

PREFACE

Plants have always been a source of nourishment and care for living beings. Their dual task as producers of nutrients and drugs played a fundamental role in the evolution (and co-evolution) of herbivorous and omnivorous organisms.

The so-called secondary (or special) metabolites are molecules with well-defined functional roles, aimed primarily at defending plants from abiotic (temperature, light, water availability, etc.) and biotic (attacks of herbivores, fungi, bacteria and viruses) stress. The complexity of the molecular structures produced by plants is only equal to their versatility and biodiversity, while the harmonious interweaving of biosynthetic and metabolic pathways offers a perfect picture of the adaptive plasticity of plants as environmental conditions change.

This book is divided into three units to offer the reader a general, biochemical and biotechnological framework of bioactive plant molecules.

The first unit analyses the concepts of biodiversity and sustainability and the functional roles of bioactive molecules, exploring the sites of synthesis and accumulation, the strategies adopted by plants to defend themselves from stress and the use of bioactive molecules as food supplements and as a source for natural medicines to combat diseases. The first unit also includes chemotaxonomy, where bioactive molecules and other secondary products play a fundamental role in support of the identification of plant species.

The second unit describes plant biochemistry with a detailed discussion on the main biosynthetic pathways leading to the synthesis of aromatic compounds (phenols and flavonoids) and terpenes (from volatile substances to phytosterols, to antioxidant molecules such as carotenoids and astaxanthin) to conclude with the biosynthetic pathways leading to the synthesis of nitrogen-containing bioactive molecules, including alkaloids, glucosinolates and cyanogenic glucosides. In this unit, one chapter is also dedicated to oxylipins, describing the biochemistry of jasmonates and

green leaf volatiles, substances typical of plant reactions to biotic stress and mechanical damage.

The third and last unit deals with plant biotechnology and the production of bioactive molecules both *in vivo* and *in vitro*. The main techniques are described, such as cell and tissue cultures and root and shoot cultures, with particular attention to the *in vitro* production of bioactive molecules of industrial interest. In addition to the defining of plant biotechnology, a chapter deals with its technological aspects by describing bioreactors, photobioreactors and cryopreservation techniques. The unit concludes with a chapter dedicated to genetic engineering for the production of bioactive molecules, where in addition to the definition of transgenic plants ethical problems, risks and benefits of using recombinant DNA in genetically modified organisms (GMOs) are discussed. Several examples of terpene, phenolic compound and alkaloid engineering are presented along with methods and techniques for industrial application. Molecular pharming is also described, revealing its peculiarities and potential, with examples of bioactive molecules produced to treat infectious diseases and to improve the quality of human life. Finally, a paragraph is dedicated to food safety issues and bioethical considerations.

I wrote this book for science students of university undergraduate and graduate courses, but the language used (especially in the first and third unit) is simple enough to be understood by all people who are interested in bioactive natural molecules. Writing a book on these issues is always a challenge, especially due to the continuous stream of new notions being published every day across hundreds of international scientific journals. The intent was to collect most of the recent notions, being fully aware of the limits imposed by the vastness of the subject.

I wish you a very good reading.

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