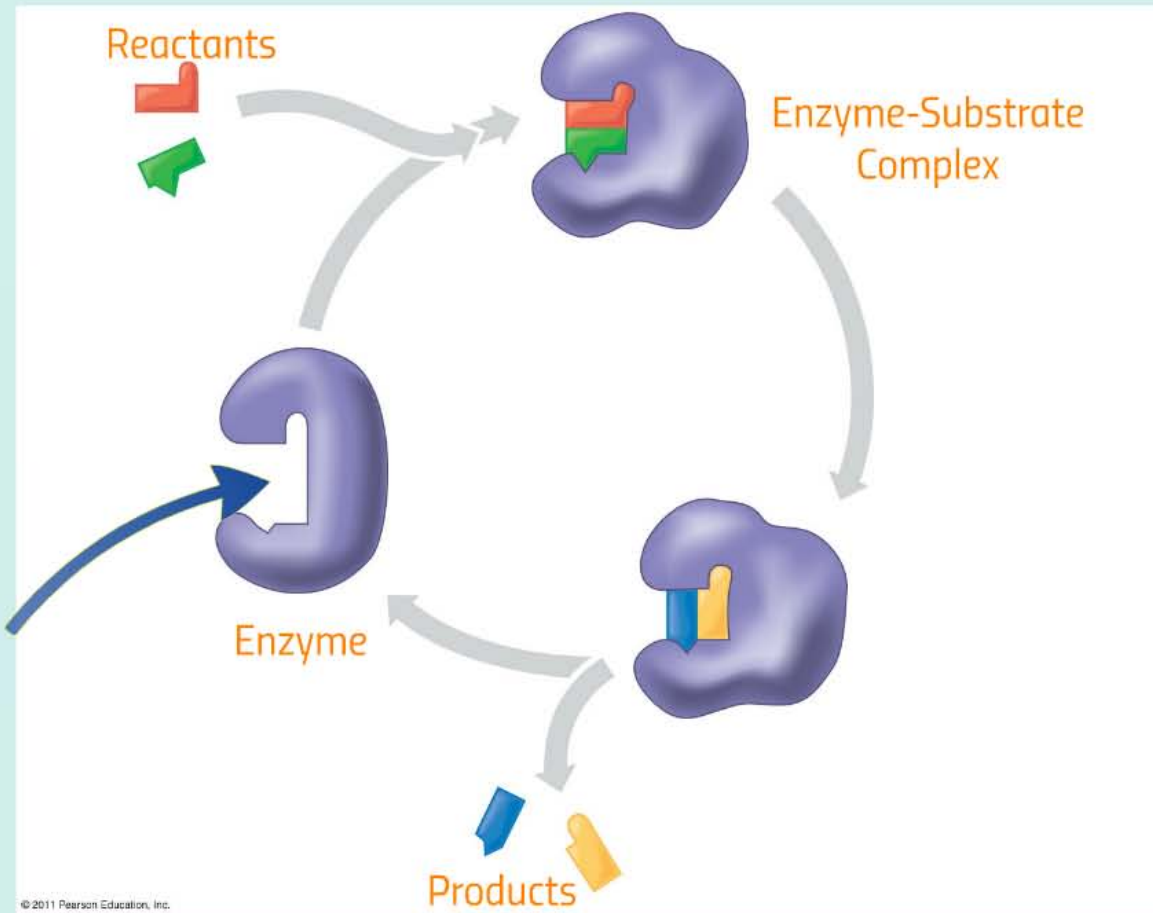
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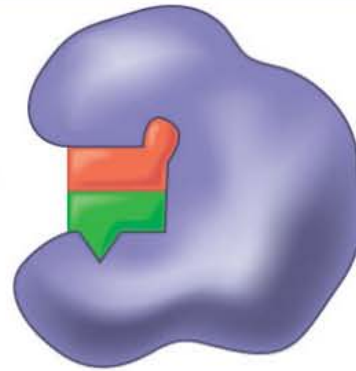
Key Considerations:

role in enzyme structure and

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a
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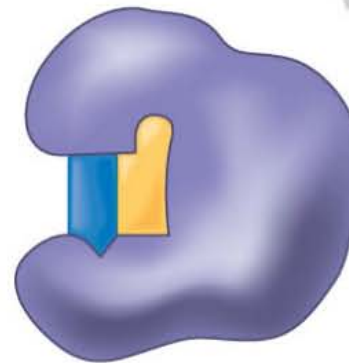
Reactants



Enzyme-Substrate
Complex



Enzyme



Products



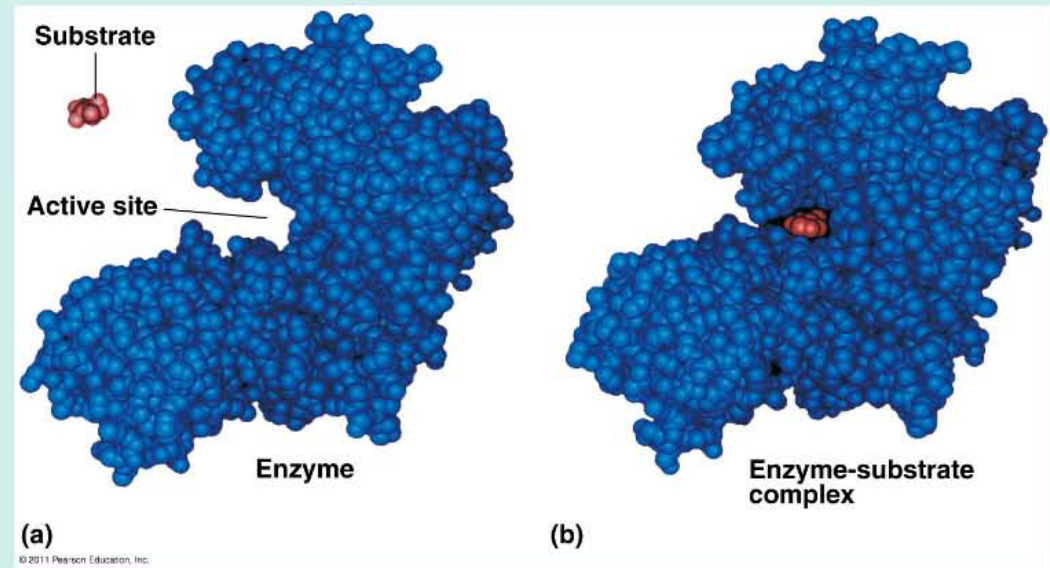
Progress of the reaction →

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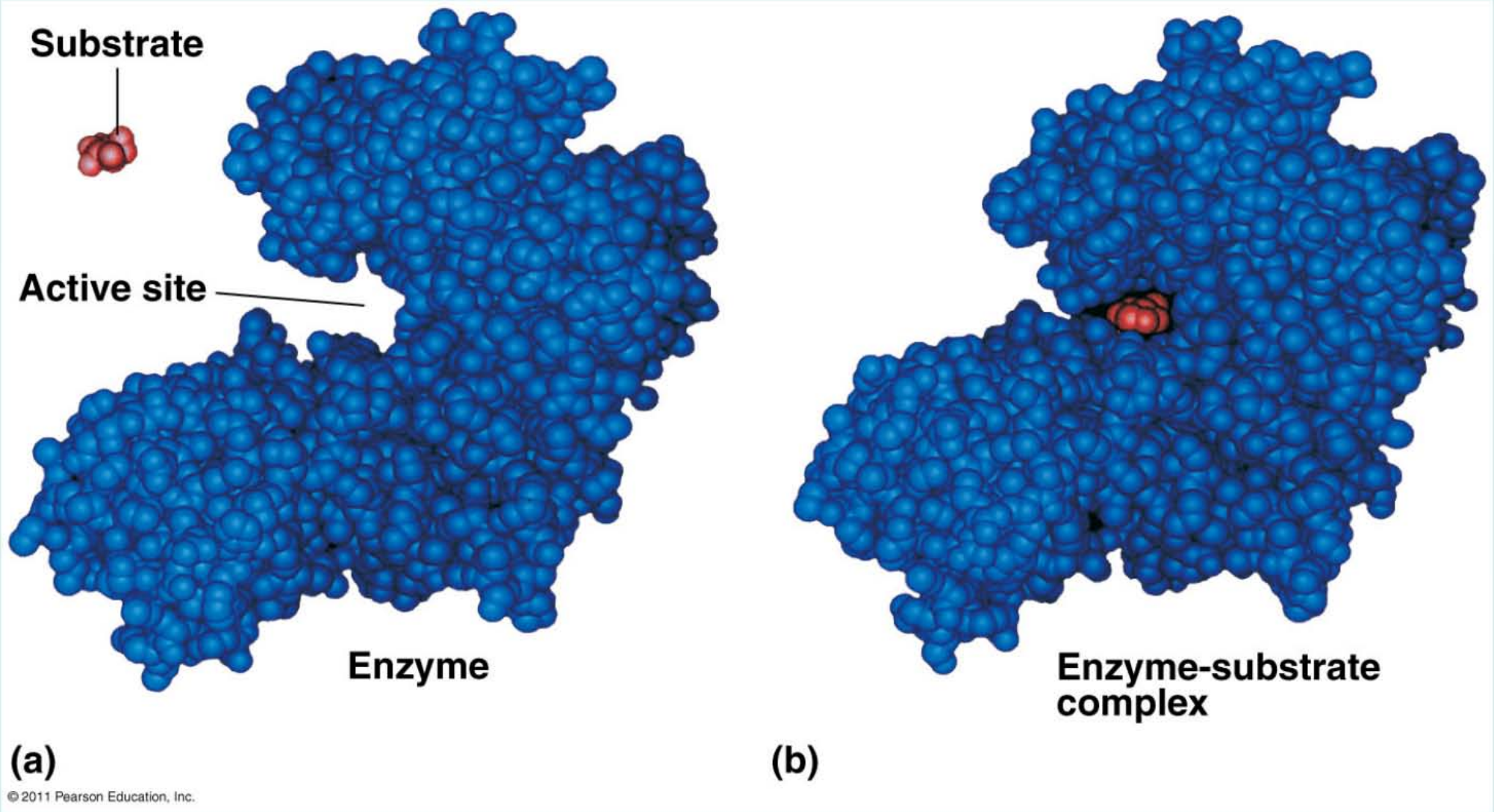
The active site is localized to a small area of the enzyme

Examples:

Prezi

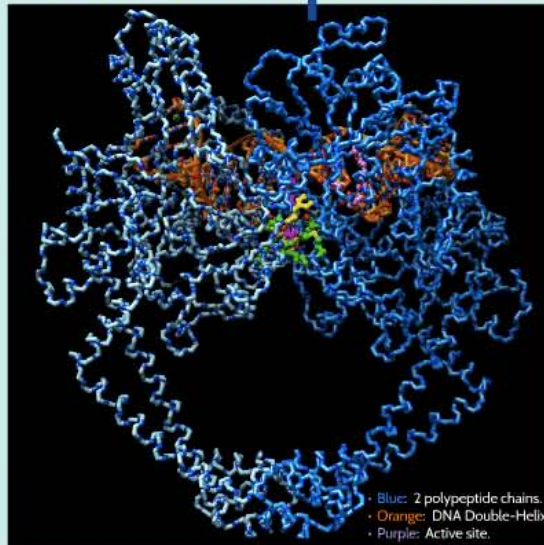
Tonoisomerase:

Evolution



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Examples:

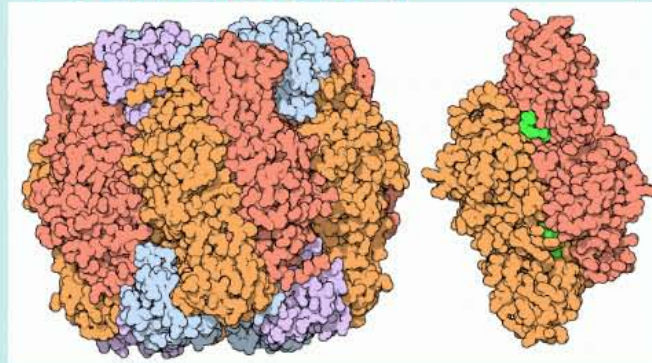


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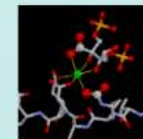


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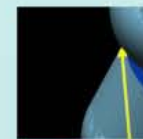
50% of all protein found in a chloroplast.

Co-factors

Most enzymes require accessory compounds many of which you are familiar with as ("vitamins") or metal ions (aka "minerals") in order to be functional.



Magnesium ion (green) associated with Rubisco's active site.



A topoisomerase active site is visible in the topoisomerase active site.

Evo

Evolutionary function

Various effects

These are

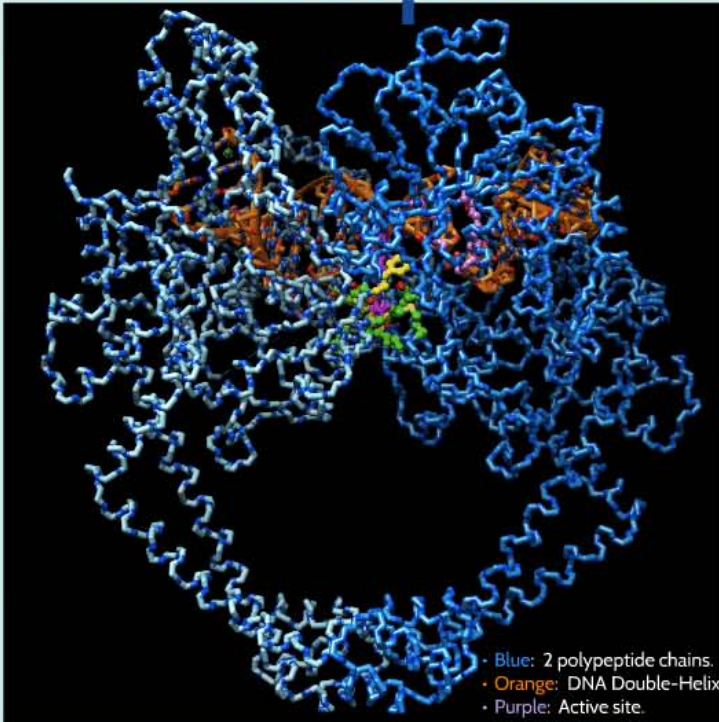
- anaerobic
- Artificially set
- Ethanol generated

Vari

change of the enzyme to catalyze the reaction.

small area of t

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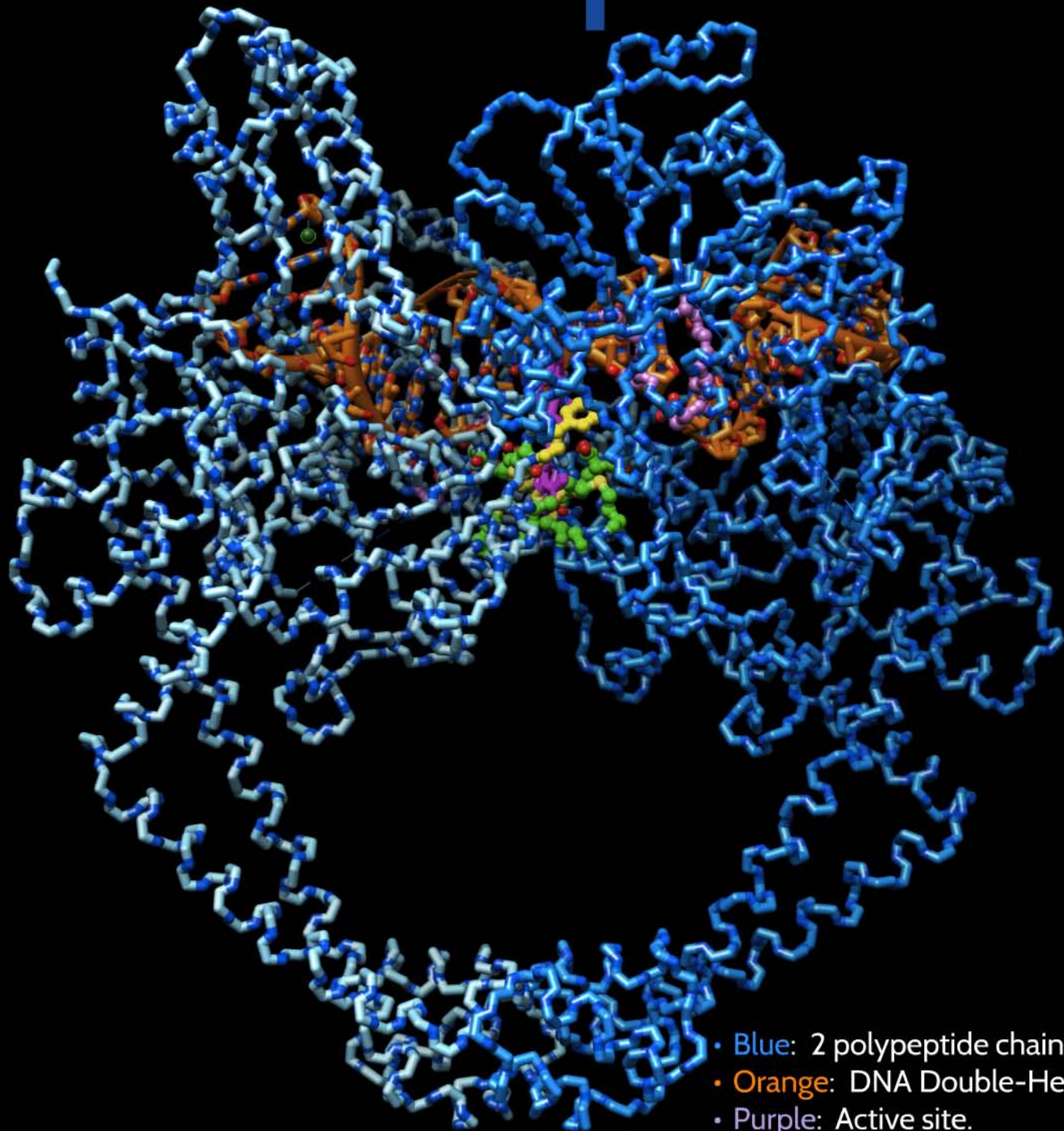
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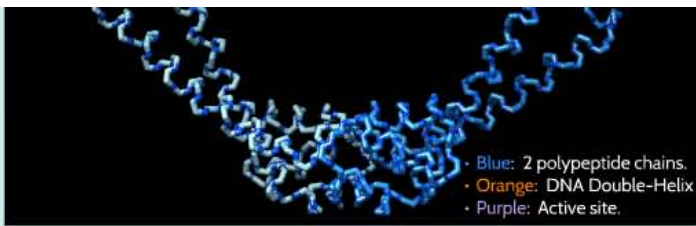
- Blue: 2 polypeptide chains.
- Orange: DNA Double-Helix
- Purple: Active site.

To

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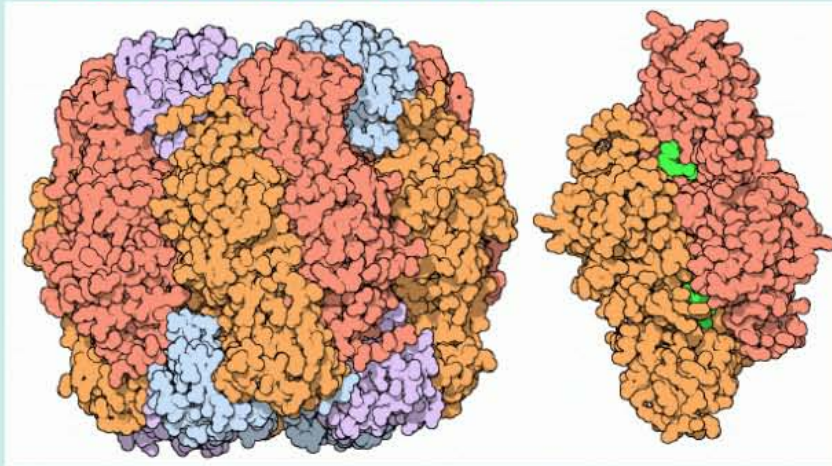
M



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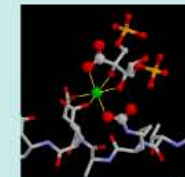
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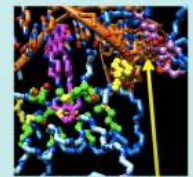
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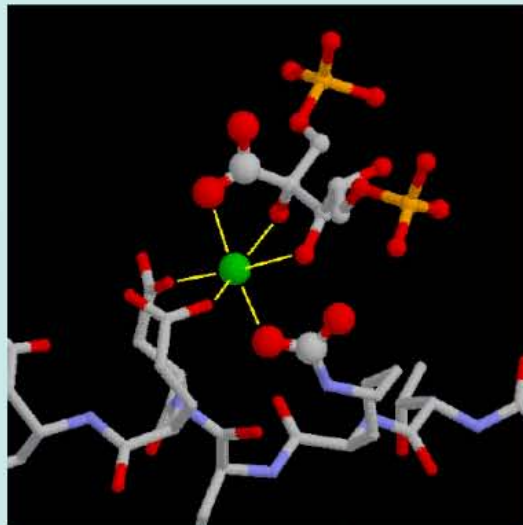
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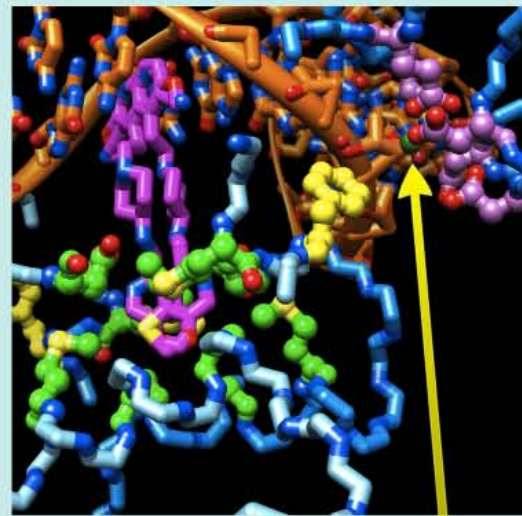
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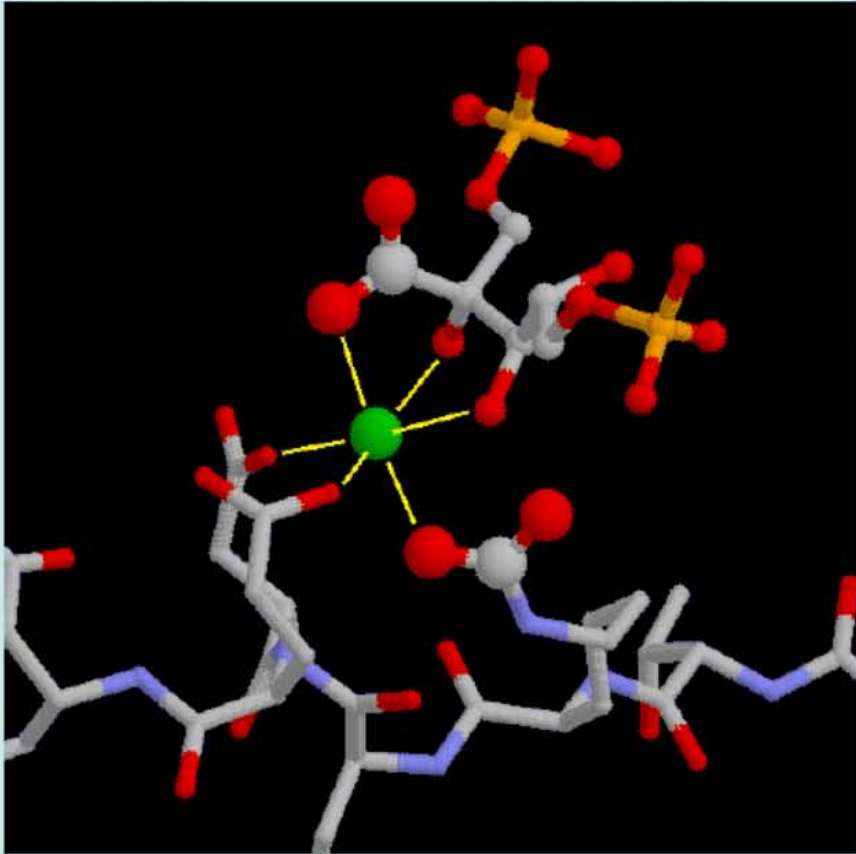


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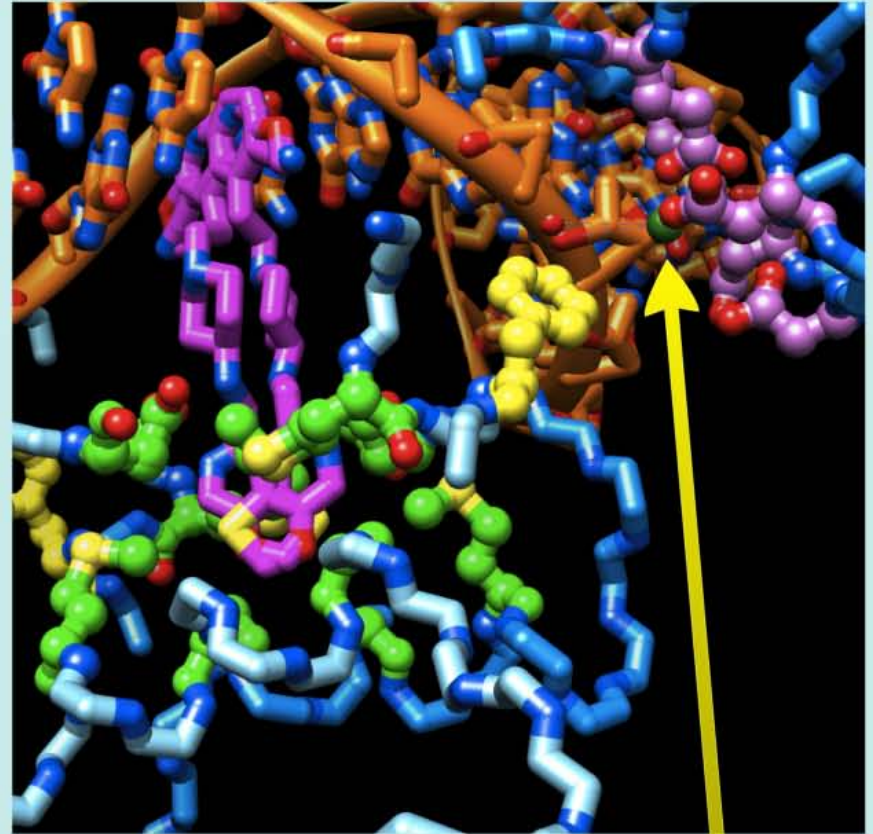


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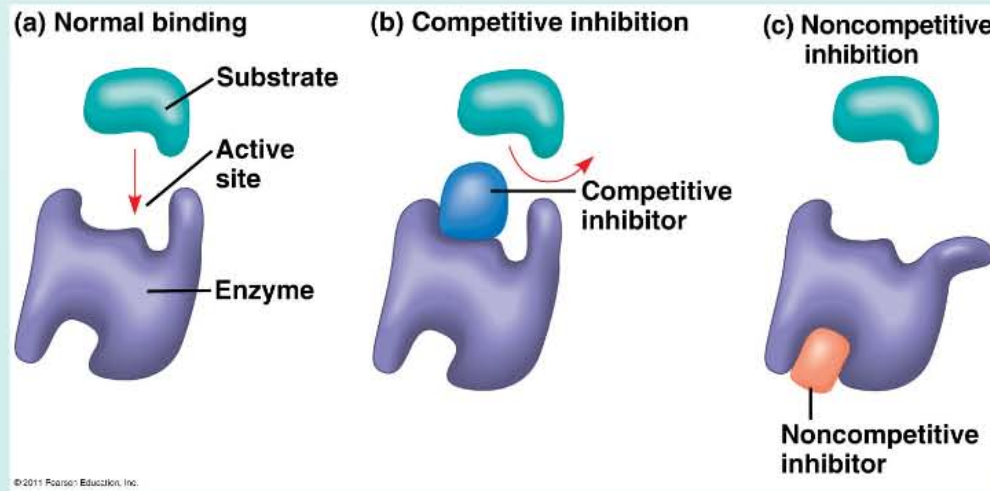
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vs.

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Binding of a substrate molecule to one active subunit of an enzyme can also trigger stabilization of the active conformation in all subunits ("cooperativity")

Activation:

Binding of an activator



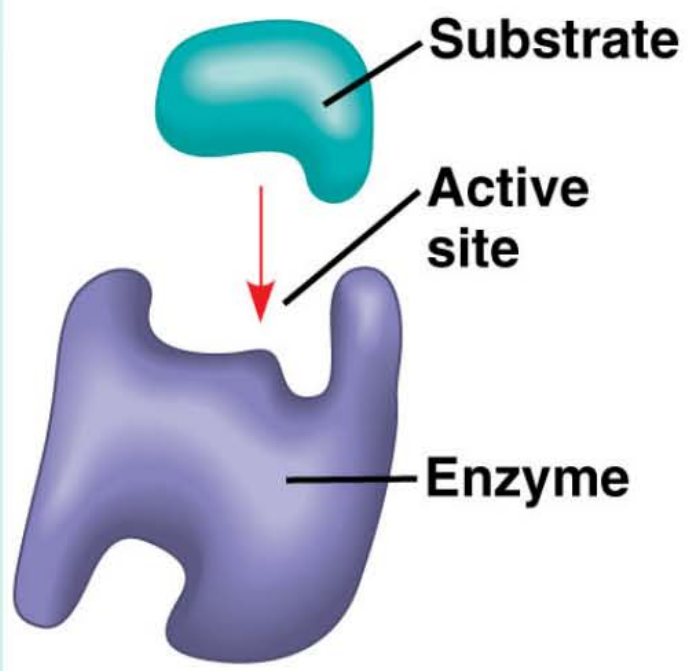
Cell.

Competitive Interactions

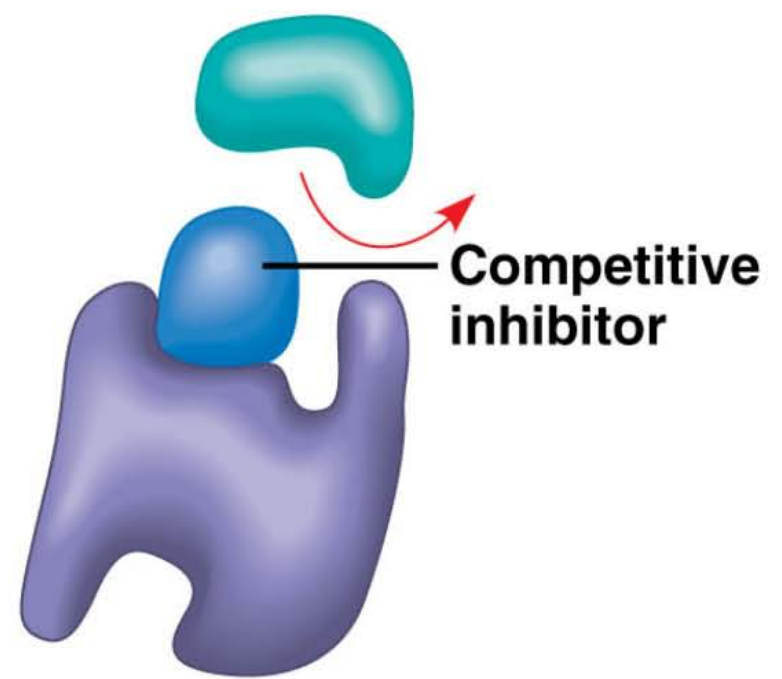
VS.

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(a) Normal binding



(b) Competitive inhibition



VS.

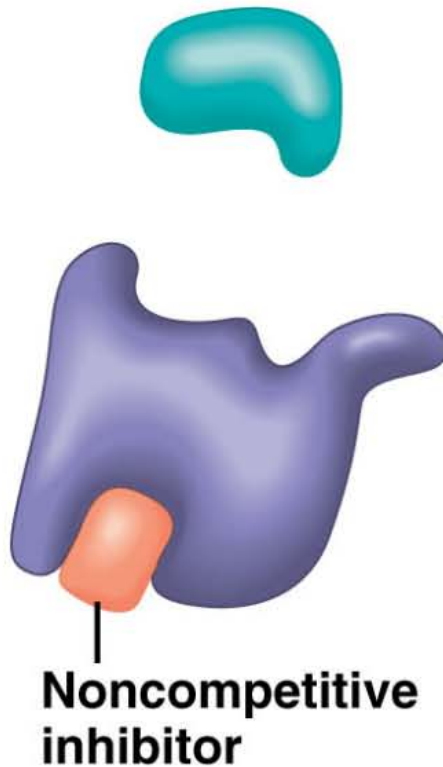
Non-Competitive Interactions

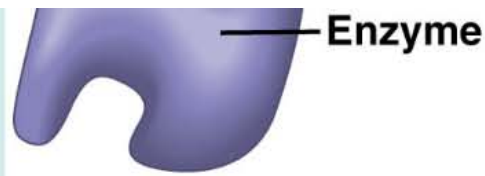
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Inhibition

(c) Noncompetitive inhibition

Competitive inhibitor



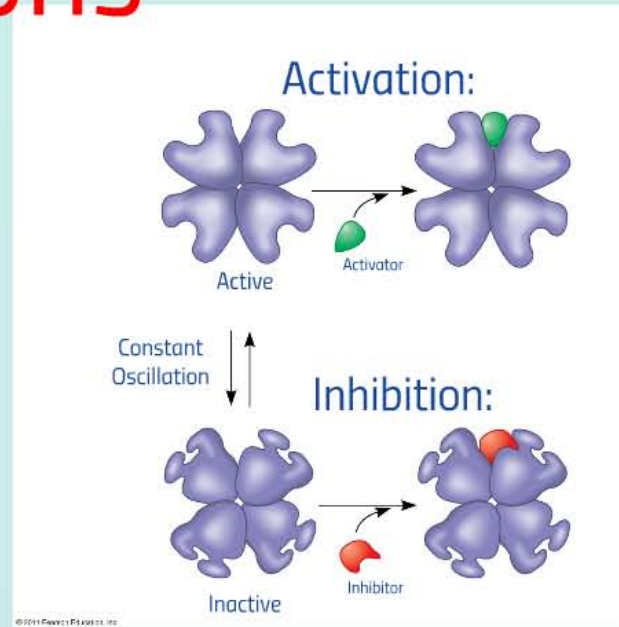


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"Other-site"

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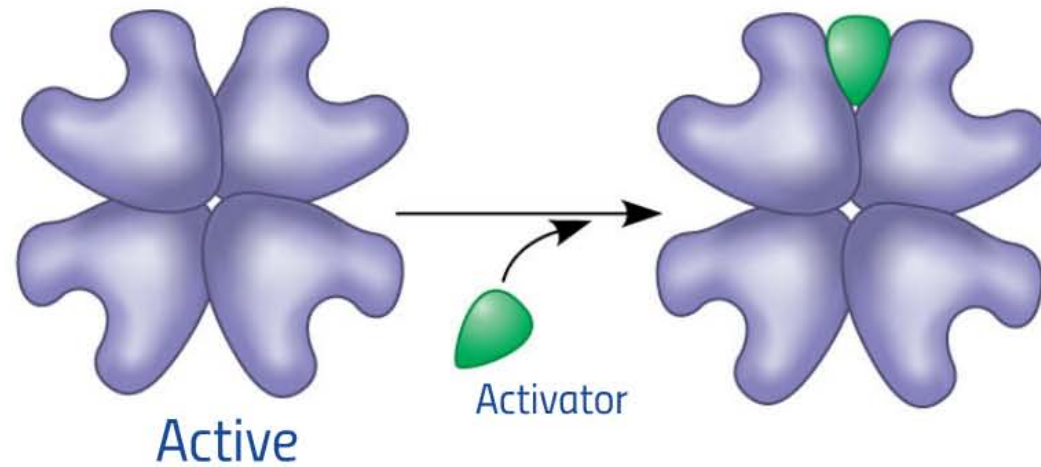
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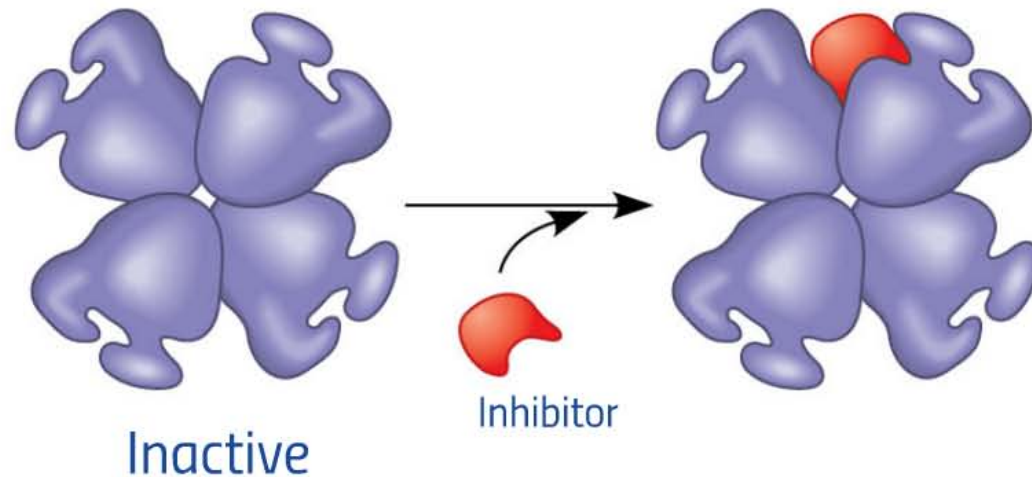


Activation:



Constant
Oscillation

Inhibition:

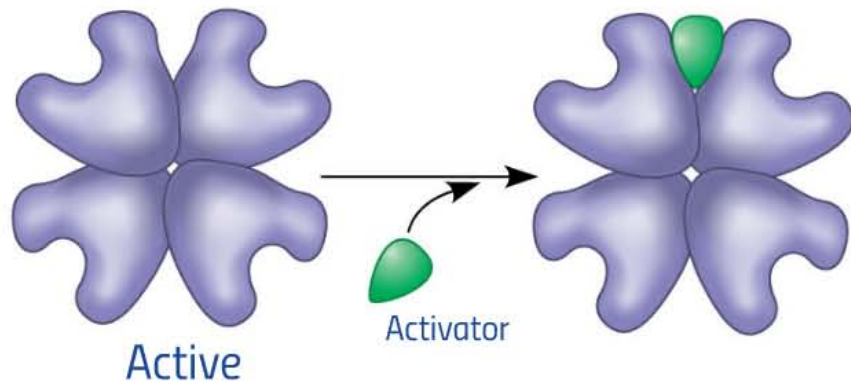


Binding
molecule
enzyme
conformation

Binding
molecule
enzyme
conformation

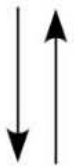
MS

Activation:

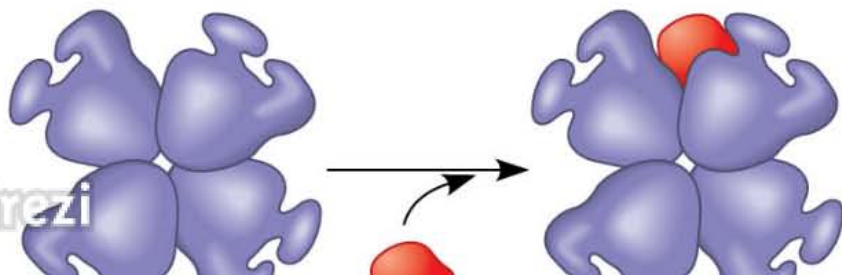


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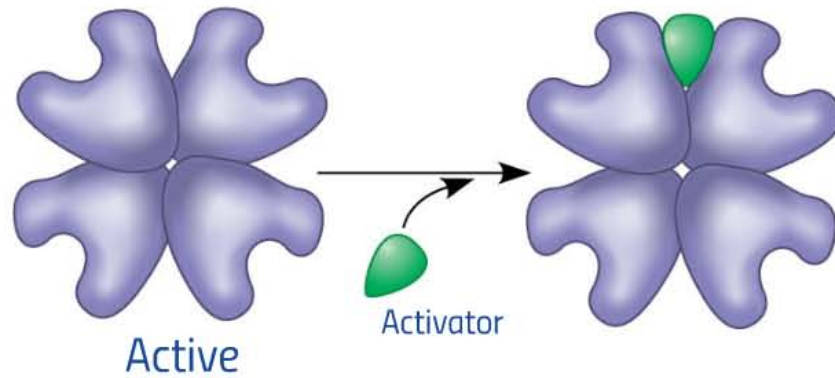


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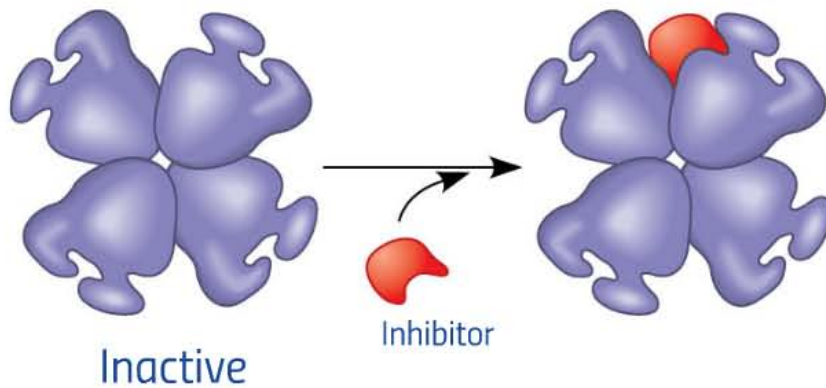


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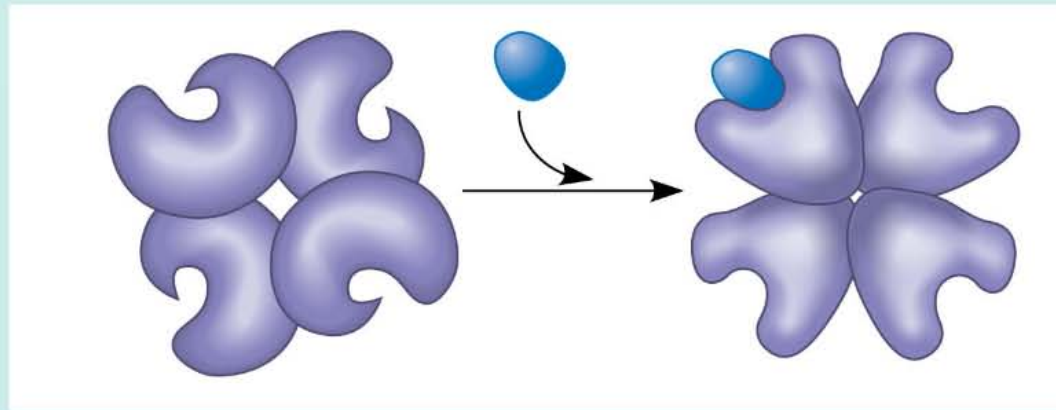


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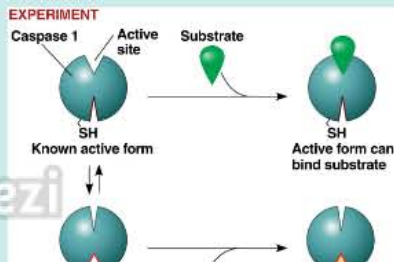


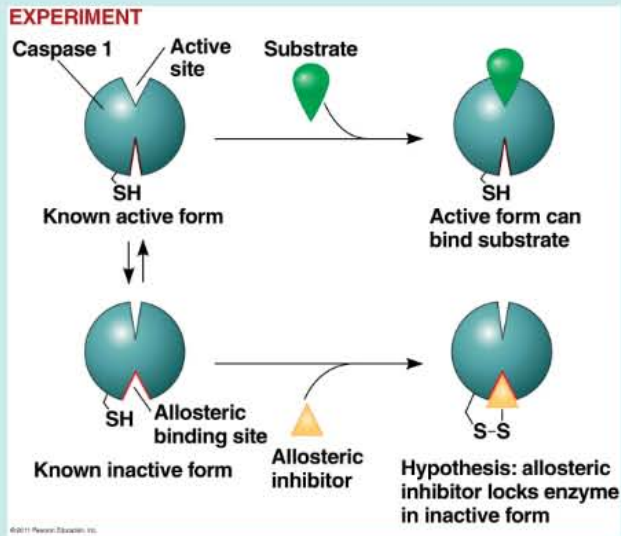
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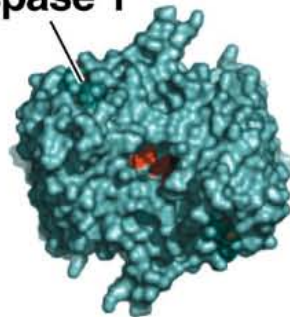
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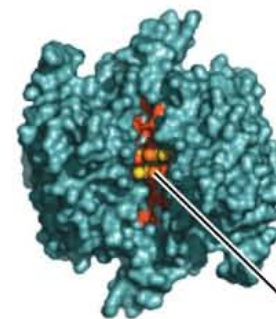
Hypothesis: Allosteric inhibition of caspase 1 will lock the enzyme in an inactive conformation.

RESULTS

Caspase 1

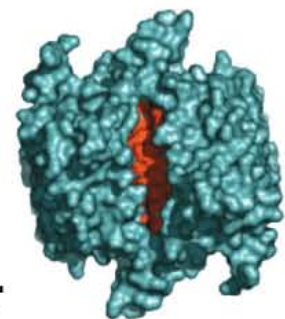


Active form



Allosterically inhibited form

Inhibitor



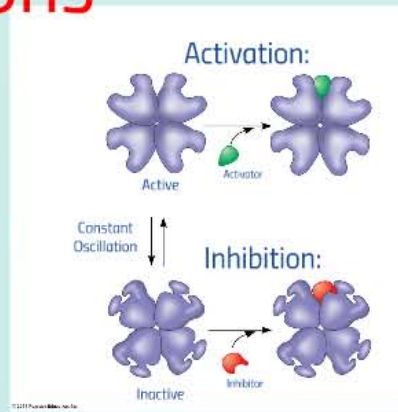
Inactive form

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ALLOSTERIC INTERACTIONS

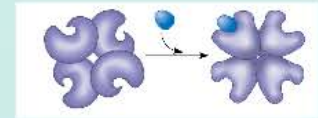
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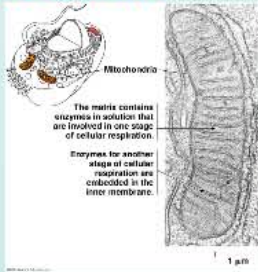
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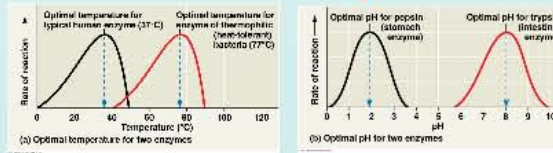
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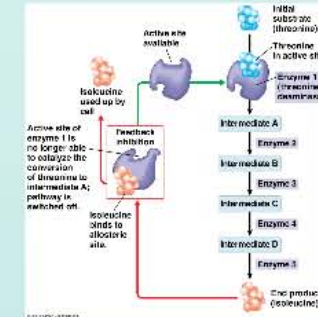
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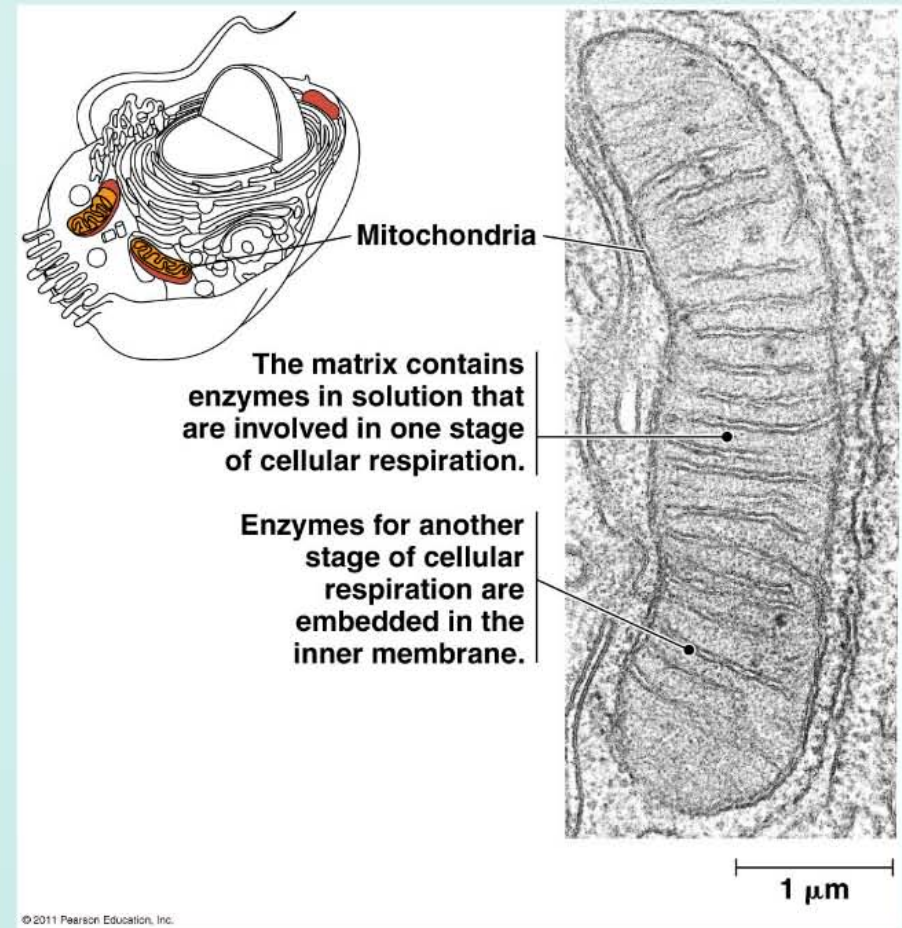


Make Sure You Can:

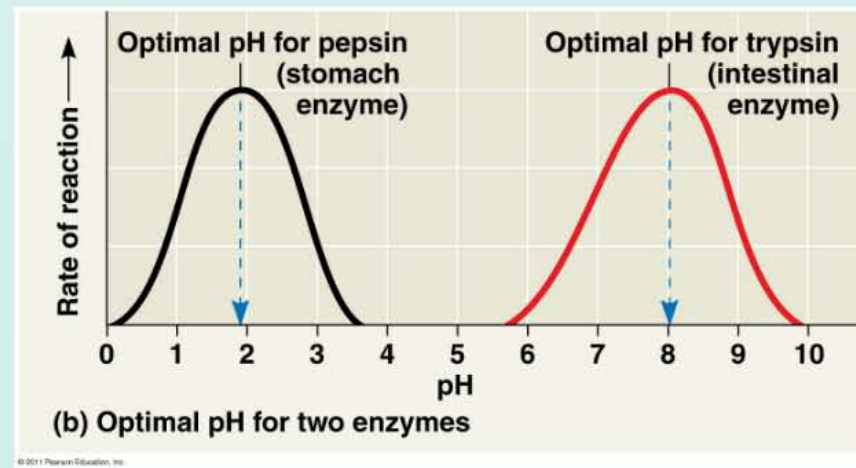
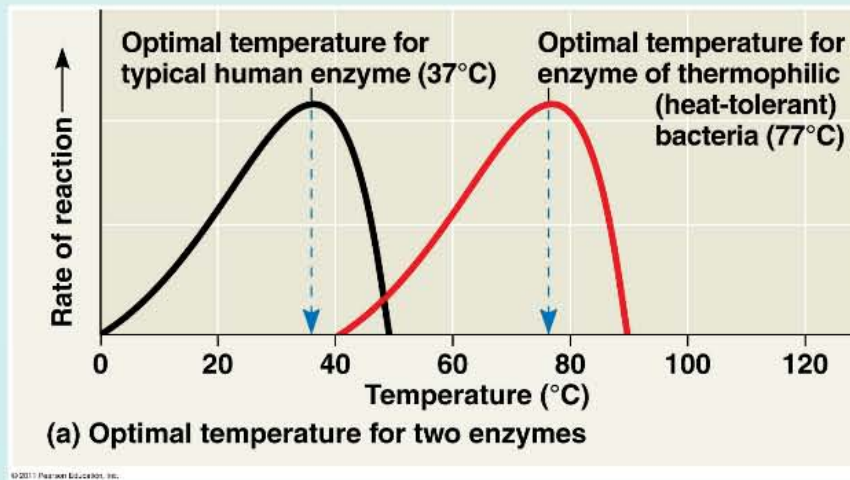
- Explain how enzymes function as catalysts.
- Explain the induced fit model of enzyme function.
- Provide examples of enzyme-catalyzed reactions in biological systems.
- Explain the relationship between enzyme structure and function.
- Explain the major modes of regulation of enzyme activity.

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Localization of specific enzymes (and the reactions they mediate) within compartments of the cell allow for more control over when and where particular metabolic reactions occur in eukaryotes.

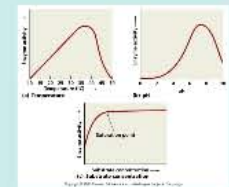


Environmental Influence:

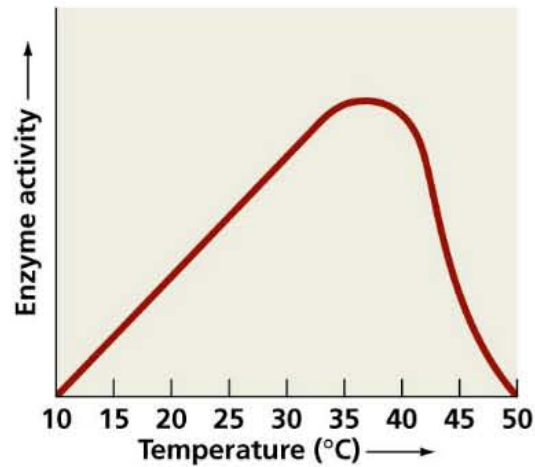


Like all proteins, enzyme structure (and therefore function) can be effected by the conditions of the enzyme's environment.

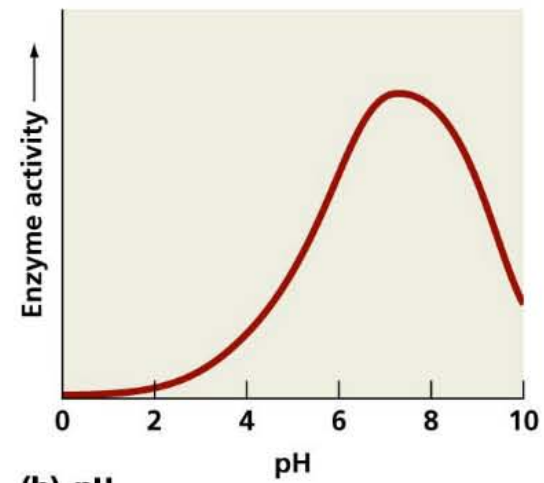
There are three major environmental conditions that effect enzyme structure and function



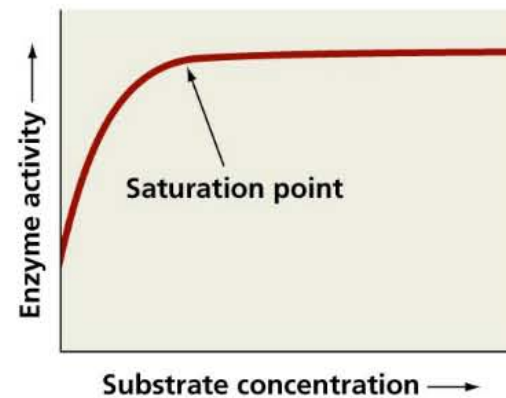
1. Temperature
2. pH
3. Concentration (enzyme, substrate, cofactors)



(a) Temperature



(b) pH



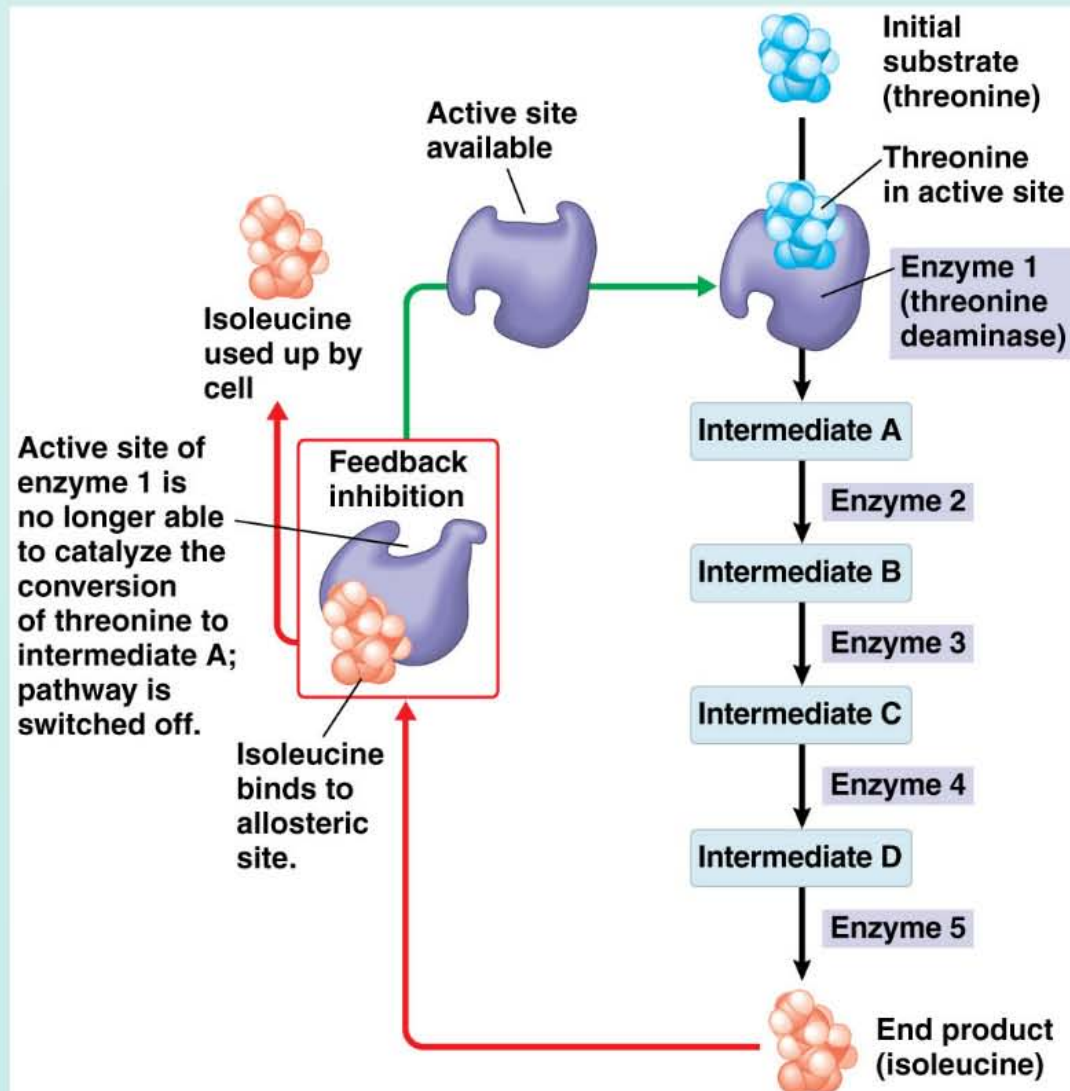
(c) Substrate concentration

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1. Temperature
2. pH
3. Concentration (enzyme, substrate, cofactors)

Feedback:

Many metabolites have regulatory effects on enzymes that catalyze the metabolic pathways that result in the production of those metabolites.



Cellular Energetics

Big Question:
How do enzymes control the reaction?
How does the cell control the activity of enzymes?

Practice

Enzymes!

"-ase"

A common nomenclature suffix for enzymes. prefix: usually refers to enzyme's substrate

Biological catalysts.

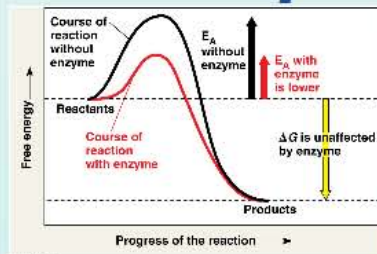
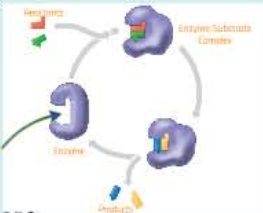
Proteins and some RNA molecules (examples?)

How do they do it?

Enzymes interact with reactants ("substrate")

Cause breaking/formation of particular atomic bonds to be more energetically favorable.

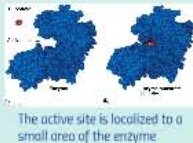
This work is localized to an area of the enzyme called the "active site".



Induced Fit

The shape of the active site of an enzyme is shape-specific for a particular substrate.

The binding of a substrate to the active site induces the necessary conformational change of the enzyme to catalyze the reaction.

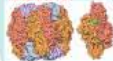


The active site is localized to a small area of the enzyme

Examples:

Topoisomerase:
Involved in minimizing mechanical stress on DNA during replication.
Makes a temporary cut in the helix.

Rubisco!
Attaches carbon dioxide to sugar precursor molecules in photosynthesis.



50% of all protein found in a chloroplast.



Evolutionary Considerations:

Evolution plays a central role in enzyme structure and function.

Various studies have been conducted to investigate the effect of evolution on enzymes.

These include:

- analysis of enzyme genes (sequence comparison)
- Artificial selection of enzyme activity in laboratory settings.
- Ethnographic/Demographic studies of enzyme genotypes and enzymatically determined phenotypes.

Variation + Natural Selection = Adaptation

Regulation:

Enzymatic function can be stimulated or inhibited by factors in the cell.

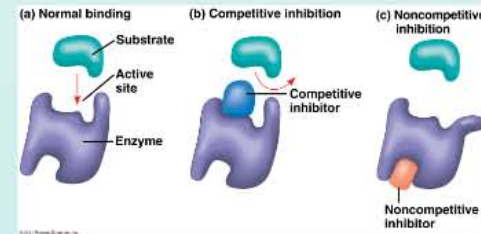
Competitive Interactions

A molecule other than the substrate binds to the active site.

vs.

Non-Competitive Interactions

Regulation is accomplished without occupying the active site.



Allosteric Interactions

"Other-site"

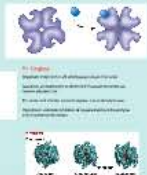
Stimulate or inhibit enzyme activity by causing a conformational change in the enzyme.



Binding of an activator molecule can stabilize the enzyme in an active conformation.

Binding of an inhibitor molecule can stabilize the enzyme in an inactive conformation.

Binding of a substrate molecule to an active subunit of an enzyme can also trigger stabilization of the active conformation in all subunits ("cooperativity")



Organization:

Compartmentalization

Localization of specific enzymes (and the reactants they mediate) within compartments of the cell allow for more control over when and where particular metabolic reactions occur in eukaryotes.



Environmental Influence:



Like all proteins, enzyme structure (and therefore function) can be affected by the conditions of the enzyme's environment.

There are three major environmental conditions that affect enzyme structure and function

Feedback:

Many metabolites have regulatory effects on enzymes that catalyze the metabolic pathways that result in the production of those metabolites.



How do the Cells Use Feedback to Control Metabolic Pathways?
Feedback inhibition is a common way for cells to control metabolic pathways. It occurs when the final product of a pathway binds to an enzyme earlier in the pathway, inhibiting its activity and preventing further production of the product.

Make Sure You Can:

Explain how enzymes function as catalysts.

Explain the induced fit model of enzyme function.

Provide examples of enzyme-catalyzed reactions in biological systems.

Explain the relationship between enzyme structure and function.

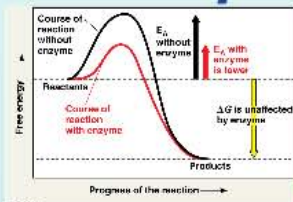
Explain the major modes of regulation of enzyme activity.

Cellular Energetics

Practice Enzymes!

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Biological catalysts.

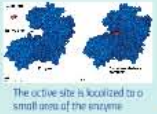
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The active site is localized to a small area of the enzyme.

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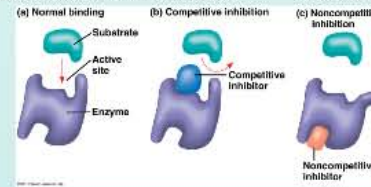
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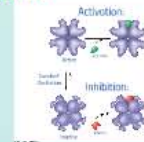
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Inhibition

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Binding of an inhibitor molecule can stabilize the enzyme in an inactive conformation.

Binding of a substrate molecule to an active subunit of an enzyme can also trigger stabilizations of the active conformation in all subunits ("cooperativity").



Binding of a substrate molecule to one subunit of a multi-subunit enzyme can also trigger stabilizations of the active conformation in all subunits ("cooperativity").

Binding of an inhibitor molecule to one subunit of a multi-subunit enzyme can also trigger stabilizations of the inactive conformation in all subunits ("cooperativity").

Binding of an activator molecule to one subunit of a multi-subunit enzyme can also trigger stabilizations of the active conformation in all subunits ("cooperativity").

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Localization of specific enzymes into the reactions they mediate within compartments of the cell allow for more control over when and where particular metabolic reactions occur in eukaryotes.



Environmental Influence:

Local proteins, enzyme structure and the nature of the reaction can be affected by the conditions of the enzyme's environment.



These are their major environmental conditions that affect enzyme structure and function.

Feedback:

Many metabolic pathways have feedback mechanisms that stabilize the metabolic pathway that result in the production of those molecules.

