“This timely book nicely summarizes the few, currently known, mechanisms underlying photobiomodulation (PBM) in the context of their most promising applications within a wide variety of health care disciplines. Its perspectives range from enthusiastic acceptance and promotion of PBM applications to the more healthy encouragement of still much needed clinical research.”

Dr. Donald Pathoff
Foundation for Photobiomodulation Research, USA

“Laser therapy is today a reality for professionals in health care. At the same time, it is still a hot topic for research with many challenges to be overcome. This book puts together fundamental concepts and applications in a single resource, creates opportunities to multiply the potential users, and provides a summary of the state of the art in the field. The authors are prominent in their fields, for which the book will certainly prove to be an important reference.”

Prof. Vanderlei S. Bagnato
University of São Paulo, Brazil

Low-level laser (light) therapy (LLLT) and photobiomodulation (PBM) are almost 50 years old and recently have been getting increasing acceptance from the scientific, medical, and veterinary communities. Discoveries are constantly being made about the cellular and molecular mechanisms of action, the range of diseases that can be treated is rising, and home-use LED devices are becoming common.

This book compiles cutting-edge contributions from the world’s leading experts in LLLT and PBM. The chapters cover general concepts, mechanisms of action, in vitro studies, pre-clinical animal studies, veterinary applications, and a wide range of clinical topics. The book appeals to anyone involved in the basic science, translational aspects, and clinical applications of LLLT and PBM.

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Handbook of Low-Level Laser Therapy

edited by
Michael R. Hamblin
Marcelo Victor Pires de Sousa
Tanupriya Agrawal
To my beautiful wife Angela to whom I have been devoted for thirty-six years

—Michael R. Hamblin

To my beloved wife Vivianne with whom I celebrate this book and all other achievements

—Marcelo Victor Pires de Sousa

Dedicated to my parents, my beloved husband, and my daughter, Aashi

—Tanupriya Agrawal
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Preface

Low-level laser (light) therapy (LLLT) has in recent years become one of the fastest growing fields of medicine. Originally considered to be firmly and enduringly sequestered in the arena of "alternative and complementary medicine", LLLT has staged something of a breakout. The reasons for this remarkable change in perception by both the medical profession and the general public are interesting to consider.

Firstly we have the substantial advances in knowledge that have been made in understanding the underlying mechanisms of action. No longer do we have to rely on hand-waving and vague comments about the cells "feeding on light" in an analogous manner to photosynthesis in the plant kingdom. Now we understand many of the molecular mechanisms of photon absorption, we know which subcellular organelles respond to light, and appreciate some of the signaling pathways and transcription factors that are activated, and the tissue responses that occur including activation and mobilization of stem cells.

The second big sea change has been the realization that we do not necessarily need lasers to carry out LLLT. In the old days much laser therapy was carried out by "practitioners" and therapists of various types and was considered to be a specialty for which significant training was required. This was reasonable in light of the real concerns for laser eye safety and protecting against other possible hazards. Now, however, the use of light-emitting diode (LED) arrays is rapidly taking off, and these devices are readily available on online shopping websites and are also sold on late-night television. Although some knowledge is still required to understand the best parameters to use for each different indication, and which can be
achieved relatively easily considering the broad dissemination of information over the Internet.

Thirdly we have the growing realization that LLLT has a broad range of systemic and regional effects in addition to the local effects that were initially the main focus of everyone’s attention. Since LED arrays by definition have a broad area illumination spot, significant amounts of tissue are exposed to light, and light is absorbed by blood flowing within the skin and other tissues that are exposed to light. Light can be applied to nerves and lymph nodes to give regional effects, as well as to the actual lesion that is being treated.

Fourthly we have seen an impressive increase in the number of applications of LLLT to the brain. LLLT was originally tested as a treatment for acute ischemic stroke and has been used for the same over the last ten years. However, now its sphere has widened and is being applied to other instances of brain trauma including chronic stroke, acute traumatic brain injury (TBI), and chronic TBI. A number of chronic neurodegenerative diseases including Alzheimer’s disease and Parkinson’s disease have shown to be benefited by LLLT. A wide range of psychiatric disorders including depression, anxiety, post-traumatic stress disorder, and autism spectrum disorder have been found to be susceptible to treatment with LLLT.

Fifthly we are beginning to see significant progress in the use of LLLT for enhancement of performance in normal people. The most developed area of this application is the enhancement of muscle performance in athletes and competitors in a wide range of sports. Not only can LLLT increase the amount of work and power that can be produced by muscles, but it can also increase the speed of recovery after exercise and can be a great help in training regimens. A less developed area is that of enhancement of cognitive performance, and improvement in memory and mood using LLLT. We expect that efforts toward realizing these goals will be emerging soon.

Lastly, but worth mentioning, is the use of LLLT for cosmetic and aesthetic improvements. Stimulation of hair regrowth is now well established, and improvement of fine lines and wrinkles in the face is also growing in popularity. The use of LLLT to combat one of the biggest problems in the modern age, obesity and excess
fat deposits is also starting to take off. These applications address many of the issues driving the home-use market for LLLT devices, as consumers are generally prepared to spend their disposable income on aesthetic improvements.

This handbook represents the most comprehensive edited book in the field of LLLT [now called photobiomodulation (PBM) therapy] that has been published to date. With 54 chapters spread over more than 1100 pages it provides broad coverage of all the multitudinous topics that comprise this most fascinating of medical therapies. The reader will find chapters on the basic principles, mechanisms of action, dosimetry, devices, in vitro studies, a large range of animal models, clinical applications in veterinary medicine, and broad coverage of a wide range of human clinical studies and uses. We expect it to become the gold-standard reference book for some considerable time to come.

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