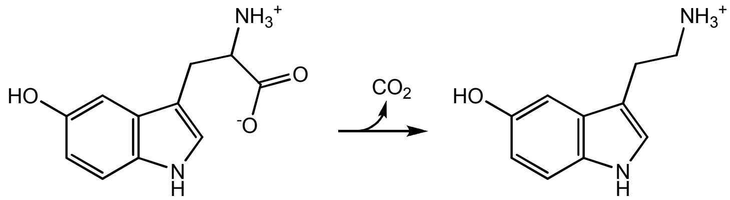
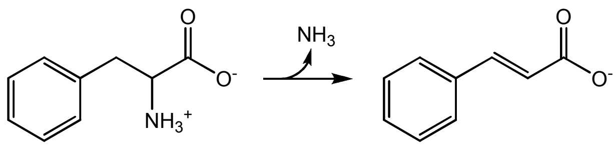
1. Name the *class* of enzyme that catalyzes each of the following reactions:

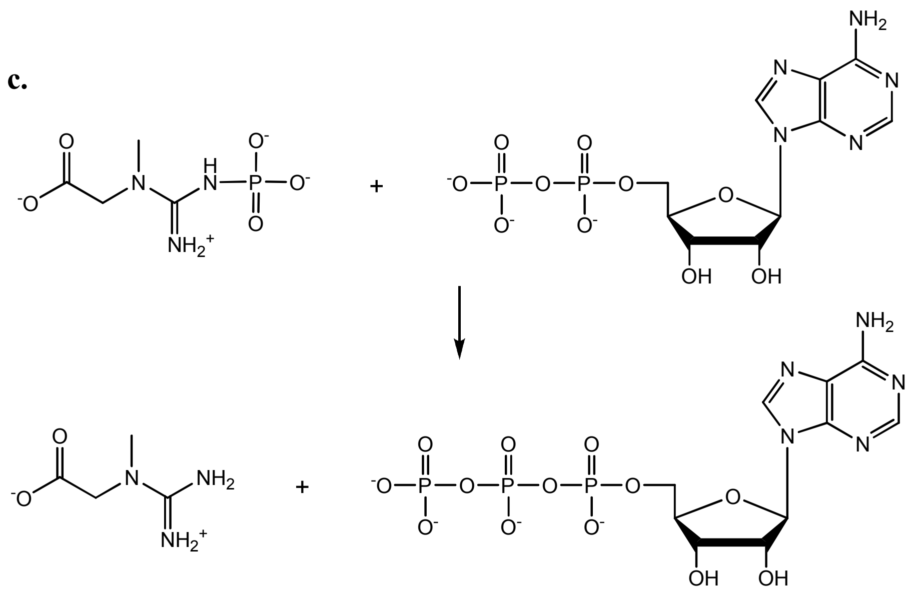
a.



b.



c.

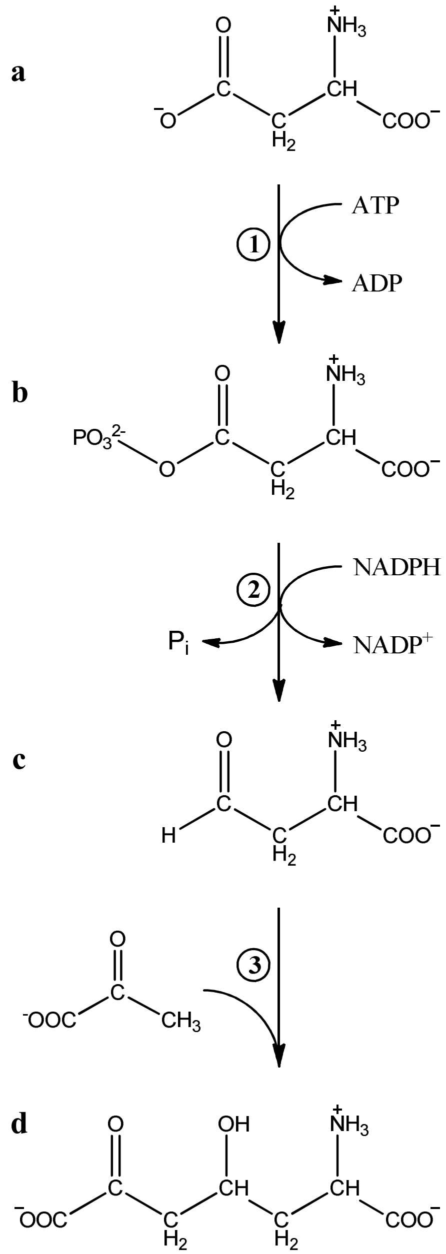


2. True or False?

   a. The free energy of the highest-energy intermediate *directly* determines the rate of a reaction.
   b. The hydrolysis reaction catalyzed by lysozyme involves an aspartate residue acting as a general base.
   c. Covalent catalysis is an example of preferential binding of an intermediate.
   d. An enzyme will catalyze a reaction in which the free energy of the product(s) is higher than the free energy of the reactant(s).
   e. The transition state of a reaction cannot be isolated.
   f. The activation energy of a reaction is the difference between the free energy of the reactants and the free energy of the highest-energy transition state.
   g. The activation energy of a reaction determines whether the reaction will be spontaneous in the forward direction.
   h. Two names of catalytic mechanisms – preferential binding of an intermediate, and preferential binding of a transition state – refer to the same thing.

3. The following reactions occur in bacteria as initial steps in the biosynthesis of certain amino acids.

   For each step (1, 2, 3), list the class and subclass (if applicable) of enzyme that catalyzes the reaction; choose the corresponding letter from the list provided below.

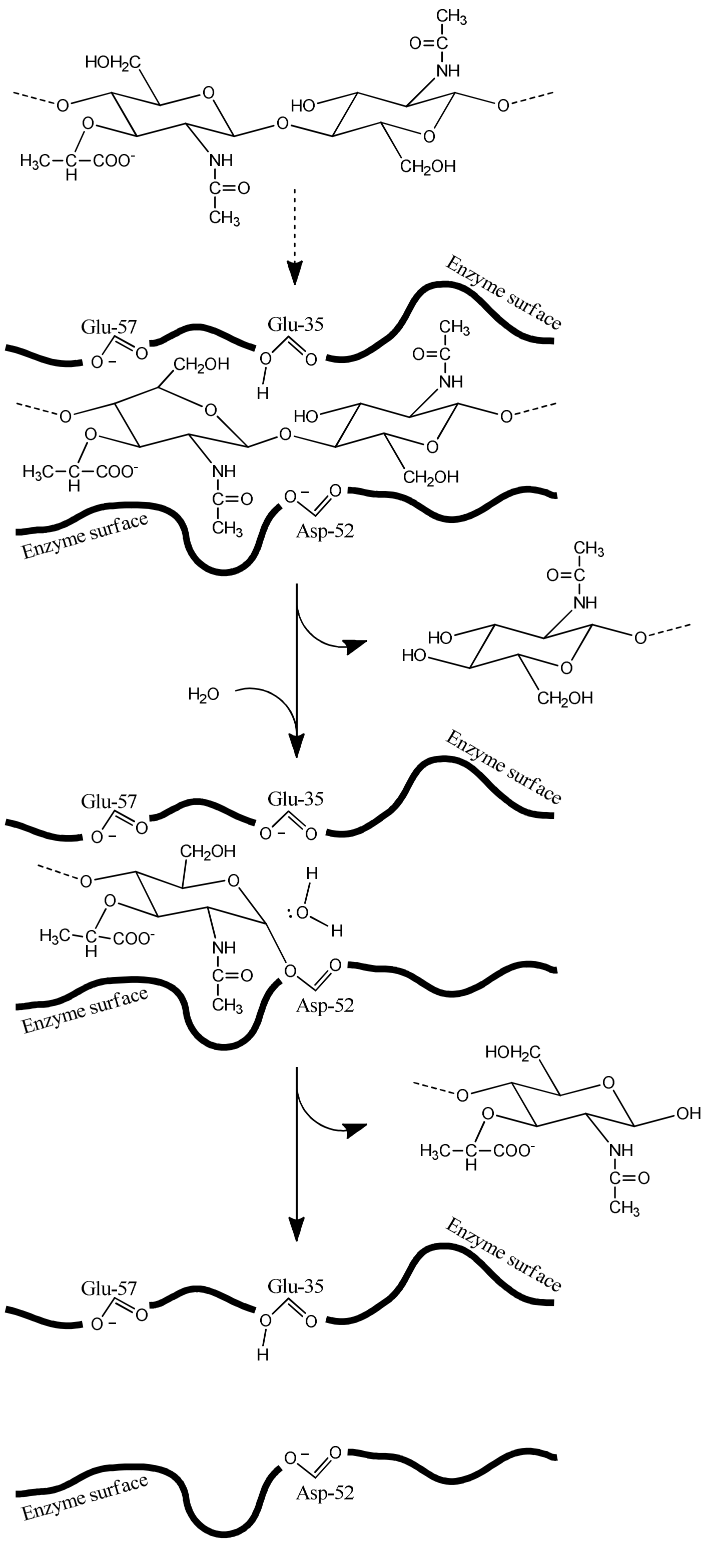


Choose from:

A. aminotransferase
B. carboxyltransferase
C. dehydrogenase
D. glycosidase
E. hydrolase
F. kinase
G. isomerase
H. ligase
I. lipase
J. lyase
K. mutase
L. oxidase
M. oxidoreductase
N. peptidase
O. phosphatase
P. phosphorylase
Q. protease
R. synthase
S. synthetase
T. transferase
U. none of the above

4. Define "preferential binding of the transition state" and explain how enzymes use this mechanism to catalyze reactions. (Do not describe specific enzymes, but give a general explanation.)

5. Below is an enzyme mechanism (with reaction arrows omitted):



a. Name the enzyme.

b. Name the biological substrate of this enzyme and the substrate's function.

c. Name the enzyme class.

d. List, in order, the catalytic mechanisms used by this enzyme (in the mechanism shown).

Please note that questions 6-9 below are unrelated to the drawing shown at left.

6. Draw the catalytic triad of a serine protease, including interactions between the residue side chains. Add in the enzyme's substrate, and show the first step of the catalysis by drawing in curved arrows.

7. You are studying the catalytic properties of chymotrypsin, and you decide to mutate the catalytic aspartate to asparagine. Describe how and why (or why not) you would expect this to affect:
    a. The binding of substrate to chymotrypsin. (30 words or fewer)
    b. The activity of chymotrypsin. (30 words or fewer)

8. What is the oxyanion hole of the serine proteases, and what is its function?

9. Briefly explain divergent and convergent evolution in terms of their similarities and differences.