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# Photobiology: introduction, overview and challenges

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Photobiology is a broad field of research that studies the biological effects of light and has made huge advances in understanding fundamental questions such as how Photosynthesis works and in the area of medicine, which has a direct impact on society. Various specialties of Photobiology have been proposed, and to simplify the overview, six major fields are considered here: Photophysics and Photochemistry, Photosynthesis, Photoreception, Photomedicine, Optogenetics and Optical Bioimaging, and Ecological Photobiology. In this review, an introduction, description and examples are given for each of these major research areas. Current challenges in Photobiology include the understanding of non-visual Photoreception, complex photoreceptive mechanisms and the development of novel therapeutic strategies that may depend on the results of advanced optogenetic approaches. Furthermore, the integration of Photobiology with other fields such as materials science and engineering may lead to artificial photoreceptors and bio-inspired light harvesting and artificial Photosynthesis systems. In an era of global change, understanding the effects of artificial light on organisms and ecosystems is essential to mitigate the ecological disruptions caused by artificial lighting. This non-exhaustive selection of research directions and challenges illustrates the complexity and breadth of Photobiology research.

## KEYWORDS

ecological photobiology, optogenetics, photobiology, photochemistry, photomedicine, photophysics, photoreception, optical bioimaging

## Introduction

Photobiology is a multidisciplinary and diverse field of research that studies the biological effects of light, bringing together physicists, chemists, biologists, biochemists, medical specialists and many others. The term “light” is generally used to refer to wavelengths that are visible to humans, but invisible infrared and ultraviolet radiation are also included in Photobiology. In general, Photobiology is concerned with understanding the mechanisms by which living organisms interact with light and the biological consequences, whether beneficial or harmful (Smith, 1989).

Because the effects of light span the complexity of biological systems, from the atomic level to that of ecological communities (see Figure 1A), Photobiology encompasses a range of research areas. Smith (1989) lists 13 major areas of Photobiology, including Photophysics, Photochemistry, Photosensitization, UV Radiation Effects, Environmental Photobiology, Photomedicine, Circadian Rhythms, Extraretinal Photoreception, Vision, Photomorphogenesis, Photomovement, Photosynthesis, and Bioluminescence. The American Society for Photobiology (ASP) lists the 7 specialties Photochemistry/Photophysics, Photosensory Biology, Public Health, Phototechnology, Molecular and Cellular Photobiology, Photomedicine and Environmental Photobiology each with 7–8 subspecialties, adding up to 50 subspecialties of Photobiology (ASP News, 2012).

# An Introduction To Photobiology

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## **Table of Contents An Introduction To Photobiology**

1. Understanding the eBook An Introduction To Photobiology
  - The Rise of Digital Reading An Introduction To Photobiology
  - Advantages of eBooks Over Traditional Books
2. Identifying An Introduction To Photobiology
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an An Introduction To Photobiology
  - User-Friendly Interface
4. Exploring eBook Recommendations from An Introduction To Photobiology
  - Personalized Recommendations
  - An Introduction To Photobiology User Reviews and Ratings
  - An Introduction To Photobiology and Bestseller Lists
5. Accessing An Introduction To Photobiology Free and Paid eBooks
  - An Introduction To Photobiology Public Domain eBooks
  - An Introduction To Photobiology eBook Subscription Services
  - An Introduction To Photobiology Budget-Friendly Options
6. Navigating An Introduction To Photobiology eBook Formats

- ePub, PDF, MOBI, and More
- An Introduction To Photobiology Compatibility with Devices
- An Introduction To Photobiology Enhanced eBook Features
- 7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of An Introduction To Photobiology
  - Highlighting and Note-Taking An Introduction To Photobiology
  - Interactive Elements An Introduction To Photobiology
- 8. Staying Engaged with An Introduction To Photobiology
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers An Introduction To Photobiology
- 9. Balancing eBooks and Physical Books An Introduction To Photobiology
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection An Introduction To Photobiology
- 10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
- 11. Cultivating a Reading Routine An Introduction To Photobiology
  - Setting Reading Goals An Introduction To Photobiology
  - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of An Introduction To Photobiology
  - Fact-Checking eBook Content of An Introduction To Photobiology
  - Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
  - Utilizing eBooks for Skill Development
  - Exploring Educational eBooks
- 14. Embracing eBook Trends
  - Integration of Multimedia Elements
  - Interactive and Gamified eBooks

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