Assessment of your knowledge

(a) Answer the following questions to assess your command on terminology, facts, concepts, and theories learned in this chapter.

1. Define what is meant by the term biodegradable and how this differs from the term bioresorbable
2. Summarize the main difference in mechanical properties between bioceramics, polymers, and biomaterials in terms of modulus, strength, and ductility.
3. What is the key structural difference between a bioceramic and a bioglass?
4. How can solubility isotherms be used to rank the dissolution rates of calcium phosphate bioceramics?
5. List three factors in the design of a bioceramic scaffold that would influence its degradation rate.
6. Beyond hydroxyapatite, what other calcium phosphate structures have found application in bioceramic scaffolds?
7. What role might osteoclasts play in the degradation of bioceramic scaffolds?
8. Describe the key distinguishing features of surface erosion compared to bulk erosion of polymers.
9. For a hydrolytically degradable polymer, explain the role of initial molecular weight on degradation.
10. With the aid of a sketch, describe the typical degradation sequence for a bioresorbable polymer such as poly-L-lactic acid (PLLA).
11. Why does the local environment sometimes become acidic during degradation of a polymer?
12. Why might a polymer become brittle after melt-processing?
13. How might the degradation rate of a polymer be accelerated to predict long-term behavior?
14. What are the common methods of sterilizing biodegradable polymers and are any of these methods likely to have no influence on degradation behavior?
15. Is degradation of polymers like to occur faster or slower in vivo compared to in vitro?
16. What biometals have been explored of applications as tissue scaffolds?
17. Why might alloys be used, as opposed to pure metals, for the development of tissue scaffolds?
18. List three types of localized corrosion effects that are typically observed for biometals.
19. Describe a method that can be used to establish the corrosion rate of a biometal.
20. Give an example of a biodegradable composite and explain what this might be more challenging to process into a scaffold than a single-component biomaterial?

(b) Answer the following questions to assess your ability to apply the concepts and theories learned in this chapter in real life, clinical, and scientific situations.

1. What factors, relating to the in vivo environment, would influence degradation of biomaterials and which of these factors would particularly dominate the mechanism when considering the cases of bioceramics, polymers, and biometals?
2. In a cell-free environment, bioceramics are known to degrade by a mechanism of physicochemical dissolution. Describe how the introduction of multinucleated cell plays a role in this process.
3. In the context of polymer degradation, why might a patient experience inflammation and discomfort at the location of an implant?
4. Give an example of a polymer that would gradually bioresorb in the body due to hydrolytic degradation. Describe this process referring to changes in molecular weight, strength, and mass during degradation.
5. A bioresorbable bone scaffold made from PDLGA has an initial strength of 25 MPa and an initial molecular weight of 330,000 g/mol. To allow time for sufficient bone healing, the scaffold is required to retain at least 50% of its initial strength for 2 weeks following implantation. Establish whether the implant will achieve this.

$k = 1.2 \times 10^{6}$/s

$A = 8.5 \times 10^{5}$ MPa/gmol

6. Outline the reasons why elevated temperature accelerated procedures need to be developed for bioresorbable polymers and the relevance of these in comparison to short-term biocompatibility testing.
7. Review commercial medical device sterilization processes, including ethylene oxide (EO) and gamma irradiation. Outline how these processes may result in changes to the degradation performance of either bioceramic, polymer, or biometal scaffolds, being particularly conscious that EO sterilization involved a preconditioning step at high humidity.
8. Outline the corrosion process of pure magnesium, describing how the specific degradation products might influence the in vivo environment.

9. Describe how modifying the microstructure of a magnesium alloy can be used to control its degradation rate.
10. Suggest how bioceramics, polymers, and biometals might be combined in the design of a hybrid, composite biomaterial, and what merits there might be developing such a material?