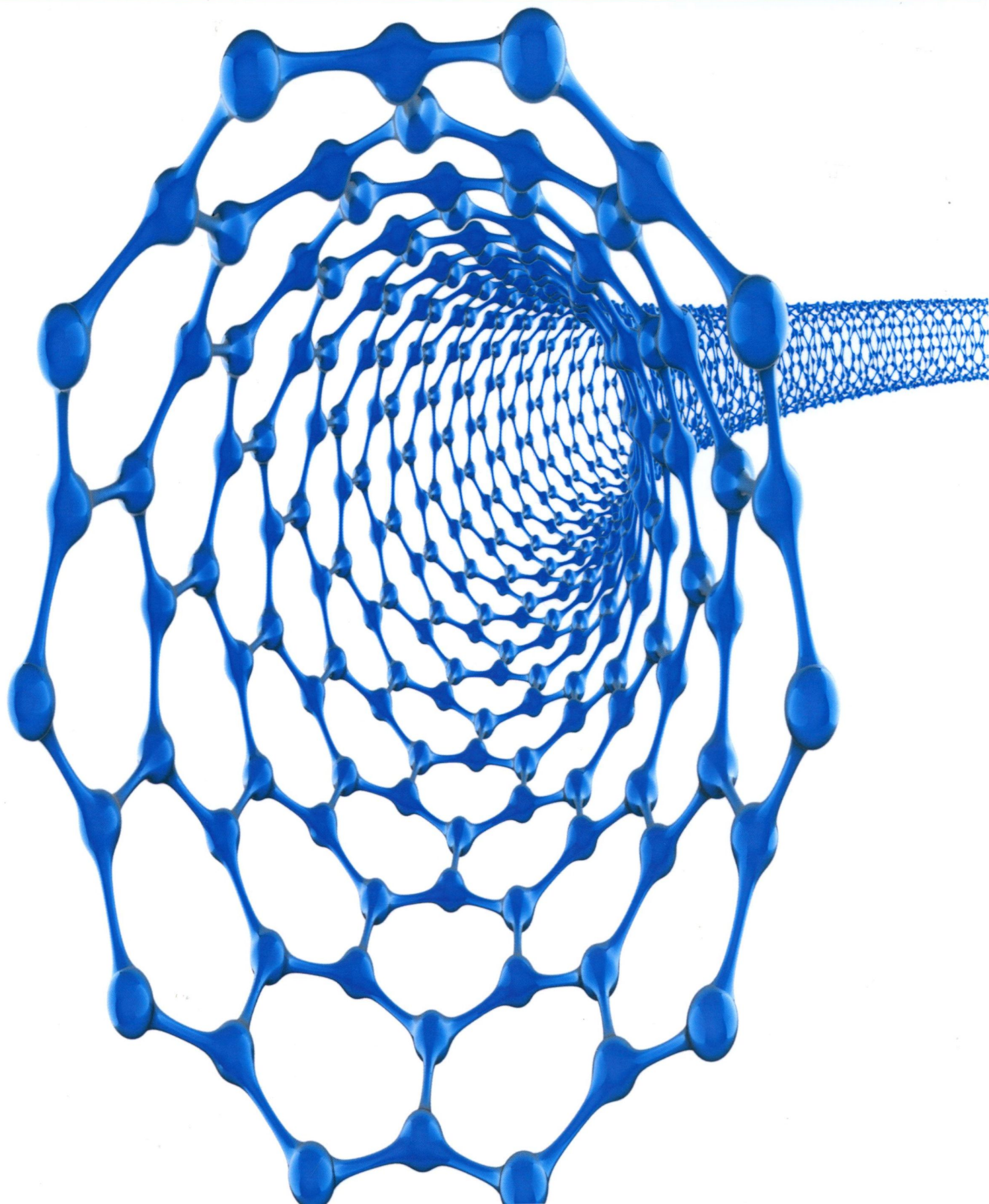


Biomaterials Research Advances

Contributors: A. Binnaz Hazar Yoruç, B. Cem Şener, et al.



About the Book

Biomaterial can be described as a combination of substances originating from natural, inorganic or organic materials that is biocompatible in exactly or partially contact with the body for healing time. They involve complete or part of a living organism or biomedical device which performs, augments or replacements any natural function. Biomaterial is a nonviable substance used in a medical device intended to interact with biological systems. Their usage within a physiologic medium needs the characteristic features such as efficient and reliable. These characteristic features have provided with a suitable combination of chemical, mechanical, physical and biological properties. Nowadays, biomaterials are commonly used in various medical devices and systems; synthetic skin; drug delivery systems; tissue cultures; hybrid organs; synthetic blood vessels; artificial hearts; cardiac pacemakers; screws, plates, wires and pins for bone treatments; total artificial joint implants; skull reconstruction; dental and maxillofacial applications. Metals and their alloys, polymers, ceramics and composites are commonly used for biomedical applications. These materials that have different atomic arrangement present the diversified structural, physical, chemical and mechanical properties and so different properties offer alternative applications in the body. The mechanical properties of metals and their alloys such as strength, elasticity coefficient and fatigue life makes them attractive materials for many load-bearing biomedical systems. Metallic materials tend to degradation in a corrosion process and even as the corrosion reactions of releasing some side products such as ions, chemical compounds and insoluble components that may cause adverse biological reactions.

This book named with Biomaterials Research Advances presents the latest fundamental and applied biomaterials research to the broader materials community. It includes contributions which advance the in-depth understanding of the relationship between the structure, the properties or the functions of all kinds of materials and covers all aspects of biomaterials research. It will facilitate interactions between the biomaterials community and the broader materials communities.

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Biomaterials Research Advances

List of Contributors

- A. Binnaz Hazar Yoruç**
Yıldız Technical University, Science and Technology Application and Research Center, Turkey
- B. Cem Şener**
Marmara University, Faculty of Dentistry, Department of Oral and Maxillofacial Surgery, Turkey
- Dustin L. Williams**
Bone & Joint Research Laboratory, Department of Veterans Affairs, Salt Lake City, USA
Department of Orthopaedics, University of Utah, Salt Lake City, USA
- Brad M. Isaacson**
The Henry M. Jackson Foundation for the Advancement of Military Medicine, Bethesda, USA
The Center for Rehabilitation Sciences Research, Department of Physical Medicine and Rehabilitation, Uniformed Services University of Health Sciences, Bethesda, USA
- Xuan Le**
Murdoch Applied Nanotechnology Research Group, Department of Physics, Energy Studies and Nanotechnology, School of Engineering and Energy, Murdoch University, Murdoch, WA 6150, Australia
- Gérrard Eddy Jai Poinern**
Murdoch Applied Nanotechnology Research Group, Department of Physics, Energy Studies and Nanotechnology, School of Engineering and Energy, Murdoch University, Murdoch, WA 6150, Australia
- Nurshahidah Ali**
Murdoch Applied Nanotechnology Research Group, Department of Physics, Energy Studies and Nanotechnology, School of Engineering and Energy, Murdoch University, Murdoch, WA 6150, Australia
- Cassandra M. Berry**
Division of Health Sciences, School of Veterinary and Biomedical Sciences, Murdoch University, Murdoch, WA 6150, Australia
- Derek Fawcett**
Murdoch Applied Nanotechnology Research Group, Department of Physics, Energy Studies and Nanotechnology, School of Engineering and Energy, Murdoch University, Murdoch, WA 6150, Australia
- Davood Almasi**
Department of Materials, Manufacturing and Industrial Engineering, Faculty of Mechanical Engineering, Universiti Teknologi Malaysia, 81310 Skudai, Johor, Malaysia
- Nida Iqbal**
Medical Implant Technology Group (MEDITEG), Faculty of Bioscience and Medical Engineering, Universiti Teknologi Malaysia, 81310 Skudai, Johor, Malaysia
- Maliheh Sadeghi**
Faculty of Chemical and Energy Engineering, Universiti Teknologi Malaysia, 81310 Skudai, Johor, Malaysia
- Izman Sudin**
Department of Materials, Manufacturing and Industrial Engineering, Faculty of Mechanical Engineering, Universiti Teknologi Malaysia, 81310 Skudai, Johor, Malaysia
- Mohammed Rafiq Abdul Kadir**
Medical Implant Technology Group (MEDITEG), Faculty of Bioscience and Medical Engineering, Universiti Teknologi Malaysia, 81310 Skudai, Johor, Malaysia
- Tunku Kamarul**
Department of Orthopaedic Surgery, NOCERAL, Faculty of Medicine, University of Malaya, 50603 Kuala Lumpur, Malaysia
- Maidy Rehder Wimmers Ferreira**
Cell Culture Laboratory, Department of Morphology, Physiology and Basic Pathology, School of Dentistry of Ribeirão Preto, University of São Paulo, 14040-904 Ribeirão Preto, SP, Brazil

Roger Rodrigo Fernandes

Cell Culture Laboratory, Department of Morphology, Physiology and Basic Pathology, School of Dentistry of Ribeirão Preto, University of São Paulo, 14040-904 Ribeirão Preto, SP, Brazil

Amanda Freire Assis

Molecular Immunogenetics Group, Department of Genetics, Ribeirão Preto Medical School, University of São Paulo, 14049-900 Ribeirão Preto, SP, Brazil

Janaína A. Dernowsek

Molecular Immunogenetics Group, Department of Genetics, Ribeirão Preto Medical School, University of São Paulo, 14049-900 Ribeirão Preto, SP, Brazil

Geraldo A. Passos

Cell Culture Laboratory, Department of Morphology, Physiology and Basic Pathology, School of Dentistry of Ribeirão Preto, University of São Paulo, 14040-904 Ribeirão Preto, SP, Brazil

Molecular Immunogenetics Group, Department of Genetics, Ribeirão Preto Medical School, University of São Paulo, 14049-900 Ribeirão Preto, SP, Brazil

Fabio Variola

Faculty of Engineering, Department of Mechanical Engineering, University of Ottawa, Ottawa, ON, Canada K1N 6N5

Karina Fittipaldi Bombonato-Prado

Cell Culture Laboratory, Department of Morphology, Physiology and Basic Pathology, School of Dentistry of Ribeirão Preto, University of São Paulo, 14040-904 Ribeirão Preto, SP, Brazil

Kanchan Maji

Department of Ceramic Engineering, National Institute of Technology, Rourkela 769008, India

Sudip Dasgupta

Department of Ceramic Engineering, National Institute of Technology, Rourkela 769008, India

Krishna Pramanik

Department of Biotechnology and Medical Engineering, National Institute of Technology, Rourkela 769008, India

Akalabya Bissoyi

Department of Biotechnology and Medical Engineering, National Institute of Technology, Rourkela 769008, India

Shunji Yunoki

Biotechnology Group, Tokyo Metropolitan Industrial Technology Research Institute, 2-4-10 Aomi, Koto-ku, Tokyo 135-0064, Japan

Yoshimi Ohyabu

Biotechnology Group, Tokyo Metropolitan Industrial Technology Research Institute, 2-4-10 Aomi, Koto-ku, Tokyo 135-0064, Japan

Hirosuke Hatayama

Biotechnology Group, Tokyo Metropolitan Industrial Technology Research Institute, 2-4-10 Aomi, Koto-ku, Tokyo 135-0064, Japan

Romina Croci

Department of Bioscience, University of Milan, 20133 Milan, Italy

Elisabetta Bottaro

Department of Life Sciences and Biotechnology, University of Ferrara, 44121 Ferrara, Italy

Kitti Wing Ki Chan

Program in Emerging Infectious Diseases, Duke-NUS Graduate Medical School, Singapore 169857

Satoru Watanabe

Program in Emerging Infectious Diseases, Duke-NUS Graduate Medical School, Singapore 169857

Margherita Pezzullo

Department of Bioscience, University of Milan, 20133 Milan, Italy

Eloise Mastrangelo

Department of Bioscience, University of Milan, 20133 Milan, Italy

Institute of Biophysics, National Research Council, 20133 Milan, Italy

Claudio Nastruzzi

Department of Life Sciences and Biotechnology, University of Ferrara, 44121 Ferrara, Italy

Patel Alpesh

Department of Chemical and Biochemical Engineering, University of Western Ontario, London Ontario, Canada

Mequanint Kibret

Department of Chemical and Biochemical Engineering, University of Western Ontario, London Ontario, Canada

Hasan Uludağ

University of Alberta, Edmonton, AB, Canada

Preface

Biomaterial can be described as a combination of substances originating from natural, inorganic or organic materials that is biocompatible in exactly or partially contact with the body for healing time. They involve complete or part of a living organism or biomedical device which performs, augments or replacements any natural function. Biomaterial is a nonviable substance used in a medical device intended to interact with biological systems. Their usage within a physiologic medium needs the characteristic features such as efficient and reliable. These characteristic features have provided with a suitable combination of chemical, mechanical, physical and biological properties. Nowadays, biomaterials are commonly used in various medical devices and systems; synthetic skin; drug delivery systems; tissue cultures; hybrid organs; synthetic blood vessels; artificial hearts; cardiac pacemakers; screws, plates, wires and pins for bone treatments; total artificial joint implants; skull reconstruction; dental and maxillofacial applications. Metals and their alloys, polymers, ceramics and composites are commonly used for biomedical applications. These materials that have different atomic arrangement present the diversified structural, physical, chemical and mechanical properties and so different properties offer alternative applications in the body. The mechanical properties of metals and their alloys such as strength, elasticity coefficient and fatigue life makes them attractive materials for many load-bearing biomedical systems. Metallic materials tend to degradation in a corrosion process and even as the corrosion reactions of releasing some side products such as ions, chemical compounds and insoluble components that may cause adverse biological reactions.

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BIOMATERIALS

A. Binnaz Hazar Yoruç¹ and B. Cem Şener²

¹Yıldız Technical University, Science and Technology Application and Research Center, Turkey

²Marmara University, Faculty of Dentistry, Department of Oral and Maxillofacial Surgery, Turkey

INTRODUCTION

Biomaterial can be described as a combination of substances originating from natural, inorganic or organic materials that is biocompatible in exactly or partially contact with the body for healing time. They involve complete or part of a living organism or biomedical device which performs, augments or replacements any natural function [1].

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Ceramic materials are desirable biomaterials due to the biocompatible properties such as bioactive, bioinert and biodegradable, however they have significant disadvantages such as brittleness, low strength etc. [1-4].

Polymers are attractive materials for biomedical applications such as cardiovascular devices, replacement and proliferation of various soft tissues. They are also used in drug delivery systems, diagnostic supports and as a reconstructive material for tissue engineering. The current applications of them include cardiac valves, artificial hearts, vascular grafts, breast prosthesis, contact and intraocular lenses, fixtures of extracorporeal oxygenators, dialysis and plasmapheresis systems, coating materials for medical products, surgical materials, tissue adhesives etc. [3]. The composition, structure and organization of constituent macromolecules specify the properties of polymers. Composite is a material comprised of two or more metal, polymer or ceramic structures which are separated by an interface. Composite materials have been widely used for a long time in innovative technological applications due to

their superior mechanical properties. The bones, tendons, skin, ligaments, teeth, etc. are natural composite structures in the human body. The amount, distribution, morphology and properties of structure components determine the final behavior of resultant tissues or organs. Some synthetic composites can be used to produce prosthesis able to simulate the tissues, to compromise with their mechanical behavior and to restore the functions of the damaged tissues. Composites are usually classified based on their matrix components like metals, ceramics, polymers or reinforcement components like particulates, short or long fibers, microfillers, nanofillers. Many matrix and reinforcement components of composite materials have been tried by several researchers in tissue engineering to advance the mechanical features, biologic functions and to deliver special molecules. Biocompatible polymers have been mostly applied as matrix for composite materials associated with ceramic fillers in tissue engineering. Although ceramics are generally stiff and brittle materials, polymers are known to be flexible and exhibit low mechanical strength and stiffness. Composites aim to combine the properties of both materials for medical applications [1-9].

There are currently thousands of surgical materials, hard and soft tissue products, biomedical devices, pharmaceutical and diagnostic products and disposable materials at the medical market. The recent biomaterial applications were aimed to engineered tissues, intelligent materials, tissue cultures, drug delivery systems, artificial organs, biomimetic systems and materials in addition to traditional medical applications. Nowadays, modern clinical procedures such as preventing and curing main genetic diseases are become significant and new medical demands cause the change of the biomaterial products. Materials scientists and engineers need researchers who work effectively in professional teams such as molecular biologists, biochemists, geneticists and physicians and they also aim for the materials which are recognised by cells, biochemical structures, molecules and genetic issues [4].

MATERIALS USED IN MEDICINE

Natural Materials

Biopolymers are natural materials such as carbohydrates, proteins, cellulose, starch, chitin, proteins, peptides, DNA and RNA produced by living organisms [10]. Generally, the synthesis procedure of them involves enzyme-catalysed polymerization reactions of activated monomers and chain growth which are characteristically formed within cells by complex metabolic processes [11]. Figure 1 shows classification, structures and functions of biopolymers. Table 1 also presents incidence and physiological functions of certain natural polymers.

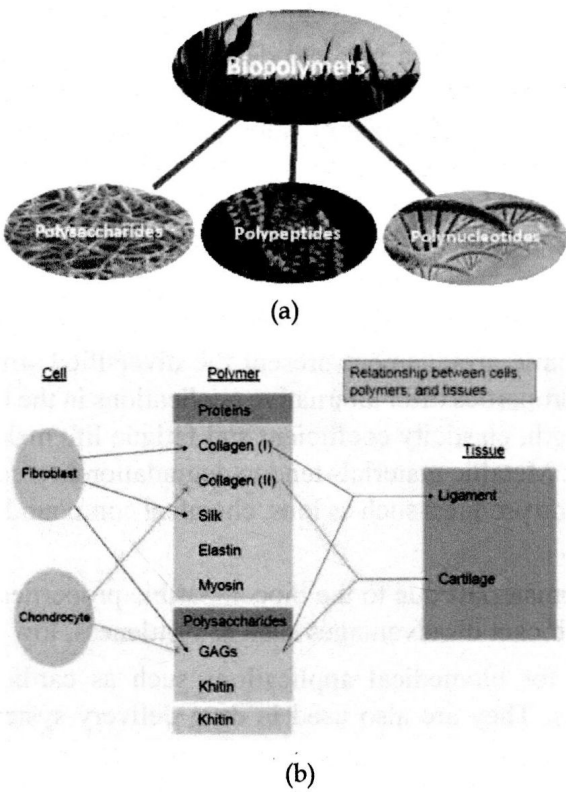


Figure 1: (a) Classification of biopolymers and (b) structure and functions of biopolymers [12].