AP BIO INSTA-REVIEW

TOPIC 3.3

Environmental Impacts on Enzyme Function

ENE-1.F.1

Change to the molecular structure of a component in an enzymatic system may result in a change of the function or efficiency of the system–

a. Denaturation of an enzyme occurs when the protein structure is disrupted, eliminating the ability to catalyze reactions.

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TOPIC 3.3

Environmental Impacts on Enzyme Function

ENE-1.F.1

Change to the molecular structure of a component in an enzymatic system may result in a change of the function or efficiency of the system–

b. Environmental temperatures and pH outside the optimal range for a given enzyme will cause changes to its structure, altering the efficiency with which it catalyzes reactions.

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TOPIC 3.3

Environmental Impacts on Enzyme Function

ENE-1.F.2

In some cases, enzyme denaturation is reversible, allowing the enzyme to regain activity.

ENE-1.G.1

RELEVANT EQUATION

$$pH = -\log[H^+]$$

Environmental pH can alter the efficiency of enzyme activity, including through disruption of hydrogen bonds that provide enzyme structure.

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TOPIC 3.3

Environmental Impacts on Enzyme Function

ENE-1.G.2

The relative concentrations of substrates and products determine how efficiently an enzymatic reaction proceeds.

ENE-1.G.3

Higher environmental temperatures increase the speed of movement of molecules in a solution, increasing the frequency of collisions between enzymes and substrates and therefore increasing the rate of reaction.

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Environmental Impacts on Enzyme Function

ENE-1.G.4

Competitive inhibitor molecules can bind reversibly or irreversibly to the active site of the enzyme. Noncompetitive inhibitors can bind allosteric sites, changing the activity of the enzyme.

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TOPIC 3.3

What happens to an enzyme if the temperature increases too high?

A. No effect

B. Enzyme increases rate

C. Enzyme decreases rate

D. Enzyme denatures

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TOPIC 3.3

What happens to an enzyme if the temperature increases too high?

D. Enzyme denatures

Recall: Enzymes are proteins. Proteins are made up of amino acids and are folded into a three dimensional structure due to bonds. If the temperature increases, the bonds break and the enzyme/protein denatures.

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TOPIC 3.3

What happens to an enzyme if the temperature decreases too low?

A. No effect

B. Enzyme increases rate

C. Enzyme decreases rate

D. Enzyme denatures

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TOPIC 3.3

What happens to an enzyme if the temperature decreases too low?

C. Enzyme decreases rate

Enzymes are proteins. The bonds will not break if the temperature decreases. This decrease in temperature will affect the kinetic energy of the system which will decrease the reaction rate as the collisions would have decreased energy nor collide as often.

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TOPIC 3.3

If the enzyme is denatured...

A. No effect

B. Reaction rate increases

C. Reaction rate decreases

D. Reaction stops

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TOPIC 3.3

If the enzyme is denatured...

C. Reaction rate decreases

Enzymes increase the reaction rate, but do not affect the Gibbs free energy. This means that the reaction will take place with or without the enzyme present.

If the enzyme is absent/denatures the reaction will still take place, just slower.

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TOPIC 3.3

Enzymes get consumed by reaction and must be re-added

A. True

B. False

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TOPIC 3.3

Enzymes get consumed by reaction and must be re-added

B. False

Enzymes are the worker horses of the cell. After they participate in the reaction, their structure returns back which allows for another substrate to bind for another reaction.

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TOPIC 3.3

Describe what happens when the enzyme is denatured

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TOPIC 3.3

Describe what happens when the enzyme is denatured

The secondary structure and up are disrupted.

The bonds between the R groups (tertiary / quaternary) and hydrogen bond between the backbone (secondary) will break, but the peptide bonds (primary) will stay intact.

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3.3

If the pH increases, why does the enzyme denature?

A. pH causes the polar R groups to be nonpolar

B. pH affects the charge on the carboxyl & amine groups

C. pH affects the charged R groups

D. pH causes hydrogen ions to act as competitive inhibitor

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TOPIC 3.3

If the pH increases, why does the enzyme denature?

C. pH affects the charged R groups

If the R group is charged and it releases or absorbs a hydrogen in the solution which will affect the bonding of the R group. If the R group bonding is affected, the three dimensional structure will be affected thus the protein will denature.

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TOPIC

3.3

What is reaction rate?

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TOPIC 3.3

What is reaction rate?

rate = change in x over time

Reaction rate is the amount of product formed over time. If there is an increase in reaction rate, then there is an increase in product formed over time.

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TOPIC 3.3

Inhibitor that binds to the active site

A. Competitive inhibitor

B. Noncompetitive inhibitor

AP BIO INSTA-REVIEW

TOPIC 3.3

Inhibitor that binds to the active site

A. Competitive inhibitor

The competitive inhibitor will COMPETE with substrate for the active site.

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TOPIC 3.3

How does a noncompetitive inhibitor block binding of substrate?

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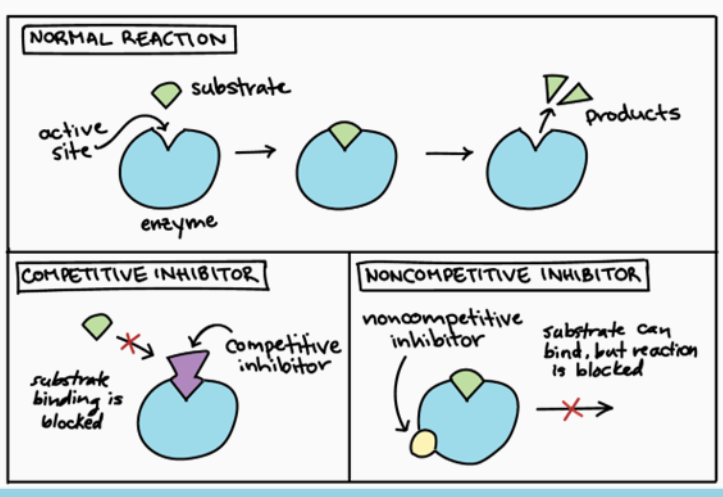
TOPIC 3.3

How does a noncompetitive inhibitor block binding of substrate?

As you can see, the competitive inhibitor binds to the same site as the substrate/ligand to block it from binding.

As you can see, the noncompetitive inhibitor causes a conformational change which blocks the substrate/ligand from binding.



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Any increase in heat will denature enzyme

A. False

B. True

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TOPIC 3.3

Any increase in heat will denature enzyme

A. False

An increase in heat will increase the kinetic energy of the molecules, but as long as it is within the optimal range of the enzyme, it will not denature. This will speed up the chemical reaction as the molecules absorb the energy increasing collision frequency and collision energy.

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TOPIC 3.3

What happens with a small increase in temperature?

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TOPIC 3.3

What happens with a small increase in temperature?

As the temperature increases, the particles will move faster. This increases the kinetic energy of substrate which increases the interactions with the enzyme. As the enzyme has more interactions, it will cause an increase in reaction rate. Also, the increased temperature can provide energy for activation of the reaction.

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TOPIC 3.3

As pH increases, what happens to the hydrogen ion concentration?

A. Decreases

B. Increases

AP BIO INSTA-REVIEW

TOPIC 3.3

As pH increases, what happens to the hydrogen ion concentration?

A. Decreases

The formula for pH = -log (concentration of H^+). So, as the pH increases, the concentration of H^+ will decrease.

Example: If solution has a pH of 3, there are $1x10^{-3}$ H^+ ions versus if solution has a pH of 6, there are $1x10^{-6}$ H^+ ions.

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TOPIC 3.3

During cellular respiration, protons are pumped from the matrix to the intermembrane space. What happens to the pH of the matrix?

A. Decreases

B. Increases

AP BIO INSTA-REVIEW

TOPIC 3.3

During cellular respiration, protons are pumped from the matrix to the intermembrane space. What happens to the pH of the matrix?

B. Increases

As the protons are pumped from the mitochondrial matrix into the intermembrane (IM) space, then the pH of the matrix will increase. There will be a decrease in the H^+ ions, so there will be an increase in the pH.

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TOPIC 3.3

How do you overcome a competitive inhibitor?

A. Add more ATP

B. Add more inhibitor

C. Add more products

D. Add more reactants

AP BIO INSTA-REVIEW

TOPIC 3.3

How do you overcome a competitive inhibitor?

D. Add more reactants

Competitive inhibitors will bind to the active site which is the SAME site as the substrate. In order to overcome this, you can increase the number of reactants (aka substrates) so there's a higher probability of a substrate binding over an inhibitor.

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TOPIC
3.3

What happens to the reaction rate as the reaction proceeds? Why?

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TOPIC 3.3

What happens to the reaction rate as the reaction proceeds? Why?

Reaction rate will decrease.

As the reaction proceeds, there is less reactants to bind to the enzyme for the reaction and more products that act as a competitive inhibitor.

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TOPIC
3.3

What conditions will affect the structure of an enzyme?

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TOPIC 3.3

What conditions will affect the structure of an enzyme?

Environmental condition changes of pH and temperature outside of optional range (directly from CED)

But also, salinity and chemical binding

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TOPIC 3.3

When an enzyme denatures, which structure is not affected?

A. Primary

B. Secondary

C. Tertiary

D. Quaternary

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TOPIC 3.3

When an enzyme denatures, which structure is not affected?

A. Primary

When the protein/enzyme denatures, it does not break the covalent (peptide) bonds between the amino acids. This means that the primary structure is not affected when the enzyme denatures. I like to think of denaturation as the process where the protein/enzymes unravels.

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TOPIC 3.3

When the structure changes, how is the function affected?

A. Does not affect function

B. Gains new function

C. Nonfunctional

D. All of the above

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TOPIC 3.3

When the structure changes, how is the function affected?

D. All of the above
(Does not affect function, Gains new function, Nonfunctional)

When the structure changes, the function can change (gain function or lose function) or there could be no change.

It all depends where the structure changes. If it affects the active site or how it is able to transfer a signal, then there will be a change in function.

AP BIO INSTA-REVIEW

TOPIC 3.3

When a protein/enzyme is denatured, it is sometimes reversible.

A. True

B. False

AP BIO INSTA-REVIEW

TOPIC 3.3

When a protein/enzyme is denatured, it is sometimes reversible.

A. True

Example:

The gelatin dessert "Jello" gels due to the presence of a protein. When Jello is heated, its structure is altered so that it is no longer a gel but a liquid. If the denaturing conditions reversed by cooling in the refrigerator, the protein reforms into its original gel structure.

-Lumen Learning

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TOPIC 3.3

A decrease in temperature will denature an enzyme.

A. True

B. False

AP BIO INSTA-REVIEW

TOPIC 3.3

A decrease in temperature will denature an enzyme.

B. False

Decreasing the temperature will decrease the kinetic energy. This will not break any bonds in the structure thus the enzyme does NOT denature when the temperature decreases.

AP BIO INSTA-REVIEW

TOPIC 3.3

What happens to reaction rate if temperatures decrease?

A. Decrease

B. Increase

C. Stays the Same

AP BIO INSTA-REVIEW

TOPIC 3.3

What happens to reaction rate if temperatures decrease?

A. Decrease

If the temperature decreases, the molecules move slower as the kinetic energy has decreased. This decrease causes a decrease in the reaction rate.

AP BIO INSTA-REVIEW

TOPIC 3.3

If the concentration of hydrogen ions increases?

A. pH decreases

B. pH increases

AP BIO INSTA-REVIEW

TOPIC 3.3

If the concentration of hydrogen ions increases?

A. pH decreases

The formula for pH = -log (concentration of H^+). So, as the concentration increases the pH will decrease.

Example: If there are $1x10^{-3}$ H^+ ions it would have a pH of 3 versus if there are $1x10^{-6}$ H^+ ions it would have a pH of 6.

AP BIO INSTA-REVIEW

TOPIC 3.3

If the pH increases, what happened to the hydrogen ion concentration?

A. Decreases

B. Increases

AP BIO INSTA-REVIEW

TOPIC 3.3

If the pH increases, what happened to the hydrogen ion concentration?

A. Decrease

The formula for pH = -log (concentration of H^+). So, as the pH increases, the hydrogen ion concentration decreases.

<u>Example:</u> If the pH is 3, then there are $1x10^{-3}$ H^+ ions. If the pH is 6, then there are $1x10^{-6}$ H^+ ions. Notice that pH of 6 has less hydrogen ions than pH of 3.

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TOPIC 3.3

How does an increase in substrate affect reaction rate?

A. Decrease forever

B. Increase forever

C. Decrease until enzyme saturated

D. Increase until enzyme saturated

AP BIO INSTA-REVIEW

TOPIC 3.3

How does an increase in substrate affect reaction rate?

D. Increase until enzyme saturated

The substrate binds to the enzyme and is the starting material for the reaction. If there is an increase in the substrate, then there will be more material to react which will increase the reaction rate until the enzyme is saturated and working as fast as it possibly can.

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TOPIC 3.3

As the product concentration increases, reaction rate ____?

A. Decrease

B. Increase

C. Stays the Same

AP BIO INSTA-REVIEW

TOPIC 3.3

As the product concentration increases, reaction rate ____?

A. Decrease

As the product increases, it will be more likely to enter the active site. Since it will enter the active site, it can act as a competitive inhibitor which will decrease the reaction rate. As the product will inhibit the reactant from binding to the enzyme.

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TOPIC
3.3

What is a competitive inhibitor?

A. Binds to the same site as the substrate
B. Binds to a different site than substrate
C. Binds to substrate to inhibit reaction
D. Binds to product to inhibit reaction

AP BIO INSTA-REVIEW

TOPIC 3.3

What is a competitive inhibitor?

A. Binds to the same site as the substrate

Competitive inhibitors will bind to the same active site as the substrate. This is why we call them COMPETITIVE because they will COMPETE for the active site.