THE GUY FOUNDATION

Light and Health

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(Eds.)

Abstract proceedings of the 2025 Autumn Series

Driving innovation in medicine through quantum biology

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Introduction to the 2025 Autumn Series

The Guy Foundation team

Light is fundamental to life on Earth. From the earliest stages of evolution, living systems have developed within a light-rich environment and learned to sense, harvest, and respond to this electromagnetic radiation. Light influences biology at every scale, from cellular energy production and redox chemistry to physiology, circadian rhythms, and behaviour. Because photons – particles of light that also behave like waves – operate at quantum scales, light also sits at the heart of the emerging field of quantum biology. Biology's important light-driven reactions and processes of photon-induced damage and adaptation, appear to rely on quantum mechanisms such as coherence, tunnelling, and spin dynamics. The Guy Foundation's 2025 Autumn Series brought together an exceptional group of scientists, clinicians, architects, and designers to examine light's important yet underappreciated influence on human health. The series explored the therapeutic potential of wavelengths spanning the electromagnetic spectrum – from ultraviolet to green, red, and infrared – while also highlighting the growing challenges posed by reduced exposure to natural sunlight in modern indoor, urban, and even extraterrestrial environments.

The programme opened with a foundational session introducing the physics of photobiology. **Dr Michal Cifra** outlined how light interacts with biological matter, the properties of different wavelengths, the types of endogenous chromophores, and the cellular pathways – particularly redox chemistry and mitochondrial modulation – through which light exerts biological effects. He also introduced concepts such as tissue optics, dielectric resonance, neuronal waveguiding, and ultraweak photon emission. **Dr Robert Fosbury** then expanded this description from the microscopic to the telescopic, reflecting on how sunlight has shaped the emergence, evolution, and maintenance of life on Earth. He highlighted the parallels between stars and organisms as energy-processing systems and introduced the idea that near-infrared light may directly support metabolism through mitochondrial "photo-metabolism".

The second session then turned our attention to the physiological importance of specific wavelengths. **Professor Richard Weller** expounded the seemingly confounding roles of UV light – on the one hand it facilitates vitamin D production, but on the other it can increase rates of melanoma. However, through a nitric oxide-mediated mechanism, the systemic benefits of UV exposure – such as lowered blood pressure, reduced cardiovascular disease, and enhanced immunity – appear to outweigh the risks of skin cancer. The session reframed conventional wisdom on sunlight exposure, with epidemiological evidence suggesting that it reduces all-cause mortality in Northern European populations.

In session three our attention turned to green light as an emerging non-invasive therapy. **Professor Mohab Ibrahim** presented compelling evidence for the analgesic effects of green LED therapy, detailing how it acts through the visual system, with both preclinical and clinical data attesting to its effects on pain, inflammation, and the endogenous opioid system. **Professor Alistair Nunn** then contextualised this within broader metabolic and mitochondrial biology as well as evolutionary hypotheses suggesting early phototrophic systems such as purple bacteria may have been green-absorbing, influencing present-day photobiology.

The series then moved to red and near-infrared wavelengths in session four, with **Dr Ifigeneia Kalampouka** and **Professor Glen Jeffery** detailing how these wavelengths modulate mitochondrial function, support cellular energy production, and influence age-related decline. They raised concerns about the modern shift from broadband sunlight and incandescent light to LED lighting, which removes much of the infrared spectrum while increasing exposure to blue light.

This concern was re-addressed in the fifth session, with **Professor Alistair Nunn** revisiting the pharmacological concept of dose-response or hormesis. He emphasised that rather than a clear distinction between good and bad wavelengths of light, the reality was more likely to be a delicate balance between the synergistic effects of different wavelengths. **Dr Roger Seheult** further extended these insights to the built environment. Modern lighting and glazing technologies filter out key infrared wavelengths, creating an artificial environment misaligned with human physiology. The session reviewed data linking this mismatch to metabolic disease, immune dysfunction, and poorer clinical outcomes, and discussed practical ways to rebalance indoor light environments without compromising safety or efficiency.

The series concluded with a comprehensive roundtable session which brought together experts from medicine, architecture, lighting engineering, and technology. The discussion highlighted growing evidence for the health implications of modern indoor lighting, while current architectural practice remains constrained by energy-efficiency metrics rather than biological needs. Speakers emphasised the lack of clear, implementable guidance for "healthy light", the need for biologically meaningful measurement of photons, and the importance of broadband light – including near-infrared wavelengths – largely absent from contemporary buildings. Despite technical and regulatory challenges, there was strong consensus that light should be understood not only as a visual requirement but as a fundamental biological input, and that progress will depend on closer collaboration between researchers, clinicians, designers, and engineers to align standards, technologies, and built environments with human health.

Introduction to The Guy Foundation

Professor Geoffrey Guy

Founder and Chairman, The Guy Foundation

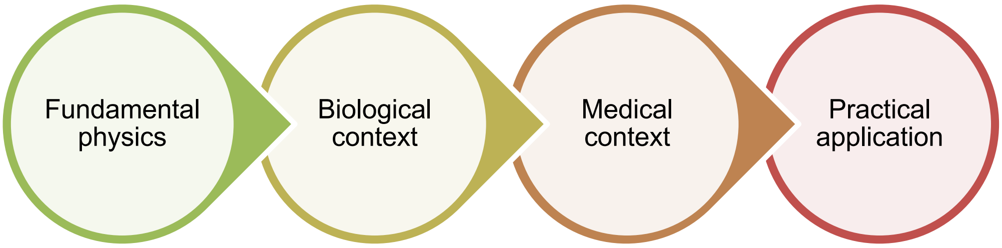
The Guy Foundation supports and promotes the investigation of quantum effects in biology, with the aim of improving our understanding of disease and thus medicine. Our belief is that significant quantum effects may well have been essential for the origins of life as well as the evolution of complex living organisms and thus a better understanding would help unlock new ways of tackling the health and disease issues that we see today.

With the development of technology, the study of quantum effects in biology has been gaining rapid pace in recent years. Classical pharmacology-based explanations for the effects of medicines remain insufficient; we aim to develop research into the effects of electromagnetic fields (both endogenous and exogenous) on biological systems. This will expand the conventional 'ball and stick' or 'lock and key' mechanisms which dominate our understanding of physiological processes, including the action of many pharmaceutical interventions. To this end we focus on the role of intracellular bioenergetics and the role of mitochondria from the point of view of dissipative thermodynamic and quantum theories. In short, if significant quantum effects are part of life, the failure to maintain this state probably plays a role in disease and ageing, and will thus be of importance to medicine.

We have also identified space travel as a key area that will benefit from a greater knowledge of the role that fields play in biology. If life is dependent on significant quantum mechanisms to function, then optimal function will be coupled to the planetary environment in which it evolved: a "Goldilocks zone" of environmental conditions. The Foundation believes that a focus on the ways in which the electromagnetic, gravitational and other effects of the space environment can be potentially mitigated, will optimise the health of astronauts and future passengers. This research would also accelerate progress in quantum biology and the advancement of medicine in general.

It is clear to us that the next generation of significant steps in medicine will need to engage with quantum biology. Our role at the Foundation is to help facilitate this mindset shift to bring quantum biology into the mainstream of medicine for the benefit of healthcare issues including ageing, neurodegeneration, metabolic syndrome, neuropsychiatric disease in the young, cancer and others. The Guy Foundation thus leads, supports and contributes to quantum biological and related research with the ultimate aim of advancing the development of new medical diagnostics and therapeutics.

The Foundation believes this advancement can be achieved in a number of ways, which is reflected by the research we fund as well as the topics we address in our scientific symposia. Our approach is summarised as encompassing research from bench to bedside:



Our priorities encompass the spectrum of theoretical, experimental, and practical advances. Understanding the fundamental physics (e.g., quantum mechanics, electrodynamics, thermodynamics) is important. More specifically we aim to understand this physics within the biological and physiological contexts, with the emphasis on furthering the study of medicine. Overall, we would like to see this knowledge translated and applied in clinical practice.

The Foundation therefore aims to provide a platform and a forum for upstream push through and downstream pull through of the understanding of the role of quantum effects and bioenergetics in biology in health and disease. We have curated and fund a collaborative research group to further investigate these interests, to advance the course of useful knowledge towards the mainstream and bring it to the attention of more conventional funders. We convene a programme of scientific meetings and publications that incorporates the diverse aspects of the field and facilitate engagement from scientists across relevant disciplines.

Abstract Proceedings

These are abstracts of a series of talks, hosted by The Guy Foundation, that were given online to an invited audience during the Autumn of 2025.

They have been written by the presenters and have not been formally peer-reviewed. We hope you enjoy them; video recordings of the lectures are available on the Foundation's website **www.theguyfoundation.org**. To receive notifications about new videos, subscribe to our **YouTube channel**.

Physics of Photobiology: A Brief Introduction

Dr Michal Cifra

The Czech Academy of Sciences

View the video recording **here**.

Light–biology interactions are surveyed from physical first principles to cellular outcomes. A brief primer is provided on light as electromagnetic wave and photon, after which the irradiation variables that determine reproducibility are defined and standardized: wavelength and bandwidth, irradiance versus fluence, pulse structure (peak power, duty cycle), coherence, polarization, and sample geometry. With these quantities established, experiments can be reported and compared across systems in a consistent way. At the molecular scale, endogenous chromophores are cataloged – aromatic amino acids and nucleic acids (UV/near-UV), hemoglobin and melanin (visible), bona fide photoreceptors such as opsins and cryptochrome, and respiratory cytochromes relevant to red/NIR responses. Excited-state fates are organized with a compact Jablonski diagram: fluorescence and phosphorescence, internal conversion and intersystem crossing, vibrational cooling, energy transfer (including FRET), and photochemical routes such as electron transfer, bond scission, and bond formation. At the cellular level, two broadly applicable pathways are highlighted. First, redox photochemistry is engaged when blue/visible light excites endogenous photosensitizers, generating transient ROS (e.g., H_2O_2) that feed into stress and antioxidant signaling. Second, mitochondrial modulation is elicited by red/NIR light, through which electron transport, mitochondrial membrane potential ($\Delta\Psi m$), ATP output, and nitric-oxide-linked signaling can be tuned, consistent with Complex IV absorption features. Specialized mechanisms (opsins, light-gated channels) are acknowledged as cell-type restricted. Concepts from the optics of tissue (transmission, scattering, diffraction), structural hypotheses (cells as dielectric resonators; possible neuronal waveguiding), and endogenous ultra-weak photon emission with its detection are briefly introduced. Throughout, practical dosimetry and controls are emphasized so that photophysics is separated from downstream biology, and open questions are outlined that connect physical measurements to function in living systems.

Relevant papers by the speaker

Cifra M. The life electric: the evidence. *The Guy Foundation 2024 Autumn Series*. 2024. Accessed January 15, 2026. URL: **www.youtube.com/watch?v=JXuD4SxUnsE**.

Červinková K, Vahalová P, Poplová M, Cifra M et al. Modulation of pulsed electric field induced oxidative processes in protein solutions by pro- and antioxidants sensed by biochemiluminescence. *Scientific Reports*. 2024;14:22649. DOI: **doi.org/10.1038/s41598-024-71626-6**.

Vahalová P and Cifra M. Biological autoluminescence as a perturbance-free method for monitoring oxidation in biosystems. *Progress in Biophysics and Molecular Biology*. 2023;177:80-108.
DOI: **10.1016/j.pbiomolbio.2022.10.009**.

Poplová M, Prasad A, Van Wijk E, Pospíšil P and Cifra M. Biological auto(chemi)luminescence imaging of oxidative processes in human skin. *Analytical Chemistry*. 2023;95:14853-14860.
DOI: **10.1021/acs.analchem.3c01566**.

Cifra M, Brouder C, Nerudová M and Kučera O. Biophotons, coherence and photocount statistics: A critical review. *Journal of Luminescence*. 2015(164):38-51.
DOI: **doi.org/10.1016/j.jlumin.2015.03.020**.

Cifra M and Pospíšil P. Ultra-weak photon emission from biological samples: Definition, mechanisms, properties, detection and applications. *Journal of Photochemistry and Photobiology B: Biology*. 2014;139:2-10.
DOI: **10.1016/j.jphotobiol.2014.02.009**.

For more about Michal's research see here.

Light and Life – A Cosmological Overview

Dr Robert Fosbury

UCL and the European Southern Observatory (ESO)

View the video recording **here**.

This talk explores how the flow of energy and entropy shapes complexity across the Universe, from the birth of stars to the metabolism of living cells. Beginning with the first light of the cosmic microwave background and the second light of stars forging the elements, it shows how planets, molecules, and eventually life emerge as natural products of cosmic evolution.

Life thrives by exploiting starlight. The familiar story is visible sunlight driving photosynthesis to produce sugars that fuel metabolism. But a complementary pathway – "photometabolism" – is now emerging. Near-infrared (NIR) photons penetrate living tissue and appear to act directly on mitochondria, boosting ATP production and supporting repair processes. Remarkably, the peak of the solar photon flux per unit energy (~0.75 eV) coincides with the characteristic activation energies of metabolic reactions (~0.6-0.7 eV). This apparent "metabolic Goldilocks zone" suggests that life may be tuned not only to visible sunlight but also to the NIR band where the Sun is brightest in photon terms.

The talk draws parallels between stars and organisms: both maintain long-lived metastability by exporting entropy – stars through starlight, life through heat. Both follow striking power-law scaling relations (stellar mass–luminosity; metabolic rate–body mass) that govern their longevity and evolution. Seen cosmologically, life and stars are dynamic heat engines, operating between the hot photospheres of suns and the cold sink of the 3 K cosmic background, continually building complexity until equilibrium is reached.

In this framework, the story of light and life is unified: stars, starlight, and stardust underpin biology, and near-infrared sunlight may be a key, often overlooked, driver of health, metabolism, and the emergence of cognition.

Relevant papers by the speaker

Fosbury R. Astrophysicist on Infrared Light & Life Interactions. *Regenerative Health Podcast*. 2024. Accessed January 15, 2026. URL: **www.youtube.com/watch?v=ZnkQSjKwH-M**.

Fosbury R. The Infrared Revolution: New Frontiers in Light and Health. *Atrium: The Meaning of Life*. 2024. Accessed January 15, 2026. URL: **www.youtube.com/watch?v=hGtBmVsWjFE**.

Fosbury RAE, Jeffery G. Reindeer eyes seasonally adapt to ozone-blue Arctic twilight by tuning a photonic tapetum lucidum. *Proceedings of the Royal Society B*. 2022;289(1977):1-9. DOI: **doi.org/10.1098/rspb.2022.1002**.

Kam JH, Hogg C, Fosbury R, Shinhmar H, Jeffery G. Mitochondria are specifically vulnerable to 420nm light in drosophila which undermines their function and is associated with reduced fly mobility. *Plos one*. 2021;16(9):1-13. DOI: **doi.org/10.1371/journal.pone.0257149**.

For more about Robert's research see here.

The Health Effects of Sunlight, UV and Blue Light

Professor Richard Weller

University of Edinburgh

View the video recording **here**.

Medical approaches to sunlight have been dominated by concerns over skin cancer. In white skinned N European populations there is however no evidence that sunlight shortens lifespan. In independent prospective epidemiological studies from Scandinavia and the UK increased sun exposure correlates with reduced all-cause mortality. Cardiovascular mortality shows the biggest fall but overall reductions in cancer deaths are most important as this is such a highly prevalent cause of death. UV induced release of nitric oxide from the skin leads to blood pressure reduction and may account for the fall in cardiovascular deaths. Work is ongoing identifying immunological mechanisms activated by UV which probably account for reductions in cancer deaths. Public health advice on sunlight needs to be re-considered in view of the greater benefits than risks for sunlight exposure in a N European population.

Relevant papers by the speaker

Riedmann U, Dibben C, de Gruijl FR, Gorman S, Hart PH, Hoel DG, Levy C, Lindqvist PG, Norval M, Parikh SS, Pilz S, Rueter K, Slominski AT, Slominski RM, Young AR, Zgaga L and Weller RB. Beneficial health effects of ultraviolet radiation: expert review and conference report. *Photochemical & Photobiological Sciences.* 2025 (24):867-893. DOI: **doi.org/10.1007/s43630-025-00743-6**.

Stevenson AC, Clemens T, Pairo-Castineira E, Webb DJ, Weller RB and Dibben C. Higher ultraviolet light exposure is associated with lower mortality: An analysis of data from the UK biobank cohort study. *Health & Place*. 2024;89(103328). **doi.org/10.1016/j.healthplace.2024.103328**.

For more about Richard's research see here.

Shedding Light on Pain: The Bright Future of Green LED Therapy

Professor Mohab Ibrahim

Department of Anesthesiology, The University of Arizona

View the video recording **here**.

Chronic pain represents a significant societal burden, with annual costs in the U.S. exceeding $600 billion, surpassing those of heart disease, cancer, and diabetes. Traditional treatments, including NSAIDs, gabapentinoids, TCAs, anticonvulsants, SNRIs, opioids, and interventions like steroid injections and spinal cord stimulation, are limited by side effects such as sedation, gastrointestinal issues, and cognitive impairment. This presentation explores green LED (GLED) therapy as a novel, non-invasive approach to pain modulation.

Our preclinical studies in rodents demonstrate that GLED exposure (8 hours daily for 5 days) significantly increases paw-withdrawal latency to noxious thermal stimuli compared to other wavelengths, indicating antinociceptive effects. The mechanism involves the visual system, where the optic nerve transmits green light impulses to central pain centers, resulting in analgesia, modulation of the endogenous opioid system, and reduced neuroinflammation.

Clinical validation shows GLED reduces chronic pain in conditions like fibromyalgia and migraine, and improves functional capacity (e.g., better sleep, exercise, and work performance).

New preclinical GLED data indicate that it decreases postsurgical pain, possibly by increasing endogenous opioids (e.g., beta-endorphin, proenkephalin, dynorphin) and mu opioid receptors in the spinal cord and rostral ventral medulla. Additionally, GLED lowers inflammatory cytokines (IL-10, TNFα, IL-6) and microglia activation, with sex-specific effects noted.

As a complementary therapy, GLED offers a promising, virtually side-effect-free adjuvant therapy, supported by collaborations across institutions.

Relevant papers by the speaker

Ismail KA, Curfman V, Park J, Louis EM, Korah H, Washington SM, Ibrahim MM and Martin LF. Optimizing photoneuromodulation techniques to evaluate the role of green light-emitting diodes in pain management. *Journal of Visualized Experiments*. 2025;217(e67821). DOI: **doi.org/10.3791/67821**.

Martin LF, Cheng K, Washington SM, Denton M, Goel V, Khandekar M, Largent-Milnes TM, Patwardhan A and Ibrahim MM. Green light exposure elicits anti-inflammation, endogenous opioid release and dampens synaptic potentiation to relieve post-surgical pain. *The Journal of Pain*. 2023; 24(3): 509-529.
DOI: **doi.org/10.1016/j.jpain.2022.10.011**.

Cheng K, Martin LF, Calligaro H, et al. and Ibrahim, M.M. Case report: Green light exposure relieves chronic headache pain in a colorblind patient. *Clinical Medicine Insights: Case Reports*. 2022;15.
DOI: **doi.org/10.1177/11795476221125164**.

Martin LF, Moutal A, Cheng K, et al. and Ibrahim, MM. Green light antinociceptive and reversal of thermal and mechanical hypersensitivity effects rely on endogenous opioid system stimulation. *The Journal of Pain*. 2021;22(12): 1611-1624. DOI: **doi.org/10.1016/j.jpain.2021.05.006**.

For more about Mohab's research see here.

Why Green: The Colour Purple

Professor Alistair Nunn

The Guy Foundation and University of Westminster

View the video recording **here**.

Life arose due to the propensity of matter to self-organise to dissipate energy potentials via generation of stable autocatalytic networks that through natural selection, evolved complexity. Key sources of energy were light, heat and geochemistry, suggesting that photons from both thermal vents and the sun could have been important. The photonic "smoking gun" is the electron transport chain (ETC) as it contains multiple photon-absorbing molecules, including water, which can absorb from the ultraviolet (UV) to the infrared so modulating electron flow and free radical generation. Critically, water is also key in the evolution of stellar systems and life due to its narrow transmission spectrum, while absorbing longer and shorter wavelengths. It is possible that on the early earth, due to high UV and free radical generation, life could not have started on the surface, but deeper in bodies of water in a photonic "Goldilocks" zone. In relation to photosynthesis, it is possible that anoxic rhodopsin-based systems evolved first, which absorb strongly in the green, suggesting that the early Earth was purple and why chlorophylls absorb best in the blue and red. Today, green sensitive retinal-based opsins are key in vision, but can modulate TRP channels, so controlling calcium flux, which in turn both modulate and are modulated by mitochondria. Complex III in the ETC is also modulated by green light and appears to be a central controller of inflammation via a ROS-based mechanism. There is thus a strong physics based evolutionary rationale as to why green light likely modulates metabolism, which not only hints at where life started, but why, in concert with other wavelengths, light could be important in maintaining optimal health in a dose-related, hormetic manner.

Relevant papers by the speaker

Nunn AVW, Guy GW, Bell JD. Bioelectric fields at the beginnings of life. *Bioelectricity*. 2022;4(4):237-247.
DOI: **doi.org/10.1089/bioe.2022.0012**.

Nunn AVW, Guy GW, Botchway SW, Bell JD. From sunscreens to medicines: Can a dissipation hypothesis explain the beneficial aspects of many plant compounds? *Phytotherapy Research*. 2020;34(8):1868-1888.
DOI: **doi.org/10.1002/ptr.6654**.

For more about Alistair's research see here.

Near Infrared (NIR) Starvation and the Therapeutic Use of Red Light

Professor Glen Jeffery

UCL

View the video recording **here**.

Life evolved over billions of years under broad spectrum sun light ranging from around 300nm to 3500nm. This did not change significantly with fire light or when we moved to the built environment because incandescent light and fire light have a similar spectrum to sunlight. But it changed radically with the introduction of light emitting diodes (LEDs) in the early 2000 whose spectrum is confined to visible light of approximately 400nm to 700nm. This removed all the ultraviolent and infrared.

Mitochondria that regulate metabolism and ageing respond positively to infrared around 700nm+ and are undermined by shorter wavelengths around 420 to 450nm. These two wavelength ranges were in balance in sunlight, but with the move to LEDs, short wavelengths have become relatively dominant and undermine physiology. Hence, exposure to longer wavelengths or incandescent lighting result in improvements in mitochondrial function including animal ageing, inflammation and human vision. However, exposure to short wavelengths results in mitochondrial and metabolic decline that can be measure functionally.

This issue is becoming a public health concern in a Western world where populations are ageing, and people spend >90% of their time in the built environment. Simple changes to lighting may provide increased health spans in these situations at minimal cost.

Relevant papers by the speaker

Kaynezhad P, Fosbury R, Hogg C, Tachtsidis I, Sivaprasad S and Jeffery G. Near infrared spectroscopy reveals instability in retinal mitochondrial metabolism and haemodynamics with blue light exposure at environmental levels. *Journal of Biophotonics*. 2022(e2916):12204-10. DOI: **doi.org/10.1002/jbio.202100283**.

Jeffery G and Barrett E. LED lighting undermines visual performance. Submitted to *Research Square* 22 May. [Preprint] 2025. Version 1. URL: **www.researchgate.net/publication/392009672**.

For more about Glen's research see here.

Our Evolving Light Environment and the Impact on Health

Dr Roger Seheult

Loma Linda University

View the video recording **here**.

Humans now live in an artificial light environment that is radically different from any other time in our history. We spend most of our time indoors, behind low-E glass and under LEDs designed for visual efficiency rather than biological impact. These technologies selectively strip out large portions of the sun's near-infrared (NIR) spectrum while allowing more blue light, profoundly changing the balance of wavelengths reaching our skin, eyes, and mitochondria.

This talk will focus on how that altered environment affects health, with particular emphasis on infrared light. I will review how NIR penetrates deep into tissue and drives physiologic changes at the level of the mitochondrion, with particular relevance to melatonin, oxidative stress, and the electron transport chain. We will then examine how modern glazing and "efficient" lighting unintentionally remove much of this protective influence, even as we continue to receive visually bright, circadian-active light.

Drawing on data from randomized clinical studies, emerging photobiomodulation research, epidemiology, and even history, I will explore how this environmental mismatch may contribute to chronic cardiometabolic disease, immune dysregulation, and worse clinical outcomes. Finally, we will consider practical ways to redesign our homes, hospitals, and daily habits to restore a more physiologic, infrared-rich light environment while maintaining safety and energy efficiency.

Relevant papers by the speaker

Skutsch M, Seheult RD and Loya J. A geographical approach to the development of hypotheses relating to Covid-19 death rates. *Melatonin Research*. 2022;5(3):278-2940. DOI: **doi.org/10.32794/mr112500132**.

For more about Roger's research see here.

Improving Our Light Environment for Better Health

Roundtable session

View the video recording **here**.

Throughout the series, recurring questions emerged: How do we integrate complex, wavelength-specific findings into a coherent understanding of light's role in biology? How do we distinguish between light needed for optimal daily health and light intentionally applied as therapy? And crucially, how do we implement this knowledge in our daily light-environments, through practical design principles? The **roundtable** aimed to take these themes forward, bringing together experts from medicine, architecture, design, technology, and lighting engineering. The session included a diverse panel of speakers including physician and health educator Dr Max Gulhane, architects Professor Stefan Behling and James Sherman from Foster & Partners, as well as lighting engineers and innovators Scott Zimmerman and Ulysse Dormoy. Dr Gulhane opened with a perspective on chronic metabolic disease, arguing that modern indoor lighting disrupts circadian biology and mitochondrial function, potentially lowering the threshold for insulin resistance and chronic disease. He contrasted this with populations living outdoors in full-spectrum light, who maintain strong metabolic health despite high-carbohydrate diets and widespread pipe-smoking.

Professor Behling followed this by reflecting on the gap between scientific insights and architectural practice, as well as the lack of a clearly identified "smoking gun" that unequivocally demonstrates the physiological importance of light. He emphasised the need for simple, implementable guidance for designers and clients, noting that large-scale architecture still lacks a clear framework for what constitutes "healthy light". He highlighted the challenges of selecting lighting and glazing that align with biological needs and called for better communication and collaboration between researchers and those shaping the built environment. Modern architecture has been driven almost entirely by energy-efficiency requirements and the industry now needs a new approach to glass coatings that strikes a healthier balance: allowing the right amounts of UV and broadband sunlight through while still managing heat and energy demands.

From architecture and design the discussion then turned to the science of light, with Scott Zimmerman explaining that to make meaningful progress, the field must quantitatively measure how different lighting technologies and glazing affect the biological availability of photons. He showed that when sunlight is expressed in biologically relevant units – such as electron volts, photon flux, and photon density – the metabolic weight of specific wavelengths becomes increasingly apparent. Indeed, long-wavelength infrared photons, which are abundant in sunlight and incandescent sources but largely absent in LEDs and filtered by modern glazing, align closely with the energy ranges of key metabolic electron-transfer reactions. Scott also stressed the importance of efficient and easily available measurement tools, emphasising that better spectral measurement, consistent units, and biological framing are essential to give architects and clients the solid evidence they need to justify healthier glazing choices.

Ulysse Dormoy then reflected on his journey from traditional lighting distribution to a deeper exploration of the biological significance of light and the mismatch between our evolutionary needs and modern indoor lifestyles. Humans now spend the majority of their time indoors under artificial light that feeds but does not nourish us, and modern lighting metrics focus too narrowly on vision, ignoring other light-biology interactions, even though we recognise the energetic power of light as essential for plant growth/productivity. Do we not want the same for humans? Ulysse highlighted the health risks of this "ultra-processed" light environment – especially as populations age and productivity demands increase – making the point that light therapy should be thought of as much in a preventative as a therapeutic context. He called for architecture and lighting design that prioritises human health, framing the challenge not as a "lighting" problem but a broader "light" problem, requiring legislative, technological, and cultural shifts.

James Sherman then closed the discussion by describing the practical design implications of this research and their attempt – at Foster & Partners – to integrate a broader spectrum of light, including near-infrared wavelengths, into their office retrofit. The project revealed key practical lessons: near-infrared LEDs are readily available and easy for manufacturers to use, but the lighting industry is reluctant to integrate filament-based infrared sources, which research suggests are biologically optimal. More significantly, while actual light sources may be relatively easy to implement, the supporting technology – drivers, power supplies, and control systems – is less well developed, with current equipment struggling to handle complex lighting demands. James concluded that, while new components may emerge soon, multi-channel biologically informed lighting is still technologically challenging to implement.

While each of the speakers approached the question of light from their own specific angle, the consensus was clear. Light is more than a question of seeing; it is an integral biological input implicated in metabolism and long-term health. To facilitate the realisation of this in our built environment, the scientific research would benefit from being accessible to a wider audience, underscoring the need for shared biological frameworks, consistent metrics, and accessible measurement tools to guide healthier design. Participants agreed that meaningful progress will require closer collaboration between researchers, clinicians, architects, and engineers, as well as shifts in standards, technologies, and regulations that currently prioritise efficiency over biology.

Closing Note

Professor Geoffrey Guy

Founder and Chairman, The Guy Foundation

As we reflect on the Autumn Series, the central lesson is both compelling and unsettling: there is now substantial evidence – at mechanistic and observational levels – that our modern light environment is biologically misaligned with human physiology. Throughout the series discussion repeatedly returned to the concern that contemporary indoor environments have been shaped primarily by energy-efficiency standards rather than by optimal health requirements. While we do not yet have decades-long epidemiology or large randomised clinical trials, history cautions us against waiting for perfect proof. Smoking was causally linked to cancer long before regulation followed, and we do not have the luxury of a similar delay in the face of rising metabolic disease and an ageing population.

The series has made it clear that light is not merely a visual convenience but an essential component of human health, intimately tied to mitochondrial function, metabolic regulation, and systemic physiological regulation. The roundtable session reinforced this conclusion and raised the issue of the technical and regulatory barriers that now impede progress. Across the many experts that we have heard from in this series there has been the emphatic agreement that natural light is inherently broadband and thermal, unlike modern narrowband sources, and yet potentially harmful technologies persist when better alternatives are already available. As one speaker put it, we have regressed in our understanding of the physiological impact of light. The discussion has also underscored the need for collaboration across disciplines that are too often siloed, and progress will require architects, engineers, clinicians, physicists, and regulators to work from shared first principles rather than isolated standards.

While this series has shown that the scientific case is already persuasive, progress now depends on translating complex ideas into clear, actionable evidence that can be understood beyond scientific circles. From my experience pioneering cannabinoid medicines, meaningful regulatory change begins with a sequence of focused studies that demonstrate risk in ways the medical and policy communities cannot ignore. As with diabetes care, where real progress followed the ability to measure blood glucose easily and routinely, advancing the case for light will also require accessible tools to quantify indoor light environments – particularly across infrared wavelengths that are currently invisible to standard instruments.

The drive for energy efficiency has inadvertently produced a large-scale biological experiment, one that may be accelerating ageing and expanding morbidity rather than compressing it, with early signals already visible in metabolic and neuropsychiatric health. Enough evidence now exists to raise serious public health concerns. The next step is perhaps not to wait for slow cultural uptake, but to act decisively: to consolidate existing knowledge on the hazards of the modern built environment and to take this evidence directly to regulators. Only by engaging policy and regulation head-on, and by working simultaneously from science, design, and governance, can we avoid repeating past failures and begin to realign our built environments with human physiology.

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