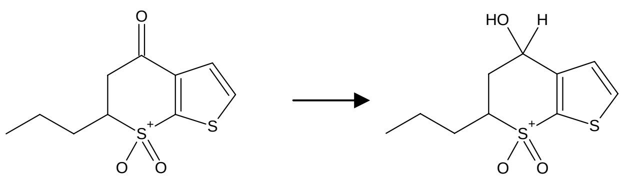
10.492 – ICE Topics: Biocatalysis
Fall 2004

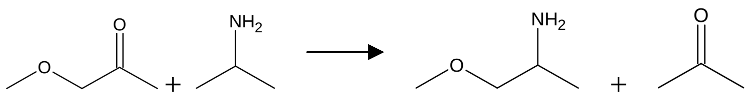
Homework #1
Due Friday, Nov 12th *at the beginning of class*. Solutions should be written and submitted on your own paper. All pages should be stapled together.

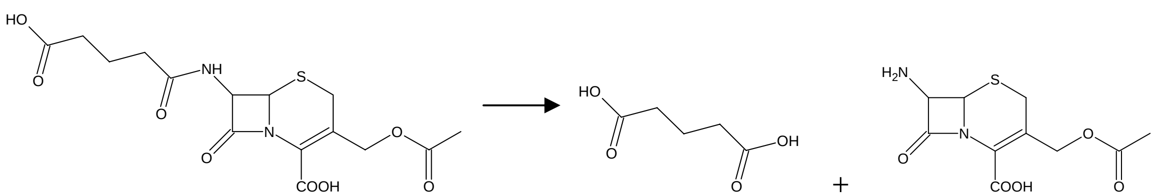
1) List three advantages of using biocatalysts over traditional (inorganic) catalysts for the production of chemical compounds.

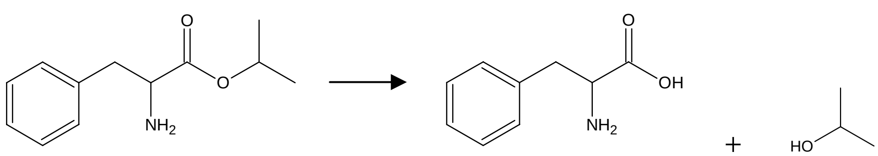
2) Name two cases in which one would likely not want to use biocatalysts and explain why.

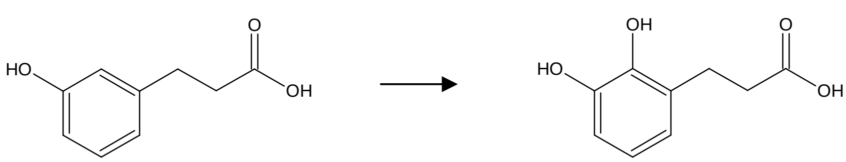
3) For the following chemical reactions, identify from which of the six enzyme classes an appropriate biocatalyst would most likely be found to perform the conversion. (Note: The reactions are not necessarily balanced as written.

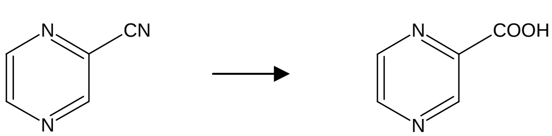
a) 

b) 

c) 

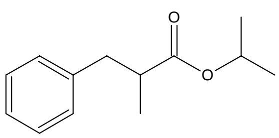
d) 

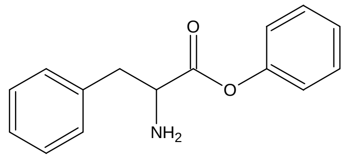
e) 

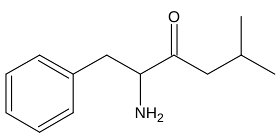
f) 

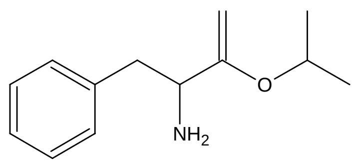
(over)

4) Look again at the bioconversion shown in Question 3(d). Using the same (unnamed) enzyme, evaluate whether the bioconversion is likely to occur for the following compounds. For each compound, give a brief statement as to why you think it will or will not be acted upon by the enzyme.

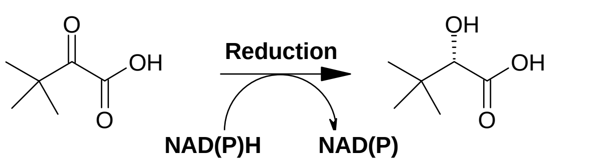
a) 

c) 

b) 

d) 

5) You would like to identify an enzyme that will perform the following reduction, giving a high yield of the *R*-enantiomer.



KETOACID **(R) HYDROXYACID**

You have at your disposable 10 different enzyme preparations that are candidate catalysts. For each enzyme, you set up a small reaction, charged with 1 g/L of substrate and let the reaction run at room temperature for 3 hours. You then obtain the following data (each value is the concentration, in g/L, of the compound listed):

Enzyme	**Ketoacid**	***R*-hydroxyacid**	***S*-hydroxyacid**
Red1	0.48	0.26	0.26
Red2	0.12	0.24	0.64
Red3	0.76	0.19	0.05
Red4	0.75	0.03	0.22
Red5	0.25	0.71	0.04
Red6	0.33	0.66	0.01
Red7	0.20	0.39	0.41
Red8	0.10	0.86	0.04
Red9	0.99	0.003	0.007
Red10	0.62	0.31	0.07

For each enzyme, calculate the conversion and the EE. Which enzymes would *not* be carried forward for process development? Of the remaining, which is your top candidate for process development and why? (Courtesy of Merck & Co., Inc. Used with permission.)

6) An enzyme with a K_M of $1x10^{-3}$ M was assayed using an initial substrate concentration of $3x10^{-5}$ M. After 2 min, 5 percent of the substrate was converted. How much substrate will be converted after 10 min, 30 min, 60 min? How long must the reaction be run to achieve 99% conversion? (Assume that the enzyme follows Michaelis-Menten kinetics.)