Preface

Biomaterials have been used from ancient times starting with the use of wound closure devices in Egypt in 2000 BC and transplantation of bones from animals to humans in India in 1000 BC. Until recently, commonly available materials such as steel, silk, and nylon were adapted for medical applications. Only in the late twentieth century, especially since the 1970s starting with the efforts of Robert Langer at MIT, materials began to be engineered specifically for biomedical applications. These include special ceramics and metals for load-bearing application such as bone, tooth, and hip implants, and plastics (or polymers) for non-load-bearing, flexible devices. While polymers are inherently softer than metal and ceramics, they can be made to have strengths approaching those of bones. In addition, recent development in functionalization of the polymers to mimic natural tissue, and in processing including 3D printing, has enhanced the utility of polymers as biomedical materials. Polymers are therefore the dominant class of materials used in biomedical industry today for a range of applications such as medical devices, drug delivery, and repair or replacement of injured and non-functional tissues. In this book, we attempt to provide an overview of the polymers that are used in biomedical applications (Chap. 1), synthetic routes to make these polymers (Chap. 2), and to process these polymers into devices (Chap. 3).

Polymers can be classified in various ways. The most obvious is to think of them as either being natural or synthetic. This is the classification used in this book. Alternative ways of classification are based on their use (structural and non-structural polymers) and their characteristics (degradable and non-degradable polymers). These aspects are discussed in the first chapter. This chapter will give an overview of the synthetic and natural degradable polymers. However, overall, the book focuses on the synthetic polymers used for biomedical applications. Amongst the class of synthetic polymers, this chapter will discuss polyesters, polycarbonates, and polyurethanes, the most commonly used synthetics polymers for biomedical applications.

The second chapter will discuss the various synthetic strategies commonly used for preparing synthetic biomedical polymers. We classify the synthetic approaches based on the type of polymerization and provide a brief mechanistic description of each of these types with representative examples for a better understanding of the reactions and the resulting polymers.

Processing of polymers is a highly developed and specialized area that draws on the knowledge of polymer chemistry, heat and mass transfer, and rheology. The challenge is to adapt these techniques to cope with the unique characteristics of biomedical polymers, in particular their degradability, and manage the presence of any residual material including processing aids and solvent that could prove to be toxic. Over the past three decades, the established techniques of injection molding, textile processing, and solution processing have been successfully adapted to fabricate biomedical devices. These will be discussed in the third chapter along with solid-free fabrication of polymers that are the exceptionally suited for tissue engineering.

We hope that this small book will provide an overview of the use of synthetic polymers in various biomedical applications for a beginner and pave the way for a more detailed study using the resources cited in the book. In closing, we want to thank the New Jersey Center for Biomaterials and Rutgers, the State University of New Jersey, for providing the resources to write this chapter and to Dr. Mayra Castro (Springer Applied Science, Germany) for her kind invitation to contribute this manuscript.

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