

Biomaterials - Tissue Interactions

Homework #1

1. Major problems with silicone breast implants (Fig. 1) are the thickening and contraction of the fibrous tissue (scar) capsule that forms around the device. Write the unit cell process(es) that are responsible for this thickening and contraction. Name possible regulators when they are known.

2. You have been hired by a firm to assist in the development of permanent (*i.e.*, nonabsorbable) porous coatings to be applied to joint replacement prostheses to facilitate the fixation of the implant to bone. Bone is to form within the pores of a metal mesh material (Fig. 2) and thereby form an interlocking bond with the coating (“bone ingrowth” for “biological fixation”).
 - a. Which unit cell process(es) are responsible for bone ingrowth? No need to name the regulators here.
 - b. Since the goal is to accelerate the bone ingrowth process your boss has suggested that certain regulators be incorporated into the coating in some way to be released after implantation. Which regulator(s) might be tried to achieve this goal, based on the UCP(s) in (a)?
 - c. It has also been suggested that the bone ingrowth process will proceed more rapidly if new blood vessels are encouraged to also invade the pores of the material. Could a single regulator be used to accelerate new blood vessel invasion and also bone ingrowth? If so, name the regulator if you know it and show which relevant UCPs for bone formation and blood vessel growth it would influence.

3. A major problem with joint replacement prostheses is polyethylene particle-induced degradation of bone (referred to as "osteolysis"; see Fig. 3). Write the unit cell process(es) to describe this phenomenon. Name possible regulators when they are known.

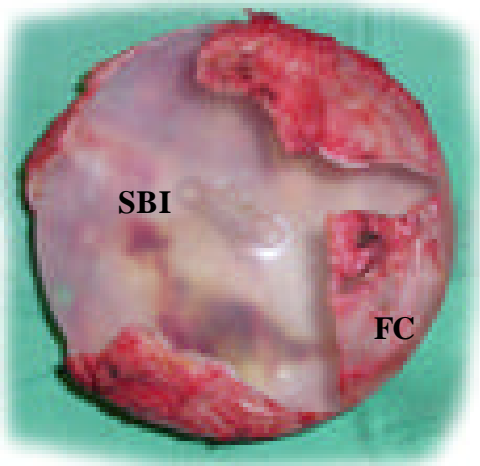


Fig. 1. The fibrous capsule (FC) that had been contracting around this retrieved Silicone breast implant (SBI) has been cut open.



Fig. 2. The metal mesh on this acetabular cup is to serve at the bone attachment vehicle. Bone tissue ingrowth into the metal mesh will allow fixation to be achieved. The polyethylene insert is not shown.

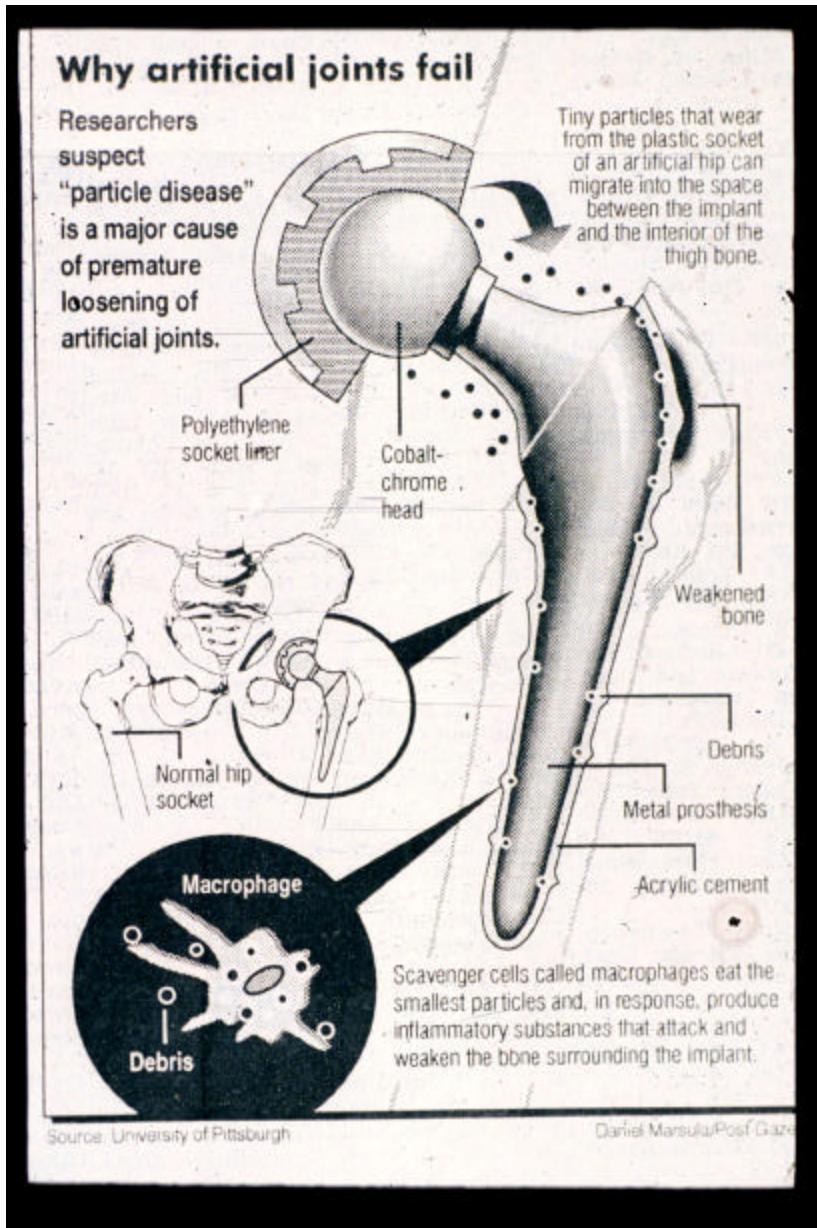


Fig. 3. Article from the Pittsburgh Post Gazette showing the particles of polyethylene, generated by a wear process, infiltrating the tissue around a prosthesis. The area shown as “weakened bone” is a region where bone resorption has resulted from the response to the polyethylene particles.