CHAPTER II.5.6

Orthopedic Application

QUESTIONS

1. What are the general mechanical property qualifications for orthopedic biomaterials, and what are the major categories of orthopedic implants?
2. (a) What is the primary problem associated with the longevity of current total joint replacement implants and why? (b) How could this be solved by improved biomaterials?
3. What are the primary cytokines associated with particle-induced osteolysis, and what is the primary cell type involved in this process?
4. Name six of the primary orthopedic implant biomaterials.
5. Name one new orthopedic biomaterial and why it was introduced (i.e., what specific problem/deficit is it attempting to solve?).
6. What is one way in which current designs of orthopedic implants are creating more challenging conditions for biomaterials to overcome and why?

ANSWERS

1. Generally orthopedic implants must be capable of high strength, fracture toughness, and most importantly corrosion resistance. The two major kinds of orthopedic implants are bone fixation and total joint arthroplasty (to a less extent new kinds of dynamic stabilization devices with articulating components are slowly making their way onto the market).
2. (a) Particle and wear debris generation at the articulating surfaces of total joint replacements causes aseptic loosening of the implants through the induction of inflammation around the implant (macrophage-particle overload), which causes a decreased production of new bone and increased bone resorption. (b) More wear-resistant materials at the articulating surface while maintaining current available levels of other mechanical properties.
3. The primary cytokines associated with osteolysis are TNF-alpha, IL-6, IL-1, Prostaglandin E2 etc., produced by macrophage interaction with particulate debris from implants.
4. Cobalt-based alloys; Titanium-based alloys; Stainless steel; PMMA; UHMWPE; and alumina.
5. Zirconium alloy was introduced to decrease the amount of metallic wear debris being generated at the bearing surface, and as an alternative metal less likely to induce hypersensitivity reactions because of its corrosion resistance and less common presence environmentally.
6. Orthopedic implant component modularity (more components that fit together in vivo) is creating more interfacial surfaces from which implant debris can be generated through fretting corrosion (micromotion) that interact both locally and systemically.