Book Review

Photobiology: The Science of Light and Life (ed. Lars Olof Björn)

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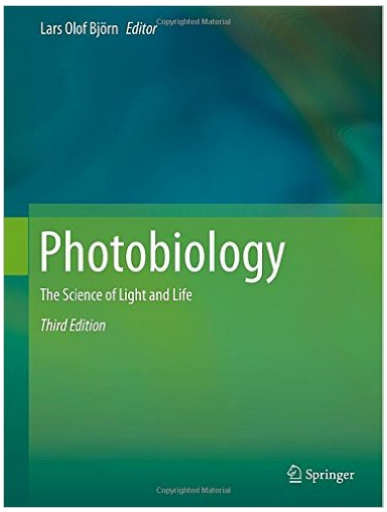

Light that comes from the Sun is of crucial importance for life. It is the driving force of the biosphere, serving as a source of energy for organisms and providing them with information about their environment. On the one hand, plants harvest light in the process of photosynthesis, and on the other hand, light directs plant development from germination to flowering. Light also has both warming and destructive effects on plant tissue. Plants can sense the quality, intensity, duration and direction of light through different sensors, while in animals, light provides information via vision. Different wavelengths of light have different effects on organisms.

The book *Photobiology: The Science of Light and Life* is edited by Lars Olof Björn, a Professor in the Department of Biology at Lund University, and in the School of Life Sciences at South China Normal University. He is a scientist with long-standing experience in photobiology research. His research is mainly concentrated on the photobiology of plants, but he is also interested in animal vision, skin photobiology, and bioluminescence. Lars Olof Björn is not only the book's editor, he is also an author or co-author of 22 of the 29 chapters. This is the third edition of this book, although it differs significantly from the first two editions in terms of the illustrative material, and also the full contents. The illustrative material is much richer than in the previous edition, and it also includes colour photographs and drawings. There are also several new chapters that have now been added: "Photoactive proteins", "Photoreceptive proteins and their evolution", "Signalling crosstalk under the control of plant photoreceptors", "Photosynthetic light harvesting", "Light-promoted infection", and as the last the chapter, which is very informative for UV scientists, "Role of ultraviolet radiation in the origin of life". This book is a comprehensive guide to the understanding of the nature of light and the structural and functional adaptations of organisms regarding their interactions with light.

Much of this book focuses in one way or another on the interactions between light and organisms, although the introductory chapters (from 1 to 7) also describe some common aspects of light: the interaction of light with matter, principles of nomenclature for quantification of light, generation and measurement of light, light as a tool for scientific research, and the properties of light in terrestrial and aquatic environments.

The second part of this book deals with the structural and functional properties of biota in relation to interactions with light, and this very comprehensively deals with different levels of organisation, from molecules to organisms.

Chapter 8 is entitled, "Action spectroscopy in biology", which is a method that serves to identify the kind of molecules that absorb active light. The action spectrum is the rate of a physiological activity plotted against the wavelength of light, and this can also be used to identify the effects of certain wavelengths on physiological activities. This knowledge is especially important in planning experiments with light sources under controlled conditions, including in UV research.

Then chapters 9 and 10 deal with spectral tuning in biology. Spectral tuning is important for photosynthesis, animal vision, plant–pollinator interactions, and bioluminiscence. These chapters answer the questions of why plants are green,

what determines the spectra of pigments, how different pigments and vision are tuned, and how different biotic structures reflect and scatter light as well as forming structural coloration, whiteness and transparency.

Chapter 11 concentrates on the photoactive proteins that are responsible for a variety of different mechanisms in plants, such as light-regulated enzymatic activities, light-driven ion pumps, light-regulated ion channels, photosynthetic light harvesting, photoreception and bioluminescence.

Chapters 12 and 13 discuss light perception and regulation in organisms. In zoology, the term photoreceptors refers to cells that respond to light (like the cones and rods in human eyes), while in plant science, photoreceptors refers to the pigment molecules that absorbs light and cause a sequence of different reactions related to this "information". Special attention is given to specific problems and evolutionary solutions in the animal kingdom, like eyes in water, chromatic aberrations, eyes of amphibians, insect eyes, eyes with mirror optics, and scanning eyes.

Chapter 14 focuses on signaling cross talk under the control of plant photoreceptors describing the basic structure and molecular mechanisms of different light signaling. Chapter 15 titled "The diversity of eye optics" is a review of different solutions to 'eye design' in the animal kingdom.

Chapters 16 and 17 summarise the important information about photosynthesis, the process in which plants harvest solar energy. Chapter 16 deals with evolution of photosynthesis and its environmental impact, which is important from the point of view of human interference in the environment and from the aspect of plant production. Photosynthetic light harvesting is presented in Chapter 17, which focuses on photochemical energy transduction in plants.

The title of Chapter 18 is, "How light resets circadian clocks". This chapter provides an overview of circadian rhythms in different organisms, such as fungi, cyanobacteria, algae, seed plants, animals and humans, and how these use the specific diurnal and annual cycles in their environment to their advantage. Special attention is given to practical problems related to circadian rhythms in humans, like shift work, jet lag, and sleep disorders. In this chapter alone, the authors cite more than 700 relevant references.

Chapter 19 provides an insight into processes related to photomorphogenesis and photoperiodism in plants. As sessile organisms, plants use the information about their environment based on the light conditions. Therefore, as well as photosynthesis, light has multiple effects on plants, including those on germination, apical hook opening, stem elongation and leaf expansion, pigment production, regulation of stomata, bud dormance, and branching and flowering. Light also serves as important information in combination with the magnetic field.

Chapter 20 is entitled, "The light-dependent magnetic compass", and it discusses magnetoreception processes that depend on light, from the behavioural, physiological, neurobiological and biophysical points of view.

Chapter 21 is dedicated to phototoxicity. Phototoxicity indicates something that is not toxic but becomes toxic by exposure to light. This chapter includes different subsections that discuss phototoxicity in plant defence, phototoxic drugs and cosmetics, and metabolic disturbances that can lead to phototoxic effects. A significant part of this chapter is dedicated to polycyclic aromatic hydrocarbons as phototoxic substances in aquatic environments, where their toxicity arises after exposure to UV-B radiation.

Although many of the previous chapters also mention UV-B radiation from different aspects, chapter 22 concentrates on the reasons and consequences of ozone depletion on life, while chapter 27 is an interesting read about the role of UV radiation in the origin of life.

Chapters 23 and 24 are also related to the effects of UV-B radiation. Chapter 23 deals with photobiological and ecological aspects of vitamin D, while chapter 24 deals with photobiology of human skin, including immunosuppression and some photosensitivity disorders. It is well know that UV radiation and other wavelengths can kill microorganisms, but there is less evidence of their positive effects.

A short chapter 25 entitled, "Light-promoted infection" then provides examples of these effects and how they are related to different organisms.

Chapter 26 is about bioluminescence, which occurs in different groups of organisms, and mainly in those living in the sea. Bioluminescence has various roles, like reproduction, protection against predation, food acquisition, protection from reactive oxygen species, and DNA repair. In addition to bioluminescence, this chapter discusses the mechanisms of light production, bioluminescence control, and human exploitation of bioluminescence.

The last two chapters (chapters 28 and 29) summarise some practical aspects that can be used in the teaching process, including including instructions on how to build an "amateur scientist's spectrophotometer".

This extensive book is a unique compilation of knowledge on the science of light and life, and it offers an exciting new perspective in photobiological research. This book is filled with concrete examples from accross levels of the hierarchy of biological organisation. This book will be of interest for many different readers, such as students and university teachers, and also scientists, not only from the field of photobiology, but also from other

scientific fields.

References

Björn, L. O. (2015). *Photobiology: the science of light and life*. 3rd ed. New York: Springer, p. 455. ISBN: 978-1-4939-1468-5, 978-1-4939-1467-8. DOI: 10.1007/978-1-4939-1468-5.