Chapter 6
Biomaterials

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ABSTRACT

From the perspective of popular science, this chapter aims at providing a basic understanding of the concept and evolution of Biomaterials. Traditional biomaterials are introduced with emphasis on the concepts, merits, and drawbacks of metals, polymer, ceramics, and composites used in biomedical science. The importance of surface modification is described, and the general behavior as well as cell interactions with artificial materials is discussed. Plasma immersion ion implantation, which is one of the important and common techniques, is described in detail. In the last part of this chapter, typical applications of biomaterials and possible future development are presented.

6.1. CHAPTER OBJECTIVES

The objectives of this chapter are to:

- Explain what biomaterials are.
- Define the biocompatibility and classification of biomaterials.
- Introduce the concepts of biomaterials′ classification, surface modification, and applications.
- Explain the interactions between biomaterials and cells.
- Introduce and foster biomaterials research.
- Generate interests concerning interactions with biomaterials.
- Promote research and education in biomaterials and related disciplines.

Upon completion of this chapter, readers can:

- Give the definition of biomaterials and biocompatibility.
- Describe classification of contemporary biomaterials.
- Develop an understanding of the characteristics and applications of different types of biomaterials as well as their general applications.

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- Understand the interactions between cells and biomaterials.
- Understand the development trends of biomaterials.
- Learn the consolidated concepts of biomaterials.

6.2. INTRODUCTION

Biomaterials science, the research of natural or synthetic materials to solve practical problems in biology and medicine, is a comprehensive interdiscipline which involves medicine, biology, chemistry, physics, biomechanics, surface science, bioengineering, and materials science. It also receives considerable input from ethicists, environmental and animal protection associations, government-regulated standard organizations, and entrepreneurs. In the biomedical industry, biomaterials are generally referred to as natural or artificial materials that are used to repair or reconstruct injured and nonfunctional tissues. They are as old as medicine and have been very widely used in tooth restoration since the beginning of 20th century. Biomaterials have only caught on in reconstructive surgery after World War II, but since then, research and application of biomaterials have progressed enormously in the field of reconstructive surgery because of the tremendous need for strengthening or replacing body components. For instance, the growing number of elderly people in the population of highly industrialized regions and countries such as Hong Kong, Germany, Japan, etc. imposes a growing demand for orthopedic, cardiovascular, ocular, and dental implants as well as medical devices. In 2006, the annual worldwide orthopedic biomaterials market totaled US$ 5 billion (Wu, 2007). According to the reported data (Chu & Liu, 2008), the worldwide biomaterials market was US$ 300 billion in 2005 and is projected to grow at a rate of 20% per year in the future. As shown in Table 1, biomaterials are widely used to repair or reconstruct various kinds of organs in the human body. And since different human organs require different materials, biomaterials with specific performance characteristics are designed; each of which has its advantages and disadvantages. Some of these biomaterials′ characteristics are delineated in Table 2.

With the aforementioned background and a rapid introduction of new ideas and productive branches, the field of Biomaterials has experienced an exponential growth, at the same time attracting the attention of more scientists and engineers from interdisciplinary areas. Hence, there is a need to develop a comprehensive understanding of biomaterials; such as their definition, classification, biomedical use, fabrication, and properties as well as future development in this area. The objective of this chapter is to describe the common characteristics of biomaterials.

Table 1. Examples of reconsructed artificial human tissues and organs. Source: Wong & Bronzino, 2007.

Organs	Examples
Heart	Cardiac pacemaker, artificial heart valve, total artificial heart
Bone	Bone plate, intramedullary rod, joints
Ear	Artificial stapes, cochlea implant
Skin	Skin regenaration scaffold
Eye	Contact lens, intraocular lens
Lung	Oxygenator machine
Kidney	Kidney dialysis machine
Bladder	Catheter and stent
Tooth	Dental implant
Nerves	Nerve guidance tube
Breast	Breast implant

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