

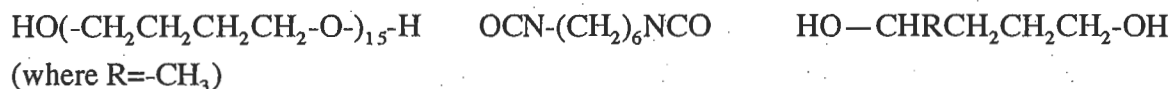
3.034 - Quiz #2 (2005)

closed book and notes

1) (25 pts) Adipic acid and ethylene glycol are reacted to form poly(ethylene adipate) via a direct esterification route. Calculate the maximum number average molecular weight (M_n) that can be obtained under the following conditions.

The reaction is carried out with a slight excess of alcohol groups (1% excess) but all of the water byproduct is not removed and 0.05 moles of water exist for every mole of unreacted acid group at the end of the reaction.

2) (25 pts) Using the monomers below, show the synthesis of a segmented polyurethane with "elastomeric" properties. Show all reaction steps and the structure of the final product.



3) (25 pts) You wish to study the rate of enzymatic hydrolysis of poly(L-lactic acid). Your idea is to attach preformed polymer chains to micron-size polystyrene beads packed in a column and then pass a solution containing an enzyme through the column and measure the amount of hydrolysis product eluting from the column as a function of time.

a) show the chemistry that you could use to attach the preformed chains of poly(L-lactic acid) to the polystyrene beads.

b) identify the type of enzyme you would use to hydrolyze the polymer chains attached to the polystyrene beads.

c) explain and sketch the basic mechanism of the hydrolysis, including the role of specific functional groups within the active part of the enzyme.

d) Is there a role for the non-active pocket part of this molecule, make a suggestion for what this region might look like based on the polymer (PLA).

e) what is the ideal pH range to use for your cleavage reaction ?

4) (25 pts) It is a well know problem that CO₂ build up (in high concentration), from human respiration in confined spaces can lead to CO₂ poisoning (hypercarbia). Hypercarbia leads

to pH changes in the body and brain swelling. Astronauts in the space station require the removal of CO₂ from their environment to survive. This is done with CO₂ scrubbers, which capture the CO₂. This year NASA has experienced problems with their CO₂ scrubbers. You have been asked to build a small biological molecule CO₂ scrubber prototype on a chip.

From 3.034 lab, you have available the choice of 3 plasmids you can use to produce proteins/enzymes in bacteria:

pBPZ + RNase A

pBPZ + trypsin

pBPZ + carbonic anhydrase

where this notation implies that pBPZ includes the sequence for the protein of interest.

You also have both monoclonal and polyclonal antibodies to RNase A, trypsin and carbonic anhydrase. You also have glass surfaces and gold surfaces, as well as any chemicals or reagents you want.

Rules for designing your CO₂-scrubber-on-a-chip:

- a) You must suggest one way in which you would modify your pBPZ to identify the bacteria that were successfully infected to produce your protein/enzyme of interest.
- b) If you make an enzyme, you must explain how you would purify it from the rest of the proteins/enzymes in the bacteria.
- c) If you use an enzyme you must know and sketch its mechanism.
- d) If you use an antibody, you must explain which type and sketch the basic structure for that type of antibody, indicating the major regions of an antibody.
- e) You must explain your ideas around designing and building this prototype.