3.034 – Quiz #2 (2004) Closed book and notes
(each question 20 pts)

1) Looking at current studies for Serine protease, suggest a way that you as a Materials Scientist could answer a question, or improve on function, detection, or a medical application.

Explain your reasoning or experimental design from principles discussed in class, which may include materials/protein structure and interfaces, catalytic activity and increased stability that might be achieved by using new types of materials.

2) Recall that in Lab 3 you used gelatin zymography to quantify levels of the cell-secreted Matrix Metalloprotease 2, which requires metal ion (zinc or calcium) cofactors.

(a) Why would gelatin bind to a hydrophobic pocket formed by aromatic chains in MMP2, rather than an exposed domain of the enzyme?

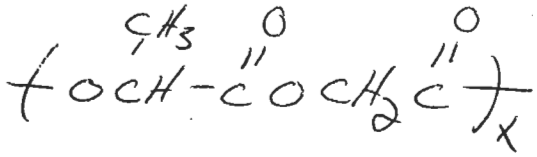
(b) Explain the mechanism by which water would coordinate with the Zn^{2+} ions in the catalytic site of the MMP2 enzyme, and how you think this would induce activity of the enzyme against the gelatin substrate.

3a) Using suitable monomers on page 2, show how you would synthesize a segmented polyurethane-urea with the following attributes (show the structure of the final polymer):

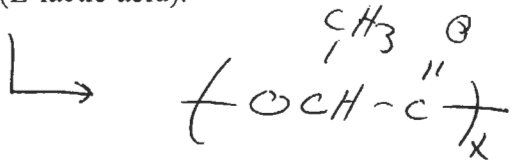
1. the soft segments contain, on average, 20 repeat units.
2. the hard segments contain both urethane and urea linkages

3b) Give examples of where a segmented polyurethane-urea of this type might be used in biomedical applications and briefly explain how its structure and properties make it suited for such applications.

4a) Using suitable protection-deprotection schemes, show how you could synthesize the following poly(hydroxy acid)as a perfectly alternating copolymer. Assume that the monomers are available in their appropriately protected forms.



4b) Give examples of where such a polymer might be used in biomedical applications and briefly discuss how its structure would influence its behavior in these applications compared to a simple homopolymer of poly(L-lactic acid).



5) Scientist have shown that antibodies can have catalytic activity, these are called "catalytic antibodies".

a) Based on what you know about enzyme mechanisms for catalyzing reactions, what kind of molecule would you use as your antigen to develop a "catalytic antibody".

b) Which fragment of the antibody would mostly likely have the catalytic activity? How could you test this?

c) You read in a paper that a catalytic antibody that has been shown to have high activity for the hydrolysis of ester bonds has an active site that resembles the active site of serine protease.

Do you believe this? Why?

Monomers for # 3