Name: ______________________________ Class: ______________________ Date: ______________________

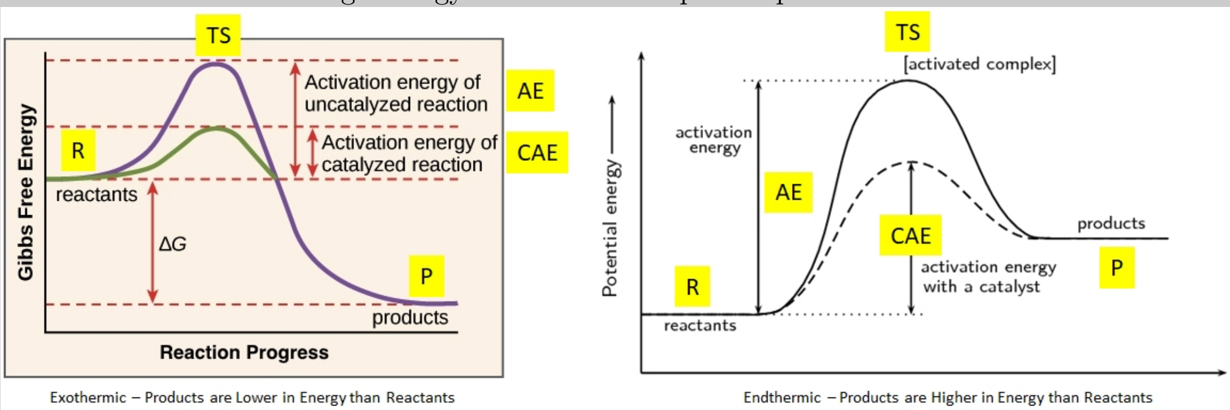
Read each question carefully. Some questions have multiple parts. Answer all questions with complete sentences.

1. Chemically what are the two easiest ways to speed up a chemical reaction?

   (1) Increase temperature
   (2) Increase concentration of Reactants/Substrate.

2. Define Activation Energy **AND** discuss how it controls the rate of a reaction. Draw a reaction/energy diagram for an **Exothermic** reaction illustrating how a catalyst speeds up a reaction. Be sure to label the: (R)eactants, (P)roducts, (T)ransition state, Activation Energy (AE) and the Catalyzed Activation Energy (CAE).

   (1) DFN- Minimum energy required for a reaction to occur.
   (2) It controls the rate of a reaction because only those molecules with enough energy can react. Increase the AE and less molecules have enough energy to react and it slows down, decrease the AE and more molecules have enough energy to react and it speeds up.

   (3) 

3. What type of reactions do each of the following classes of enzymes catalyze?
   (a) Oxidoreductase: catalyze oxidation/reduction reactions (gain/lose electrons)

   (b) Transferase: transfer a functional group from one molecule to another

   (c) Hydrolase:

   catalyze hydrolysis reactions of ester, carbohydrates and polypeptides (ie opposite of dehydration reactions that made the molecules

   (d) Lysase: removal of a functional group from substrate by mechanisms other than hydrolysis.

   (e) Isomerase: catalyze the inter-conversion of stereoisomers and structural isomers.

   (f) Ligase: catalyze linking of two molecules by breaking an ATP.

4. What are three common ways to increase a reaction rate? Which method does your body use?

   1. Temperature - increases the number of molecules that have the energy required to overcome the Activation Energy.

   2. Concentration - increases the number of molecules that can react, therefore more interactions

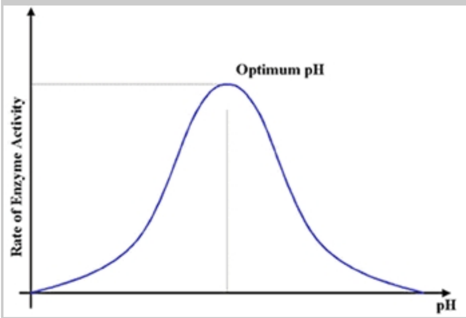
between molecules occur and more molecules have enough energy to react.

3. Catalysts - speed up reactions by decreasing the Activation Energy therefore more molecules will have enough energy to react.
Your body uses Enzymes!

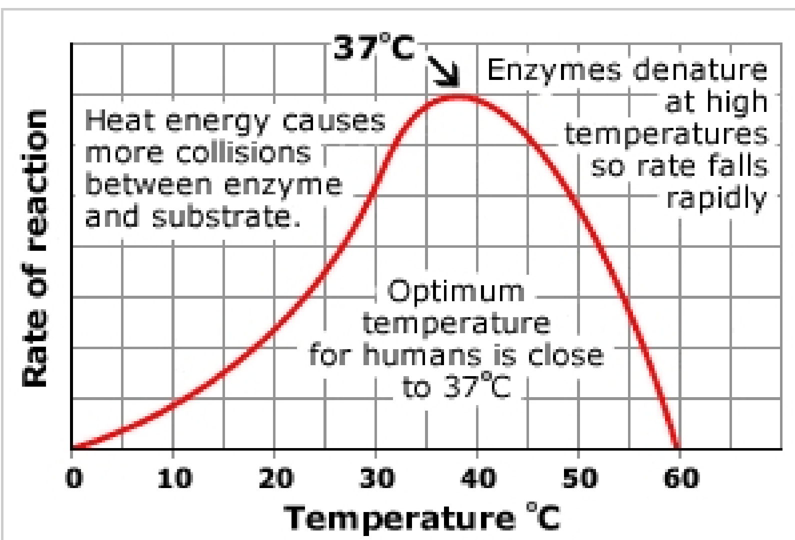
5. Draw a picture showing how the rate of reaction (y-axis) of an enzyme is effected by pH (x-axis). Label the pH value at peak. What happens to an enzyme at very high and very low pH?

2 points - At very low and high pH enzymes are denatured (lose 2°, 3°, and 4° structure), losing there specific 3D shape required to catalyze a reaction.

3 points - Optimal pH should be 7.4 (ish) although it depends on where in the body the enzyme is located.



6. Draw a picture showing how the rate of reaction (y-axis) of an enzyme is effected by Temperature (x-axis). Label the temperature value at peak. What happens to an enzyme at very high and very low temperature?



At low temperatures molecules lack energy to reaction, the enzyme also changes shape/conformation and is not as effective at increasing the reaction rate.
At high temperatures the enzyme begins to denature, the enzyme also changes shape/conformation and is not as effective at increasing the reaction rate.

7. Define each of the following terms and explain why they enable an enzyme to speed up a reaction:

   (a) Active Site

Small portion of enzyme that catalyzes the reaction due to its very specific shape determined by the 3D structure of the protein.

(b) Proximity Catalyst:

Increases the rate of reaction by holding the substrate and other molecules required for the reaction to occur in close proximity (instead of them randomly bumping into each other).

(c) Productive Binding

Increases the rate of reaction by holding the substrate and other molecules in the proper orientation so that only the desired reaction can occur.

(d) Stereospecific

Means that enzymes are specific to only 1 molecules (being sensitive enough to differentiate between even enantiomers. This increases the rate of reaction because only the proper molecule is allowed to react.

(e) Lock and Key hypothesis

Just like a key is unique for a lock, each enzyme is unique for a substrate/reaction. Highlights the specificity of enzymes.

(f) Induced-fit model

The enzyme is not rigid (like a lock or key) but can change shape to help catalyze reactions. It can change shape to bind the substrate in place. It is dynamic.

(g) strain hypothesis

Enzymes are dynamic - they change shape to "strain" (make it easier to break) a chemical bond. It can change shape to cause a reaction to occur. It can also change shape to release the products. Its very dynamic process.

8. For each reaction below what class of enzyme would be most likely to catalyze the reaction. (Choices are: (1) Oxidoreductase (2) Transferase (3) Hydrolase (4) Lysase (5) Isomerase (6) Ligase Explain.

   (a) Aldeyhyde $\longrightarrow$ Alcohol — 8(a) **Oxidoreductase**

   Ald are reduced to form alc.

   (b) Maltose $\longrightarrow$ Glucose + Glucose — 8(b) **Hydrolase**

   Disaccharides are hydrolyzed when broken apart

   (c) cis-oleic acid $\longrightarrow$ trans-oleic acid — 8(c) **Isomerase**

   cis and trans are types of isomers

9. Biologically the easiest way to speed up a reaction is with an enzyme. Explain how an enzyme speeds up a chemical reaction. You may want to include a picture.

   Enzymes lower the activation energy of a reaction by creating/facilitating a new lower energy pathway. It does this by Proximity Catalysis, Productive Binding, and Straining the chemical bond). The catalyzed activation energy (CAE) is lower therefore more molecules have enough energy to react at any given temperature. A diagram of this would look like those for Question 2.

10. Explain the physical mechanisms by which enzymes catalyse reactions. In your discussion include the terms: (1) Active Site, (2) Stereospecificity, (3) Induced Fit (4) Proximity catalysis, and (5) Productive binding (6) Transition State. Use complete sentences in your discussion.

    A discussion should be a series of sentences describing the process's involved and not a bunch of bullet points!

    One example might be that Enzymes speed up reactions because they have a very specifically shaped Active Site that is unique to a specific substrate and to a specific reaction. The active site is stereospecic it can differentiate between 2 stereoisomers (for example α-1,4 vs β-1,4 glycosidic bonds) and only catalyzed the reaction for one stereoisomer. In the induced fit model the enzyme is functional and the active site can change shape to bind/lock the substrate in place. Once bound in place the enzyme keeps the Substrates and any other molecules required to react in close proximity and in the proper orientation for only the desired reaction to occur, this is refered to as Proximity Catalysis and Productive binding. (the last two sentences are pretty bad!). When all the molecules are in proper place a Transition State is formed that is 1/2 way between the starting reactants and 1/2 between the product. The Enzyme catalyzed activation energy (CAE)is lower in energy than the normal activation energy because of the induced fit, proximity catalysis and productive binding making the reaction occur more readily.

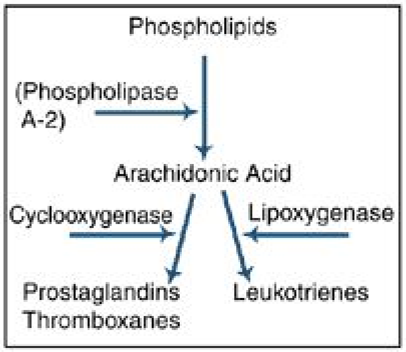
11. Define the terms enzyme inhibition and enzyme activation. What do the two processes have in common?

    Inhibiting an enzyme will decrease the rate of the reaction while activating an enzyme will increase the rate of a reaction. They are both ways in which metabolic pathways are regulated/controlled. In class this was done by covalent modification or allosteric regulation.

12. What is meant by the term "Limited Catalytic Ability" when applied to enzymes.

    Enzymes can only speed up a reaction so much, they have a maximum rate.

13. The following metabolic pathway shows the production of local hormones made from arachidonic acid. Answer the following questions about metabolic pathways.



(a) Circle the parent molecule. Define the term.

Circle the phospholipid (its the start of the metabolic pathway). Parent molecules are the starting molecule for a series of daughter molecules.

(b) Put a square around the daughter molecules. Define the term.

Place a square around arachiconic acid, Prostaglandins/thromboxanes and leukotrienes. Daughter molecules are the products of a metabolic pathway that modifies the parent molecule

(c) What class of molecules does cycloxygenase belong too?

Enzymes (ends in -ase)

(d) If the production of Leukotrienes interferes with Phospholipase A-2 this is an example of feedforward activation or feedback inhibition? Explain.

Feedback inhibition - a molecules further along in the metabolic pathway (normally when in excess) inhibits/interferes with an earlier step to slow the reaction down .

(e) In allosteric regulation if a phospholipid acts as an activator for Lipooxygenase, this would be an example of feedforward activation or feedback inhibition? Explain.

Feedforward activation, a molecule (in excess) early in the metabolic pathway activates an enzyme later in the pathway to speed up the reaction.

(f) Define the term Local Hormone and give the name of one molecule that is a local hormone and how local hormones effect the body.

Hormones that have a localized effect in the body, and the examples in this pathway are Prosta/Throm/Leuko which cause inflammation. (really more of a Ch 28 lipids topic so not likely to be on this exame)

14. Explain the concept of Allosteric Regulation. In your discussion include the terms: (1) Active site, (2) Regulatory Site, (3) Inhibition, (4) Activation. Draw and label a picture illustrating the concept.

Allosteric regulation says that in addition to the active site which catalyzes a reaction, enzymes also have additional regulatory sites that can cause a reaction to be inhibited (slowed down) or activated (speed up). Generally a substrate in an early step will act as an activator for an enzyme later in a metabolic pathway to speed it up (due to an excess of substrate). Conversely a substate latter in a metabolic pathway will often act as an inhibitor for an enzyme earlier in the pathway to prevent an excess of a product from building up.

So many good choices on google. I personally like the one in the slide show, but here are other acceptable examples.

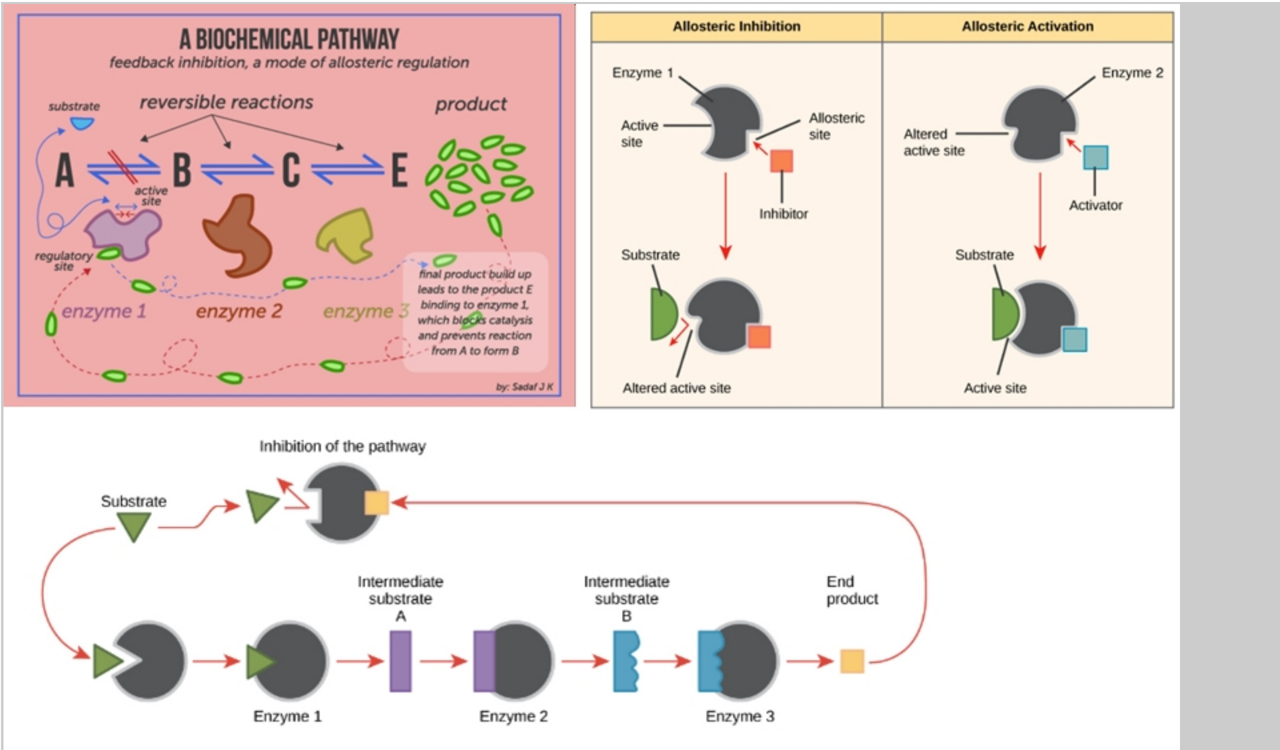


Image credit: OpenStax Biology.