Problem Set 4 **20.462J/3.962J**
Issued: 03/10/06 **Spring 2006**
Due: 03/17/06
100 points total

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1. Physically associating polymers are used as drug carriers, tissue bulking agents, and cell delivery scaffolds.

    a. Explain why physical hydrogels are most often formed using *block* copolymers, where polymer chains are made up of repeating stretches of monomers which can take part in physical cross-links.

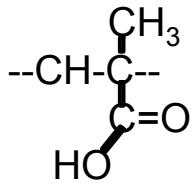
    b. (15 points) For the 3 types of gels described below, provide the following **3** pieces of information: **(A)** State what type of polymer functional groups would be used to create physical gels with the described properties, **(B)** give one specific example of such a functional group, showing how it forms physical crosslinks, and **(C)** state how that functional group or groups provide the desired behavior:

        i. Gels that are stable at reduced temperatures but dissolve at elevated temperature.

        ii. Gels that are stable at elevated temperatures but dissolve at reduced temperatures.

        iii. Gels that are stable in low ionic strength buffers but dissolve in high-ionic strength buffers.

2. Consider a covalent poly(methacrylic acid) hydrogel designed to be used as a drug carrier for oral drug delivery, which has the following physical parameters:



M = molecular weight of chains prior to crosslinking = 175,000 g/mole

M_c = 10,000 g/mole

Molar volume of water = 18 cm^3/mole $\phi_{2,r}$ = 0.4

Specific volume of PHEMA = 0.869 cm^3/g

χ = polymer-water interaction parameter ~ 0.5

pKa methacrylic acid groups = 6.0

We will make use of Peppas theory for the swelling behavior of this ionizable gel, governed by the master swelling equation:

$$\overline{V}_1\left(\frac{10^{-pK_a}}{10^{-pH}+10^{-pK_a}}\right)^2\left(\frac{\phi_{2,s}^2}{4Iv_{sp,2}^2M_0^2}\right)=\ln(1-\phi_{2,s})+\phi_{2,s}+\chi\phi_{2,s}^2+\phi_{2,r}\left(\frac{\overline{V}_1}{v_{sp,2}M_c}\right)\left(1-\frac{2M_c}{M}\right)\left[\left(\frac{\phi_{2,s}}{\phi_{2,r}}\right)^{1/3}-\frac{1}{2}\left(\frac{\phi_{2,s}}{\phi_{2,r}}\right)\right]$$

a. Suppose the gel is synthesized in the form of microspheres that have a diameter of 5 μm at pH 7.4 and 100 mM ionic strength. What will the diameter of the particles be in the acid climate of the stomach (pH~2.0, ionic strength 20 mM)? What is the degree of ionization of the gel in the stomach?

b. What % change in diameter will these microspheres undergo on passing from the stomach to the intestine (pH 7.2, ionic strength 20 mM)?

c. Basic ionic swelling theory neglects interactions between monomer units in the gel. Would you expect any such interactions are possible in this hydrogel? What effect could they have on swelling?