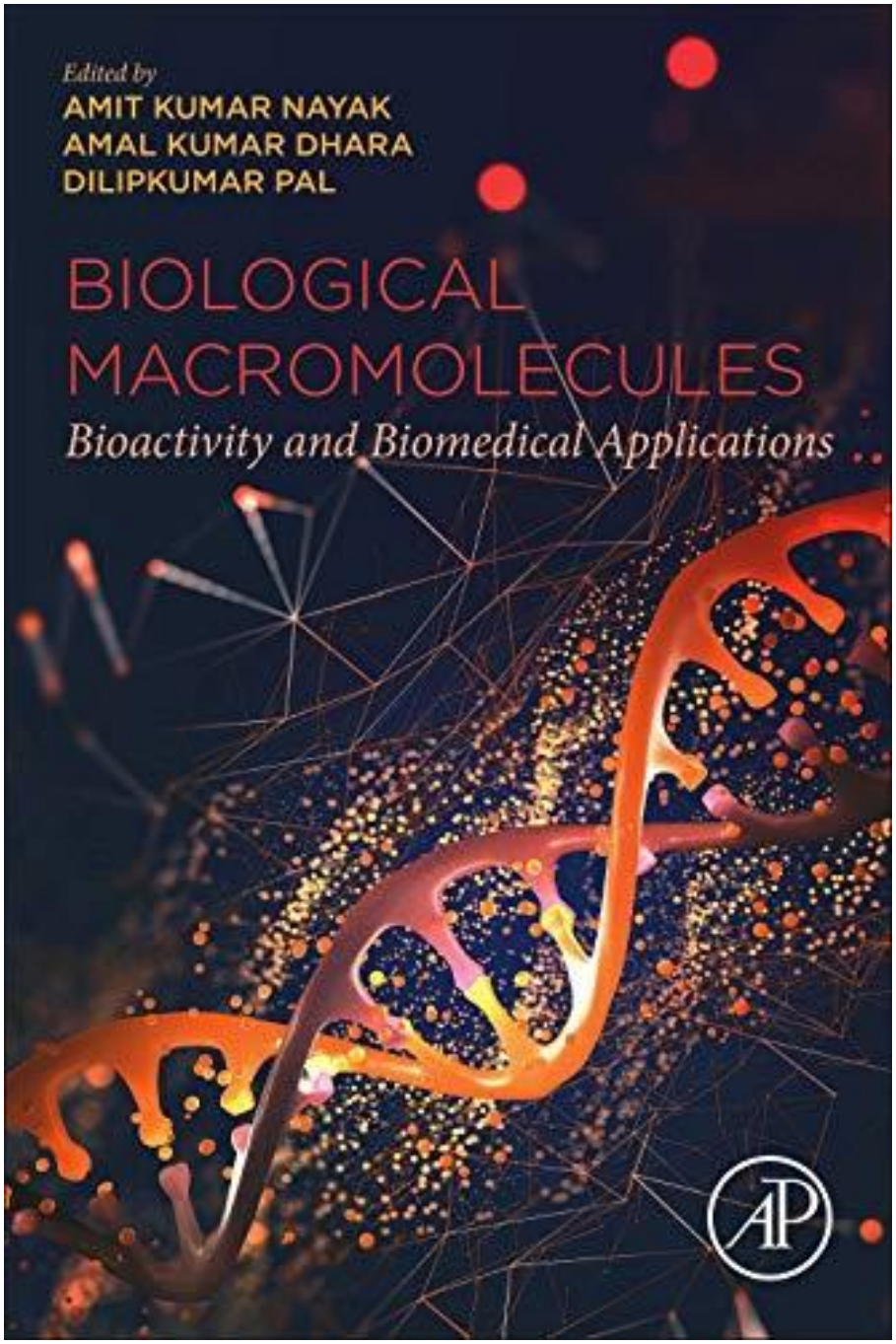

Biological Macromolecules: Bioactivity and Biomedical Applications 1st Edition

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Preface

The scope of this book, entitled *Biological Macromolecules: Bioactivity and Biomedical Applications*, is the coverage and review of recent trends and applications of biological macromolecules, such as carbohydrates, lipids, proteins, peptides, and nucleic acids in biomedicines, drug delivery, growth factors delivery, nutrients and nucleic acids delivery, cell encapsulation, enzyme mobilization, and tissue engineering.

The mysteries of life lie in biological macromolecules. A large volume of biological macromolecules is obtained from different biological origins such as plants, algae, fungi, animals, and microbial sources. Biological macromolecules exhibit some significant and favorable advantages over synthetic macromolecules, such as sustainable and economic production, biocompatibility, biodegradability, and improved bioavailability. In recent years, a plethora of biological macromolecules (carbohydrates, lipids, proteins, peptides, and nucleic acids) has been used in the biomedical and healthcare fields. They showed varieties of bioactivities such as antioxidant, anticancer, antidiabetic, antimicrobial, immunomodulatory activities on the central nervous system, and gastrointestinal activity. The other biomedical applications include drug delivery, growth factors delivery, nutrients and nucleic acids delivery, cell encapsulation, enzyme mobilization, and tissue engineering. The structure−property relationship is also an important aspect for a thorough understanding of the bioactivity of biological macromolecules.

This book, containing 4 sections and 26 chapters, provides a systematic insight into the inclusive discussions on bioactivity and biomedical applications of different biological macromolecules. We are glad to see that many authors across the globe accepted our invitation and contributed valued chapters for this book, covering a wide spectrum of fields. A concise account of the contents of each chapter has been described to provide a glimpse of the book to the potential readers of various fields.

The topics in the book (in order of preference) include the following: *Biological Macromolecules: Sources, Properties, and functions* (Chapter 1)—this chapter describes sources physicochemical properties, bioactivity and biomedical applications of different biological macromolecules concisely; *Structure−Activity Relationship of Biological Macromolecules* (Chapter 2)—this chapter aims to provide an overview of the structural features influencing the bioactivities of biological macromolecules, namely L-amino acid oxidases, lysostaphin, and metallo-β-lactamase-such as lactonase and chitosan; *The Importance of Biological Macromolecules in Biomedicine* (Chapter 3)—this chapter highlights the therapeutic aspects of macromolecules and the medicinal use of biological macromolecules against various diseases and ailments; *Modification Techniques for Carbohydrate Macromolecules* (Chapter 4)—this chapter characteristically abridges the significant developments of the last five to ten years and discusses critically in the area of modification of carbohydrates macromolecules;

Biological Macromolecules as Nutraceuticals (Chapter 5)—this chapter aims to demonstrate some recent knowledge regarding the nutraceutical and biological activities of the macromolecules of biological origin, as well as some frontier applications of these in healthcare; *Biological Macromolecules as Antioxidants* (Chapter 6)—this chapter highlights the potential applications of biological macromolecules as antioxidants to scavenge reactive oxygen species and control oxidative stress, which leads to various pathogenesis; *Biological Macromolecules as Antimicrobial Agents* (Chapter 7)—the chapter describes the antimicrobial activity of biological macromolecules (chitosan, cellulose, alginate, gelatin, collagen, and keratin) and also, comprehensively elucidates their applications in addressing challenges associated with drug delivery, wound dressing, food packaging, and so on *Biological Macromolecules From Algae and Their Antimicrobial Application*s (Chapter 8) −this chapter provides an overview of bioactive macromolecules and their antimicrobial activities with particular reference to algal sources; *Biological Macromolecules Acting on Central Nervous System* (Chapter 9)—in this chapter, the role of biological macromolecules on central nervous system and their critical role in downregulation after the various neurological disorders have been discussed; *Biological Macromolecules as Antidiabetic Agents* (Chapter 10)—this chapter is an overview of different types of biological macromolecules and their applications as potential antidiabetic agents and also, highlights the advantages, limitations and future perspectives of biological macromolecules as antidiabetic agents; *Biological Macromolecules as Anticancer Agents* (Chapter 11)—this chapter presents the extraction of macromolecules such as carbohydrate, proteins, lipids, and nucleic acid (miRNAs) from different biological sources, such as plants, animal, algae and fungi. The various mechanisms by which the macromolecules exhibit their anticancer activity have been discussed briefly along with several assays done to evaluate cytotoxicity of the macromolecules against various cancers such as lung cancer, breast cancer, cervical cancer, and colon cancer. *Biological Macromolecules as Immunomodulators* (Chapter 12)—this topic focuses on the potential modulations of immune response of biomacromolecules (three major classes of compounds: lipids, proteins and polysaccharides); *Biological Macromolecules Acting on Gastrointestinal Systems* (Chapter 13)—this chapter describes the role of biological macromolecules for the management of gastrointestinal system and related disorders; *Synthetic Macromolecules With Biological Activity* (Chapter 14)—this chapter describes some classes of synthetic macromolecules with biological activity that have a great importance on the human comfort and health, including antimicrobial polymers, antioxidant polymers, and polymeric sequestrants; *Biological Macromolecules in Drug Delivery* (Chapter 15)—this chapter focuses on the advancements in the uses of various biological macromolecules in drug delivery applications; *Biological macromolecules in tissue engineering* (Chapter 16)—this chapter provides an overview on the important role of natural-derived biomaterials (alginate, chitosan, carrageenan, fucoidan, ulvan, collagen, and gelatin) combining with ceramic biomaterials for bone tissue construction; *Biological Macromolecules for Drug Delivery in Tissue Engineering* (Chapter 17)—This chapter is focused on the preparation and physicochemical characterization of engineered biomaterials, based on biological macromolecules (polysaccharides and proteins), as scaffolds which are capable of supporting physiological activities of cells, but also can act as drug delivery systems for tissue engineering and wound healing; *Biological Macromolecules for Growth Factor Delivery* (Chapter 18)—this chapter discusses the fabrication of synthetic and natural macromolecules, sometimes combined with other mineral or metallic compounds for growth factor delivery; *Biological*

Macromolecules for Growth Factor Delivery in Bone Regeneration (Chapter 19)—this chapter describes the process of bone tissue regeneration in healing injuries and arthritic conditions, introduces the main ideas through the scope of allogenous and autogenous transplantation and demonstrates the role of growth factors in these processes; *Biological Macromolecules for Nutrients Delivery* (Chapter 20)—This chapter focuses on the types of nutrients that need to be delivered, the biological macromolecules that can be used to construct edible delivery systems, the most common delivery systems currently used for this purpose, and some of the major challenges that must be addressed in the future; *Biological Macromolecules for Nucleic Acid Delivery* (Chapter 21)—this chapter describes the nonviral nucleic acid delivery systems made up of biological macromolecules, such as peptides, lipids, and carbohydrates and also gives an introduction on the history and structure of nucleic acids; *Biological Macromolecules in Cell Encapsulation* (Chapter 22)—this chapter aims to review the most examined, most promising and recently proposed biopolymers that are used in tissue engineering scaffolds, and to highlight their main properties, drawbacks, fields of applications and fabrication technologies in order to provide readers with important guidelines for selecting appropriate scaffold biomaterials; *Biological Macromolecules for Enzyme Immobilization* (Chapter 23)—this chapter provides a broad overview of properties and the applications of various naturally occurring biopolymers, that is, chitosan, chitin, agarose, alginates, cellulose, gelatin, dextran, carrageenan, pectin and xanthan gum for their applications in enzyme immobilization with recent literature studies indicating biopolymer-based support material development and their utilization to make biocatalysts with desired stability and catalytic functionalities; *Carbohydrates for Enzyme Inhibition and Their Use as Target Molecules for the Interference of Diseases* (Chapter 24)—this chapter describes the study of a widespread group of enzymes and the inhibition of these enzymes constitutes an interesting and novel strategy to approach new therapies against numerous diseases; *Current Challenging Issues of Biological Macromolecules in Biomedicine* (Chapter 25)—this chapter provides information on recent innovations in various biomaterials, engineered from macromolecules ranging from drug delivery, cancer therapies, tissue engineering, bioprinting and wound healing; *Future Perspectives of Biological Macromolecules in Biomedicine* (Chapter 26)—this chapter discusses the impact of the combination of nanotechnology and chronobiology in personalized cancer treatment.

We sincerely acknowledge the valuable contribution of the distinguished authors and convey our sincere thanks. This book could not have been published without the cooperation of Barbara Makinster, Editorial Project Manager. We wish to express our cordial gratitude to Elsevier Inc., Michelle Fisher (Acquisition Editor), and other editorial staff for their invaluable supports in organizing the intelligent editing of the book. We also gratefully acknowledge all the permissions we received for reproducing the copyright materials from different sources. Finally, we cannot overlook the sacrifices and supports from our family members during the preparation of the current book. All our friends, colleagues, and students who have helped in the process of editing this book deserve our great appreciation. Contributing authors, the publishers, and we, the editors, will be extremely happy if our endeavor fulfills the needs of the academicians, researchers, students, pharmaceutical experts, biomedicine experts, and formulators.

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CHAPTER

8

Biological macromolecules from algae and their antimicrobial applications

Natanamurugaraj Govindan[1,2], *Gaanty Pragas Maniam*[1,2], *Mohd Hasbi Ab. Rahim*[1,2], *Ahmad Ziad Sulaiman*[3] *and Azilah Ajit*[4]

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8.1 Introduction

Algae are the dominated diverse group of the unicellular and multicellular organisms in the eukaryotic phylum. They have close resemblance with photosynthetic plants in the form of metabolic pathways, but the actual root systems are not similar (Delwiche, Andersen, Bhattacharya, Mishler, & McCourt, 2004). Microalgae can be cultured using ordinary or simulated lights using freshwater, marine water blackish water, and waste effluent that feed the species and at the same time removing nutrients and organic pollutants from the effluent (Garcia-Moscoso, Teymouri, & Kumar, 2015). Peptides (BP) are specific protein fragments that are involved in a wide range of therapeutic activities as antihypertensive, antioxidant, antitumoral, antiproliferative, hypocholesterolemic, and antiinflammatory (Sánchez & Vázquez, 2017). Besides, they are also involved in triggering mechanisms to stimulate healthy cell growth (Hartmann & Meisel, 2007). Microalgae antimicrobial peptides (AMPs) have several advantages including gene expression similar to higher plants and efficiently can be grown for numerous applications.

8.2 Bioactive macromolecules

8.2.1 Terpenoids

Culturing of algae has been exponentially increasing along course of decades due to the exploration of unique bioactive compounds available in various forms of algae species. Terpenoids are the class of bioactive components present in several marine algae species. Based on the number of isoprene units, terpenoids are further classified as monoterpenoids, sesquiterpenoids, diterpenoids, sesterterpenoids, triterpenoids, tetraterpenoids

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Chapter 8 - Biological macromolecules from algae and their antimicrobial applications

Natanamurugaraj Govindan [1, 2], Gaanty Pragas Maniam [1, 2], Mohd Hasbi Ab. Rahim [1, 2], Ahmad Ziad Sulaiman [3], Azilah Ajit [4]

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Abstract

Algae are the dominated diverse group of the unicellular and multicellular organisms in the eukaryotic phylum. They have close resemblance with photosynthetic plants in the form of metabolic pathways, but the actual root systems are not similar. Microalgae can be cultivated using natural or artificial light systems using freshwater, marine water blackish water and even wastewater providing additional benefit by removing nutrients and organic pollutants from wastewater. Peptides (BP) are specific protein fragments that are involved in a wide range of therapeutic activities as antihypertensive, antioxidant, antitumoral, antiproliferative, hypocholesterolemic, and antiinflammatory. Besides, their also involved triggering mechanisms as well as nutritive function that providing the amino acid units as building blocks for new proteins to cells. Microalgae antimicrobial peptides (AMPs) have several advantages including gene expression similar to higher plants and cost effective phototrophic cultivation with simple and inexpensive medium and a safe food additive, so oral delivery of AMPs containing algae is possible.

Keywords

Algae; macromolecules; antimicrobial compounds; seaweed; metabolic pathways

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