BIOMATERIALS

The Intersection of Biology
and Materials Science

Solution Manual

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Preface and Acknowledgments

This solution manual is an accompaniment to *Biomaterials: The Intersection of Biology and Materials Science* by J.S. Temenoff and A.G. Mikos (Pearson Prentice Hall, Upper Saddle River, 2008) intended for educators only. It contains the end-of-chapter problems written in this textbook and their solutions. It is important to indicate that the answers to the problems were formulated taking into consideration the material covered up to that point in the textbook.

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Chapter 1

1.1 One common biomaterial application is the construction of an arterial graft, a device that replaces a section of an artery. An artery is a flexible blood vessel that can withstand varying pressures and regulates the flow of blood. Arteries also provide a smooth interior surface to inhibit blood clotting within the vessel.

a. You need to design a vascular graft. List some advantages and disadvantages with each of the three major types of biomaterials. Which would you choose for this application?

Answer:

	Advantage	***Disadvantage***
Ceramics	*Strong*	*Rigid* *Brittle*
Metals	*Strong* *Easy to shape* *Inexpensive and available*	*Inflexible*
Polymers	*Can be flexible, smooth*	

A polymer would be more suitable for the vascular graft application, since neither metals nor ceramics offer the necessary elasticity.

b. What specific material characteristics need to be considered for the arterial graft application?

Answer: Flexibility is very important, and the material should also possess a certain tensile strength. The surface properties of the material like smoothness and hydrophobicity must be also considered in terms of its ability to support adhesion of endothelial cells or not cause damage to platelets. Moreover, the material should be easy to shape.

c. Would you use a natural or synthetic material for this application? What are the advantages and disadvantages of each?

Answer: A natural polymer would be more likely to integrate into the surrounding tissue. However, natural polymers may not possess the necessary mechanical properties for this application. There is also the possibility of evoking an immune response or a pathogen transmission. Synthetic polymers could be manufactured to have the necessary mechanical properties but may not integrate well with native tissue. Either natural or synthetic material is acceptable with proper justification.

1.2 Various biomaterials can be used for joint replacement applications, such as hip implants (see Fig. 1.4). A hip joint replacement must withstand large forces (standing on one leg results in a load of 2.4 times body weight on the femoral head [19]; jumping and running generate higher forces) normally transferred through the hip joint. It must also allow for proper rotation of the joint.

a. Which of the three major types of biomaterials would you use for the femoral stem? Why?

Answer: Metals and ceramics both may be present in the stem of a hip replacement. Metals are typically used in the core of the stem because of their strength and because they are easily molded into complex shapes. Ceramics may be used on the surface of the stem to facilitate integration with the bone.

b. Would integration of the femoral stem with the surrounding tissue be an acceptable biological response? Why or why not?

Answer: Integration of the stem with the surrounding bone would be desirable, as it would better fix the implant into the surrounding tissue. Integration at the joint space would be undesirable, as it could impair movement.