Algae-Based Biopharmaceuticals

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Preface

Photosynthetic microorganisms have been used for the benefit of human beings since ancient times. For instance, the first known report on the use of cyanobacteria as food was published in 1520 by Hernán Cortés, commenting the fact that Aztecs ate tecuitlatl, a cake made from Spirulina that was an important part in their diet. In the case of eukaryotic algae, important biotechnology applications have been developed for many species. The invention of molecular cloning and genetic engineering tools allowed for the development of numerous products that tremendously favored the human and animal health worldwide. For instance, the recombinant biopharmaceuticals (BFs) such as insulin, cytokines, monoclonal antibodies, and subunit vaccines allowed for the treatment, cure, or prevention of many diseases saving millions of lives. Improvements on the platforms for producing these recombinant BFs are under development or still needed. During the last decade, algae species have been explored as a next-generation platform for BFs production with clear advantages in terms of efficacy, safety, and cost. The current developments comprise the production of several BFs in some algae species, which have been evaluated at the preclinical level with positive outcomes. Moreover, the ambitious objectives in this field consist in the use of whole algae cells for the development of photosynthetic biomaterials for regenerative medicine and for the oral delivery of BFs eliminating the need for purification and sterile injections. This book provides an updated outlook on the use of algae for the production and delivery of BFs. Although the case of *Chlamydomonas reinhardtii* is emphasized since the majority of the studies have been performed in this model microalga, the use of other algae species such as *Dunaliella* sp., *Phaeodactylum tricornutum*, and *Schizochytrium* sp. is also covered.

First, the features of algae as convenient hosts for the production of BFs are analyzed in terms of production costs, biosynthetic capacity, and safety (Chap. 1). Second, the genetic engineering tools for algae species are described. Nuclear- and chloroplast-based expression approaches are analyzed and compared in terms of biosynthetic advantages, gene expression complexity, and DNA transfer approaches (Chap. 2). In the following sections, Chaps. 3, 4, 5, 6, and 7, the state of the art on producing distinct types of BFs in algae species is presented. Although this book is

mainly focused on BFs, considering that the production of compounds with health-promoting properties are achieved using genetically engineered algae strains, Chap. 8 deals with nutraceuticals. In Chap. 9, the developments reported thus far are placed in perspective and challenges for the field are discussed. Critical future prospects comprise the following: optimizing large-scale production in bioreactors, implementing glycoengineering approaches, optimizing nuclear expression, exploring new approaches for oral delivery, and implementing regulatory frameworks to accomplish technology transfer and regulatory approval of algae-made BFs.

Consequently, this book constitutes a key reference on the use of algae in the BFs production field, providing an updated outlook on the achievements accomplished thus far and transmitting a prospective view for this biotechnological application.

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