Take notes while watching the following video tutorials to prepare for the "Proteins Part 2 Activity".

Proteins & Enzymes Part 2: Chirality and Amino Acids

Chiral: non-superimposable on its mirror image

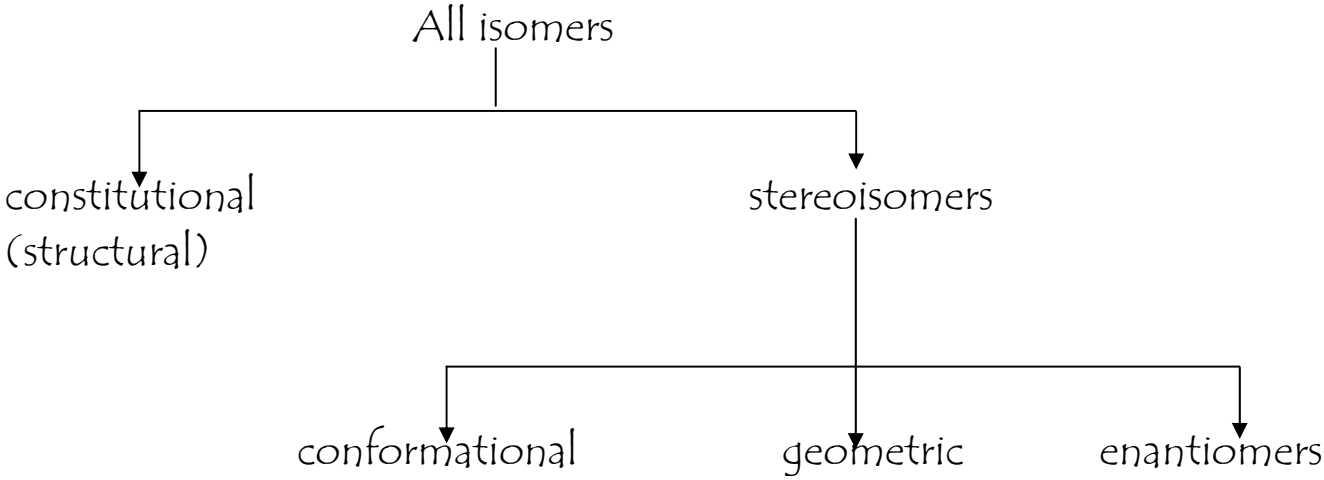
Achiral: superimpopsable on its mirror image

Chiral carbons are tetrahedral carbons bonded to 4 different groups.

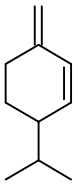
Chiral carbon = chirality center = stereocenter = asymmetric carbon

Chirality can create a pair of non-superimposable mirror image molecules called **enantiomers**.

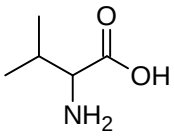
Enantiomers are one type of stereoisomer.



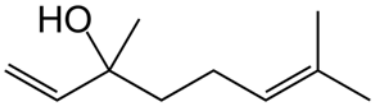
Star the chiral carbons.



Geranium oil

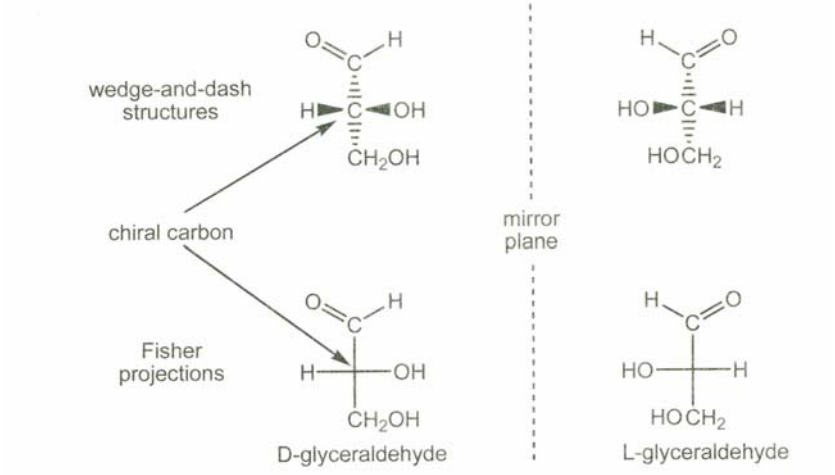


Valine

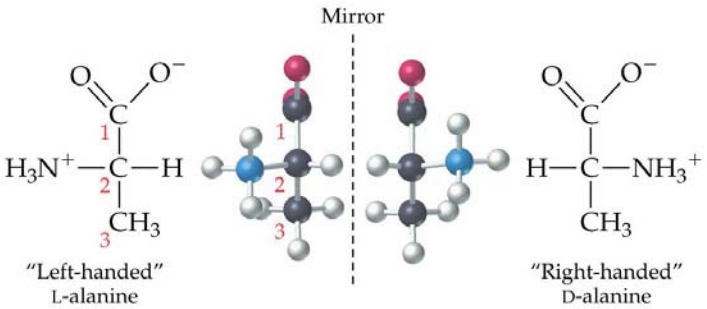


Linalool

Fischer Projections – a simple way to draw chiral carbons



Alanine drawn with a Fischer Projection



Properties of Enantiomers

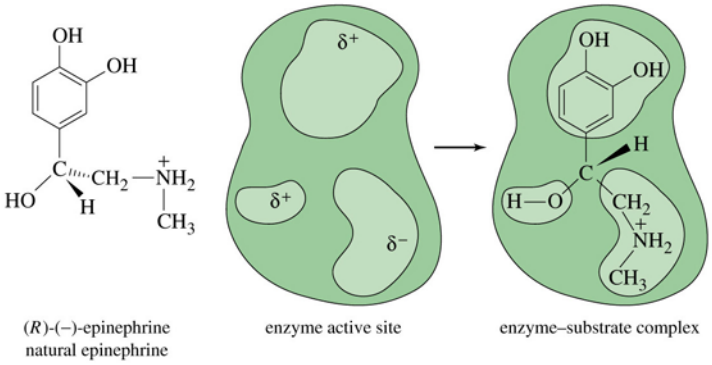
Enantiomers share many properties

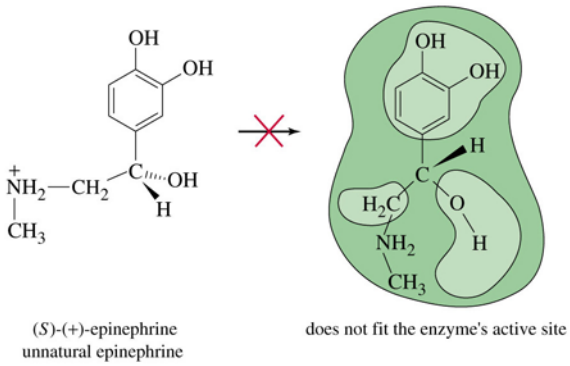
bp, mp, density, refractive index & solubilities

However, they interact differently with

1) other chiral systems/compounds
2) polarized light

More than half of all drugs have a single enantiomer as the active pharmaceutical ingredient.





Racemic Mixture:

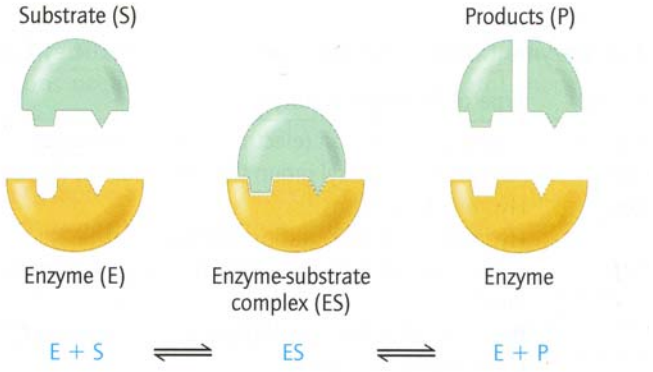
Ibuprofen – a racemic mixture

Proteins and Enzymes Part 8: Introduction to Enzymes

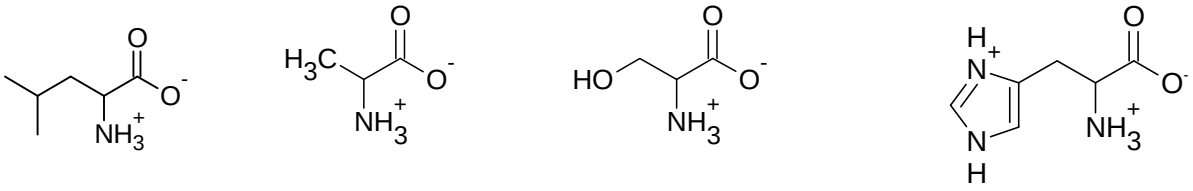
Enzymes

Catalysts increase the rate of a chemical reaction without being changed themselves. Most biological catalysts are protein enzymes that change the way a reaction takes place so that it occurs faster. The reactants in enzyme-catalyzed reactions are called substrates.

Enzymes lower the activation energy (Ea) of a reaction by binding one or more substrates into an active site, using hydrophobic or hydrophilic interactions (H-bonding, dipole-dipole, London, etc.) This binding stretches each substrate into a reactive form and aligns it properly for the chemical reaction to take place.



Circle the side chains in each amino acid below.
Classify the side chains as hydrophobic, polar, acidic or basic.

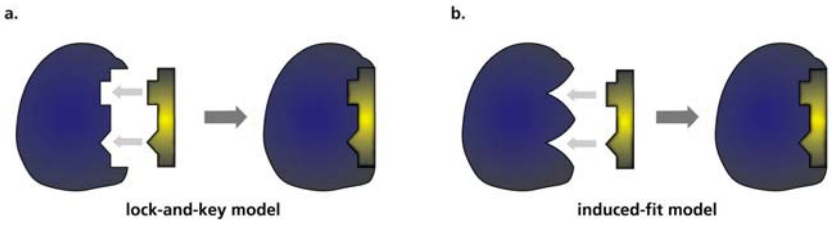


If the first amino acid above is part of a substrate, hypothesize which of the other three amino acid residues might be present in the active site of an enzyme. Explain your reasoning.

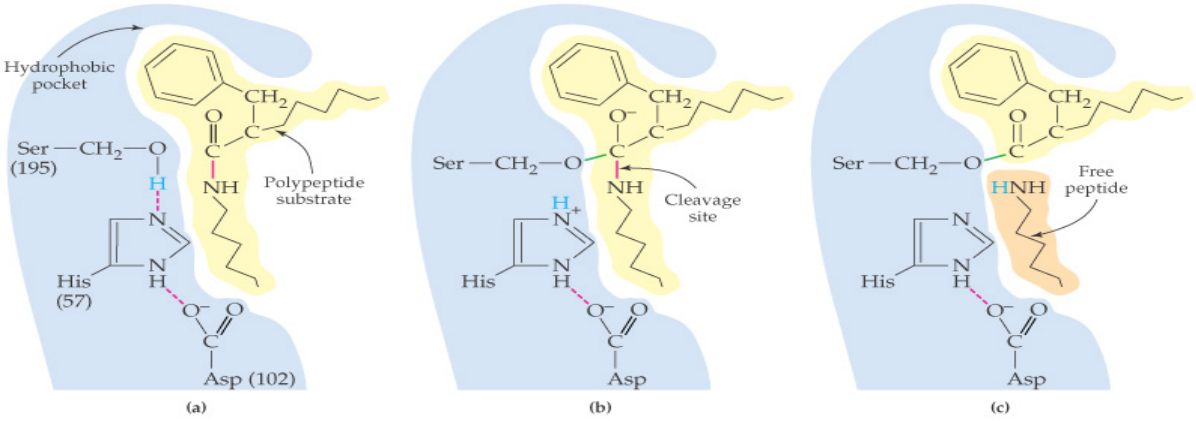
2 Models for the Enzyme Substrate Interaction

Lock & Key model: The substrate fits into the active site as a key fits into a lock.

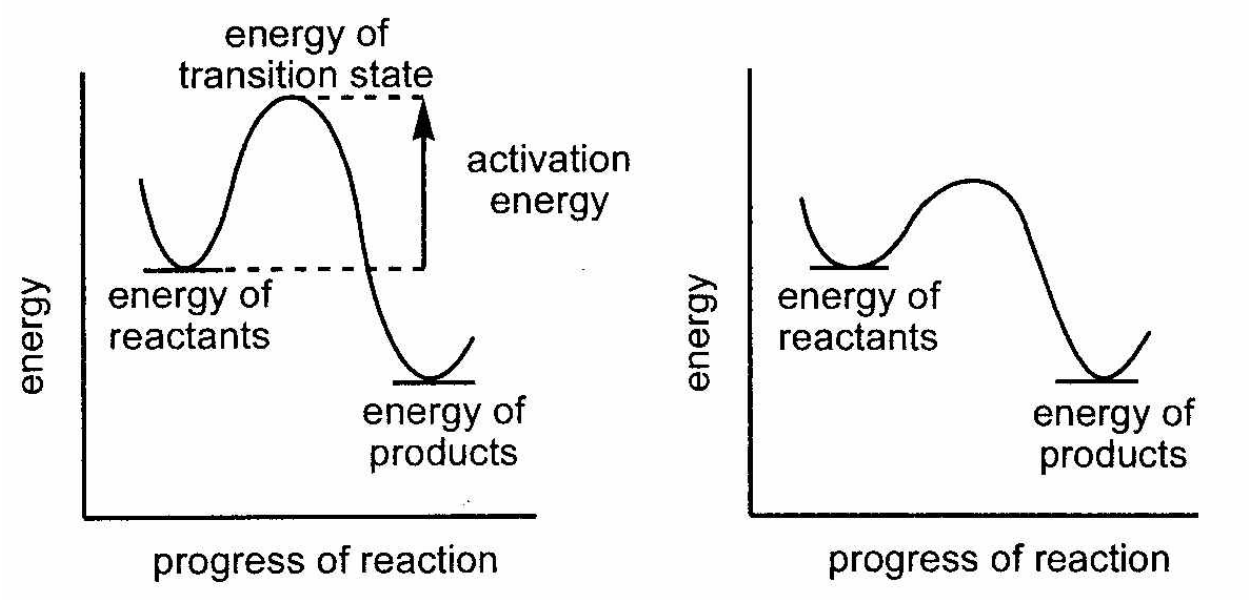
Induced Fit model: The enzyme has a flexible active site that changes shape to accommodate the substrate & facilitate the reaction



Example:



Energy diagrams – comparing uncatalyzed and catalyzed reactions



Are these reactions endothermic or exothermic?

Identify which reaction is catalyzed. How could you tell?

Draw in a vertical arrow to represent the magnitude of the Ea in the catalyzed reaction.

Does the enzyme change the energies of the reactants or products?

Does an enzyme change the equilibrium amounts of reactants and products? Explain.

Proteins and Enzymes Part 9: Enzyme Inhibiton

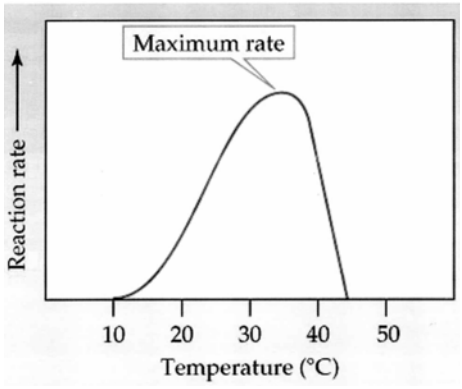
Enzyme Inhibitors: any compound or environmental condition that prevents an enzyme from performing its function

Nonspecific Inhibitors:

Nonspecific Inhibition – a closer look

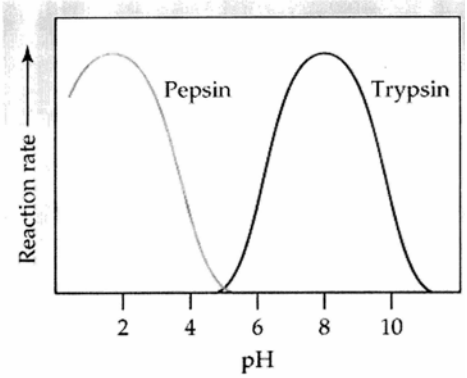
Effect of Temperature

Increase in temperature increases the rate of enzyme catalyzed reactions. The rate reaches a maximum and then begins to decrease. The decrease in rate at higher temperature is due to denaturation of enzymes.



Effect of pH

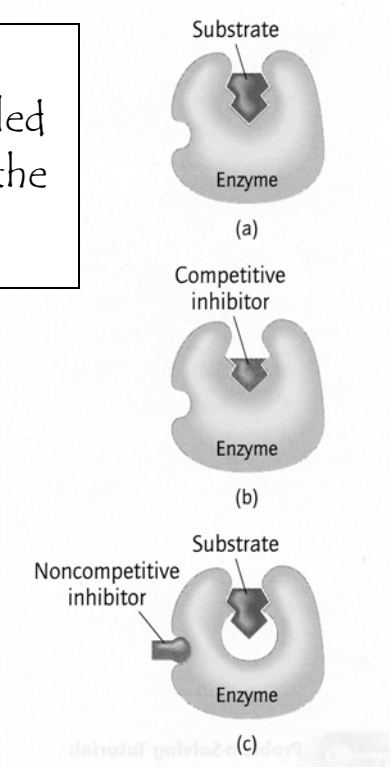
The catalytic activity of enzymes depends on pH and usually has a well defined optimum point for maximum catalytic activity.



Specific Inhibition – a closer look

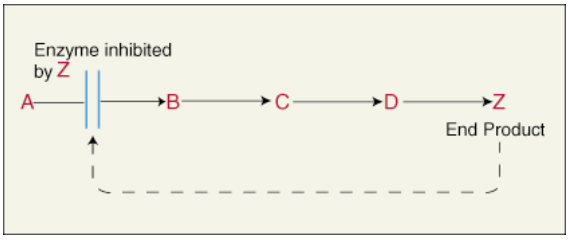
Competitive Inhibition vs Non-competitive Inhibition

The activity of an enzyme is controlled by the binding at the active site.

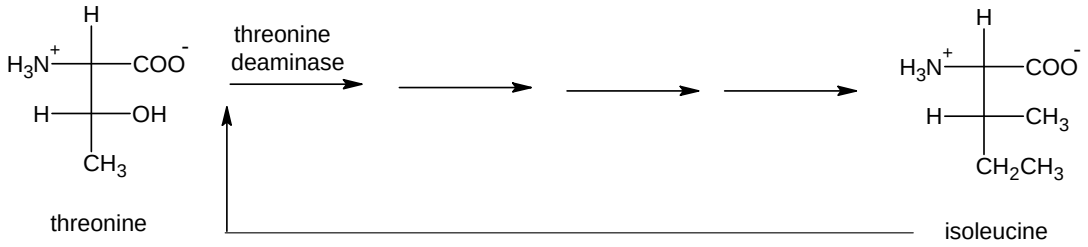


The activity of an enzyme is controlled by the binding of an activator or inhibitor at a location other than an active site.

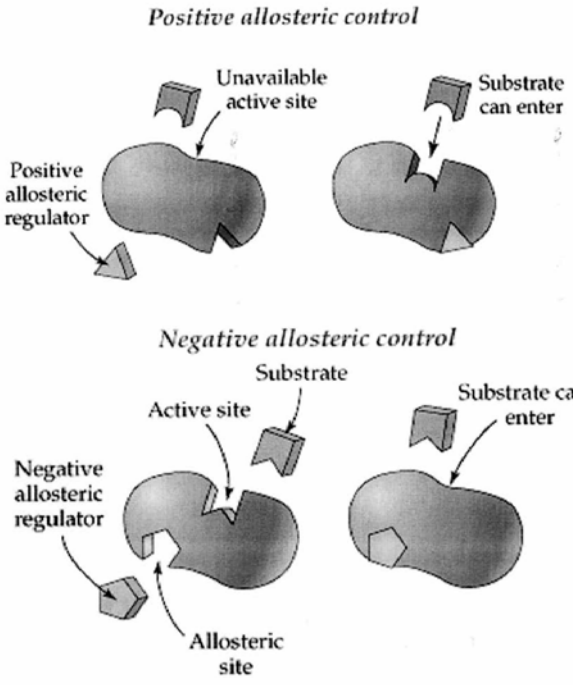
Feedback inhibition: regulation of an enzyme's activity by the product of a reaction later in a pathway



Example: Threonine deaminase is inhibited by the isoleucine. Isoleucine binds to a different site on the enzyme and changes the conformation so that threonine no longer binds properly.



Allosteric control = Non-competitive Inhibition or Activation



A **positive regulator** changes the activity site so that the enzyme becomes a better catalyst and rate accelerates.

A **negative regulator** changes the activity site so that the enzyme becomes less effective catalyst and rate slows down.

Proteins and Enzymes Part 10: Enzyme Classification & Reaction Catalysis

Six main classes:

1. Oxidoreductase: redox reactions

2. Transferase: transfer functional groups

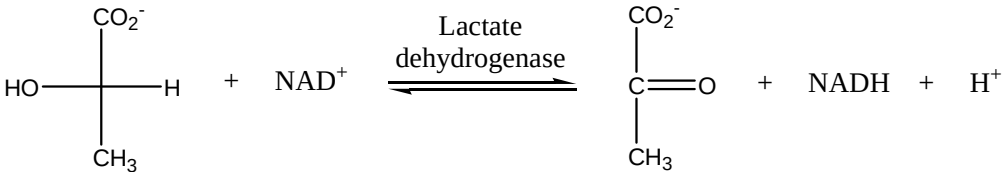
3. Hydrolase: hydrolysis reactions

4. Lyase: addition and elimination reactions

5. Isomerase: isomerization reaction

6. Ligase: bond formation coupled with ATP

Oxidoreductase: redox reactions; a coenzyme is required

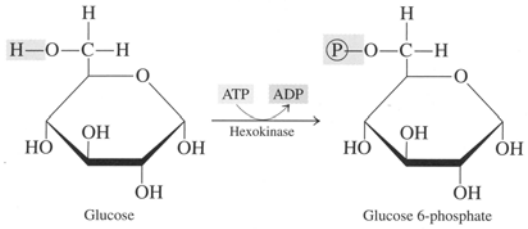


1. Label the reaction above to indicate which compound is oxidized and which compound is reduced.

2. Lactate dehydrogenase is the enzyme. What is the name of the term given to NAD^+ in this reaction?

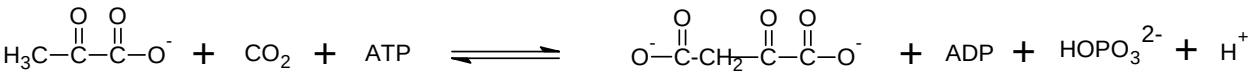
Transferase: transfer functional groups (phosphates, acyl groups, amines); often have the name kinase

Structure of Functional Group transferred at physiological pH



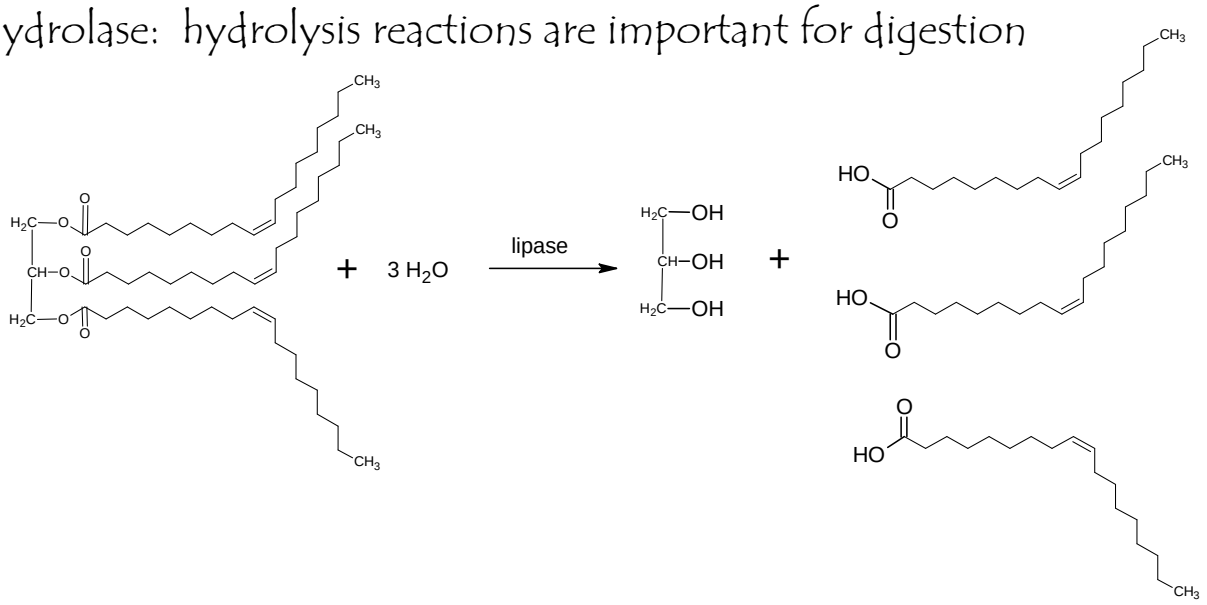
3. Draw the structure of the functional group transferred in the reaction above at physiological pH in the box above.

Ligase: bond formation coupled with an ATP-ADP reaction



4. Describe how you can distinguish between a reaction catalyzed by a ligase enzyme and a reaction catalyzed by a transferase enzyme.

Hydrolase: hydrolysis reactions are important for digestion



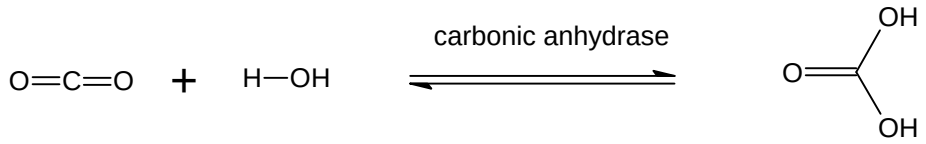
fat (triglyceride) glycerin fatty acids

5. Draw lines through the bonds in the reactant (fat) that are split apart by the water molecules.

6. Circle the hydroxyl groups in the product(s) that were derived from the water molecules.

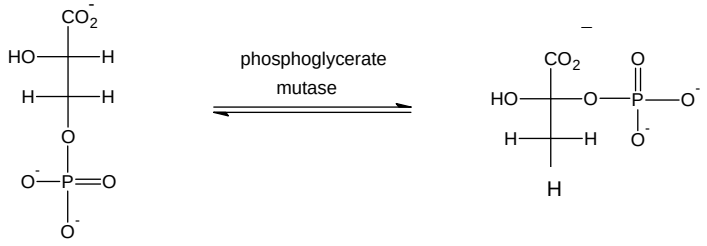
7. Box the hydrogen atoms in the product(s) that were derived from the water molecules.

Lyase: catalyze the addition of groups such as H_2O, CO_2, or NH_3 to a double bond or reverse reaction in which the group is eliminated to create a double bond



8. Describe how you can distinguish between a reaction catalyzed by a hydrolase enzyme and a reaction catalyzed by a lyase enzyme.

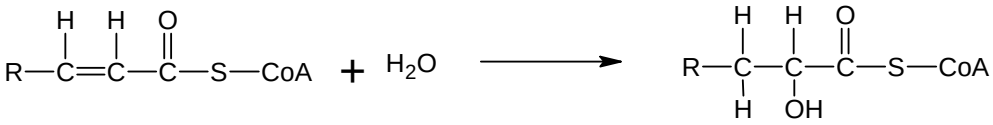
Isomerase: isomerization reaction (rearranges functional groups within a molecule)



9. The term to describe the relationship between the substrate and product of the reaction above is structural isomer or geometric isomer (circle one).

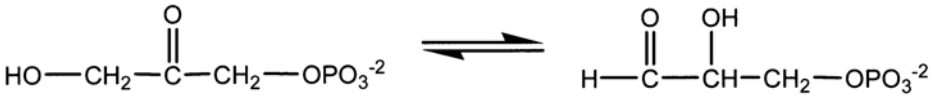
10. Identify the class of enzyme (oxidoreductase, transferase, hydrolase, lyase, isomerase, or ligase) needed to catalyze each of the following reactions?

a.

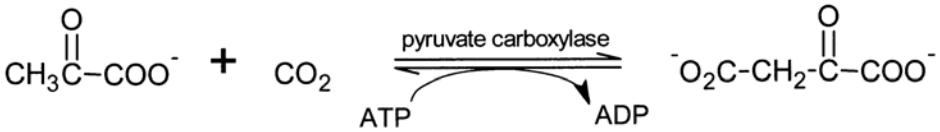


b.

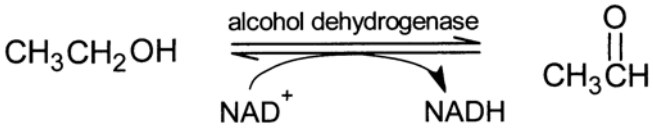
c.



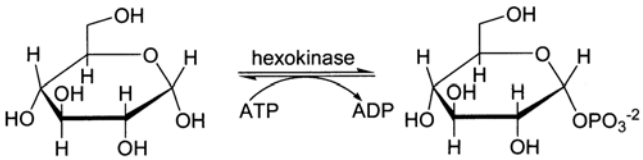
d.



e.



f.



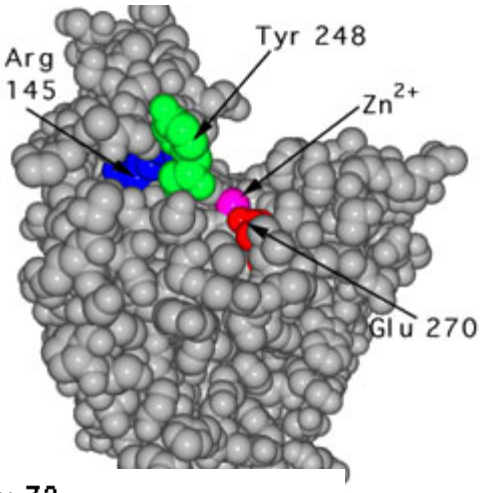
Many enzymes are conjugated proteins that require non-protein portions known as cofactors.

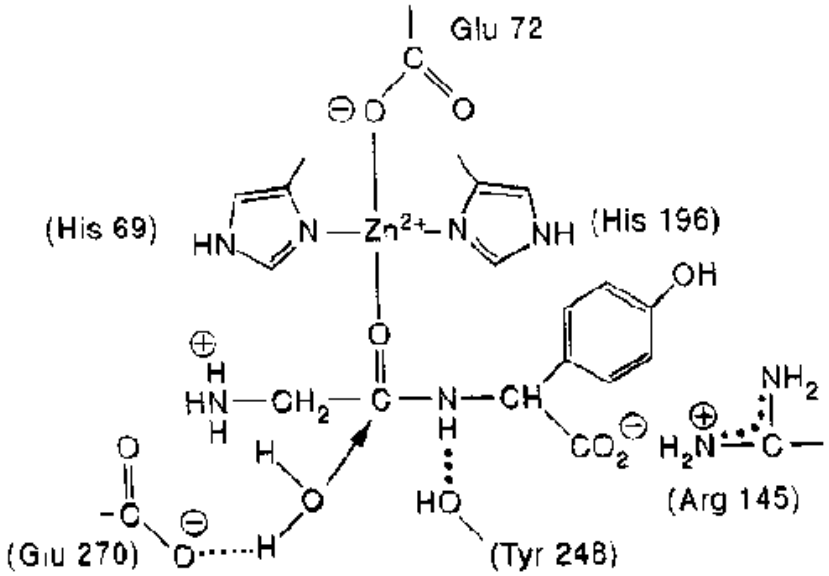
Cofactors can be

- metal ions
- coenzymes - non-protein organic molecules

Example of a metal ion cofactor - Zn^{2+}

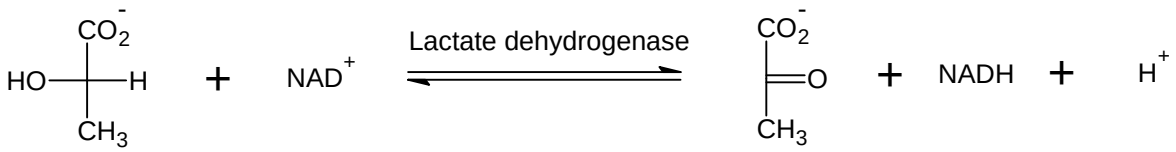
Carboxypeptidase is an enzyme that requires a Zn^{2+} ion as a cofactor. This enzyme hydrolyzes the first amide bond at the C-terminal end of peptides. Carboxypeptidase is synthesized in the pancreas and secreted in the small intestine.





Example of a coenzyme cofactor – NAD^+/NADH

Lactate dehydrogenase is an enzyme that requires the coenzyme NAD^+ /NADH for enzymatic function.



Which species has been reduced?

Which species has been oxidized?

Remember, enzymes catalyze both the forward and the reverse processes.

Biochemical reactions are often represented with the coenzymes/ enzymes written in conjunction with the equation "reacts to form" arrow.