2.785J/3.97J/BEH.411J/HST523J
Spring 2004

CELL-MATRIX MECHANICS

Homework #1

Figure 1 shows the density of bone at three levels of a hip prosthesis in a postmenopausal woman three years after the device was implanted. (The black central zone of sections "a," "b," and "c" is cross-section of the prostheses.) A control section shows a typical section of the bone before the prosthesis was implanted and before the patient entered menopause. The following gives the relative force (stress) as a result of implanting the device (Fn is the force that normally occurs in bone):
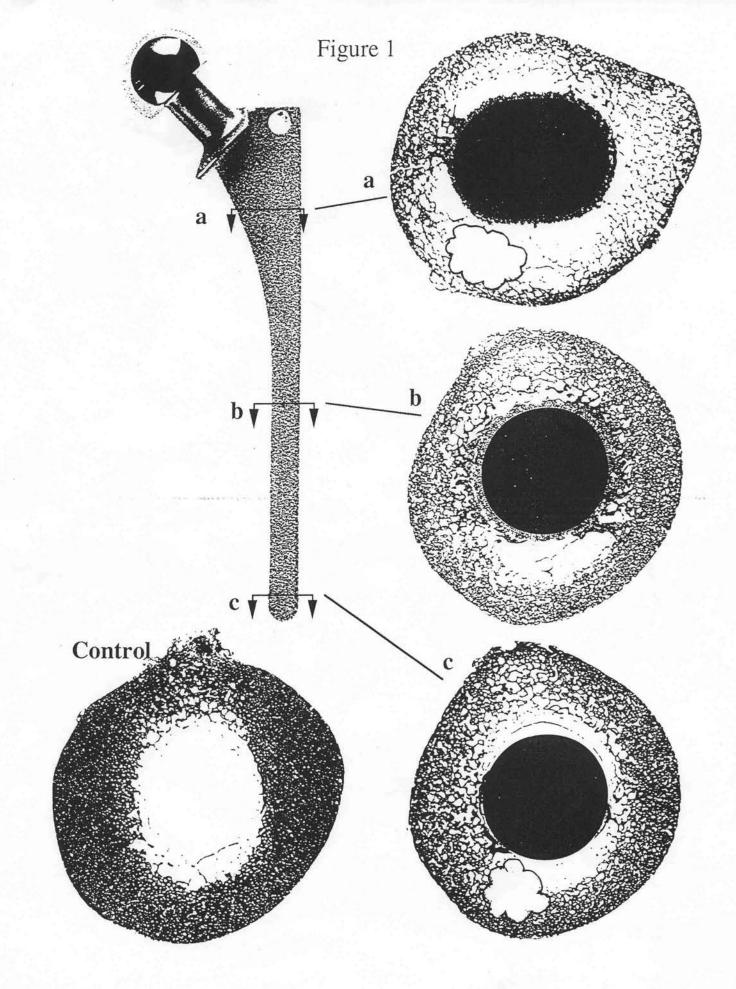
$$F_a < F_b < F_c = F_n$$

a. Write the unit cell processes that might explain the loss of bone density (*i.e.*, bone mass) at sections a and b as a result of implantation of the prosthesis.
(Ignore the scalloped regions in sections "a" and "c.")

b. Note in the unit cell processes in answer to (a) what factor(s) might explain the loss of bone in section "c" (ignore the scalloped region). Explain.

c. The scalloped zones in sections "a" and "c" are related to the macrophage response to particulate debris. Write the unit cell process that explains this localized bone resorption. Include names of regulators when they are known.

d. Assuming that the prosthesis has now loosened and there is more motion at section "c" than at section "a," how could you explain that the amount of localized bone loss due to the particulate debris would be greater in section "c" than in section "a?" Explain in the unit cell processes.

Figure 1