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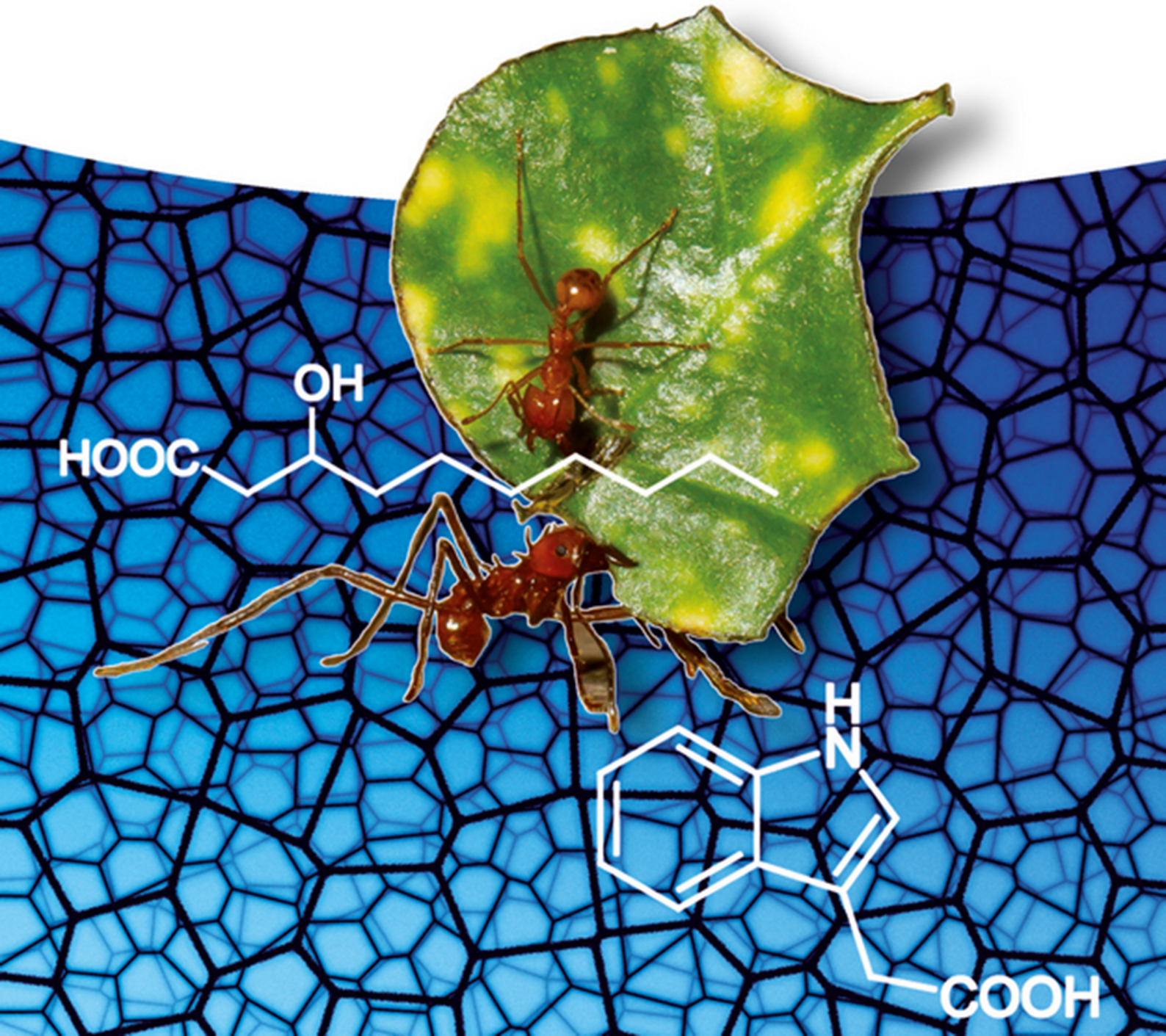
Ecological Biochemistry

Environmental and Interspecies Interactions



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"It is interesting to contemplate an entangled bank, clothed with many plants of many kinds, with birds singing on the bushes, with various insects flitting about, and with worms crawling through the damp earth, and to reflect that these elaborately constructed forms, so different from each other, and dependent on each other in so complex a manner, have all been produced by laws acting around us."

Charles Darwin, The Origin of the Species (1859), John Murray, London

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Foreword

Ecological Biochemistry takes centre stage in modern biology. From fundamentals of secondary metabolism to resultant survival, this book gives a comprehensive view of the organisms that shape our planet, their evolution, and their biotic and abiotic interactions.

Most of the functions of organisms are expressed in their ecological biochemistry. Knowledge of their signal perception, information processing, generation of chemicals for communication, and adaptation informs about our future as organisms are exposed to environmental conditions that range from long-experienced to those that have not existed before.

Plants and microbes, which are the main focus, are experiencing a multitude of environments from soils containing salts, limiting nutrients, metal contaminants, or xenobiotics to exposure to drought, UV radiation, and temperature extremes. In natural and humanmade environments, organisms are confronted with abiotic and biotic settings, and adaptations pivot around biochemical competence.

The unifying basis of life of bacteria, Archaea, fungi, and plants is presented from a microscopic scale to a large scale and from single cells to forest ecosystems. This book provides the reader with an insight into food webs, organism interactions, and ecosystem function across biomes. Complex communities such as those experienced at the interface of soil, microbes, and roots are presented with new views of beneficial and detrimental interactions. The dialog between plants and animals, driven by biochemical signals, is presented in the context of multipartner mutualisms.

With methodological advances and new opportunities enabled by "omics" tools and latest microscopy techniques, this book bring us a modern view of biology, unifying life, and the challenges ahead.

Prof. Susanne Schmidt (PhD, MSc)
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Preface

Ecological Biochemistry refers to the interaction of organisms with their abiotic environment and other organisms by chemical means. Abiotic and biotic factors challenge the biochemical flexibility of organisms, which are usually able to adapt easily to environmental changes by alterations in their metabolism. This book covers the biochemistry behind these interactions, with a bottom-up approach from the atomic level to the systemic level.

The introductory part of the book deals with the physicochemical basis and biochemical roots of living cells, leading to secondary metabolites as crucial bridges between organisms and their respective ecosystem. These specialized compounds illustrate the heterogeneity and multitude of ecological habitats and niches that organisms have colonized so far. The metabolite diversity shows tremendous plasticity and evolutionary potential.

This book concerns the link between biochemical insights and ecological research. The study of ecosystems requires an understanding of general characteristics of ecosystem functionality. This includes knowledge about the biochemistry, biodiversity, and the dynamics of biological components (e.g., individual organisms, populations, communities) under stress, and the related capacities of ecosystems (e.g., with respect to resilience and functional redundancy) that respond to the changing environment. Furthermore, environmental research can help to maintain ecosystem health or, if necessary, to restore ecosystems. Functioning of ecosystems and communities depends highly on the interplay of its different biota in acquisition and distribution of resources required for maintenance, growth and development, adaptation to stress, and competitive and symbiotic interactions.

Our book is focused on interactions of plants, bacteria, and fungi with their environment. Plants are the fundamental constituents of terrestrial and aquatic ecosystems, which are responsible for the majority of biomass produced in our planet. Sessile plants have especially evolved intricate biochemical response mechanisms to fit into a changing environment. They employ numerous signaling molecules to perceive their environment by many sensory systems. The information is transduced toward appropriate responses via parallel signal transduction pathways, which transform environmental stimuli into the biochemical "language" of the cell.

Environmental stress factors can be classified into abiotic and biotic factors. Abiotic stress factors are variable physicochemical parameters of the surroundings, such as oxygen, light, water, minerals, and transition metals, and also xenobiotics from human impact. These parameters are interlinked with biotic stress factors, which represent influences originating from other organisms that live as coinhabitants within the habitat. Microorganisms living in biofilms or symbiotic associations may frequently alter parameters of soil and water. Specific environmental conditions may attract and favor certain microorganisms and animals in the proximity of plants. Secondary metabolites enable plants to interact with pollinators, herbivors, and animals of higher trophic level.

The last part of the book deals with methodology, which allows network-based analysis of molecular processes underlying systems phenomena. Modern techniques provide new tools for answering a range of multidisciplinary questions from the molecular basis of evolutionary adaptation to mechanisms of phenotypic plasticity, interspecies relationships, biochemical communication, and sensing of xenobiotic compounds in human-influenced ecosystems. The "omic" technologies, microscope techniques, and single cell analysis have the ambitious aim to integrate genome, transcriptome, proteome, and metabolome data, and to expand the knowledge of organisms living in and interacting with their environment.

This book is primarily designed for use by advanced undergraduate and graduate students studying biochemistry, plant physiology, ecology, microbiology, pharmacy, agriculture, and forestry. The teachers receive a compendium, allowing a feasible setup of interdisciplinary courses in life sciences. We hope that this book might be of interest to postgraduates, scientists, and those working in different disciplines in applied sciences.

We are very grateful to all contributing authors and colleagues for their excellent and timely work. We would like to thank Anke Poltermann for her extremely resourceful preparation of figures in a homogeneous design, and Dirk Dobritzsch for his excellent intention to develop various graphics of high scientific significance.

Many thanks are due to members of the editorial team of WILEY-VCH, Gregor Cicchetti, and Andreas Sendtko for their editing support, and Anne du Guerny for her patience and excellent assistance throughout the publication process.

Our aim is to enable the reader to develop an understanding of Ecological Biochemistry as an integrative scientific field. We welcome comments, suggestions, and feedback from readers of this textbook.

Halle/Saale *Gerd-Joachim Krauss*
June 2014 *Dietrich H. Nies*

Companion Website

This book spans a multitude of systems levels from atoms to ecosystems. It builds on knowledge of some essential basics in the field which might need refreshing for a better access to "Ecological Biochemistry". Professor Nies, co-editor of the book, offers a thorough presentation of these essentials, based on the latest state of knowledge, in Chapter S1 "Basic Biochemical Roots" on the companion website of the book:

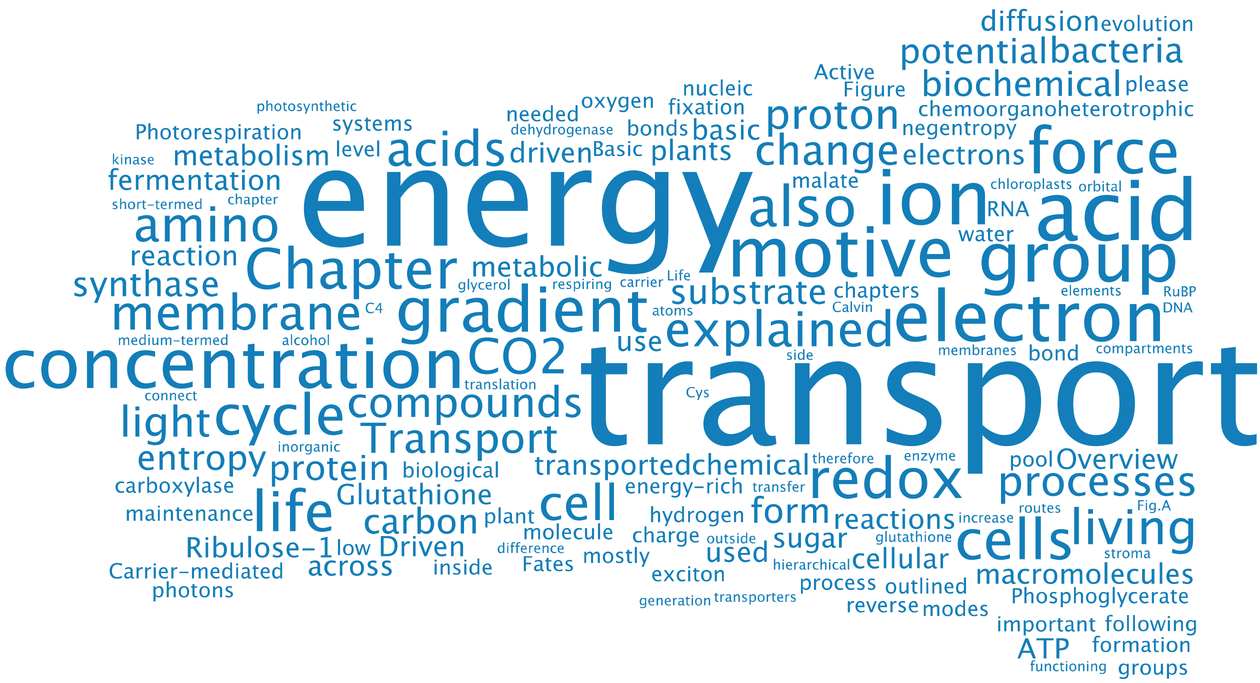
http://www.wiley.com/go/Krauss/Nies/EcologicalBiochemistry 

In the print and e-book versions of the book you will find a summary of these essentials including the most important figures. All references to the website are marked by an "S".

Part I
Basics of Life

Ecological Biochemistry: Environmental and Interspecies Interactions, First Edition. Edited by Gerd-Joachim Krauss and Dietrich H. Nies.

Companion Website: http://www.wiley.com/go/Krauss/Nies/EcologicalBiochemistry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